BUREAU OF RECLAMATION

Office of the State Engineer — Interstate Stream Commission

New Mexico Unit of the Central Arizona Project Draft Environmental Impact Statement Volume 1

U.S. Department of the Interior
Bureau of Reclamation
Interior Region 8: Lower Colorado Basin

New Mexico Interstate Stream Commission

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MISSION STATEMENTS

The Department of the Interior conserves and manages the Nation's natural resources and cultural heritage for the benefit and enjoyment of the American people, provides scientific and other information about natural resources and natural hazards to address societal challenges and create opportunities for the American people, and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities to help them prosper.

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.

The mission of the New Mexico Interstate Stream Commission is to investigate water supply, to develop, to conserve, to protect, and to do any and all other things necessary to protect, conserve, and develop the waters and stream systems of this state, interstate, or otherwise.

Front Cover: Gila River near Cliff, New Mexico

Dear Reader:

Thank you for taking the time to review this Draft Environmental Impact Statement (EIS). Normally, under Council on Environmental Quality Regulation, the Department of the Interior (Department) would identify a preferred alternative in the Draft EIS. In this instance, the Department is not identifying a preferred alternative in the Draft EIS stage of planning due to complex and controversial issues within the State of New Mexico yet to be resolved.

This project has generated controversy amongst stakeholders and elected officials. New Mexico's Governor and both Senators, for example, have publicly opposed a project that is not economically and financially viable, and have opposed the extension of additional construction funding that could have been made available if a Record of Decision would have been signed by December 31, 2019. Because the Secretary decided on December 20, 2019 not to extend the deadline, those funds are no longer available.

The Department is releasing this Draft EIS so parties within the State of New Mexico—including the Governor, the Interstate Stream Commission, the New Mexico Central Arizona Project Entity, and potential water users—can review the merits of the action alternatives and have the chance to secure funding. To date, no funding has been secured to undertake any action alternative.

The Draft EIS explains that Reclamation's economic analysis shows that all action alternatives, including the Virden Valley (Alternative D), are not economically viable, nor are they financially viable without funding commitments. If parties in New Mexico do not secure project funding commitments that make an action alternative financially viable to the end water users, it is unlikely that an action alternative will be selected as the final agency action.

In reviewing this Draft EIS, we encourage commenters to focus on the analysis of costs and benefits of the alternatives for the proposed project so the Department can make any future decisions using the best information.

While the Department cannot pre-judge the outcome of a Record of Decision in this EIS process, it is likely that the Department will select the no action alternative if no viable funding commitments for an action alternative solidify by the end of calendar year 2020. Even if the no action alternative is selected, it is possible that this project could become viable in the future; in that case, it can be re-considered at that time. More broadly, the Department remains committed to supporting the construction and operation of necessary water infrastructure to provide reliable water supplies to rural communities.

Thank you,

Department of the Interior

New Mexico Unit of the Central Arizona Project
Draft Environmental Impact Statement

Joint Lead Agencies: Bureau of Reclamation, Lower Colorado Basin; New Mexico Interstate Stream Commission

Cooperating Agencies:

Federal

United States Army Corps of Engineers
United States Bureau of Land Management
United States Fish and Wildlife Service
United States Geological Survey

State and Local

Catron County
New Mexico Department of Game and Fish
San Carlos Irrigation and Drainage District
San Francisco Soil and Water Conservation District

Abstract:

The Bureau of Reclamation and New Mexico Interstate Stream Commission are evaluating a proposal by the New Mexico Central Arizona Project Entity to construct and operate a New Mexico Unit of the Central Arizona Project (NM Unit) through a series of water diversion, storage, conveyance, and delivery components. The NM Unit would divert water from the Gila River or its tributaries in New Mexico, including the San Francisco River, and underground water sources in southwestern New Mexico. The NM Unit would provide an additional supply of water in accordance with the Arizona Water Settlements Act of 2004 (AWSA) (Public Law 108-451) and the Colorado River Basin Project Act of 1968 (CRBPA) (Public Law 90–537).

The NM Unit is needed to improve agricultural use within the Cliff-Gila, Virden, and/or San Francisco River Valleys, particularly addressing the availability of stored water during the irrigation season and for drought protection. It is also needed to provide capability and flexibility for future expansion for the beneficial purposes authorized by the CRBPA and the AWSA.

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Acronyms and Abbreviations

°F	degrees Fahrenheit
ACEC	Area of Critical Environmental Concern
AF	acre-feet
AFY	acre-feet per year
APE	area of potential effect
ASR	Aquifer Storage and Recovery wells
aum	animal-unit-month
AWSA	Arizona Water Settlements Act of 2004
BIA	U.S. Bureau of Indian Affairs
BLM	U.S. Bureau of Land Management
BMPs	best management practices
CAP	Central Arizona Project
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
COA	Conservation Opportunity Area
CRBPA	Colorado River Basin Project Act
CT	Census Tract
CUFA	New Mexico Consumptive Use and Forbearance Agreement
CWA	Clean Water Act
dB	decibel
DCH	designated critical habitat
DOI	Department of the Interior
EC	Electrical Conductivity
EIA	economic impact analysis
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FMI	Freeport-McMoRan, Inc.
FY	fiscal year
GBIC	Gila Basin Irrigation Commission
GDP	Gross Domestic Product
GIS	geographic information system
GLO	Government Land Office
gpm	gallon per minute
GRIC	Gila River Indian Community
GVID	Gila Valley Irrigation District
IBA	Important Bird and Biodiversity Area
IDC	interest during construction
IMPLAN	input-output model
ISC	New Mexico Interstate Stream Commission
ITA	Indian Trust Asset
LF	linear feet
MBTA	Migratory Bird Treaty Act

mg/l	milligrams per liter
MIS	management indicator species
NAGPRA	Native American Graves Protection and Repatriation Act
NAMS	North American Monsoon
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NM Unit	New Mexico Unit
NMAC	New Mexico Annotated Code
NMDGF	New Mexico Department of Game and Fish
NMDOH	New Mexico Department of Health
NMDOT	New Mexico Department of Transportation
NMED	New Mexico Environment Department
NMHPD	New Mexico Historic Preservation Division
NMOSA	New Mexico Office of the State Auditor
NMOSE	New Mexico Office of the State Engineer
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NWI	National Wetland Inventory
O&M	operation and maintenance
OM&R	operation, maintenance, and replacement
ORV	outstandingly remarkable value
OSHA	Occupational Safety and Health Administration
PCH	proposed critical habitat
PR&Gs	Principles, Requirements, and Guidelines
Reclamation	U.S. Bureau of Reclamation
RM	river mile
RNCA	Riparian National Conservation Area
ROD	Record of Decision
ROW	right-of-way
SCIDD	San Carlos Irrigation and Drainage District
SCIP	San Carlos Irrigation Project
SHPO	State Historic Preservation Officer
SSPA	S. S. Papadopulos & Associates, Inc.
SWPPP	stormwater pollution prevention plan
SWReGAP	Southwest Regional Gap Analysis Project
TCP	traditionally cultural property
THPO	Tribal Historic Preservation Officer
TMDL	total maximum daily load
TNC	The Nature Conservancy
U.S.	United States
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
WSA	Wilderness Study Area

Executive Summary

ES.1 Introduction

The United States (U.S.) Department of the Interior, Bureau of Reclamation (Reclamation), Interior Region 8: Lower Colorado Basin, and the New Mexico Interstate Stream Commission (ISC), together known as the Joint Leads, have prepared this environmental impact statement (EIS). Its purpose is to analyze the environmental impacts of, and potential alternatives to, construction and operation and maintenance (O&M) of the proposed New Mexico Unit (NM Unit) of the Central Arizona Project (CAP) in southwestern New Mexico.

The New Mexico CAP Entity (Entity) is the project proponent. It is composed of representatives of counties, municipalities, irrigation districts, and soil and water conservation districts in Grant, Hidalgo, Catron, and Luna Counties in southwest New Mexico. The ISC is a non-voting member and a fiscal agent of the Entity. The Entity's Proposed Action is to establish the NM Unit through a series of water diversion, storage, conveyance, and delivery components. The proposal would allow the Entity to divert and use a portion of the 14,000 acre-feet (AF) (349 – 1,845 AF depending on the alternative) of water allotted under the Arizona Water Settlements Act of 2004 (AWSA), Public Law 108-451, while not precluding the future development of the full amount. The Colorado River Basin Project Act of 1968 (CRBPA), Public Law 90-537, as amended by the AWSA, authorized the Secretary of the Interior (Secretary) to contract with water users in New Mexico for consumptive use of water,[1] up to an annual average of 14,000 AF over 10 consecutive years (hereinafter referred to as the 14,000 AF of water), in exchange for delivery of CAP water to downstream users in Arizona. Congress specifically authorized this consumptive use, over and above those uses provided by Article IV of the Decree of the Supreme Court of the United States in *Arizona v. California*, 376 U.S. 340 (1964). Furthermore, the AWSA ratified the New Mexico Consumptive Use and Forbearance Agreement (CUFA),[2] signed by downstream Gila River users in Arizona and New Mexico.[3]

As the lead federal agency, Reclamation prepared this EIS in concert with the ISC as the joint lead agency. The U.S. Army Corps of Engineers, U.S. Geological Survey, U.S. Bureau of Land Management, US Fish and Wildlife Service (USFWS), New Mexico Department of Game and Fish, San Carlos Irrigation and Drainage District, Catron County, and the San Francisco Soil and Water Conservation District have participated as cooperating agencies in the National Environmental Policy Act (NEPA) process. The EIS complies with the National Environmental Policy Act of 1969 (42 United States Code 4321 et seq.), the Council on Environmental Quality's Regulations for Implementing the Procedural Provisions of the

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[1] Consumptive use is the amount of water used up by applying that water to crops or other beneficial use. Under the Consumptive Use and Forbearance Agreement (CUFA), consumptive use also includes reservoir/pond evaporation losses. The total consumptive use is the sum of the AWSA consumptive use and reservoir/pond evaporation, pursuant to Paragraph 2.15 of the CUFA as required by Section 304(f) of the CRBPA.

[2] http://www.ose.state.nm.us/Basins/Colorado/AWSA/Legal_Documents/2005_CUFA.pdf.

[3] The San Carlos Apache Tribe is not a signatory to the CUFA, nor are the States of New Mexico or Arizona.

National Environmental Policy Act (40 Code of Federal Regulations [CFR] 1500–1508), the Department of the Interior's NEPA regulations (43 CFR 46), and other relevant Federal and state laws and regulations.

ES.2 Setting

The proposed NM Unit is in southwestern New Mexico. A general project area is defined and shown on Map 1-1 (**Appendix A, Map 1-1** [Project Vicinity]). The project area includes lands around and in portions of the Gila River and its tributaries, including the San Francisco River, in three counties in southwestern New Mexico: Grant, Hidalgo, and Catron. While Luna County is represented in the Entity, no project components are proposed for Luna County as part of this action.

Infrastructure is proposed in the following areas: the Upper Gila location in Grant County (along the Gila River in the Cliff-Gila Valley), the Virden Valley location in Hidalgo County (along the Gila River in New Mexico near the Arizona-New Mexico state line), and the San Francisco River location in Catron County (the Spurgeon, Thomason Flat, and West Side [W-S] Ditches near Alma and the east and west side ditches at Pleasanton). Collectively, these three locations are referred to as the project area.

ES.3 Purpose of and Need for Action

The purpose of the Proposed Action is to develop a NM Unit to allow for consumptive use of water from the Gila River, its tributaries, or underground water sources in southwestern New Mexico, diverted in accordance with the CUFA and pursuant to the terms of the AWSA. The water developed via the NM Unit pursuant to the AWSA and the CUFA is for the benefit of the Entity. The Secretary is authorized to design, build, operate, and maintain the NM Unit. The NM Unit is defined in the NM Unit Agreement, which the Secretary executed on November 23, 2015. The Secretary is directed to carry out all necessary environmental compliance required by Federal law in implementing the CUFA and the NM Unit Agreement.

The needs for the Proposed Action are as follows: (a) to develop water for delivery at the times, locations, and quantities that would improve agricultural use within the Cliff-Gila, Virden, and/or San Francisco River Valleys; and (b) to provide capability for future expansion for the beneficial purposes authorized by the CRBPA and the AWSA. The Proposed Action identified in this EIS is needed for agricultural use and does not include or preclude the independent development of subsequent projects to address these future needs. Future projects involving water developed pursuant to the AWSA and the CUFA would be subject to all environmental compliance required by law.

ES.4 Objectives of the Project

The following have been identified as objectives for the Proposed Action:

- Provide storage capacity for the Cliff-Gila Valley, the Virden Valley, and/or along the San Francisco River

- Provide water for improvements and diversification of agricultural uses. The project would create the ability to store water for use during times of the year when the flows of the Gila River and the San Francisco River are low and water for agricultural uses is needed but is scarce.
- Operate in accordance with the CUFA
- To the extent practicable, avoid and minimize adverse impacts on physical, biological, socioeconomic, cultural, and tribal resources
- Plan, design, construct, operate, and maintain the NM Unit in accordance with Reclamation standards
- Provide flexibility for expansion to meet future water needs

ES.5 Federal Decisions to Be Made

This EIS supports Federal decisions related to a NM Unit. Specifically, the Joint Leads are evaluating the Entity's proposal for constructing and operating water diversion, storage, conveyance, and delivery facilities for a portion of the 14,000 AF of water (349 – 1,845 AF depending on the alternative) for New Mexico agricultural users, in accordance with the AWSA and CUFA. Additionally, the Secretary is the authorized diverter and responsible for ensuring AWSA diversions are in accordance with the CUFA. The Secretary was directed to carry out all necessary environmental compliance required by Federal law in implementing the CUFA and the NM Unit Agreement. In the long term, the Entity intends to develop up to 14,000 AF of water to the maximum viable extent; however, additional environmental compliance would be required to address future actions that are beyond those studied in this EIS.

The Joint Leads would also use the analysis and findings from this EIS to help inform the negotiation of various agreements related to the NM Unit, including construction contracts and construction funding contracts, water service contracts, water delivery contracts, and the operating and maintenance contract to transfer O&M responsibility for the NM Unit to the Entity (NM Unit Agreement, Sections 9.1 through 9.5).

ES.6 NM Unit Alternatives

This EIS assesses the potential environmental impacts of the five NM Unit alternatives under consideration: the No Action Alternative (Alternative A) and four action alternatives (Alternatives B, C, D, and E). The action alternatives are each described by location (i.e., Cliff-Gila, Virden, and San Francisco) and further divided into components at those locations. The components at each location include the proposed diversion methods and structures, conveyance, storage, wells (if applicable), power, construction, and operations.

The Joint Leads developed a preliminary suite of possible project components and alternatives and screened them to determine which would be carried forward for detailed analysis. Screening criteria were used to evaluate each component's ability to (1) meet the purpose of and need for action, (2) be technically, legally, and economically practicable and feasible, and (3) achieve the project objectives. Project components that satisfied the criteria were combined into complete alternatives.

Infrastructure projects such as the proposed NM Unit often need refinements to the design during, or leading up to, construction. The alternatives contain sufficient information to analyze the environmental impacts of the Proposed Action and alternatives; however, the components analyzed in detail in subsequent sections may evolve before the NM Unit design is finalized, and the NM Unit is constructed. Some details of the proposed NM Unit will not be known until future events occur or future plans are developed, such as contracts for water service or delivery, and plans for operation or maintenance. Because contracts for the delivery of AWSA water do not yet exist, the precise water delivery locations and irrigation facilities needed to deliver AWSA water at those locations are currently unknown. Additionally, prior to final design and construction of the NM Unit, geotechnical investigations and additional engineering analyses would be needed for all alternatives. The Joint Leads would conduct any additional site-specific environmental reviews that may be necessary to address the impacts of future changes, refinements, or developments not analyzed in this EIS, including O&M requirements.

ES.6.1 Alternative A: No Action Alternative

Alternative A is the No Action Alternative. Under this alternative, the NM Unit would not be constructed. While New Mexico's rights to access AWSA water would not be legally affected if no NM Unit was built at this time, it is not known how the ISC would vote to use the money in the NM Unit Fund. Since 2014, the ISC has allocated funding to 16 water utilization projects in southwest New Mexico that are not associated with the NM Unit project. These non-NM Unit projects include ditch improvement, effluent reuse, and municipal water conservation activities. Reclamation has no authority over the non-NM Unit projects, and they are not part of the Proposed Action or alternatives. Current non-NM Unit projects would continue under Alternative A.

Under Alternative A, and in accordance with existing laws and agreements, the diversion of water for irrigation and other uses in the Gila and San Francisco River Basins would continue. Proposed NM Unit infrastructure would not be built; however, individuals, irrigation districts, and other entities would continue improvement and maintenance of existing facilities or could propose new facilities under different authorities. Funded non-NM Unit projects that are reasonably foreseeable and within the project area are considered under the cumulative impact analysis in this EIS.

ES.6.2 Action Alternatives

The action alternatives are summarized below, in **Table ES-1**.

Table ES-1. Summary Comparison of Action Alternatives

Alternative	Cliff-Gila Location	Virden Location	San Francisco Location
Alternative B (Entity Proposed Action) Total Consumptive Use[4] = 1,782 AF	• One fixed crest weir diversion with 60-foot-long riffle rundown replacing the existing Upper Gila, Fort West, and Gila Farms Diversions • Various conveyance improvements and extensions • Four new gravity-fed, clay-lined storage ponds (combined surface storage capacity of 1,890 AF) • Five production wells, 120 feet deep	• Use existing Sunset and New Model Diversion Structures with no modifications • Use existing canals with no modifications • Two new clay-lined, gravity-fed storage ponds (10P and 11P) (combined surface storage of 551 AF)	• New fixed crest weir diversion with 20-foot-long engineered fill boulder riffle rundown, replacing the existing Spurgeon and Thomason Flat push-up diversions • Various conveyance improvements and extensions
Alternative C Total Consumptive Use = 1,845 AF	• Three rock vane weir semi-permanent diversions (no engineered fill) to replace push-up diversions at the existing Upper Gila, Fort West, and Gila Farms Ditch headings • Existing ditch configurations and capacities for conveyance • Four gravity-fed, clay-lined storage ponds(combined surface storage of 1,890 AF)	• Same as Alternative B	• One new rock vane diversion to replace the existing Thomason Flat push-up diversion • Various conveyance improvements and extensions • Earthen embankment dam and unlined reservoir with a storage capacity of 600 AF in Weedy Canyon
Alternative D Total Consumptive Use = 349 AF	• No project components would be constructed	• Same as Alternative B	• No project components would be constructed

[4] The total consumptive use amount is an annual average. See footnote 1 for a definition of consumptive use.

Alternative	Cliff-Gila Location	Virden Location	San Francisco Location
Alternative E Total Consumptive Use = 1,459 AF	• Pneumatically adjustable Obermeyer gate diversion, replacing the existing Upper Gila Diversion • Various conveyance improvements and extensions • Two new pump-fed, unlined ponds (2P and 3P) as aquifer and storage recovery (ASR) basins and surface storage in Winn Canyon (combined surface storage of 1,820 AF). One new gravity-fed clay-lined pond (5P) for surface storage in the Cliff-Gila Valley (surface storage of 258 AF) • Three ASR wells, 60 feet deep	• Same as Alternative B	• New fixed crest weir diversion with 20-foot-long engineered fill boulder riffle rundown at the existing Spurgeon push-up diversion site, replacing the existing Spurgeon and Thomason Flat push-up diversions • Various conveyance improvements and extensions • Unlined earthen embankment dam and reservoir with a storage capacity of 1,610 AF in Weedy Canyon

ES.7 Alternatives Considered but Eliminated from Detailed Study

The Joint Leads considered various alternatives, ranging from different diversion locations and techniques to different geographic areas; however, these alternatives were not brought forward for detailed analysis, as they did not meet the stated purpose of and need for the project or were not technically, economically, or legally practicable or feasible.

ES.8 Final EIS and Record of Decision

At the conclusion of this NEPA analysis, the Secretary may select one of the alternatives or may choose to combine or separate analyzed project components from the alternative scenarios. One or more analyzed project components from any of the three project locations (Cliff-Gila, Virden, and San Francisco) under any action alternative could be advanced separately under a Record of Decision by the Secretary. The public is encouraged to comment on specific or individual project components and locations described in this EIS. These comments will be used to further refine the analysis for the Final EIS and develop the Joint Leads' preferred alternative. The Joint Leads have not identified a preferred alternative for this Draft EIS.

However, on October 21, 2019, the Entity sent a letter to the Joint Leads requesting "…that the joint leads designate Alternative D, the 'Virden only' alternative, as the Preferred Alternative in the final EIS. The NM CAP Entity is not requesting a change to its [July 2019] proposed action." The Joint Leads will consider public comment before identifying a preferred alternative in the Final EIS in accordance with the Council on Environmental Quality's regulations.

ES.9 Environmental Consequences and Summary of Impacts

The purpose of the environmental consequences analysis is to describe the anticipated environmental and socioeconomic impacts that would result from each alternative for the proposed NM Unit. **Chapter 3** presents the potential direct, indirect, and cumulative impacts on the human and natural environment that could occur from implementing the alternatives for each project. Potential impacts on the relevant resources are described in terms of context, duration, and intensity. Key findings of the impact analysis are summarized below. They are based on the key resource issues identified during public scoping and subsequent meetings with the cooperating agencies and tribal governments. They are organized in the same order as they are in the EIS.

ES.9.1 Water Resources

The replacement of the existing push-up diversions with permanent structures could increase flows directly below the diversions due to improved operation; however, under all action alternatives, AWSA diversions would decrease river flows during certain months compared with Alternative A. These decreases would happen predominantly from August to February, with the largest flow decreases in December and January. Alternative D would result in the lowest flow decreases on the Gila River and have no impact on flows on the San Francisco River. Of the remaining action alternatives, Alternative B would result in the lowest flow decreases on the San Francisco River. The CUFA mitigates direct adverse impacts on senior water right holders.

Salinity in river flows may increase with implementation of the NM Unit, compared with Alternative A; however, the degree of salinity changes would be minor and is not anticipated to have direct impacts for irrigation suitability using river water, compared with Alternative A. Most of the proposed storage ponds and lined ditches (as applicable per alternative) would have minor impacts on deeper aquifers, and some may have a minor adverse impact on the shallow alluvial aquifers by preventing infiltration and recharge. Groundwater level declines modeled in the Cliff-Gila location, for example, are anticipated to recover within 2 weeks after AWSA diversions cease. Some existing wells may experience changes in groundwater levels from production wells under Alternative B or ASR facilities under Alternative E. River flows would change predominantly outside channel-forming events. Permanent proposed diversion structures under Alternative B and E would increase floodwater surface elevations and flooded areas. However, these changes would be negligible because an increase in inundated areas would not affect any roads or buildings.

ES.9.2 Biological Resources

The nature and type of impacts on biological resources from implementation of the NM Unit would be similar under all action alternatives. Under all action alternatives, there would be minor direct adverse impacts on vegetation and wildlife habitat. Adverse impacts on special status species, Federally listed threatened and endangered species, and riparian and terrestrial species would be minor to moderate due to: 1) the area of habitat disturbed relative to the total habitat available, and 2) the timing of AWSA diversions, which would maintain surface water flows during breeding and juvenile rearing periods. Adverse impacts on aquatic species (e.g., fish) could rise to the level of moderate due to reductions in surface flows and potential habitat loss. Consideration of fish passage in the design of the proposed fixed crest weir diversion structure under Alternative B (Cliff-Gila and San Francisco locations) and Alternative E (San Francisco location only), as well as modeled increased flows during the summer base flow periods, would provide minor beneficial impacts to fish populations. Indirect impacts from flow alterations would have negligible to minor impacts on biological resources under all action alternatives.

Alternative D proposes the least amount of ground disturbance and flow diversion of all the action alternatives, resulting in the least potential for adverse impacts on biological resources. Alternative E would have the most ground disturbance, resulting in the greatest potential for direct adverse impacts on habitat for Federally listed threatened and endangered species, Federally designated or proposed critical habitat, and wetland and riparian areas, followed by Alternatives B, C, and D. Alternative C proposes the greatest annual average diversion amount followed by Alternatives E, B, and D. Alternative E would have the greatest amount of return flows followed by Alternatives C, B, and D. Consequently, based on annual average diversion amounts and return flows, Alternative C would have the greatest potential impacts (adverse and beneficial) on aquatic species, followed by Alternatives E, B, and D. However, modeled changes in downstream flows as a result of proposed diversions are within the range of variation for the system, so adverse impacts to species would be most likely to occur during low flow conditions. Implementation of best management practices (BMPs) and mitigation measures would minimize adverse impacts to biological resources.

ES.9.3 Cultural Resources

The nature and type of impacts associated with all the action alternatives would be similar. Historic properties are likely to be affected by construction and operation of the NM Unit under any of the alternatives. A programmatic agreement is being prepared to address specific processes for identification, evaluation, effects determination, and resolution of any anticipated adverse effects in the final area of potential effects (APE). Identification of specific Traditional Cultural Properties (TCPs), tribal use areas, sacred sites, or other tribal concerns is ongoing; consultation with Federally recognized tribes on impacts would continue. Location-specific APEs would be developed for proposed NM Unit components. Based on ongoing tribal and State Historic Preservation Officer consultation on the draft programmatic agreement, the final project APE will be larger than the facility and construction disturbance area used in this analysis and more cultural resources may be present.

Because Alternative E proposes the largest amount of ground disturbance among the action alternatives, including two large ponds and the largest reservoir, this alternative would have the most potential for impacts on cultural resources, followed by Alternatives B and C. Alternative D would have the least potential for affecting cultural resources, other than Alternative A.

Because of the limited survey, large unevaluated sites, early historical-period use, and relatively compact area for placing infrastructure, avoidance of cultural resources would be most challenging in the Cliff-Gila location. The limited acreage of new disturbance anticipated at the Virden location would reduce the likelihood of unavoidable impacts on cultural resources there. Although there are historic properties at the San Francisco location and large disturbance areas associated with the proposed reservoirs under Alternatives C and E, there is some existing knowledge of the resource base and potential siting options for some of the components. However, all survey information is over 10 years old and tribal consultation has indicated that several tribes have identified TCPs in Weedy Canyon.

ES.9.4 Geology and Soils

Implementation of the NM Unit would result in direct, short- and long-term impacts on geology and soils under all action alternatives. The main impacts on geology and soils would occur from proposed project-related activities that would disturb areas containing erosive soils during the construction of project components and by the physical presence of project components overlying these soils. Short-term impacts would be minor, given that these impacts would end after construction is complete. Long-term impacts would be moderate, given the level of existing disturbance at the project locations. In the short term, construction of NM Unit project components would expose erosive soils to wind and water by intentionally or incidentally removing or destroying vegetation during operations. Eroded soils could be transported, and their loss could inhibit the remediation of disturbed areas and post-construction revegetation; however, the use of BMPs during construction and reclamation would help mitigate these impacts. In some areas, farmland of statewide importance and prime farmland if irrigated would be lost to the placement and operation of long-term project components. However, additional irrigation capacity could allow an increase in land classified as prime farmland if irrigated.

ES.9.5 Land Use

Implementation of the NM Unit would result in direct, short- and long-term impacts on land use and recreation under all action alternatives. Direct, minor short-term impacts would primarily occur during construction of the NM Unit by temporarily reducing access to some land and recreation areas, ending once construction is complete. Installation and operation of project components would result in direct, moderate long-term impacts by converting land use types from open space[5] to industrial and agricultural use. Where project components are placed on public land, public access could be permanently limited. The greatest potential for impacts on land use and recreation would occur under Alternatives C and E, where new reservoirs are proposed on U.S. Forest Service-managed lands. These lands would be converted from current uses to new uses associated with the reservoirs.

Under all action alternatives, except Alternative D, the NM Unit could affect some dispersed recreation on U.S. Forest Service managed land within and immediately surrounding the project locations, although these impacts would likely be negligible given the limited amount of dispersed recreation in the vicinity of the project locations overall. Restricted access to public land during construction would also cause direct, short-term impacts by temporarily reducing access to some public land; however, these impacts would generally be minor, and limited to initial construction and periodic maintenance. Mitigation measures and BMPs would help reduce impacts on land use and recreation from implementation of the NM Unit.

Flow reductions from implementation of the NM Unit would affect fish and other wildlife, indirectly affecting recreation that depends on wildlife. However, these flow reductions are not anticipated to substantially affect river-based recreation downstream of the project locations, given that most of this recreation takes place during spring runoff and upstream of the project locations. Additionally, reduced flows from proposed diversion structures are not expected to substantially affect recreational activities in special designation areas. Further, implementation of the NM Unit is not anticipated to result in substantial disturbance on any special designation areas given the disturbance estimates associated with the alternatives.

ES.9.6 Socioeconomic Resources

Operating the NM Unit would provide an additional water supply to be allocated to irrigation. Estimated annual economic benefits of a NM Unit range from $110,388 for Alternative D to $581,694 for Alternative B. Under all action alternatives, estimated annual economic costs exceed estimated economic benefits.

[5] Piece of land that is generally undeveloped or generally does not have any designated use

Alternative D has the lowest estimated annual economic costs at $335,347, while Alternative E has the highest ($6,660,353).

Short-term construction impacts could occur for ecosystem services, due to increased disturbance, potentially affecting regulating services associated with riparian/wetland habitat. Impacts may be limited, due to the site-specific nature of construction activity, and they could be mitigated through the inclusion of project design features. An increase in cultivated lands could also benefit some supporting services (i.e. reduction in erosion).

Short-term impacts from construction could also occur for cultural services, due to impacts on the visual setting from construction. Should long-term changes in instream water quantity or quality occur, then changes could occur to long-term cultural services that depend on instream water, such as recreation; however, current variability in water flow may limit project-specific impacts. Reclamation anticipates that after project construction, irrigators would see an increase in provisioning services due to the project. Access to water storage would support the continued presence of farming and provide resilience to climate change.

Two scenarios are also used to analyze financial costs for each action alternative: (1) no public funding for the project; and (2) up to $60 million in public funding available for construction-related costs from the New Mexico Unit Fund. Based on the financial analysis, financial cost per acre foot to be paid by water users without public funding ranges from $730 for Alternative D to $3,326 for Alternative E. The financial cost per acre foot with public funding ranges from $248 for Alternative B to $2,395 for Alternative E.

The increased agricultural output from implementation of the NM Unit would support direct, indirect, and induced jobs, with Alternative B and C supporting the largest number of jobs (19) and Alternative D the least (3). Construction is expected to support direct, indirect, and induced jobs, with Alternative E supporting the largest number of jobs (963) and Alternative D the least (40). Additionally, construction could affect the recreation and tourism sectors and related economic contributions from those sectors in the short-term. Short-term impacts could occur as a result of construction including increased employment over the construction period. Further, proposed project activities represent the potential for increased spending and employment in the project area, resulting in direct and indirect economic impacts for the region. Total annual regional output from the NM Unit varies from $4,039,056 (Alternative D) to $102,987,432 (Alternative E) over the 5-year construction period. Long term annual regional output from agricultural production varies from $283,440 (Alternative D) to $1,245,059 (Alternative B).

ES.9.7 Indian Trust Assets (ITAs)

All parties to the CUFA agreed that the diversion and consumptive use of the Gila and San Francisco River water according to the terms of the CUFA would not impair water rights in those sources existing as of September 30, 1968, and would not cause economic injury or cost. The potential effects of the implementation of the NM Unit on ITAs would be negligible to minor from the action alternatives. Implementation of the CUFA reduces the potential for impacts on ITAs from operation of the NM Unit.

ES.9.8 Environmental Justice

Under all alternatives, no low income, minority, or tribal populations are in the direct vicinity of proposed project construction locations, and no direct disproportionate impacts are anticipated on these populations as a result of implementation of the NM Unit. Regional economic impacts from proposed project activities would represent increased economic contributions; therefore, they would not result in disproportionate adverse impacts. Further, while long-term indirect impacts could occur as a result of changes to the flow of the Gila River from proposed project activities, impacts likely would not be disproportionately allocated to environmental justice communities. Diminished water quality (e.g., elevated salinity) would continue due to the baseline conditions, but the additional impacts from the action alternatives would be negligible and would not represent disproportionate adverse impacts on low income, minority, or tribal populations.

ES.9.9 Public Health and Safety

Under all action alternatives, implementation of the NM Unit would result in both direct and indirect impacts on public health and safety. These impacts would generally be minor. Direct impacts would primarily occur during the construction and operation of project components. Risks associated with construction would end once construction is completed; operation risks would last as long as the project components are functioning. Although unlikely, injury or death is possible from public and construction worker encounters with large machinery and construction sites. Additionally, construction workers could encounter health and safety issues associated with temporary access roads or river crossings.

Construction of the NM Unit could potentially affect public exposure to disease from mosquitoes (from standing water generated from proposed water storage sites), increased levels of agricultural contaminants, and increased flood risk from potential embankment failure. Additionally, during operation of the NM Unit, storage ponds could create a risk of drowning and flooding to the general public if accessible, particularly in areas near recreation sites. Impacts on public health and safety could be mitigated or minimized through various measures, including mosquito control plans, safety plans, Occupational Safety and Health Administration regulations, BMPs, and standard operating procedures.

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Chapter 1. Purpose and Need

1.1 Introduction

The United States (U.S.) Department of the Interior (DOI), Bureau of Reclamation (Reclamation), Interior Region 8: Lower Colorado Basin, and the New Mexico Interstate Stream Commission (ISC), together known as the Joint Leads, have prepared this environmental impact statement (EIS). They have analyzed the environmental impacts of and potential alternatives to construction and operation and maintenance (O&M) of the proposed New Mexico Unit (NM Unit) of the Central Arizona Project (CAP).

The NM Unit would include water diversion, storage, conveyance, and delivery components, in accordance with the Arizona Water Settlements Act of 2004 (AWSA), Public Law 108-451. It would divert water from the Gila River and its tributaries in New Mexico, including the San Francisco River, and underground water sources and convey it for storage in off-river (not on the main stem of the Gila and San Francisco Rivers) sites in the Cliff-Gila Valley, in the Virden Valley, and/or along the San Francisco River in New Mexico. The NM Unit would deliver water allotted under the AWSA to users in southwestern New Mexico.

The Colorado River Basin Project Act of 1968 (CRBPA), Public Law 90-537, as amended by the AWSA, authorized the Secretary of the Interior (Secretary) to contract with water users in New Mexico for the total consumptive use of water,[1] up to an annual average of 14,000 acre-feet (AF) over 10 consecutive years (hereinafter referred to as the 14,000 AF of water), in exchange for delivery of Colorado River water through the Central Arizona Project canal (referred to here as NM CAP water) to downstream Gila River water users in Arizona. Congress specifically authorized this consumptive use in New Mexico over and above those uses provided by Article IV of the Decree of the Supreme Court of the United States in *Arizona v. California*, 376 U.S. 340 (1964).

The New Mexico CAP Entity (Entity) is the project proponent. It is composed of representatives of counties, municipalities, irrigation districts, and soil and water conservation districts in Grant, Hidalgo, Catron, and Luna Counties in southwest New Mexico. The ISC is a non-voting member and a fiscal agent of the Entity.

In addition to acting as the project proponent, the Entity has certain authorities and responsibilities pursuant to the AWSA, including, but not limited to the following:

- Enter into the NM Unit Agreement with the Secretary[2]
- Own and hold title to all portions of the NM Unit

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[1] Consumptive use is the amount of water used up by applying that water to crops or other beneficial use. Under the Consumptive Use and Forbearance Agreement (CUFA), consumptive use also includes reservoir/pond evaporation losses. The total consumptive use is the sum of the AWSA consumptive use and reservoir/pond evaporation, pursuant to Paragraph 2.15 of the CUFA as required by Section 304(f) of the CRBPA.

[2] This agreement was signed in November 2015.

- Assume responsibilities to design, build, operate, and maintain the NM Unit, if the Entity requests a transfer of such responsibilities from the Secretary[3]
- Be responsible for paying the cost of delivering NM CAP water to downstream users in Arizona following construction of the NM Unit

The Entity's Proposed Action is to establish the NM Unit through a series of water diversion, storage, conveyance, and delivery components. The proposal would allow the Entity to divert and use a portion of the 14,000 AF of water allotted under the AWSA, while not precluding future development of the full amount. **Chapter 2,** Alternatives, discusses the Entity's Proposed Action in detail.

The AWSA ratified the New Mexico CUFA,[4] signed by downstream Gila River users in Arizona and New Mexico.[5] The CUFA details the conditions that must be met for New Mexico users to divert water from the Gila River and its tributaries, including the San Francisco River. Before diverting in New Mexico, the Entity must purchase credits equal to the amount of water it intends to consumptively use in one year. In exchange for every AF of AWSA water consumptively used in New Mexico, the Secretary must deliver an equal amount of NM CAP water to downstream users in Arizona.

The AWSA also provides for several separate tiers of funding for New Mexico projects. Under the first tier, the AWSA directs the Secretary, acting through Reclamation, to disburse $66 million (adjusted for inflation in 2012 to $90.4 million) from the Lower Colorado River Basin Development Fund to the ISC in ten annual payments. Each payment is $9.04 million, and the first payment began in calendar year 2012. These disbursements are deposited into the New Mexico Unit Fund (NM Unit Fund), established in the New Mexico State Treasury and administered by the ISC. Currently, there are approximately $60 million in the NM Unit Fund. This first tier of funding has not retained its Federal character once disbursed to New Mexico and has not been treated as Federal money subject to the reporting requirements of the Office of Management and Budget Super Circular. Pursuant to the AWSA, the ISC, in consultation with the Southwest New Mexico Water Study Group or its successor,[6] may use the NM Unit Fund for paying costs of the NM Unit or for other water utilization alternatives to meet water supply demands in the Southwest Water Planning Region of New Mexico (AWSA 212(i)). The currently financed other water utilization alternatives are called non-NM Unit projects and are discussed in **Chapter 2**.

The AWSA also authorized, under certain conditions, distribution of a second tier of funding, an additional $34 million (to be adjusted for inflation) from the Development Fund, exclusively for construction of a NM Unit. One of the conditions was the issuance of a record of decision (ROD) by December 31, 2019. Since this deadline could not be met the Entity requested that the Secretary grant an extension of that deadline in order to allow New Mexico to access this tier of funding. On December 20, 2019 the Department of the Interior denied the Entity's request for an extension of the December 31, 2019 deadline. Because the extension applies only to federal funding under Section 212(j) of the AWSA, the Entity retains the option to pursue the NM Unit with other funding sources, including funds available under Section 212(i) of the Act. The ISC, in consultation with the NM CAP Entity, has the discretion to allocate funds

[3] In April 2016, the Entity requested that the Secretary transfer design responsibility to the Entity. The transfer took place in May 2016. In August 2018, the Entity requested the transfer of additional responsibilities for construction, operation, and maintenance of the NM Unit. This request is still pending.
[4] See http://www.ose.state.nm.us/Basins/Colorado/AWSA/Legal_Documents/2005_CUFA.pdf.
[5] The San Carlos Apache Tribe is not a signatory to the CUFA, nor are the States of New Mexico or Arizona.
[6] The Entity, formed in 2015, is the successor to the Southwest New Mexico Water Study Group (http://nmcapentity.org/).

from the NM Unit Fund for a NM Unit or non-NM Unit projects. At this time, no decision has been made by the ISC on future use of the funds in the NM Unit Fund. [7]

1.2 Purpose of and Need for Action

The purpose of the Proposed Action is to develop a NM Unit to allow for consumptive use of water from the Gila River, its tributaries, or underground water sources in southwestern New Mexico, diverted in accordance with the CUFA and pursuant to the terms of the AWSA. The water developed via the NM Unit pursuant to the AWSA and the CUFA is for the benefit of the Entity.

The Secretary is authorized to design, build, operate, and maintain the NM Unit. The NM Unit is defined in the NM Unit Agreement, which the Secretary executed on November 23, 2015. The Secretary is directed to carry out all necessary environmental compliance required by Federal law in implementing the CUFA and the NM Unit Agreement.

The needs for the Proposed Action are as follows: (a) to develop water for delivery at the times, locations, and quantities that would improve agricultural use within the Cliff-Gila, Virden, and/or San Francisco River Valleys; and (b) to provide capability for future expansion for the beneficial purposes authorized by the CRBPA and the AWSA. The Proposed Action identified in this EIS is needed for agricultural use and does not include or preclude the independent development of subsequent projects to address these future needs. Future projects involving water developed pursuant to the AWSA and the CUFA would be subject to all environmental compliance required by law.

1.3 Project Objectives

In concert with the purpose of and need for the Proposed Action, the following have been identified as objectives for the Proposed Action:

- Provide storage capacity for the Cliff-Gila Valley, the Virden Valley, and/or along the San Francisco River.
- Provide water for improvements and diversification of agricultural uses. The project would create the ability to store water for use during times of the year when the flows of the Gila River and the San Francisco River are low and water for agricultural uses is needed but is scarce.
- Operate in accordance with the CUFA
- To the extent practicable, avoid and minimize adverse impacts on physical, biological, socioeconomic, cultural, and tribal resources.
- Plan, design, construct, operate, and maintain the NM Unit in accordance with Reclamation standards.
- Provide flexibility for expansion to meet future water needs.

[7] The AWSA also authorized up to $28 million (to be adjusted for inflation) from the Development Fund for construction, if earnings in the Development Fund exceeded an average effective annual rate of 4 percent from December 10, 2004, through the date of initiation of construction of a NM Unit. Given current data, the analysis in this document assumes that this $28 million will not be available. In addition, per Section 107(a) of the AWSA, the AWSA authorizes up to $500,000 to pay costs for installation of gages on the Gila River and its tributaries for purposes of the CUFA.

1.4 Principles, Requirements, and Guidelines

This evaluation is consistent with the Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies (PR&Gs; Council on Environmental Quality [CEQ] 2014). The PR&Gs are not regulations and do not substitute for or supersede any National Environmental Policy Act (NEPA) requirements or any other planning requirements required by law; nevertheless, integrating relevant portions of the PR&Gs analysis into the EIS will provide economic and ecological information that inform this NEPA analysis and the Proposed Action (**Appendix I**, PR&Gs).

1.5 Description of the Project Area

The project area includes lands around and in portions of the Gila River and its tributaries, including the San Francisco River, in three counties in southwestern New Mexico: Grant, Hidalgo, and Catron (**Appendix A, Map 1-1** [Project Vicinity]). While Luna County is represented in the Entity, as described in **Section 1.1**, above, no project components are proposed for Luna County as part of this action.

Infrastructure is proposed in the following areas: the Upper Gila location in Grant County (along the Gila River in the Cliff-Gila Valley), the Virden Valley location in Hidalgo County (along the Gila River in New Mexico near the Arizona-New Mexico state line), and/or the San Francisco River location in Catron County (in the vicinity of the Highway 180 crossing north of Alma, New Mexico, and the Pleasanton area further downriver). Collectively, these three locations are referred to as the project area.

1.6 Relationship with Other Plans, Policies, and Regulations

Construction and operation of the NM Unit would require a number of permits, the list of which can be found in **Appendix B**, Preliminary List of Actions for the NM Unit. The Entity would obtain all applicable permits for the NM Unit.

1.7 Cooperating Agencies

To date, cooperating agencies for this EIS (pursuant to 43 Code of Federal Regulations [CFR] 46) are the U.S. Fish and Wildlife Service (USFWS), U.S. Army Corps of Engineers, U.S. Geological Survey, U.S. Bureau of Land Management (BLM), New Mexico Department of Game and Fish (NMDGF), San Carlos Irrigation and Drainage District (SCIDD), Catron County, and the San Francisco Soil and Water Conservation District. Their participation provides expertise to supplement the EIS analysis; however, it does not constitute their approval of the analysis, conclusions, or alternatives presented in this EIS.

In addition to working with the local, state, and Federal cooperating agencies on this EIS, the Joint Leads have met with tribes to receive their input. The Federal government works with tribes to protect their resources and to uphold the rights of indigenous peoples to govern themselves on tribal lands. Under pertinent executive orders and regulations, Reclamation initiated tribal consultation in July 2017 and will continue tribal consultation throughout the environmental planning process.

1.8 Federal Decisions to Be Made

This EIS supports Federal decisions related to a NM Unit. On behalf of the Secretary, the Joint Leads are evaluating the Entity's proposal for constructing and operating water diversion, storage, conveyance, and delivery facilities for a portion of the 14,000 AF of water for New Mexico agricultural users, in accordance with the AWSA and CUFA. Additionally, the Secretary is the authorized diverter responsible for ensuring that AWSA diversions are in accordance with the CUFA. Provisions in the CUFA include direction to the Secretary and the Entity for handling the NM CAP water exchange. The Secretary was directed to carry out all necessary environmental compliance required by Federal law in implementing the CUFA and the NM Unit Agreement. In the long term, the Entity intends to develop up to 14,000 AF of water to the maximum viable extent; however, additional environmental compliance would be required to address future actions that are beyond those studied as part of this EIS.

The Joint Leads would also use the analysis and findings from this EIS to help inform the negotiation of various agreements related to the NM Unit, including construction contracts and construction funding contracts, water service contracts, water delivery contracts, and the operating and maintenance contract to transfer O&M responsibility for the NM Unit to the Entity (NM Unit Agreement, Sections 9.1 through 9.5). If those future agreements result in construction or O&M changes that have environmental or economic effects beyond those analyzed in this EIS, additional environmental compliance may be needed.

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Chapter 2. Description of Alternatives

2.1 Introduction

This chapter discusses the various project components used to create the alternative scenarios for the NM Unit. The chapter also summarizes the alternatives development and screening process. The No Action Alternative (Alternative A) and four action alternative scenarios are described in detail, along with alternatives considered but eliminated from detailed analysis. A matrix is provided to summarize differences and similarities among the alternative scenarios.

2.2 Alternatives Development and Screening Process

The Entity, as the project proponent, developed and refined its Proposed Action for analysis in the EIS. The Entity is designing the project for a 100-year life span with the recognition that components would be maintained and replaced over time.

The Joint Leads used a structured alternatives-development process that included engagement with the public, coordination with cooperating agencies, a literature review of past studies, and workshops with agency technical experts. During the scoping period, the Joint Leads solicited input on both the Proposed Action and the alternatives for consideration (EMPSi 2018). Considering public comments, the Joint Leads developed a preliminary suite of possible project components and alternative scenarios to carry forward for detailed analysis. The alternatives were further refined to ensure that a comparative analysis with the Proposed Action could be conducted. Reclamation conducted the preliminary engineering for Alternatives C and E (Reclamation 2019b). The Entity modified its Proposed Action to address data gaps and new information.

Screening criteria were used to evaluate each component's ability to: (1) meet the purpose of and need for action; (2) be technically, legally, and economically practicable and feasible; and (3) achieve the project objectives (see **Chapter 1**, Purpose and Need). Alternatives or proposed components that failed to satisfy these criteria were eliminated from detailed consideration. Speculative alternatives, including those lacking the specificity or detail to enable meaningful analysis of environmental impacts, were also eliminated from detailed analysis. The end of this chapter provides a discussion of alternatives considered but eliminated from detailed study.

After reviewing preliminary analyses of the costs and effects of implementing the Proposed Action, the Entity eliminated certain components of the Proposed Action in July 2019 and later provided additional clarifications and construction details necessary to revise the analysis (NM CAP Entity 2019). These changes were proposed in response to preliminary analyses of the environmental impacts, construction costs, O&M costs, and AWSA water irrigators' costs. The purpose of these changes was to provide a Proposed Action that was more consistent with the budgeted money that would be available for construction and could be analyzed according to the required timeline. In turn, the Joint Leads reviewed and reduced the scope of one of the preliminary alternatives (Alternative D) in order to provide a better range of alternatives in sizes and costs.

Regarding alternatives development, the Joint Leads considered the NEPA decision that can be made in the near term, versus decisions that would be premature because of changing circumstances, speculation, or lack of essential information. Infrastructure projects, such as the proposed NM Unit, often need design refinements during, or leading up to, construction. The alternatives described in this chapter contain sufficient information to analyze the environmental impacts of the Proposed Action and alternatives; however, the components analyzed in detail in subsequent sections may evolve before the NM Unit design is finalized and the NM Unit is constructed. Similarly, some details of the proposed NM Unit cannot be known until future events occur or future plans are developed, such as water service or delivery contracts and operation or maintenance plans. Because AWSA water delivery contracts do not yet exist, the precise water delivery locations, volumes, and irrigation facilities needed to deliver AWSA water at those locations are currently unknown. If, for example, fallow land would be brought into production with AWSA water, additional site-specific NEPA compliance would be required prior to issuance of a water service contract. Additionally, prior to final design and construction of the NM Unit, geotechnical investigations and additional engineering analyses would be needed for all alternatives.

The Joint Leads would conduct any additional environmental reviews that may be necessary to address the impacts of future changes, refinements, or developments not analyzed in this EIS, including O&M requirements. Such reviews could include preparation of a supplemental information report, categorical exclusion, environmental assessment, supplemental EIS, or other documents, as appropriate.

2.3 Final EIS and Record of Decision

At the conclusion of this NEPA analysis, the Secretary may select one of the alternatives or may choose to combine or separate analyzed project components from different alternatives. One or more analyzed project components from any of the three project locations (Cliff-Gila, Virden, and San Francisco) under any action alternative could be advanced separately under a Record of Decision (ROD) by the Secretary. The public is encouraged to comment on specific or individual project components and locations described in this EIS. These comments will be used to further refine the analysis for the Final EIS and develop the Joint Leads' preferred alternative. The Joint Leads have not identified a preferred alternative for this EIS.

However, on October 21, 2019, the Entity sent a letter to the Joint Leads requesting "…that the joint leads designate Alternative D, the 'Virden only' alternative, as the Preferred Alternative in the final EIS. The NM CAP Entity is not requesting a change to its [July 2019] Proposed Action."

The Joint Leads will consider public comment before identifying a preferred alternative in the Final EIS, in accordance with CEQ regulations.

2.4 Alternatives Considered in Detail

This section summarizes the components that would be constructed under each alternative and highlights the major differences between the alternatives at the Cliff-Gila, Virden, and San Francisco locations. Alternative A is the No Action Alternative and outlines the existing facilities and current methods of diverting and conveying water at the three locations. The priority, amount of water, and other elements of each water right for water currently diverted and conveyed from the Gila and San Francisco Rivers has been determined through legal proceedings called adjudications. Gila and San Francisco River water in New Mexico that was adjudicated pursuant to the 1964 U.S. Supreme Court Decree in *Arizona v. California* and state adjudications is referred to as adjudicated water in this EIS. Decree water refers to Gila River water adjudicated pursuant to the Globe Equity Decree No. 59, dated June 29, 1935. All AWSA water accessed through the NM Unit would be in addition to adjudicated and Decree water, and all senior rights would continue to be exercised if a NM Unit was built.

The action alternatives are each described by location (i.e., Cliff-Gila, Virden, and San Francisco) and further divided into components at those locations. The components at each location include the proposed diversion methods and structures, conveyance, storage, wells (if applicable), power, construction, and operations. Maps of the existing components and structures, and the proposed NM Unit components analyzed under each alternative, are found in **Appendix A**, Maps.

2.4.1 Alternative A: No Action Alternative

Alternative A is the No Action or "no build" alternative that represents the conditions that would exist in the absence of the NM Unit. Alternative A would not meet the purpose of and need for the Proposed Action, but it provides a basis for comparison with the action alternatives.

All three locations have a long history of ongoing agricultural use involving land clearing, crop production, river diversions, ditch construction and maintenance, roads, power lines, and, in some cases, homes. Water diversions from the Gila and San Francisco Rivers for conveyance to farm fields and return flows to the river have occurred for over 100 years. Land and river flows in the vicinity of the three locations have been modified and disturbed by past and ongoing actions.

Under Alternative A, the NM Unit would not be built, and infrastructure to divert, convey, store, or otherwise support access to AWSA water would not be developed. New Mexico's rights to access AWSA water would not be legally affected if no NM Unit were built at this time. The Development Fund would continue to fund disbursements authorized by the CRBPA, as amended by the AWSA, in accordance with the priorities established in these statutes. Possible scenarios available to the ISC could include providing additional funding to existing non-NM Unit projects, or soliciting proposals for additional projects.

Since November 2014, the ISC has allocated $9.1 million from the NM Unit Fund to 16 non-NM Unit water utilization projects in the four counties of southwestern New Mexico.[1] These non-NM Unit projects include ditch improvement, effluent reuse, and municipal water conservation activities. In the past five years, only about 52 percent of the $9.1 million has been spent on those projects by the grantees. Seven of the 16 projects are currently operational, while others are in various stages of design and construction. An array of technical, legal and financial issues has delayed construction or implementation of the remainder of the projects. Reclamation has no authority over the non-NM Unit projects, and they are not part of the Proposed Action or alternatives. Current non-NM Unit projects would continue under Alternative A. Funded non-NM Unit projects that are reasonably foreseeable and within the project area

[1] See Non-NM Unit Funding Agreements and Notices to Proceed in https://www.ose.state.nm.us/Basins/Colorado/isc_AWSA.php.

are considered under the cumulative impact analysis in this EIS (see **Section 3.2**, Impact Methods and Cumulative Effects).

Under Alternative A, and in accordance with existing laws and agreements, the diversion of adjudicated and Decree water for irrigation and other uses in the Gila and San Francisco River basins would continue at multiple locations along both rivers. There are no provisions for storage of Gila and San Francisco Rivers adjudicated surface flows in New Mexico, except for the export of water from the Silver City wellfield to Silver City in the Mimbres Basin for municipal uses, and to Bill Evans Lake and Tyrone Mine for consumptive use in mining operations (see **Section 3.3** for a further discussion of existing adjudicated water diversions). Proposed NM Unit infrastructure, including storage facilities and conveyance improvements, would not be built; however, it is assumed that individuals, irrigation districts, and other entities would continue improvement and maintenance of existing facilities or could propose new facilities under different authorities.

There is no current provision or facilities to store adjudicated water and Decree Water in any of the project locations under Alternative A. New diversion, conveyance, storage, and other infrastructure supporting the access of AWSA water would not be constructed.

Cliff-Gila Location

There are three main community ditches (acequias) at the Cliff-Gila location with ongoing diversions: Upper Gila, Fort West, and Gila Farms. The irrigators on these ditches have senior rights that were established in the 1880s. The ditches and approximate diversion locations are shown in **Appendix A, Map 2-1** (Alternative A: Cliff-Gila).

- The Upper Gila Ditch diverts water for irrigation from the Gila River approximately 6.5 miles upstream from the town of Cliff, New Mexico. The estimated conveyance capacity of the Upper Gila Ditch is approximately 30 cubic feet per second (cfs).
- The Fort West Ditch Diversion heading is approximately 0.50-river mile downstream from the Upper Gila Ditch Diversion heading. The estimated conveyance capacity of the Fort West Ditch is also 30 cfs.
- The Gila Farms Ditch diverts water for irrigation from the Gila River approximately 3 river miles downstream from the Fort West Diversion heading, with an estimated conveyance capacity of approximately 40 cfs (ISC 2000, L. Madrid, personal communication 2018[2]).

Gila River water is shared among the three ditches for flood irrigation. All three ditch associations in the Cliff-Gila area currently divert water from the Gila River by using bulldozers in the riverbed and creating "push-up" diversions out of riverbed materials (**Figure 2-1** [Example Push-up Diversion]). Push-up diversions do not allow for the direct adjustment of water volumes being diverted at the point of diversion (Telesto 2017); however, the ditches have head gates and gages approximately 0.25-mile downstream from the points of diversion, which enable the irrigators to regulate flows based on the ditch capacity and route excess flow to the river. In addition, the irrigators typically close the head gates for ditch maintenance in late February to early March prior to the irrigation season.

[2] Luis Madrid, ISC contractor, personal communication with Helen Sobien, ISC, on October 18, 2018, regarding current ditch capacities.

There is not a precise apportionment for each ditch. The position of the Upper Gila head gate determines how much water moves into the ditch, and therefore how much water flows downstream. A similar system determines the amount of water that flows into the Fort West and Gila Farms ditches. Each diversion has a small gap or "spillway" to shunt water back to the river. During low-flow periods, when there is not enough water in the river to supply all the irrigators on each ditch, the community initiates a sharing operation where each field is watered on a schedule, called "rotation." This may occur among all three ditches or just along one ditch. Flood irrigation is used in the Cliff-Gila location (HDR 2019a).

Figure 2-1. Example Push-Up Diversion: Looking Upstream at the Gila Farms Push-up Diversion. The water flowing to the left is directed to the Gila Farms Ditch.

Portions of the ditch flows return to the river as surface and subsurface flow further downstream. Some ditches flow almost year long and are commonly called "live ditches." Live ditches flow constantly, primarily to offset low diversion and conveyance efficiencies and to maintain sufficient head and easier access for flood irrigation during the irrigation season. They also provide water for livestock during the non-irrigation season in late fall to early spring.

The push-up diversions remain in place year-round (i.e., they are not removed at the end of the irrigation season and continue to divert river water into irrigation ditches even when farmers are no longer irrigating). Normal seasonal monsoon flooding from July through September routinely washes out these push-up diversions, reducing the period that the structures are functional, sometimes during the heart of the growing season. The diversion structures typically are damaged one to three times in most years, which requires irrigators to repair or rebuild them. Repairs are sometimes delayed by a matter of days, or weeks, due to high water levels (Telesto 2017; T. Thorpe, personal communication 2019[3]). Heavy machinery is brought into the riverbed, when possible, to repair the push-up diversions.

Flows at the U.S. Geological Survey gage on the Gila River near Gila, New Mexico (approximately 2.5 miles upstream of the existing Upper Gila diversion) normally drop below 60 cfs from May through July. When that occurs, surface river flows can cease in a reach of river approximately 1.2 miles long below the Fort West push-up diversion, creating intermittent pools in the Gila River channel (SWCA 2014a). Return flows from the Fort West Ditch and agricultural fields recharge the river in the vicinity of the Gila Farms Ditch heading.

Downstream of the Cliff-Gila Valley there are other surface water diversions. In addition to agricultural diversions, there is an ongoing surface diversion from the Gila River using a low-head concrete diversion

[3] Topper Thorpe, Gila Basin Irrigation Commission, personal communication with Helen Sobien, ISC, on July 26, 2019 regarding push-up diversion operations.

structure spanning the floodplain, owned by Freeport McMoRan, Inc. (FMI). This would continue, along with groundwater pumping from the Gila Basin's Silver City wellfield, owned by Silver City.

Other water management features near the Cliff-Gila location are 12 jurisdictional flood-sediment control dams in the side canyons surrounding the Cliff-Gila Valley. According to the New Mexico Office of the State Engineer (NMOSE), many of these earthen structures are considered to be in poor or fair condition. Ongoing maintenance of these dam structures and debris basins would continue.

The Gila Basin Irrigation Commission (GBIC) is investigating construction of permanent diversion structures at the three existing diversion points, in lieu of the current push-up diversions. It is unknown at this point if or when this project would occur and if all three diversions would be built. This project is further described in **Section 2.5**, Alternatives Considered but Eliminated from Detailed Study.

Virden Location

In the Virden location, there are two main canals, Sunset and New Model, that convey water from the Gila River to farms in the Virden Valley. Existing permanent diversion structures would continue to divert Decree Water (**Figure 2-2** [Virden Location: Existing Sunset Diversion on the Gila River] and **Figure 2-3** [Virden Location: Existing New Model Diversion on the Gila River.]). The Sunset Diversion is on BLM-administered land and the New Model Diversion is on private land. Both diversions and canals have approximate maximum capacities of 35 cfs (**Appendix A, Map-2-2** [Alternative A: Virden]). Flood irrigation accounts for most of the irrigated acreage in the Virden area, but sprinklers and drip irrigation are also used. Irrigators would continue offsetting the lack of surface water with costly groundwater pumping. The Virden location has the most robust agricultural practices and most diverse crop mixes of the three project areas, but still faces flow fluctuations and dry-ups.

Figure 2-2. Virden Location: Existing Sunset Diversion on the Gila River.

Figure 2-3. Virden Location: Existing New Model Diversion on the Gila River.

San Francisco Location

There are two unlined main community ditches on the San Francisco River in the vicinity of the Highway 180 crossing approximately 5.5 miles upstream from the town of Alma, New Mexico: Spurgeon

Ditch #2 and Thomason Flat Ditch. Spurgeon Ditch #2 diverts water to the east side of the river for irrigation approximately 100 yards upstream of the Highway 180 bridge. The estimated maximum capacity of Spurgeon Ditch #2 is approximately 27 cfs. Thomason Flat Ditch diverts water to the west side of the river for irrigation approximately 0.50-mile downstream of the Spurgeon Ditch #2 heading. The estimated maximum capacity of Thomason Flat Ditch is approximately 23 cfs (L. Madrid, personal communication 2018[4]). Flood irrigation is used in the San Francisco location (HDR 2019a).

The acreage irrigated by Spurgeon Ditch #2 and the associated return flows to the river from the ditch are located downstream from the Thomason Flat Ditch heading (ISC 2000, L. Madrid personal communication 2018[5]). The Thomason Flat Ditch heading is immediately downstream of the Pueblo Creek confluence, an ephemeral tributary to the San Francisco River on the west side of the river.

Like the Cliff-Gila ditches, both the Spurgeon Ditch #2 and Thomason Flat Ditch use push-up diversions to divert their adjudicated water for flood irrigation (**Appendix A, Map 2-3** [Alternative A: San Francisco]). Spurgeon Ditch #2 starts diverting water early in the irrigation season. At that time of the year, there is generally enough water, and some water is bypassed from the Spurgeon push-up diversion for downstream ditches, including Thomason Flat Ditch and W-S Ditch, which is approximately 2.5 miles downstream of the Thomason Flat Ditch heading (**Appendix A, Map 2-4** [Alternative A: San Francisco (W-S Diversion)]). A permanent diversion structure supplies the W-S Ditch with an estimated maximum capacity of 30 cfs (ISC 2000, L. Madrid, personal communication[6]). During low-flow periods, the operators of the W-S Ditch, Thomason Flat Ditch, and Spurgeon Ditch #2 coordinate diverting their adjudicated water. Spurgeon Ditch #2 does not have a head gate, but the operator adjusts the push-up diversion to divert or bypass water. The Spurgeon Ditch #2 operator rebuilds the diversion whenever heavy rain washes it out, typically three or four times per season (T. Klumker, personal communication 2018[7]).

Further downstream, the Pleasanton East-Side Ditch Diversion is another permanent diversion structure on the San Francisco River. Ditches in this area include the Pleasanton East-Side and Pleasanton West-Side Ditches that have an estimated total maximum capacity of 20 cfs (L. Madrid, personal communication 2018[8]; **Appendix A, Map 2-5** [Alternative A: San Francisco (Pleasanton)]).

2.4.2 Assumptions Common to All Action Alternatives

The following actions and assumptions are common to all action alternatives.

Additional Actions and Permitting

Appendix B (Preliminary List of Actions for the NM Unit) presents a preliminary list of approval and permitting actions that could be applicable to all action alternatives. Rights-of-way (ROWs), easements,

[4] Luis Madrid, ISC contractor, personal communication with Helen Sobien, ISC, on October 18, 2018, regarding San Francisco operations.
[5] Luis Madrid, ISC contractor, personal communication with Helen Sobien, ISC, on October 18, 2018, regarding current ditch capacities.
[6] Luis Madrid, ISC contractor, personal communication with Helen Sobien, ISC, on October 18, 2018, regarding current ditch capacities.
[7] Tom Klumker, Spurgeon Ditch #2 operator, personal communication with Helen Sobien, ISC, on December 7, 2018, regarding San Francisco Ditch operations.
[8] Luis Madrid, ISC contractor, personal communication with Helen Sobien, ISC, on October 18, 2018, regarding current ditch capacities.

and support areas for construction, material source areas, disposal areas, and O&M are defined where possible. Additional site-specific reviews and authorizations would be completed as appropriate when specifics are known.

Existing Water Rights and Diversions

This analysis assumes that all currently permitted and adjudicated uses of water are being exercised, and would continue to be exercised, in any valleys that would contain portions of the NM Unit. It is anticipated that the current amount and timing of currently permitted water uses would remain the same in all three valleys; however, some existing diversion points would change under certain alternatives, which would require permitting from the NMOSE. The diversion, storage, and use of AWSA water would be above and beyond all existing uses and is analyzed in that context.

Water Measurement and Reporting

Because the diversion and conveyance infrastructure would be used for both AWSA water and adjudicated/Decree water, accurate measurement, monitoring, and reporting is needed to ensure compliance with all applicable diversion constraints. Flow measurement devices would be installed at appropriate locations.

State Water Use Authorizations

Because the State of New Mexico regulates water rights and diversions, any diversion, storage, and use of AWSA water proposed as part of the NM Unit would be subject to permitting by the NMOSE. The NMOSE application process mandates publication of a notice in local newspapers in the geographical area of the application and offers potentially affected water rights owners the opportunity to protest an application. Whether or not an application is protested, in the course of the permitting process, the NMOSE evaluates each application based on three statutorily mandated criteria: (1) impairment of other existing water rights; (2) public welfare; and (3) conservation of water in the State of New Mexico. If those criteria are not met, the NMOSE may deny the application or impose conditions upon the applicant so that these criteria are met.

In addition, portions of the action alternatives involving dams would be under the jurisdiction of the appropriate agency, either Reclamation or the NMOSE Dam Safety Bureau.

CAP Water Exchange

Section 304(f) of the CRBPA, as amended by the AWSA, requires the Secretary, as the CAP owner, to deliver up to 14,000 acre-feet per year (AFY) of mainstem Colorado River water through the CAP Canal to downstream users of Gila River water in Arizona in exchange for consumptive use of the AWSA water in New Mexico (NM CAP water). Consumptive use under the CUFA is defined as measured diversions minus return flows, and includes reservoir and pond evaporation losses. Through this exchange, the NM CAP water would be delivered to the Gila River Indian Community (GRIC) and the SCIDD. The delivery of the NM CAP water in Arizona, and the diversion and consumptive use of the AWSA water in New Mexico, are both subject to applicable authorities, including the provisions of the CRBPA, AWSA, CUFA, NM Unit Agreement, and CAP Water Delivery Contract with the GRIC. According to the CUFA, the exchange is one for one; for every AF of water used in New Mexico, the GRIC and SCIDD collectively would receive one AF of CAP water at the CAP turnout. Each AF would be divided among the Arizona users, with the GRIC receiving 55 percent and the SCIDD receiving 45 percent.

Before diverting water in New Mexico, the Entity must purchase credits equal to the amount of water it intends to consumptively use in the next year, by paying the Secretary for the CAP fixed operations, maintenance, and replacement (OM&R) charge and the CAP pumping energy charge for water delivered to downstream users in exchange for consumptive use in New Mexico. This is identified as the Federal rate for CAP water. The 2020 rate is $155 per AF.[9]

Consumptive Use and Forbearance Agreement (CUFA)

The AWSA water diverted by the NM Unit would be subject to the CUFA, an agreement among the GRIC, SCIDD, U.S., and numerous other parties, which Congress approved, authorized, and confirmed in AWSA Section 212(b). It describes how the CAP water exchange would work and the timing, amounts, bypass, and available credits that must be met for New Mexico users to be able to divert the AWSA water. The CUFA enables New Mexico to develop an average of 14,000 AF per year over a rolling 10-year average without objection by the CUFA parties.

As described above, pursuant to the CUFA, the Secretary, through Reclamation, would provide NM CAP water to downstream Gila River water users in Arizona in exchange for the consumptive use of the AWSA water by users in New Mexico. To fully protect downstream users in New Mexico and Arizona, certain minimum flows must be bypassed each day of each year. Moreover, New Mexico users could not divert water unless the San Carlos Reservoir in Arizona had reached 30,000 AF in storage that year. Additionally, the CUFA limits the maximum AWSA diversion rate to 350 cfs. Applicable laws, regulations, permitting processes, water rights, and contracts also govern AWSA diversions.

Per CUFA Section 12.4, the parties to the CUFA would establish a Technical Committee to address and resolve technical issues that may arise regarding CUFA implementation, including, but not limited to, timing and methodology for measurement and accounting for stream flow, diversions, and return flows; determination of the timing and impact of groundwater pumping as part of the NM Unit on river flows; and other issues agreed upon by the CUFA parties. Although not a party to the CUFA, the Entity would be allowed to participate as a member of the Technical Committee. The Technical Committee has not yet been formed. Under all alternatives, it is assumed that technical issues regarding CUFA implementation would be addressed and resolved by agreement through the authorities granted to the Technical Committee.

Contracts

Pursuant to the AWSA, under all action alternatives, the Secretary shall offer to contract with water users in the State of New Mexico for AWSA water, with the approval of the ISC. In accordance with the AWSA and the NM Unit Agreement, the Secretary, acting through Reclamation, and the Entity would negotiate and execute a water service contract and water delivery contracts prior to the commencement of any deliveries of the AWSA water. Reclamation would publish a notice in the *Federal Register* and make the water service contract available for public review and comment. Also, per the NM Unit Agreement, construction contracts, construction funding contracts, and an O&M transfer contract would be negotiated if a NM Unit would be constructed. The ISC would have to approve all such negotiated contracts.

[9] Projected rates are not guaranteed and are subject to change. Current, historical, and projected rates are available on the CAP website at https://www.cap-az.com/documents/departments/finance/Final-2020-2024-Water-Rate-Schedule-BaseCase-06-06-19.pdf

The NM Unit Agreement stipulates that the Entity shall demonstrate financial viability prior to execution of construction contracts and construction funding contracts, water service contracts, and the O&M transfer contract. Reclamation and the Entity would negotiate and agree on an objective standard, including costs and revenue streams, to determine the Entity's financial viability (NM Unit Agreement, Section 9, Supplemental Terms). Reclamation and the Entity have yet to negotiate the contracts and terms.

Construction and Operations Assumptions

As specified in the NM Unit agreement, planning, design, construction, and O&M of the NM Unit would, at a minimum, be in accordance with applicable Reclamation standards. "Reclamation standards" refer to design standards and construction specifications that Reclamation has developed for critical infrastructure such as dams, canals, pipelines, flood channels, structures, embankments, and others to ensure that project components with the potential to affect life and property are designed and constructed properly.[10] Components that facilitate implementation of the AWSA and CUFA, such as flow measurement devices, must also comply with Reclamation standards and requirements. Applicable design standards and construction specifications would be addressed as part of design and construction contracting and could result in further refinements in constructing and operating the proposed NM Unit. **Appendix C**, Best Management Practices and Standard Operating Procedures, contains standard best management practices (BMPs) that may be implemented.

Construction of the NM Unit components may be implemented at different times and locations based on funding availability, permitting needs, mitigations, contracting, season, and other factors. Given lack of data on the construction and O&M specifics of the NM Unit at this time, certain assumptions were made to allow the impacts to be analyzed in this EIS, including assumptions on funding sources. Wherever there was an uncertainty regarding the implementation of the Proposed Action, the Joint Leads first contacted the Entity for information or clarification. If the Entity was unable to provide adequate data, then the Joint Leads made assumptions solely for the purpose of the resource topics analyzed in this EIS. Comparable assumptions were also made for the other action alternatives. An example of this process is as follows.

In order to estimate the amount of AWSA water that the project could put to consumptive use, the Joint Leads asked the Entity to identify acres for potential irrigation using AWSA water. The Entity provided target irrigation demands and acres of lands typically underserved by existing water rights. These acreages are called "potential AWSA lands" herein. In addition, the Entity formally indicated to the Joint Leads its desire to use AWSA water as supplemental to existing water supplies to increase productivity or to offset shortages; however, for this part of its Proposed Action, the Entity did not provide any additional information or assumptions on the timing and delivery of the AWSA water.

The Joint Leads considered the use of AWSA water under two discrete modeling scenarios: 1) to supply potential AWSA lands only; and 2) to supply potential AWSA lands and to supplement the irrigation of currently irrigated lands that use adjudicated/Decree water. As part of the second scenario, it was assumed that, after the potential AWSA lands needs have been met, any excess stored AWSA water would be released from the ponds to offset shortages on lands irrigated using the adjudicated/Decree water, until the storage nears zero.

[10] See https://www.usbr.gov/tsc/techreferences/designstandards-datacollectionguides/designstandards.html.

Under both scenarios, only the AWSA water would be stored in the proposed ponds and reservoirs. The operation of the storage ponds could include incremental diversions, resulting in an option for ponds to be filled, drawn upon, and refilled. Ponds may or may not be emptied between diversion occurrences.

Preliminary modeling of the second scenario showed insignificant changes in diversion timing and amounts when compared to the results of the first scenario. After careful consideration of the preliminary data, and in recognition of the time and budget constraints on the EIS, the Joint Leads decided to use the hydrological modeling results from the first scenario in the impacts analysis for this EIS.

As noted in **Section 2.2**, Alternatives Development and Screening Process, because the AWSA water delivery contracts do not yet exist, the precise water delivery locations and irrigation facilities needed to deliver the AWSA water at those locations are currently unknown; therefore, the potential AWSA lands identified and provided by the Entity have been used solely for hydrological modeling purposes. This EIS analysis does not intend to speculate on specific locations where the AWSA water would be delivered. Additional site-specific environmental reviews would be conducted, as appropriate, to address any impacts of future changes, refinements, or developments not analyzed in this EIS.

AWSA Water Availability and Reliability

Assumptions regarding AWSA water availability and reliability are based on the following methods. The first step was to model the AWSA diversions under the terms of the CUFA. Historical records were used to estimate approximately how much AWSA water could have been diverted from the Gila and San Francisco Rivers on each day during the period of record (1936 to 2017), under all CUFA conditions. To ensure that New Mexico senior rights are not impacted, existing New Mexico irrigation diversions were accounted for in this diversion model, in addition to the CUFA conditions.

AWSA diversions would be expected to occur in most years. During the 82 years of the period of record, modeling shows that AWSA diversions could have occurred in all but 8 of those 82 years (almost 10 percent of years). In all of those 8 zero-diversion years, the limiting factor is the San Carlos Reservoir levels being below 30,000 AF. Six of those 8 zero-diversion years occurred during the first 18 years of the period of record (1936 to 1953), and the other 2 years occurred in the last 64 years. Pursuant to the CUFA, once the 30,000 AF limit is met, the limit is no longer applicable to the remainder of the calendar year, meaning diversions would be allowed to continue, even if the storage in San Carlos Reservoir dropped below 30,000 AF at any point later in that year.

Generally, based on the simulated operations, most AWSA diversions would occur in the months outside the irrigation season (i.e., October through March). The monthly AWSA diversion reliability in December, January, and February is higher than in the rest of the year; however, the Entity has indicated that, if the CUFA conditions were met anytime during the year, and storage capacity was available, the Entity might choose to divert AWSA water at any time. The stored AWSA water could then be released to meet irrigation needs in the same year, or it could be retained for use in the next year.

The timing of AWSA water availability in a given calendar year may also affect the AWSA diversions. For example, in 2013, modeling shows that diversions would not have been allowable under the CUFA until October. In such a circumstance, the Entity may choose to forego diverting for the rest of the calendar year, or it may choose to divert and store the AWSA water over the winter, as described above.

This carry-over storage may make some AWSA water available in the early part of the irrigation season, depending on the irrigation method and crop type; however, AWSA water may not be available to fully meet the irrigation demands. Depending on the available storage volume at the start of the calendar year and how much AWSA water was diverted in the first half of the year to refill storage, there may not be AWSA water available later in the irrigation season, especially during the summer months.

Estimated evaporative losses make up part of the credits that the Entity must purchase by paying the Secretary for the CAP water exchange, pursuant to CUFA Section 6. Due to the cost associated with evaporation, the Entity may decide not to store AWSA water over extended time periods. Under the scenario modeled for this EIS, the average annual evaporation accounts for about one-third of all AWSA water consumptively used; therefore, infrastructure capacity, timing, acreage, or evaporation could limit the Entity's ability to divert and store the maximum amount of AWSA water at times when that water may be otherwise available for diversion within CUFA requirements.

Reclamation (2011), Garfin (2014), and Gutzler (2013 and 2016) have used Global Climate Models coupled with hydrologic models to project future hydrology in the Gila basin for the next 30 to 50 years. While it remains difficult to downscale analyses to the local level and to precisely quantify future variability in streamflow timing and magnitude, three common themes arose from these works:

- Lower overall water supply
- Higher variability in extreme conditions of floods and droughts
- Higher uncertainty in projecting monsoon contributions to water supply

The Gila River is projected to have an average annual decrease in flow of 6 percent to 8 percent, while the San Francisco River is projected to have an average annual decrease of 11 percent. Future projections also indicate shifting of the spring snowmelt earlier in the year, which would affect the overall AWSA diversion timeframe.

Annual extreme rainfall events are projected to increase in intensity due to higher temperatures, which can lead to increased flood events. That said, there is considerable uncertainty in the Global Climate Models projections, particularly in projecting monsoon contributions to water supply, and there are known deficiencies in the capability of these models to replicate certain historical aspects.

2.4.3 Alternative B: Entity Proposed Action

Alternative B describes the facilities and components that the Entity has proposed (**Appendix A**, **Map 1-1** [Project Vicinity]). The proposed infrastructure is designed to improve agricultural use and efficiency in three locations on the Gila and San Francisco Rivers and allow for consumptive use of AWSA water when available under the CUFA. It is intended to provide capability for future expansion for beneficial purposes consistent with the CRBPA and the AWSA. The current Proposed Action was defined by the Entity after review of preliminary impact and cost analysis. The Entity submitted the current Proposed Action to the Joint Leads in July 2019, and further refined it through August 2019.

On October 21, 2019, the Entity sent a letter to the Joint Leads requesting "…that the joint leads designate Alternative D, the 'Virden only' alternative, as the Preferred Alternative in the final EIS. The NM CAP Entity is not requesting a change to its [July 2019] Proposed Action." The Joint Leads have not identified a preferred alternative for this EIS. The Joint Leads will consider public comment before identifying a preferred alternative in the Final EIS.

Cliff-Gila Location

Cliff-Gila Diversion As described above, irrigators at the Cliff-Gila location currently divert their water using earthen push-up diversions. As part of the Proposed Action, three existing push-up diversions would be replaced with one permanent diversion located on private property approximately 500 feet upstream of the existing Upper Gila Diversion. The new permanent diversion structure would replace the function of the existing Upper Gila, Fort West, and Gila Farms Diversions for diverting adjudicated water, while also diverting AWSA water (**Appendix A, Map 2-6** [Alternative B: Cliff-Gila Components]). As part of permitting the diversion structure with the NMOSE, the Entity would negotiate an agreement with local irrigators to divert both adjudicated and AWSA water through this structure.

The proposed diversion structure is a fixed crest weir with a 60-foot engineered fill riffle rundown[11] (**Figure 2-4** [Fixed Crest Weir with Engineered Riffle Rundown – Plan View]). The diversion structure would consist of a 155-foot reinforced concrete weir wall spanning the channel approximately at a height of 3 feet above the riverbed, with a 2-foot-deep, 20-foot-wide depressed center weir section, or notch, extending across the main channel of the Gila River. The top of the depressed notch would be approximately 1 foot above the deepest part of the existing river channel.

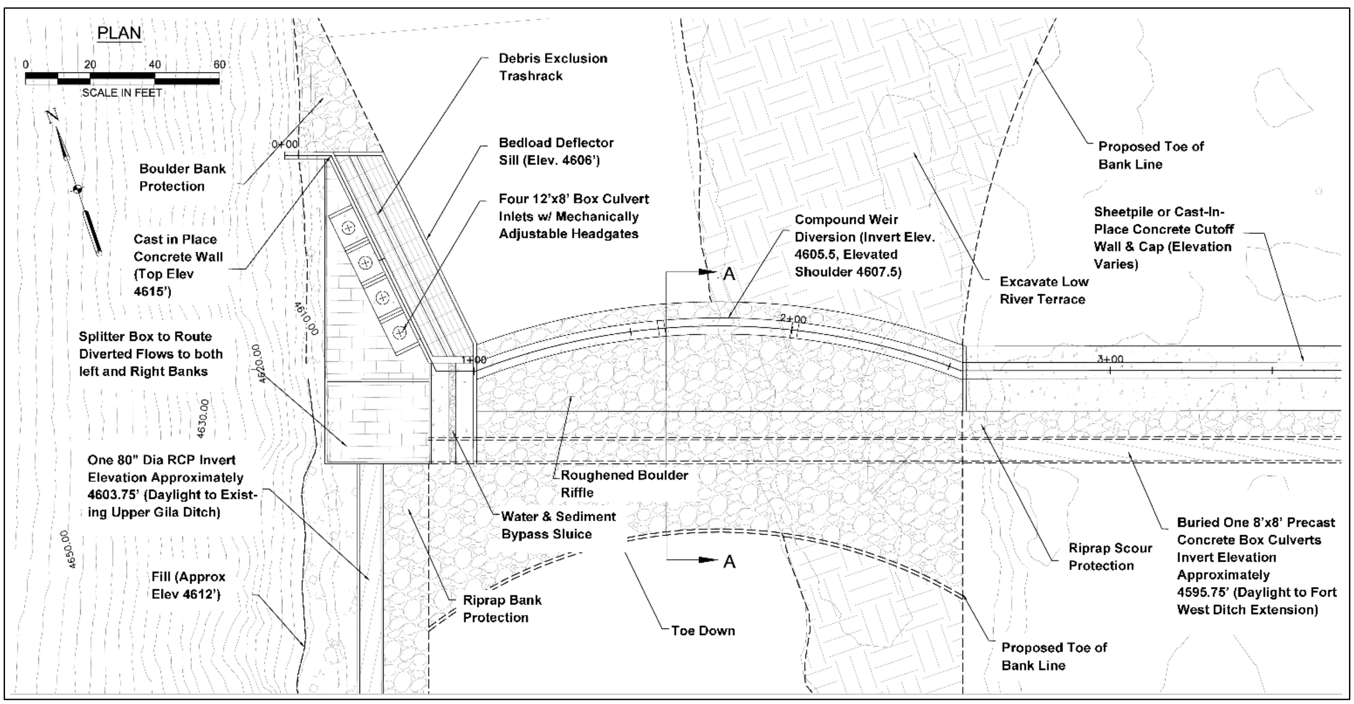

Figure 2-4. Fixed Crest Weir with Engineered Riffle Rundown - Plan View (excerpted from the Draft Upper Gila Diversion engineering drawings for Cliff–Gila location – Proposed Action)

A series of intakes would be located along the west riverbank, along with sediment and debris exclusion facilities. The maximum diversion rate would be 125 cfs. The diversion structure would include an 8-foot by 8-foot box culvert buried siphon to convey diverted water to the east side of the river. The Upper Gila Ditch and Fort West Ditch would both be extended and tied into the diversion structure via a buried pipe and an open ditch, respectively.

[11] Weir: a low dam built across a river to raise the level of water upstream or regulate flow. Riffle rundown: a constructed rocky or shallow part of a stream or river to dissipate energy and provide erosion control.

To control downstream scour and provide fish passage, an engineered fill boulder riffle rundown would be constructed using a mix of large, immobile boulders and smaller native alluvium. The riffle rundown would be shaped to the river channel immediately downstream from the diversion weir. The top end of the approximately 60-foot-long boulder riffle would be flush with the low-flow notch to allow fish passage and would slope at an approximate rate of 1:60 to tie back into the stream channel (Stantec 2018a, 2018b). The final design of the diversion structure would consider and incorporate Reclamation guidelines for fish passage (Reclamation 2007). The final slope and length of the rundown and substrate type would be determined based on site-specific conditions, including fish passage needs. Riprap[12] bank protection would be installed immediately downstream of the diversion weir. The new diversion structure and abutments would key into the depth of scour, or bedrock, where possible.

Cutoff walls would be constructed across the 1,200-foot floodplain to ensure the river does not shift and bypass the diversion. The new diversion structure and floodplain cutoff wall would key down into the alluvium an estimated 20 feet to protect the structures from river scour erosive action. If deemed necessary by geotechnical evaluations, cutoff walls could include additional flow passage features, such as openings through the concrete or sheet piling. The top of the cutoff wall would roughly match the existing terrain across the floodplain; however, localized variability of the terrain would result in locations where the top of the cutoff wall may be above or below the existing grade.

Cliff-Gila Conveyance Table 2-1 summarizes conveyance modifications in the Cliff-Gila location. As described above, water diverted through gate-controlled intakes on the west side of the new diversion structure would be divided between the Upper Gila Ditch and across the river to the Fort West Ditch via a concrete box culvert located adjacent to the diversion structure. To connect the new diversion structure to the Upper Gila Ditch, a buried pipe totaling 3,200 linear feet (LF) with a capacity of 50 cfs would be installed and would surface into the existing Upper Gila Ditch. Approximately 9,700 LF of the Upper Gila Ditch would be widened and lined with shotcrete.[13] Ditch lining would be avoided in areas where there are stands of riparian vegetation (**Appendix A, Map 2-6** [Alternative B: Cliff-Gila Components]).

Table 2-1. Cliff-Gila Location Ditch Additions/Modifications

Ditch	Piped Extension (LF)	Lined Extension (LF)	Widen and Line Existing (LF)	Widen Existing (LF)	Total Modification (LF)
Upper Gila Ditch	3,200	0	9,700	0	12,900
Fort West Ditch	0	4,200	16,000	0	20,200
Gila Farms Ditch	0	0	3,900	0	3,900
Fort West/Gila Farms Connection	0	0	2,500	0	2,500
McMillen Ditch	0	0	0	9,700	9,700
Total	**3,200**	**4,200**	**32,100**	**9,700**	**49,200**

Source: Stantec 2018c

[12] Riprap: rock or other material placed to armor streambeds against scour and water erosion.
[13] Shotcrete is an all-inclusive term for spraying concrete or mortar with either a dry or wet mix process.

The Fort West Ditch would be extended to connect to the new diversion structure. The new extension of the Fort West Ditch, totaling 4,200 LF, would be fully lined using shotcrete. A 48-inch diameter siphon measuring 520 LF of the extension would be constructed to cross Spar Canyon.

Approximately 16,000 LF of the existing Fort West Ditch, from the end point of the extension to the start point of the Gila Farms Connector, would be widened and lined using shotcrete. Lining would be avoided in areas where there is existing riparian vegetation along the ditch to keep vegetation supplied with water. The Upper Gila and Fort West Ditches would deliver AWSA water to four surface storage ponds. The capacity of the existing Fort West Ditch would be increased to 75 cfs. The capacity of the existing Upper Gila Ditch would remain the same (50 cfs).

The Fort West/Gila Farms Connector is an abandoned ditch that would be reconstructed, widened, and lined with shotcrete. The reconstructed portion of the connector would measure approximately 2,500 LF and accommodate up to 25 cfs to supply the Gila Farms Ditch. In addition, approximately 3,900 LF of the existing Gila Farms Ditch would be widened and lined using shotcrete.

On the west side of the river, a 9,700-LF portion of the McMillen Ditch, starting from the intersection with the Upper Gila Ditch, would be reconstructed with a capacity of 13 cfs (**Appendix A, Map 2-6** [Alternative B: Cliff-Gila Components]; Stantec 2018b).

Cliff-Gila Storage Under Alternative B, the Entity would excavate four off-channel gravity-fed storage ponds within the Cliff-Gila Valley lined with clay (4P, 5P, 7P, and 8P; **Appendix A, Map 2-6** [Alternative B: Cliff-Gila Components]) with a total AWSA water storage capacity of approximately 1,890 AF. The approximate pond surface areas are 30 acres (4P), 38 acres (5P), 25 acres (7P), and 94 acres (8P). All ponds would use gravity to move water from the ditches into storage. Ponds 4P and 5P would use gravity to move water out of storage into ditches, while Ponds 7P and 8P would use pumps. Outfall pipes and gates would discharge water back into the ditches.

Cliff-Gila Production Wells This alternative includes five wells for diversion and/or alternative delivery to irrigators through ditches (**Appendix A, Map 2-6** [Alternative B: Cliff-Gila Components]). Well depth is estimated to be 120 feet. The total amount of water pumped by the five wells would be approximately 332 AFY (Stantec 2019a). No specific pumping schedule for the individual wells has been determined; however, the wells would be constructed for a maximum capacity of 500 gallons per minute (gpm) for each well. The production wells would be used as AWSA points of diversion in accordance with CUFA conditions. The main intent of these wells would be to provide a pressurized source of water for sprinkler or drip irrigation methods. The Entity has indicated that, at times when the wells cannot be operated as a direct point of diversion in accordance with CUFA, stored AWSA water from storage ponds would be released into the river to offset the pumped amounts. The timing and amount of such releases have not been determined in the Proposed Action.

Generally, water could be supplied more cost effectively by releasing the stored water from the ponds to the ditches; however, the production wells could also discharge directly to the ditches, if needed. That is, during periods when CUFA allowed diversions, AWSA water could be pumped into the ditches for surface irrigation in the event water was unavailable for release from storage, or if there was a temporary loss of the ability to divert from the surface diversion structure (Stantec 2019a**)**. The timing of impacts on the river that result from operating the production wells would be considered prior to operation.

Cliff-Gila Power The electrical load for the production well pumps and wells on the west side of the Cliff-Gila Valley would not likely exceed the load capacity of the closest existing overhead power line. The existing power line on the south side of the Cliff-Gila Valley also has sufficient capacity to power the two pond pumps and the production well pump for that side of the valley. Possible tie-ins to new facilities are depicted in (**Appendix A, Map 2-6** [Alternative B: Cliff-Gila Components]). The local power company has not determined the exact power line alignments or the final power needs; however, these would be developed as the project design is refined.

Cliff-Gila Construction Access and supporting sites would be further refined, and necessary approvals and permits obtained, prior to construction. For components within the Cliff-Gila Valley, the Entity anticipates using local existing roads and previously disturbed areas with minor improvements. The Entity has identified and mapped potential local material source sites (**Appendix A, Map 2-6** [Alternative B: Cliff-Gila Components]). Offsite spoils or disposal sites outside of construction disturbance areas are not anticipated.

Cliff-Gila Operational Assumptions The diversion structure and ditches would be used to divert and convey both AWSA water and adjudicated water. The estimated annual AWSA diversion would include amounts diverted from the production wells.

The maximum AWSA diversion rate is 125 cfs. The proposed maximum estimated average annual AWSA diversion at the Cliff-Gila location is 1,969 AF. The proposed estimated average annual return flow to the river is 588 AF. The proposed average annual total consumptive use of AWSA water is estimated at 1,425 AF at the Cliff-Gila location under Alternative B (HDR 2019a).

Annual Average AWSA Diversion*—The actual annual amount of water projected to be diverted under operational restrictions and infrastructure capabilities. Diversions can be incremental; therefore, diversions can exceed the total storage capacity.*

Total Consumptive Use*—Measured diversions pursuant to the CUFA, minus return flows. This definition of "Total Consumptive Use" in CUFA Paragraph 2.15 includes reservoir evaporation losses as required by Section 304(f) of the Colorado River Basin Project Act; therefore, Total Consumptive Use = Consumptive Use + Reservoir/Pond Evaporation.*

Return flow*—Water that returns to the river after it has been applied to beneficial use. Return flows may return as surface flow or as an inflow of tributary groundwater.*

Virden Location

Virden Diversion The existing Sunset and New Model Diversions would be used without any modifications. The maximum surface diversion capacity at each of these facilities is 35 cfs.

Virden Conveyance In the Virden location, water would be diverted through the existing diversion structures and conveyed through existing canals. Gated gravity-fed inlets from the canals would drain into new surface storage. Pumps would discharge water from the ponds back into the canals. Alternative B does not include any canal modifications.

Virden Storage Under Alternative B, the Entity proposes two gravity-fed storage ponds lined with clay and associated pumping facilities (**Appendix A, Map 2-7** [Alternatives B, C, D, and E: Virden Components]). The 10P and 11P storage ponds would be constructed directly adjacent to the New Model and Sunset Canals in the Virden Valley. The Sunset Canal is north of the Gila River, and Pond 10P would be approximately 2.5 miles downstream of the Sunset Diversion. The lined Pond 10P would be 21 feet deep with approximately 260 AF of storage volume. A pump station would be required to lift water back into the Sunset Canal. The New Model Canal is south of the Gila River, and Pond 11P would be approximately 3 miles downstream of the New Model Diversion. Pond 11P would be 31 feet deep with approximately 290 AF of storage volume, requiring a pump station to lift water back into the New Model Canal. The total proposed storage capacity is 551 AF.

Virden Power Existing power lines could support the electrical load for the proposed lift pumps at Ponds 10P and 11P. Power for Pond 10P would require a 500-foot extension from the existing power line. The power line that would serve Pond 11P is currently aligned through the middle of the proposed pond location and would require realignment of approximately 2,100 feet of line. Final routes of the proposed power lines would be developed as the project design is refined in collaboration with the local utility.

Virden Construction The proposed ponds, pump stations, and construction supporting areas would be on private land with close access from public roads. BLM-administered lands are adjacent to anticipated construction disturbance areas at both pond locations, but no direct disturbance is planned on BLM-administered lands. The administrative boundary of the Blue Creek Wilderness Study Area (WSA) abuts the Pond 11P spoils disposal area, but the WSA would not be directly disturbed. Access and supporting sites would be further refined, and necessary approvals and permits obtained, prior to construction.

Virden Operational Assumptions Existing diversion structures would be used to divert AWSA water, in addition to diverting Decree water. The maximum AWSA diversion rate is 20 cfs per structure, with the maximum capacity of 35 cfs per structure for conveying both AWSA water and Decree water. The proposed estimated average annual AWSA diversion at the Virden location is 481 AF. The proposed estimated annual return flow to the river is 141 AF. The proposed estimated total consumptive use of AWSA water is 349 AF at the Virden location (HDR 2019a).

San Francisco Location

San Francisco Diversion At the San Francisco location, there are four existing agricultural diversions conveying adjudicated water. Spurgeon Ditch #2 and Thomason Flat Ditch are supplied by push-up diversions.

At or near the site of the existing Spurgeon Ditch #2 push-up diversion, a permanent fixed crest weir diversion structure with an engineered fill riffle rundown would be constructed, replacing the two push-up diversions (**Appendix A, Map 2-8** [Alternative B: San Francisco Components]). The 55-foot-long reinforced concrete weir wall would extend across the main San Francisco River channel with a 1-foot-deep, approximately 10-foot-wide, depressed section along the east side of the weir. The structure would be low profile, generally raising the river level by 1 foot.

To control downstream scour and provide fish passage, a boulder riffle rundown would be constructed using a mix of large, immobile boulders and smaller native alluvium. The toe of the riffle rundown would be keyed into the depth of scour or tie into bedrock, where possible. The upstream end of the 20-foot-long boulder riffle rundown would be flush with the low-flow notch to allow fish passage and would slope to tie back into the stream channel on the downstream end (Stantec 2019b). The final design of the diversion structure would consider and incorporate Reclamation guidelines for fish passage (Reclamation 2007). The final slope and length of the rundown and substrate type would be determined based on site-specific conditions, including fish passage needs. Riprap bank protection is planned immediately downstream of the diversion weir.

Cutoff walls, constructed of sheetpile or cast concrete, would be required to prevent piping, channel avulsion, and lateral bypass of the control section. The new diversion structure and abutments would key down to below the depth of scour or tie to bedrock, where possible. Cutoff walls would be used across the floodplain to an estimated depth of approximately 20 feet and a length of approximately 335 feet, including the diversion structure. The depth of alluvium would allow subsurface flow to pass unimpeded beneath the structure, but cutoff walls could have additional flow passage features included, such as openings through the concrete or sheet piling, if needed. The top of the cutoff wall would roughly match the existing terrain across the floodplain; however, localized variability of the terrain would result in locations where the top of the cutoff wall may be above or below the existing grade.

A series of three gate-controlled intakes on the east side would be constructed, along with sediment- and debris-exclusion facilities. Two concrete box culvert siphons (each 4 feet by 4 feet) at the diversion facility would carry diverted water to the west side of the river and would accommodate delivery of adjudicated water and AWSA water through a pipeline to Thomason Flat Ditch. On the east side, no AWSA water and only adjudicated water would be delivered to the Spurgeon #2 Ditch. The maximum AWSA diversion rate would be 20 cfs.

San Francisco Conveyance The new Spurgeon diversion structure would channel river water to the west side of the river through a gated control structure. To provide irrigation water to the west side of the river, a 2,500-LF, 36-inch diameter pipe would be installed starting at the diversion structure and following the county-maintained Alma Mesa Road. The pipeline would include a 36-inch siphon with 20 cfs capacity under Pueblo Creek to the existing Thomason Flat Ditch heading. The Thomason Flat Ditch would retain a capacity of approximately 20 cfs through maintenance, and there would be no planned widening or lining. A downstream portion of the Thomason Flat Ditch, described below, would be used temporarily as an access route and rebuilt after construction. No conveyance improvements would be made to other ditches in the San Francisco location under the Proposed Action (**Appendix A, Map 2-8** [Alternative B: San Francisco Components]).

San Francisco Storage No AWSA surface storage would be constructed at the San Francisco location under Alternative B; only direct use is proposed.

San Francisco Power There would be no new power needs for the San Francisco location under Alternative B.

San Francisco Construction There would be a temporary closure of approximately 2,000 feet of Alma Mesa Road from U.S. Highway 180 to Pueblo Creek to allow for construction of the pipeline from the new diversion structure to the Thomason Flat Ditch. This construction would be completed within a total period of 3 months and would be built outside of the irrigation season. Prior to initiating the pipeline construction, a temporary road near Mills Canyon with a culvert crossing at the San Francisco River would provide access from U.S. Highway 180 for vehicle and construction traffic. After crossing the river, the temporary access road would continue south along the east side of the Thomason Flat Ditch from where it meets the temporary river crossing. After approximately 1,000 feet, the road would be ramped up to the top of the ditch. The ditch would be temporarily reconstructed for another 1,000 feet as a roadway approximately 15 to 18 feet wide and filled in with material from onsite. This temporary roadway would connect to the Thompson Tank Road (**Appendix A, Map 2-8** [Alternative B: San Francisco Components]). All portions of the temporary crossing and access road would be eliminated, and the Thomason Flat Ditch would be restored following completion of the pipeline and re-opening of Alma Mesa Road. No offsite source or disposal areas would be needed outside of construction disturbance areas.

San Francisco Operational Assumptions The Spurgeon diversion structure would deliver water to both the west and east sides of the river. Both AWSA and adjudicated water would be conveyed to the west side of the river, while the east side would receive only adjudicated water. The maximum AWSA diversion rate would be 20 cfs. Because there would be no storage facilities, all AWSA water would be direct use when available under the CUFA. The proposed average annual AWSA diversion at the San Francisco location is estimated at 11 AF. The proposed estimated the annual return flow to the river is 3 AF. The proposed estimated total consumptive use of AWSA water is 8 AF at the San Francisco location (HDR 2019a).

2.4.4 Alternative C

Alternative C was developed based on public scoping comments. It would replace the use of existing earthen push-up diversions in the Cliff-Gila and San Francisco locations with rock vane weir diversions and would retain the existing ditch configuration without lining or expansion. This alternative does not include production wells in the Cliff-Gila Valley. Alternative C would construct a reservoir in the San Francisco location in Weedy Canyon with a storage capacity of 600 AF. In Virden, due to adequate existing permanent diversion structures and conveyance, components and operation would be the same as under Alternative B.

Cliff-Gila Location

Cliff-Gila Diversion Three rock vane weir diversions would be constructed to replace existing earthen push-up diversions used on the mainstem of the Gila River at the Upper Gila, Fort West, and Gila Farms Ditch headings. Rock vane weirs are rock structures typically spanning a stream channel. There are several different configurations that are frequently used. For this alternative, it is assumed that each of the three diversion structures would be constructed from rocks arranged in a "V" shape with the narrow point of the "V" pointing upstream (**Figure 2-5** [Rock Vane Weir Diversion Conceptual Design Example 5]). The downstream, or wide end of the "V" would span approximately 90 feet across the floodplain. The structure would raise the water surface elevation to allow water to divert into ditches. The structure would extend approximately 90 feet down the river. The top of the rock would be approximately 2 feet above the deepest part of the existing river channel. Rock vane weir structures potentially permit fish passage over diversions and create aquatic habitat. Since the direction of flow over the rocks is toward the center of the stream, the erosion potential to the banks is reduced. Additionally, the upward sloping of the legs in the downstream direction captures sediment and debris, rebuilding and stabilizing the banks.

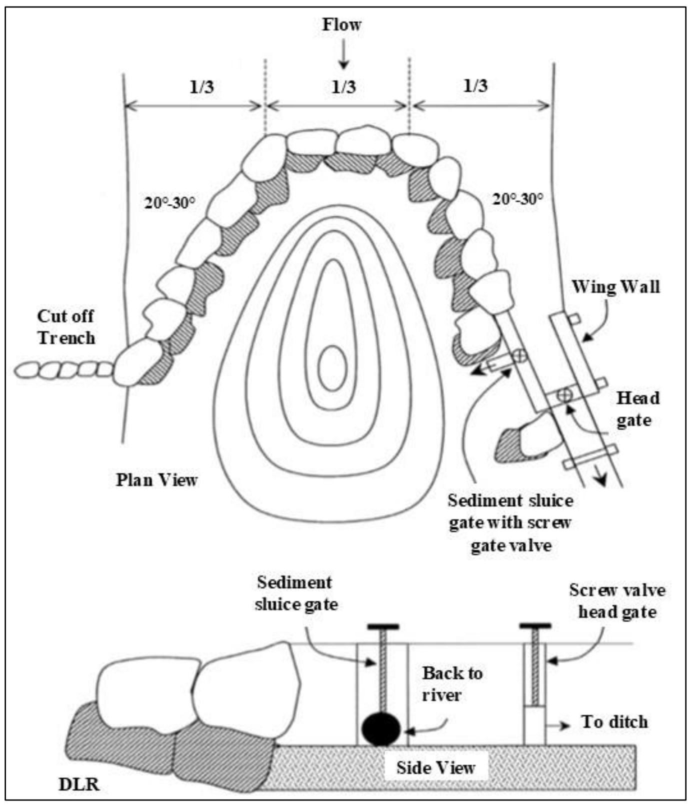

Figure 2-5. Rock Vane Weir Diversion Conceptual Design Example 5

No cutoff walls are proposed, consistent with public scoping comments; however, at higher flows, there is potential for the river to flank the structures and for the rocks to dislodge and move downstream and compromise structure integrity and effectiveness. After high-flow events, depending on their intensity, maintenance and repair using heavy equipment in the river could be necessary.

Appendix A, Map 2-9 (Alternative C: Cliff-Gila Components) shows the approximate locations of the proposed rock weir diversion structures that would continue to be on private land. Both adjudicated and AWSA water would be routed into ditches in a similar fashion as the current push-up diversions. Because of the proposed use of loose rock, intake gates would not be incorporated into the diversion structures. Flow measurement and overflow turnouts for return flows back to the river would be incorporated into the ditches downstream of the diversion. The final design of the diversion structures would consider and incorporate Reclamation guidelines for Rock Weir Design (Reclamation 2016).

Cliff-Gila Conveyance Water from the diversion structures would be diverted into the existing ditch system for direct use or into new gravity-fed storage ponds for later use. For Alternative C, ditches would not be widened or lined, and only minimum modifications and repairs would be implemented to connect infrastructure and maintain conveyance capacity. Water from the diversion structures to the four new storage ponds in the Cliff-Gila Valley would travel through the existing Fort West Ditch and Upper Gila Ditch via gravity flow. Delivery of AWSA water from storage ponds to agricultural users would be similar to that under Alternative B, with outlet lines feeding into existing ditches.

Cliff-Gila Storage Under Alternative C, four gravity-fed and clay-lined surface storage ponds (4P, 5P, 7P, and 8P) would be constructed as described in Alternative B (**Appendix A, Map 2-9** [Alternative C: Cliff-Gila Components]). The maximum surface storage capacity for the four ponds would be 1,890 AF. Ponds 7P and 8P would require pumping to discharge water back into the ditches.

Cliff-Gila Production Wells No production wells would be constructed.

Cliff-Gila Construction Access and supporting sites would be further defined, and the necessary approvals and permits obtained, prior to construction. Local existing roads and previously disturbed areas would be used with minor improvements. Temporary construction activities would include construction access, stream diversion, dewatering, excavation, spoil piles, and laydown areas. Some of these activities would occur within the floodplain. Because rock vane weirs are made up of loose rocks, they should not be considered permanent structures. Based on historical data (Reclamation 2016), it is assumed that comprehensive repairs of the rock vane weir structures would periodically be needed, requiring access to the sites for the operation, maintenance, and importation of rock for the diversion structure. Potential local material source and disposal sites would be as defined under Alternative B, but rocks could also be supplied from outside sources (**Appendix A, Map 2-9** [Alternative C: Cliff-Gila Components]).

Cliff-Gila Power needs would be similar to Alternative B. Power line routes would be developed as the project design is refined in collaboration with the local utility.

Cliff-Gila Operational Assumptions The diversion structures would be used to divert both AWSA water and adjudicated water. The proposed combined maximum AWSA surface diversion rate is 125 cfs for all three structures. Ditches would be maintained, and sediment removed to ensure adequate capacity. Operational assumptions for Alternative C storage ponds are consistent with those for Alternative B. The proposed average annual AWSA diversion at the Cliff-Gila location is estimated at 1,825 AF. The proposed estimated annual return flow to the river is 636 AF. The proposed total consumptive use of AWSA water is estimated at 1,321 AF at the Cliff-Gila location (HDR 2019a). For the purposes of this analysis, it is assumed that structural maintenance would be required up to three times per year, each consisting of delivery and placement of one truckload of rock (approximately 12 cubic yards). It is also assumed that each of the structures would need to be rebuilt every 5 years, with 30 percent of the existing rock being salvageable (Reclamation 2016).

Virden Location

All Virden Location components and operational assumptions would be the same as under Alternative B (**Appendix A, Map 2-7** [Alternatives B, C, D, and E: Virden Components]).

San Francisco Location

San Francisco Diversion The approximate location of the proposed components in the San Francisco River area under Alternative C is shown on **Appendix A, Map 2-10** (Alternative C: San Francisco Components). One rock vane weir diversion structure would be installed at the Thomason Flat Ditch head for diverting both adjudicated and AWSA water, replacing the use of an earthen push-up diversion at that location. The design and dimensions would be the same as those described above for the Alternative C *Cliff-Gila Diversion* and would be designed to allow base flow, allow sediment transport, and potentially permit fish movement. The structure would be constructed from rocks arranged in "V" shape, with the narrow point of the "V" pointing upstream. The downstream, or wide end of the "V," would span approximately 90 feet across the floodplain. The structure would raise the water surface elevation to allow water to divert into ditches. The structure would extend approximately 90 feet down the river. The top of the rock would be approximately 2 feet above the deepest part of the existing river channel.

There would be no new diversion structure at the current Spurgeon location for AWSA water. Irrigators would continue to use a push-up diversion for conveyance of adjudicated water only to Spurgeon Ditch #2 on the east side of the San Francisco River. The existing W-S and Pleasanton East-side Diversion Structures would be used with no modifications to capture AWSA water releases from the proposed Weedy Reservoir and to divert adjudicated water. The structures have current diversion capacities of up to 30 and 20 cfs, respectively.

San Francisco Conveyance The capacity of a segment of the Thomason Flat Ditch would be widened to convey up to 40 cfs from the diversion structure to a proposed AWSA storage reservoir in Weedy Canyon. The ditch would remain unlined. A pump station, connector ditch, and pipelines would be constructed to convey and release AWSA water to and from the proposed Weedy Reservoir. Calls for AWSA water would be supplied by releasing stored water from the reservoir downstream segments of the Thomason Flat Ditch or back into the San Francisco River and allowing water to flow downstream to the W-S Diversion and/or the Pleasanton East-Side Diversion Structure, where it would be distributed into ditches for agricultural use. Adjudicated water would also continue to be diverted at the Thomason Flat, W-S, and Pleasanton East-Side Diversion Structures and conveyed in existing ditches.

The existing W-S and Pleasanton East-side Ditches would be retained with no extensions and no new lining or capacity expansion. The Pleasanton West-Side Ditch would not have any ditch modifications.

San Francisco Storage Alternative C would construct an off-channel unlined reservoir in Weedy Canyon with a storage capacity of 600 AF. The embankment dam in Weedy Canyon would be located approximately 600 feet from the San Francisco River, and its footprint would be 2 acres. The embankment dam height would be 112 feet, and the length of the dam at the crest would be 581 feet. A concrete-lined spillway 125 feet wide and approximately 680 linear feet long would drain to the San Francisco River. Outfalls would allow draining to the Thomason Flat Ditch and river. The top of the active conservation pool and spillway crest elevation would be at 102 feet, and freeboard of 4 feet would be maintained above the probable maximum flood level. The reservoir footprint would be approximately 20 surface acres. The dam would be constructed with an impermeable clay core (**Appendix A, Map 2-10** [Alternative C: San Francisco Components]).

San Francisco Power A power study would be performed to confirm power needs, constraints, and existing power line capacity. A new connection and permanent easement across the valley and San Francisco River from the existing distribution line along U.S. Highway 180 would supply power for Weedy Reservoir pumps (**Appendix A, Map 2-10** [Alternative C: San Francisco Components]). Routes of any additional distribution lines would be developed as the project design is refined in collaboration with the local utility.

San Francisco Construction Temporary construction activities would include construction roads, stream diversion, dewatering, excavation, spoil piles, and laydown areas. Some of these activities would occur within the floodplain. The potential material source area for embankment construction would be adjacent to the Weedy Reservoir site. A temporary road near Mills Canyon with a culvert crossing at the San Francisco River would provide access from U.S. Highway 180 for vehicle and construction traffic. The power line would also be routed through this temporary construction road river crossing to minimize river crossings. An existing local dirt road would be widened to 60 feet wide for construction hauling from the borrow area to the dam site. This road would be restored to 24 feet wide following construction and connected to a new permanent road on top of the Weedy Dam embankment. New parking areas would be created at the top of the dam on each side of the spillway, connected by a footbridge. A new road along Thomason Flat Ditch would be created to provide O&M access to the pump station facility and diversion structure. A permanent box culvert would be installed where Alma Mesa Road crosses the Weedy Canyon wash for vehicular dam access during flood events (**Appendix A, Map 2-10** [Alternative C: San Francisco Components]).

San Francisco Operational Assumptions The rock vane diversion structure would be used to divert both AWSA water and adjudicated water with a maximum AWSA diversion rate of 40 cfs. Operation under the CUFA could include diversion methods that would allow Weedy Reservoir to be filled, drawn upon, and refilled. The W-S and Pleasanton East-Side Diversions would continue to divert adjudicated water and would divert AWSA water released from Weedy Reservoir.

The proposed average annual AWSA diversion at the San Francisco location is estimated at approximately 879 AF. The proposed estimated annual return flow to the river is 657 AF. The proposed total consumptive use of AWSA water is estimated to be 175 AF at the San Francisco location (HDR 2019a).

2.4.5 Alternative D

Alternative D does not propose any NM Unit components at the Cliff-Gila or San Francisco locations. As such, it would not provide any AWSA water to those locations but would establish the NM Unit of the CAP with AWSA water diversion and storage in the Virden Valley only, and reduce overall costs compared with other action alternatives. There are adequate existing diversion structures and conveyance components at the Virden location to access the AWSA water.

Virden Location

All Virden Location components and operational assumptions would be the same as those under Alternative B (**Appendix A, Map 2-7** [Alternatives B, C, D, and E: Virden Components]).

2.4.6 Alternative E

Alternative E incorporates components proposed by the San Francisco Soil and Water Conservation District for the San Francisco location. In addition, the Joint Leads included an alternative diversion structure design for analysis at the Cliff-Gila location and reduced the number of ponds constructed in the Cliff-Gila Valley. Facilities on the west side of the Cliff-Gila Valley would include the Winn Canyon storage ponds, aquifer storage and recovery (ASR) wells, and the 5P pond. No new pond or ditch infrastructure would be constructed on the east side of the river in the Cliff-Gila location. In the San Francisco location, a reservoir in Weedy Canyon would be built, and it would be larger than the reservoir described under Alternative C. The Pueblo Creek crossing would also be elevated, rather than a siphon and the diversion rate and conveyance capacity would be reduced, compared with Alternative B, with delivery to ditches on both sides of the river. In Virden, due to adequate existing diversion structures and conveyance, components and operation would be the same as those under Alternative B.

Cliff-Gila Location

Cliff-Gila Diversion Under Alternative E, a pneumatically adjustable Obermeyer gate diversion structure would be constructed on private property approximately 500 feet upstream of the current Upper Gila push-up diversion site. The proposed Obermeyer gate diversion would replace the existing Upper Gila push-up diversion for diverting both AWSA and adjudicated water. The gate-controlled intakes on the west side of the dam with 50 cfs of capacity would only carry diverted AWSA water to the Upper Gila Ditch with no siphon under the structure to the east side. The Fort West and Gila Farms push-up diversions would continue to be used at their current locations for adjudicated water only. **Appendix A, Map 2-11** (Alternative E: Cliff-Gila Components) shows the approximate locations of the proposed components of Alternative E in the Cliff-Gila location.

Adjustable Obermeyer gates would consist of hinged steel gates with pneumatic bladders attached to a cast concrete sill spanning the active river channel (approximately 35 feet long) constructed at the streambed level, approximately 1.5 feet above the deepest part of the existing river channel (**Figure 2-6**, Obermeyer Gate Diversion Example). Three hinged 10-foot-wide steel gates attached to the concrete sill would be raised and lowered with pneumatic bladders. These would be designed to accommodate hydraulic depths up to 6.5 feet. When the gate is down, the drop height would be 2 feet.

Figure 2-6. Obermeyer Gate Diversion Example

A cutoff wall constructed of sheetpile or cast concrete spanning the active floodplain would prevent scour-related failure, piping, channel avulsion, and lateral bypass of the diversion structure. The cutoff wall, including the diversion structure, would measure approximately l,200 feet wide and 20 feet deep across the floodplain. Alluvium depth would allow subsurface flow to pass unimpeded beneath the structures, but cutoff walls could have additional flow passage features included, if necessary, such as openings through the concrete or sheet piling. The diversion structure would include gate-controlled intakes on the west side.

The operator of the diversion structure could raise and lower the headwater elevations by raising and lowering the gates as needed to supply the intake structures. This would create opportunities for potential fish passage and reduce sediment buildup when the structure is lowered and not in operation. Additionally, the gates could be laid flat on the concrete sill during extreme flooding events when boulders and debris are mobile, minimizing the potential for damage to the structure. The air compressors associated with Obermeyer gates typically fill the bladders in approximately 1 hour. Gates could be lowered as quickly as needed by sizing release valves appropriately. The Obermeyer system would require an air compressor, a receiver tank, control valves, electrical control panels, and primary and backup power.

Cliff-Gila Conveyance One 8-foot by 8-foot precast concrete box culvert would extend from the diversion structure to the Upper Gila Ditch. The box culvert extension would measure approximately 4,200 LF and partially replace the existing ditch. There would be no widening or change in conveyance capacity of Upper Gila Ditch, but 9,700 LF of the existing ditch would be lined with shotcrete. Lining would occur in areas where riparian vegetation is not present. A 9,700-LF portion of McMillen Ditch would also be reconstructed, but remain unlined, with a 13-cfs capacity.

Other existing ditch configurations and capacities would not change. A pumping station along the Upper Gila Ditch would be required to convey water to and from the proposed 2P and 3P ponds (**Appendix A, Map 2-11** [Alternative E: Cliff-Gila Components]).

Cliff-Gila Storage There would be two unlined storage ponds proposed in Winn Canyon as surface storage and ASR basins. In addition, only one lined pond (5P) would be constructed for surface storage in the Cliff-Gila Valley. Total surface storage would be approximately 2,178 AF.

Ponds 2P and 3P in Winn Canyon would be unlined and would be used to feed an underground basin for ASR, as well as provide surface storage. These two storage/recharge ponds would be excavated upstream and downstream of an existing jurisdictional flood-sediment control dam and have a total surface storage capacity of approximately 1,820 AF. Excavation upstream of the existing jurisdictional flood-sediment control dam would provide Pond 2P's capacity. Excavation and construction of an embankment downstream of the existing jurisdictional flood-sediment control dam would provide the capacity of Pond 3P. The total storage capacity of the proposed ASR basin is estimated to be 1,050 AF. A pumping station along the Upper Gila Ditch would be required to feed these ponds. A pump would be used to convey water from the Upper Gila Ditch and recirculate water from ASR wells into storage. The flood-sediment control dam would require upgrades to meet current NMOSE dam safety standards.

Discharge from the Winn Canyon ponds into the Upper Gila Ditch would be gravity fed through 30-inch lines. The 2P embankment would be approximately 57 feet high, 4,500 feet long, and 930 feet wide. The 3P embankment would be approximately 35 feet high, 1,110 feet long, and 770 feet wide. A portion of the infiltrated water from the Winn Canyon ponds could be captured and recirculated into those ponds.

Cliff-Gila ASR Wells Three ASR wells, each 60 feet deep, would be constructed at the mouth of Winn Canyon (**Appendix A, Map 2-12** [Alternatives E: Cliff-Gila Components (ASR Detail)]). The ASR wells would capture the seepage water mound created by the infiltrated AWSA water recharged from Ponds 2P and 3P in Winn Canyon. The proposed wells would be situated to provide for operation and construction access and would be constructed to help secure the wellhead infrastructure against flood damage. Each well would have a pumping capacity of 500 gpm. The ASR wells would direct releases to the Upper Gila Ditch or back into storage. They would also provide the flexibility to use one or more of the wells as a pressurized source of clear water for irrigation by sprinkler or drip methods.

Cliff-Gila Production Wells No production wells would be constructed.

Cliff-Gila Power The electrical load for the Winn Canyon booster pumps and ASR wells would likely exceed the load capacity of the closest existing overhead power line. The Obermeyer gate diversion would require operational and backup power. On the west side of the valley, it may be necessary to construct or rehabilitate the three-phase line from Cliff Substation to Winn Pumping Station. There are no anticipated additional power needs for the east side of the Cliff-Gila Valley. Routes of power lines and facility locations would be developed as the project design is refined in collaboration with the local utility.

Cliff-Gila Construction Access and supporting sites would be further defined, and necessary approvals and permits obtained, prior to construction. For components within the Cliff-Gila location, the local existing roads and previously disturbed areas would be used with minor improvements. Temporary construction activities would include excavation, general construction activities, stream diversion, and dewatering. The Entity identified and mapped potential local material source and disposal sites (**Appendix A, Map 2-11** [Alternative E: Cliff-Gila Components]). Material for the 2P and 3P pond embankments in Winn Canyon would be obtained on site or by excavating upstream of the existing flood-sediment control dam.

Cliff-Gila Operational Assumptions The proposed Obermeyer gate diversion would divert both AWSA and adjudicated water, while the Fort West and Gila Farms push-up diversions would continue to be used for adjudicated water only. The proposed AWSA diversion rate for Alternative E would be 50 cfs. The proposed average annual AWSA diversion at the Cliff-Gila location is estimated at approximately 1,329 AF. The proposed estimated annual return flow to the river would be 445 AF. The proposed total consumptive use of AWSA water is estimated at 927 AF at the Cliff-Gila location (HDR 2019a).

Virden Location

All Virden Location components and operational assumptions would be the same as those under Alternative B (**Appendix A, Map 2-7** [Alternatives B, C, D, and E: Virden Components]).

San Francisco Location

San Francisco Diversion Alternative E would include a fixed crest weir diversion with 20-foot-long engineered fill riffle rundown at the existing Spurgeon Ditch #2 diversion on private property. The new permanent structure would replace the existing push-up diversions at Spurgeon Ditch #2 and Thomason Flat Ditch. The fixed crest weir diversion would have the same specifications as the diversion described in Alternative B, except the diversion rate would be reduced from 40 cfs to 20 cfs. The diversion structure would divert water to conveyances on both sides of the river but would continue to provide only adjudicated water to the Spurgeon Ditch #2 on the east side of the San Francisco River. **Appendix A,**

Map 2-13 (Alternative E: San Francisco Components) shows the approximate locations of proposed Alternative E components.

The existing W-S and Pleasanton East-Side diversion structures would not require improvements. The structures have current capacities of up to 30 and 20 cfs, respectively. Calls for AWSA water in these areas would be supplied by releasing stored water from the Weedy Reservoir into the San Francisco River and allowing water to flow downstream to the W-S and/or the Pleasanton East-Side diversion structures, where it would be distributed into ditches for agricultural use.

San Francisco Conveyance Under Alternative E, there would be a 36-inch pipe (approximately 2,700 LF) conveyance from the west side of the new diversion structure that would surface at the Thomason Flat Ditch heading. The pipe would be buried for its length, except for a 700-foot-wide portion that would be elevated over the Pueblo Creek floodplain. Additionally, Alternative E would retain the existing Thomason Flat Ditch capacity of approximately 20 cfs, and there would be no ditch modifications.

Alternative E would include a pumping station to lift water from Thomason Flat Ditch into Weedy Reservoir. Conveyance facilities from the W-S Ditch and Pleasanton East-Side Diversion Structures are in good operating condition and would not require improvement. The Pleasanton West-Side Ditch would be reconstructed and widened for approximately 7,500 LF. A 36-inch siphon, measuring 265 LF from the Pleasanton East-Side Ditch, would provide water to the Pleasanton West-Side Ditch (**Appendix A, Map 2-14** [Alternative E: San Francisco Components (Pleasanton)]).

San Francisco Storage Alternative E would include construction of an off-channel unlined reservoir in Weedy Canyon with an earth embankment dam and a proposed storage capacity of 1,610 AF. The dam would be approximately 600 feet from the San Francisco River. The dam embankment height would be 151 feet. The top of the active conservation and spillway crest elevation would be 141 feet. The length of the dam would be approximately 1,550 feet at the top of the dam, and the reservoir footprint would be approximately 64 surface acres. The embankment would include a 125-foot-wide, 740-foot-long concrete-lined spillway to drain back to the San Francisco River. Outfall pipes would be installed to the San Francisco River and Thomason Flat Ditch. The dam would be constructed with an impermeable clay core (**Appendix A, Map 2-13** [Alternative E: San Francisco Components]).

San Francisco Power The local utility indicates that adequate power could be supplied from an existing distribution line along U.S. Highway 180. A new distribution line would be constructed from the existing line, crossing the river to the new pumping station at the Weedy Reservoir (**Appendix A, Map 2-13** [Alternative E: San Francisco Components]). The route for this distribution line would be on an easement reserved by the previous property owner for future construction of the power service line. The power line crossing would not be routed in the temporary construction river crossing. Routes of any additional distribution lines would be developed as the project design is refined in collaboration with the local utility.

San Francisco Construction Temporary construction activities would include construction roads, stream diversion, dewatering, material excavation, spoil piles, and laydown areas. Some of these activities would occur within the floodplain. There would be a temporary closure of 2,000 feet of Alma Mesa Road from U.S. Highway 180 to Pueblo Creek to allow for construction of the pipeline from the new diversion structure to the Thomason Flat Ditch. A temporary road near Mills Canyon with a culvert crossing at the San Francisco River would provide access from U.S. Highway 180 for vehicle and construction traffic.

The power line crossing mentioned above would not be routed in this temporary construction river crossing.

A potential material source area for embankment construction has been identified adjacent to the Weedy Reservoir site. An existing local dirt road would be widened to 60 feet for construction hauling from the borrow area to the dam site. This road would be restored to 24 feet wide following construction and connected to a new permanent road on top of the Weedy Canyon Dam embankment. New parking areas would be created at the top of the dam on each side of the spillway and connected by a footbridge. A new road along Thomason Flat Ditch would be created to provide O&M access to the pump station facility and diversion structure. A permanent box culvert would be installed where Alma Mesa Road crosses the Weedy Canyon Wash for vehicular dam access during flood events (**Appendix A, Map 2-13** [Alternative E: San Francisco Components]).

San Francisco Operational Assumptions The AWSA diversion rate under Alternative E would be 20 cfs. The proposed average annual AWSA diversion at the San Francisco location is estimated at approximately 1,114 AF. The proposed estimated annual return flow to the river is 908 AF. The proposed total consumptive use of AWSA water is estimated at 183 AF at the San Francisco location (HDR 2019a).

2.4.7 Summary of Action Alternatives

This section includes five tables that summarize the key features of the action alternatives. **Table 2-2** provides an overview of the key components of each alternative. **Table 2-3** provides a summary of water diversion, storage, and consumption. **Table 2-4** summarizes costs. **Table 2-5** and **Table 2-6** summarize the estimated short- and long-term disturbance associated with each action alternative.

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Table 2-2. Summary Comparison of Alternatives

Components	Alternative A – No Action	Alternative B – Entity Proposed Action	Alternative C	Alternative D	Alternative E
			Cliff-Gila Project Location		
Cliff-Gila: Diversion					
Diversion Type	Three existing sediment push-up diversions at the existing Upper Gila, Fort West, and Gila Farms Ditch headings for diverting adjudicated water only. No gate-controlled intakes at diversions.	One fixed crest weir diversion with 60-foot long engineered fill riffle rundown to replace existing Upper Gila, Fort West, and Gila Farms push-up diversions for diverting AWSA and adjudicated water.	Three rock vane weir semi-permanent diversions (no engineered fill) to replace sediment push-up diversions at the existing Upper Gila, Fort West, and Gila Farms Ditch headings for diverting AWSA and adjudicated water. No gate-controlled intakes at the diversion. Control and metering would occur at existing ditch head gates.	Not applicable	Pneumatically adjustable Obermeyer gate diversion to replace existing Upper Gila Diversion for diverting AWSA and adjudicated water. The existing Fort West and Gila Farms push-up diversions would continue to be used at the current locations for adjudicated water only.
Location	Private property: approximate location at existing Upper Gila, Fort West, and Gila Farms Ditch headings.	Private property: approximately 500 feet above the location of the existing Upper Gila Ditch push-up diversion.	Private property: approximate location at existing Upper Gila, Fort West, and Gila Farms Ditch headings.	Not applicable	Same as Alternative B
Diversion Structure Dimensions	Variable, push-up diversions that are re-built several times a year.	Diversion: 155-foot-long concrete weir wall, 60-foot-long riffle-run 3 feet above the riverbed, 20-foot-wide depressed notch 1 foot above the deepest part of the existing river channel. Cutoff Wall: Approximately 20 feet deep and 1,200 feet long across the floodplain, including the diversion structure.	Each of the three diversion structures would be constructed from rocks arranged in "V" shape, with the narrow point of the structure facing the stream flow. The wide end of the structure would span approximately 90 feet across the floodplain to raise the water surface elevation to allow water to divert into ditches. The structure would extend approximately 90-feet down the river. The top of the rock would be approximately 2 feet above the deepest part of the existing river channel. No cutoff wall	Not applicable	Concrete sill constructed at approximately 1.5 feet above the deepest part of the existing river channel for the Obermeyer gates, approximately 35 feet long. Three hinged steel gates 10 feet wide at hydraulic depth of 6.5 feet, attached to the concrete sill raised and lowered with pneumatic bladders. Drop height of 2 feet when the gate is down. Cutoff Wall: Same as Alternative B
Intakes	No gate-controlled intakes	Gate-controlled intakes on the west side. Siphon 8-foot by 8-foot box culvert at the diversion structure to take water to other side of river.	No gate-controlled intakes at the diversion structures. Existing head gates in ditches would be used for control and metering.	Not applicable	Gate-controlled intakes on the west side

Components	Alternative A – No Action	Alternative B – Entity Proposed Action	Alternative C	Alternative D	Alternative E
Cliff-Gila: Conveyance					
From Diversion to Upper Gila Ditch	Existing ditch configuration; 30cfs capacity	3,200 LF buried pipe extension of Upper Gila Ditch would be constructed; 50 cfs capacity	Use existing ditch configurations and capacities. No buried pipeline extension.	Not applicable	One 8-foot by 8-foot precast concrete box culvert of approximately 4,200 LF to carry diverted water only to the west side. Use existing ditch configurations and capacities. No buried pipeline extension.
Upper Gila Ditch Improvements	No improvements to unlined earthen ditch	Approximately 9,700 LF of existing ditch from the new pipe would be widened and lined with shotcrete.	Same as Alternative A	Not applicable	Same as Alternative B
From Diversion to the Fort West Ditch	No equivalent facility; diversion directly from river	New 4,200 LF lined (shotcrete) extension of the Fort West Ditch from the culvert at the diversion to the existing ditch.	Use existing ditch configurations and capacities	Not applicable	No connection to the new diversion
Spar Canyon Siphon	No equivalent facility	520 LF, 48-inch siphon constructed at Spar Canyon as part of the Fort West Extension.	Same as Alternative A	Not applicable	Same as Alternative A
Existing Fort West Ditch to the Gila Farms Connector	No improvements to unlined earthen ditch	Approximately 16,000 LF of the existing Fort West Ditch from the end point of the extension to the start point of the Gila Farms Connector would be widened and lined with shotcrete; capacity would be increased to 75 cfs.	Not applicable	Not applicable	Same as Alternative C
Gila Farms Connector Ditch Reconstruction	No improvements to unlined earthen ditch	Reconstruct and line with shotcrete connector (2,500 feet) between Fort West Ditch and Gila Farms Ditch to accommodate up to 25 cfs.	Not applicable	Not applicable	Same as Alternative C
McMillen Ditch Reconstruction	No improvements to unlined earthen ditch	Reconstruct (widen) 9,700 LF portion of McMillen Ditch with a 13 cfs capacity, unlined	Not applicable	Not applicable	Same as Alternative B
Cliff-Gila: Storage					
Storage Overview	No storage facilities	Four gravity-fed, clay-lined storage ponds (4P, 5P, 7P, and 8P) in the valley. AWSA water storage **only**. Pond surface area: 4P= 30 acres, 5P=38 acres, 7P=25 acres, 8P=94 acres. Total surface storage of 1,890 AF.	Same as Alternative B	Not applicable	Two pump-fed, unlined ponds (2P and 3P) as ASR basins and surface storage in Winn Canyon. One gravity-fed clay-lined pond (5P) for surface storage. Would be used to store AWSA water **only**. Total surface storage of 2,178 AF.

Components	Alternative A – No Action	Alternative B – Entity Proposed Action	Alternative C	Alternative D	Alternative E
Valley Ponds	No equivalent facilities	All ponds gravity fed for intake. Pump facilities needed for delivery of water from 7P and 8P into the ditches. Gravity flow out anticipated for ponds 4P and 5P. Combined capacity of 1,890 AF.	Same as Alternative B	Not applicable	One gravity-fed lined pond (5P) for surface storage in the Cliff-Gila Valley. Gravity flow out. Capacity of 258 AF. Pond surface area of 38 acres.
Winn Canyon – Surface Storage and Recharge	No equivalent facilities	Not applicable	Not applicable	Not applicable	Ponds 2P (76 surface acres) and 3P (15 surface acres) storage/recharge with a surface storage capacity of 1,820 AF. Pump facility constructed to convey water from the Upper Gila Ditch and recirculate water from ASR Wells into storage.
Winn Canyon – Components	No equivalent facilities	Not applicable	Not applicable	Not applicable	Capacity of the existing flood control basin at 2P would be increased by excavating upstream of the existing flood-sediment control dam. The flood-sediment control dam would require upgrades to meet current dam safety standards. Excavation downstream of 2P and construction of an embankment dam would create the storage capacity in 3P. Discharge lines from Winn Canyon ponds into Upper Gila Ditch would be gravity fed through 30-inch lines. The 2P embankment would be approximately 57 feet high, 4,500 feet long, and 930 feet wide. The 3P embankment would be approximately 35 feet high, 1,110 feet long, and 770 feet wide. A portion of the infiltrated water from the Winn Canyon pond would be recirculated back into Winn Canyon ponds.

Components	Alternative A – No Action	Alternative B – Entity Proposed Action	Alternative C	Alternative D	Alternative E
Cliff-Gila: Wells					
ASR Wells Below Winn Canyon	No equivalent facilities	Not applicable	Not applicable	Not applicable	3 ASR Wells, 60 feet deep, 500 gpm capacity. Released to Upper Gila Ditch, recirculated to Winn Canyon ponds, surface storage, or pressurized for sprinkler/drip irrigation.
Production Wells	No equivalent facilities	5 wells, 120 feet deep, 500 gpm capacity each for direct AWSA diversions and offsets. Primarily pressurized for sprinkler or drip irrigation but could be directed to ditches or surface storage.	No production wells for AWSA water	Not applicable	Same as Alternative C
Cliff-Gila: Power					
Power Source	No changes to existing facilities	Use existing local power infrastructure and facilities with any needed upgrades.	Similar to Alternative B, but less power would be needed. Use existing local power infrastructure and facilities with any needed upgrades.	Not applicable	Use existing local power infrastructure and facilities with any needed upgrades. On west side of the valley, construct/rehabilitate three-phase line from Cliff Substation to Winn Pumping Station. Obermeyer gates diversion would require operational and backup power.
Power Lines	No changes to existing facilities	Final power needs and final footprint of power lines would be developed as the project design is refined in collaboration with the local utility. Existing power lines available near all proposed facilities.	Same as Alternative B	Not applicable	Same as Alternative B
Cliff-Gila: Construction					
Access	Not applicable	Local roads, minor improvements	Same as Alternative B	Not applicable	Same as Alternative B
Material/ Disposal	Not applicable	Use proposed mapped clay sources for ponds; no disposal sites needed.	Mapped clay sources	Not applicable	Excavation for embankment upstream of Winn; use proposed mapped local disposal and clay sources for ponds

Components	Alternative A – No Action	Alternative B – Entity Proposed Action	Alternative C	Alternative D	Alternative E
Cliff-Gila: Operations					
Operational Assumptions	No AWSA water diverted	Divert both adjudicated water and AWSA water. No Diversion of AWSA water until CUFA requirements are first met.	Same as Alternative B	Not applicable	Same as Alternative B
	"Live ditch" operations would continue, push-up diversions not removed, and ditches flow constantly	"Live ditch" operations would not continue with the replacement of push-up diversions.	Same as Alternative B	Same as Alternative A	Same as Alternative B
	• No AWSA water diverted	• Maximum AWSA diversion rate: 125 cfs	• Maximum AWSA diversion rate: 125 cfs (same as Alternative B)	Not applicable	• Maximum AWSA diversion rate: 50 cfs
	• No AWSA water diverted	• Average annual AWSA diversion: 1,969 AF	• Average annual AWSA diversion: 1,825 AF	Not applicable	• Average annual AWSA diversion: 1,329 AF
	• No AWSA return flows	• Average annual return flow: 588 AF	• Average annual return flow: 636 AF	Not applicable	• Average annual return flow: 445 AF
	• Consumptive use limited to existing adjudicated water use; no AWSA consumptive use.	• Average annual total consumptive use: 1,425 AF	• Average annual consumptive use: 1,321 AF	Not applicable	• Average annual total consumptive use: 927 AF
Virden Project Location					
Virden: Diversion					
Diversion	No AWSA water diverted through existing permanent diversions structures. Capacity of 35 cfs.	Use existing Sunset and New Model diversion structures with no modifications for diversion of AWSA water and Decree water	Same as Alternative B	Same as Alternative B	Same as Alternative B
Virden: Conveyance					
Conveyance	No change to existing conveyance. Capacity of 35 cfs.	Utilize existing canals with no modifications	Same as Alternative B	Same as Alternative B	Same as Alternative B
Virden: Storage					
Storage	No equivalent facilities	Two clay-lined, gravity-fed storage ponds (10P and 11P) with total capacity of 551 AF adjacent to the Sunset and New Model canals. For storage of AWSA water **only**. Each pond approximately 20 acres. Pump facilities for delivery of water from ponds back into canals.	Same as Alternative B	Same as Alternative B	Same as Alternative B

Components	Alternative A – No Action	Alternative B – Entity Proposed Action	Alternative C	Alternative D	Alternative E
Virden: Power					
Power	No changes to existing facilities	Existing power lines would provide the three-phase power to address the electric load for the proposed lift pumps at Ponds 10P and 11P. Power for Pond 10P would require a 500-foot extension from the existing power line. Power for Pond 11P would require potential realignment of approximately 2,100 feet of existing line.	Same as Alternative B	Same as Alternative B	Same as Alternative B
Virden: Construction					
Access	Not applicable	Road access through existing local roads	Same as Alternative B	Same as Alternative B	Same as Alternative B
Material/ Disposal Areas	Not applicable	Disposal and staging areas adjacent to the ponds; clay material sites are mapped.	Same as Alternative B	Same as Alternative B	Same as Alternative B
Virden: Operations					
Operational Assumptions	No AWSA water diverted	Divert both Decree water and AWSA water. No Diversion of AWSA water until CUFA requirements are first met.	Same as Alternative B	Same as Alternative B	Same as Alternative B
	• No AWSA water diverted	• Maximum AWSA diversion rate: 20 cfs	Same as Alternative B	Same as Alternative B	Same as Alternative B
	• No AWSA water diverted	• Average annual AWSA diversion: 481 AF	Same as Alternative B	Same as Alternative B	Same as Alternative B
	• No AWSA return flows	• Average annual return flow: 141 AF	Same as Alternative B.	Same as Alternative B	Same as Alternative B
	• Consumptive use limited to existing Decree water use. No AWSA consumptive use.	• Average annual total consumptive use: 349 AF	Same as Alternative B.	Same as Alternative B	Same as Alternative B

Components	Alternative A – No Action	Alternative B – Entity Proposed Action	Alternative C	Alternative D	Alternative E
San Francisco Location					
San Francisco: Diversion					
Diversion Overview	Continue to use the Spurgeon and Thomason Flat push-up diversions for adjudicated water only. Continue to use the permanent W-S and Pleasanton East-Side diversions for adjudicated water only.	New fixed crest weir with riffle rundown at Spurgeon location replacing existing pushup diversions at Spurgeon and Thomason Flat for direct deliveries to Spurgeon Ditch #2 and Thomason Flat. Only adjudicated water would be directed to the Spurgeon Ditch #2. Thomason Flat would receive adjudicated and AWSA water through a new pipeline.	Irrigators would continue to use a push-up diversion at the current Spurgeon location for conveyance of adjudicated water only to Spurgeon Ditch #2. One new rock vane diversion to replace existing Thomason Flat push-up diversion for diverting AWSA and adjudicated water. Use existing W-S Ditch and Pleasanton East-Side diversion structures to capture releases from the Weedy Reservoir.	Not applicable	New fixed crest weir with riffle rundown at Spurgeon location replacing existing pushup diversions at Spurgeon and Thomason Flat; new structure would provide only adjudicated water to the Spurgeon Ditch #2. Thomason Flat would receive both AWSA and adjudicated water through a new pipeline. Use existing W-S Ditch and Pleasanton East-Side diversion structures to capture releases from the Weedy Reservoir.
Diversion Type	No changes to existing structures	New fixed crest weir diversion with 20-foot-long engineered fill boulder riffle rundown, replacing the existing Spurgeon and Thomason Flat push-up diversions for AWSA and adjudicated water.	One new rock vane weir diversion to replace sediment push-up diversion at Thomason Flat for diversion of AWSA and adjudicated water. Ditch heading, south of the Pueblo Creek confluence.	Not applicable	New fixed crest weir diversion with 20-foot-long engineered fill boulder riffle rundown at the existing Spurgeon push-up diversion site, replacing the existing Spurgeon and Thomason Flat push-up diversions, only adjudicated water would be directed to the Spurgeon Ditch #2. Thomason Flat would receive adjudicated and AWSA water.
Location	No change to existing facilities. All on private land except for the W-S diversion, which is on USFS land.	Private property at or near the site of the existing Spurgeon Ditch #2 push-up dam site.	Private land at or near the location of the existing Thomason Flat Ditch heading, south of the Pueblo Creek confluence with the San Francisco River.	Not applicable	Same as Alternative B

Components	Alternative A – No Action	Alternative B – Entity Proposed Action	Alternative C	Alternative D	Alternative E
Dimensions	Variable, push-up diversions that are rebuilt several times a year	55-foot-long reinforced concrete weir wall 3 feet above the riverbed, 10-foot wide depressed notch section on the east side of the weir 1 foot deep. The structure would be low profile, generally raising the river level by 1 foot, and the top end of the boulder riffle would be flush with the low flow notch. Cutoff walls across the floodplain to an estimated depth of approximately 20 feet, for a total length of approximately 335 feet with diversion structure. A 20-foot-long engineered fill boulder riffle rundown would extend downstream.	V- shaped. The wide end of the structure would span approximately 90 feet across the floodplain to raise the water surface elevation to allow water to divert into ditches. The structure would extend approximately 90 feet down the river. The top of the rock would be approximately 2 feet above the deepest part of the existing river channel. No cutoff wall.	Not applicable	Same as Alternative B
Intake	No gate-controlled intakes	Three gate-controlled intakes on east side. Two concrete box culvert siphons (each 4 feet by 4 feet) at the diversion facility to carry diverted water to west side of the river. East side diversion to Spurgeon #2 Ditch would not deliver AWSA water.	No gate-controlled intakes at the diversion. Direct diversion of AWSA and adjudicated water into Thomason Flat and W-S ditch. Control and metering would occur at existing ditch head gates.	Not applicable	Gate-controlled intakes on both west and east sides of the new diversion structure. Diversion of AWSA and adjudicated water into Thomason Flat and W-S ditch. Spurgeon #2 Ditch would receive only adjudicated water.
San Francisco: Conveyance					
From Spurgeon Diversion to Thomason Flat Ditch Heading	No new conveyance infrastructure from Spurgeon. Continue diverting from the river at the push-up diversions at the Thomason Flat Ditch heading.	36-inch buried pipe (approximately 2,500 LF) conveyance from Spurgeon Diversion that would daylight at the Thomason Flat Ditch. Includes a siphon (approximately 300 feet) under Pueblo Creek. Alignment would partially follow and require temporary closure of the existing unpaved Alma Mesa Road.	Water would be diverted at the Thomason Flat Ditch heading into the ditch. No new conveyance infrastructure from Spurgeon.	Not applicable	36-inch buried pipe (approximately 2,700 LF) conveyance from Spurgeon Diversion that would daylight at the Thomason Flat Ditch heading. Includes an elevated pipeline (approximately 700 feet) over Pueblo Creek. Alignment would partially follow and require temporary closure of the existing unpaved Alma Mesa Road.

Components	Alternative A – No Action	Alternative B – Entity Proposed Action	Alternative C	Alternative D	Alternative E
Thomason Flat Ditch Improvements	No improvements. Ditch capacity approximately 20 cfs.	Retain existing Thomason Flat Ditch capacity of approximately 20 cfs. No lining.	Expand Thomason Flat Ditch capacity from approximately 20 cfs to 40 cfs from ditch heading to Weedy Reservoir. No lining.	Not applicable	Same as Alternative B
Conveyance to Reservoir Storage	Not applicable	Not applicable	Pumping station to lift water from Thomason Flat Ditch into Weedy Reservoir	Not applicable	Same as Alternative C
Pleasanton West Side Ditch Improvements	No equivalent facility	Not applicable	Not applicable	Not applicable	Reconstruct and widen approximately 7,500 LF of the Pleasanton West-Side Ditch
Pleasanton Siphon	No equivalent facility	Not applicable	Not applicable	Not applicable	36-inch, 260 LF siphon from the Pleasanton East-Side Ditch to the Pleasanton West-Side Ditch
San Francisco: Storage					
Surface Storage	No equivalent facility	No AWSA surface storage, only direct use	Construct earthen embankment dam and unlined reservoir with a storage capacity of 600 AF in Weedy Canyon.	Not applicable	Construct unlined earthen embankment dam and reservoir with a storage capacity of 1,610 AF in Weedy Canyon.
Dimensions	Not applicable	Not applicable	Approximately 600 feet from the San Francisco River. Dam embankment 112 feet high. Top of active conservation and spillway crest elevation 102 feet. Freeboard of 4 feet above PMF. Approximately 581 feet long at the top of the dam. Approximately 20 surface acres footprint.	Not applicable	Approximately 600 feet from the San Francisco River. Dam embankment 151 feet high. Top of active conservation and spillway crest elevation 141 feet. Freeboard of 4 feet above PMF. Approximately 1,550 feet long at the top of the dam. Approximately 64 surface acres footprint.
Spillway	Not applicable	Not applicable	Concrete lined. 125 feet wide. Approximately 680 feet long to the San Francisco River channel.	Not applicable	Concrete lined. 125 feet wide. 740 feet long to the San Francisco River channel.
Outfalls	Not applicable	Not applicable	Outfall pipes to the San Francisco River and to Thomason Flat Ditch	Not applicable	Same as Alternative C
San Francisco: Power					
Reservoir Pumps	Not applicable	Not applicable	Power for Weedy Reservoir pumps supplied by a new connection and permanent easement across the valley and San Francisco River from the existing distribution line along U.S. Highway 180. Power line crossing would be routed in the temporary construction river crossing.	Not applicable	Power for Weedy Reservoir pumps supplied by a new connection and permanent easement across the valley and San Francisco River from the existing distribution line along U.S. Highway 180. Powerline crossing would not be routed in the temporary construction river crossing.

Components	Alternative A – No Action	Alternative B – Entity Proposed Action	Alternative C	Alternative D	Alternative E
All Components	No changes to existing facilities	Not applicable	The final footprint of any needed power lines would be developed as the project design and power needs are refined in collaboration with the local utility.	Not applicable	Same as Alternative C
San Francisco: Construction					
Access	Not applicable.	Temporary closure of approximately 2,000 feet of Alma Mesa Road from U.S. Highway 180 to Pueblo Creek for pipeline construction. Temporary access road with culvert crossing at the San Francisco River to maintain property access during pipeline construction. Removed following reopening of Alma Mesa Road. Construct temporary access road along the east side of the Thomason Flat Ditch, going south from where it meets the temporary river crossing. After approximately 1,000 feet, the road would be ramped up to the ditch. The ditch would be temporarily reconstructed as a roadway approximately 15 to 18. feet wide, connecting to the Thompson Tank Road. When this road is no longer needed, the ditch would be reconstructed.	Temporary access road with culvert crossing at the San Francisco River for construction access during Weedy Reservoir construction. Temporary 60-foot-wide construction haul from borrow area to dam, restored to 24-foot road following construction. Access pump station with new road along Thomason Flat Ditch from north. New permanent road to and across Weedy Dam. New parking areas at each end of spillway with a pedestrian foot bridge. Permanent box culvert where Alma Mesa Road crosses Weedy Canyon wash for vehicular dam access during flood events.	Not applicable	Temporary closure of 2,000 feet of Alma Mesa Road from U.S. Highway 180 to Pueblo Creek for pipeline construction. Temporary access road with culvert crossing at the Santa Francisco River to maintain access during pipeline and Weedy Reservoir construction. Temporary 60-foot-wide construction haul from borrow are to dam. Rehabilitated to 24-foot road following construction. Access pump station with new road along Thomason Flat Ditch from north. New permanent road to and across Weedy Dam. New parking areas at each end of spillway pedestrian foot bridge. Permanent box culvert where Alma Mesa Road crosses Weedy Canyon wash for vehicular dam access during flood events. Saddle dam/ramped road improvement on Alma Mesa Road near the intersection with the Thompson Tank Road through the proposed borrow area.
Material/ Disposal	Not applicable	No off-site source and material disposal areas needed	Source area mapped adjacent to reservoir	Not applicable	Same as Alternative C

Components	Alternative A – No Action	Alternative B – Entity Proposed Action	Alternative C	Alternative D	Alternative E
San Francisco: Operations					
Operational Assumptions	Divert only adjudicated water	Divert both adjudicated water and AWSA water. No Diversion of AWSA water until CUFA requirements are first met.	Same as Alternative B	Not applicable	Same as Alternative B
	• No AWSA water diverted	• Maximum AWSA diversion rate: 20 cfs	• Maximum AWSA diversion rate: 40 cfs	Not applicable	• Maximum AWSA diversion rate: 20 cfs (same as Alternative B)
	• No AWSA water diverted	• Average annual AWSA diversion: 11 AF	• Average annual AWSA diversion: 879 AF	Not applicable	• Average annual AWSA diversion: 1,114 AF
	• No AWSA return flows	• Average annual return flow: 3 AF	• Average annual return flow: 657 AF	Not applicable	• Average annual return flow: 908 AF
	• Consumptive use limited to existing adjudicated water use. No additional consumptive use.	• Average annual total consumptive use: 8 AF	• Average annual total consumptive use: 175 AF	Not applicable	• Average annual total consumptive use: 183 AF

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Table 2-3. Proposed Storage Capacity, Annual Average AWSA Diversion, Return Flows, and Consumptive Use by Action Alternatives

Water amounts are calculated based on the assumption that all CUFA requirements will first be met. They include estimated amounts for the AWSA water only but were developed with the assumption that currently permitted and adjudicated uses of water will continue to be exercised.

Estimates of Annual Average AWSA Water Amounts in AF	Alternative B – Entity Proposed Action	Alternative C	Alternative D	Alternative E
Proposed Storage Capacity	2,441	3,041	551	4,339
Diversion[1]	2,461	3,185	480	2,924
Return Flows	732	1,434	141	1,494
Total Consumptive Use[2]	1,782	1,845	349	1,459

Source: HDR 2019a

[1] Annual AWSA diversion is the actual annual amount of water projected to be diverted under operational restrictions and infrastructure capabilities. Diversions can be incremental; therefore, realized diversion can exceed the total storage capacity.

[2] Total consumptive use, as calculated for the analysis, does not exactly equal the difference between diversion and return flows due to variability in pond inflows, ditch seepage, and time lag for return flows.

Table 2-4. Summary Comparison of Estimated Costs of Action Alternatives

Project Components	Alternative B Cliff-Gila	Alternative C Cliff-Gila	Alternative E Cliff-Gila	Alternative B San Francisco	Alternative C San Francisco	Alternative E San Francisco	Alternatives B, C, D, and E Virden
Construction							
Design	$3,703,649	$2,079,626	$5,978,200	$502,398	$5,719,199	$8,437,205	$724,797
Construction Management	$1,463,400	$821,710	$2,362,129	$342,400	$2,259,792	$3,333,741	$385,400
Diversion	$10,914,679	$3,608,064	$7,180,200	$2,368,550	$1,018,656	$2,368,550	N/A
Production Wells	$2,654,712	N/A	N/A	N/A	N/A	N/A	N/A
ASR Wells	N/A	N/A	$828,700	N/A	N/A	N/A	N/A
Storage	$13,624,408	$14,754,552	$30,840,000	N/A	$42,510,200	$73,400,000	$4,398,654
Pump Facilities	$1,823,107	$1,032,000	$9,930,000	N/A	$10,525,000	$3,200,000	$1,349,500
Conveyance	$6,152,403	$342,000	$7,957,000	$1,401,909	$224,000	$2,230,000	N/A
Construction Total	**$40,336,358**	**$22,637,952**	**$65,076,229**	**$4,615,257**	**$62,256,847**	**$92,969,496**	**$6,858,351**

Project Components	Alternative B Cliff-Gila	Alternative C Cliff-Gila	Alternative E Cliff-Gila	Alternative B San Francisco	Alternative C San Francisco	Alternative E San Francisco	Alternatives B, C, D, and E Virden
Operation, Maintenance, and Replacement							
Diversion	$29,568	$659,340	$114,710	$30,088	$219,780	$30,088	N/A
Production Wells	$23,131	N/A	N/A	N/A	N/A	N/A	N/A
ASR Wells	N/A	N/A	$4,109	N/A	N/A	N/A	N/A
Storage	$84,914	$85,949	$308,400	N/A	$234,000	$404,000	$42,455
Pump Facilities	$16,438	$12,500	$99,300	N/A	$43,400	$29,400	$21,904
Conveyance	$26,041	$4,200	$114,600	$0	$2,940	$50,200	N/A
CAP Exchange							
CAP Exchange Cost	$220,875	$204,755	$143,685	$1,240	$27,125	$28,365	$54,095
Total Annual OM&R (including exchange costs)	**$400,967**	**$950,044**	**$670,094**	**$31,328**	**$527,245**	**$542,053**	**$118,454**
Total CU x 2020 CAP rate[1]	1425 AF X $155	1321 AF X $155	927 AF X $155	8 AF X $155	175 AF X $155	183 AF X $155	349 AF X $155

Source: Reclamation 2019c

[1] https://www.cap-az.com/documents/departments/finance/Final-2020-2024-Water-Rate-Schedule-BaseCase-06-06-19.pdf. Exchange rate of $187 is forecasted for 2021.

The costs detailed above do not include additional anticipated costs related to implementation of the NM Unit. Cost would vary by alternative, extent of disturbance, and locations. These would likely include, but would not be limited to, the Entity's annual management costs, Reclamation contract/transfer negotiation costs, design review, Reclamation contract management, biological and cultural resource studies, mitigation, and construction monitoring.

Table 2-5 and **Table 2-6** describe preliminary estimates of short- and long-term disturbance, respectively, of each alternative. For analysis purposes, short-term estimated disturbance is defined during construction and includes a 50-foot buffer, and long-term estimated disturbance is defined for the facility location with a 25-foot buffer. These numbers are for alternative comparison purposes and do not imply that all these lands are currently undisturbed or that they represent the full extent of historic disturbance. In addition, construction could require up to 6 acres of upstream disturbance for river diversion, dewatering, and material stockpiling activities within the floodplain. All the calculations are estimates based on current information and mapping and are subject to further refinement and updating. Estimated unbuffered disturbance footprints for existing infrastructure, diversion locations, ditches, and other features within the action alternatives footprint account for 114 acres in the Cliff Gila location, 20 acres in the San Francisco location, and 95 acres in the Virden location.

Table 2-5. Short-Term Disturbance Estimates by Action Alternative

Location	Alternative B (acres)	Alternative C (acres)	Alternative D (acres)	Alternative E (acres)
Cliff-Gila	382	262	0	346
Virden	132	132	132	132
San Francisco	15	111	0	168
Total	**529**	**505**	**132**	**646**

Source: Reclamation GIS 2019
Note: Short-term disturbance = 50-foot buffer around proposed features.

Table 2-6. Long-Term Disturbance Estimates by Action Alternative

Location	Alternative B (acres)	Alternative C (acres)	Alternative D (acres)	Alternative E (acres)
Cliff-Gila	294	235	0	284
Virden	116	116	116	116
San Francisco	8	91	0	132
Total	**418**	**442**	**116**	**532**

Source: Reclamation GIS 2019
Note: Long-term estimated disturbance = 25-foot buffer around new permanent features.

2.5 Alternatives Considered but Eliminated from Detailed Study

Federal agencies are required to rigorously explore and objectively evaluate all reasonable alternatives and to discuss the reasons for eliminating any alternatives from detailed study (40 CFR 1502.14). As discussed above, the Joint Leads used a screening process to evaluate all alternatives. Alternatives considered but eliminated from detailed study are summarized below.

2.5.1 Use Upper Watershed Lakes for Storage

The USFS submitted a written comment proposing the use of Luna Lake on the upper San Francisco River, Snow Lake on the upper Gila River, and Lake Roberts on upper Sapillo Creek, a tributary to the Gila River, as alternative storage locations. All three lakes are on lands administered by the USFS. This alternative was eliminated due to the high degree of uncertainty as to their technical, legal, and economic feasibility (ISC 2018a). Some of the obstacles to this proposal include:

- Significant questions regarding the technical suitability of using the current capacity or the feasibility of an expansion, diversion and yield reliability, and the costs for any structural and operational alterations; and
- The three lakes range from 45 to 80 miles away from the proposed locations where the water would be diverted and used, and there would be an unacceptably high conveyance loss, especially from Snow Lake.

2.5.2 Private Wells, Push-up Arroyo Diversions, and Livestock Ponds in the San Francisco Basin

During coordination with cooperating agencies, the San Francisco Soil and Water Conservation District submitted a proposed alternative pertaining only to the San Francisco basin. Alternative E includes part of this proposed alternative. The other part focused on the use of private wells, arroyo diversions, and livestock ponds to divert AWSA water. This concept involves developing and using new private wells with a pumping capacity of approximately 500 gpm, push-up arroyo diversions, and livestock storage ponds, as a future action to fully develop the remaining available AWSA water. Under this concept, the diverted water would be measured, and an equivalent amount of water would then be released from Weedy Reservoir back into the San Francisco River as an offset.

The proposal does not include the number and, more importantly, specific locations and water needs of proposed private wells, livestock ponds, and arroyo diversions. Specific locations are needed for hydrologic analyses (including, but not limited to, diversion and yield modeling based on the proposed wells and ponds in accordance with the CUFA), cultural resources analyses, biological analyses to assess impacts on threatened and endangered species, and NMOSE permitting (including metering) requirements. It is unclear how many landowners may be interested in this proposal, which has consequences for the alternative's economic analyses. Finally, there are contracting and O&M questions regarding this proposal. Additional details of this proposal would be required to analyze the operation of private wells and ponds and the required administrative and management actions. This proposal also assumes that Weedy Reservoir would be built because AWSA water would be used to offset the operation of those wells or ponds. The NMOSE would need to verify that AWSA water was available for offsets before granting a permit. While not ripe for detailed study, these permutations may be reasonably foreseeable in the future. As such, they are considered as potential future projects in the cumulative impact analysis.

In summary, this proposal was eliminated from detailed study because it lacks the required specific information for detailed analyses, and there are substantial questions regarding the technical, legal, and economic feasibility of the wells, arroyo diversions, and ponds (ISC 2018b).

2.5.3 Gila Basin Irrigation Commission (GBIC) Alternative

The GBIC is pursuing permanent diversion structures in the Cliff-Gila Valley as a non-NM Unit project, based on the funding it has received from the ISC. Because the GBIC project involves the same Cliff-Gila location as the NM Unit, there had been some consideration of integrating the two projects. The GBIC is investigating permanent structures at three current push-up diversion points in the Cliff-Gila Valley; however, at the time of writing, the GBIC project is limited to one diversion structure and is considering replacing the existing Upper Gila push-up diversion with an engineered riffle diversion.

The GBIC operates independently on its own time frame. A proposed design for the Upper Gila diversion was prepared in mid-July 2019. The other proposed diversion structures are still in the preliminary engineering phase. Additionally, there is no federal nexus for the GBIC project. It is unclear whether the interests of the Entity and the GBIC are aligned on this matter. Moreover, at this time, there is limited data and uncertainty on how much the full GBIC project would cost, how it would be funded, and whether GBIC’s proposed facilities would be capable of diverting both adjudicated and AWSA waters.

Finally, the GBIC project’s status may change during the NM Unit EIS process and affect how the NM Unit Proposed Action is treated in the analysis and in the Federal decision for the NM Unit. For all these reasons, the GBIC project cannot be integrated into the NM Unit timeline at this time; however, this is a reasonably foreseeable future action that is considered in the cumulative impact analysis. Additionally, Alternative C incorporates some of the concepts that the GBIC is considering, based on public input during the scoping process.

2.5.4 Alternatives and Project Components Considered in Past Studies

There is a long history of studies that evaluate diverting and storing water in the Gila and San Francisco watersheds, along with more recent specific reports that identify different project components for developing a NM Unit (Reclamation 1987, 2014, and 2015; BHI 2014a; NM CAP Entity 2016; AECOM 2016, 2017a, 2017b, and 2017c).

The Entity used these recent reports to help inform its Proposed Action. The Joint Leads conducted a detailed literature review, assessment, and screening of these reports. After this review, possible project components within these reports that met the screening criteria were incorporated into the action alternatives described above. Other components were eliminated from detailed consideration because they did not meet the screening criteria or offer any additional benefit from the action alternatives. These eliminated components include, but are not limited to, the following:

- Placement of a diversion structure at the confluence of the Gila River and Mangas Creek and pumping water to either the Mangas Creek Dam, Schoolhouse Dam, or groundwater recharge/recovery in Silver City well fields
- Placement of a diversion structure at the top of the Gila Middle Box and pumping water to either Saddlerock Canyon Dam or to groundwater recovery/recharge in Silver City well fields
- Placement of a diversion structure and construction of associated conveyance infrastructure near the Gila stream gage site
- Placement of a surface river diversion structure at the confluence of Spar Canyon with the Gila River and construction of either the Upper or Lower Spar Reservoir
- Placement of a surface river diversion structure near the Gila stream gage and construction of either the Upper, Middle, or Lower Spar Reservoir

- Placement of a surface river diversion structure at Mogollon Creek and construction of either the Winn, Miller, or Doyle Reservoir
- Placement of a subsurface river diversion structure at Mogollon Creek and construction of the Winn Reservoir
- Construction of diversion, conveyance, and storage structures along the Gila River between Turkey Creek and Cherokee Canyon, with:
    - diversions to Spar, Winn, or Pope Canyons
    - single storage configuration options at Spar, Maldonado, Greenwood, Winn, Pope, Dam, Sycamore, or Dix Canyons
    - multiple storage configuration options at Greenwood Canyon and Sycamore Canyon, Mogollon Creek and Winn Canyon, and Spar Canyon and Garcia Canyon
- Combined storage reservoir at the San Francisco River location, where water would be routed from the Pueblo Creek Diversion location to the Weedy Reservoir and then conveyed by gravity to a reservoir in Keller Canyon
- Use of FMI infrastructure to supply Luna and Grant Counties with AWSA water
- Delivery of AWSA water over the Continental Divide via either the Tyrone Mine or Twin Sisters Canyon along U.S. Highway 180
- Block releases of AWSA water from one of the proposed reservoir(s) in the Cliff-Gila Valley for agricultural uses in the Redrock and Virden areas
- Alternative diversion structure designs and components, including Coanda screen[14] diversions with adjustable Obermeyer gates, shallow connector wells with horizontal wells, infiltration galleries, passive intake screens, engineered fill boulder weirs, low-profile concrete weirs with titled wedge wire screens, concrete weirs with control gates, diversion channels with upstream vanes, and inflatable rubber dams

Among the primary reasons for dismissal of these components are as follows;

1. The locations described in the reports do not meet the purpose of and need for the Proposed Action to adequately serve the agricultural use within the Cliff-Gila, Virden, or San Francisco River Valleys.
2. The components, such as large pumping or long conveyance requirements, outlined in the reports were both technically and economically infeasible.
3. The components outlined in the reports were speculative, given the limited data and inadequate information provided in the reports, including whether the components described would have the ability to capture needed flows while meeting the CUFA, as well as a lack of information required to assess their feasibility.

[14] Coanda screen: a tilted profile wire bar screen; only the bottom layer of water falls through the screen, while fish and debris pass over.

Chapter 3. Affected Environment and Environmental Consequences

3.1 Resources for Analysis

3.1.1 Issues and Related Resource Topics Retained for Further Consideration and Analysis in this EIS

The Joint Leads used internal, agency, tribal, and public scoping to identify environmental and socioeconomic resource issues to consider in the EIS (EMPSi 2018). They identified the following resource topics for detailed analysis in **Chapter 3**: surface water and groundwater, vegetation, aquatic and terrestrial wildlife (including special status species), threatened or endangered species, cultural resources, geology and soils, land use (including land use and ownership, recreation, and special designation areas), socioeconomics, Indian Trust Assets (ITAs), environmental justice, and public health and safety. See **Appendix D**, Summary of Scoping Issues and Related EIS Resource Topics, for a detailed summary of issues identified through scoping and the corresponding resource topics for analysis.

3.1.2 Issues and Related Resource Topics Dismissed from Further Analysis in this EIS

Several additional potential issues and resource topics were raised during scoping and the project planning phase. The Joint Leads analyzed these issues and determined that they did not warrant more detailed discussion in this EIS, given that they would not be significantly affected by the construction and implementation of the NM Unit and their further consideration would not aid in the discernment among alternatives. Consequently, the following issues and resources topics were dismissed from further analysis in this EIS: air, hazardous materials, noise impacts on the human environment, stream flow below San Carlos Reservoir, transportation, visual resources, and Wild and Scenic Rivers.

Air

According to the U.S. Environmental Protection Agency (EPA) Greenbook and New Mexico Environment Department (NMED), the counties that encompass the project area are currently in attainment with National Ambient Air Quality Standards and State ambient air quality standards.[1]

The main impacts on air quality in the project area would be from temporary construction-related air pollution. This includes fugitive emissions, such as dust from vehicular traffic, and pollutants released from internal combustion engines during construction of the diversion, storage, conveyance, and delivery structures; however, all construction-related air impacts would be localized, minor, and short term.

Further, the Entity would work with the NMED Air Quality Bureau to obtain any permits required for emissions during construction and operation of the project components. This would include complying

[1] See https://www3.epa.gov/airquality/greenbook/anayo_nm.html; https://www.env.nm.gov/air-quality/nonattainment-areas/. While Grant County was in nonattainment status for sulfur dioxide from 1992 to 2002, the NMED Air Quality Bureau submitted a re-designated plan in February 2003, which the EPA approved in September 2003. It submitted the Grant County SO_2 Limited Maintenance Plan in November 2013 to the EPA, which approved the plan on July 18, 2014.

with the New Source Performance Standards and the requirements for the Prevention of Significant Deterioration under the Clean Air Act.

Ultimately, in the context of local and regional air quality, construction of the NM Unit would represent a very small proportion of all the sources of criteria pollutants and fugitive emissions that could affect air quality in the project area. Additionally, none of the permanent project components are expected to release air pollutant emissions after the construction phase is complete. While electricity generators could be used temporarily as backup for equipment, if needed, the Proposed Action and the other action alternatives in the EIS are unlikely to significantly affect air quality or disrupt air quality standard attainment levels in the project area. As such, this resource topic was dismissed from further analysis.

Hazardous Materials

Although minor, localized spills could occur during construction and operation, the project components proposed under the action alternatives are not expected to release hazardous materials in the project area. Construction under all the action alternatives would primarily create diversion and storage structures, or conveyance and delivery structures, using heavy machines, concrete, and other materials. Equipment would require oils, fuels, and other potential pollutants. No permanent hazardous waste storage facilities would be required for construction or operations. Any spills from equipment use would not have a large volume and would be localized. Standard operating procedures and BMPs would be in place to prevent and minimize any spills (see **Appendix C**, Best Management Practices and Standard Operating Procedures for a full list of BMPs). Consequently, the Joint Leads do not anticipate the release of hazardous materials from the construction or operation of any of the project components, and the Joint Leads dismissed this resource topic from further consideration. It should be noted that under Alternative A, there would be pollution from releases of motor oil, gasoline, or diesel when conducting motorized work in the active river channel associated with the reconstruction of existing push-up diversions by bulldozers and other heavy machinery.

Noise Impacts on the Human Environment

Construction under any action alternative would cause some noise impacts on the human environment in the project area from the use of heavy machinery and other equipment. Characteristic equipment that would generate the loudest noise includes excavators (81 to 85 decibels [dB]), concrete mixer trucks (79 to 85 dB), front-end loaders (79 to 80 dB), and dump trucks (76 to 84 dB).[2]

At approximately 1,000 feet, an 80-dB noise source would be reduced to a nonintrusive level of 50 dB, which is comparable to light traffic or moderate rainfall. The noise would take several miles to be reduced to ambient levels of 35 to 45 dB.[3, 4] Impacts would be limited in scope, as they would be close to construction sites, temporary, and short term. Further, on completion of construction, the project components would not produce any continuous long-term noise impacts in the project area.

[2] Noise levels reflect those measured by the U.S. Department of Transportation's Construction Noise Handbook (USDOT 2006), which aligns with estimates in the Nuclear Regulatory Commission's Biological Assessment Preparation Technical Manual (NRC 2012). All noise estimates are measured at the source.

[3] NRC 2012 references an EPA estimate of 35 to 40 dB as a background noise estimate for rural areas, which is consistent with other authoritative sources, such as the National Academy of Science.

[4] Noise attenuation levels and distances were calculated based on point source distance equations in NRC 2012, using a conservative alpha value of 20.

Annually, under Alternative A, there is intermittent, local noise associated with ditch cleaning and the reconstruction of existing push-up diversions by bulldozers and other heavy machinery. Under the action alternatives, there would be intermittent, local noise in some areas from repairing and reconstructing rock vane weirs, as well as from operating some of the proposed project components, such as any backup generators not housed in buildings and pumping stations used to pump water. This noise would be consistent with existing noise conditions. The BMPs would be implemented to reduce noise impacts on the human environment to the extent possible (see **Appendix C**, Best Management Practices and Standard Operating Procedures, for a full list of BMPs).

The project area is in a mostly rural agricultural region of southwestern New Mexico; consequently, construction and operation activities under the Proposed Action and alternatives are not within 0.25 mile of any identified noise-sensitive receptors.[5] As such, due to the limited potential for significant noise impacts on the human environment in the project area, this resource topic was not carried forward for further analysis in the EIS. For noise impacts on wildlife, see **Section 3.4,** Biological Resources.

Stream Flow Below San Carlos Reservoir

The Globe Equity Decree of 1935 delegated ownership of the stored water in San Carlos Reservoir and control of the Coolidge Dam to the Bureau of Indian Affairs (BIA) for the sole purpose of meeting the irrigation demand of San Carlos Irrigation Project (SCIP) water users, the SCIDD, and the GRIC. Operation of the facilities is supervised by the Gila Water Commissioner.

Stream flow in the Gila River between San Carlos Reservoir and the Ashurst-Hayden Diversion Dam is highly variable and depends on releases from Coolidge Dam, flows from tributaries, including the San Pedro River, and precipitation in the watershed. Currently, releases from Coolidge Dam are based almost entirely on irrigation water orders from the SCIDD and the GRIC. Normally, each year, water stored in San Carlos Reservoir is released during the irrigation season, depleting reservoir storage to the point where little or no water can be released from the dam. An overall 17-year average annual Gila River water delivery to the SCIDD and the GRIC is 112,575 and 140,459 AF, respectively, based on unpublished data provided by SCIP in 2012.[6] Deliveries to each entity can exceed 200,000 AF in years with higher water levels in the San Carlos Reservoir.

Data from 2008 to 2017 indicate significant variability in San Carlos Reservoir storage and releases from Coolidge Dam. Water is typically released from the reservoir throughout spring and early summer, generally depleting reservoir storage, after which GRIC and SCIDD irrigators transition to CAP water; however, records show there is a wide variability in when this transition occurs. Stream flow data from 1999 to 2018 were collected from the U.S. Geological Survey stream gauge on the Gila River below Coolidge Dam (Station No. 09469500) and the U.S. Geological Survey stream gauge on the Florence Casa Grande Canal near Florence (Station No. 09475500) below the Ashurst-Hayden Diversion Dam. These data show that, during this period, the greatest flow levels were from March through August, with a monthly average flow rate of 329 cfs in the Gila River; the highest average monthly flow rate of 894 cfs

[5] Noise-sensitive receptors are areas where people reside or where the presence of unwanted sound could adversely affect human activity or land use. Residences, schools, hospitals, guest lodging, libraries, churches, nursing homes, auditoriums, concert halls, amphitheaters, playgrounds, and parks are considered to be noise sensitive. The U Bar Ranch is a family-owned and operated livestock and beef production operation. While it is located within 0.25 mile of the proposed ASR wells at the Cliff-Gila location, it is not considered a noise-sensitive receptor.
[6] L. Nelson, BIA/SCIP, personal communication, March 5, 2012.

in the river was in July 2010. Comparatively, the average monthly flow for January and February of that same year was 76.6 cfs. These numbers confirm that agricultural interests rely most heavily on irrigation water from Coolidge Dam in the spring and summer.

To facilitate maintenance activities on SCIP structures, releases from Coolidge Dam are typically suspended for approximately 10 weeks each year from November to January. The suspension of irrigation water releases from Coolidge Dam during these maintenance dry-ups results in temporary but substantial flow reductions in the Gila River downstream of Coolidge Dam for up to 10 weeks each year. During these dry-ups, the Gila River still experiences low levels of flow from several sources, including minor leakage from the Coolidge Dam spillway, flows into the Gila River from tributaries downstream of Coolidge Dam, and occasional surfacing of shallow subsurface flows due to localized geologic conditions. With increasing distance downstream, however, surface flow during dry-ups becomes more intermittent.

Because of the unpredictability of timing and amount of release flows to the river downstream of the dam, the exact impacts of the proposed NM Unit project on the Coolidge Dam releases are difficult to determine; however, a method is applied herein to provide a reasonable estimate of the scale of the impact for the purpose of this EIS.

Based on the modeled changes in flow at the U.S. Geological Survey stream gauge on the Gila River at Calva, Arizona (Station No. 09466500) upstream of San Carlos Reservoir, the average annual reduction in storage in San Carlos Reservoir due to the total consumptive use of the AWSA water is estimated to be from 178 to 1,491 AF under the action alternatives, with the low end being Alternative D, and the high end being Alternative C. For example, for the total consumptive use of 1,782 AF in a year under Alternative B, the San Carlos Reservoir storage is estimated to be reduced by 1,448 AF. Because the reservoir level would be lower than without the project, the assumption is that releases from Coolidge Dam would cease earlier due to the reduced lake level. If a release of 300 cfs from Coolidge Dam was assumed to be fairly typical, then converting that flow to a volume of 1,448 AF indicates flows from Coolidge Dam would end 2.4 days earlier than they would without the NM Unit project.

Historical records show that the GRIC and the SCIDD call for the CAP water all year long.[7] The SCIDD, unlike the GRIC, has no long-term subcontract allocation and each year must purchase excess (Agricultural Settlement Pool) CAP water from the Central Arizona Water Conservation District. As noted in **Section 2.3.2** and pursuant to the CUFA, the Entity must pay for the exchange costs; hence, the NM CAP water would be without economic injury or cost to the GRIC and the SCIDD. Considering the historical San Carlos Reservoir levels and historical GRIC and SCIDD irrigation calls, the most likely impact of the NM Unit project on the Coolidge Dam releases is expected to be an earlier transition to the CAP water by the GRIC and the SCIDD by a few days. Because the AWSA allows flexibility as to when the GRIC and the SCIDD can call for NM CAP water, it would be too speculative to assume a schedule for the CAP water exchange.

Similarly, the most likely impact of the NM Unit project under the action alternatives on the 68 miles of Gila River from Coolidge Dam to the Ashurst-Hayden Diversion Dam is a cessation of releases from Coolidge Dam 1 to 3 days earlier under a 300 cfs constant release scenario than without the NM Unit project. Releases from the Coolidge Dam currently are terminated based on actual storage and hydrologic inflows to the reservoir and have historically occurred anytime from June to December. Because of this,

[7] The CAP water is a secondary source of surface water available to the SCIDD.

the downstream impacts are minimal, compared with the range of regular operations, which include limited irrigation releases and extended maintenance dry-ups.

Transportation

Construction under any action alternative would impact transportation in the project area. This is because heavy machinery and other vehicles would be used on project area roads during construction, and there is the potential for construction through and on road corridors; however, these impacts would be short-term and confined to potential delays or restricted access during construction.

Temporary increases in transportation traffic would be limited primarily to existing routes, but new routes would be needed for construction access in some areas. Construction and operation requirements for new routes would be addressed through county permitting processes. After the construction phase is complete, there would be few vehicle trips associated with operations and maintenance, resulting in negligible impacts. As such, this resource topic was not carried forward for full analysis in the EIS.

Visual

Visual resources relate to the observable features on a landscape—land, water, vegetation, animals, and structures. These features contribute to the landscape's scenic or visual quality and appeal. A viewshed encompasses the land, vegetation, and other elements that are visible from a fixed vantage point. Such resources as scenic byways are considered to be lands that are managed for preservation and protection.

Under all of the action alternatives, various project components, including diversion, storage, conveyance, and delivery structures, would be constructed or modified. Many of these structures would be designed with low profiles or would be underground, and thus would be visually compatible with existing structures and agricultural landscapes. Consequently, these structures would not significantly impair the project area's visual landscape. Any storage ponds constructed under the action alternatives would be either unlined or would be lined with locally sourced soil-based material. This would help to incorporate these ponds into the project area's existing visual landscape.

Weedy Reservoir would be constructed under Alternatives C and E. The dam and associated features would likely be visually noticeable, although these features would be partially obscured by the location of the dam, as well as by existing trees, reducing the dam's visual impact. The adjacent material source areas would be visible, but would be recontoured after construction, reducing these areas' visual impact.

Although distribution lines would be constructed under the action alternatives to supply pumping stations, they would be limited in scope and extent. Compared with existing power lines, proposed distribution lines (consisting of overhead power lines and wooden poles) would be similar or smaller in size. Additionally, the project area's visual setting already includes electric power poles and overhead power lines, diversion structures, dams, bridges, and other industrial facilities. Federal and local land use plans do not identify any of the project locations as having special scenic qualities or any special visual resource management concerns. Therefore, implementation of the NM Unit is not anticipated to impact the visual qualities of the designated Gila Wilderness or the two WSAs at the Virden location (the Blue Creek WSA and the Gila Lower Box WSA).

For the reasons listed above, there is limited potential for the NM Unit to cause significant adverse effects on visual resources in the project locations under any of the action alternatives. Additionally, this issue was not raised during the scoping period for the Proposed Action. As a result, the Joint Leads dismissed this resource topic from further analysis.

Wild and Scenic Rivers

During public scoping, two issues were raised related to Wild and Scenic Rivers:

- What are the potential impacts of the Proposed Action on Wild and Scenic River characteristics?
- Should the Gila River be considered for protection under the Wild and Scenic Rivers Act?

The U.S. Forest Service (USFS) is the regulatory agency that would determine whether the Gila or any other river in the project vicinity should be considered for future protection under the Wild and Scenic Rivers Act. The USFS is revising the land and resource management plan for the Gila National Forest. As part of that process, it is evaluating river segments in the Gila National Forest to identify whether they are eligible and potentially suitable for inclusion in the National Wild and Scenic Rivers System under the Wild and Scenic Rivers Act. The eligibility study process will be limited to any rivers that were not previously evaluated for eligibility and those previously studied that now have changed circumstances that warrant a new evaluation. The eligibility study, including assigning all eligible rivers a preliminary classification, is not anticipated to be completed before the ROD for the NM Unit is signed.

There are currently no designated, eligible, or suitable Wild and Scenic River segments within the project area, so there would be no direct impacts on Wild and Scenic Rivers segments from construction of the NM Unit. The San Francisco location overlaps segments of the San Francisco River in Catron County that are currently being evaluated for eligibility by the USFS. Additionally, there are several river segments downstream of the Cliff-Gila and San Francisco locations that are currently being evaluated for eligibility by the USFS. In Grant County, these segments primarily include the portion of the Gila River that runs through the Gila Middle Box, Bear Canyon, Foxtail Creek, and Slate Creek. In Catron County, these segments primarily include Keller Canyon, Little Whitewater Creek, Sandy Wash, and Silver Creek. It is unlikely that the NM Unit project would be fully developed before the USFS has made an eligibility determination for these river segments. The Proposed Action and alternatives would reduce or maintain the same number of diversions in the segments that overlap the project area. Because of this, the project should not affect an eligibility determination for these segments by the USFS; however, should any of the river segments described above be determined to be eligible, the USFS should consider this project and any changes to river flows during the suitability evaluation.

There are various river segments downstream of the project area that have been classified as eligible. Most notably, all 23 miles of the Gila River within the boundaries of the Gila Box Riparian National Conservation Area (RNCA) (referred to as the Gila box segment) were found eligible in the 1991 Safford District Resource Management Plan and found suitable for inclusion in the National Wild and Scenic Rivers System in 1996, with 15.2 miles recommended for “scenic” classification and two segments (one on each end of the scenic segment, totaling 7.8 miles) recommended for “recreational” classification. The Safford District Resource Management Plan identified scenic, fish and wildlife habitat, recreation, geologic, historical and cultural resources, and hydrological features as outstandingly remarkable values (ORVs) for the Gila box segment. These river segments were formally recommended to Congress as potential components of the National Wild and Scenic Rivers System. To date, Congress has not approved this recommendation. These segments remain under BLM management prescriptions to protect their ORVs and preliminary classification until Congress acts upon these recommendations.

The Proposed Action is not anticipated to affect the "scenic" or "recreational" classification of the Gila box segment or its ORVs. Under all alternatives, the Gila River would experience flow reductions downstream of the project locations in Arizona (ranging from 1 to 2 percent in wet conditions and 2 to 14 percent in dry conditions), which could impact some river-based recreation in the Gila Lower Box RNCA (see **Section 3.3**, Water Resources for further information on potential flow reductions under all alternatives, specifically at the U.S. Geological Survey stream gauges on the Gila River near Clifton and Safford, Arizona). However, these flow reductions would generally occur between September and March. River-based recreation in this area takes place primarily during the spring run-off season and continues throughout the summer when river conditions support rafting. Consequently, the flow reductions from implementation of the NM Unit are not anticipated to substantially impact river-based recreation in the Gila lower box segment, or any other ORVs in the RNCA. Further, any reductions resulting from the Proposed Action are expected to fall within historical flow fluctuations (see **Section 3.3**, Water Resources for further information on potential flow reductions). Flow reductions on the San Francisco River in Arizona are expected to be low across all alternatives (0 to 2 percent in wet and dry conditions); consequently, these reductions are not anticipated to substantially impact river-based recreation or other ORVs in the Gila lower box segment for the same reasons discussed above. As a result, the Joint Leads dismissed this resource topic from further analysis.

3.2 Impact Methods and Cumulative Effects

Impact Methods and Terminology

The project area refers to the aggregate of the three NM Unit locations at Cliff-Gila, Virden, and San Francisco. These locations are distinct and geographically separated. The affected environment considered in this analysis varies by resource and is defined in the respective sections. The affected environment describes the context for evaluating the potential for resource presence, importance, and impact risk.

The impact analysis for each resource is focused only on areas where the applicable resource is likely to be impacted by the Proposed Action and alternatives. The impact analysis area represents a conservative estimate of the total extent of the potential for impacts. However, not all resources would experience impacts within their entire analysis area, and not all impacts from project construction and operation would extend across the entire analysis area. The analysis area includes the direct and indirect impact areas that are defined for each resource.

For each resource, this section describes the current project area conditions, analysis methods, and impact and intensity descriptors. This is followed by an analysis of the impacts of the Proposed Action and alternatives during construction and operation, using the following impact type descriptors:

- Direct—A direct impact is an effect on a resource that is caused by the action and occurs at a particular time and place. Direct impacts are associated with proposed construction activities (e.g., ground-disturbing activities) and operations (water diversions).
- Indirect—An indirect impact is an effect on a resource that is caused by the action later in time or farther away and is still reasonably foreseeable (e.g., increased likelihood of nonnative, invasive species moving into the area after disturbance). Indirect impacts could occur upstream or downstream of any direct impacts due to hydrologic changes.

- Cumulative—Cumulative impacts are those impacts on resources that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions.
- Short-term—Short-term impacts are temporary, generally occurring during construction. Specific time periods relating to short-term impacts are not defined for this project but would likely occur during construction (4 to 6 months) or for a limited time thereafter (generally 1 to 3 years). These time periods are subject to change due to funding limitations or the geographic location of construction activities. To help quantify impacts and assess differences in effects between alternatives, a short-term potential disturbance area of 50 feet around any project component was calculated. This area is used in the analysis for alternative comparison, unless otherwise noted. Final disturbance areas appropriate to local conditions and resource issues would be defined before construction.
- Long-term—Long-term impacts are permanent, generally occurring during operations. Long-term impacts typically last beyond the construction period, and the resources impacted may not regain their preconstruction conditions for a longer period of time. A long-term potential disturbance area of 25 feet around any project component was calculated. This area is used in the analysis for alternative comparison, unless otherwise noted. Final disturbance areas appropriate to local conditions and resource issues would be defined before construction.

Where appropriate to help provide context, potential impacts are characterized using the following descriptors:

- Negligible or inconsequential—This indicates no measurable or observable change from current conditions: The impact on the resource would be at or below the levels of detection.
- Minor or minimal— This indicates a small, detectable, or measurable change. The impact: (A) could be outside the range of natural or typical variability but occur for a very brief duration; or (B) could be within the natural or typical range of variability but occur for a longer period of time. Mitigation, if implemented, would be easily applied and successful with a high degree of certainty.
- Moderate— This indicates an easily discernible or measurable change. The effects would either:
  - A) be readily apparent or would result in measurable impacts on the resource; these impacts would affect the availability or natural recovery of those environmental elements over the long-term; or
  - B) could be substantial but of a short duration with no permanent impact on 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—This indicates a large observable or measurable change: 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.[8]
- Beneficial—This indicates a positive change in the condition, appearance, or function of the resource.

[8] For several resource topics, the intensity descriptors outlined in **Section 3.2** were further refined to provide a more detailed and accurate description of the context and intensity of the Proposed Action's impacts on those resource topics (see relevant resource sections for further detail). Unless otherwise stated, the intensity descriptors outlined in **Section 3.2** apply.

- Adverse—This indicates a negative change that moves the resource away from or detracts from its condition, appearance, or function.

In some instances, the intensity and duration of impacts could 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.

The short- and long-term disturbance estimates were derived using geographic information system (GIS) buffers. All numbers are approximate, unless stated otherwise, and may be rounded based on the scale of the impact. These numbers are for action alternative comparison purposes and do not imply that all these lands were previously undisturbed. The project area is disturbed by existing ditches, temporary and permanent diversions, roads, dams, bridges, and electric power lines (overlapping disturbance areas were counted only once). Ongoing disturbances associated with temporary diversions and ongoing maintenance activities could be reduced if an action alternative is implemented. However, due to the dynamic nature of these activities (e.g., push-up diversions), these disturbances have not been quantified. Impacts associated with the action alternatives do not account for any ongoing disturbances which could result in an overstatement of impacts.

In some instances, the use of these buffers has resulted in higher disturbance calculations than is actually occurring from direct disturbance in the project area due to the placement of project components (e.g., physical structures). Disturbance estimates are preliminary and subject to change with refinement of project footprints, access, construction needs, and potential resource avoidance and mitigation. For some resource analyses, other buffer distances may be applicable to be consistent with other analysis methods and regulatory standards. These are referenced on a case-by case basis in the respective resource sections.

Due to the dynamic nature of operating procedures under the constraints of the CUFA, river flow variability, and other uncertainties, the analysis may provide a range of variability to account for these conditions. The analysis captures effects to the extent reasonably possible, based on the best available information; however, the actual timing and amount of future diversions in any given year are not, and cannot, be reflected precisely in the analysis.

The analysis accounts for the constraints inherent in implementing the CUFA; however, the capacity of the diversion and conveyance infrastructure would limit the maximum diversions allowable under the CUFA.

Incomplete or Unavailable Information

The CEQ's implementing regulations for NEPA require that, in an EIS, a Federal agency identify relevant information that may be incomplete or unavailable for an evaluation of reasonably foreseeable significant adverse effects (40 CFR 1502.22). Knowledge and information are, and necessarily always remain, incomplete, particularly with complex ecosystems considered at various scales. In developing this EIS, the best available information pertinent to analyzing impacts and decisions to be made is used. Considerable effort was made to acquire and convert resource data into GIS or other digital formats for use in the EIS. Certain information was unavailable because resource inventories have either not been conducted or are incomplete. Types of data that are incomplete or unavailable include the following:

- Existing ongoing disturbance estimates and associated O&M costs under Alternative A, due to the dynamic nature of these activities (e.g., push-up diversions).
- Pedestrian surveys of vegetation, wetland, and wildlife, and species-specific surveys for biological resources, were limited to what could be observed during time and season of the survey, and surveys could exclude some species (e.g., nocturnal and cryptic species). Landowner access was not granted for portions of the project area which limited the extent of surveys.

Cumulative Analysis Projects

In addition to assessing the direct and indirect effects, this analysis considers the cumulative impacts, consistent with CEQ NEPA regulations and guidance (40 CFR 1508.25; CEQ 1997). The CEQ defines a cumulative impact as "the impact on the environment that results from the incremental impact of [an] action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or nonfederal) or person undertakes such other actions" (40 CFR 1508.7). The evaluation of cumulative impacts is intended to capture the full range of potential consequences of an action under review, in combination with the additive or combined effects of other actions on the same resources of concern.

The cumulative impact assessment area is the San Francisco River and Gila River watersheds from their headwaters downstream to Ashurst-Hayden Dam, as shown in **Appendix A**, **Map 3-1** (Cumulative Impact Assessment Area). This cumulative impact assessment area applies to all resources analyzed, unless an alternate area is provided.

Past, present, and reasonably foreseeable projects are described in **Table 3-1**. Reclamation guidance states that the assessment of future cumulative impacts should be based on known or reasonably foreseeable long-range plans, regulations, operating agreements, or other information that establishes them as reasonably foreseeable (Reclamation 2012; CEQ 1997). Ongoing and reasonably foreseeable future actions considered in the cumulative impact analysis are the projects, programs, and plans of various Federal agencies and other, nonfederal entities that are likely to occur within the next 10 years. Based on a review of proposed projects and in coordination with cooperating agencies, the Joint Leads determined that 10 years adequately captures what is reasonably foreseeable. Most regional planning documents do not go beyond 10 years, so identifying projects farther out becomes speculative.

Table 3-1. Impacting Factors Associated with Past, Present, and Reasonably Foreseeable Future Actions

Cumulative Project	Description
GBIC permanent diversion structures	In November 2014, the ISC allocated initial funding for a project proposed by the GBIC for designing, engineering, and constructing permanent structures to divert water from the Gila River into ditches in the Cliff-Gila Valley, in lieu of the existing push-up diversions. It is assumed that these diversion structures would be constructed at the current push-up diversion locations. To date, designs have been completed for one diversion structure at the location of the current push-up diversion for the Upper Gila Ditch. This project is one of the non-NM Unit projects funded by the ISC under the AWSA.

Cumulative Project	Description
San Francisco private wells	The San Francisco Soil and Water Conservation District's future plans envision individual use of privately developed wells and push-up surface diversions on local arroyos for livestock water impoundments in the San Francisco project location. These wells could divert AWSA water directly or could rely on water releases from Weedy Reservoir to offset their impacts on the river. The number and specific locations, timing, and operations of those future San Francisco wells and impoundments are yet to be defined. When these future actions advance in their planning and site-specific definition, they will be subject to environmental compliance under NEPA, Endangered Species Act (ESA), National Historic Preservation Act (NHPA), and other laws, as appropriate per their specific impacts and agency jurisdiction.
Town of Silver City 40-Year Water Plan	In December 2017, the town of Silver City in Grant County, New Mexico, adopted the 2017 Town of Silver City Supplement on Water Use and Wellfield Service 40-Year Water Plan.[9] As part of this supplement, Silver City used a planning model to analyze the capacity of the Town of Silver City wellfield in the Gila Basin to meet the high annual growth rate for water demand. The analysis indicated that, as presently configured, the Town of Silver City wells can supply the growth in demand. Recommendations to maintain water supply or meet future water supply include preparing to re-drill and/or deepen wellfields in future years to extend service lifetime to meet required demand levels, monitoring the Town's water use growth relative to its existing permits and seeking water rights as needed to transfer into the Town water system, and tracking adjacent wellfield withdrawals and acting as needed to intervene with large-scale changes that could impact the Town's sources.
Non-NM Unit AWSA projects funded by the ISC	The ISC is funding 16 AWSA projects in southwestern New Mexico that are not associated with the NM Unit project. These include ditch improvement, effluent reuse, and municipal water conservation activities. Relevant projects that are in the cumulative impact assessment area are the following: • GBIC permanent diversion structures, as discussed above • New Mexico New Model Canal improvement project—Located off the Gila River, this project involves lining canals with pipe, installing plug valves on turnouts, and installing meter turnouts. • 1892 Luna Irrigation Ditch Association permanent diversion structure—Located in the headwaters of the San Francisco River, the Luna Irrigation Ditch Association proposes to construct permanent diversion structures and to replace ditches with closed pipes for efficiency.

[9] See http://www.townofsilvercity.org/r/town_of_silver_city_NM.php?r=28,q7kfr

Cumulative Project	Description
Freeport McMoRan (FMI) mining operations	FMI operates the Tyrone mine, an open-pit copper mining complex, and the Chino mine, a porphyry copper deposit with adjacent copper skarn deposits, both of which are in Grant County, New Mexico. The Tyrone mining district, the second-largest porphyry copper deposit in New Mexico, is 10 miles southwest of Silver City in the Burro Mountains of southwestern New Mexico. FMI holds water rights and operates a category 2 low-head concrete diversion structure spanning the floodplain on the mainstem Gila River downstream of the Cliff-Gila location as part of its mining operations. Water from this diversion is released into the Moss-Crawford Ditch, and then pumped to Bill Evans Lake then to the Tyrone Mine, which is approximately 13 miles southeast of Bill Evans Lake. These operations are expected to continue. As allowed under its Joint Powers Agreement, the Entity plans to investigate and obtain, through lease, purchase, or other transfer mechanism, the right to operate, manage, and use water resources and infrastructure currently owned by FMI for future operations.
Gila River Basin Native Fishes Conservation Program	This program was established under a series of USFWS biological opinions (in 1994, 2001, and 2008) to partially mitigate impacts of the CAP canal. It supports recovery and conservation efforts of Federally listed, candidate, and other non-listed fish species native to the Gila River basin in New Mexico and Arizona. It would implement existing and future recovery plans for these species. As described in the 2008 biological opinion, Reclamation committed to native fish conservation and nonnative fish eradication, as well as to constructing 12 native fish barriers by 2023. As of 2018, it had constructed physical barriers in eight streams: Aravaipa Creek, Cottonwood Spring, Fossil Creek, Bonita Creek, Hot Springs Canyon, Blue River, Spring Creek, and the west fork of the Black River. The program has investigated the potential to construct barriers in Arizona (O'Donnell Creek, Eagle Creek, and Verde River) and the middle fork of the Gila River in New Mexico (USFWS et al. 2018).
Gila National Forest Plan Revision	The Gila National Forest is currently revising the existing 1986 Gila Forest Plan pursuant to the 2012 Forest Planning Rule (36 CFR 219). The Forest has completed its preliminary Draft Forest Plan, which describes the strategic direction for management of forest resources for the next 10 to 15 years.
Gila River Farm Riparian Preserve	This project involves The Nature Conservancy (TNC) constructing a shallow seasonal wetland spanning 3 acres for wintering waterfowl and migratory birds along the Gila River. The wetland will be constructed in the Gila River Farm, a tract of land in TNC's Gila Riparian Preserve, approximately 23 miles northwest of Silver City, New Mexico. The preserve covers 1,300 acres and spans 5 miles of the 14-mile-long Cliff-Gila Valley.
USFS Stateline Range NEPA	The Clifton Ranger District of the Apache-Sitgreaves National Forests and the Glenwood Ranger District of the Gila National Forest are proposing to authorize ongoing grazing on 14 allotments in the Apache-Sitgreaves National Forests and the Gila National Forest. Six allotments occur primarily in Arizona, and eight occur primarily in New Mexico, with portions of six allotments extending across the state line. The San Francisco River runs through, or adjacent to, 10 of the 14 allotments. Permitted numbers vary from 3,791 to 4,022 head of cattle and horses, depending on the time of year, for a total of 45,462 animal unit months (AUMs) currently permitted through term grazing permits or authorized per decision notices on these allotments.

Cumulative Project	Description
Double E Ranch Habitat Protection and Improvement	The Double E Ranch property, which consists of 5,900 acres of deeded land, was acquired by the New Mexico State Game Commission in 2014. The property is along the southwestern edge of Gila National Forest, approximately 4 miles east of Gila, New Mexico. The acquisition of the Double E Ranch helps protect and restore riparian habitat and maintains perennial flow along Bear Creek. NMDGF habitat restoration goals and objectives include regenerating younger age classes of deciduous riparian trees; encouraging formation of a vegetative understory to provide nesting habitat; managing Bear Creek to provide food, water, and cover for wildlife species; establishing and/or maintaining wetlands and off-channel ponds; and protecting loach minnow designated critical habitat from destruction or adverse modification. Restoration actions funded by the New Mexico Office of Natural Resources Trustee and the USFWS focus on passive restoration, including allowing riparian vegetation to reestablish naturally. It may include changes to grazing management or construction of exclosure fences to limit grazing and off-road vehicle use in the riparian areas.
Southwest Sufi-Bear Creek Conservation Easement and Habitat Improvement Project	This project, funded by the New Mexico Office of Natural Resources Trustee and the USFWS, aims to protect approximately 1,453 acres of wildlife habitat on the Southwest Sufi-Bear Creek property in Grant County, New Mexico. It would create a conservation easement and restore riparian areas on 34 acres of riverine and marsh wetlands (2.6 miles) along Bear Creek. This project focuses on preventing further fragmentation of critical riparian habitat in this area. Additional work to repair fencing on the property would help protect valuable wildlife habitat from trespassing cattle. The New Mexico Land Conservancy performed the necessary due diligence activities and closed on the acquisition of the easement in January 2018.
USFS Luna Restoration Project	The USFS is proposing to restore grasslands and forests to reduce the potential for high-severity fires and improve watershed health, ecological functionality, wildlife habitat, and water quality. A portion of the project would be in the upper San Francisco River watershed. This project is undergoing a separate NEPA process by the USFS. The proposed action in the USFS Draft EIS incorporates the 1892 Luna Irrigation Ditch Association permanent diversion structure, one of the non-NM Unit projects funded by the ISC, as discussed above. The Final EIS was published in April 2019, and a final ROD was published in November 2019.
Upper Gila Watershed Riparian Restoration Project	This Gila Watershed Partnership of Arizona project, funded by grants from the Walton Family Foundation, FMI, and United Way of Graham County, aims to remove invasive tamarisk and restore portions of the Upper Gila River banks to native vegetation. This project focuses on building resilient and self-sustaining native riparian communities in order to reestablish the natural functions of riparian systems along the Upper Gila River.
San Francisco and Blue Rivers *Escherichia coli* (*E. coli)* Reduction Project	This Gila Watershed Partnership of Arizona project, funded by the Arizona Department of Environmental Quality, aims to reduce the sediment and *E. coli* impairment on the San Francisco and Blue Rivers. The project focuses on slowing sediment, which carries *E. coli*, by installing small, one-rock check dams with native plants on the landscape above the rivers, contributing to cleaner water sources in the area.
San Francisco River Pumped Hydro Project P-14995	This project, proposed by Pumped Hydro Storage LLC, is for 1,250-megawatt pumped storage on the San Francisco River 0.25 mile west of the Arizona/New Mexico border. It aims to develop, conserve, and use water resources to benefit the public in various ways, including promoting renewable power and increasing electrical distribution system reliability and resiliency. This project will involve constructing new water storage, water conveyance, and power-generation facilities, as well as a tunnel access road and primary transmission lines.

Cumulative Project	Description
Proposed issuance of an enhancement of survival permit under the ESA to FMI, and the Morenci Water and Electric Company for conservation of Federally listed fish species	The activities for FMI's proposed project would include ongoing land and water management associated with water-related improvements. Plan components are a diversion dam and appurtenant pumping facilities and pipelines, groundwater pumping stations and water transmission pipelines, access roads, power lines, and related infrastructure. During the term of the safe harbor agreement, FMI anticipates improving, replacing, repairing, reconstructing, and maintaining these facilities and related infrastructure on land next to Eagle Creek and the lower San Francisco River, Arizona. The USFWS has worked with FMI to design activities to have a net conservation benefit to the Federally listed fish species in the area to be covered under this proposed safe harbor agreement. These conservation activities are as follows: • Allocating $4 million over the next 10 years to complete the design and construction of a fish barrier on Eagle Creek in Arizona with Reclamation to protect and enhance aquatic habitat for the covered species; the fish barrier would prevent nonnative aquatic species from moving upstream into the upper portion of the creek, protecting the covered species and their habitat • Developing and implementing a 3-year monitoring program to detect the presence of other types of nonnative invasive species in the upper reach of Eagle Creek and investigating the practicability and cost of actions to suppress these species in the upper segment of Eagle Creek, above the fish barrier • Annual monitoring along Eagle Creek and the lower reach of the San Francisco River to gather data for use in informing future conservation and management activities and assisting in the recovery of the covered species The USFWS published in the *Federal Register* (83 Federal Register 14287-14289, April 3, 2018)[10] a Notice of Intent to prepare an environmental assessment on this proposed safe harbor agreement.
Burro Cienega Watershed Restoration Project	This project, funded by the New Mexico Office of Natural Resources Trustee and the USFWS, restores riparian and wetland habitats throughout the Upper Burro Cienega Watershed with the repair of severe erosion damage to the Burro Cienega. This project will also reconstruct stock tanks and ponds to provide habitat for migrating waterfowl and other wildlife. The restoration activities will take place within the Upper Burro Ciénega Watershed, approximately 25 miles southwest of Silver City, New Mexico, on the southeastern corner of the Burro Mountains, on both privately-owned ranches and sections of the Gila National Forest. Restoration activities began in late 2014.
Headwaters Burro Ciénega Watershed Restoration Project	The Burro Ciénega watershed is comprised of approximately 109,257 acres owned by the Gila National Forest, New Mexico State Land Office, BLM, and private individuals. The headwaters of the Burro Ciénega are located in Gila National Forest and on private lands approximately 23 miles southwest of Silver City, New Mexico. Ranchers in this area have assembled to form the Upper Burro Ciénega Watershed Association, which works to restore and enhance habitat conditions and overall watershed health. The Headwaters Burro Ciénega Watershed Restoration project includes planting riparian shrub and tree buffers on suitable streambanks in the headwater portion of the ciénega and identifying, locating, and treating undesirable nonnative State-listed noxious plant species. Restoration activities within the Gila National Forest started in early 2018, and the project is expected to continue through 2020.

[10] https://www.govinfo.gov/content/pkg/FR-2018-04-03/pdf/2018-06713.pdf

Cumulative Project	Description
Pima-Maricopa Irrigation Project/San Carlos Irrigation Project	The Pima-Maricopa Irrigation Project and the SCIP are ongoing actions led by Reclamation that provide a common use irrigation system in the GRIC and rehabilitate the SCIP Facilities (Reclamation 1997). While the projects are outside the cumulative impact assessment area, they provide for water savings that would be realized at San Carlos Reservoir.
Tularosa River Sediment Check Dams	This project consists of building sediment check dams across the Tularosa River to trap sediment and impound 4,000 AF of water. These actions will improve water quality, as well as create additional riparian habitat. The check dam construction will consist of standard BMP structures.
West Fork Gila River fish barrier	The USFS is conducting maintenance work on the West Fork Gila River fish barrier to continue conservation and recovery of the Gila trout in the Gila River. In order to remove two rock boulders currently blocking the West Fork fish barrier, barrier holes will be drilled into the rock using primitive tools (i.e., hand drill and sledgehammer), and the boulders will be blasted and reduced to fragment sizes that can be removed by hand. This action is categorically excluded from documentation in an EIS or an environmental assessment, given that it is a “modification or maintenance of stream or lake aquatic habitat improvement structures using native materials or normal practices” (36 CFR 220.6[e][7]).
2017 Southwest New Mexico Regional Water Plan	The 2017 Southwest New Mexico Regional Water Plan identifies strategies, including infrastructure projects, conservation programs, watershed management policies, and other types of strategies, that may help balance water supplies and projected demands to address the Southwest New Mexico region’s future water management needs and goals (ISC 2017). As part of the plan, the Southwest New Mexico region planners discussed and compiled new project, program, and policy information; identified key collaborative projects; and provided recommendations for the state water plan. The project, program, and policy list in the plan primarily includes recommendations for water system infrastructure, water conservation and efficiency, and watershed restoration projects. Foreseeable projects listed in the plan (and not accounted for elsewhere in this table) are the following: • Maintain, repair, or decommission flood, sediment control, and recreational dams on public lands in Carton, Grant, Hidalgo, and Luna Counties • Restore the riverside ditch south of Cliff, New Mexico • Replace the Gila Farm Ditch siphon under Bear Creek • Make wastewater improvements for Virden, New Mexico
2007 Catron County Comprehensive Plan	The 2007 Catron County Comprehensive Plan identifies some of the policies that implement county residents’ visions for Catron County over the course of the next 5 to 20 years (Catron County 2007). The plan also addresses and responds to several key issues that affect the county, including water use.
2017 Grant County Comprehensive Plan	In 2017, Grant County repealed its 2004 Comprehensive Plan and approved the 2017 Comprehensive Plan (Grant County 2017). This plan guides County policy decisions on land use, transportation, infrastructure, housing, economic development, and the environment. In the 2017 plan, Grant County outlined its interest in securing additional water rights to meet residential and commercial needs and support potential economic development. In order to achieve this, Grant County listed four main goals: (1) manage the risks associated with natural and human-made disaster; (2) reduce water consumption through conservation and resource management practices; (3) provide sustainable long-term supply of water for residential, commercial, and agricultural needs; and (4) preserve the natural landscapes and delicate habitats of the region.

Cumulative Project	Description
2011 Hidalgo County Comprehensive Plan	In 2011, Hidalgo County updated its 2004 County Comprehensive Plan to describe and respond to conditions in 2011 (Hidalgo County 2011). The plan is a policy document that establishes the present and future goals of residents, property owners, and other stakeholders for Hidalgo County. Regarding water resources, the plan outlines three main goals: (1) to secure, protect, and maintain safe and sustainable water quality and quantity through effective and coordinated watershed and aquifer management; (2) to promote, protect, and restore the open spaces and natural resources in the County; and (3) to recognize, honor, and protect historical water rights for future generations. The plan recommends various actions for the County to implement in order to achieve these goals.

Other projects were eliminated from analysis under one of the following circumstances:

- If they are outside the cumulative impacts area of analysis
- If they are proposed beyond the cumulative project timeline (2030)
- If readily available data on project magnitude, location, or description is insufficient, such that potential impacts cannot be ascertained
- If they would affect the environment only slightly, such as maintenance and repair of existing facilities
- If they were plans or policies without a physical action or development component

The cumulative impact assessment area has many water users that operate in accordance with water rights, laws, and court orders, including the 1964 Supreme Court decree in Arizona v. California. There are many factors that influence the timing, location, and volume of water use. Climate change is also an ongoing action. The cumulative impact assessment recognizes the continued use and variability of existing water supplies and demand, and climate change, in addition to the specific actions listed in **Table 3-1**.

3.3 Water Resources

The water resources analyzed as part of this EIS are surface water, groundwater, water quality, and fluvial geomorphology. The surface water resource topics are surface water hydrology, climate trends, water rights and uses, and flooding. The groundwater topics are local geology, aquifer setting, and current groundwater use, and a review of groundwater models developed in the area to provide the context of current groundwater conditions and potential project effects. The water quality topic documents the water quality of the affected environment and potential effects of the alternatives, including surface water quality, groundwater quality, constituent loads, flow source mixing, and the regulatory environment. The fluvial geomorphology topics are historical observations of river changes and sediment transport.

3.3.1 Affected Environment

The water resources area of analysis is the watershed, from the three project locations to the Gila River above the San Carlos Reservoir. The area of analysis comprises two main river systems: the Gila River and the San Francisco River, which is a tributary of the Gila. The confluence of the Gila and San Francisco Rivers is a location where any effects of the Proposed Action on river flows from the projects at the San Francisco, Cliff-Gila, and Virden project locations would combine. **Appendix A, Map 3-2** (Major Surface Water Features above the Gila-San Francisco River Confluence) shows the area of analysis above the confluence. **Appendix A, Map 3-3** (Major Surface Water Features between the Gila-San Francisco Confluence and the Ashurst-Hayden Diversion Dam) shows the area of analysis below the confluence to the Calva gage. The Calva gage is another important component of the area of analysis because it is the last U.S. Geological Survey gage on the Gila River before it empties into San Carlos Reservoir. Data derived from the Calva gage are used for water modeling in this EIS, particularly to evaluate effects on projected surface water quantity and quality from the confluence downstream to the San Carlos Apache Indian Reservation. The area of analysis does not encompass San Carlos Reservoir, nor does it extend beyond it. See **Section 3.1.2**, Stream Flow Below San Carlos Reservoir.

River reaches bounding the Cliff-Gila proposed diversion, the San Francisco proposed diversion, and Weedy Reservoir (Alternatives C and E) river outflow were selected as study reaches for groundwater and geomorphology. Additionally, the existing Virden proposed diversion reach was included. While no infrastructure is proposed in the Virden channel, the Proposed Action would affect river flows in this reach. Projected surface water quantity and quality effects from the Proposed Action were evaluated through the confluence and downstream to the San Carlos Apache Tribe Reservation, as represented by stream gage measurements at Calva.

Surface Water

The Gila River is the southernmost snowmelt-influenced watershed in the continental U.S. (Gutzler 2013), forming part of the Colorado River Basin (CADMUS Group 2011). The climate of the region is arid to sub-humid (Garfin et al. 2014). Precipitation principally falls as a combination of winter snow and late summer rainstorms (Gutzler 2016). Snow begins to accumulate starting in November, with peak snowpack in February or March. Storms can occur in fall and winter as a result of storms in the tropics (TNC 2014) and can result in regional floods, such as the Aldridge flood in 1970 and Aldridge and Hales flood in 1983. Snowmelt begins in March in most areas, with snowpack depleted by around April or May.

The North American Monsoon System (NAMS) also influences precipitation in the area of analysis and generally begins in mid-July. Total NAMS-influenced precipitation received from July to September is 47 percent of the annual precipitation, based on the 1980 to 2010 published normals (National Environmental Information Service 2019). Monthly average streamflow volumes are directly correlated to precipitation and temperature. Gutzler (2013) described December to June runoff as highly correlated with November to April precipitation, with temperatures having an influence. Flows in June are highly related to snowmelt in May, while July flows are sensitive to monthly precipitation (Gutzler 2016).

The area of analysis contains two main river systems: the Gila River and a tributary, the San Francisco River. **Appendix A, Map 3-4** (Detail of Surface Water Features—Cliff-Gila Location) shows the rivers and surface water features in the Cliff-Gila location. The Gila River originates in the Gila National Forest in New Mexico. The upper Gila River originates as a collection of tributaries before flowing through a narrow canyon (the Upper Box) then emerging into the Cliff-Gila Valley. The total drainage area of the Gila River, just upstream of Mogollon Creek (at River Mile [RM][11] 107.7) is 1,853 square miles. Mogollon Creek provides an additional 126 square miles of drainage area at the upstream end of the proposed Cliff-Gila project reach.

[11] River miles are measured upstream of the Gila River-San Francisco River confluence along either the Gila River or San Francisco River, based on 2016 aerial imagery.

Mangas Creek flows into the Gila River at RM 90.3, downstream of the Cliff-Gila location and upstream of sections of USFS and BLM-administered wilderness land. Mangas Creek collects water from 204 square miles of mostly scrub and some forested land. Mangas Creek is perennial because it is supplied by Mangas Springs, which are in turn fed by the Mangas Trench (Balleau 2011). Mangas Trench is a groundwater feature that undercuts the Continental Divide. Discharge estimates of Mangas Trench to surface water ranges from 15,000 to 20,000 AFY, 40 percent of which enters the Gila Basin. Of the water entering the Gila Basin via the Mangas Trench, about 1,300 AFY discharges to Mangas Springs. The remainder presents as underflow between Cliff and Redrock (Hydrosphere 2007). Silver City wells in the Mimbres Basin can influence conditions in the Mangas Trench and affect Gila River water. Groundwater modeling estimates indicate Silver City municipal pumping reduces groundwater discharge to the Gila River by 70 AFY (Hydrosphere 2007).

Appendix A, Map 3-5 (Detail of Surface Water Features—Virden Location) shows the rivers and surface water features in the Virden location. The Gila River flows through two canyon reaches, the Middle and Lower Boxes, through the Redrock area. Blue Creek joins between the two canyon reaches at RM 60.3, providing 139 square miles of drainage area. The Gila River at the Virden location reach has a cumulative drainage area of 3,218 square miles. The Gila River at the confluence, not including the San Francisco River, drains 4,036 square miles.

Downstream of the Virden location, the Gila Water Commissioner monitors Cosper Crossing for the presence or absence of flowing conditions (Gila Water Commissioner 2019). The Cosper Crossing reach is on the Gila River, between York and Sheldon, Arizona, and next to Cosper Loop Road. When this portion of the reach is not flowing, the Gila River becomes disconnected, and water rights upstream of the location operate without regard to downstream senior rights.

The San Francisco River is the largest tributary in the area of analysis, and it flows into the Gila River downstream of both the Cliff-Gila and Virden reaches. The San Francisco River originates in the White Mountains of Arizona and Apache-Sitgreaves National Forest. **Appendix A, Map 3-6** (Detail of Surface Water Features—San Francisco Location) shows the rivers and surface water features in the San Francisco location. The first large tributary, the Tularosa River, flows into the San Francisco River at RM 116.1, just downstream of the village of Reserve. The total drainage area at the upstream end of the Spurgeon Ditch #2 (starting at RM 87) is 1,304 square miles. This drainage area does not include Pueblo Creek, which joins upstream of the Thomason Flat Ditch at RM 85.6, with a drainage area of 81 square miles. The Tularosa and San Francisco Rivers are perennial features, while Pueblo Creek flows intermittently. Pueblo Creek periodically contributes considerable flow and sediment to the San Francisco River.

Two other tributaries to the San Francisco River of note are Whitewater Creek (RM 70.7) and Blue River (RM 32.4). Whitewater Creek has its origins in the highest elevation of the watershed, Whitewater-Baldy Peak. Its 56-square-mile drainage area is mostly forested and scrub. Whitewater Creek is an intermittent creek in New Mexico. Blue River is a perennial feature in Arizona, with a drainage area of 618 square miles. The total drainage area of the San Francisco River at the confluence with the Gila River is 2,809 square miles.

Figure 3-1 (Historical Flows on the Gila River) and **Figure 3-2** (Historical Flows on the San Francisco River and Gila River at Calva) provide the median and average flows at selected river stream gages on the Gila and San Francisco Rivers. The selected gages were established between 1910 and 1930; each has approximately 90 years of record, except for the Redrock gage, which has 55 years of record.

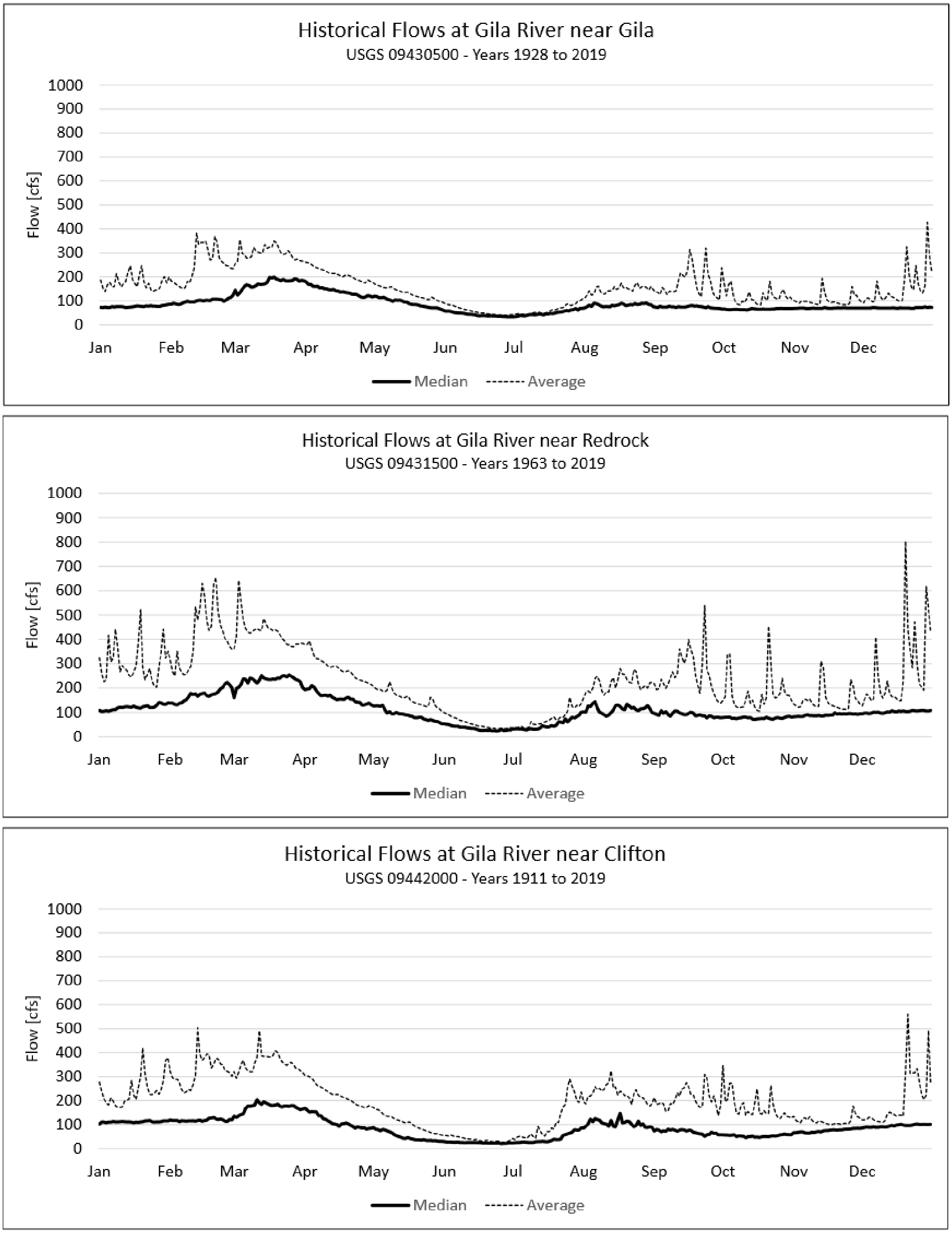

Figure 3-1. Historical Flows on the Gila River

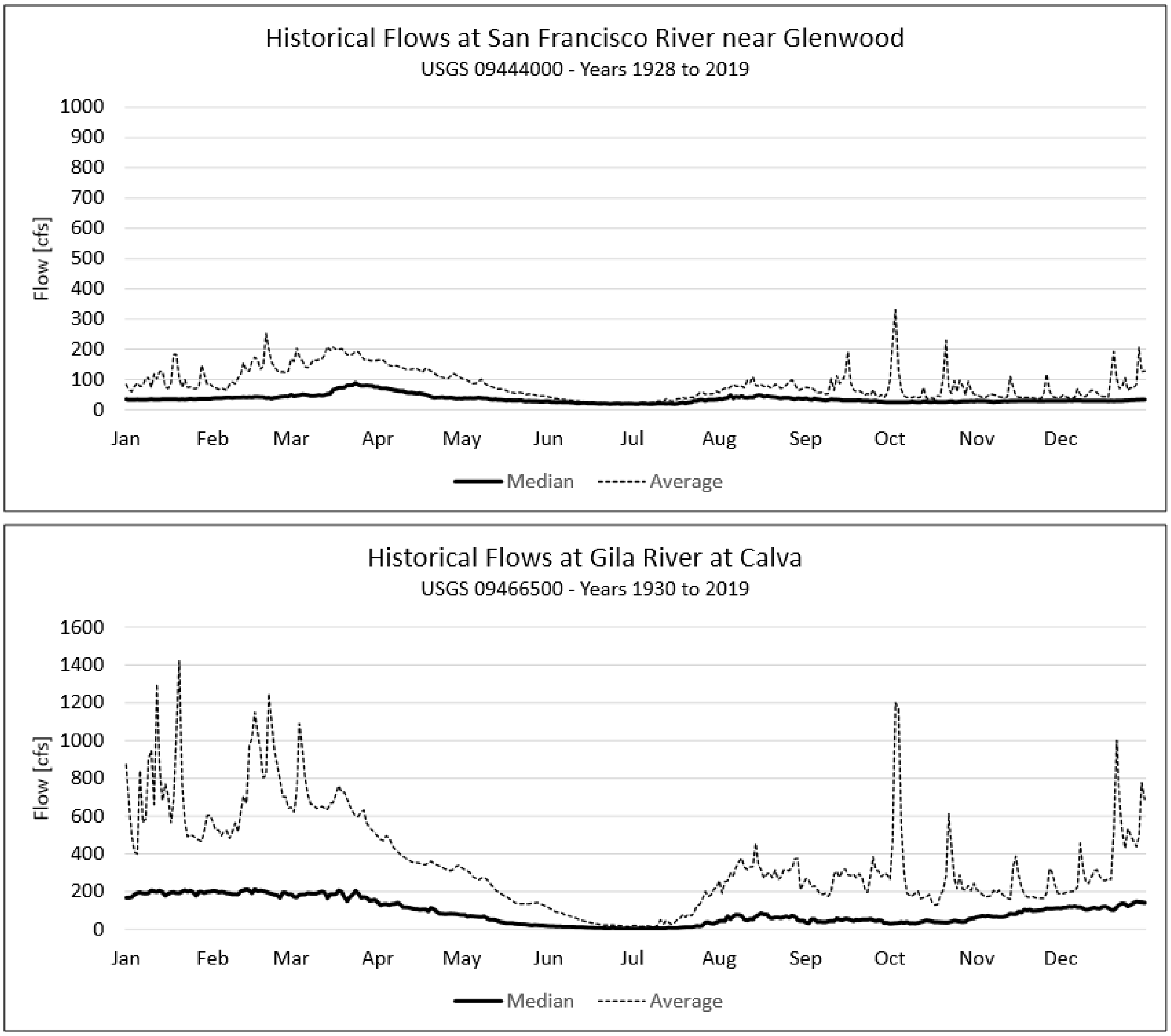

Figure 3-2. Historical Flows on the San Francisco River and Gila River at Calva

In low-flow years, the Gila River between Gila and Clifton is a losing system, where flow diversions (MEI 2006) and transmission losses cause flow volumes to decrease with an increasing drainage area. In high-flow years, flow accretes with drainage areas in the downstream direction. Stream gages on the San Francisco River are near Reserve, Glenwood, and Clifton. Trends of these gages are increasing streamflow, with an increasing drainage area.

River flows are affected by the occurrence of drought and wet periods. Drought conditions (months with National Oceanic and Atmospheric Administration's Modified Palmer Drought Severity Index less than -0.5) occurred in 41 percent of all months from 1895 to 2017. Historical droughts, as provided by the National Oceanic and Atmospheric Administration, of long duration and high severity were in the early 1900s, the 1950s, and the 2010s. The years 1995 to 2016 were characterized by drought conditions. Overall, the twentieth century tended to have wet conditions. Paleohydrologic reconstructions of drought conditions demonstrate that long-term conditions have been drier (Garfin et al. 2014). Significant past droughts were from years 1566 to 1579, 1666 to 1676, the 1770s, and 1882 to 1905.

Historically, the minimum annual flow volume on the Gila River at the Gila gage in 1956 was 31,179 AFY, while the maximum was recorded in 1993, at 299,493 AFY. Over the entire period of record at the Gila gage, the average annual flow volume of the Gila River is 114,256 AFY. On the San Francisco River, the minimum annual flow volume was recorded in 1956 at 8,742 AFY, while the maximum was recorded in 1983 at 271,380 AFY. Over the entire period of record at Glenwood, the average annual flow volume of the San Francisco River is 61,679 AFY.

Surface Water Uses Irrigation uses in the area of analysis in New Mexico were adjudicated between 1964 and 1966. The primary use of adjudicated water from the Gila River in the area of analysis is for agricultural irrigation. While irrigation has been practiced in the region for a long time, the quantity of irrigated acreage has fluctuated substantially in some areas. Areas in both rivers have similar trends of declining irrigated acres from the mid-1970s to early 1990s, followed by a trend of increasing acres afterward.[12]

Figure 3-3 provides the available historical irrigated acreage. The Cliff-Gila, Buckhorn, and Duck Creek areas had the largest fluctuations in irrigated areas, with 990 fewer acres (58 percent)being irrigated from 1984 to 1993, compared with that from 2007 to 2016. The Glenwood area on the San Francisco River had little change in irrigated acres from 1982 to 1991, compared with that from 2007 to 2016. In some cases, floods required irrigation infrastructure to be repaired, which affected operations and irrigated acreage. The December 1978 flood, for example, damaged or destroyed diversion dams in the project areas, along with 20 percent of irrigated lands and stream and ditch flow gage stations (ISC 1980).

Flood irrigation is used in the San Francisco River locations and the Cliff-Gila location (Longworth et al. 2013). A combination of flood and sprinkler irrigation is used in the Virden Valley, where 94 percent of lands are flood irrigated and in 6 percent of the area where sprinklers are used. From 1968 to 2016, irrigation consumptive use averaged 1,674 AFY in the San Francisco areas and 3,333 AFY in the Gila areas. Between 2006 and 2016, the irrigation consumptive use averaged 1,812 AFY in the San Francisco areas and 4,257 AFY in the Gila River areas in New Mexico. Additional acreage is irrigated in the Virden location of New Mexico under the Globe Equity decree, ranging from 1,560 to 2,474 acres, with an average of 2,200 acres.

Gila River adjudicated water is also used for mining. Phelps Dodge (now FMI) developed a pumping station off the Moss-Crawford de Foresta Ditch at RM 92.9, between the Cliff-Gila and Virden locations. The system exports water to the Tyrone area, which has a copper-producing mine on the boundary of the Gila River watershed. The system also provides water for Gila River irrigation uses. As part of the Tyrone Mine pump station project, an earthen dam impounding Bill Evans Lake was constructed in 1969 (NMED 2007), storing up to 2,100 AF. Water is diverted into Bill Evans Lake using a gated low-head concrete diversion structure on the Gila River and the pumping station (BHI 2014b). Water stored in Bill Evans Lake is also subject to evaporation and seepage losses. Seepage from Bill Evans Lake returns to Mangas Creek, which later flows into the Gila River. The operation of this diversion is reported to frequently dewater the Gila River below the pumping station (Haney 2006). Historical municipal and industrial uses

[12] The New Mexico Interstate Stream Commission produces annual reports on “irrigated acreage, diversion and consumptive use of water for all purposes in New Mexico from the Gila River, San Francisco River, and San Simon Creek” for the *Arizona v. California* settlement. Reports from 1968 to 2017 were reviewed.

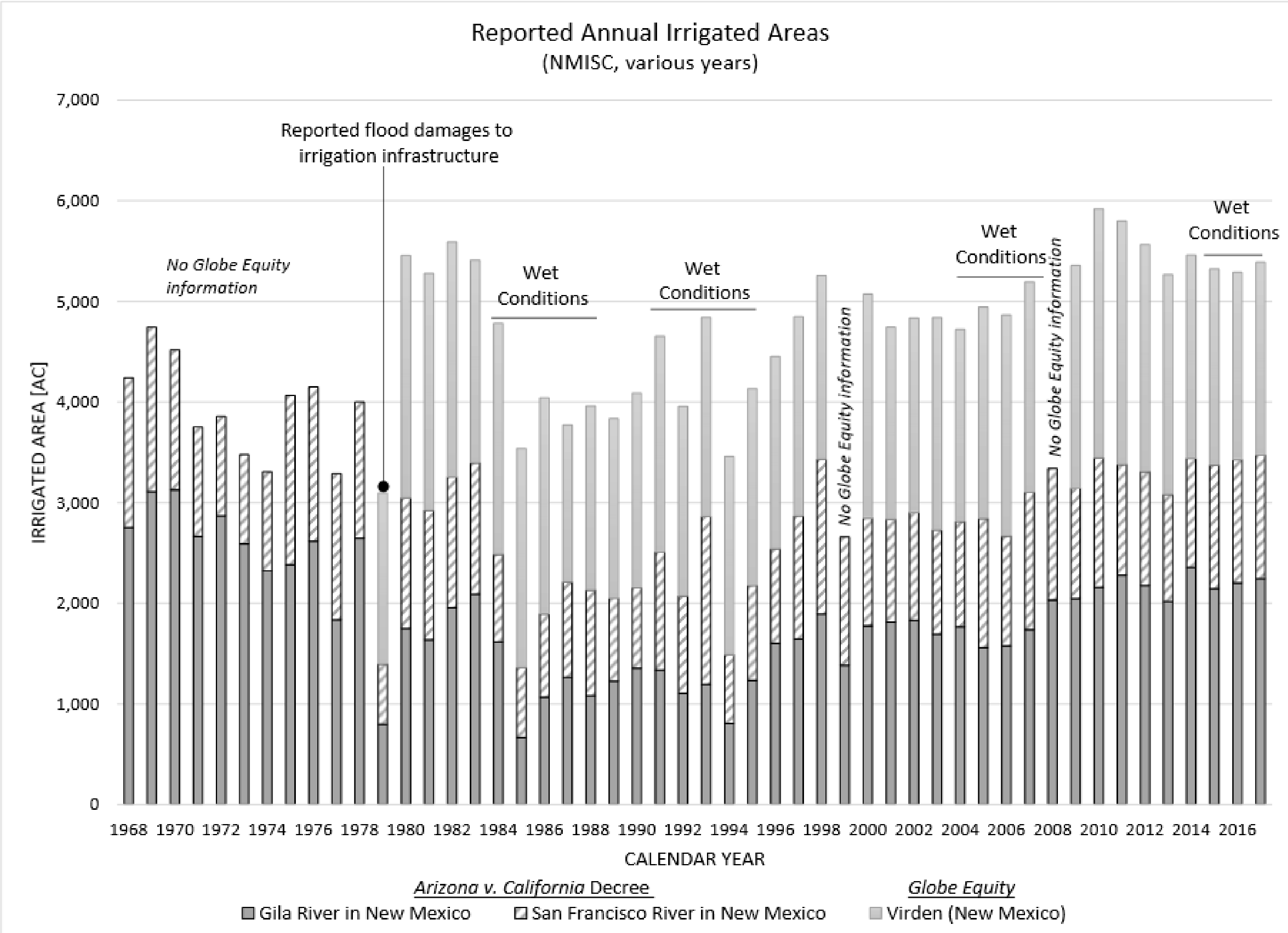

Figure 3-3. Historical Irrigated Acreage in New Mexico

in the Cliff-Gila area, of which this pumped storage is a part, averaged about 6,000 AFY from the 1970s to 1990s. Municipal and industrial uses averaged 4,000 AFY from 2000 to 2016.

Irrigation ditches and water uses for non-project areas in the area of analysis are described in the New Mexico Unit EIS Surface Water Resources Technical Memorandum (HDR 2019a).

Flooding and Flood Management The San Francisco and Virden locations are not delineated in Federal Emergency Management Agency (FEMA) flood insurance studies. Portions of the Cliff-Gila location are mapped in an approximate Zone A, although no detailed hydrologic or hydraulic data are available for the area (FEMA 2011). The 100-year flood (1 percent annual chance of occurrence) calculated using U.S. Geological Survey gage stations and Bulletin 17C is approximately 47,700 cfs on the Gila River near Gila, 46,200 cfs on the Gila River near Blue Creek, and 31,200 cfs on the San Francisco River near Glenwood. Many of the historical floods occurred during years with El Niño conditions (Garfin et al. 2014) and during the winter.

The Upper Gila Valley Watershed District owns 12 dams on side drainages in the Cliff-Gila location (ISC 2017). These dams temporarily impound water on side tributaries and are not water supply facilities. Their purpose is flood and sediment management. Cumulatively, the drainage areas to the dams are approximately 30 square miles. The reservoirs' sediment pools have filled to various amounts. Uncertified levees are located along portions of the Cliff-Gila and Virden location reaches. Reclamation (2004) mapped 8.8 miles of levees in the Cliff-Gila location reach and 10.9 miles of levees in the Virden location reach. Comparing the levee alignments with 2016 aerial photography shows that most of the levees have failed and are now part of the Gila River floodplain. Possibly 3.5 miles of remnant levees remain in the Cliff-Gila location reach and 4.5 miles in the Virden location reach.

Water Uses Downstream of the Project Area Irrigation between the confluence and San Carlos Reservoir includes areas in the Safford Valley and the San Carlos Apache Tribe Reservation. Irrigation in the Safford Valley had begun by the 1870s (Sowders 2017). The Gila Valley Irrigation District (GVID) was formed in 1923 to provide a reliable diversion from the Gila River for the 11 canal companies in the area. The GVID operates the San Jose Diversion Dam, located approximately 19.6 RMs downstream of the confluence. Other diversion locations are the Brown Canal (16.4 RMs from the confluence) and the Graham Canal (29.8 RMs from the confluence). The Gila River Water Commissioner reported 22,560 to 27,408 acres irrigated in the Safford Valley between 2006 and 2017 (Gila Water Commissioner 2019). Water duty for the area is 6 AF per acre.

The San Carlos Apache Tribe's irrigation is based on river flows from the Gila River near Bylas and the San Carlos River, with supplemental well water (ADWR undated). The San Carlos Apache Tribe Reservation boundary begins approximately 67.3 RMs downstream of the confluence. Decreed irrigated acres are 1,000 acres, while the Gila River Water Commissioner reported irrigated acres between 225.6 and 311.4 from 2005 to 2017 (Gila Water Commissioner 2019).

Coolidge Dam was authorized through the San Carlos Irrigation Project Act of 1924 (Pfaff 1996). The project impounds San Carlos Reservoir to supply irrigation on the GRIC and non-Indian irrigation in the SCIDD. Dam construction was completed in 1928, with a storage of 1.2 million AF. The upstream end of the reservoir begins about 98.3 RMs downstream of the San Francisco-Gila Rivers confluence. Approximately 72.3 RMs downstream of Coolidge Dam is the Ashurst-Hayden Diversion Dam, which provides water for GRIC and SCIDD. Average annual diversions from the dam were 187,580 AFY between 2006 and 2017 (Gila Water Commissioner 2019). Central Arizona Project interconnections to GRIC and SCIDD were established in the 1990s (Reclamation 2017).

A portion of Gila River water is also diverted for mining in Arizona. Mining in this area began in the 1870s (Lacroix et al. 2014). The Morenci Mine is next to the confluence. It is an open-pit copper mine producing both copper and molybdenum concentrate, with a potential of 3.1 billion metric tons (FMI 2017). Mining operations use water imported from outside the Gila River watershed and in-watershed pumping from Eagle Creek and the San Francisco River. The Gila River Water Commissioner (2019) recorded average annual mining water use of 1,501 AFY from 2005 to 2017, not including waters imported from outside the watershed.

Groundwater

The Gila-San Francisco watershed is dominated by river valleys and narrow rift basins filled with sediments from surrounding volcanic mountains. The alluvial aquifer and the Upper and Middle Gila Conglomerate provide the local sources of groundwater to wells in the area. The Upper Gila Conglomerate has good aquifer potential, whereas the middle and lower units are more cemented and consolidated. A description of the geology and aquifers is provided in the New Mexico Unit EIS Groundwater Resources Technical Memorandum (HDR 2019b).

In the Gila Wilderness, the Bolson system, which is an unconfined aquifer with a sediment matrix found along streams, is most prevalent. Some fractured rock aquifers are also present. The San Francisco-Gila Valley aquifers are mainly unconfined sediment aquifers in the rift basin-fill and local aquifers in volcanic bedrock where fractures or permeable areas occur. Local groundwater flow systems have developed in the volcanic rocks. Throughout the area of analysis, there are variations in thickness and structural relationships that control groundwater flow. In the areas near the Gila River, groundwater is found in the unconsolidated to weakly consolidated sediments of the Upper Member of the Gila Conglomerate. The Upper Gila Conglomerate has well discharges of tens of gallons per minute (gpm). Groundwater wells completed in the Quaternary alluvial deposits have well yields that range from 1 to 375 gpm. Wells completed in the Quaternary Bolson fill produce as much as 975 gpm. Wells completed in the deeper Gila Conglomerate range from 2 to 5 gpm (Basabilvazo 1997).

The Cliff-Gila location is in Grant County, where wells completed in the granitic and metamorphic rock have a yield of 0.1 to 15 gpm. Wells completed in marine sediments and limestone are likely to have yields of from 3 to 1,000 gpm. The Tertiary and Quaternary age rocks have only small quantities of water but may yield large amounts of water locally (Trauger 1972).

The Virden location lies in the Mexican Highlands section of the Basin and Range physiographic providence. In this area, there are two materials classified as aquifers: the Bolson fill and the alluvial deposits of the Gila River Valley aquifer. Bolson fill is the more productive aquifer and is composed of alluvial, fluvial, and lacustrine deposits interbedded with gravel, sand, silt, and clay. The data in the area suggest thickness may be around 2,600 feet of water-bearing sediment. The Gila River Valley aquifer is near the channel and floodplain of the Gila River only. The aquifer consists of fluvial gravel, sand, and silt; its thickness is unknown. Most wells in the location areas yield small quantities of water, below 50 gpm.

The NMOSE has declared two underground water basins in the Gila-San Francisco watershed area of analysis in New Mexico: the Gila-San Francisco and the Virden Valley Underground Water Basins. Under these declarations, the state engineer assumed jurisdiction over the appropriation and use of groundwater in these basins (ISC 2017).

For all three counties, public water supply comes almost entirely from groundwater. Groundwater use in Catron County was 567 AFY in 2015 (Magnuson et al. 2019). As of 2017, groundwater in this county was used for irrigated agriculture, mining, public water supply, and domestic, livestock, commercial, and industrial purposes. In Grant County, groundwater has historically been used for industry, mainly mining. Groundwater has also been used in urban areas for various water supply systems, ranging from 73 to 291 gallons per capita per day. In 2015, groundwater use was 23,249 AF. Hidalgo County is in a rural area, and the largest community is Lordsburg. The Gila River flows through the extreme north part of this county. All other streams in the county are ephemeral. Groundwater use was 47,145 AF in 2015. Most groundwater use, 90 percent of total usage, is for irrigated agriculture. Many old wells in the area have gone dry, so new deeper wells are being drilled.

Groundwater levels have varied in the Gila-San Francisco watershed, with some groundwater elevations declining as much as 59 feet and some groundwater elevations rising as water use decreased (ISC 2017). The groundwater level changes were calculated by comparing median measurements for monitoring wells from 1985 through 1995 with those from 2007 through 2017. For the Cliff-Gila location, groundwater levels declined between 1.23 and 3 feet between these two periods, for the Virden location, they declined between 1.88 and 9 feet between these two periods, and for the San Francisco location, groundwater levels have declined between 5.5 and 7.2 feet.

Recent research has shown that there is a high degree of connectivity between groundwater and surface water in the Cliff-Gila Valley (Stone and Samson 2014b). While the research focused on two wetlands in the valley, data collected between 2012 to 2014 indicate that the alluvial fill in the Cliff-Gila Valley exhibits extremely high hydraulic conductivity. Results from the groundwater model suggested that low groundwater levels, which were associated with reduced streamflow, recovered and rose rapidly after streamflow reductions ceased. Research also showed that streamflow reductions would affect wetland vegetation conditions. Results from the groundwater model also indicated that decreased groundwater elevations associated with streamflow reductions recovered rapidly after the flow reductions ceased.

More information on local aquifers, aquifer properties, and existing groundwater use is included in the New Mexico Unit of the Central Arizona Project EIS Groundwater Technical Memorandum (HDR 2019c). This technical memorandum found that project effects were limited geographically to the immediate project locations, based on project seepage and, in some alternatives, groundwater pumping; therefore, additional information on aquifer conditions downstream of the Gila River-San Francisco River confluence is not provided.

Water Quality

Water quality is based on the chemical, physical, and biological contents of water. The chemical quality of the water is characterized by measuring pH, dissolved oxygen, and concentrations of dissolved constituents, like minerals and chemicals. The physical quality of water is measured by recording temperature, color, and turbidity. The biological quality of water is assessed by evaluating algae and chlorophyll in it.

Several water quality studies have been implemented in the area of analysis (Acuna and Dahm 2007; ADEQ 2000; NMED 2009 and 2014; USGS 1977). Overall, ambient surface water quality in the Gila

River Basin in Arizona has been characterized as fresh, hard, and slightly alkaline (ADEQ 2000). In the area of analysis, water quality depends greatly on, and has a direct relationship to, the geologic unit and discharge of the water source. These two factors strongly influence the types and quantities of dissolved constituents (cations and anions) in the water. In general, the Gila River surface water ranges from mixed cations to alkali and bicarbonate rich (Acuna and Dahm 2007).

When stream flows in the Gila River decrease, the concentration of most dissolved constituents increases, with the exception of phosphate which is also linked to erosion and desorption. Some parameters, such as hardness and dissolved solids, have a large increase between Solomon and Calva. NMED (2009) reported general information on the Gila River watershed in its Watershed Improvement Plan and Strategies publication. The publication identifies five water quality impairments on the Gila River: aluminum, conductivity, plant nutrients, temperature, and turbidity. As base flow declines, nutrient concentrations, temperature, and conductivity increase.

The U.S. Geological Survey (1977) summarized water quality on the Gila River and impacts related to removing deep-rooted vegetation in Arizona. They concluded that the volume of water flowing from tributaries has little effect on the water quality of the Gila River. During low-flow conditions, the water was a sodium chloride type near the water table and a calcium chloride type in the upper zone. During high-flow conditions, the water remained the same type near the water table but was a calcium sodium bicarbonate type in the upper zone. Dissolved solid concentrations were lowest near the river in the saturated groundwater zone. Water with less than 500 milligrams per liter (mg/L) of dissolved solids was considered calcium bicarbonate to sodium bicarbonate, while the water with more dissolved solids was considered sodium chloride. For most of the year, sodium and chloride are the principal ions in the stream. Sodium and chloride contribute 70 and 40 percent of total ions during low and high flows, respectively.

Regulatory Environment and Impairments The designated use for waters is specified in the New Mexico Annotated Code (NMAC) and the Arizona Administrative Code. The designated uses in the main stem of the Gila River are mining, irrigation, livestock watering, marginal cold-water aquatic life, warmwater aquatic life, and wildlife habitat. These are also the designated uses in the main stem of the San Francisco River, along with marginal warm water aquatic life.

The Clean Water Act (CWA) requires an assessment to evaluate if water quality is achieved for the designated uses. Waters not meeting the goals or water quality-impaired features are identified and placed on the Section 303(d) list requiring action to improve water quality. NMED (2014) reported on a water quality survey of the Gila and San Francisco watersheds. NMED collected chemical water quality samples monthly, biological sampling in summer and fall of 2011, and physical measurements during base flow conditions at 34 locations. Samples were analyzed for nutrients, total dissolved solids, total suspended sediment, dissolved metals, total metals, hardness, organics, and radionuclides. The assessment conclusions were incorporated into the 2014-2016 Integrated Report, which was completed in 2014.

Water in some stretches of the Gila River has been identified as impaired for its designated use. The headwaters, the Virden location, and the Redrock reach exhibit temperature and nutrient impairments, while the Cliff-Gila location has temperature impairments. Biological (*E. coli*), temperature, and sedimentation impairments have been identified where the Gila River flows through Arizona. Likewise, some portions of the San Francisco River exhibit impairments. At the headwaters, temperature has been identified as an impairment, while sedimentation and siltation have been recorded at the San Francisco location. These impairments are exacerbated by the use of heavy machinery in the river channels to repair washed-out push-up diversions.

Data collected from 22 locations between the New Mexico/Arizona state line to Calva, Arizona, demonstrate significant differences in boron, stream stage, dissolved bicarbonate, total ammonia, and nitrate/nitrite (ADEQ 2000). Analytical results indicated no nutrient problems; however, water quality standards were exceeded for turbidity, dissolved oxygen, and total beryllium. The exceedance of beryllium is infrequent, occurring at the San Francisco River near Clifton, and the cause is unknown. Impairment to macroinvertebrate populations in the Upper Gila was attributed to 38 percent natural, 31 percent intermittency, 18 percent livestock grazing, and 12 percent road development. Sediment is the primary cause of macroinvertebrate impairment in cold-water reaches. Sediment problems identified in the spring cold-water samples in the San Francisco River were attributed to livestock grazing.

The Gila River is classified as not attaining *E. coli* and suspended sediment standards above the confluence with the San Francisco River (ADEQ 2018). A TMDL was developed for *E. coli*. Below the confluence, the Gila River is impaired with respect to lead and *E. coli*, and the San Francisco River is impaired for *E. coli*. Luna Lake, on the San Francisco River upstream of Reserve, exceeds water quality standards for ammonia, dissolved oxygen, and pH. Some samples of mercury also exceeded the standards. Dissolved oxygen on the San Francisco River above Luna Lake may be impaired, possibly due to groundwater upwelling in the area.

Stratus (2003) reported on groundwater and surface water quality of the Gila River Basin in the context of a prescreening for mining operations. The Tyrone Mine (New Mexico) has recorded exceedances in copper concentration. Downstream of the Morenci Mine (Arizona), copper and zinc concentrations in surface water indicate metal transport to perennial rivers. The USFWS conducted bird surveys between September and November 2000 and counted many bird carcasses around the mining sites; this is an indication of toxicity in the streams and ponds. The groundwater at the mines was also affected, and analyses demonstrated exceedances of cadmium, copper, lead, manganese, antimony, and beryllium.

The NMED (2007) Surface Water Quality Bureau reported on the water quality of the Gila River and San Francisco River watersheds. NMED recorded discharge, dissolved oxygen, pH, and temperature data at 13 survey stations and analyzed samples for organics, radionuclides, total metals, dissolved metals, nutrients, ions, and *E. coli*. NMED also conducted biological studies of benthic macroinvertebrate, periphyton, and fish communities and assessed habitats for quality. NMED concluded that water quality in the Gila and San Francisco watersheds was generally good, with five general exceptions of identified impairments: aluminum, plant nutrients, temperature, turbidity, and benthic macroinvertebrates. In its Watershed Improvement Plan and Strategies (2009), NMED identified aluminum, plant nutrients, temperature, turbidity, and conductivity as impairments.

Available data on groundwater quality are limited. A general theme in the literature is that the groundwater quality was sufficient for most uses, although some localized poor quality sources exist (NRCS 2013; Trauger 1972). Well water samples submitted by citizens at the Water Fairs in Lordsburg (2015), Mimbres (2013 and 2015), and Reserve (2008 and 2012) provide some record of constituents in aquifers in those New Mexico counties. Sulfate, nitrate, fluoride, and iron were detected in samples from all three counties for drinking water quality standards. Arsenic and manganese exceeded drinking water quality standards in samples submitted at the Mimbres and Lordsburg Water Fairs.

Well water samples are available for the Cliff Community School (New Mexico Public Water Supply NM3590009) near Duck Creek and Highway 211. The school is served by three wells, finished between 90 and 120 feet. The raw well water, before it is treated using reverse osmosis, is alkali, with a median pH of 9.1. The sodium concentration in the well water is 100 mg/L. Sulfates and chloride in the well water are similar in concentration to the surface water quality of the nearby Gila River.

Fluvial Geomorphology

In the New Mexico Unit of the Central Arizona Project EIS Geomorphology Technical Memorandum (HDR 2019c), HDR found that project effects were geographically limited to specific project reaches: the Cliff-Gila diversion reach, the Virden diversion reach, and the San Francisco diversion reach.

The Cliff-Gila diversion reach is an incised channel (AECOM 2017d). Bank heights are up to 12 feet. The river is constricted from Gila Conglomerate bedrock escarpment upstream of the reach (BHI 2014b). The Mogollon Mountains contribute to the riverbed sediment (MEI 2006). Materials are widely varied and include sands, gravels, and cobbles for bed material and in the floodplain.

Information about historical changes to the Gila River channel in the Virden reach were described on a larger scale that extended through the Safford Valley. The channels in several of the project reaches have undergone various widening and vegetation encroachment in response to drought and floods. The Safford Valley channel widths ranged from 70 to 220 feet in the late 1800s (MEI 2006). One of the wettest periods and major floods was in the early 1900s, with a major flood in 1904. The river channel increased to 2,000 feet wide at this time. Droughts in the 1950s narrowed the river channel to 290 to 530 feet. Later floods in the 1960s and 1970s widened the river.

The San Francisco diversion reach (near the present Spurgeon Ditch #2 Diversion) has shallow banks, ranging from 2 to 4 feet in height (AECOM 2017d). The active channel width is 75 feet and, based on a review of aerial photographs from 1990 to 2016, it has been relatively stable. Channel and floodplain sediments are silts, sands, gravels, and cobbles. Vegetation is grasses, sedges, scrubs, and trees. Pueblo Creek can contribute debris flows during floods.

Over the long term the Gila River channel has changed within a fixed limit, both vertically and laterally (Reclamation 2004; MEI 2006). Channel morphology is controlled by infrequent floods of more than 15,000 cfs and of long duration, from which the river does not quickly recover. In the Gila River system, large floods that alter channel morphology have occurred more frequently in the recent past than the time it takes for the floodplain to stabilize. As a broad generalization, project reaches along the San Francisco River appear to be similar in character to conditions along the Gila River. Lateral migration of the channel has occurred in some areas, such as near the U.S. State Highway 180 Bridge; however, other portions of the project area appear to be more stable.

3.3.2 Environmental Consequences

Methods of Analysis

The Joint Leads reviewed literature and data pertaining to water availability, water quality, water rights and uses, and historical floods. Historical data measured river and ditch flows, snowpack, geology, and aquifers. Water uses considered by the Joint Leads were historical decreed irrigated acreage and consumptive uses, mining water use, and groundwater pumping for various uses.

The Joint Leads reviewed modeling studies and performed calculations for each proposed alternative. Groundwater-surface water interactions were developed for the three project locations, which included existing groundwater modeling for the Cliff-Gila location. Water quality changes were evaluated using a regression analysis of constituents of concern. Surface water quantity and project operations were also calculated. The factors used to analyze impacts on water resources include:

- Surface water—A calculation method produced alternative-specific changes in daily river flows, based on water available under the CUFA, project diversions, storage, consumptive use, and return flows. The CUFA mitigates the project effects on senior surface water rights. Indirect impacts from changes in river flows were evaluated in other topics, such as water quality and biological resources.
- Fluvial geomorphology—The frequencies of project diversions during channel-forming events was used as a measure of changes in river forms. Flood effects from proposed diversion weirs were evaluated based on increases in flooded acreage and affected buildings or roads.
- Groundwater—The change in infiltration from ditch seepage (all alternatives), pond seepage (all alternatives), ASR operations (Alternative E), and pumping depletions (Alternative B) was used to assess changes in local groundwater levels and surface water depletions. The direct impact indicator is the number of existing wells where groundwater levels could change. Other indirect impacts were assessed in biological resources.
- Water quality—The change in constituent concentrations in river flows was used to assess the change in suitability of surface waters for irrigation. Other indirect impacts were assessed in biological resources.

Assumptions Some uncertainty is due to discretion of those contracting for AWSA water as to where to irrigate, what crops to irrigate, and the irrigation methods selected. Other uncertainty is based on data gaps on the existing ditch systems and uncertainty in measured streamflow measurements. The U.S. Geological Survey provided uncertainty ranges for streamflow measurements for each location. A sensitivity analysis was used to evaluate a range of cropping patterns, on-farm efficiency, and ditch seepage rates. Other parameters, such as pond seepage rates, were estimated from typical ranges from literature. Site-specific information to facilitate a quantitative impact analysis is not available for the hydrogeology and geology of the nearby sites to the storage and irrigation lined ditches.

There are also unknowns related to climate projections and water availability. Recent water supply climate trends appear to be transitioning from higher-than-normal wet conditions into dry conditions. Future climate projections indicate that there will be less water overall, higher-intensity floods and monsoon thunderstorms, and spring snowmelt coming earlier in the year. A historical range of water availability was examined from dry to wet conditions. These conditions were used to estimate how future climate change might affect water availability under the CUFA and project operations.

Alternative A: No Action Alternative

Surface Water Without the NM Unit, surface water use would continue on the basis of historical use and adjudicated water rights. Alternative A conditions assume that the historical cropping patterns and irrigation methods would continue without the project.

Alternative A also assumes that mining and reclamation would continue at Tyrone Mine, resulting in the same historical diversions from the Gila River to Bill Evans Lake. Evaporation and seepage at Bill Evans

Lake would continue. Some reclamation projects have been completed at Tyrone Mine or are ongoing, including certain tailing dams and stockpiles (Golder Associates 2013). Trans-basin depletions from Silver City wells would also continue. Without the project, the San Carlos Reservoir would continue to supply the Gila River Indian Community and SCIDD. Surface water availability would continue to reflect historical conditions.

Dry river beds would occur at the same frequency in reaches susceptible to drying. These include reaches below the Upper Gila and Fort West diversions (Intera 2014), the FMI diversion (Haney 2006), and Cosper Crossing (Gila Water Commissioner 2019). Non-flowing conditions at Cosper Crossing were assessed based on flow at the downstream Clifton gage. Under Alternative A, non-flowing conditions averaged between 79 and 176 days per year, depending on the hydrologic condition (wet to dry years). Most of the non-flowing days occurred between April and October. December averaged between 0 and 1 day of non-flowing conditions.

Flow at the Redrock stream gage reflects conditions below the Cliff-Gila location, and the Gila River near Clifton stream gage is downstream of the Virden location. The San Francisco River near Glenwood stream gage is downstream of the Pleasanton area. The Gila River near Calva stream gage is downstream of all project locations and upstream of the San Carlos Reservoir. The Alternative A river flows reproduce the historical flows in **Figure 3-1** (Historical Flows on the Gila River) and **Figure 3-2** (Historical Flows on the San Francisco River and Gila River at Calva).

Current water use conditions were selected from 1968 to 2016; years before 1968 lacked the FMI pump station operations. Alternative A conditions were selected to avoid years where floods or other events may have affected agricultural operations. The intent is to compare a fully operational existing irrigation system with conditions under the proposed alternatives. **Figure 3-3** shows the range of historical irrigated acreage. Selected irrigated acres on the Gila River areas range from 1,737 to 3,127 acres, which excludes years of reduced acres in the 1980s to 1990s. For the San Francisco River areas, the selected irrigated acres range from 1,065 to 1,683 acres. The assessed years cover hydrologic conditions similar to 78 of the 81 years where flow information is available, 1936 to 2016, indicating that the range represented by the selected years is hydrologically similar to that of the period of record. The Alternative A river flow calculations are described in the New Mexico Unit EIS Surface Water Resources Technical Memorandum (HDR 2019a).

Groundwater Municipal groundwater use is expected to increase. The population in this region is growing slowly, with a typical growth rate of around 1 percent annually. Water use in the livestock category is expected to decline in all counties (ISC 2017). There is a decreasing trend in the number of ranches and farms, and it is likely that associated water demands will decline in the future without more stored water for use during the irrigation season. For Grant and Hidalgo Counties, in areas that rely mainly on groundwater for agriculture use, well levels may stay the same and recover by 2060, due to an expected decline in agricultural production.

Fluvial Geomorphology Under Alternative A, historical geomorphologic conditions would continue. Channels would have long-term stability punctuated with alterations from infrequent floods (Reclamation 2004; MEI 2006). Local alterations to the channel using push-up diversions would continue. These push-up diversions are frequently breached during floods.

Water Quality NMED's assessments show that most streams in the area do not meet water quality standards and beneficial uses for one or more water quality parameter. Most of the time, water quality standards are met, but exceedances do occur and are the cause of the listing impairments. Overall trends in water quality are likely improving as TMDLs are implemented, regulations are enforced, and best management practices are put in place.

Use of heavy machinery to construct and maintain the push-up diversions would continue to affect the in-stream habitat, riparian habitat along the banks, and upland habitat as it is moved from farm storage to the Gila and San Francisco Rivers. In addition, disruption of the streambed and banks due to construction or repair of the earthen diversions can increase turbidity. There may also be short duration, localized increases in turbidity when the push-up diversions are damaged or breached during high-flow events. Pollution from releases of motor oil, gasoline, or diesel would remain a concern when conducting this motorized work in the active river channel (USFS 2011).

Ayers and Westcot (1994) describe degrees of restriction of water for use in irrigation, based on three salinity measures. Water having sodium concentrations of less than 68 mg/L, chloride less than 106 mg/L, and total dissolved solids less than 450 mg/L is suitable for irrigation. Water with sodium concentrations more than 68 mg/L, chloride more than 106 mg/L, and total dissolved solids between 450 and 2,000 mg/L have slight to moderate restrictions for irrigation. Water having total dissolved solids more than 2,000 mg/L has severe restrictions for irrigation use.

The concentrations of river sodium, chloride, and total dissolved solids were calculated by applying regression equations describing flow and concentrations measured in the field by the USGS, as described in the New Mexico Unit EIS Water Quality Resources Technical Memorandum (HDR 2019d). Gila River waters above the confluence have average sodium concentrations of 70 mg/L, chloride concentrations of 30 mg/L, and total dissolved solids of 360 mg/L. These waters have generally no restrictions for irrigation use with respect to these constituents, although sodium can exceed 68 mg/L in the summer on the Gila River at Clifton. San Francisco River water has average sodium concentrations of 26 mg/L, chloride concentrations of 13 mg/L, and total dissolved solids of 240 mg/L, making it suitable for irrigation.

Salinity conditions worsen considerably below the confluence. Concentrations of sodium near Calva average 560 mg/L, chloride 770 mg/L, and total dissolved solids 2,100 mg/L. Water here has severe irrigation restrictions from April to July due to these constituents and slight to moderate irrigation restrictions in other months.

Impacts Common to All Action Alternatives

Project diversions are controlled in part by the CUFA, which limits when water is available. Most of the project diversions would take place between August and February (HDR 2019a). In moderately dry and dry conditions, the CUFA would generally limit or prevent project diversions except from November to January. Most AWSA diversions tend to occur during low river flows; that is, flows more frequent than a 1.25-year peak flow (NM Unit EIS Geomorphology Technical Memorandum [HDR 2019b]). There can be times within a month when higher diversions are possible under the CUFA. Diversions are reduced and sometimes not allowed in summer due to the CUFA. Locations containing project storage would release water for agricultural use and could increase river flows due to return flows.

Specific constituents that may be transported in the irrigation delivery system or additional heat from greater exposure to sunlight may increase loading to the Gila and San Francisco Rivers. Constituents of concern that could be added are salts, agricultural products, such as herbicides and pesticides, and metals and soluble constituents. Flow through the irrigation delivery system has the potential to solubilize and mobilize more constituents; therefore, tailwater runoff from irrigation generally does not "dissolve a statistically significant amount of salts from the soil for transport to the river" but can move sediments and nutrients (Duke et al. 1976). "Thus, from the standpoint of salt contribution, the surface water component appears to be a minor contributor to degradation of return flow" (Duke et al. 1976).

Water used for irrigation that is not consumptively used infiltrates to the shallow groundwater. Most return flow is estimated to return to surface water in approximately 2 months, as calculated in the New Mexico Unit EIS Surface Water Resources Technical Memorandum (HDR 2019a). The volume of return flows depends on the quantity of water used for irrigation, the irrigation method, the efficiency, and the soil infiltration rates. Water infiltrations through the soils could cause salt to leach from the soil into the water. Conditions would vary, depending on the types of soils and the amount of water loading in the soil and infiltrating to the water table. Many of the soils in the area appear to be low in salts (as measured with sodium adsorption ratios from USDA (2018); however, soils near meandering rivers in arid climates tend to have salt deposits from prior river water infiltration and evaporation. In areas with salts, the leaching would likely change over time, with little increase at first, then some years of flushing, and then some stabilized value at some point after years of irrigation (Duke et al. 1976). Detailed soil information with respect to sodium adsorption ratios is lacking for the San Francisco location.

Local flow rates and soils would similarly control the rate of leaching of other constituents. Constituents from agricultural chemicals would also depend on application, including timing, rate, and specific products. Metals may be naturally present in the soil and could be solubilized by constant saturation or frequent wetting and drying from irrigation water infiltration (USUF 1969).

Alternative B: Proposed Action

Surface Water For Alternative B, Reclamation calculated average annual river project (AWSA) diversions of 2,461 AFY. **Table 3-2** provides the diversions from adjudicated and AWSA operations, along with the return flows from the AWSA operations. **Table 3-3** provides the calculated increases and decreases in monthly average river flows downstream of each project location and at Calva. As modeled, the project storage would begin to fill in August to February, when water is available under the CUFA. Peak filling of storage would occur in November, December, and January. River flows in December are calculated to decrease 12 cfs (-5 percent) at Redrock, 10 cfs (-4 percent) at Gila River near Clifton, and 10 cfs (-2 percent) at Calva. As no storage would be provided in the San Francisco location, project diversions would occur only during the irrigation season. Diversions would continue to replace storage seepage and evaporation losses in February and March.

Table 3-2 provides average monthly flow changes for all of the historical years examined. For just months with moderate dry to dry conditions, the CUFA would generally limit or prevent project diversions except from November to January. River flows in dry Decembers would decrease between 11 cfs and 14 cfs on the Gila River, approximately 14 percent to 16 percent of Alternative A river flows. At Calva, December river flows could decrease 11 cfs, or 14 percent of river flows. Non-flowing conditions at Cosper Crossing are estimated to increase up to 4 days per month in December, during lower river flows and when exercising of AWSA diversions. Non-flowing conditions sometimes may increase an average of 1 day in November, depending on hydrologic conditions. Cosper Crossing conditions would remain unchanged in other months.

Table 3-2. Operational Diversions and Return Flows—Alternative B

Operational Item	Cliff-Gila	Virden	San Francisco
Adjudicated diversions	13,122 to 13,351 AFY	16,915 to 21,141 AFY	5,148 to 5,331 AFY
AWSA diversions	1,459 to 2,449 AFY	392 to 539 AFY	4 to 22 AFY
Production well pumping	169 to 187 AFY	Not applicable	Not applicable
Total diversions	14,935 to 15,941 AFY	17,420 to 21,657 AFY	5,154 to 5,344 AFY
Return flows from AWSA operations	539 to 653 AFY	122 to 157 AFY	1 to 6 AFY

Source: HDR 2019a
Note: **Chapter 2** provides the average for AWSA diversions, consumptive use, and return flows.

Table 3-3. Monthly Average River Flow Increases and Decreases—Alternative B Compared with Alternative A

Month	Gila River near Redrock	Gila River near Clifton	San Francisco River near Glenwood	Gila River at Calva
January	-4 cfs (-2%)	-3 cfs (-2%)	0 cfs	-3 cfs (-1%)
February	-3 cfs (-1%)	-2 cfs (-1%)	0 cfs	-2 cfs *
March	-1 cfs *	-1 cfs *	0 cfs	-1 cfs *
April	1 cfs *	*	0 cfs	*
May	2 cfs (1%)	1 cfs (1%)	*	1 cfs *
June	*	*	*	*
July	1 cfs (1%)	*	*	*
August	*	*	*	*
September	-2 cfs (-1%)	-2 cfs (-1%)	*	-2 cfs (-1%)
October	-3 cfs (-1%)	-3 cfs (-1%)	0 cfs	-3 cfs *
November	-6 cfs (-4%)	-5 cfs (-3%)	0 cfs	-5 cfs (-2%)
December	-12 cfs (-5%)	-10 cfs (-4%)	0 cfs	-10 cfs (-2%)

Source: HDR 2019a
* Some positive or negative change is possible, with values rounding to 0 cfs or 0% or both.

Fluvial Geomorphology Alternative B proposes a fixed crest weir configuration that would typically promote local sedimentation upstream of the diversion structure. This alternative would incorporate a low-flow notch that would promote formation of a pilot channel during channel-forming flows to maintain some sediment transport downstream. Local sedimentation accumulation away from the pilot channel and toward the channel banks would still be possible. Debris flows could become lodged in the low-flow notch and require heavy equipment in the river channel for proper maintenance.

Most AWSA diversions would occur when river flows are not mobilizing bed materials. Finer particles could still be transported under lower-flow conditions; however, the reduced river flows from project diversions would be unlikely to have effects overall. Sediment would accumulate behind the proposed structures during years with low peak flows and would be scoured out by high-flow events. Scour on the downstream face of the structures should be minor with a properly maintained downstream protection.

Alternative B proposes a fixed weir configuration for the Cliff-Gila and San Francisco locations. The increase in water surface elevations of the 100-year (1 percent annualized probability) flood was compared with that under Alternative A, assuming the push-up diversions would be breached at these flows. The increase to the 100-year water surface elevation would be 0.5 feet for the proposed permanent San Francisco Diversion and 3.0 feet for the proposed permanent Cliff-Gila Diversion. The increase in water surface elevation is projected to extend up to 1,400 feet upstream of the San Francisco diversion and 2,500 feet upstream of the Cliff-Gila diversion.

Table 3-4 (Alternative B Flooding Changes from Alternative A—Spurgeon Diversion) and **Table 3-5** (Alternative B Flooding Changes from Alternative A—Upper Gila Diversion) provide additional changes from the proposed weirs. These changes would not affect any roads or buildings. Water surface elevations downstream of the proposed permanent San Francisco and Cliff-Gila diversions could decrease as the existing push-up diversions would no longer be required. Flood effects are not projected to change in the Virden location. The existing diversion structures in Virden would remain, and project diversions of up to 20 cfs would be minor, compared with 100-year flood flows of 46,200 cfs.

Table 3-4. Alternative B Flooding Changes from Alternative A—Spurgeon Diversion

Flood Annual Probability (“Reoccurrence Interval”)	Downstream of Proposed Diversion		Upstream of Proposed Diversion	
	Decreases in Water Surface Elevation (Feet)	Decreases in Flooded Area (Acres)	Increases in Water Surface Elevation (Feet)	Increases in Flooded Area (Acres)
50% (2-year)	0.9	2.3	2.1	1.4
10% (10-year)	0.5	1.5	1.2	0.9
2% (50-year)	0.0	0.0	0.3	0.3
1% (100-year)	0.0	0.0	0.5	0.4

Source: HDR 2019a

Note: Alternative A condition assumes push-up diversions would remain in place for the 2- and 10-year floods and would be breached by the 50- and 100-year floods.

Table 3-5. Alternative B Flooding Changes from Alternative A—Upper Gila Diversion

Flood Annual probability (“Reoccurrence Interval”)	Downstream of Proposed Diversion		Upstream of Proposed Diversion	
	Decreases in Water Surface Elevation (Feet)	Decreases in Flooded Area (Acres)	Increases in Water Surface Elevation (Feet)	Increases in Flooded Area (Acres)
50% (2-year)	0.5	4.3	2.7	5.5
10% (10-year)	1.4	15.7	2.8	6.1
2% (50-year)	0.0	0.0	2.7	3.0
1% (100-year)	0.0	0.0	3.0	0.5

Source: HDR 2019a

Note: Alternative A condition assumes push-up diversions would remain in place for the 2- and 10-year floods and would be breached by the 50- and 100-year floods.

Groundwater The proposed diversion structure, the diversion of surface water flows, and the operation of production wells could all affect groundwater. The 20-foot-deep cutoff walls of the diversion structure would be unlikely to affect subsurface groundwater because the alluvial aquifer likely extends deeper than the cutoff wall; however, the cutoff wall would be designed with openings to facilitate groundwater flow if the wall penetrated over half of the alluvial aquifer thickness.

The five production wells proposed for Alternative B could draw down groundwater levels in the immediate area of each proposed well. The wells most likely to be affected are those near the proposed production wells. The wells near the Gila River are generally for domestic use, noncommercial domestic use, irrigation, and stock tanks. Approximately 67 wells could be drawn down by between 1 and 5 feet if the proposed production wells each pump 125 gpm for 4 months. This pumping scenario was developed based on the Entity's stated intent of pumping 332 AF over an irrigation season in total for all five wells. In this same pumping scenario, one existing well could see 5 to 10 feet of drawdown.

Actual drawdown impacts at existing wells would vary, depending on pumping rates and durations, distance from the pumping well, and aquifer properties. More information regarding the potential impacts on groundwater and existing wells, including a detailed description of the assumptions used in the pumping scenario, is provided in the NM Unit EIS Groundwater Technical Memorandum (HDR 2019c). In order to offset the effects of groundwater pumping on river flow depletions, the Entity has proposed releasing AWSA water from storage ponds into the Gila River.

S. S. Papadopulos & Associates, Inc. (SSPA) developed a groundwater model (SSPA model) covering around 32 square miles along the Gila River near the Cliff-Gila location, including 10 miles of the river and extending laterally over about 1 mile of the valley (SSPA 2014b and 2011). The SSPA model was calibrated using field data gathered over the course of 4 years and simulated groundwater-surface water interactions and shallow groundwater conditions along the Gila River to examine the effects of additional surface water diversions. None of the scenarios evaluated by SSPA match the current proposed alternatives, and the scenarios did not include proposed production wells. One scenario simulated surface water diversions of 5,008 AFY. Those modeled diversions decreased groundwater levels from 0.5 foot to 1 foot during March, but then showed groundwater levels recovered from a few days to about 2 weeks after the flow reductions ceased. Overall, in the SSPA modeled scenarios, groundwater declines were noted during periods of AWSA diversions, ranging from about 0.25 foot to 1 foot. Groundwater declines associated with the AWSA diversions did not persist beyond a period ranging from a few days to about 2 weeks, depending on subsequent conditions.

Ditch and pond seepage would average 294 AFY (see HDR 2019a and 2019b). Proposed surface water diversions and storage may lessen groundwater recharge through reduced streamflow downstream of the diversion or impoundment. Other proposed project features that could have an impact on groundwater are lined storage ponds or ditches. The lined ponds and lined ditches could impede groundwater flow to the alluvial aquifer in the vicinity of the river. Most of the proposed storage ponds and lined ditches would have minimal impact on a deeper aquifer, and some may have a slight impact on the shallow alluvial aquifers, by preventing infiltration and recharge.

Water Quality Salinity concentrations due to changes in river flows from project operations were evaluated at four locations. River flows and salinity were calculated using methods described in HDR 2019a and HDR 2019d. **Table 3-6** presents increases and decreases in sodium concentrations of river water. The NM Unit EIS Water Quality Technical Memorandum also discusses changes in chloride and total dissolved solids, which are similar to sodium concentration changes. Most changes would occur from November to January, when the project primarily would divert to fill surface storage.

Table 3-6. Monthly Median River Sodium-Ion Concentration Increases and Decreases—Alternative B Compared with Alternative A

Month	Gila River near Redrock	Gila River near Clifton	San Francisco River near Glenwood	Gila River at Calva
January	0 mg/L	1 mg/L (2%)	0 mg/L	14 mg/L (3%)
February	0 mg/L	0 mg/L	0 mg/L	0 mg/L
March	0 mg/L	0 mg/L	0 mg/L	-2 mg/L *
April	0 mg/L	-1 mg/L (-2%)	0 mg/L	-2 mg/L *
May	0 mg/L	0 mg/L	0 mg/L	-6 mg/L (-1%)
June	0 mg/L	0 mg/L	0 mg/L	0 mg/L
July	0 mg/L	0 mg/L	0 mg/L	1 mg/L *
August	-1 mg/L (-3%)	0 mg/L	0 mg/L	-4 mg/L (-1%)
September	0 mg/L	-1 mg/L (-1%)	0 mg/L	-3 mg/L (-1%)
October	0 mg/L	0 mg/L	0 mg/L	0 mg/L
November	0 mg/L	0 mg/L	0 mg/L	10 mg/L (3%)
December	1 mg/L (3%)	1 mg/L (2%)	0 mg/L	13 mg/L (3%)

Source: HDR 2019d

* Some positive or negative change is possible, with values rounding to 0 mg/L or 0% or both.

Alternative B could cause 1 mg/L, about 3 percent, increase in salinity concentrations in December or January at locations immediately downstream of the project locations. At Calva, median increases in sodium salinity would range from 10 to 14 mg/L.[13] This would be a 3 percent increase in salinity, compared with the Alternative A river concentrations of from 324 to 455 mg/L. Salinity might improve some in the summer due to return flows generated by the project, assuming these return flows would continue past the Safford Valley without being diverted. Based on criteria developed by Ayers and Westcot (1994), the suitability of river water for irrigation would remain the same as that of Alternative A. River water is generally suitable for irrigation above the confluence. Below the confluence, river water has slight to moderate suitability for irrigation, including severe irrigation restrictions from April to July at Calva.

Conclusion for Alternative B Under Alternative B, most river flow changes would occur between August and February, with December having the largest flow reduction, averaging 10 to 12 cfs (2 to 5 percent change) on the Gila River. Minor river flow changes would occur on the San Francisco River. The CUFA prevents direct impacts on senior water right holders. Salinity in the Gila River could increase from 10 to 14 mg/L (a 3 percent change from Alternative A). The degree of salinity changes is minor, so this is

[13] The Gila Water Commissioner (2019) reports salinity at Geronimo Station in terms of Electrical Conductivity (EC) as micro-Siemens per centimeter (µS/cm). The conversion between EC and concentration is 1,000 µS/cm (EC) = 640 mg/L.

not anticipated to have direct impacts for irrigation suitability using river water, compared with Alternative A.

In the Cliff-Gila location, AWSA diversions could result in up to a 1-foot decrease in local groundwater levels, which would recharge in about 2 weeks after AWSA diversions end. Project effects would have a minor impact on a deeper aquifer. Production wells in the Cliff-Gila location would reduce local groundwater levels when pumping. Approximately 67 existing wells may experience a 1- to 5-foot reduction in groundwater levels, and an existing well may experience a 5- to 10-foot reduction. Surface water impacts from pumping would be mitigated by releasing stored AWSA water to the Gila River. The proposed diversion structures would have design elements to facilitate alluvium groundwater flow if penetrating more than half of the alluvium.

Changes in river flows would predominantly occur outside of channel-forming events. The proposed diversion structures may increase flood water surface elevations for the 100-year (1 percent annual chance) event. The increase is estimated at 0.5 feet water surface elevation increase and a 0.4 acre flooded area increase for the San Francisco proposed diversion. The increase is estimated at a 3.0-foot water surface elevation increase and a 0.5-acre flooded area increase for the Cliff-Gila proposed diversion. These changes would not affect any roads or buildings.

Alternative C

Surface Water Alternative C would have average annual river project diversions of 3,185 AFY. **Table 3-7** provides the diversions from adjudicated and AWSA operations, along with return flows from the AWSA operations. **Table 3-8** provides the calculated increases and decreases in monthly average river flows downstream of each project location and at Calva. As modeled, the project storage would begin to fill in August and September, when water is available under the CUFA. Peak filling of storage would occur in November, December, and January. December river flows are calculated to decrease 12 cfs (-5 percent) at Redrock, 9 cfs (-4 percent) at the Gila River near Clifton, and 11 cfs (-2 percent) at Calva. Peak storage would occur in January for the San Francisco location, with river reductions of 3 cfs (-5 percent). Diversions would continue to maintain storage by replacing seepage and evaporation losses in February and March. The CUFA reduces or sometimes prevents summer diversions. Project storage releases from April to July could increase river flows due to return flows. Non-flowing conditions at Cosper Crossing would increase between 3 and 4 days per month in December, during lower river flows and exercising of AWSA project diversions. Cosper Crossing conditions would remain unchanged in other months.

Table 3-7. Operational Diversions and Return Flows—Alternative C

Operational Item	Cliff-Gila	Virden	San Francisco
Adjudicated diversions	13,134 to 13,377 AFY	16,915 to 21,142 AFY	5,148 to 5,331 AFY
AWSA Diversions	1,346 to 2,298 AFY	393 to 540 AFY	655 to 1,070 AFY
Total diversions	14,664 to 15,644 AFY	17,420 to 21,656 AFY	5,885 to 6,401 AFY
Return flows from AWSA operations	580 to 674 AFY	122 to 157 AFY	474 to 805 AFY

Source: NM Unit EIS Surface Water Technical Memorandum (2019a)
Note: **Chapter 2** provides the average for AWSA diversions, consumptive use, and return flows.

Table 3-8. Monthly Average River Flow Increases and Decreases—Alternative C Compared with Alternative A

Month	Gila River near Redrock		Gila River near Clifton		San Francisco River near Glenwood		Gila River at Calva	
January	-3 cfs	(-2%)	-3 cfs	(-2%)	-3 cfs	(-5%)	-6 cfs	(-2%)
February	-2 cfs	(-1%)	-2 cfs	(-1%)	-2 cfs	(-3%)	-4 cfs	(-1%)
March	-1 cfs	*	-1 cfs	*	*		-1 cfs	*
April	*		*		1 cfs	(1%)	1 cfs	*
May	2 cfs	(2%)	1 cfs	(1%)	2 cfs	(2%)	3 cfs	(1%)
June	1 cfs	(1%)	*		1 cfs	(4%)	1 cfs	(3%)
July	1 cfs	(2%)	*		*		1 cfs	(1%)
August	1 cfs	*	*		*		*	
September	-2 cfs	(-1%)	-2 cfs	(-1%)	-1 cfs	(-1%)	-2 cfs	(-1%)
October	-2 cfs	(-1%)	-2 cfs	(-1%)	*		-2 cfs	*
November	-5 cfs	(-3%)	-5 cfs	(-3%)	*		-5 cfs	(-2%)
December	-12 cfs	(-5%)	-9 cfs	(-4%)	-1 cfs	(-1%)	-11 cfs	(-2%)

Source: HDR 2019a
* Some positive or negative change is possible, with values rounding to 0 cfs or 0% or both.

Fluvial Geomorphology Alternative C proposes a sequence of rock cross vane weirs at the three Cliff-Gila diversions and Thomason Flat Ditch. Flood and sedimentation effects of the diversion structures should be similar to the current push-up diversions, assuming that the rock would be fully mobilized during high-flow events.

Groundwater Under Alternative C, no production wells or ASR facilities would be constructed. There would be no impacts on the deep groundwater and there would be no large mounding of infiltration water. Proposed surface water diversions or new impoundment projects could lessen groundwater recharge through reduced flow downstream of the diversion or impoundment. Another proposed project component that could have an impact on groundwater is lined storage ponds. The lined ponds could result in a small amount of groundwater recharge to the alluvial aquifer in the vicinity of the river, whereas proposed unlined Weedy Reservoir would result in significant amounts of groundwater recharge. The proposed storage ponds would not be likely to affect deeper aquifers, although the Gila Conglomerate could see additional recharge from unlined ponds in areas where the unit sub-crops at shallow depths beneath the alluvial aquifer.

Water Quality The leaching and runoff changes to water quality described in Alternative B also would apply to Alternative C. River flows and salinity changes were calculated using methods described in the New Mexico Unit EIS Surface Water Resources Technical Memorandum (HDR 2019a); water quality calculations were described in the New Mexico Unit EIS Water Quality Technical Memorandum (HDR 2019d). **Table 3-9** presents estimated increases and decreases in sodium concentrations of river water. The New Mexico Unit EIS Water Quality Technical Memorandum also discusses changes in chloride and total dissolved solids, which would be similar to changes in sodium concentrations. Salinity would increase from November to February, when the project would primarily divert to fill surface storage.

Table 3-9. Monthly Median River Sodium-Ion Concentration Increases and Decreases—Alternative C Compared with Alternative A

Month	Gila River near Redrock	Gila River near Clifton	San Francisco River near Glenwood	Gila River at Calva
January	0 mg/L	1 mg/L (2%)	0 mg/L	24 mg/L (5%)
February	0 mg/L	0 mg/L	1 mg/L (4%)	1 mg/L *
March	0 mg/L	0 mg/L	0 mg/L	-3 mg/L (-1%)
April	0 mg/L	-1 mg/L (-2%)	0 mg/L	-11 mg/L (-1%)
May	0 mg/L	0 mg/L	-1 mg/L (-5%)	-16 mg/L (-2%)
June	0 mg/L	0 mg/L	-1 mg/L (-4%)	7 mg/L (1%)
July	0 mg/L	0 mg/L	-1 mg/L (-4%)	5 mg/L (1%)
August	-1 mg/L (-3%)	0 mg/L	0 mg/L	-6 mg/L (-1%)
September	0 mg/L	-1 mg/L (-1%)	0 mg/L	-5 mg/L (-1%)
October	0 mg/L	0 mg/L	0 mg/L	-1 mg/L *
November	0 mg/L	0 mg/L	0 mg/L	11 mg/L (3%)
December	0 mg/L	1 mg/L (2%)	0 mg/L	14 mg/L (3%)

Source: HDR 2019d
* Some positive or negative change is possible, with values rounding to 0 mg/L or 0% or both.

Median increases in sodium salinity would range from 5 to 24 mg/L at Calva, which is a 5 percent increase over Alternative A river concentrations of from 325 to 355 mg/L. Based on criteria developed by Ayers and Westcot (1994), the suitability of river water for irrigation would remain the same as that of Alternative A. River water would generally be suitable for irrigation above the confluence. Water quality below the confluence has slight to moderate suitability for irrigation, including severe irrigation restrictions from April to July at Calva.

Conclusion for Alternative C Under Alternative C, most river flow changes would occur between August and February, with December having the largest flow reduction, averaging 11 to 12 cfs (a 1 to 5 percent change). The CUFA prevents direct impacts on senior water right holders. Salinity in the Gila River could increase from 5 to 24 mg/L (a 5 percent change from Alternative A) due to the change in the flows. The degree of salinity changes is minor and is not anticipated to have direct impacts for irrigation suitability using river water, compared with Alternative A. In the Cliff-Gila location, AWSA diversions could result in up to a 1-foot decrease in local groundwater levels, which would recharge in about 2 weeks after AWSA diversions end. In other locations, project effects on the shallow aquifer are minor, based on changes in recharge from lining and pond storage. Project effects would have minor impacts on deeper aquifers.

River flows would change predominantly outside of channel-forming events. The proposed rock vane diversion structures would likely become mobilized during a 100-year (1 percent annual chance) flood, resulting in no changes in flooded areas, compared with Alternative A.

Alternative D

Surface Water Alternative D would have average annual river project diversions of 480 AFY. **Table 3-10** provides the diversions from adjudicated and AWSA operations, along with return flows from the

Table 3-10. Operational Diversions and Return Flows—Alternative D

Operational Item	Virden
Adjudicated diversions	17,015 to 21,229 AFY
AWSA diversions	397 to 537 AFY
Total diversions	17,526 to 21,732 AFY
Return flows from AWSA operations	122 to 157 AFY

Source: HDR 2019a
Note: No project operations would occur in the Cliff-Gila and San Francisco locations.
Chapter 2 provides the average for AWSA diversions, consumptive use, and return flows.

AWSA operations in the Virden location. Only adjudicated operations would take place in the Cliff-Gila and San Francisco locations. Peak filling of Virden location storage is modeled to occur in December. December river flows are calculated to decrease 2 cfs (-1 percent) at the Gila River near Clifton and also at Calva. There could be river flow changes in other months that would not exceed 1 cfs or 1 percent of river flow on average. No river flow changes would take place below the Cliff-Gila location or on the San Francisco River. Non-flowing conditions at Cosper Crossing would increase by up to 1 day per month in December, during dry conditions. Cosper Crossing conditions would remain unchanged in other months and also unchanged in December in average or wetter conditions.

Fluvial Geomorphology Most AWSA diversions in the Virden location would occur when riverbed changes are not anticipated. The physical diversion structures in Virden would not be altered. No project diversions or operations would take place in the Cliff-Gila and San Francisco locations.

Groundwater Under Alternative D, groundwater conditions in the Cliff-Gila and San Francisco locations would not change. No impacts on the deep groundwater or large mounding of infiltration water would occur. Minor or slight groundwater impacts in the Virden location would be projected under this alternative. Proposed surface water diversions or new impoundment projects could lessen groundwater recharge through reduced streamflow downstream of the diversion or impoundment. The other proposed project component that could have an impact on groundwater is lined storage ponds. The lined ponds could result in a small amount of groundwater recharge to the alluvial aquifer in the vicinity of the river. The proposed storage ponds would not be likely to affect deeper aquifers.

Water Quality The leaching and runoff changes to water quality described under Alternative B also would apply to Alternative D. River flows and salinity changes were calculated using methods described in the New Mexico Unit EIS Surface Water Resources Technical Memorandum (HDR 2019a) and the New Mexico Unit EIS Water Quality Technical Memorandum (HDR 2019d). **Table 3-11** presents increases and decreases in sodium concentrations of river water. The New Mexico Unit EIS Water Quality Technical Memorandum also discusses changes in chloride and total dissolved solids, which would be similar to sodium concentration changes. No water quality changes would occur in the Cliff-Gila and San Francisco locations. There would be an increase in salinity below the Virden location when the project primarily diverts to fill surface storage. Median increases in sodium salinity at Calva would range from 1 to 7 mg/L. This could be up to a 1 percent increase in salinity, compared with Alternative A river concentrations of from 324 to 455 mg/L. Salinity might also increase 7 mg/L in July, which is a less than a 1 percent increase, compared with Alternative A river concentrations of 461 mg/L.

Table 3-11. Monthly Median River Sodium-Ion Concentration Increases and Decreases—Alternative D Compared with Alternative A

Month	Gila River at Calva	
January	1 mg/L	*
February	-1 mg/L	*
March	-1 mg/L	*
April	0 mg/L	
May	-1 mg/L	*
June	0 mg/L	
July	7 mg/L	(1%)
August	-4 mg/L	(-1%)
September	-2 mg/L	*
October	-1 mg/L	*
November	1 mg/L	*
December	2 mg/L	*

Source: HDR 2019d
Note: There are no changes from Alternative A river salinity concentrations below Cliff-Gila and San Francisco locations.
* Some positive or negative changes are possible, with values rounding to 0 mg/L or 0% or both.

Project return flows would be reduced, relative to Alternative B, due to reduced sized surface storage and elimination of project components in the Cliff-Gila and San Francisco locations. Based on criteria developed by Ayers and Westcot (1994), the suitability of river water for irrigation would remain the same as that of Alternative A. River water would be suitable for irrigation above the confluence. Below the confluence, river water has slight to moderate suitability for irrigation, including severe irrigation restrictions from April to July at Calva.

Conclusion for Alternative D Under Alternative D, most river flow changes would occur between August and February, with December having the largest flow reduction averaging 2 cfs (1 percent change). All river flow changes would occur below the Virden location. No river changes would occur below the Cliff-Gila location or on the San Francisco River. The CUFA prevents direct impacts on senior water right holders.

Salinity in the Gila River below Virden could increase from 1 to 7 mg/L (a 1 percent change from Alternative A) due to the change in the flows. The degree of salinity changes is minor and is not anticipated to have direct impacts for irrigation suitability using river water, compared with Alternative A. Minor or slight groundwater impacts in the Virden location from additional AWSA diversions and resulting ditch, pond, and on-farm infiltration would be projected with this alternative. No impacts on the deep groundwater or large mounding of infiltration water would occur. Changes in river flows would predominately occur outside of channel-forming events. No physical changes to diversion structures would occur, and no changes in flood impacts would occur, compared with Alternative A.

Alternative E

Surface Water Alternative E has average annual river project diversions of 2,924 AFY. **Table 3-12** provides the diversions from adjudicated and AWSA operations, along with return flows from the AWSA operations. **Table 3-13** provides the calculated increases and decreases in monthly average river flows downstream of each project location and at Calva. As modeled, project storage would begin to fill when water is available under the CUFA. Peak filling of storage would occur in November, December, and January. In December, river flows would decrease 9 cfs (-4 percent) at Redrock and 8 cfs (-3 percent) at the Gila River near Clifton. Peak river flow at Glenwood and Calva would decrease in January, with an 8 cfs (-12 percent) reduction for Glenwood and 9 cfs (-3 percent) reduction at Calva. Diversions to project storage would be maintained to replace seepage and evaporation losses in January and February. Non-flowing conditions at Cosper Crossing would increase to between 2 and 4 days per month in December, during lower river flows and AWSA diversions. Cosper Crossing conditions would remain unchanged in other months.

Table 3-12. Operational Diversions and Return Flows—Alternative E

Operational Item	Cliff-Gila	Virden	San Francisco
Adjudicated diversions	13,126 to 13,359 AFY	16,919 to 21,144 AFY	5,148 to 5,331 AFY
AWSA diversions	1,030 to 1,671 AFY	394 to 540 AFY	715 to 1,474 AFY
Total diversions	14,330 to 15,002 AFY	17,425 to 21,656 AFY	5,945 to 6,805 AFY
Return flows from AWSA operations	378 to 527 AFY	122 to 157 AFY	545 to 1,229 AFY

Source: HDR 2019d
Note: **Chapter 2** provides the average for AWSA diversions, consumptive use, and return flows.

Table 3-13. Monthly Average River Flow Increases and Decreases—Alternative E Compared with Alternative A

Month	Gila River near Redrock		Gila River near Clifton		San Francisco River near Glenwood		Gila River at Calva	
January	-2 cfs	(-1%)	-2 cfs	(-1%)	-8 cfs	(-12%)	-9 cfs	(-3%)
February	-2 cfs	(-1%)	-1 cfs	*	-2 cfs	(-3%)	-3 cfs	(-1%)
March	*		*		1 cfs	(1%)	1 cfs	*
April	1 cfs	*	*		2 cfs	(2%)	2 cfs	(1%)
May	3 cfs	(2%)	1 cfs	(1%)	2 cfs	(4%)	3 cfs	(2%)
June	1 cfs	(2%)	*		1 cfs	(5%)	1 cfs	(4%)
July	2 cfs	(3%)	1 cfs	(1%)	1 cfs	(2%)	1 cfs	(2%)
August	2 cfs	(2%)	1 cfs	(1%)	*		1 cfs	(1%)
September	*		-1 cfs	*	-1 cfs	(-1%)	-1 cfs	*
October	-2 cfs	(-1%)	-2 cfs	(-1%)	*		-2 cfs	*
November	-4 cfs	(-3%)	-4 cfs	(-2%)	*		-4 cfs	(-1%)
December	-9 cfs	(-4%)	-8 cfs	(-3%)	*		-8 cfs	(-2%)

Source: HDR 2019d
* Some positive or negative change is possible, with values rounding to 0 cfs or 0% or both.

Fluvial Geomorphology The Cliff-Gila location diversion under Alternative E proposes an Obermeyer weir. Operation of this weir during lower flows would allow irrigation diversions, while during higher flows and debris flows the weir could be deflated to promote sediment and debris transport downstream. **Table 3-14** shows the proposed diversion weir results in water surface elevation increases immediately upstream of the weir of up to 1.9 to 2.9 feet. Removing the push-up diversions would decrease floodwater surface elevations for frequent events downstream of the proposed diversion structure. The San Francisco location proposes a fixed crest diversion structure at the existing Spurgeon push-up diversion location, and flood and sediment effects would be the same as under Alternative B. These changes would not affect any roads or buildings.

Groundwater Under Alternative E, ASR wells would be installed, and no production wells would be constructed. Minor or moderately positive groundwater impacts are projected under this alternative. By raising groundwater elevations, the ASR facilities could result in supplementing river flows during periods of low water flows. The wells closer to the river and near the Winn Canyon infiltration basin would be likely to have rising groundwater levels with ASR project implementation. Wells close to the river and downstream of Winn Canyon that are at depths of less than 100 feet could be affected by the ASR wells if they are pumping, but these impacts would likely be short term. Since wells in the shallow alluvial aquifer system also would have more recharge potential, adverse impacts would not be significant.

Table 3-14. Cliff-Gila Alternative E Floodplain Changes

Flood Event Annual probability (“Reoccurrence Interval”)	Downstream of Proposed Diversion		Upstream of Proposed Diversion	
	Decreases in Water Surface Elevation (Feet)	Decreases in Flooded Area (Acres)	Increases in Water Surface Elevation (Feet)	Increases in Flooded Area (Acres)
50% (2-year)	0.5	4.3	2.9	5.9
10% (10-year)	1.4	15.7	2.1	4.7
2% (50-year)	0.0	0.0	1.7	2.5
1% (100-year)	0.0	0.0	1.9	0.3

Source: HDR 2019b

Proposed surface water diversions or new impoundment projects could lessen groundwater recharge through reduced streamflow downstream of the diversion or impoundment. The cutoff walls of the diversion structure, with a depth up to 20 feet, are not be likely to affect subsurface groundwater, as alluvial aquifer likely would extend deeper than the cutoff wall; however, the cutoff wall would be designed with openings to facilitate groundwater flow if the wall were to penetrate over 50 percent of the alluvial aquifer thickness.

The other proposed project components that could have an impact on groundwater is a lined storage pond in the Cliff-Gila location. The lined pond could result in a small amount of groundwater recharge to the alluvial aquifer in the vicinity of the Gila River, whereas proposed unlined ASR-related ponds would result in larger amounts of groundwater recharge. The proposed storage ponds would not be likely to affect deeper aquifers; however, the Gila Conglomerate could see additional recharge from the proposed unlined ponds in Winn Canyon and ditches in areas where the unit sub-crops at shallow depths beneath the alluvial aquifer.

Water Quality The leaching and runoff changes to water quality described in Alternative B also would apply under Alternative E. River flows and salinity were calculated using methods described in HDR 2019a and 2019d. **Table 3-15** presents increases and decreases in sodium concentrations of river water. The New Mexico Unit EIS Water Quality Technical Memorandum also discusses changes in chloride and total dissolved solids, which are similar to sodium concentration changes. Most increases would occur from November to January, when filling the project storage under Alternative E would divert river flows. Median increases in sodium salinity would range from 8 to 26 mg/L at Calva. This is up to a 5 percent increase, compared with Alternative A river concentrations of from 324 to 455 mg/L. Some improvement in salinity might occur due to project return flows, assuming these return flows would continue past the Safford Valley without being diverted. Based on criteria developed by Ayers and Westcot (1994), the suitability of river water for irrigation would remain the same as that of Alternative A.

Table 3-15. Monthly Median River Sodium-Ion Concentration Increases and Decreases—Alternative E Compared with Alternative A

Month	Gila River near Redrock	Gila River near Clifton	San Francisco River near Glenwood	Gila River at Calva
January	0 mg/L	0 mg/L	1 mg/L (4%)	26 mg/L (5%)
February	0 mg/L	0 mg/L	0 mg/L	-1 mg/L *
March	0 mg/L	0 mg/L	0 mg/L	-7 mg/L (-2%)
April	0 mg/L	-1 mg/L (-2%)	0 mg/L	-15 mg/L (-2%)
May	0 mg/L	0 mg/L	-1 mg/L (-5%)	-17 mg/L (-2%)
June	0 mg/L	0 mg/L	-1 mg/L (-4%)	4 mg/L *
July	0 mg/L	0 mg/L	-1 mg/L (-4%)	8 mg/L (1%)
August	-1 mg/L (-3%)	0 mg/L	0 mg/L	-8 mg/L (-1%)
September	0 mg/L	-1 mg/L (-1%)	0 mg/L	-4 mg/L (-1%)
October	0 mg/L	0 mg/L	0 mg/L	-1 mg/L *
November	0 mg/L	0 mg/L	0 mg/L	9 mg/L (3%)
December	0 mg/L	1 mg/L (2%)	0 mg/L	14 mg/L (3%)

Source: HDR 2019d
* Some positive or negative change is possible, with values rounding to 0 mg/L or 0% or both.

Conclusion for Alternative E Under Alternative E, most river flow changes would occur between August and February, with December and January having the largest flow reduction, averaging 8 to 9 cfs (2 to 12 percent change). The CUFA prevents direct impacts on senior water right holders. Salinity in the Gila River could increase from 8 to 26 mg/L (a 5 percent change from Alternative A), due to the change in the flows. The degree of salinity changes is minor as it is not anticipated to have direct impacts for irrigation suitability using river water, compared with Alternative A.

In the Cliff-Gila location, AWSA diversions could cause up to a 1-foot decrease in local groundwater levels, which would recharge in about 2 weeks after AWSA diversions end. Wells close to the river and downstream of Winn Canyon that are less than 100 feet deep could be affected by the ASR wells if they are pumping. These impacts would likely be short term and may be offset by recharge from the ASR system. The proposed diversion structures would have design elements to facilitate alluvium groundwater flow if penetrating more than half of the alluvium.

River flows would predominantly change outside of channel-forming events. The proposed diversion structures may increase floodwater surface elevations for the 100-year (1 percent annual chance) flood. The increase is estimated at 0.5 feet water surface elevation and a 0.4-acre flooded area increase for the San Francisco proposed diversion. The increase is estimated at 1.9 feet water surface elevation and a 0.2-acre flooded area increase for the Cliff-Gila proposed diversion. These changes would not affect any roads or buildings.

Cumulative Impacts

Water supply climate trends appear to be transitioning from higher than normal wet conditions into dry conditions. Future projections indicate less water supply overall, higher intensity floods and monsoon thunderstorms, and spring snowmelt shifting to earlier in the year. Project effects on surface water quantity tend to be less in drier conditions, because the CUFA would limit diversions. Project operations in dry conditions tend to influence December to January river flows more than in other months. Projected shifts in the spring snowmelt to earlier in the year would further compress the AWSA diversion time frame.

Climate trends are projected to increase thunderstorm intensity or to compress the spring snowmelt period, which could lead to higher flood flows. Wildfires potentially influence runoff and flood conditions, suitability of surface waters for use, and snowmelt. Fire effects have contributed to several historical floods. The proposed diversions are low-head structures, which generally would have more effect on frequent than infrequent floods. Trends in higher flood flows are not expected to introduce greater risk with the project. Climate trends may affect the timing of storage and some project operations. These elements have less of an impact on water quality; thus, the difference in timing would not change the conclusions regarding water quality.

The AWSA water availability might increase or decrease, based on reasonably foreseeable actions. As part of its awards to non-NM Unit projects, the ISC has allocated funding to install more permanent diversion structures for acequias in southwest New Mexico. Diversions identified for replacement under ISC's program are those that service the GBIC ditches, Kiehne Middle Frisco ditch, and Luna irrigation ditch. If more precise diversions replace live ditch flows upstream, the proposed project locations may gain access to additional river flows during the irrigation season. Conveyance efficiency improvements being funded by the ISC for the Pleasanton East Side Ditch Company, Luna irrigation ditch, and New Model canal might reduce the need for river diversions for lands currently irrigated with adjudicated water. This could lead to more flow remaining in the river and be available to the project under the CUFA; however, it is possible that irrigated acreage and consumptive uses in the non-project areas might increase because of higher potential on-farm deliveries and reliability.

Future private well development proposed by the San Francisco Soil and Water Conservation District would offset river depletions from pumping through surface water releases from Weedy Reservoir (Alternatives C and E). Filling of Weedy Reservoir would likely remain the same. Releases from Weedy Reservoir may be similar between the two action alternatives, although timing may change based on well pumping schedules. River transmission losses associated with the action alternatives may be less if the wells are closer to Weedy Reservoir than the supporting acreage on the W-S Ditch or Pleasanton ditches.

Mitigation Measures and Residual Impacts

Construction may introduce temporary structures into the floodplain. These structures could include coffer dams, temporary diversions, and stockpiles of materials. The construction contractor would be required to mitigate for temporary flood risks. If possible, construction operations in the floodplain should take place during months when flood risks are lower. Floods of note typically occur during the NAMS or due to winter rain.

During the construction of in-channel works and upland excavation of storage ponds, a stormwater pollution prevention plan (SWPPP) would be implemented at each construction site. SWPPPs include best management practices for erosion prevention, such as stockpiling soil for reuse and surrounding construction zones with barriers to prevent or limit stormwater and sediment runoff. After construction, disturbed areas would be reclaimed to native vegetation. Guidelines for SWPPPs can be found in Storm Water Management Guidelines for Construction and Industrial Activities (NM DOT et al. 2012).

Diversion infrastructure could include measures that would limit impacts within the channel. Most AWSA diversions are projected to occur during river flows of less than the 1.25-year flood flows and would not affect channel-forming conditions. Alternatives B and E propose a fixed-crest weir with a low-flow notch or Obermeyer weirs, which should facilitate sediment transport. Sediment entrainment into the irrigation system could be reduced through filtering screens to prevent some sizes of sediment from passing. Head gate design could include a bypass gate to move sediment downstream of the diversion structure.

The proposed permanent or semi-permanent diversion structures are intended to require less maintenance than the existing push-up diversions. Some maintenance would still occur, ranging from removing debris to reforming rock-vane weirs. Incorporating dedicated riverine access points as part of the downstream scour protection measures would assist in limiting impacts from heavy equipment during maintenance.

There could be groundwater level drawdown impacts at nearby existing wells as a result of the Alternative B production wells. Before pumping the production wells, the construction details of existing wells within approximately half a mile of the production wells would be tabulated from available well logs. This would be used to assess which existing wells are installed in the same aquifer as the production wells and would, therefore, be more likely to be affected. Mitigation measures for groundwater level drawdown impacts on existing wells could include the installation of observation wells to track drawdown at some distance from the production well. Observation wells would serve as sentry monitoring points and provide an estimate of the degree of drawdown before the drawdown affects existing wells. If excessive drawdown were to occur in the observation wells, mitigation strategies would be developed with individual well owners whose wells have a proven negative impact resulting from the project.

3.4 Biological Resources

3.4.1 Affected Environment

The following section is a description of the existing conditions for vegetation, aquatic and terrestrial wildlife, and threatened and endangered species at the three project locations. A more detailed description of these biological resources is provided in the Biological Evaluation (SWCA Environmental Consultants, Inc. [SWCA] 2019a).

The analysis area for biological resources is the area where potential direct and indirect impacts on vegetation communities, wetlands, and wildlife, including special status plant and wildlife species, have the potential to occur. Direct impacts are caused by the Proposed Action and alternatives and would occur at the same time and place. Indirect impacts are caused by or would result from the Proposed Action and alternatives and would occur later in time or farther removed in distance but are still reasonably certain to occur. The analysis area includes the following components (see Figure 1 of the Biological Evaluation [SWCA 2019a]):

- **Direct impacts area—**This is the project location with the addition of a 0.25-mile buffer. It extends upstream of the proposed diversion structures and includes the areas where water is anticipated to pool. This is where there may be direct short- and long-term impacts from development and operation of the proposed infrastructure and hydrologic impacts.
- **Indirect impacts area—**This is the area upstream and downstream of the direct impacts area. Upstream areas are limited to the riverine environment and are relevant for analyzing potential genetic impacts on fish; downstream areas are limited to the riparian corridor and waterway. These areas are subject to potential impacts due to temporary drying or permanent changes in hydrological conditions. These conditions would result of operating the diversion facilities and of drawing water from the system for consumptive use.

The area of analysis is subdivided into the Upper Gila analysis area, Virden Valley analysis area, San Francisco River analysis area, and Lower Gila analysis area (see **Appendix A**, **Maps 3-7** through **3-10** of this EIS).

Vegetation

Vegetation in the analysis area is made up of 23 Southwest Regional Gap Analysis Project (SWReGAP 2005) land cover types (**Table 3-16**). Figures A-6 through A-16 in Appendix A of the Biological Evaluation illustrate the land cover types occurring on the Gila River; Figures A-17 through A-21 of Appendix A illustrate the land cover types occurring on the San Francisco River.

Plant species observed in the direct impacts areas during surveys are boxelder (*Acer negundo*), tree of heaven (*Ailanthus altissima*), ragweed (*Ambrosia* sp.), mule-fat (*Baccharis salicifolia*), netleaf hackberry (*Celtis laevigata* var. *reticulata*), yellow star-thistle (*Centaurea solstitialis*), bull thistle (*Cirsium vulgare*), saltgrass (*Distichlis spicata*), Apache plume (*Fallugia paradoxa*), juniper (*Juniperus* sp.), Arizona sycamore (*Platanus wrightii*), Fremont cottonwood (*Populus fremontii*), Goodding's willow (*Salix gooddingii*), catclaw acacia (*Senegalia greggii*), Russian olive (*Elaeagnus angustifolia*), velvet ash (*Fraxinus velutina*), Arizona walnut (*Juglans major*), five-stamen tamarisk (*Tamarix chinensis*), lotebush (*Ziziphus obtusifolia*), cattail (*Typha* sp.), Siberian elm (*Ulmus pumila*), and canyon grape (*Vitis arizonica*) (SWCA 2019a and 2019b).

Wetland and Riparian Areas Potential riparian and wetland areas in the area of analysis were identified during limited biological surveys, focused on the direct impacts areas, and were mapped using SWReGAP and USFWS National Wetlands Inventory (NWI) data (USFWS 2019a).

Wetlands and riparian areas are found primarily along the Gila and San Francisco Rivers and along ditches and canals, where groundwater and surface water levels are sufficient to support wetland soils and vegetation. Vegetation found in riparian areas includes native and nonnative species, such as Goodding's willow, Fremont cottonwood, mule-fat, Siberian elm, five-stamen tamarisk, and tree of heaven.

Table 3-16. SWReGAP Land Cover Types in the Area of Analysis

SWReGAP Land Cover Class	Acres in Upper Gila Area of Analysis	Acres in Virden Valley Area of Analysis	Acres in San Francisco River Area of Analysis	Acres in Lower Gila Area of Analysis	Total Acres
Agriculture	1,977.7 (15.6%)	3,352.3 (32.0%)	507.5 (6.3%)	4,620.0 (29.7%)	**10,457.5 (22.3%)**
Apacherian-Chihuahuan Mesquite Upland Scrub	1,514.7 (12.0%)	3,686.8 (35.1%)	2,150.8 (26.5%)	2,631.1 (16.9%)	**9,983.4 (21.3%)**
Apacherian-Chihuahuan Piedmont Semi-Desert Grassland and Steppe	1,242.2 (9.8%)	158.6 (1.5%)	460.3 (5.7%)	9.9 (0.1%)	**1,870.9 (4.0%)**
Chihuahuan Creosotebush Mixed Desert and Thornscrub	423.5 (3.3%)	2,054.7 (19.6%)	56.3 (0.7%)	1,367.8 (8.8%)	**3,902.2 (8.3%)**
Chihuahuan Mixed Salt Desert Scrub	0	0	0	1,939.7 (12.5%)	**1,939.7 (4.1%)**
Chihuahuan Succulent Desert Scrub	0	0	0	12.8 (0.1%)	**12.8 (<0.1%)**
Colorado Plateau Mixed Bedrock Canyon and Tableland	0	0	3.9 (0.1%)	0	**3.9 (<0.1%)**
Developed, Medium-High Intensity	0	27.0 (0.3%)	140.4 (1.7%)	0	**167.3 (0.4%)**
Invasive Southwest Riparian Woodland and Shrubland	0	0	4.7 (0.1%)	0	**4.7 (<0.1%)**
Madrean Encinal	0.9 (<0.1%)	0	2.9 (<0.1%)	0	**3.8 (<0.1%)**
Madrean Juniper Savanna	100.7 (0.8%)	<0.1 (<0.1%)	16.0 (0.2%)	0	**116.7 (0.2%)**
Madrean Pine-Oak Forest and Woodland	15.4 (0.1%)	5.9 (0.1%)	26.2 (0.3%)	0	**47.5 (0.1%)**
Madrean Pinyon-Juniper Woodland	3,237.2 (25.6%)	5.6 (0.1%)	1,916.5 (23.6%)	12.3 (0.1%)	**5,171.6 (11.0%)**
Mogollon Chaparral	2,635.0 (20.8%)	116.0 (1.1%)	1,481.6 (18.3%)	1.8 (<0.1%)	**4,234.4 (9.0%)**
North American Warm Desert Bedrock Cliff and Outcrop	0	0	0	5.0 (<0.1%)	**5.0 (<0.1%)**
North American Warm Desert Lower Montane Riparian Woodland and Shrubland	1,436.8 (11.4%)	803.2 (7.7%)	1,219.6 (15.0%)	170.0 (1.1%)	**3,629.5 (7.8%)**
North American Warm Desert Riparian Mesquite Bosque	0	0	0	2,298.5 (14.8%)	**2,298.5 (4.9%)**
North American Warm Desert Riparian Woodland and Shrubland	0	1.8 (<0.1%)	1.3 (<0.1%)	14.2 (0.1%)	**17.4 (<0.1%)**
North American Warm Desert Wash	71.9 (0.6%)	2.0 (<0.1%)	0	0	**73.9 (0.2%)**
Open Water	0	0	2.6 (<0.1%)	3.1 (<0.1%)	**5.7 (<0.1%)**
Sonora-Mojave Creosotebush-White Bursage Desert Scrub	0	30.9 (0.3%)	0	2.7 (<0.1%)	**33.6 (0.1%)**

SWReGAP Land Cover Class	Acres in Upper Gila Area of Analysis	Acres in Virden Valley Area of Analysis	Acres in San Francisco River Area of Analysis	Acres in Lower Gila Area of Analysis	Total Acres
Sonora Mid-Elevation Desert Scrub	0.2 (<0.1%)	137.3 (1.3%)	96.9 (1.2%)	158.6 (1.0%)	**393.0 (0.8%)**
Sonoran Paloverde-Mixed Cacti Desert Scrub	0	108.3 (1.0%)	25.7 (0.3%)	2,295.0 (14.8%)	**2,429.0 (5.2%)**
Total	**12,656.1**	**10,490.4**	**8113.0**	**15,542.4**	**46,802.3**

Sources: ESRI 2013 and SWReGAP 2005

Wetland and riparian areas mapped as SWReGAP classifications make up 7.8 percent of the area of analysis and include North American Warm Desert Lower Montane Riparian Woodland, Shrubland and Invasive Southwest Riparian Woodland and Shrubland, and North American Warm Desert Riparian Woodland and Shrubland (see **Table 3-16**). NWI riparian wetland types occur on 3,960.5 acres in the direct impacts area and on 27,385.6 acres in the indirect impacts area (**Table 3-17**). The NWI data indicate that Forested/Shrub Riparian and Herbaceous Riparian vegetation occurs on about 1,897.0 acres in the direct impacts area and on about 20,022.0 acres in the indirect impacts area.

Special Status Plant Species Special status species are those that are identified by federal or state agencies for special management consideration. Seventy-nine special status plant species were analyzed for the potential to occur in the area of analysis (see Biological Evaluation, Section 3.1 and Appendix F, Table F-1: BLM, USFS, State of New Mexico, and USFWS Special Status Plant Species). Seven of these species—night-blooming cereus (*Peniocereus greggii* var. *greggii*), Parish's alkali grass (*Puccinellia parishii*), Clifton rock daisy (*Perityle ambrosiifolia*), Pima Indian mallow (*Abutilon parishii*), Arizona alum root (*Heuchera glomerulata*), Greene milkweed (*Asclepias uncialis* ssp. *uncialis*), and Wilcox's pincushion cactus (*Mammillaria wrightii* var. *wilcoxii*)—are known to occur or have the potential to occur (**Table 3-18**). This is because the area of analysis is within the range of these species, and suitable habitat is present. These seven species may directly or indirectly be affected by the project and are described in detail in the Biological Evaluation, Section 4.1.2.

Two ESA-listed plant species—Arizona cliffrose (*Purshia subintegra*) and Zuni fleabane (*Erigeron rhizomatus*)—are unlikely to occur. This is because the area of analysis is beyond the known geographic or elevational range of these species, or it does not contain vegetation or landscape features known to support the listed species. These species are not discussed further.

Noxious Weeds The New Mexico Department of Agriculture divides its listed noxious weed species into four categories: Class A species are those that are not present in New Mexico or have limited distribution; Class B species are those that are limited to portions of the state; Class C species are those that are widespread in the state; and Watch List Species are those that have the potential to become problematic, but for which data are limited (New Mexico Department of Agriculture 2016). State of New Mexico noxious weed species identified as occurring or potentially occurring in the area of analysis are Class A species yellow star-thistle in the Upper Gila area of analysis; Class B species bull thistle in the Upper Gila area of analysis; and Class C species Russian olive, tamarisk, Siberian elm, and tree of heaven (New Mexico Department of Agriculture 2016).

Table 3-17. NWI Wetland and Riparian Types in the Area of Analysis

NWI Wetland and Riparian Landcover Class	Upper Gila Area of Analysis		Virden Valley Area of Analysis		San Francisco River Area of Analysis		Lower Gila Area of Analysis	Total Area of Analysis	
Landcover Class	**Direct Impacts Area**	**Indirect Impacts Area**	**Direct Impacts Area**	**Indirect Impacts Area**	**Direct Impacts Area**	**Indirect Impacts Area**	**Indirect Impacts Area**	**Direct Impacts Area**	**Indirect Impacts Area**
Forested/Shrub Riparian	555.2 (30.7%)	1,214.8 (34.3%)	626.1 (43.5%)	1,641.0 (41.6%)	424.8 (59.4%)	2,221.2 (49.9%)	4,458.6 (28.9%)	1,606.1 (40.6%)	9,535.6 (34.8%)
Freshwater Emergent Wetland	163.5 (9.1%)	198.0 (5.6%)	52.6 (3.7%)	199.6 (5.1%)	4.1 (0.6%)	13.4 (0.3%)	309.9 (2.0%)	220.3 (5.6%)	720.8 (2.6%)
Freshwater Forested/Shrub Wetland	352.2 (19.5%)	613.1 (17.3%)	42.6 (3.0%)	125.2 (3.2%)	46.9 (6.6%)	560.0 (12.6%)	6,065.1 (39.3%)	441.7 (11.2%)	7,363.4 (26.9%)
Freshwater Pond	11.6 (0.6%)	0	5.5 (0.4%)	1.5 (0.0%)	0.6 (<0.1%)	0	224.4 (1.5%)	17.6 (0.4%)	225.9 (0.8%)
Herbaceous Riparian	146.2 (8.1%)	377.6 (10.7%)	141.7 (9.8%)	820.4 (20.8%)	3.0 (0.4%)	0	388.0 (2.5%)	290.9 (7.3%)	1,586.0 (5.8%)
Riverine	577.7 (32.0%)	1137.9 (32.1%)	570.5 (39.6%)	1161.1 (29.4%)	235.7 (33.0%)	1,658.6 (37.2%)	3,996.2 (2.5%)	1,383.9 (34.9%)	7,953.9 (29.0%)
Total	**1,806.4 (100%)**	**3,541.4 (100%)**	**1,438.8 (100%)**	**3,948.9 (100%)**	**715.2 (100%)**	**4,453.2 (100%)**	**15,442.2 (100%)**	**3,960.5 (100%)**	**27,385.6 (100%)**

* Sources for category definitions: https://www.fws.gov/wetlands/Data/Mapper-Wetlands-Legend.html and https://www.fws.gov/wetlands/data/mapper.html

Table 3-18. Special Status Plant Species Known to Occur or that Have the Potential to Occur in the Area of Analysis

Common Name (*Scientific Name*)	Special Status	Area of Analysis	Habitat
Pima Indian mallow (*Abutilon parishii*)	BLM sensitive species for Arizona	Potential to occur in the Lower Gila area of analysis	Full sunlight exposure at high elevations (1,720–4,900 feet above mean sea level [amsl]) in desert scrub. The plant prefers rocky hillsides and ledges and canyon bottoms; in riparian zones, the plant favors flat, rocky terraces and can be found along hiking trails (Arizona Game and Fish Department [AZGFD] 2000).
Greene milkweed (*Asclepias uncialis* ssp. *uncialis*)	Gila National Forest and Apache-Sitgreaves National Forests sensitive species	Potential to occur in the Upper Gila and San Francisco River area of analysis	Plains grassland-shortgrass communities on open hills and lower side slopes at the base of mesas, canyons, and bluffs. The species has an elevational range of 4,000–6,400 feet amsl (AZGFD 2006).
Arizona alum root (*Heuchera glomerulata*)	Apache-Sitgreaves National Forests sensitive species	Potential to occur in the San Francisco River area of analysis	Inhabits mountainous regions on shaded, rocky slopes near springs, streams, and riparian areas. Typically occurs on north-facing slopes at elevations of 4,000–9,000 feet amsl (AZGFD 2004a; NatureServe 2019).
Night-blooming cereus (*Peniocereus greggii* var. *greggii*)	BLM sensitive species for New Mexico and a State of New Mexico endangered species	Potential to occur in the Virden Valley area of analysis	Chihuahuan desert scrub and desert grassland habitats, mostly in sandy to silty, gravelly soils in gently broken to level terrain. The species has an elevational range of 3,900–5,000 feet amsl (AZGFD 2015a).
Clifton rock daisy (*Perityle ambrosiifolia*)	BLM sensitive species for Arizona	Potential to occur in the Lower Gila indirect impacts areas on BLM-administered lands. It also occurs in the San Francisco River area of analysis on private lands; thus, it has the potential to occur on nearby BLM-administered lands in the San Francisco River area of analysis; however, this species does not have the potential to occur in any direct impacts area, as these locations are distant to known its occurrences.	Found in fissures and crevices near seeps and waterfalls, in the high desert in pinyon-juniper grassland above riparian areas at elevations of 1,800–4,900 feet amsl (AZGFD 2005).

Common Name (*Scientific Name*)	**Special Status**	**Area of Analysis**	**Habitat**
Parish's alkali grass (*Puccinellia parishii*)	BLM sensitive species for New Mexico, Apache-Sitgreaves National Forests sensitive species, and a State of New Mexico endangered species	Potential to occur in Virden Valley area of analysis	Occurs in disjunct populations near alkaline seeps, springs, and seasonally wet areas that occur at the heads of drainages or on gentle slopes between 2,295 and 7,215 feet amsl (AZGFD 2015b; New Mexico Rare Plant Technical Council 1999; Sivinski and Tonne 2011). Occurs in Apache, Coconino, and Yavapai Counties in Arizona and Catron, Cibola, Grant, Hidalgo, McKinley, Sandoval, and San Juan Counties in New Mexico. A population occurs in the Apache-Sitgreaves National Forests in Apache County (USFWS 1998).
Wilcox's pincushion cactus (*Mammillaria wrightii* var. *wilcoxii*)	State of New Mexico endangered species	Potential to occur in the Upper Gila and Virden Valley area of analysis	Occurs in southwestern New Mexico in Grant and Hidalgo Counties. Habitat includes semidesert grasslands, Madrean pine-oak woodlands, steep, rocky slopes, canyons, and valleys, usually on alluvial or igneous substrates. The species has an elevational range of 3,600–6,560 feet amsl (NatureServe 2019).

Noxious weeds species that have the potential occur in the Lower Gila area of analysis in Arizona are bull thistle, tamarisk, tree of heaven, and Russian olive (Howery 2016).

Aquatic and Terrestrial Wildlife Habitat

Aquatic Wildlife Habitat

Upper Gila Area of Analysis Riverine habitat upstream of the Upper Gila area of analysis is varied and described by Paroz et al. (2010). The East Fork and Middle Fork meander through meadows and have gravel-sand substrates, with few boulders and woody debris. The West Fork is canyon-bound, with coarse substrata. Five habitat types were identified: small tributary, large tributary, canyon-bound main stem, and low- and high-modification valley main stem.

The direct impacts area is in an alluvial valley, downstream of the confluence with Mogollon Creek. The Cliff-Gila project location has been shaped by human-made levees that were breached and eroded during the 2005 flood (MEI 2006). Downstream of the project location, three large tributaries—Duck Creek, Bear Creek, and Mangas Creek—contribute alluvial sediments. The site is composed of alluvial sediments, and the channel morphology is primarily pool-riffle with fine-grained mid-channel bars (MEI 2006). Downstream reaches in the indirect impacts area near Redrock Gage traverse through two canyon reaches, the Middle Box and the Lower Box. The channel morphology is pool-riffle, with riffles composed of cobble-boulder-sized materials (MEI 2006).

Riverine aquatic habitat in the direct impact area is dominated by cobble substrate, with pool, riffle run complexes. Turner and Probst (2014) characterize the aquatic habitat at the Riverside sampling site (NMDGF 2018a) as a single channel with low-relief sand-gravel islands. Habitat includes shallow backwaters and embayments and moderately steep-gradient cobble-bottom riffles, and pool habitat associated with uprooted trees. The most common habitat type sampled was moderate velocity and moderate-depth runs and shoals. Wildfires in the upper basin have contributed to heavy sediment and ash inputs into the river, which contributes to lateral migration of the river channel (Turner and Propst 2014).

Habitat availability is influenced by three push-up diversions that service irrigation diches. In the direct impacts area there are four irrigation ditches: the Gila Farms Ditch (19,635 feet), Fort West Ditch (39,128 feet), Upper Gila Ditch (39,515 feet), and the McMillen Ditch (1,011 feet). Ditch associations in the Upper Gila area of analysis divert water from the Gila River by using bulldozers to push diversions up out of riverbed materials. The push-up diversion stays in the river all year; that is, they are not removed at the end of the irrigation season and continue to divert river water into irrigation ditches even when farmers are no longer irrigating. The diversions typically are damaged one to three times a year in a normal year, which requires irrigators to repair or rebuild the structure. Most often such damage occurs during the monsoon season (July–September).

The Gila River dries up frequently between the Fort West Diversion and the Gila Farms Diversion. The area experiences varying degrees of dryness, depending on the precipitation during the year. During low flow conditions, dry areas may extend from the diversion downstream approximately 1.2 miles (SWCA 2014b). During fish surveys in October 2018, SWCA found the Fort West push-up dam in place and all water was diverted from the channel, drying the river for approximately 2 miles; however, as return flows come back to the river, some downstream reaches are rewetted.

Intermittent drying also occurs downstream of the direct impacts area; it has been documented in the lower reaches for the indirect impacts area above the Sunset Diversion (ISC 2000).

The Upper Gila area of analysis contains 14 springs and 10 water improvements on U.S. Forest Service (USFS)-administered lands. All 14 springs are in the northern portion of the direct impacts area. Seven of the water improvements are in the northern portion of the area of analysis and three are in the southern portion.

Virden Valley Area of Analysis The Virden Valley area of analysis was not surveyed because the landowners did not permit access. On the site visit in 2018, the river was much wider in Virden than at the Upper Gila area of analysis and the dominant substrate was sand. MEI (2006) describes the Virden Valley area of analysis as an open valley reach. This is a low-gradient reach, with loss of sediment transport capacity resulting in deposition of finer sand and gravels and a low-flow braided channel morphology (MEI 2006, HDR 2019c). Fine sediments are continually moved out of the reach, forming a single-channel pool riffle (HDR 2019c).

There are two irrigation canals in the Virden Valley area of analysis, the New Model Canal (24,755 feet) and the Sunset Canal (58,221 feet), each fed by a permanent diversion structure.

Downstream of the Virden Valley location at Cosper Crossing in Arizona, the river dries during low-flow conditions. HDR (2019a) reports that Cosper Crossing dries 79 percent of the time when discharge is less than 40 cubic feet per second (cfs).

The Virden Valley area of analysis contains one spring and four water improvements on BLM-administered lands. The spring is in the southeastern portion of the area of analysis and is classified as a water improvement. All four water improvements are also in the southeastern portion of the area of analysis.

San Francisco River Area of Analysis The riverine habitat in the San Francisco River area of analysis is dominated by sandy sediment with cobble. The river in this area consists mostly of riffle/run complexes, with less pool habitat than the main stem Gila. Aquatic habitat is influenced by current push-up diversion operations at the Spurgeon Ditch #2 Diversion and the Thomason Flat Diversion and a permanent diversion structure for the W-S Ditch (see Biological Evaluation, Section 4.2.1.1.4). The San Francisco River is mostly perennial in New Mexico. The W-S Ditch Diversion creates large sediment deposition upstream and downstream of the diversion. During the November 2018 surveys, fish were found only downstream of the diversion; the substrate upstream of the diversion lacked periphyton and macroinvertebrates, indicating it had been dry before the November survey (SWCA 2019d).

The San Francisco River area of analysis contains six irrigation ditches: the Spurgeon Ditch #2 (8,689 feet), Thomason Flat Ditch (16,826 feet), W-S Ditch (8,644 feet), Pleasanton East Side Ditch (15,650 feet), East Pleasanton Lateral (2,007 feet), and Pleasanton West Side Ditch (11,883 feet). It also contains 6 springs and 42 water improvements on USFS-administered lands. The springs and water improvements are dispersed throughout the direct impacts area but occur in higher density toward the southern portion.

Lower Gila Area of Analysis The Lower Gila area of analysis below the confluence of Gila and San Francisco Rivers was not surveyed, because there are no direct project impacts. This is an open valley reach. Channel widths range from 70 to 220 feet and vary in response to floods and droughts (MEI 2006; HDR 2019b). Aquatic habitat is influenced by scour and bank erosion associated with floods, sediment deposition and formation of bars, and a single channel pool-riffle condition.

Terrestrial Wildlife Habitat A variety of terrestrial wildlife habitats are found in the area of analysis (see **Table 3-16**). Terrestrial habitat is made up of a combination of land cover classes, physical factors (soil, water availability, topography, elevation, weather, and climate), historical land use patterns, and prior disturbances that affect how terrestrial wildlife use the area of analysis. **Table 3-16** lists the land cover types and acreages by area of analysis that make up wildlife habitat. A description of each land cover class is given in Appendix E of the Biological Evaluation.

Upper Gila Area of Analysis In the Upper Gila area of analysis the most abundant land cover types are upland scrub, woodland, and agricultural vegetation communities. The most common types are Madrean Pinyon-Juniper Woodland (3,237.2 acres), Mogollon Chaparral (2,635.0 acres), Agriculture (1,977.7 acres), North American Warm Desert Lower Montane Riparian Woodland and Shrubland (1,436.8 acres), Apacherian-Chihuahuan Piedmont Semi-Desert Grassland and Steppe (1,242.2 acres), and Apacherian-Chihuahuan Mesquite Upland Scrub (1,514.70 acres).

Virden Valley Area of Analysis In the Virden Valley area of analysis, the most abundant land cover types associated with terrestrial wildlife habitats are the Apacherian-Chihuahuan Mesquite Upland Scrub (3,686.8 acres), Agriculture (3,352.3 acres), and Chihuahuan Creosotebush, Mixed Desert and Thorn Scrub (2,054.7 acres).

San Francisco Area of Analysis In the San Francisco River area of analysis, the most abundant land cover types associated with terrestrial wildlife habitats are the Apacherian-Chihuahuan Mesquite Upland Scrub (2,150.8 acres), Madrean Pinyon-Juniper Woodland (1,916.5 acres), Mogollon Chaparral (1,418.6 acres), and North American Warm Desert Lower Montane Riparian Woodland and Shrubland (1,219.6 acres).

Lower Gila Area of Analysis In the Lower Gila area of analysis the most abundant land cover types associated with terrestrial wildlife habitats are the North American Warm Desert Riparian Mesquite Bosque (2,298.5 acres), Agriculture (4,620.0 acres), Apacherian-Chihuahuan Mesquite Upland Scrub (2,631.1 acres), Sonoran Paloverde-Mixed Cacti Desert Scrub (2,295.0 acres), Chihuahuan Mixed Salt Desert Scrub (1,939.7 acres), and Chihuahuan Creosotebush Mixed Desert and Thorn Scrub (1,367.8 acres).

General Wildlife Species A variety of wildlife occurs in the area of analysis, including mammal, bird, amphibian, reptile, fish, and invertebrate species. More information on these species can be found in Cartron et al. (2010), Degenhardt et al. (1996), Findley (1987), Painter et al. (2017), Shook (2017), USFWS (2012), and Sublette et al. (1990). Species observed during surveys are listed in Section 4.2.2 of the Biological Evaluation and in the survey results technical memoranda (see SWCA 2019b). Spikedace (*Meda fulgida*) and loach minnow (*Tiaroga cobitis*) were the only Federally listed species observed during 2018 field reconnaissance. Other special status wildlife species were observed during SWCA 2018 field surveys.

Important Bird Areas Appendix A, Figure A-5 in the Biological Evaluation shows Important Bird Areas (IBAs) that overlap with the area of analysis.

The Gila-Cliff Area IBA is approximately 2,767.8 acres in the Upper Gila direct impacts area (2,396.2 acres of overlap) and Upper Gila indirect impacts area (371.6 acres of overlap). This IBA includes the U-Bar Ranch, which has the largest known breeding concentration of southwestern willow flycatchers (*Empidonax traillii extimus*) in the boxelder, cottonwood, willow, and Russian olive riparian habitat of the Gila River. The area also supports the special status Lucy's warbler (*Oreothlypis luciae*), summer tanager (*Piranga rubra*), and common black hawk (*Buteogallus anthracinus*) (Audubon 2019a).

The Gila Bird Area IBA is on BLM-administered lands and USFS lands in the Gila National Forest (Audubon 2019b), approximately 4 miles south (downstream) of the Upper Gila direct impacts area. This IBA is completely within the Upper Gila indirect impacts area. It overlaps the Upper Gila indirect impacts area on approximately 321.3 acres. Two Federally listed bird species, the southwestern willow flycatcher and yellow-billed cuckoo (*Coccyzus americanus*), breed in portions of the Gila Bird Area IBA. Also present are special status species, such as Lucy's warbler, brown-crested flycatcher (*Myiarchus tyrannulus*), and common black hawk.

The Lower Gila Box IBA is in a designated WSA and Area of Critical Environmental Concern on BLM-administered lands, about 3 miles east (upstream) of the Virden Valley project location. It overlaps approximately 504.0 acres of the Upper Gila indirect impacts area and 60.7 acres of the Virden Valley direct impacts area. This IBA supports many bird species of conservation concern, including breeding southwestern willow flycatchers and yellow-billed cuckoos (Audubon 2019c). Other bird species of conservation concern found in the IBA are scaled quail (*Callipepla squamata*), Mexican whip-poor-will (*Antrostomus arizonae*), Bell's vireo (*Vireo bellii*), desert purple martin (*Progne subis hesperia*), Bendire's thrasher (*Toxostoma bendirei*), and elf owl (*Micrathene whitneyi*).

The Blue and San Francisco Rivers Ecosystem, Apache-Sitgreaves National Forests IBA is approximately 106,642.0 acres in the San Francisco River indirect impacts area of Arizona (overlaps the area by 1,301.5 acres). This IBA supports habitat for southwestern willow flycatchers and other riparian-dependent bird species, including Bell's vireo, Lucy's warbler, common black hawk, great egret (*Ardea alba*), snowy egret (*Egretta thula*), and wintering bald eagles (*Haliaeetus leucocephalus*) (Audubon 2019d). The lands in the IBA are managed by the Apache-Sitgreaves National Forests; the IBA does not include private lands that are within its boundary.

Neo-tropical Migratory Birds and Bald and Golden Eagles The Migratory Bird Treaty Act (MBTA) prohibits the taking, killing, or possessing of migratory birds unless permitted by regulations promulgated by the Secretary of the Interior. Bald and golden (*Aquila chrysaetos*) eagles are also protected under the MBTA and the Bald & Golden Eagle Protection Act.

Habitat conditions in the area of analysis for migratory bird species have been altered and degraded over time by a combination of human activities in the area, such as agriculture, operation and maintenance of diversion structures, and recreation. These impacts lead to the degradation, fragmentation, and destruction of functional habitats. The level of impact varies, both by the intensity and extent of the activity and by the specific type of impact on the habitat. In each case, the original natural characteristics of the land were altered or eliminated, disrupting the functional ecosystem and the associated ecological value for aquatic and terrestrial species (Southerland 1993).

Special Status Wildlife Species Special status species are those that are identified by federal or state agencies for special management consideration. Seventy-one special status wildlife species are known to occur or have the potential to occur in at least one portion of the area of analysis. Of these, 31 species are listed under the New Mexico Wildlife Conservation Act, and 28 are USFS sensitive species. Thirty-five species are BLM sensitive that have the potential to occur on lands administered by the BLM in New Mexico or that are verified or have potential or historic occurrences on lands administered by the BLM in Arizona. Special status wildlife species with the potential to occur in the area of analysis and may directly or indirectly be affected by the project are summarized in **Table 3-19** by area of analysis. Detailed species' descriptions are provided in Section 4.2.5 of the Biological Evaluation.

Threatened and Endangered Species Twenty-eight Federally listed, proposed, and experimental population species were evaluated for their potential to occur in the area of analysis (**Table 3-19**). Fourteen of the species have the potential to occur or are known to occur on some portion of the area of analysis. The other 14 sensitive species have been excluded from analysis; this is because the area of analysis is beyond the known geographic or elevational range of the species or it does not contain vegetation or landscape features known to support the listed species.

Species in the analysis are Chiricahua leopard frog (*Rana chiricahuensis*), northern Mexican gartersnake (*Thamnophis eques megalops*), narrow-headed gartersnake (*T. rufipunctatus)*, interior least tern[14] (*Sternula antillarum*), Mexican spotted owl (*Strix occidentalis lucida*), southwestern willow flycatcher, yellow-billed cuckoo, Mexican gray wolf (*Canis lupus baileyi*), Gila chub (*Gila intermedia*), Gila topminnow (*Poeciliopsis occidentalis occidentalis*), Gila trout (*Oncorhynchus gilae*), loach minnow, razorback sucker (*Xyrauchen texanus*), and spikedace. Nine of these 14 species have designated or proposed critical habitat in the area of analysis. The razorback sucker (*Xyrauchen texanus*) has unoccupied critical habitat in the Virden Valley and Lower Gila area of analysis. Proposed or designated critical habitat for wildlife species listed under the ESA is displayed in the Biological Evaluation, Appendix A.

[14]On October 24, 2019, the USFWS proposed to delist the interior least tern (see the Proposed Rule at https://federalregister.gov/d/2019-23119).

Table 3-19. Special Status Wildlife Species Known to Occur or with Potential to Occur within the Area of Analysis

Amphibians	Special Status	Area of Analysis	Habitat
Arizona toad (*Anaxyrus microscaphus*)	BLM sensitive species for New Mexico and Arizona	Known to occur in the Upper Gila and Lower Gila area of analysis and potentially occurs in the San Francisco River and Virden Valley area of analysis (AZGFD 2013a; BLM 2019b)	Rocky streams and canyons in mixed broadleaf riparian, cottonwood-willow riparian, and mesquite (Prosopis spp.) bosque areas, at elevations from about 6,000 to 9,000 feet amsl (AZGFD 2013a)
Chiricahua leopard frog (*Rana chiricahuensis*)	ESA (threatened)	Known to occur in the Arizona portions of the San Francisco River area of analysis (Arizona Heritage Geographic Information System [AZHGIS] 2019; Ritter 2019)	Springs, livestock tanks, lakes, reservoirs, streams, and rivers at elevations of 3,281–8,890 feet amsl (AZGFD 2015c)
Lowland leopard frog (*Lithobates yavapaiensis*)	BLM sensitive species for Arizona	Potential to occur in the Lower Gila area of analysis and in the portions of the Upper Gila and Virden Valley area of analysis in Arizona	Small to medium streams and occasionally in small ponds at elevations below 4,920 feet amsl (NMDGF 2018a)
Sonoran Desert toad (*Incilius alvarius*)	State of New Mexico threatened	Potential to occur in the Virden Valley area of analysis	Vegetation communities with mesquite, creosote bush, and other shrubs, forbs, and grasses at elevations around 5,000 feet amsl (Biota Information System of New Mexico [BISON-M] 2019; NMDGF 2018a)

Birds	Special Status	Area of Analysis	Habitat
Abert's towhee (*Melozone aberti*)	Gila National Forest sensitive species threatened species for New Mexico	Known to occur in the Upper Gila and Virden Valley area of analysis (eBird 2019)	Cottonwood-willows with a dense understory of shrubs and mesquite woodlands (BISON-M 2019)
American peregrine falcon (*Falco peregrinus anatum*)	BLM sensitive species for Arizona	Known to occur in the Upper Gila, Virden Valley, and Lower Gila area of analysis and the potential to occur in the San Francisco River area of analysis (eBird 2019; BLM 2019b)	Many habitats, typically with cliffs for nesting and open landscapes for foraging

Birds	Special Status	Area of Analysis	Habitat
Arizona Bell's vireo (*Vireo bellii arizonae*)	BLM Sensitive Species for New Mexico and a Gila National Forest Sensitive Species and is a subspecies of Bell's vireo (Vireo bellii), which is listed as a State of New Mexico Threatened Species	Known to occur at the Upper Gila, San Francisco River, and Virden Valley area of analysis (eBird 2019)	Native and nonnative-dominated riparian areas and areas with dense shrubby vegetation (New Mexico Avian Conservation Partners 2017)
Bald eagle (*Haliaeetus leucocephalus*)	BLM sensitive species for Arizona and threatened species for New Mexico	Known to occur in the Upper Gila, San Francisco River, Virden Valley, and Lower Gila area of analysis (eBird 2019; BLM 2019b)	Requires large trees or cliffs near water with a good supply of fish (Buehler 2000)
Bendire's thrasher (*Toxostoma bendirei*)	BLM sensitive species for New Mexico	Potential to occur in the Upper Gila and Virden Valley area of analysis	Favors open grasslands, shrublands, or woodlands with scattered shrubs or trees and is not found in areas with dense vegetation (International Union for Conservation of Nature [IUCN] 2017)
Botteri's sparrow (*Peucaea botterii*)	BLM sensitive species for New Mexico	Potential to occur in the Upper Gila and Virden Valley area of analysis and is known to occur in the Lower Gila area of analysis (BLM 2019b)	Grassland, savanna, upland mesquite grassland, and oak woodland (Webb and Bock 2012)
Broad-billed hummingbird (*Cynanthus latirostris*)	New Mexico threatened species	Potential to occur in the Upper Gila, San Francisco River and Virden Valley area of analysis	Riparian woodlands at elevations ranging from 2,800–5,500 feet amsl (Powers and Wethington 1999)
Chestnut-collared longspur (*Calcarius ornatus*)	BLM sensitive species for New Mexico	Potential to occur in the Upper Gila and Virden Valley area of analysis	Short-grass prairie and desert grasslands dominated by low grasses and forbs (Bleho et al. 2015)
Common black hawk (*Buteogallus anthracinus*)	Gila National Forest sensitive species and New Mexico threatened species	Known to occur in the Upper Gila, San Francisco River and Virden Valley area of analysis (eBird 2019)	Riparian obligate that favors remote, mature gallery forest corridors with perennial and occasionally intermittent streams (BISON-M 2019)
Common ground-dove (*Columbina passerina*)	Gila National Forest sensitive species and New Mexico endangered species	Known to occur in the Upper Gila and Virden Valley area of analysis (eBird 2019)	Agricultural areas, mesquite flats, near edges of desert riparian areas, and in desert washes at elevations below 5,410 feet amsl (BISON-M 2019)

Birds	Special Status	Area of Analysis	Habitat
Costa's hummingbird (*Calypte costae*)	Gila National Forest sensitive species and New Mexico threatened species	Potential to occur in the Upper Gila, San Francisco River and Virden Valley area of analysis	Found nesting in a variety of plants in Guadalupe Canyon, including netleaf hackberry, algerita (*Mahonia haematocarpa*), and Arizona white oak (*Quercus arizonica*) (Baltosser and Scott 1996)
Desert purple martin (*Progne subis hesperia*)	BLM sensitive species for Arizona	Potential to occur in the westernmost portion of the Lower Gila area of analysis	Purple martins are cavity nesters in saguaro cacti, trees, buildings, and cliffs (Audubon 2019e). The *hesperia* subspecies nests in deserts at low elevation in saguaro cacti (Wiggins 2005).
Ferruginous hawk (*Buteo regalis*)	BLM sensitive species for Arizona	Potential to occur in the San Francisco River area of analysis and is known to occur in the Lower Gila area of analysis (BLM 2019b)	Open grasslands, agricultural fields, flats, and desert (BISON-M 2019). The species can be found throughout Arizona and New Mexico during the non-breeding season (September through April) (AZGFD 2013b).
Gila woodpecker (*Melanerpes uropygialis*)	Gila National Forest sensitive species and New Mexico threatened species	Known to occur in the Upper Gila and Virden Valley area of analysis	Lower-elevational woodlands, especially those with cottonwood along stream courses (BISON-M 2019)
Gilded flicker (*Colaptes chrysoides*)	BLM sensitive species for Arizona	Known to occur in the Lower Gila area of analysis and has the potential to occur in the San Francisco River area of analysis (eBird 2019)	Cottonwoods or other trees in riparian areas at lower elevations (BISON-M 2019)
Golden eagle (*Aquila chrysaetos*)	Protected by the Bald and Golden Eagle Protection Act and is a BLM sensitive species for Arizona	Known to occur in all areas of analysis (eBird 2019)	Prairies, open wooded country, and barren areas, particularly in hilly or mountainous regions (BISON-M 2019); prefers to nest on cliffs
Gray vireo (*Vireo vicinior*)	Gila National Forest sensitive species and New Mexico threatened species	Potential to occur at the Upper Gila and San Francisco River area of analysis	Pinyon-juniper and scrub oak habitats and preferring gently sloped canyons, rocky outcrops, ridgetops, and moderate scrub cover (BISON-M 2019)
Interior least tern (*Sternula antillarum*)	Endangered under the ESA and is a New Mexico endangered species	Known to occur in the Lower Gila area of analysis (eBird 2019)	Sandy beaches, sandbars, gravel pits, or exposed flats along shorelines of inland rivers, lakes, reservoirs, and drainage systems (USFWS 2009)
Mexican spotted owl (*Strix occidentalis lucida*)	Threatened under the ESA	Potential to occur in the San Francisco River area of analysis, which contains designated critical habitat (Unit UGM-7)	Mature montane forests and woodlands and steep, shady, wooded canyons (USFWS 1995)

Birds	Special Status	Area of Analysis	Habitat
Neotropic cormorant (*Phalacrocorax brasilianus*)	New Mexico threatened species	Known to occur in the Upper Gila and San Francisco River area of analysis and has potential to occur in the Virden Valley area of analysis (eBird 2019)	Ponds or lakes where fish are present (BISON-M 2019)
Northern beardless-tyrannulet (*Camptostoma imberbe*)	New Mexico endangered species	Known to occur in the Upper Gila area of analysis and possibly in the Virden Valley area (eBird 2019)	Lowland riparian woodland with adjacent scrub; typical plant species in these areas include willow (*Salix* spp.), cottonwood, mesquite, and canyon hackberry (*Celtis reticulata*) (BISON-M 2019).
Northern goshawk (*Accipiter gentilis*)	BLM sensitive species for Arizona, Gila National Forest and Apache-Sitgreaves National Forests sensitive species	Potential to occur in the San Francisco River area of analysis	Occupies a variety of forest types, including deciduous, coniferous, and mixed forests; typically nests in mature or old-growth forests, commonly in ponderosa pine
Pinyon jay (*Gymnorhinus cyanocephalus*)	BLM sensitive species for New Mexico and Arizona	Potential to occur in the Upper Gila and San Francisco River area of analysis	Pinyon-juniper woodland is used most often but flocks have also bred in sagebrush, scrub oak, and chaparral communities (BISON-M 2019).
Southwestern willow flycatcher (*Empidonax traillii extimus*)	New Mexico endangered species, ESA endangered, Arizona 1A species	Known to occur in all areas of analysis (AZGFD 2019a; eBird 2019; Shook 2018a; USFWS unpublished data)	Dense riparian vegetation near surface water or where soil moisture is high enough to maintain dense vegetation (BISON-M 2019)
Sprague’s pipit (*Anthus spragueii*)	BLM sensitive species for New Mexico	Potential to occur in the Virden Valley area of analysis	Shortgrass prairies and overgrazed areas and agricultural fields (BISON-M 2019)
Varied bunting (*Passerina versicolor*)	State of New Mexico threatened species	Potential to occur in the Virden Valley area of analysis	Dense stands of mesquite and associated growth in canyon bottoms (BISON-M 2019)
Virginia’s warbler (*Oreothlypis virginiae*)	BLM sensitive species for New Mexico	Known to occur in the Upper Gila and Virden Valley area of analysis (eBird 2019)	Pinyon-juniper, oak woodlands, and mixed-conifer forests with scrubby vegetation (Olson and Martin 1999)
Western burrowing owl (*Athene cunicularia hypugaea*)	BLM sensitive species for New Mexico and Arizona and a USFS Gila National Forest and Apache-Sitgreaves National Forests sensitive species	Potential to occur in the Virden Valley and Lower Gila area of analysis	Croplands, pastures, fallow fields, and sparsely vegetated areas (USFWS 2003)

Birds	Special Status	Area of Analysis	Habitat
Yellow-billed cuckoo (*Coccyzus americanus*)	ESA threatened	Known to occur in all area of analysis (AZGFD 2019b; eBird 2019; Griffin 2016; Shook 2018b)	Low- to moderate-elevation mature riparian woodlands (BISON-M 2019)

Fish	Special Status	Area of Analysis	Habitat
Desert sucker (*Catostomus clarki*)	BLM sensitive species for New Mexico and Arizona, Gila National Forest and Apache-Sitgreaves National Forests sensitive species	Known to occur in the Upper Gila, San Francisco River Virden Valley, and Lower Gila area of analysis (NMDGF 2018b; Blasius 2019)	Rapids and flowing pools of streams, typically over bottoms of gravel-rubble with sandy silt; juveniles are typically found in quiet pools along the bank (BISON-M 2019).
Gila chub (*Gila intermedia*)*	ESA endangered	Known to occur in the San Francisco River area of analysis and possibly in the Virden Valley area of analysis (USFWS 2017)	Gila chub commonly inhabit pools in smaller streams and cienegas throughout its range at elevations between 2,000 and 5,500 feet. Riparian plants typically associated with these habitats are willows, tamarisk (Tamarix spp.), cottonwood, mule-fat, and ash. The species is highly secretive and depends on undercut banks, terrestrial vegetation, boulders, root wads, fallen logs, and thick overhanging or aquatic vegetation for cover (USFWS 2015).
Gila trout (*Oncorhynchus gilae*)	ESA threatened and New Mexico threatened species	Potential to occur in the Upper Gila area of analysis; occurs in West Fork due to stocking	Small headwater streams with limited pool availability and generally low base flows (BISON-M 2019)
Gila topminnow (*Poeciliopsis occidentalis occidentalis*)	ESA endangered and New Mexico threatened species	Possibly occurs in the Upper Gila and Lower Gila area of analysis	Shallow warm water in a moderate current with dense aquatic vegetation and algae mats (BISON-M 2019)
Headwater chub (*Gila nigra*)*	Gila National Forest sensitive Species and New Mexico endangered species	Potential to occur in the Upper Gila and San Francisco River area of analysis	Pools and runs near cover, such as rocks, root wads, undercuts, or deep water (BISON-M 2019, USFWS 2015)

Fish	Special Status	Area of Analysis	Habitat
Loach minnow (*Tiaroga cobitis*)	ESA endangered and New Mexico endangered species	Known to occur in the Upper Gila and San Francisco River area of analysis and has designated critical habitat in all portions of the area of analysis (NMDGF 2018b); potential to occur in the Virden and Lower Gila area of analysis	Moderate to swift current velocity and gravel or cobble substrates (BISON-M 2019)
Longfin dace (*Agosia chrysogaster*)	BLM sensitive species for Arizona	Known to occur in all portions of the area of analysis (NMDGF 2018b; Blasius 2019)	Riffle areas with moderate to rapid water velocities and moderate to high gradients (BISON-M 2019)
Razorback sucker (*Xyrauchen texanus*)	ESA endangered	The species is considered extirpated from the area of analysis because only historical (pre-1940) accounts of the species are documented (USFWS 2002).	Mainstream channels to the backwaters of medium and large streams of rivers (BISON-M 2019
Roundtail chub (*Gila robusta*)*	BLM sensitive species for New Mexico and Arizona, Gila National Forest and Apache-Sitgreaves National Forests sensitive species, and New Mexico endangered species	Potential to occur in all of the areas of analysis	Cool to warm water in mid-elevation streams and rivers where pools up to 6.5 feet deep are next to swifter riffles and runs (BISON-M 2019)
Sonora sucker (*Catostomus insignis*)	BLM sensitive species for New Mexico and Arizona, Gila National Forest and Apache-Sitgreaves National Forests sensitive species	Known to occur in all of the areas of analysis (NMDGF 2018b; BLM 2018)	Warm-water rivers to trout streams (AZGFD 2002a)
Speckled dace (*Rhinichthys osculus*)	BLM sensitive species for Arizona	Known to occur in the upper Gila and San Francisco Virden Valley and potential to occur in the Virden Valley area of analysis (NMDGF 2018b; BLM 2018)	Bottom dweller that favors shallow headwater pools and runs and small to medium rivers
Spikedace (*Meda fulgida*)	ESA endangered, New Mexico endangered	Known to occur in the Upper Gila and San Francisco River area of analysis and has designated critical habitat in all portions of the area of analysis (NMDGF 2018b); potential to occur in the Virden and Lower Gila area of analysis	Mid-water habitats of runs, pools, and swirling eddies (AZGFD 2013c)

Invertebrates	Special Status	Area of Analysis	Habitat
A caddisfly (*Lepidostoma apache*)	Apache-Sitgreaves National Forests sensitive species	Potential to occur in the San Francisco River area of analysis	Very little is known about this species' range and habitat requirements (USFS 2013a).
A caddisfly (*L. knulli*)	Apache-Sitgreaves National Forests sensitive species	Potential to occur in the San Francisco River area of analysis	Cool-water springs, streams, and rivers of swift-flowing current; large cobbles with low embeddedness are common features in the habitat (USFS 2013a).
Dashed ringtail (*Erpetogomphus heterodon*)	Gila National Forest sensitive species	Potential to occur in the Upper Gila and San Francisco River area of analysis	Shallow, rocky streams in mountains, in open desert or pine-oak woodland (BISON-M 2019); most recent finding near the Gila Cliff Dwellings, along the Gila River (iNaturalist 2019)
"Gila" mayfly (*Lachlania dencyanna*)	Gila National Forest sensitive species	Potential to occur in the Upper Gila area of analysis	High-gradient, warm, medium rivers (BISON-M 2019); last known records of larva along the East Fork Gila River, above the confluence with the Middle Fork (NatureServe 2019)
Monarch butterfly (*Danaus plexippus plexippus*)	BLM sensitive species for New Mexico and Arizona	Potential to occur in the Upper Gila, San Francisco River, and Virden Valley area of analysis and known to occur in the Lower Gila area of analysis (BLM 2019b)	Occurs in a variety of habitats (BISON-M 2019
Notodontid moth (*Euhyparpax rosea*)	Gila National Forest sensitive species	Potential to occur in the Upper Gila and San Francisco River area of analysis	Occurs on shrubs, trees, and leguminous plants, likely oak-juniper or oak-pine-juniper; larvae may feed on oaks

Mammals	Special Status	Area of Analysis	Habitat
Allen's lappet-browed bat (*Idionycteris phyllotis*)	Gila National Forest and Apache-Sitgreaves National Forests sensitive species, BLM sensitive species for Arizona	Potential to occur in all of the areas of analysis	Ponderosa pine, pinyon-juniper, and riparian areas with sycamores, cottonwoods, and willows (BISON-M 2019)
Arizona gray squirrel (*Sciurus arizonensis arizonensis*)	Gila National Forest sensitive species	Known to occur in the San Francisco River area of analysis	Dense, mixed broad-leaf forested canyon floors and drainages in conifer or evergreen forests (AZGFD 2014a)

Mammals	Special Status	Area of Analysis	Habitat
Arizona myotis (*Myotis occultus*)	BLM sensitive species for Arizona	Potential to occur in San Francisco River, Virden Valley, and Lower Gila area of analysis	Ponderosa pine and oak-pine woodlands near water (AZGFD 2011a)
Banner-tailed kangaroo rat (*Dipodomys spectabilis*)	BLM sensitive species for Arizona	Potential to occur in the Virden Valley and Lower Gila area of analysis	Well-developed grasslands with shrub; hard soils are preferred to support burrow construction; found throughout southeastern Arizona and in parts of Apache and Navajo Counties
California leaf-nosed bat (*Macrotus californicus*)	BLM sensitive species for Arizona	Potential to occur in the San Francisco River and Virden Valley area of analysis; known to occur in the Lower Gila area of analysis (BLM 2019b)	Day roosts in rock shelters, caves, and mines during the summer; in winter, prefers mines that extend over 100 feet from the entrance for warmth (AZGFD 2014b)
Cave myotis (*Myotis velifer*)	BLM sensitive species for Arizona	Potential to occur in the San Francisco River and Virden Valley area of analysis; known to occur in the Lower Gila area of analysis (BLM 2019b)	Roosts in caves, tunnels, and bridges near water and is found in desertscrub of creosote bush (*Larrea tridentata*), palo verde, and cacti (AZGFD 2002b)
Mexican wolf (*Canis lupus baileyi*)	ESA endangered, New Mexico endangered	Potential to occur in portions of the Upper Gila and San Francisco River area of analysis	Montane woodlands, upper Sonoran woodlands and grasslands, Madrean evergreen woodland, and semidesert grasslands; found at elevations ranging from 3,000 to 12,000 feet amsl (AZGFD 2001a)
Greater western mastiff bat (*Eumops perotis californicus*)	BLM sensitive species for Arizona	Potential to occur in the San Francisco River Virden Valley and Lower Gila area of analysis	Roosts consist of deep, tight rock crevices near cliffs of the Lower and Upper Sonoran desertscrub (AZGFD 2014c).
Gunnison’s prairie dog (prairie population) (*Cynomys gunnisoni*)	Gila National Forest sensitive species and a BLM sensitive species for Arizona	Potential to occur in the Upper Gila area of analysis and is known to occur in the San Francisco River area of analysis	Shortgrass and midgrass prairies and grass-shrub habitats with an elevational range of 6,700–12,000 feet amsl (BISON-M 2019)
Hooded skunk (*Mephitis macroura milleri*)	Gila National Forest sensitive species	Known to occur in the Upper Gila and San Francisco River area of analysis (BISON-M 2019)	Ponderosa pine forest to deserts, typically near water or riparian vegetation (BISON-M 2019)
Lesser long-nosed bat (*Leptonycteris yerbabuenae*)	New Mexico Threatened, BLM sensitive species for New Mexico and Arizona	Potential to occur in the Virden Valley and Lower Gila area of analysis	Desert grasslands, canyons, and scrublands, including lower edges of oak woodlands (BISON-M 2019)

Mammals	Special Status	Area of Analysis	Habitat
Pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*)	Gila National Forest and Apache-Sitgreaves National Forests sensitive species and a subspecies of Townsend's big-eared bat (*Corynorhinus townsendii*) listed as a BLM sensitive species for New Mexico and Arizona	Potential to occur in all areas of analysis	Scrub-grassland, desertscrub, semidesert shrublands, chaparral, saxicoline brush, tundra, open montane forests, spruce-fir, mixed hardwood-conifer, and oak woodlands and forests (AZGFD 2003a)
Spotted bat (*Euderma maculatum*)	Gila National Forest and Apache-Sitgreaves National Forests sensitive species; BLM sensitive species for New Mexico and Arizona and a New Mexico threatened species	Potential to occur in all areas of analysis	Habitat is seasonal; found during warm months in ponderosa pine woodlands and during cooler months at lower elevations in pinyon-juniper woodlands and semi-desert shrublands (AZGFD 2003b)
Springerville silky pocket mouse (*Perognathus flavus goodpasteri*)	Apache-Sitgreaves National Forests sensitive species	Potential to occur in the San Francisco River area of analysis	Sparse vegetation of shortgrass and tumbleweeds, with the presence of sandy, rocky areas (AZGFD 2002c)
Western red bat (*Lasiurus blossevillii*)	Gila National Forest and Apache-Sitgreaves National Forests sensitive species	Potential to occur in the Upper Gila and San Francisco River area of analysis	Riparian and wooded areas at elevations ranging from 1,900–7,200 feet amsl (AZGFD 2011b)

Reptiles	Special Status	Area of Analysis	Habitat
Reticulate Gila monster (*Heloderma suspectum suspectum*)	New Mexico endangered species	Potential to occur in the Virden Valley area of analysis	Lower slopes of mountains and nearby outwash plains, especially in canyons and arroyos where water is at least periodically present (AZGFD 2013d)
Green ratsnake (*Senticolis triaspis*)	New Mexico threatened species	Potential to occur in the Upper Gila and San Francisco River area of analysis	Rocky canyon bottoms near streams or in areas with intermittent water (AZGFD 1998)

Reptiles	Special Status	Area of Analysis	Habitat
Narrow-headed gartersnake (*Thamnophis rufipunctatus*)	ESA threatened, New Mexico threatened species	Known to occur in all areas of analysis (USFWS 2014a)	Shallow, swift-flowing, rocky rivers and streams where it typically uses predominantly pool and riffle habitat that includes cobbles and boulders (AZGFD 2012a)
Northern Mexican gartersnake (*T. eques megalops*)	ESA threatened, New Mexico endangered species	Known to occur in the Upper Gila and Virden Valley area of analysis, with potential to occur in the San Francisco River area of analysis (USFWS 2014a)	Shallow, slow-moving, and at least partially vegetated bodies of water (AZGFD 2012b)
Sonora mud turtle (*Kinosternon sonoriense*)	BLM sensitive species for Arizona	Potential to occur in the Virden Valley and San Francisco River area of analysis and known to occur in the Lower Gila area of analysis (BLM 2019b) and Upper Gila area of analysis (SWCA 2019e)	Creeks, streams, ponds, or any water hole (AZGFD 1999)

* Gila chub, headwater chub, and roundtail chub were formerly considered separate taxonomic entities but are now recognized as a single taxonomic species—the roundtail chub (*Gila robusta*) (82 *Federal Register* 16981); however, until the USFWS completes an evaluation and potential proposed and final rules to delist the Gila chub are published, its legal status remains as an endangered species with designated critical habitat. It is evaluated as endangered in this document.

3.4.2 Environmental Consequences

Methods of Analysis

The Joint Leads documented the available literature, data, regulations, and technical approaches to assess the affected environment and potential effects of the Proposed Action and alternatives on biological resources. To address issues identified during public scoping, the Joint Leads implemented the following:

- Accessed the USFWS Information for Planning and Consultation website (USFWS 2018a) to determine the Federally listed wildlife and plant species that have the potential to occur in the project area and critical habitat data
- Analyzed fish community survey and habitat assessment data and reports from NMDGF, ISC, The Nature Conservancy, and other sources
- Conducted desktop analysis using such information sources as National Wetland Inventory (NWI) (USFWS 2018b), Southwest Regional Gap Analysis Project (SWReGAP 2005), and USFS, BLM, and New Mexico and Arizona special status species data and information
- Conducted field studies to document current biological conditions for vegetation and wildlife (SWCA 2019b) and wetlands (SWCA 2019c) and conducted protocol surveys for listed fish species (SWCA 2019d) and herpetofauna (SWCA 2019e)
- Applied the hydrologic modeling reference in **Section 3.3**, above, to assess potential impacts on biological resources due to hydrologic alteration

Direct impacts were calculated using the long- and short-term disturbance estimates described in **Section 3.2**, above. NWI and SWReGAP data were used as a proxy for suitable habitat. GIS methods used to calculate disturbances to habitats are described in Appendix C of the Biological Evaluation. Impact and intensity descriptors outlined in **Section 3.2** were used to analyze impacts on biological resources in the area of analysis. Specific to biological resources, factors assessed are as follows:

- The direct loss of riparian vegetation, or beneficial effects due to flow augmentation and implementation of conservation measures to minimize impacts from the Proposed Action and alternatives
- The amount of habitat that would be directly disturbed by project activities for each plant species; the magnitude of impact is determined by the amount of suitable habitat lost, as well as potential suitable habitat that is next to and near the project area
- Direct adverse effects may include habitat loss or construction-related effects, such as noise disturbance and disruption of breeding seasons. Beneficial effects may be accrued due to flow augmentation and implementation of conservation measures to minimize impacts on the proposed project. The magnitude of this direct impact would be determined by the amount of suitable habitat lost, relative to other potentially suitable habitat that is next to and near the project area.

- Indirect effects through habitat alteration, including habitat fragmentation, habitat conversion, water flow regime changes, soil erosion and compaction, and increased human presence and disturbance
    - Habitat fragmentation—A qualitative assessment of how the project activities would affect habitat connectivity for a species, both in the project area and between the project area and surrounding landscapes. This assessment would consider suitable habitats in these areas and suitable corridors that the species may use to travel between these habitats.
    - Habitat conversion—A qualitative assessment of the likelihood of the introduction of nonnative plant and animal species as a result of project construction and other related activities
    - Water flow regimes—An assessment of how the project activities would alter existing surface water and groundwater flow regimes in the project area of analysis
    - Direct project effects can occur through project construction and other activities that increase human presence and disturbance, which can increase noise and vibration and artificial lighting. This impact depends on the types and amount of project-related equipment and vehicles.

Assumptions The analysis has the following assumptions:

- Best available science is used for all analyses, but occurrence records and scientific knowledge can be incomplete, inaccessible, or outdated. Review and analysis rely on published manuscripts to the extent that they are available.
- Pedestrian surveys of vegetation, wetland, and wildlife and focused species surveys were limited to what is available to be observed during time and season of the survey and surveys could exclude some species, such as nocturnal and cryptic species. Landowner access was not provided for much of the direct impacts area of analysis in the Upper Gila, Virden Valley, and San Francisco areas, further limiting the survey.
- Species-specific surveys may not observe target species, even if any are present. Results of the survey are but one part of the analysis, which may also include suitability of habitat, outside scientific knowledge, and occurrence records.
- Areas mapped by NWI data have not been ground-truthed and may not contain suitable habitat or the vegetation may be different than that mapped by NWI; however, each habitat category indicates which species might be present.
- No new project features will be constructed on BLM-administered lands. While there will be no direct impacts on BLM sensitive species on BLM-administered lands, these species are evaluated for direct and indirect impacts.

Alternative A: No Action Alternative

Vegetation

General Vegetation Under Alternative A, the NM Unit would not be constructed, so there would be no new impacts on vegetation communities or special status plant species. General vegetation in the area of analysis has been disturbed as a result of previous and ongoing land uses in and next to the river corridors. This disturbance would continue under Alternative A. The area of analysis contains approximately 10,457.5 acres of agricultural land and 167.3 acres of medium- to high-intensity developed land (see **Table 3-16**). Land uses, including grazing and water diversions, have likely influenced the extent and distribution of vegetation and would continue to do so under Alternative A.

Push-up diversion activities and existing agricultural and land use practices (including mining) in the area of analysis would continue and impacts on vegetation communities and special status plant species would continue to occur. These potential impacts would include vegetation removal, direct loss of individual plants and habitat and soil compaction during push-up diversion maintenance and impacts on riparian and wetland vegetation from modifications to surface and groundwater hydrology.

Groundwater pumping and water diversions would continue to increase the depth to groundwater in the area of analysis (HDR 2019b). Creation and maintenance of diversion structures, grazing, and other disturbances have also disturbed areas, providing suitable conditions for noxious weed establishment and spread. In addition, ongoing diversions of the water from the river to irrigation ditches would continue to create dry reaches in the riverbed, downstream of the diversion sites. Individual plants may experience reduced vigor or death as a result of the river drying downstream because of push-up diversions; however, vegetation in or next to unlined irrigation ditches would receive diverted water and would continue to experience beneficial impacts from diversion.

A detailed analysis of the impacts of Alternative A is provided in the Biological Evaluation, Chapter 5–Effects of the Action.

ESA Plant Species No effects on ESA-protected plant species from Alternative A are expected because none of these species are present in the area of analysis.

New Mexico Endangered Plant Species Three New Mexico endangered plant species have the potential to occur in the area of analysis (**Table 3-18**): Wilcox's pincushion cactus (*Mammillaria wrightii* var. *wilcoxii*), night-blooming cereus (*Peniocereus greggii* var. *greggii*) and Parish's alkali grass (*Puccinellia parishii*). Individuals of these species would continue to be affected through ongoing maintenance and water diversion; however, ongoing impacts are not anticipated to affect whole-population trends for any of these species. This is because project activities would continue to affect a limited amount of suitable habitat, compared with the amount of habitat available to these species in the area of analysis and vicinity.

In addition, potential impacts on Wilcox's pincushion cactus and night-blooming cereus would be less likely. This is because these species do not occur in riparian habitats where disturbance and hydrological changes associated with Alternative A would occur.

USFS Sensitive Plant Species Three USFS sensitive plant species have the potential to occur in the area of analysis (**Table 3-18**): Parish's alkali grass, Arizona alum root (*Heuchera glomerulata*), and Greene milkweed (*Asclepias uncialis* ssp. *uncialis*). Individuals of these species could continue to be affected through ongoing maintenance and water diversion; however, impacts are not anticipated to reach the population level for any of these species because project activities would affect limited suitable habitat, compared with the amount of habitat available to these species on National Forest lands. In addition, impacts on Greene milkweed would be unlikely to occur because this species does not occur in riparian habitats, where disturbance associated with maintenance and hydrological changes from operations would continue to occur as a result of Alternative A.

BLM Sensitive Plant Species Four BLM sensitive plant species have the potential to occur in the area of analysis (**Table 3-18**): Parish's alkali grass, night-blooming cereus, Clifton rock daisy (*Perityle ambrosiifolia*), and Pima Indian mallow (*Abutilon parishii*). These species could be affected through ongoing maintenance and water diversion activities; however, potential impacts are not anticipated to reach the population level for these species because the amount of suitable habitat that is affected for project activities is limited, compared with the amount of habitat available on BLM-administered lands. In addition, the Clifton rock daisy and Pima Indian mallow would experience only indirect impacts because known occurrences of these species are downstream of all direct impact areas.

Wetland and Riparian Areas Under Alternative A, potential impacts on wetlands and riparian areas would be as follows

- The ongoing disturbance from heavy equipment on wetland and riparian vegetation during push-up diversion maintenance
- Increased potential for noxious and invasive weed colonization and spread into wetland and riparian areas
- A reduction in the health and areal extent of wetlands, wet meadows, and riparian areas due to reductions in available surface water and increasing depth to groundwater from ongoing diversions and pumping in the area
- Decreased recruitment/survivorship of native riparian trees and other groundwater-dependent species due to increased depth to groundwater

Diversions from the main river channels into unlined ditches have created and maintained stringers of mixed native and nonnative riparian trees along those ditches. Weedy species could create conditions that limit the normal growth and reproduction of native plant species and special status plant species. Riparian vegetation may continue to be limited or stressed in known dry-up areas due to reduced surface water availability.

Noxious Weeds The creation of new and maintenance of existing push-up diversions would continue to create the potential for the establishment and spread of noxious weeds due to ground disturbance and removal of native vegetation. Equipment that has been used in locations containing noxious weeds may introduce noxious weed in other areas where the equipment is used.

Aquatic and Terrestrial Wildlife Conditions in the Gila River watershed have been influenced by past and current agricultural and forestry practices, construction and operation of diversions, levees, and flood sediment control dams in local drainages; wildfires; and the randomness of precipitation and floods (HDR 2019a–c and references therein; Horner and Dahm 2014; Kindscher 2014). These factors have had regional and localized effects on the availability of terrestrial and aquatic habitat and the abundance of species that depend on these habitats. A detailed analysis of impacts of the Alternative A on aquatic and terrestrial wildlife is provided in Section 5.3 of the Biological Evaluation.

General Wildlife Under Alternative A, ongoing minor to moderate adverse impacts on wildlife species would continue to result from continued operation of the push-up diversions for agricultural purposes; however, there would be no additional impacts on general wildlife species from construction or operation of a NM Unit. Ongoing adverse impacts on wildlife species and habitat would be as follows:

- Injury or death of individuals during repair of the push-up diversions
- Death of aquatic and semi-aquatic species from river drying, and aquatic or semi-aquatic individuals being entrained in ditches and agricultural fields from which they may not return to the river
- Behavioral changes in individuals due to noise and disturbance during the breeding/nesting season, which may in turn lead to lowered reproductive success, lower foraging or predation success, increased predation, or lowered survival
- Ongoing disruption of the natural flood regime, which could alter the distribution and quality of aquatic and riparian habitat in the long term
- Increased backwater habitat created by the diversions, which may increase habitat for nonnative species known to cause adverse impacts on native species through predation, competition, or increased prevalence of disease or parasites
- Increased turbidity during push-up diversion construction or breaches, which may adversely affect aquatic or semi-aquatic species
- The potential for fuel or chemical pollution releases into the water, which could adversely affect wildlife by death, injury, or habitat degradation

Springs, Seeps, and Water Improvements There are 52 springs, seeps, and water improvements within 1 mile of the Upper Gila, Virden Valley, and San Francisco River direct impacts areas. These areas may be frequented by wildlife and used by livestock in areas where grazing occurs. Springs, seeps, and ponds may provide habitat for amphibians and reptiles and provide dispersal habitat for the Chiricahua leopard frog (USFWS 2012). Additionally, these features provide habitat for nonnative species, including American bullfrogs and nonnative predatory fish (Global Invasive Species Database 2019; Rinne 1994; Rosen and Schwalbe 1995; USFWS 2014c). There are insufficient available data to determine the magnitude of any effects that may have occurred or are ongoing. Any ongoing effects, such as reduced flows, would continue to occur under Alternative A.

Important Bird Areas Impacts on the IBAs from Alternative A are ongoing. Equipment may crush plants and reduce the amount of habitat available. Disturbance from noise or human presence may cause birds to change their behavior or temporarily avoid the vicinity while work occurs. All four IBAs that overlap the area of analysis experience minor adverse impacts on bird habitat suitability through reduction in flow of the Gila and San Francisco Rivers from existing diversions. Diversion of water for agricultural use has created the distribution and influenced the abundance of downstream riparian, wetland, and aquatic habitats in these IBAs. All four IBAs would continue to provide habitat for birds, including special status species.

Amphibians Four special status amphibian species have the potential to occur in the area of analysis (see **Table 3-19**). Many of the special status amphibian species could continue to be affected through ongoing maintenance and water diversion. Individuals in the river or adjacent riparian corridor at the time of maintenance could be injured or killed. Individuals may avoid the area during maintenance, disrupting natural behaviors and leading to increased predation or reduced foraging success. Ongoing water diversion would reduce the availability of or further degrade aquatic and riparian habitat downstream of the diversions. This would reduce available habitat for special status amphibian species, decrease potential breeding habitat, increase predation on adults or larvae, and increase both intra- and interspecies competition.

Birds Twenty-nine special status bird species are known to occur or have the potential occur in the area of analysis (see **Table 3-19**). Four of these special status bird species are listed under the ESA: Mexican spotted owl (*Strix occidentalis lucida*), interior least tern, southwestern willow flycatcher, and yellow-billed cuckoo. Potential impacts on these species are discussed in detail in Section 5.2.5 of the Biological Evaluation. Under Alternative A, many of the special status bird species could continue to be affected through ongoing maintenance and water diversion and associated impacts on habitat.

Individual birds in the direct impacts areas would be expected to flee and avoid it during maintenance as a result of noise levels and equipment. Adult individuals would be unlikely to experience death or injury related to diversion construction or maintenance, as long as construction is conducted outside of the nesting season. Behavior changes or avoidance of the area could reduce foraging or predation success or reduce breeding success by nest abandonment or disruption of courtship or nest building behavior. Ongoing water diversion could reduce the availability of aquatic and riparian habitat available downstream of the diversions, either temporarily in the river areas that dry due to diversion or permanently if the quality and quantity of riparian habitat is affected. There would be continued minor to moderate adverse impacts on bird populations associated with ongoing water diversion.

Species primarily associated with uplands (see **Table 3-19**) would not experience impacts from ongoing maintenance and minor adverse impacts on suitable habitat through diversion.

The following special status bird species use agricultural fields or disturbed areas and would benefit from ongoing diversions of water for agriculture in the direct impacts areas: common ground-dove (*Columbina passerina*), ferruginous hawk (*Buteo regalis*; nonbreeding), Sprague's pipit (*Anthus spragueii*; nonbreeding), and western burrowing owl (*Athene cunicularia hypugaea*; migratory and year-round). These species would experience adverse minor impacts from ongoing maintenance when activities can be seen or heard from the species' preferred habitat. The northern goshawk (*Accipiter gentilis*) is known to occur in the area only in the San Francisco River area of analysis in mature forests. As such, this species is unlikely to use area of analysis for anything other than dispersal; thus, potential impacts would be limited to those short periods and they would not be affected. No breeding habitat for the peregrine falcon occurs in the area of analysis, and only foraging habitat for the species would be affected under Alternative A.

Neotropical Migratory Birds and Bald and Golden Eagles Ongoing impacts on migratory birds and bald and golden eagles under Alternative A would be similar to those described above for *General Wildlife and Birds*. Ongoing water diversion would reduce or eliminate flows downstream of push-up diversions; this would, in turn, decrease quality and quantity of breeding, foraging, and migratory habitat for bald eagles that use riparian, wetland, or aquatic areas downstream of push-up diversions. Although eagle breeding habitat would not undergo direct impacts, disturbance or reduced flow could alter or reduce the quality or quantity of available foraging habitat, resulting in indirect adverse impacts on the species. While there is breeding habitat for bald eagles in the area of analysis, the species is a very uncommon breeder in New Mexico (Stahlecker 2009), so no impacts are anticipated.

Fish Twelve special status fish species occur or potentially occur in the area of analysis (see **Table 3-19**). All that occur are directly affected by the current conditions under Alternative A. The construction and maintenance of the push-up diversions in the Upper Gila and San Francisco River areas of analysis may kill any fish that are in the immediate area by crushing and habitat destruction and downstream of the area by sedimentation and river drying. When the push-up diversions are in place and the river is flowing less than 100 cfs at the Gila U.S. Geological Survey stream gage, there is an observed loss of aquatic habitat of up to 1.2 miles downstream of the Fort West Diversion created by the river drying. Fish passage and genetic flow[15] upstream may be blocked for much of the year. Water pools upstream of each diversion, creating habitat for nonnative fish species. There would be continued adverse impacts on fish species due to predation and competition.

Invertebrates Six special status invertebrate species have the potential to occur in the area of analysis (see **Table 3-19**).

Continued operation of the push-up diversions and the W-S Diversion may continue to affect caddisfly species habitat and individuals; however, impacts would be minor and would not reach the population level for these species. This is because project activities under Alternative A would continue to affect a small amount of suitable habitat, compared with the amount of habitat available to these species on USFS lands.

Impacts on dashed ringtail (*Erpetogomphus heterodon*), Gila mayfly (*Lachlania dencyanna*), and monarch butterfly (*Danaus plexippus plexippus*) under Alternative A are continued hydrological alterations and resulting impacts on riparian/wetland vegetation downstream, arising from ongoing river diversion. In addition, individuals of these species may be injured or killed by equipment in the riparian corridor, or equipment may cause behavior changes that could reduce foraging success, disrupt breeding, or increase predation on individuals. Impacts are minor and not anticipated to reach the population level for these species. This is because project activities under Alternative A would continue to affect a small amount of suitable habitat, compared with the amount of habitat available to these species.

The notodontid moth (*Euhyparpax rosea*) occurs in upland areas, so impacts are not expected to occur on this species as a result of Alternative A.

Mammals Fifteen special status mammal species are known to occur or have the potential to occur in the area of analysis (see **Table 3-19**). One species, the Mexican wolf, is listed under the ESA and is discussed in detail in Section 5.2.5 of the Biological Evaluation.

Under Alternative A, many of the special status mammal species would continue to be affected through ongoing maintenance and water diversions. Nine special status bat species are known to

[15] Genetic flow is the transfer of genetic variation from one population to another.

occur or have potential to occur in the area of analysis. Bat species typically do not experience direct impacts under Alternative A. Maintenance work on the existing diversions would be conducted during daytime, when these nocturnal species are not active, and maintenance activities do not increase the amount of nighttime lighting. Insect populations (prey species for insectivorous bats) may experience minor fluctuations with ongoing maintenance activities.

Bat species that particularly rely on water or riparian areas, including Allen's lappet-browed bat, Arizona myotis, cave myotis, and western red bat, may experience adverse impacts on their habitat. Ongoing water diversion could reduce or eliminate flows downstream, which would in turn decrease quality and quantity of breeding, foraging, and migratory habitat for bat species that use riparian, wetland, or aquatic areas downstream of push-up diversions.

Under Alternative A, riparian obligate species, such as the Arizona gray squirrel (*Sciurus arizonensis arizonensis*) and hooded skunk (*Mephitis macroura milleri*) could continue to have minor to adverse impacts through ongoing maintenance and water diversion activities. Individuals occurring in the direct impacts analysis areas would be expected to flee the area and avoid it as a result of the noise and equipment during maintenance. Individuals would be unlikely to experience death or injury related to diversion construction or maintenance. Behavior changes or avoidance of the area could result in reduced foraging or predation success, or reduced breeding success, or disruption of courtship or other intraspecific behaviors.

Upland species, such as the banner-tailed kangaroo rat (*Dipodomys spectabilis*) and Gunnison's prairie dog (*Cynomys gunnisoni*) (prairie population), would not be affected from ongoing maintenance or operations under Alternative A.

Reptiles Five special status reptile species are known to occur or have the potential to occur in the area of analysis (see **Table 3-19**). The northern Mexican gartersnake and narrow-headed gartersnake are discussed in detail in Section 5.2.5 of the Biological Evaluation. The remaining special status species could continue to be adversely affected through ongoing maintenance and water diversion activities under Alternative A.

The reticulate Gila monster (*Heloderma suspectum suspectum*) is primarily associated with uplands. It would not experience impacts from ongoing maintenance and would experience minor impacts on suitable habitat through ongoing diversion activities, such as when this species occasionally uses riparian areas downstream to forage or disperse. The green ratsnake (*Senticolis triaspis*) occurs in riparian areas, and the Sonora mud turtle (*Kinosternon sonoriense*) occurs in creeks, streams, and waterholes. Individuals of these species in the river or adjacent riparian corridor could be injured or killed during maintenance activities; however, this is unlikely to occur because individuals may avoid the area during maintenance. Potential impacts from maintenance are disruption of natural behaviors, which could lead to increased predation or reduced foraging success.

Ongoing water diversion could reduce the availability of aquatic and riparian habitat available downstream of the diversions; however, impacts are not anticipated to reach the population level for either of these species. This is because project activities would affect a small amount of suitable habitat, compared with the amount of habitat available to these species in the area of analysis.

Impacts Common to All Action Alternatives

The following impacts common to all action alternatives may not occur at each project location for all alternatives. The impacts described below are common to all alternatives where there are proposed diversions. These common impacts are broken down by biological resource and by action and are intended to be a general discussion of impacts; this is so as to avoid repetition, and a more specific discussion is provided under each alternative. A more detailed discussion of impacts on vegetation, aquatic and terrestrial wildlife, and special status species from the action alternatives is provided in Chapter 5 of the Biological Evaluation. Land cover impacts by alternative in each area of analysis is provided in **Table 3-21**, **Table 3-22**, and **Table 3-23**.

Surface Water Flow Alteration Impacts on Wildlife The modeled timing of the proposed diversions and consumptive use of water under the AWSA may affect the surface water hydrology of the riverine environment. The timing of proposed diversions and the potential changes to the surface water flow conditions were analyzed by HDR (2019a). Indicators of hydrological alteration (IHA) (Mathews and Richter 2007; The Nature Conservancy 2009) were used to determine the effects in the direct impacts areas for the Upper Gila and San Francisco River areas of analysis. The HDR (2019a) surface water modeling uses data from gages that are downstream of the point of irrigation return flows and inputs from tributaries; therefore, the surface water modeling does not adequately reflect potential changes immediately downstream due to the construction and operation of the proposed push-up diversions.

To address these changes, HDR and SWCA developed and analyzed an IHA model for Alternative B. Based on the results of the surface water modeling summarized in HDR (2019a), the changes in surface water flows under Alternatives C and E in the Gila and San Francisco areas of analysis follow a similar trend as modeled under Alternative B and are all within the range of variation for all years modeled; therefore, Alternatives C and E were not modeled.

No diversions are proposed under Alternative D in the Gila and San Francisco areas of analysis. In the Virden Valley area of analysis, Alternatives B, C, D, and E are the same; however, impacts on the Virden Valley conditions from Alternative D are not comparable to the other alternatives because there are no upstream diversions. The results for each area of analysis are discussed in the Flow Alteration Summary (Section 5.1) of the Biological Evaluation.

The effects of surface water flow alteration for all alternatives are varied and affect biological resources differently at different times. To the extent that the flow rate contributes to the establishment of new riparian woodlands and a dynamic riverine system, there may be beneficial impacts for riparian or wetland-dependent species and aquatic species. Maintaining flows during the spring, summer, and monsoon seasons minimizes impacts. The largest impacts noted are related to reduced flows during the fall/winter base flow period, from November through January. These are associated with the modeled diversion timing and changes in surface water average monthly low-flow conditions.

The overall reduction in surface water flows under the Proposed Action may decrease available subsurface flows during the dormant season and may increase the overall depth to the water table across the area of analysis; however, depth to groundwater may decrease during the spring runoff, summer base flow, and monsoon seasons in response to increased surface water flows. Changes in the rate of river recession, as measured by fall rate, may influence groundwater levels (Hathaway et al. 2016; S. S. Papadopulos and Associates, Inc. [SSPA] 2014a). Declining rates of river recession, such as when the fall rate of recession is slower, would have beneficial impacts on riparian and wetland vegetation. Conversely, increases in the fall rate, such as when the rate of recession is faster, would have adverse effects on groundwater and riparian/wetland vegetation. Hathaway et al. (2016) and SSPA (2014a) concluded the potential changes in groundwater depths are not expected to have a large effect on riparian and wetland vegetation for a diversion project where the AWSA diversion amounts are greater than those under the action alternatives in this EIS.

Proposed diversions for all alternatives result in modeled changes in downstream flows that are within the normal range of variation. Changes would most likely affect aquatic and terrestrial wildlife during low flow conditions. Diversions during dry to moderately dry conditions may affect vegetation and could increase water stress. This could lead to decreased health, extent, and future recruitment of riparian and wetland vegetation and an increase in nonnative species that are more adapted to dry conditions in affected areas. Potential impacts would be similar under all action alternatives, differing only in the magnitude of impacts.

Changes in surface flow and groundwater in the Cliff-Gila and San Francisco project locations would have hydrological impacts downstream of the indirect impact areas. Changes in hydrology could affect wildlife by reducing the areal extent or health of riparian and wetland habitats. The precise impacts and impact locations are not known. There is more variability in the system from natural sources than upstream diversions would be expected to produce. **Table 3-20** summarizes the seasonal impacts due to surface water flow alteration on wildlife groups, and impacts on breeding/juvenile rearing, migratory, and active adult seasons. Impacts may be adverse or beneficial and range from negligible to moderate, depending on the season.

Vegetation Acres of disturbance to vegetation communities are given to show the magnitude of the potential effects and the differences between action alternatives. Acres of disturbance to vegetation communities for all action alternatives are given below in **Table 3-21**, **Table 3-22**, and **Table 3-23** for the Upper Gila, Virden Valley, and San Francisco River area of analysis, respectively. There would be no direct impacts on vegetation in the Lower Gila area of analysis. SWReGap land cover maps for each direct impacts area by alternative can be found in Appendix A of the Biological Evaluation, as follows: Upper Gila direct impacts area, Figures A-38 through A-40; Virden Valley Direct Impacts, A-41; and San Francisco River direct impacts area, A-42 through A-45.

Construction

Vegetation Communities Direct long- and short-term impacts on vegetation communities from all action alternatives would be associated with construction, including for diversions, ditch/canal improvements, ground clearing, and water storage features. Long-term impacts on vegetation would be from the direct loss of individual plants and habitats. Short-term impacts would be from removing or crushing individual plants, disturbing vegetation communities, and compacting and disturbing soil. Short-term impacts also would be from the increased potential for noxious and invasive weed establishment.

For the purposes of this analysis the short-term disturbance areas were determined using a 50-foot buffer around project features; long-term disturbance areas were calculated using a 25-foot buffer. On-site conditions may require minor shifting of planned component locations, which could adversely affect any individual plants within the shifted construction footprint. In the Upper Gila, Virden Valley, and San Francisco River direct impact areas, there would be minor adverse short- and long-term impacts. As noted in **Table 3-21**, **Table 3-22**, and **Table 3-23**, there would be minor impacts on vegetation across all land cover types and total vegetation for all action alternatives. Impacts for total vegetation are less than 5 percent of the vegetation in the direct impact areas.

For the purposes of this analysis the short-term disturbance areas were determined using a 50-foot buffer around project features; long-term disturbance areas were calculated using a 25-foot buffer. On-site conditions may require minor shifting of planned component locations, which could adversely affect any individual plants within the shifted construction footprint. In the Upper Gila, Virden Valley, and San Francisco River direct impact areas, there would be minor adverse short- and long-term impacts. As noted in **Table 3-21**, **Table 3-22**, and **Table 3-23**, there would be minor impacts on vegetation across all land cover types and total vegetation for all action alternatives. Impacts for total vegetation are less than 5 percent of the vegetation in the direct impact areas.

Vegetation communities in the Upper Gila, Virden Valley, San Francisco River, and Lower Gila indirect impact areas would not be directly affected by construction or operations; because no disturbance is planned in these areas, they would experience indirect impacts, ranging in severity from negligible to minor.

Wetland and Riparian Vegetation Similar to vegetation communities, there would be minor adverse impacts on wetland and riparian vegetation across all action alternatives. Some existing wetland and riparian vegetation would be disturbed or removed during construction; it would primarily affect narrow stringers of vegetation along ditches in riparian areas along the Gila and San Francisco Rivers. This vegetation would also be affected by project facilities within the riparian corridor. Riparian and wetland vegetation may recover in areas of temporary disturbance; however, conditions created by construction may affect species composition. This would come about by favoring the establishment of nonnative riparian vegetation, including tamarisk and Russian olive. Implementing BMPs (see **Appendix C**, Best Management Practices and Standard Operating Procedures) would avoid or minimize impacts on wetland areas.

Noxious Weeds Construction could lead to increased potential for introduction and spread of noxious and invasive weeds from clearing vegetation, changes to habitat from noxious and invasive weed establishment and spread, and direct and indirect impacts on and competition with native vegetation and special status species. BMPs would be used to mitigate disturbed areas and prevent or slow the spread of weedy species (see **Appendix C**, Best Management Practices and Standard Operating Procedures).

Table 3-20. Seasonal Surface Water Flow Alterations Impacts on Wildlife Common to All Action Alternatives

Wildlife Group	Snowmelt/Runoff				Summer Low Flow		Monsoon		Fall/Winter Base Flow				Comments
	Feb	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	
Migrating birds	Negligible to minor, adverse impact		No impact		No impact		No impact		Negligible to minor, adverse impact		No impact		Reduced flow reduces habitat for water bird stopover and decreases available prey for migrating birds, which may impede migration or reduce survival.
Breeding birds	No impact	Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Adverse negligible to minor impact			Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Adverse negligible to minor impact		Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Adverse negligible to minor impact		No impact	No impact			Increased flow may increase prey availability, leading to increased survival or breeding success. Decreased flow may decrease prey availability, leading to decreased survival or breeding success. Habitat is maintained or created with increased surface water for better survival rates and breeding success, whereas with low flow, the amount of suitable habitat is reduced, adversely affecting individuals.
Southwestern willow flycatcher	No impact	Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Adverse negligible to minor impact			Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Adverse negligible to minor impact		Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Adverse negligible to minor impact		No impact				Increased surface water raises humidity, increases invertebrate prey, and may expand breeding habitat for breeding success and increased nesting habitat, while decreased surface water lowers breeding success and quantity of habitat; additional surface water increases tree vigor in growing season while lower flows may reduce tree vigor, which affects nesting substrate and breeding success.
Yellow-billed cuckoo	No impact		Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Adverse negligible to minor impact		Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Adverse negligible to minor impact		Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Adverse negligible to minor impact		No impact				Increased surface water raises humidity, increases invertebrate prey and may expand breeding habitat for increased breeding success, while decreased surface water lowers breeding success and quantity of habitat. Additional surface flow increases tree vigor in growing season, while lower flows may reduce tree vigor. Increased tree vigor provides suitable nesting habitat and increases breeding success.
Mexican spotted owl	Negligible adverse impact	No impact			No impact		No impact		Negligible adverse impact				Some individuals migrate to lower elevations in winter, and low flow in winter could reduce available prey. In the summer breeding season, this species occurs only in Indirect areas of analysis, and effects are expected to be extremely minor. Lower flows may reduce suitable canyon habitat values by decreasing prey or humidity, while higher flows would increase canyon habitat values by increasing prey or humidity.
Migrating Bats	No impact				No impact	No impact	No impact	Negligible beneficial impact	Negligible beneficial impact		No impact		Predation success may increase with increased quantity of insect prey (increases with water); surface water may create or maintain habitat for species that are associated with water.
Breeding Bats	No impact	Negligible adverse impact		No impact	No impact	No impact	No impact	Negligible impact	Negligible impact		No impact		Breeding success may depend on presence of water and presence of insect prey, which increases with water; quantity of flow determines the amount of habitat for species associated with water.
Mammals	Negligible adverse impact			No impact	No impact	No impact	No impact	No impact	No impact	No impact	No impact	Negligible adverse impact	Breeding success depends on quantity of forage or prey, which increases with increased flow, aquatic or wetland habitat creation or maintenance, and increased vigor of riparian woodland during breeding season, which increases with increased flow.

Wildlife Group	Snowmelt/Runoff				Summer Low Flow		Monsoon		Fall/Winter Base Flow				Comments
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	
Invertebrates	No impact	Negligible beneficial impact			Negligible to minor, beneficial or adverse impact		Negligible to minor, beneficial or adverse impact		No impact				Breeding success could increase with increasing water quantity because of increased habitat and better water quality. Lower or absent surface water flow may reduce habitat and water quality, adversely affecting survival or reproduction.
Herpetofauna	No impact	Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Negligible to minor adverse impact			Negligible to minor, beneficial or adverse impact	Negligible to minor, beneficial or adverse impact	Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Negligible to minor adverse impact		Negligible to minor, beneficial or adverse impact	No impact			Increased surface flow could increase prey, increase suitable wetland or aquatic habitat, increase humidity, and lower heat, all of which provide beneficial impacts on some species by increasing survival, available prey, and foraging or breeding success. Decreased surface flow could adversely affect these species by reducing prey and habitat or providing suboptimal microhabitats. Nonnative species, such as bullfrogs, could adversely affect species through predation and competition pressure.
Narrow-headed and northern Mexican gartersnakes	No impact	Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Negligible to minor adverse impact			Negligible to minor, beneficial or adverse impact	Negligible to minor, beneficial or adverse impact	Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Negligible to minor adverse impact		Negligible to minor, beneficial or adverse impact	No impact			Increased surface water could increase the amount of suitable clear stream habitat and native fish prey species for this gartersnake, whereas decreased surface water decreases it. Survival, breeding success, and predation success increase when surface flow increases but decrease with flow decreases. Nonnative species, such as bullfrogs, could adversely affect species through predation and competition pressure.
Chiricahua leopard frog	No impact	Negligible adverse impact			Negligible adverse impact	Negligible adverse impact	Negligible adverse impact		Negligible adverse impact	No impact			Chiricahua leopard frogs are not known to occur in any of the direct impact areas. This species may occur in the Arizona portion of the San Francisco River indirect area of analysis and in the Lower Gila area of analysis. Increased surface water during the breeding period would increase breeding habitat, such as pools and backwater. A post-breeding surface water increase would maintain habitat for adults and larvae; it also would increase foraging opportunity to increase survival and would increase water quality, which has beneficial impacts for individuals and their prey. A surface water decrease reduces habitat for adults and larvae and decreases water quality, reducing survival by decreasing availability of prey and amount of habitat, and by increasing predation on individuals concentrated into remaining habitat.
Fish	Minor to moderate adverse impacts		Minor adverse impacts		Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Negligible to minor adverse impact		Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Negligible to minor adverse impact		Minor to moderate adverse impacts				Lower flows during spawning could reduce spawning habitat or spawning cues; higher flows during spring and summer could increase spawning and rearing habitat. Decreased winter flows may reduce riffle habitat. Increased low flows during dry to moderate dry conditions may increase predation and competition from nonnative fish species.
Loach minnow	Minor to moderate adverse impacts		Minor adverse impacts		Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Negligible to minor adverse impact		Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Negligible to minor adverse impact		Minor to moderate adverse impacts				Same as described for all fish species.

Wildlife Group	Snowmelt/Runoff				Summer Low Flow		Monsoon		Fall/Winter Base Flow				Comments
	Feb	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	
Spikedace	Minor to moderate adverse impacts				Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Negligible to minor adverse impact		Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Negligible to minor adverse impact		Minor to moderate adverse impacts	Minor to moderate adverse impacts			Same as described for all fish species.
Roundtail/Gila chub	Moderate to minor adverse impacts			Minor adverse impacts	Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Negligible to minor adverse impact		Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Negligible to minor adverse impact		Minor to moderate adverse impacts	Minor adverse impacts			Same as described for all fish species.
Gila topminnow	No impact	No impact			No impact	No impact	No impact		No impact				Gila topminnow are not present in the main stem of the Gila or San Francisco Rivers; they are found only in tributaries. Implementation of the NM Unit is unlikely to have an impact on the species.
Gila trout	No impact				No impact		No impact		No impact	No impact			Gila trout are present in the area of analysis only through stocking programs. They are found upstream of the area of analysis and would not be affected by AWSA diversions.
Longfin dace	Minor to moderate adverse impacts	Minor adverse impacts			Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Negligible to minor adverse impact		Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Negligible to minor adverse impact		Minor to moderate adverse impacts	Minor to moderate adverse impacts			Same as described for all fish species.
Speckled dace	Minor to moderate adverse impacts				Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Negligible to minor adverse impact		Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Negligible to minor adverse impact		Minor to moderate adverse impacts	Minor to moderate adverse impacts			Same as described for all fish species.
Suckers	Minor to moderate adverse impacts			Minor adverse impacts	Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Negligible to minor adverse impact		Upper Gila and San Francisco direct impacts area: Beneficial minor impact; Indirect area of analysis: Negligible to minor adverse impact		Minor to moderate adverse impacts	Minor to moderate adverse impacts			Same as described for all fish species.

Source: SWCA 2019e
Note:
Light shading = Breeding or juvenile rearing periods
Dark shading = Migratory and active adult periods

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Table 3-21. SWReGAP Land Cover Impacts within the Upper Gila Area of Analysis (in Acres)

Land Cover	Total Acreage in Area of Analysis	Indirect Impacts Area Impacts	Direct Impacts Area Impacts	Alternative B		Alternative C		Alternative D		Alternative E	
				Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts
Agriculture	1,977.7	88.6	1,889.1	51.7 (2.7%)	39.6 (2.1%)	38.4 (2.3%)	35.1 (1.9%)	0	0	1.7 (2.1%)	0.3 (<0.1%)
Apacherian-Chihuahuan Mesquite Upland Scrub	1,514.7	1,034.7	480.0	15.5 (3.2%)	13.5 (2.8%)	13.9 (2.9%)	12.6 (2.6%)	0	0	7.4 (1.5%)	5.5 (1.2%)
Apacherian-Chihuahuan Piedmont Semi-Desert Grassland and Steppe	1,242.2	105.8	1,136.4	74.2 (6.5%)	67.0 (5.9%)	63.9 (5.6%)	61.7 (5.4%)	0	0	94.7 (8.3%)	84.6 (7.4%)
Chihuahuan Creosotebush, Mixed Desert and Thorn Scrub	423.5	401.2	22.3	0	0	0	0	0	0	0	0
Madrean Encinal	0.9	0	0.9	0	0	0	0	0	0	0	0
Madrean Juniper Savanna	100.6	1.1	99.5	3.2 (3.2%)	2.9 (2.9%)	2.7 (2.7%)	2.7 (2.7%)	0	0	1.9 (1.9%)	1.0 (1.4%)
Madrean Pine-Oak Forest and Woodland	15.4	4.2	11.2	0.5 (4.5%)	0.1 (0.9%)	0	0	0	0	0	0
Madrean Pinyon-Juniper Woodland	3,237.2	233.0	3,004.2	74.9 (2.5%)	52.7 (1.8%)	52.8 (1.8%)	41.8 (1.4%)	0	0	136.1 (4.5%)	111.3 (3.7%)
Mogollon Chaparral	2,635.0	680.1	1,954.9	153.9 (7.8%)	114.3 (5.9%)	90.3 (4.6%)	80.9 (4.1%)	0	0	87.5 (4.5%)	68.2 (3.5%)

Land Cover	Total Acreage in Area of Analysis	Indirect Impacts Area Impacts	Direct Impacts Area Impacts	Alternative B		Alternative C		Alternative D		Alternative E	
				Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts
North American Warm Desert Lower Montane Riparian Woodland and Shrubland	1,436.8	1,020.9	415.9	7.7 (1.9%)	4.0 (1.0%)	0	0.3 (0.1%)	0	0	7.2 (1.7%)	3.6 (0.9%
North American Warm Desert Wash	72.0	36.2	35.8	0	0	0	0	0	0	9.5 (2.7%)	9.4 (3.3%)
Sonoran Mid-Elevation Desert Scrub	0.2	0.2	0	0	0	0	0	0	0	0	0
Total	**12,656.2**	**3,606.0**	**9,050.1**	**381.6 (4.2%)**	**294.1 (3.3%)**	**262.5 (2.9%)**	**235.0 (2.9%)**	**0**	**0**	**346.1 (3.8%)**	**284.0 (3.1%)**

Sources: ESRI (2013); SWReGAP (2005)
Note: Percent is the percentage of direct impacts area acreage.

Table 3-22. SWReGAP Land Cover Impacts within the Virden Valley Area of Analysis (in Acres)

Land Cover	Total Acreage in Area of Analysis	Indirect impacts Area Impacts	Direct Impacts Area Impacts	Alternatives B, C, D, and E	
				Direct, Short-Term Impacts	Direct, Long-Term Impacts
Agriculture	3,352.4	134.2	3,218.2	25.3 (0.8%)	21.9 (0.7%)
Apacherian-Chihuahuan Mesquite Upland Scrub	3,686.8	2,041.2	1,645.6	74.0 (4.5%)	66.5 (4.0%)
Apacherian-Chihuahuan Piedmont Semi-Desert Grassland and Steppe	158.6	55.4	103.2	4.5 (4.4%)	4.0 (3.9%)
Chihuahuan Creosotebush, Mixed Desert and Thorn Scrub	2,054.7	31.7	2,023.0	27.3 (1.3%)	23.3 (1.2%)
Developed, Medium - High Intensity	27.0	27.0	0	0	0
Madrean Juniper Savanna	<0.1	<0.1	0	0	0
Madrean Pine-Oak Forest and Woodland	5.9	0.8	5.1	0	0
Madrean Pinyon-Juniper Woodland	5.6	5.6	0	0	0
Mogollon Chaparral	116.0	58.6	57.4	0	0
North American Warm Desert Lower Montane Riparian Woodland and Shrubland	803.2	627.8	175.4	0	0
North American Warm Desert Riparian Woodland and Shrubland	1.8	1.8	0	0	0
North American Warm Desert Wash	2.0	0	2.0	0	0
Sonora-Mojave Creosotebush-White Bursage Desert Scrub	30.9	14.0	16.9	0.4 (2.4%)	0.3 (1.8%)
Sonoran Mid-Elevation Desert Scrub	137.3	131.1	6.2	0	0
Sonoran Paloverde-Mixed Cacti Desert Scrub	108.2	89.1	19.1	0	0
Total	**10,490.4**	**3,218.3**	**7,272.1**	**131.5 (1.8%)**	**116.0 (1.6%)**

Sources: ESRI (2013); SWReGAP (2005)
Note: Percent is the percentage of direct impacts area acreage.

Table 3-23. SWReGAP Land Cover Impacts within the San Francisco River Area of Analysis (in Acres)

Land Cover	Total Acreage in Area of Analysis	Indirect Impacts Area Impacts	Direct Impacts Area Impacts	Alternative B		Alternative C		Alternative D		Alternative E	
				Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts
Agriculture	507.0	13.5	494.0	0.3 (0.1%)	0.04 (<0.1%)	0.7 (0.1%)	0.5 (0.1%)	0	0	1.1 (0.2%)	0.5 (0.1%)
Apacherian-Chihuahuan Mesquite Upland Scrub	2,150.8	1,469.3	681.5	3.1 (0.5%)	1.4 (0.2%)	27.3 (4.0%)	22.6 (3.3%)	0	0	38.9 (5.7%)	31.9 (4.7%)
Apacherian-Chihuahuan Piedmont Semi-Desert Grassland and Steppe	460.3	81.7	378.6	1.4 (0.4%)	0.7 (0.2%)	12.5 (3.3%)	9.9 (2.6%)	0	0	14.7 (3.9%)	11.5 (3.0%)
Chihuahuan Creosotebush, Mixed Desert and Thorn Scrub	56.3	40.8	15.5	0	0	0	0	0	0	0	0
Colorado Plateau Mixed Bedrock Canyon and Tableland	3.9	2.8	1.1	0	0	0	0	0	0	0	0
Developed, Medium - High Intensity	140.4	140.4	0	0	0	0	0	0	0	0	0
Invasive Southwest Riparian Woodland and Shrubland	4.7	4.7	0	0	0	0	0	0	0	0	0
Madrean Encinal	2.9	0.1	2.8	0	0	0	0	0	0	0	0
Madrean Juniper Savanna	16.0	4.0	12.0	0	0	0	0	0	0	0	0
Madrean Pine-Oak Forest and Woodland	26.2	18.0	8.2	0	0	0	0	0	0	0	0

Land Cover	Total Acreage in Area of Analysis	Indirect Impacts Area Impacts	Direct Impacts Area Impacts	Alternative B		Alternative C		Alternative D		Alternative E	
				Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts
Madrean Pinyon-Juniper Woodland	1,916.5	216.4	1,700.1	1.7 (0.1%)	0.8 (<0.1%)	60.7 (3.6%)	50.9 (3.0%)	0	0	87.7 (5.2%)	74.6 (4.4%)
Mogollon Chaparral	1,481.5	822.7	658.8	3.0 (0.5%)	1.5 (0.2%)	6.4 (1.0%)	4.7 (0.7%)	0	0	14.9 (2.3%)	8.2 (1.2%)
North American Warm Desert Lower Montane Riparian Woodland and Shrubland	1,219.6	877.0	342.6	6.1 (1.8%)	3.1 (0.9%)	3.5 (1.0%)	2.0 (0.6%)	0	0	11.1 (3.2%)	5.6 (1.6%)
North American Warm Desert Riparian Woodland and Shrubland	1.3	1.3	0	0	0	0	0	0	0	0	0
Open Water	2.6	2.6	0	0	0	0	0	0	0	0	0
Sonoran Mid-Elevation Desert Scrub	96.9	96.9	0	0	0	0	0	0	0	0	0
Sonoran Paloverde-Mixed Cacti Desert Scrub	25.7	25.7	0	0	0	0	0	0	0	0	0
Total	**8,113.1**	**3,818.0**	**4,295.0**	**15.5 (0.4%)**	**7.7 (0.2%)**	**111.1 (2.6%)**	**90.7 (2.1%)**	**0**	**0**	**168.4 (3.9%)**	**132.4 (3.1%)**

Sources: ESRI (2013); SWReGAP (2005)
Note: Percent is the percentage of direct impacts area acreage

Special Status Plant Species Potential impacts on special status plant species would be similar to those described above for vegetation communities; however, the magnitude of impacts may be greater for special status plant species due to their more limited ranges and more specific habitat requirements. Impacts would be minor to moderate on the local and regional populations of these species. This is due to the limited area of potential impacts in relation to the overall habitat availability for these species. Potential impacts on special status plant species are discussed in more detail in Section 5.1.3.4 of the Biological Evaluation.

Operations and Maintenance

Vegetation Communities Potential impacts on vegetation communities and special status plant species from all action alternatives would occur during operation and maintenance. Potential long-term impacts from operation include changes in vegetation structure and establishment due to modifications to the surface flow regime, reduced recruitment and retention of riparian and wetland vegetation from increases in depth to groundwater in shallow aquifers, and creation of conditions that could increase noxious and invasive weed establishment and spread.

The potential impacts associated with maintenance would be similar to those described above for construction of project components. Potential acres of long-term disturbances would occur in less than 5 percent of the area for each land cover type and total vegetation in the direct impact areas for all project locations. Maintenance would occur infrequently, in limited areas that have been previously disturbed, and for a shorter duration than during construction. Because of this, the magnitude of potential impacts would be less than from construction. There would be negligible to minor direct, adverse impacts on vegetation communities related to operation and maintenance across all action alternatives.

Wetland and Riparian Vegetation Potential operational impacts on wetland and riparian vegetation would be related to changes in surface water hydrology and groundwater hydrology associated with water diversions, storage areas, and pumping. Potential adverse impacts include a reduction in the areal extent of wetlands due to a reduction in water availability in the rooting zone of wetland vegetation and changes in the frequency, magnitude, duration, and timing of floods. These impacts could include reduced wetland and riparian vegetation establishment near the rivers in the direct impact areas. This would be due to changes in the amount and timing of surface water flow, reduced recruitment of riparian and wetland vegetation, reduced health of riparian vegetation that relies on having groundwater within the rooting zone, and creation of conditions that could favor the establishment and spread of nonnative riparian species. Recovery of wetland and riparian vegetation after construction-related disturbance may be limited, due to potential increases in depth to groundwater associated with the operation of the proposed project.

Proposed surface water diversions or storage are not anticipated to significantly reduce near-surface groundwater (SSPA 2013; Stone and Samson 2014). Lined ponds and ditches would reduce groundwater flow to the alluvial aquifer near the rivers in comparison to Alternative A; however, the proposed storage sites that are lined are modeled to have a minor impact on the deeper aquifer under all action alternatives.

Unlined ditches would have a localized minor beneficial impact on wetland and riparian vegetation due to increased seepage resulting from the increase in ditch capacity.

There would be minor adverse direct impacts on wetland and riparian vegetation.

Noxious Weeds The anticipated change in timing of flows would continue to support the establishment of native riparian trees and would be unlikely to increase conditions that favor tamarisk or Russian olive.

Special Status Plant Species Potential impacts on special status plant species from operating the proposed project would be similar to those described above for general vegetation.

Aquatic and Terrestrial Wildlife

Construction Potential construction-related direct adverse impacts from all action alternatives common to all wildlife groups would involve injury or death resulting from collisions with and crushing by construction vehicles. This would be the case during grading, diversion construction, modification or creation of conveyance ditches/pipes, storage pond and well construction, improvements to local roads for access, removal of clay used to line ponds or conveyance ditches, and power line improvements and installation of new power lines.

Chemicals or fuel could be inadvertently released into the aquatic environment, killing or injuring individuals and lowering water quality. Wildlife species that are smaller, less mobile, or restricted to the river channel—small mammals, amphibians, aquatic invertebrates, fish, eggs or young in nests or burrows, or estivating or hibernating individuals—would experience a greater magnitude of impacts than larger, more mobile species. This is because larger or more mobile individuals would flee the area.

Construction of the diversion structures would also temporarily increase turbidity or sedimentation downstream, which may cause direct, adverse impacts, such as death or injury, to aquatic or semi-aquatic species. While individuals may be killed or injured, direct impacts from construction would be localized and would not continue to occur once construction is completed or habitat is removed from an area; thus, direct construction impacts are not expected to rise to affect whole populations of species.

Potential minor impacts related to noise and vibration or human presence would be temporary and of short duration and would diminish with the completion of construction. Construction areas are already disturbed by human noise and presence.

Construction of diversions (Upper Gila and San Francisco River direct impacts areas), storage ponds, and associated pumps and wells would result in loss of wildlife habitat. Where conveyance ditches would be created, expanded, or lined, there would be a small permanent loss of foraging, dispersal, or breeding habitat. Expansion of power lines at the Upper Gila and Virden area of analysis would cause minor loss, degradation, and fragmentation of wildlife habitats.

Disturbance associated with construction would result in some species losing breeding, foraging, or migratory habitat at the time of construction and into the future. As shown in **Table 3-21**, **Table 3-22**, and **Table 3-23**, acres of vegetation communities to be disturbed are a small percentage of the total acres of each vegetation type in the direct impacts areas under all action alternatives. The linear nature of impacts associated with conveyance channels or power lines could increase habitat fragmentation or edge effects, compared with nonlinear portions of the project. These impacts may be of a relatively minor magnitude in areas where construction is in existing conveyance ditches or where pipes would be installed rather than ditches. Impacts of vegetation disturbance on any given individual or species would depend on habitat requirements of that species and on its current distribution in the direct impact areas. These direct adverse impacts would range from negligible to minor on vegetation communities that comprise terrestrial wildlife habitat.

Potential permanent and temporary impacts would be reduced or mitigated through the application of BMPs (see **Appendix C**, Best Management Practices and Standard Operating Procedures) during implementation and would minimize potential disturbance to species and habitats.

Operations and Maintenance

Operations Potential changes to surface water and groundwater hydrology resulting from operations to divert AWSA water could result in the loss or modification of habitat for wildlife and special status species. If AWSA diversions occur during periods of low flows, there would be a seasonal reduction in flows, which could decrease aquatic habitat. This could kill aquatic or semiaquatic species and habitat would be lost temporarily. If drying occurs, the volume of water in pools and soil moisture downstream of the diversion would decrease, which could reduce the areal extent or health of riparian habitat and wildlife species that require moist soils and flowing water.

A reduction of stream flow could affect water quality by creating stagnant conditions, reducing dissolved oxygen in the water, and increasing water temperature. Individuals may die directly from drying or because predation succeeds more often in smaller pools. As a result of degraded or reduced habitat, individuals may experience lowered health and reproductive success or, in the case of semi-aquatic species, they may need to expend additional metabolic energy foraging or searching for more appropriate habitat, leading to lowered survival.

Although river drying downstream of the diversions would occur, the duration, length, and timing of river drying could change from current conditions; these changes would depend on many factors, including rainfall, snowmelt, and the diversion schedule and quantity of water diverted. Potential impacts from direct mortality or reduced survival or health of individuals would be limited to areas of drying.

Aquatic or semiaquatic individuals may be entrained in ditches and agricultural fields and may not be able to return to the river. Similar to river drying, the direct, adverse impacts on individuals through entrainment at the existing push-up diversions occurs but it has not been quantified.

The intensity of the impact of river drying on wildlife habitat for all action alternatives would be minor in the direct impact areas and negligible to minor in the indirect impact areas, when compared with Alternative A. This is because the changes in overall distribution of riparian areas and wetlands under all action alternatives (as described in Section 5.2 of the Biological Evaluation) would be negligible to minor and localized (HDR 2019b, 2019c).

The proposed permanent or semi-permanent diversions would alter wildlife habitat by backing up water upstream of the proposed diversions on the Gila and San Francisco Rivers. Permanent (Alternatives B and E) and semi-permanent (Alternative C) diversion structures would likely back up water at a broader range of flows than the current push-up diversion structures, which may be breached at higher flows. Water would be backed up by an approximate maximum of 2,500 feet on the Gila River and 1,400 feet on the San Francisco River (HDR 2019a). This would create an area of deeper pool habitat immediately upstream of the diversions.

The precise amount of water backup at any given time would depend on surface flow conditions, such as during wet or dry years, time of year, such as during snowmelt or monsoon rains, leading to more surface flow, and timing of diversion; however, deeper pools may create habitat that favors nonnative predators, including American bullfrogs (*Lithobates catesbeiana*) or nonnative predatory fish (Global Invasive Species Database 2019; Rinne 1994; Rosen and Schwalbe 1995; USFWS 2014b), over native frog, toad, and fish species. Such species evolved in more dynamic southwestern riverine systems. Potential minor to moderate adverse impacts on native aquatic and riparian species from an increase of nonnative predator habitat and abundance could be death of individuals, lower survival of individuals, change in demographics or population dynamics locally, reduction or extirpation of local populations of native species arising from predation by and competition with nonnative species, or introduction of parasites or diseases.

Native wildlife would experience adverse impacts as a result of these nonnative species and the conversion of suitable habitat into habitat that favors nonnative predators. Similarly, the creation of storage ponds could create pool habitat that would favor nonnative predators and have adverse impacts on native aquatic and riparian species. In addition, the creation of storage ponds may have beneficial impacts on some wildlife species that may use these areas for drinking, foraging, or hunting, which would increase survival of individuals.

Operation of the action alternatives could allow for some persistence and establishment of riparian habitat along stringers of riparian woodlands and narrow shelves next to ditches. Because riparian and wetland habitats already occur in the direct impact areas and these areas of habitat would be narrow, these increases could have a minor beneficial impact on some species.

Maintenance Impacts from maintenance would be similar to those from construction; however, these impacts would occur for a short period and would be limited to the surrounding area. Maintenance would be for pumps, conveyance ditches/canals and ponds, and diversions and other infrastructure.

There would be beneficial impacts on wildlife by transitioning from push-up diversions in the Cliff-Gila and San Francisco River project locations that currently require maintenance several times a year. Such maintenance uses heavy equipment in the channel. The transition would be to permanent or semi-permanent diversion structures under some alternatives, such as fixed crest weir, rock vane weir, or Obermeyer Diversion, that require maintenance annually or less frequently. This is because individuals would not be disturbed, injured, or killed in the river channel and adjacent areas as frequently. Moreover, they would experience fewer noise- or human-related impacts, such as behavior changes, reduced survival, and reduced reproductive success.

Conveyance ditches and canals and storage ponds would require periodic dredging to remove sediment and maintain capacity. Impacts on wildlife would be similar to those under Alternative A and would be noise- or human-related impacts.

All action alternatives would increase the level of noise in the direct impact areas. Although specifics among alternatives vary, noise impacts would result from well pumps, pumps to move water from storage ponds into ditches, and operation of the Obermeyer Diversion. Potential noise impacts would decrease with increasing distance from the source and would affect different wildlife species differently. This is because some species are not as sensitive to noise impacts as others.

Operational noise may temporarily change habitat use patterns for some species. Some individuals would likely move away from the source of the noise to nearby habitats, which may increase competition for resources in these areas. Noise may also increase stress on individuals, which could decrease their overall fitness due to increased metabolic expenditures. These impacts would be intermittent throughout the life of the project. Potential impacts from noise and vibrations would likely be limited to individuals and would be unlikely to have impacts at the local or regional population level.

Wildlife

Seeps and Springs No impacts on seeps and springs are anticipated during the construction phase of the proposed project. This is because none occur in the project component footprint of short-term and long-term disturbance areas.

Important Bird Areas The Gila-Cliff IBA, which overlaps the Upper Gila direct impacts area, would experience minor, direct, adverse impacts on the quality and quantity of bird habitat under all alternatives except Alternative D. Under the alternative, no changes would be made to diversion structures, and no storage ponds or other components would be constructed in the Upper Gila direct impacts area; impacts would continue to occur, as described under Alternative A. Even though this IBA overlaps the Upper Gila direct impacts area for approximately 2,396 acres of its approximately 2,768 acres, no action alternatives would have short- or long-term construction and operations impacts greater than 351.4 acres.

IBAs that overlap the area of analysis—the Blue and San Francisco River Ecosystem IBA, Apache-Sitgreaves National Forests IBA, Gila-Cliff IBA, Gila Bird IBA, and Lower Gila Box IBA—would experience adverse impacts on bird habitat suitability. This would come about through a loss of flow, and subsequent loss or degradation to wetlands or riparian areas in or next to the river channel, to the Gila and San Francisco Rivers. This would be a result of project operation under all alternatives (flow impacts on vegetation are described in Section 5.2.3 of the Biological Evaluation); however, because riparian woodlands and wetlands are not expected to degrade or contract in area substantially as a result diversion under any action alternative (see Section 5.2.2 of the Biological Evaluation), impacts on these four IBAs would be minor. These areas would continue to provide suitable bird habitat for breeding, foraging, migrating, or dispersing, under all action alternatives.

Neotropical Migratory Birds and Bald and Golden Eagles Potential impacts on migratory bird species would be the same as described above for other terrestrial wildlife. All action alternatives may affect habitat and individuals; however, there would be no detectable effect at the population level on the viability of these species by project-related activities. Moreover, there would be no contribution toward a downward population trend or listing of these bird species as threatened or endangered. Implementing construction timing restrictions and pre-construction nesting surveys would avoid impacts on nesting birds, such as destruction of nests by construction or maintenance equipment and increased noise and vibration, leading to nest abandonment or failure.

Management Indicator Species The project-related disturbance associated with all action alternatives would decrease available habitat for management indicator species (MIS); however, the proposed project would affect a small portion of the overall habitat on the Gila National Forest in the project vicinity for these species under all action alternatives. Because of this, the proposed project would not alter existing trends on the Forest for MIS habitat (see Biological Evaluation, Sections 5.3.2 and 5.3.3).

Special Status Species Seventy-one special status species have the potential to occur or are known to occur in the combined area of analysis, including 4 amphibian species, 29 bird species, 12 fish species, 6 invertebrates, 15 mammal species, and 5 reptile species. Impacts on special status species would be similar or identical to impacts described for general wildlife species above.

Amphibians Four special status amphibian species have the potential to occur in the area of analysis, including the Chiricahua leopard frog, which is listed under the ESA and is discussed in detail in Section 5.2.5 of the Biological Evaluation.

Similar to general wildlife, impacts on special status amphibians are related to disturbance or loss of habitat. The potential impacts would be minor for these species, given the small percentage of suitable habitat disturbed in relation to the overall amount of habitat in the area of analysis; thus, all action alternatives may affect individuals but would not likely result in a downward trend toward Federal listing or a loss of population viability for the Arizona toad, lowland leopard frog, and Sonoran Desert toad. Because of this, these impacts would be minor on populations. Seasonal indirect impacts on amphibians are summarized in the Section 5.3.4.3.1 of the Biological Evaluation.

Birds Twenty-nine special status bird species are known to occur or have the potential to occur in the area of analysis. Four of these special status bird species are listed under the ESA: Mexican spotted owl, interior least tern, southwestern willow flycatcher, and yellow-billed cuckoo. These species are discussed in detail in Section 5.2.5 of the Biological Evaluation.

Similar to general wildlife, impacts on special status birds are related to habitat disturbance or loss. Potential impacts would be minor on populations of these species, given the small percentage of suitable habitat disturbed in relation to the overall amount of habitat in the area of analysis. All action alternatives may affect individuals but would not likely result in a downward trend toward Federal listing or a loss of population viability for any of the special status bird species identified in **Table 3-19**; thus, these impacts would be minor on populations. (See Biological Evaluation, Section 5.3.4.3.2 for a detailed species discussion of potential impacts on bird species).

Fish Twelve special status fish species occur in or have the potential to occur in the area of analysis, including the loach minnow, spikedace, Gila topminnow, Gila chub, which are listed under the ESA. These species are discussed in detail in Section 5.2.5 in the Biological Evaluation.

All action alternatives may affect individuals but would not likely result in a downward trend toward Federal listing or a loss of population viability for any of the special status fish species identified in **Table 3-19**. Impacts are not anticipated to reach the population level for any of these species. This is because project activities would affect a small amount of suitable habitat, compared with the amount of habitat available to these species in the area of analysis. All alternatives could improve upstream passage for fish species over Alternative A because the river would no longer be blocked by push-up diversions; thus, these impacts would be minor on populations. Seasonal indirect impacts on fish, including special status species are summarized in in Section 5.3.4.3.3 of the Biological Evaluation.

Invertebrates Six special status invertebrate species have the potential to occur in the area of analysis. Based on these species' life histories and distributions, all action alternatives may affect individuals but would not be likely to result in a downward trend toward Federal listing or a loss of population viability for the invertebrate species of two caddisflies (*Lepidostoma apache* and *L. knulli*) and monarch butterfly. The dashed ringtail, Gila butterfly, and notodontid moth each would experience no impact under Alternative D. Alternatives B, C, and E may affect individual but are not likely to result in a downward trend toward Federal listing or a loss of population viability; thus, these impacts would be minor on populations. Seasonal indirect impacts on invertebrates are found in Section 5.3.4.3.4 of the Biological Evaluation.

Mammals Fifteen special status mammal species are known to occur or are possible to occur in the area of analysis. One species, the Mexican wolf, is listed under the ESA and is discussed in detail in Section 5.2.5 of the Biological Evaluation.

Impacts on special status mammals would be related to habitat degradation or disturbance from construction or operations the same as described for general wildlife above. Potential impacts would be minor on these species, given the small percentage of suitable habitat disturbed in relation to the overall amount of habitat in the area of analysis; thus, all action alternatives may affect individuals but would not likely result in a downward trend toward Federal listing or a loss of population viability for any of the special status mammal species identified in **Table 3-19** above. These impacts would be minor on populations. A detailed discussion of impacts on mammal species including seasonal indirect impacts on mammals, migrating bats, and breeding bats is found in Section 5.3.4.3.5 of the Biological Evaluation.

Reptiles Five special status reptile species are known to occur or are possible to occur in the area of analysis. Two species, the narrow-headed gartersnake and northern Mexican gartersnake, are Federally listed threatened species with designated habitat. They are discussed in detail in Section 5.2.5 in the Biological Evaluation. All action alternatives may affect individuals but would not likely result in a downward trend toward Federal listing or a loss of population viability for any of the special status reptile species identified in **Table 3-19** above. This is because impacts are not anticipated to reach the population level for any of these species; project activities would affect only a small amount of suitable habitat, compared with the amount of habitat available to these species in the area of analysis. For this reason, these impacts would be minor on populations (see Biological Evaluation, Section 5.3.4.3.6). **Table 3-20** summarizes impacts by period and life history requirements on reptiles.

Threatened and Endangered Species Fourteen species listed under the ESA are addressed in this EIS. A more detailed analysis of potential impacts on these species is included in the Biological Evaluation and will be included in the Biological Assessment. These species are the following: Chiricahua leopard frog, northern Mexican gartersnake, narrow-headed gartersnake, interior least tern, Mexican spotted owl, southwestern willow flycatcher, yellow-billed cuckoo, Mexican gray wolf, Gila chub, Gila topminnow, Gila trout, loach minnow, razorback sucker, and spikedace. Nine of these species have designated or proposed critical habitat in the area of analysis. This critical habitat and potential acres of short- and long-term impacts are given in **Table 3-24**; **Table 3-25** summarizes the potential direct and indirect impacts on species. Impacts of all action alternatives on species listed under the ESA are presented in detail in Section 5.2.5 of Biological Evaluation. **Table 3-20** summarizes seasonal impacts on threatened and endangered species. Specific impacts of each action alternative are presented in the following sections.

Alternative B: Proposed Action

Alternative B would result in direct and indirect impacts on biological resources, as described below. Acres of disturbance to vegetation communities for all action alternatives are provided in **Table 3-21**, **Table 3-22**, and **Table 3-23** for the Upper Gila, Virden Valley, and San Francisco River area of analysis, respectively. There would be no direct impacts on vegetation in the Lower Gila area of analysis.

Vegetation

Riparian and Wetlands Potential impacts on riparian and wetland areas would be as described above in *Impacts Common to all Alternatives*. Additional specific impacts on riparian and wetlands by area of analysis are described in the sections that follow. Acres of disturbance to riparian and wetland areas in each area of analysis are given in **Table 3-27**, **Table 3-28**, and **Table 3-29**.

Upper Gila Area of Analysis Project components unique to the Upper Gila area of analysis under Alternative B are lining the existing ditches and operating five production wells. Seepage from lined ditches would be reduced, adversely affecting the stringers of native riparian and wetland vegetation next to lined sections. The potential impact would be minimal because locations for lining were selected to avoid wetland and riparian vegetation. Direct short- and long-term impacts are summarized in **Table 3-27**.

The operation of production wells may adversely affect native riparian and wetland vegetation in the groundwater drawdown cone of depression. Approximately 10 feet of groundwater drawdown would occur at each of the five production wells 100 feet out; the depth would decrease to 5 feet of groundwater drawdown at a distance of 540 feet from each production well and 1 foot of drawdown at a distance of 2,100 feet from the production wells (HDR 2019b). Production wells 3 and 5 would each affect about a 0.5-mile reach of the Gila River, where depth to groundwater would increase 1 to 5 feet (HDR 2019b).

Roots for established riparian species are able to draw water from depths of greater than 5 feet (Rood et al. 2013); modeled changes would not occur at a rate that would exceed the ability of the existing riparian trees to grow roots to maintain a connection with groundwater (SSPA 2013). The potential impacts would be moderate on riparian vegetation in the two 0.5-mile stretches of the Gila River but would be minor elsewhere.

Table 3-24. Critical Habitat Impacts by Action Alternative (in Acres)

Area of Analysis and Critical Habitat	Total Acreage in Area of Analysis	Indirect Impacts Area Impacts	Direct Impacts Area Impacts	Alternative B		Alternative C		Alternative D		Alternative E	
				Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts
Upper Gila Area of Analysis											
Proposed critical habitat (PCH) for the yellow-billed cuckoo (*Coccyzus americanus*)	5,443.4	3,285.9	2,157.5	72.5 (3.4%)	48.9 (2.3%)	35.3 (1.6%)	29.7 (1.4)	0	0	51.6 (2.4%)	37.1 (1.7%)
PCH for the northern Mexican gartersnake (*Thamnophis eques megalops*)	4,784.7	2,923.5	1,861.2	30.5 (1.6%)	19.0 (1.0%)	12.7 (0.7%)	10.0 (0.5%)	0	0	8.2 (0.4%)	4.1 (0.2%)
Designated critical habitat (DCH) for the southwestern willow flycatcher (*Empidonax traillii extimus*)	3,740.2	2,803.5	936.7	19.1 (2.0%)	10.3 (1.1%)	5.7 (0.6%)	3.2 (0.3%)	0	0	5.6 (0.6%)	3.1 (0.3%)
DCH for Mexican spotted owl (*Strix occidentalis lucida*)	0	0	0	0	0	0	0	0	0	0	0
DCH for Gila chub (*Gila intermedia*)	16.4	16.4	0	0	0	0	0	0	0	0	0
PCH for narrow-headed gartersnake (*Thamnophis rufipunctatus*)	4,784.7	2,923.5	1,861.2	30.5 (1.6%)	19.0 (1.0%)	12.7 (0.7%)	10.0 (0.5%)	0	0	8.2 (0.4%)	4.1 (0.2%)
DCH for loach minnow (*Tiaroga cobitis*) (values in feet)[†]	459,959.6	413,549.2	46,410.4	140.0 (0.3%)	70.8 (0.2%)	103.6 (0.2%)	52.0 (0.1%)	0	0	0	0

Area of Analysis and Critical Habitat	Total Acreage in Area of Analysis	Indirect Impacts Area Impacts	Direct Impacts Area Impacts	Alternative B		Alternative C		Alternative D		Alternative E	
				Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts
DCH for spikedace (*Meda fulgida*) (values in feet)†	453,439.2	413,549.2	39,890.0	140.0 (0.4%)	70.8 (0.2%)	103.6 (0.3%)	52.0 (0.1%)	0	0	0	0
Virden Valley Area of Analysis											
PCH for the yellow-billed cuckoo	1,673.4	475.3	1,198.1	19.8 (1.7%)	18.0 (1.5%)	19.8 (1.7%)	18.0 (1.5%)	19.8 (1.7%)	18.0 (1.5%)	19.8 (1.7%)	18.0 (1.5%)
PCH for the northern Mexican gartersnake	4,202.7	2,819.9	1,382.8	0	0	0	0	0	0	0	0
DCH for the southwestern willow flycatcher	1,663.0	671.3	991.7	0	0	0	0	0	0	0	0
DCH for razorback sucker	727.9	727.3	0.6	0	0	0	0	0	0	0	0
PCH for narrow-headed gartersnake	4,202.7	2,819.9	1,382.8	0	0	0	0	0	0	0	0
DCH for loach minnow (values in feet)†	47,212.1	0	47,212.1	0	0	0	0	0	0	0	0
DCH for spikedace (values in feet)†	47,212.1	0	47,212.1	0	0	0	0	0	0	0	0
San Francisco River Area of Analysis											
PCH for the yellow-billed cuckoo	2,451.1	1,371.9	1,079.2	22.5 (2.1%)	15.8 (1.5%)	24.1 (2.2%)	18.6 (1.7%)	0	0	48.4 (4.5%)	28.8 (2.7%)
PCH for the northern Mexican gartersnake	22.0	22.0	0	0	0	0	0	0	0	0	0
DCH for the southwestern willow flycatcher	2,364.8	1,584.7	780.1	14.1 (1.8%)	9.2 (1.2%)	15.2 (1.9%)	10.8 (1.4%)	0	0	35.4 (4.5%)	19.6 (2.5%)
DCH for Mexican spotted owl	398.9	398.9	0	0	0	0	0	0	0	0	0

Area of Analysis and Critical Habitat	**Total Acreage in Area of Analysis**	**Indirect Impacts Area Impacts**	**Direct Impacts Area Impacts**	**Alternative B**		**Alternative C**		**Alternative D**		**Alternative E**	
				Direct, Short-Term Impacts	**Direct, Long-Term Impacts**	**Direct, Short-Term Impacts**	**Direct, Long-Term Impacts**	**Direct, Short-Term Impacts**	**Direct, Long-Term Impacts**	**Direct, Short-Term Impacts**	**Direct, Long-Term Impacts**
DCH for razorback sucker	0.3	0.3	0	0	0	0	0	0	0	0	0
DCH for Gila chub	3.0	3.0	0	0	0	0	0	0	0	0	0
PCH for narrow-headed gartersnake	5,123.1	3,722.3	1,400.8	19.1 (1.4%)	11.1 (0.8%)	19.8 (1.4%)	12.6 (0.9%)	0	0	45.8 (3.3%)	24.8 (1.8%)
DCH for loach minnow (values in feet)†	450,613.0	446,216.4	4,396.6	1,088.4 (24.8%)	750.1 (17.1%)	605.1 (13.8%)	145.6 3.3%)	0	0	695.1 (15.8%)	401.7 (9.1%)
DCH for spikedace (values in feet)†	447,991.3	443,594.7	4,396.6	1,088.4 (24.8%)	750.1 (17.1%)	605.1 (13.8%)	145.6 3.3%)	0	0	695.1 (15.8%)	401.7 (9.1%)
PCH for the yellow-billed cuckoo	14,315.9	14,315.9	0	0	0	0	0	0	0	0	0
PCH for the northern Mexican gartersnake	1.0	1.0	0	0	0	0	0	0	0	0	0
DCH for the southwestern willow flycatcher	10,024.7	10,024.7	0	0	0	0	0	0	0	0	0
DCH for razorback sucker	2,080.6	2,080.6	0	0	0	0	0	0	0	0	0
PCH for narrow-headed gartersnake	162.6	162.6	0	0	0	0	0	0	0	0	0

Source: USFWS Environmental Conservation Online System (ECOS) 2019b, Internet website: https://ecos.fws.gov/ecp/report/table/critical-habitat.html
† DCH for loach minnow and spikedace values are all reported in feet of impacts not acres.
Note: Percent is the percentage of direct impacts area acreage.

Table 3-25. Habitat Acres Impacted by Action Alternative for Select ESA-listed Species (in Acres)[16]

Area of Analysis and Critical Habitat	Total Acreage in Area of Analysis	Indirect Impacts Area Impacts	Direct Impacts Area Impacts	Alternative B		Alternative C		Alternative D		Alternative E	
				Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts
Upper Gila Area of Analysis											
Yellow-billed cuckoo	2735.3	1827.9	907.4	32.4 (3.6%)	19.9 (2.2%)	12.3 (1.4%)	9.2 (1.0%)	0	0	20.6 (2.3%)	13.4 (1.5%)
Southwestern willow flycatcher	2735.3	1827.9	907.4	32.4 (3.6%)	19.9 (2.2%)	12.3 (1.4%)	9.2 (1.0%)	0	0	20.6 (2.3%)	13.4 (1.5%)
Northern Mexican gartersnake	5347.8	3541.4	1806.4	50.4 (2.8%)	31.6 (1.7%)	17.6 (1.0%)	13.2 (0.7%)	0	0	67.9 (3.8%)	56.8 (3.1%)
Narrow-headed gartersnake	5347.8	3541.4	1806.4	50.4 (2.8%)	31.6 (1.7%)	17.6 (1.0%)	13.2 (0.7%)	0	0	67.9 (3.8%)	56.8 (3.1%)
Virden Valley Area of Analysis											
Yellow-billed cuckoo	2495.8	1827.1	668.7	0	0	0	0	0	0	0	0
Southwestern willow flycatcher	2495.8	1827.1	668.7	0	0	0	0	0	0	0	0
Northern Mexican gartersnake	1708.4	1137.9	570.5	3.0 (0.5%)	2.1 (0.4%)	3.0 (0.5%)	2.1 (0.4%)	3.0 (0.5%)	2.1 (0.4%)	3.0 (0.5%)	2.1 (0.4%)
Narrow-headed gartersnake	1708.4	1137.9	570.5	3.0 (0.5%)	2.1 (0.4%)	3.0 (0.5%)	2.1 (0.4%)	3.0 (0.5%)	2.1 (0.4%)	3.0 (0.5%)	2.1 (0.4%)
San Francisco River Area of Analysis											
Yellow-billed cuckoo	2496.6	1827.9	668.7	12.9 (1.9%)	8.4 (1.3%)	8.8 (1.3%)	6.2 (0.9%)	0	0	21.4 (3.2%)	12.5 (1.9%)

[16] Habitat for the yellow billed cuckoo and southwestern willow flycatcher is based on NWI Forested/Shrub Riparian and Freshwater Forested/Shrub Wetland NWI classifications. Gartersnakes include these and the Freshwater Emergent Wetland, Herbaceous Riparian Wetland, Freshwater Pond and Riverine NWI classifications. These differ from designated critical habitat acres.

Area of Analysis and Critical Habitat	Total Acreage in Area of Analysis	Indirect Impacts Area Impacts	Direct Impacts Area Impacts	Alternative B		Alternative C		Alternative D		Alternative E	
				Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts	Direct, Short-Term Impacts	Direct, Long-Term Impacts
Southwestern willow flycatcher	2496.6	1827.9	668.7	12.9 (1.9%)	8.4 (1.3%)	8.8 (1.3%)	6.2 (0.9%)	0	0	21.4 (3.2%)	12.5 (1.9%)
Northern Mexican gartersnake	4980.2	3541.4	1438.8	16.9 (1.2%)	11.6 (0.8%)	13.1 (0.9%)	9.8 (0.7%)	0	0	32.2 (2.2%)	19.0 (1.3%)
Narrow-headed gartersnake	4980.2	3541.4	1438.8	16.9 (1.2%)	11.6 (0.8%)	13.1 (0.9%)	9.8 (0.7%)	0	0	32.2 (2.2%)	19.0 (1.3%)

Source: USFWS 2019b

* Note: Percent is the percentage of direct impacts area acreage. Totals may not add up due to rounding.

Table 3-26. Vegetation Potentially Impacted by Drawdown related to the Production Wells in the Upper Gila Area of Analysis (Alternative B)

NWI Wetlands Class	Acres within Drawdown Contour		
	1-foot contour	5-foot contour	10-foot contour
Forested/Shrub Riparian	62.2	1.7	0.0
Freshwater Emergent Wetland	12.5	0.0	0.0
Freshwater Forested/Shrub Wetland	44.5	0.0	0.0
Freshwater Pond	3.9	0.0	0.0
Herbaceous Riparian	25.5	0.2	0.0
Riverine	62. 1	2.6	0.1

Source: USFWS 2019a
Note: NWI Wetland categories used for calculation of riparian/wetland vegetation acreage.

Table 3-27. Upper Gila Area of Analysis Riparian/Wetland Direct Impacts (in Acres)[†]

Area of Analysis	Total Acreage in Area of Analysis	Indirect Impacts Area Impacts	Direct Impacts Area Impacts	Alternative B		Alternative C		Alternative E	
				Direct, Short-Term Impacts*	Direct, Long-Term Impacts*	Direct, Short-Term Impacts*	Direct, Long-Term Impacts*	Direct, Short-Term Impacts*	Direct, Long-Term Impacts*
Forested/ Shrub Riparian	1,770.0	1,214.8	555.2	15.1 (2.7%)	10.0 (1.8%)	6.8 (1.2%)	5.8 (1.0%)	5.8 (1.0%)	4.9 (0.9%)
Freshwater Emergent Wetland	361.5	198.0	163.5	2.1 (1.3%)	1.2 (0.7%)	0.4 (0.2%)	0.2 (0.1%)	29.6 (18.1%)	28.7 (17.6%)
Freshwater Forested/ Shrub Wetland	965.3	613.1	352.2	17.4) (4.9%)	9.9 (2.8%)	5.4 (1.5%)	3.4 (1.0%)	14.7 (4.2%)	8.5 (2.4%)
Freshwater Pond	11.6	0	11.6	1.1 (9.5%)	1.1 (9.5%)	1.1 (9.5%)	1.1 (9.5%)	0	0
Herbaceous Riparian	523.8	377.6	146.2	0.6 (0.4%)	0.1 (0.1%)	0	0	0	0
Riverine	1,715.6	1,137.9	577.7	14.2 (2.5%)	9.4 (1.6%)	3.9 (0.7%)	2.7 (0.5%)	17.7 (3.1%)	14.7 (2.5%)
Total	**5,347.8**	**3,541.4**	**1,806.4**	**50.4 (2.8%)**	**31.6 (1.7%)**	**17.6 (1.0%)**	**13.2 (0.7%)**	**67.9 (3.8%)**	**56.8 (3.1%)**

Source: USFWS 2019a
Note: NW Wetland types used for calculation of total riparian/wetland vegetation acreage: Forested/Shrub Riparian, Freshwater Emergent Wetland: Freshwater Forested/Shrub Wetland, Freshwater Pond, Herbaceous Riparian, and Riverine.
[†]There are no project components proposed for Alternative D in the Upper Gila area of analysis.
***** Percent is the percentage of the direct impact acres.

Table 3-28. Virden Valley Area of Analysis Riparian/Wetland Direct Impacts (in Acres)

Area of Analysis	Total Acreage in Area of Analysis	Indirect Impacts Area Impacts	Direct Impacts Area Impacts	Alternatives B, C, D, and E	
				Direct, Short-Term Impacts*	Direct, Long-Term Impacts*
Forested/Shrub Riparian	1,840.9	1,214.	626.1	0	0
Freshwater Emergent Wetland	250.6	198.0	52.6	0	0
Freshwater Forested/Shrub Wetland	655.7	613.1	42.6	0	0
Freshwater Pond	5.5	0	5.5	0	0
Herbaceous Riparian	519.3	377.6	141.7	0	0
Riverine	1,708.4	1,137.9	570.5	3.0 (0.5%)	2.1 (0.4%)
Total	**4,980.2**	**3,541.**	**1,438.8**	**3.0 (0.2%)**	**2.1 (0.1%)**

Source: USFWS 2019a
Note: NWI Wetland types used for calculation of total riparian/wetland vegetation acreage: Forested/Shrub Riparian, Freshwater Emergent Wetland: Freshwater Forested/Shrub Wetland, Freshwater Pond, Herbaceous Riparian, and Riverine
***** Percent is the percentage of the direct impact acres.

Table 3-29. San Francisco River Area of Analysis Riparian/Wetland Direct Impacts (in Acres)[†]

Area of Analysis	Total Acreage in Area of Analysis	Indirect Impacts Area Impacts	Direct Impacts Area Impacts	Alternative B		Alternative C		Alternative E	
				Direct, Short-Term Impacts*	Direct, Long-Term Impacts*	Direct, Short-Term Impacts*	Direct, Long-Term Impacts*	Direct, Short-Term Impacts*	Direct, Long-Term Impacts*
Forested/ Shrub Riparian	1,840.9	1,214.8	626.1	8.6 (1.4%)	4.6 (0.7%)	8.6 (1.4%)	6.1 (1.0%)	20.1 (3.2%)	11.7 (1.9%)
Freshwater Emergent Wetland	250.6	198.0	52.6	0	0	0	0	0	0
Freshwater Forested/ Shrub Wetland	655.7	613.1	42.6	0.1 (0.2%)	0.1 (0.2%)	0.2 (0.5%)	0.1 (0.2%)	1.3 (3.1%)	0.8 (1.9%)
Freshwater Pond	5.5	0	5.5	0	0	0	0	0	0
Herbaceous Riparian	519.3	377.6	141.7	0	0	0	0	0	0
Riverine	1,708.4	1,137.9	570.5	2.9 (0.5%)	3.9 (0.7%)	2.9 (0.5%)	3.9 (0.7%)	3.8 (0.7%)	2.7 (0.5%)
Total	**4,980.2**	**3,541.4**	**1,438.8**	11.7 **(0.8%)**	8.5 **(0.6%)**	11.8 **(0.8%)**	10.1 **(0.7%)**	25.2 **(1.8%)**	15.2 **(1.1%)**

Source: USFWS 2019a
Note: NWI Wetland types used for calculation of total riparian/wetland vegetation acreage: Forested/Shrub Riparian, Freshwater Emergent Wetland: Freshwater Forested/Shrub Wetland, Freshwater Pond, Herbaceous Riparian, and Riverine.
[†]There are no project components proposed for Alternative D in the San Francisco area of analysis.
***** Percent is the percentage of the direct impact acres.

Freshwater Emergent Wetland and Herbaceous Riparian vegetation types may be affected by groundwater drawdown within the 5-foot drawdown contour on about 1.9 acres and on about 87.7 acres in the 1-foot drawdown contour; no riparian or wetland vegetation is anticipated for the 10-foot drawdown contour area (**Table 3-26**). Impacts on groundwater levels expected from production wells #3 and #5 would adversely affect wetland vegetation.

Virden Valley Area of Analysis All action alternatives in the Virden Valley are the same. Project diversions would not affect spring runoff and there may be some recharge from unlined sections of the existing canals from AWSA water (HDR 2019b). Direct short- and long-term impacts are summarized in **Table 3-28**.

San Francisco River Area of Analysis Seepage from unlined ditches may have localized beneficial impacts on wetland and riparian vegetation. Project diversions do not affect spring runoff, allowing for downstream alluvial recharge. There would be negligible to minor local effects on wetland and riparian vegetation. Direct short- and long-term impacts are summarized in **Table 3-29**.

Springs, Seeps, and Water Improvements Potential impacts on seeps and springs in the Upper Gila area of analysis would include reduced flows from seeps and springs in areas where groundwater pumping from production wells could locally increase the depth to groundwater. This could affect riparian and wetland vegetation in the direct impacts area. Upland vegetation would likely not be affected. These impacts are described in detail in Section 5.2.3.2 of the Biological Evaluation.

Based on HDR (2019b), seven seeps or springs occur between 540 and 2,100 feet from a production well. Under Alternative B there could be changes in flows associated with increases in depth to groundwater of 1 to 5 feet. These potential impacts on seeps and springs would range in severity from minor to negligible in the Cliff-Gila area of analysis. No production wells are proposed in the Virden Valley and San Francisco River areas of analysis; in these areas, impacts on springs and seeps would be negligible.

Special Status Plant Species The potential direct impacts on special status species would be similar to those described above in *Impacts Common to All Action Alternatives*. Acres of potential impacts and percent of habitat to be disturbed for special status plant species are given in **Table 3-21**, **Table 3-22**, and **Table 3-23**.

Upper Gila Area of Analysis As none of the special status species that are found in riparian areas are possible or known to occur in the Upper Gila area of analysis, there would be no potential impacts from Alternative B from hydrologic alterations or increasing depth to groundwater from cones of depression associated with production wells. Greene milkweed occurs in yucca grasslands with scattered junipers and has the potential to occur in the Upper Gila area of analysis in upland vegetation communities. Potential minor to moderate short-term impacts on Greene milkweed would be from direct disturbance associated construction. Wilcox's pincushion cactus has the potential to occur in upland habitats. Potential impacts would be limited to direct disturbance of habitat associated with construction and would be negligible to minor.

Virden Valley Area of Analysis Potential impacts on Parish's alkali grass would be limited to the Virden Valley area of analysis. None of this species' habitats would be disturbed under any of the action alternatives. This species has the potential to occur at seeps and springs in this area; however, no impacts on seeps and springs are expected in the Virden Valley area of analysis. This is because changes in groundwater levels would be minor (HDR 2109b). As such, potential impacts on the species from Alternative B and all other action alternatives would be negligible.

Potential minor adverse impacts on night-blooming cereus from Alternative B would be limited to direct disturbance-related impacts in the Virden Valley area of analysis. Potential impacts on Wilcox's pincushion cactus in the Virden Valley would be limited to minor direct disturbance to its habitat.

San Francisco River Area of Analysis Potential minor impacts on habitat for Arizona alum root and Clifton rock daisy would occur only in the San Francisco River area of analysis in the riparian area.

Greene milkweed occurs in yucca grasslands with scattered junipers and has the potential to occur in both the Upper Gila area of analysis and the San Francisco River area of analysis in upland vegetation communities. Potential minor impacts on the species would be from direct disturbance.

Lower Gila Area of Analysis Clifton rock daisy and Pima Indian mallow could occur in the Lower Gila indirect impacts area; however, no impacts on these species are anticipated. This is because no direct disturbance is planned, and changes to surface and groundwater hydrology would be negligible in this area.

Aquatic and Terrestrial Wildlife Potential impacts of Alternative B on general wildlife species would occur, as described in *Impacts Common to All Action Alternatives*. The following describes specific impacts expected to occur under Alternative B, broken down by construction, operation, and maintenance activities for each area of analysis.

Construction

Upper Gila Area of Analysis Wildlife habitat would be permanently or temporarily disturbed under Alternative B. Approximately 294.1 acres would be affected long term in the Upper Gila direct impacts area, and approximately 381.6 acres would be affected in the short term (see **Table 3-21** for a breakdown of disturbance to vegetation communities). Because some of the area of analysis is currently disturbed, these areas are typically lower-quality wildlife habitat than undisturbed areas. Because these acreages of disturbance would represent less than 4 percent of the total of the Upper Gila direct impacts area, loss of habitat for any given wildlife species under Alternative B would be minor.

As proposed under Alternative B, power lines extending from existing lines would occur within areas that are already moderately to highly disturbed; thus, adverse, indirect impacts on wildlife arising from habitat loss, degradation, or fragmentation from power line construction under Alternative B would be minor.

Indirect, adverse impacts are expected on wildlife from habitat loss and habitat fragmentation resulting from the following: buried pipe extension of the Upper Gila Ditch; widening and lining of existing ditches at the Upper Gila Ditch, Fort West Ditch, Gila Farms Connector Ditch, and McMillen Ditch; creation of an extension of the Fort West Ditch; and construction of a siphon at the Fort West Extension. Many of these impacts would be in existing conveyance ditches or would involve pipe installation; because of this, permanent impacts on habitat and habitat fragmentation under Alternative B would be localized around areas of disturbance and would be minor.

Virden Valley Area of Analysis Approximately 116.0 acres would be affected long term in the Virden Valley direct impacts area; approximately 131.5 acres would be affected in the short term (see

Table 3-22). Some of the area is disturbed and this is typically lower-quality wildlife habitat, and these acreages represent less than 2 percent of the total of the Virden Valley direct impacts area. Because of this, loss of habitat for any given wildlife species would be minor and would not rise to the level of population-wide impacts for any species.

Construction may adversely affect nesting western burrowing owls. Implementation of BMPs and mitigation measures would minimize impacts on burrowing owls; examples of these measures are avoiding construction during burrowing owl nesting and fledging periods and conducting pre-construction nesting surveys. While some individuals could be affected, a downward trend toward Federal listing or a loss of population viability is unlikely; thus, these impacts would be minor on populations.

At the Virden Valley direct impacts area, pond 10P would require a 500-foot extension from the existing power line and pond 11P could require a realignment of approximately 2,100 feet of power line. Because these extensions would be short distances and would occur in areas that are moderately to highly disturbed, such as dirt roads or cleared areas, impacts on wildlife from habitat loss, degradation, and fragmentation would be minor.

San Francisco River Area of Analysis Approximately 7.7 acres would be affected long term in the San Francisco River direct impacts area; approximately 15.5 acres would be affected in the short term (see **Table 3-23**). Some of the areas are disturbed and are typically lower-quality wildlife habitat and these acreages represent less than 1 percent of the total of the San Francisco River direct impacts area. Because of this, loss of habitat for any given wildlife species would be minor, depending on individual species' life history and distribution, and would not rise to the level of population-wide impacts for any species.

Indirect, adverse impacts are expected on wildlife from habitat loss and habitat fragmentation that would result from the buried pipe conveyance from Spurgeon Diversion to the Thomason Flat Ditch and would include a siphon under Pueblo Creek. Because a large portion of these impacts would involve installing pipes, permanent impacts on habitat would be minimal. There would not likely be permanent habitat fragmentation in the San Francisco River direct impacts area as a result of the installing a buried pipe conveyance.

Operation and Maintenance

Upper Gila Area of Analysis The proposed permanent diversions would alter wildlife habitat by backing up water upstream of the proposed diversions on the Gila River. Similarly, the creation of four storage ponds under Alternative B would create pool habitat that could favor nonnative predators. Impacts from nonnative predators would be as described above in *Impacts Common to All Action Alternatives*. Because these nonnative predators already occur and are widespread and abundant in portions of the Gila River main stem (SWCA 2019d; USFWS 2014b), adverse impacts on native species would be minor at the population level. In addition, the creation of storage ponds may have beneficial impacts on some wildlife species, as described above in *Impacts Common to All Action Alternatives*. Because other, natural, water sources occur in the area, these pools would represent a small increase in potential habitat for wildlife species in the area of analysis.

The expansion in capacity of the Ft. West Ditch would result in additional unlined surface area and would increase ditch flows. This could allow for some persistence and establishment of riparian habitat in the direct impacts area. These increases could have a beneficial impact on some species, as described in *Impacts Common to All Action Alternatives*. Conversely, sections of the Ft West Ditch and Ft. West

Extension would be lined, resulting in localized minor adverse impacts on riparian habitat due to reduced seepage.

Operation of the five production wells would increase the level of noise in the Upper Gila direct impacts area. Impacts would be minor for individuals and would be negligible at the population level. In addition, some of the pumps are in areas where ambient noise levels would be higher.

Potential impacts on riparian and wetland habitats could occur from increasing depths to groundwater by operating the five production wells (see Table 5-8 in the Biological Evaluation). This could have a moderate adverse impact on riparian and wetland vegetation in the area. As such, impacts on wildlife would arise from long-term loss or degradation of habitat and could be moderate on individuals in the cone of depression; however, they would be minor on populations of these species due to the amount of additional riparian and wetland habitat in the area of analysis.

Potential impacts under Alternative B from operating additional power lines include the potential for birds striking electrical distribution lines. Small and agile bird species would have a very low potential for collisions. The presence of electrical distribution poles would provide perches and nesting habitat for some species and could increase impacts on prey species nearby. While some individuals could be affected, these impacts would be unlikely to occur and would be negligible to minor for bird populations.

The proposed permanent diversions would alter wildlife habitat by backing up water upstream of the proposed diversions on the Gila River. The proposed fixed crest weir diversion structures would likely back up water at a broader range of flows than the current push-up diversion structures.

Nonnative species were commonly encountered during surveys of the Upper Gila direct impacts area (SWCA 2019a, 2019d). Aquatic, wetland, or riparian species would experience measurable adverse impacts long term under Alternative B; however, these nonnative species already occur and are widespread and abundant in portions of the Gila River mainstem (SWCA 2019d; USFWS 2014c). Because of this, impacts on native species would be minor at the population level.

Virden Valley Area of Analysis There would be no increase or decrease in diversion maintenance frequency in the Virden Valley direct impacts area. This is because the existing Sunset and New Model Diversion structures would remain unmodified under Alternative B. Impacts on wildlife would remain the same as under current conditions.

The creation of two clay-lined storage ponds at the Virden Valley direct impacts area could create pool habitat that would favor nonnative species. Impacts on wildlife from nonnative species would be as described above in *Impacts Common to All Action Alternatives*. In the Virden Valley area of analysis, native species that are restricted to the aquatic, wetland, or riparian habitats may experience minimal impacts from the increase of nonnative predator habitat and abundance; however, these nonnative species already occur and are widespread and abundant in portions of the Gila River main stem (SWCA 2019d; USFWS 2014b). In addition, the creation of storage ponds may have beneficial impacts on some wildlife species, as described above in *Impacts Common to All Action Alternatives*. Because other natural water sources occur in the area, these pools would represent a small increase in potential habitat for wildlife species.

Potential impacts from operating additional power lines include the birds striking electrical distribution lines. Small and agile bird species would have a very low potential for collisions. The presence of electrical distribution lines would provide perches and nesting habitat for some species and could increase impacts on prey species nearby. While some individuals could be affected, these impacts would be unlikely and would be negligible to minor for bird populations.

San Francisco River Area of Analysis Maintenance may be required in the San Francisco River channel to repair any damage to the fixed crest weir diversion and accompanying components. Impacts from maintenance would be similar to those described above from construction; however, these impacts would occur for a short period and would be limited to the area surrounding maintenance activities, so they would be of a lower intensity than during construction. The potential impacts would be minor at the species' population level because of the small area affected, compared with the overall available wildlife habitat in the area of analysis and the short duration of impacts.

Diversion operations would affect downstream flows in the San Francisco River. The extent and location of drying near or downstream of the diversion may change under Alternative B (see Section 4.2.1.1.4 of the Biological Evaluation). Overall impacts on riparian vegetation in the San Francisco River area of analysis are expected to be minor (see Section 5.2.3.2 of the Biological Evaluation); therefore, impacts on wildlife habitat under Alternative B would also be minor.

The impacts of the proposed permanent diversions backing up water would be the same as described for the Upper Gila area of analysis. There would be no storage ponds or new powerlines created in the San Francisco River area, so there would be no impacts on wildlife from these features.

The proposed permanent diversion would alter wildlife habitat by backing up water upstream of the proposed diversions on the San Francisco River. The proposed fixed crest weir would likely back up water at a broader range of flows than the current push-up diversion structures, which may be breached at higher flows. Aquatic habitat would be created that favors nonnative species, as described above in *Impacts Common to All Action Alternatives*. In the San Francisco River area of analysis, native species that are restricted to the aquatic, wetland, or riparian habitats may experience minor impacts from an increase of nonnative predator habitat and abundance. Aquatic, wetland, or riparian species would experience adverse long-term impacts under Alternative B; however, because these nonnative species already occur and are widespread and abundant in portions of the San Francisco River mainstem, impacts on native species would be minor at the population level.

Special Status Species Impacts on special status species would be as described under *Impacts Common to All Action Alternatives*. Additional impacts on special status species specific to Alternative B are described below.

Alternative B also would affect riparian obligate species, such as the Arizona toad, dashed ringtail, Gila mayfly, and the notodontid moth species. This would come about through additional loss or degradation of riparian and wetland habitat from production wells in the Upper Gila direct impacts areas and associated groundwater drawdown and loss of riparian and wetland habitat. Impacts would be minor on populations of these species, given the small percentage of suitable habitat disturbed in relation to the overall amount of habitat in the area of analysis.

Alternative B may affect individuals but would not likely result in a downward trend toward Federal listing or a loss of population viability for any of the special status fish species. This is because impacts would not reach the population level for any of these species; instead, project activities would affect a small amount of suitable habitat, compared with the amount of habitat available to these species in the area of analysis. The inclusion of a riffle run-down apron may improve upstream and downstream fish passage for such species as spikedace and loach minnow. Increases in surface water flows during spring and summer (see HDR 2019a and Appendix G in the Biological Evaluation) may provide minor beneficial impacts on fish species. See **Table 3-20** for a summary of impacts.

Threatened and Endangered Species Alternative B would have no impact on the Chiricahua leopard frog because none are present in any direct impact areas. There would be minor to moderate adverse effects on the following species: southwestern willow flycatcher, interior least tern, northern Mexican gartersnake, and narrow-headed gartersnake. This would be due to direct short- and long-term impacts on proposed and designated critical habitat (see **Table 3-24**) and habitat (see **Table 3-25**). Indirect impacts due to surface water alteration would be minor for these species.

There may be minor beneficial impacts in the Upper Gila and San Francisco direct impacts areas due to increased surface water flow during spring and summer (see **Table 3-20**). There would be moderate adverse impacts on listed fish species due to short- and long-term impacts on critical habitat (see **Table 3-24**). Reductions in surface water flows during periods of heavy diversion, such as during the winter base flow period, could affect winter habitat and would adversely affect fish populations. Impacts would be greater in the Cliff-Gila and San Francisco River areas of analysis than the Virden Valley area of analysis due to the greater impacts from constructing the proposed diversion, conveyance, storage components.

Fish passage considered in the design of the proposed fixed crest weirs would provide minor beneficial impacts on fish populations through enhancing the ability of fish passage upstream of the diversion. To assess the ability of fish to pass through the fish passage features, swim performance thresholds were adapted from Ward et al. (2003) and Molles and Nislow (unpublished) and from swim trials of spikedace and loach minnow at the Aquatic Research and Conservation Center in Cornville, Arizona (Stahr 2019).

Table 5-10 in the Biological Evaluation summarizes swim performance thresholds that would allow for fish passage and Table 5-11 in the Biological Evaluation summarizes the results of HEC-RAS modeling of flow velocities through the proposed fixed crest weir diversion at the Cliff-Gila project location (HDR 2019a). Loach minnow would be able to pass through the diversion structure at flows at or less than 750 cfs (1.25-year event); they would be able to maintain position at flow of less than 2,250 cfs (2-year event); however, spikedace would pass through the diversion structure only during low flow conditions of less than 10 cfs and would be able to maintain position at flows of less than 143 cfs. Incorporating the fish passage structures would provide a minor to moderate beneficial impact for the loach minnow and a minor benefit for the spikedace, compared with Alternative A.

Modeled flow velocities in the San Francisco project location are presented Table 5-12 in the Biological Evaluation. Loach minnow would be able to pass through the diversion structure during low flow conditions of approximately 88 cfs and would be able to maintain position at the 1.05-year event of approximately 108 cfs. Spikedace would pass through the diversion at very low flows, approximately 10 cfs. Spikedace may be able to maintain position at the 1.01-year flow of approximately 79 cfs. There would be minor beneficial impacts on both species due to the consideration of fish passage in the design of the proposed fixed crest weir.

There would be no or negligible effects on other listed species.

Conclusion Under Alternative B, there would be minor direct impacts on vegetation and wildlife habitat for all project locations. Short-term construction affects a small percentage of the available habitat win the direct impacts areas and would be of short duration. Long-term impacts are associated with operations and maintenance.

A small amount of available habitat would be affected in the long term. Periodic disturbance in the form of noise and human presence would continue for the duration of the project. Localized minor adverse impacts on riparian and wetland vegetation would occur from lining irrigation ditches.

Impacts on wildlife at the population level are generally minor, given the amount of habitat available in the area of analysis. Impacts on special status species and Federally listed threatened and endangered species range from adverse minor to moderate impacts. Impacts on riparian and terrestrial species would be minor to moderate. This is due to the small acreages disturbed, relative to the total habitat available and the timing of diversions, which would maintain surface water flows during breeding and juvenile rearing periods. Impacts on aquatic species, such as fish, could rise to the level of moderate adverse impacts due to habitat loss and overall reduction in surface water flows.

Incorporating fish passage in the diversion structure design provides beneficial impacts on fish populations by allowing for upstream and downstream fish passage. Increased flows during the snowmelt/runoff and summer base flow periods would provide beneficial impacts on fish species in the direct area of analysis. Indirect impacts due to flow alterations would have negligible to minor impacts, given that the proposed diversions are not anticipated to substantially affect river flows downstream in the indirect impact areas.

Alternative C

Alternative C would result in direct and indirect impacts on biological resources, as described below. Direct impacts on vegetation communities for all action alternatives are provided in **Table 3-21**, **Table 3-22**, and **Table 3-23** for the Upper Gila, Virden Valley, and San Francisco River areas of analysis, respectively. There would be no direct impacts on vegetation in the Lower Gila area of analysis.

Vegetation

Riparian and Wetland Areas Potential impacts on riparian and wetland areas would be as described above in *Impacts Common to all Alternatives*. Additional specific impacts on riparian and wetlands by area of analysis are described in the following sections. Acres of disturbance to riparian and wetland in each area of analysis are given in **Table 3-27**, **Table 3-28**, and **Table 3-29**.

Upper Gila Area of Analysis Proposed project components do not include lining irrigation ditches or production wells. The proposed diversions consist of rock vane weirs in the general location of the existing push-up diversions. Impacts on riparian and wetland vegetation would be similar to those under Alternative A. Seepage from unlined irrigation ditches would continue to support riparian and wetland vegetation next to the irrigation ditches. Decreased surface water flow may affect riparian and wetland vegetation along the river edge; however as demonstrated by Hathaway et al. 2016 and SSPA 2013, changes in surface water flows would not greatly affect streamside vegetation. There would be negligible to minor impacts on riparian and wetland vegetation.

Virden Valley Area of Analysis For the Virden Valley, the components proposed for Alternative C are the same as for Alternative B and construction impacts would be the same.

San Francisco River Area of Analysis Proposed project components that would affect riparian and wetland vegetation are the expanding of unlined ditches and water storage in an unlined reservoir in Weedy Canyon. The proposed diversion structure would be a rock vane weir near the existing Thomason Flat push-up diversion. There would be minor impacts on riparian and wetland areas and minor to moderate impacts on all vegetation communities due to storage in Weedy Canyon. There may be localized negligible to minor beneficial impacts due to groundwater seepage from expanded, unlined ditches or from the unlined storage at Weedy Canyon.

Springs, Seeps, and Water Improvements There would be negligible impacts on springs, seeps, and water improvements. There are no production wells proposed. Impacts would be related to changes in surface water hydrology, which would not affect upland vegetation.

Special Status Plant Species Potential direct impacts on special status species would be similar to those described above in *Impacts Common to All Action Alternatives*. Acres of potential impacts and percent of habitat to be disturbed for special status plant species are given in **Table 3-21**, **Table 3-22**, and **Table 3-23**. For all special status plant species, except Pima Indian mallow and Parish's alkali grass, which would have negligible impacts, the potential impacts under Alternative C would be minor at the population level. This would be due to the small percent of the available habitat to be disturbed in relation to the overall area of analysis.

Upper Gila Area of Analysis Greene milkweed occurs in yucca grasslands with scattered junipers and has the potential to occur in the Upper Gila area of analysis. Wilcox's pincushion cactus also could occur in the Upper Gila area of analysis. Impacts would occur on about 105.0 acres of habitat for the species short term and 95.0 acres long term in the Upper Gila area of analysis. This represents about 1.6 and 1.5 percent, respectively, of the habitat for the species in this area of analysis.

Wilcox's pincushion cactus also could occur in the Upper Gila area of analysis. Approximately 101.7 acres of suitable habitat would be disturbed under Alternative C.

Virden Valley Area of Analysis The potential impacts on these species from Alternative C are the same as those given for Alternative B. Potential impacts on Wilcox's pincushion cactus in the Virden Valley area of analysis under Alternative C would be the same as under Alternative B.

San Francisco River Area of Analysis In the San Francisco River area of analysis, about 100.5 acres of short-term and 83.4 acres of long- term disturbance would occur on suitable habitat for Greene milkweed. This would be about 2.2 and 1.8 percent, respectively, of the available suitable habitat for the species in the San Francisco River area of analysis.

Potential minor impacts on Arizona alum root and Clifton rock daisy would occur only in the San Francisco River area of analysis in riparian areas.

Lower Gila Area of Analysis Pima Indian mallow could occur in the Lower Gila indirect impacts area, but no impacts on this species are anticipated in this area. This is because no direct disturbance is planned and changes to surface and groundwater hydrology would be negligible in this area.

Clifton rock daisy could occur in the Lower Gila indirect impacts area, but no impacts on this species are anticipated in this area. This is because no direct disturbance is planned and changes to surface and groundwater hydrology would be negligible in this area.

Aquatic and Terrestrial Wildlife Potential impacts of Alternative C on general wildlife species would occur as described in *Impacts Common to All Action Alternatives*. The following outlines specific impacts expected to occur under Alternative C, broken down by construction and operation and maintenance activities for each area of analysis.

Construction

Upper Gila Area of Analysis Impacts on general and special status wildlife species for constructing the diversions, storage ponds, clay sources, and temporary roads would occur as described in above for *Impacts Common to All Alternatives*. Impacts on wildlife would be minor for populations of these species. This is because many would flee the area of disturbance and impacts would be only within the project footprint or for a short distance downstream. Wildlife habitat would be permanently lost or temporarily affected (see **Table 3-21** for a breakdown of vegetation types occurring). Approximately 235.0 acres would be affected long term in the Upper Gila direct impacts area, with approximately 262.5 acres affected in the short term.

Under Alternative C, the potential impacts on wildlife from constructing the four storage ponds would be similar to those described above for Alternative B.

Because no changes would be made to conveyance ditches in the Upper Gila area of analysis under Alternative C, impacts on wildlife would be the same as those described for Alternative A.

Because ponds 7P and 8P would require pump facilities for delivering water from ponds into ditches under Alternative C, impacts on wildlife from power line installation would be similar to those discussed previously under Alternative B. Because both proposed power lines would be in areas that have been previously disturbed, adverse, indirect impacts on wildlife arising from habitat loss, degradation, or fragmentation would be negligible.

The multiple rock vane diversion structures proposed under Alternative C could discourage fish from moving upstream, due to the need to pass through three structures; however, there would be enough distance between the diversion to allow for resting habitat. Downstream movement may be affected, due to the increased opportunity for entrainment in the three ditches. Fish passage incorporated into the design of the rock vane weirs would provide a minor beneficial impact on fish populations; however, the rock vane weirs would provide habitat for nonnative species that would be similar to the current push-up diversions.

As the structures in Alternative C are semi-permanent, there would be recurring construction impacts because the structures would need to be repaired or rebuilt after a high flow event. These impacts would include deaths directly from crushing and indirectly from habitat loss and due to increased sedimentation downstream. There would continue to be minor to moderate impacts on fish populations.

Virden Valley Area of Analysis For the Virden Valley, the components proposed for Alternative C are the same as for Alternative B, so construction impacts would be the same as discussed for Alternative B.

San Francisco River Area of Analysis Impacts on general and special status wildlife species from construction diversion structures, conveyance ditches, reservoir, and access roads would occur as described in *Impacts Common to All Action Alternatives*. These potential impacts would be minor on species at the population level.

Wildlife habitat would be permanently lost or temporarily affected (see **Table 3-23**). Approximately 90.7 acres would be affected long term in the San Francisco River direct impacts area, with approximately 111.1 acres affected in the short term. Some of the area is disturbed, which is typically lower quality wildlife habitat, and these acreages represent less than 3 percent of the total of the San Francisco River direct impacts area. Because of this, loss of habitat for any given wildlife species would be minor, depending on individual species' life history and distribution. This would not rise to the level of population-wide impacts for any species.

The expansion of Thomason Flat Ditch capacity could cause construction impacts, as outlined above. Because this conveyance ditch is existing, direct long-term impacts on wildlife would be minor and localized. Disturbed vegetation would recover because this ditch would not be lined.

Under Alternative C, various extensions of the power lines would need to be made in collaboration with local utility companies. Because the distance needed to extend the power lines would be less than 0.5 miles for any given spur, impacts on wildlife from habitat loss, degradation, and fragmentation would be minimal.

Under Alternative C, a rock vane weir would divert water at the Thomason Flat Ditch. As discussed above in the Upper Gila area of analysis, the rock vane weir would require periodic maintenance to repair or rebuild the structure after a high flow event, in which case construction impacts would reoccur. These would include death directly from crushing and habitat loss and indirectly from increased sedimentation downstream. There would continue to be minor to moderate impacts on fish populations.

Operation and Maintenance

Upper Gila Area of Analysis The rock vane weirs used in this alternative are likely to require frequent maintenance, including occasionally rebuilding, particularly after high-flow events, as they are not rigid structures; thus, in addition to the initial construction impacts on wildlife, there would be additional maintenance impacts under Alternative C that would happen with more frequency than under other action alternatives. In addition, under Alternative C future maintenance of the diversion structures would be expected in three locations instead of one location under Alternative B; impacts would be similar to those discussed under Alternative B. These temporary, adverse impacts would be localized to the area immediately surrounding the weirs and would occur for a short duration. Impacts would be minor on populations of these species.

Aquatic or semiaquatic wildlife inhabiting the water at or downstream of the weir loose rock structures may be killed or injured by boulders or loose rock materials when the weirs shift or fail during high-flow events. Because these impacts would be infrequent and confined to a small area near or downstream of the weirs, they would be minor impacts on populations of these species.

Under Alternative C, the construction of semi-permanent diversions on the Gila River would alter wildlife habitat by creating areas of deeper pool habitat upstream of the diversions that would favor nonnative predators. These adverse impacts would be similar to those discussed for Alternative B, though there could be three areas of ponding, similar to Alternative A, instead of one.

Four storage ponds would be created under Alternative C, and impacts on wildlife from increasing habitat, both for natives and nonnative predators, would be the same as those discussed under Alternative B.

Because no new conveyance ditches would be created, the riparian and wetland habitat would remain the same as under current conditions.

No impacts would occur from pumping because no production wells would be constructed under Alternative C.

The potential for birds striking additional electrical distribution lines would be present, but this would be unlikely under Alternative C because few power lines would be constructed. These adverse impacts on birds would be negligible to minor at the population level.

Virden Valley Area of Analysis For the Virden Valley, the components proposed for Alternative C are the same as for Alternative B; thus, maintenance and operations impacts would be the same as discussed for Alternative B.

San Francisco River Area of Analysis The rock vane weir used at Thomason Flat under this alternative is likely to require frequent maintenance, including occasionally rebuilding, particularly after high-flow events, as it is not a rigid structure; thus, in addition to the initial construction impacts on wildlife, there would be maintenance impacts under Alternative C that would happen with more frequency than under other action alternatives.

Maintenance may be required in the San Francisco River channel in the future to repair any damage to the semi-permanent rock vane weir diversion. These impacts would be similar to those discussed under Alternative B but would occur with more frequency than for a fixed crest weir. Because these temporary, adverse impacts on wildlife are localized to the area surrounding the weir and would occur for a short duration, impacts would be minor on populations of these species.

Under Alternative C, the construction of a semi-permanent diversion on the San Francisco River would alter wildlife habitat by creating areas of deeper pool habitat that favor nonnative predators. These adverse impacts would be similar to those discussed for Alternative B.

A reservoir at Weedy Canyon would be created in the San Francisco River direct impacts area under Alternative C. This storage reservoir would create nondynamic pool habitat that would favor nonnative predators. Impacts on wildlife from the addition of nonnative predator habitat would be as discussed in *Impacts Common to All Action Alternative*.

Thomason Flat Ditch would have its capacity increased, but no new conveyance ditches would be created under Alternative C. Because of this, there would be minimal negative impacts on riparian and wetland vegetation. There may be a temporary loss of vegetation, but it would likely recover.

Operating the pump station would increase the level of noise in the San Francisco direct impacts area. Potential impacts in the San Francisco River direct impacts area from well pump noise under Alternative C would be minor for individuals and would be negligible to inconsequential at the population level.

Potential impacts of operation of additional power lines would include the potential for birds striking electrical distribution lines. Small agile bird species would have a low potential for collisions. The presence of electrical distribution poles would provide perches and nesting habitat for some species and could increase impacts on prey species nearby. While some individuals could be affected, these impacts would be unlikely and would be minor for bird populations.

The creation of permanent access roads could increase wildlife mortality from impacts with vehicles, habitat fragmentation, and noise impacts (Forman and Alexander 1998). Impacts on wildlife under Alternative C from building permanent roads would be minor for populations of these species. This is because many individuals would flee the area when roads are used, and disturbance and impacts would be localized to areas in or near the new access road.

Potential impacts from Alternative C in the indirect impact area of analysis would be as described above for Alternative B.

Special Status Species Impacts on special status species would be as described under *Impacts Common to All Action Alternatives*. Additional impacts on special status species specific to Alternative C are described below.

The proposed rock vane weirs would follow Reclamation guidelines (Reclamation 2016), which include fish passage requirements. As compared with Alternative A, rock vane weirs may improve the habitat and passage for such species as spikedace and loach minnow by reducing maintenance associated with the existing push-up diversions.

Threatened and Endangered Species Alternative C would have no impact on the Chiricahua leopard frog because it is not found in any direct impact area. There would be minor to moderate adverse effects on the following species: southwestern willow flycatcher, interior least tern, northern Mexican gartersnake, and narrow-headed gartersnake. This is due to direct short- and long-term impacts on proposed and designated critical habitat (**Table 3-24**) and habitat (**Table 3-25**). Indirect impacts due to surface water alteration would be minor for these species.

There may be minor beneficial impacts in the Upper Gila and San Francisco direct impacts areas due to increased surface water flow during spring and summer (**Table 3-20**). There would be moderate impacts on listed fish species due to short- and long-term impacts on critical habitat (**Table 3-24**). The semi-permanent diversion structures would require periodic maintenance, for example, following high flow events, which would affect aquatic habitat. Reductions in surface water flows during periods of heavy diversion, such as during the winter base flow period, could affect overwintering habitat and would adversely affect fish populations. There would be no or negligible effects on other listed species.

In the Cliff-Gila project location, the multiple structures proposed under Alternative C could discourage fish from moving upstream, due to the need to pass through three structures; however, there would be enough distance between the diversions to allow for resting habitat. Downstream movement may be affected due to the increased opportunity for entrainment into the three ditches. (Modeled flow velocities are presented in Table 5-13 in the Biological Evaluation.) Loach minnow may be able to pass through the Gila Farms Diversion at flows of up to 2,234 cfs (2-year flood event), the Fort West Diversion at flows up to 752 cfs (1.25-year event), and at the Upper Gila Diversion at flows up to 752 cfs (1.25-year event). Spikedace would be able to maintain position or pass through the Gila Farms Diversion at flows up to 752 cfs (1.25-year flood event), the Fort West Diversion at flows up to 269 cfs (1.05-year event), and at the Upper Gila Diversion at flows up to 269 cfs (1.05-year event). There would be minor beneficial impacts on both species.

Modeled flow velocities for the proposed Thomason Flat rock vane weir in the San Francisco project location are presented in Table 5-14 in the Biological Evaluation. Loach minnow would be able to pass through the diversion structure up to 627 cfs (1.11-year event) and would be able to maintain position up to 1,008 cfs (1.05-year event). Spikedace would pass through the diversion up to 204 cfs (1.01-year event) and may be able to maintain position at 424 cfs (1.05-year flow event). There would be a negligible to minor beneficial impact for both species because upstream fish passage may be improved at the Thomason Flat rock vane diversion; however, maintenance would result in minor to moderate adverse impacts on fish species, due to impacts on aquatic habitat. The Thomason Flat rock vane weir would require infrequent maintenance to repair or rebuild it after a high flow event. These recurring events would include direct deaths due to crushing and habitat loss and indirect deaths due to increased sedimentation downstream.

Impacts would be greater in the Cliff-Gila and San Francisco River areas of analysis than in the Virden Valley area of analysis. This would be due to the greater impacts related to construction of proposed diversion, conveyance, storage components.

Implementing BMPs and mitigation measures (see **Appendix C**, Best Management Practices and Standard Operating Procedures) would minimize impacts on Federally listed species. Examples of such BMPs are minimizing potential disturbance to species and habitats, timing restrictions during migratory nesting season, pre-construction nesting and listed terrestrial species surveys, using a biological monitor for construction monitoring, stream block-netting to avoid impacts on aquatic species, and reducing the potential for sedimentation with stormwater pollution prevention plan regulations.

Conclusion Under Alternative C, there would be minor direct impacts on vegetation and wildlife habitat for all project locations. Short-term construction impacts affect a small percentage of the available habitat in the direct impacts areas and would be of short duration. Long-term impacts are associated with operations and maintenance. A small amount of available habitat would be affected. Periodic disturbance in the form of noise and human presence would continue for the duration of the project.

Impacts on wildlife at the population level is generally minor, given the amount of habitat available in the area of analysis. Impacts on special status species and Federally listed threatened and endangered species range from adverse minor to moderate. Impacts on riparian and terrestrial species are minor, due to the small acreages disturbed relative to the total habitat available and the timing of diversions, which would maintain surface water flows during breeding and juvenile rearing periods.

Impacts on aquatic species, such as fish, could be moderate adverse impacts, due to habitat loss and overall reduction in surface water flows. Incorporating fish passage in the diversion structures would provide beneficial impacts for fish populations by allowing for upstream and downstream fish passage. Increased flows during the snowmelt/runoff and summer base flow periods would provide beneficial impacts on fish species in the direct area of analysis. Indirect impacts due to flow alterations would have negligible to minor impacts, given that the proposed diversions would substantially affect river flows downstream in the indirect impact areas.

Alternative D

No project components are proposed in the Upper Gila and San Francisco River areas of analysis under Alternative D. In the Virden Valley, Alternative D is the same as proposed under Alternative B. The following discussion is for the Virden Valley area of analysis.

Vegetation

Riparian and Wetland Areas Impacts on riparian and wetland areas would be the same as for the Virden Valley area of analysis under Alternative B.

Aquatic and Terrestrial Wildlife As described above, the only project components proposed for Alternative D are in the Virden Valley area of analysis. For the Virden Valley, the components proposed under Alternative D are the same as under Alternative B; thus, construction, operation and maintenance impacts on wildlife would be the same as under Alternative B.

Potential impacts from Alternative D in the indirect impact area of analysis would be as described above for Alternative B; however, they would be reduced because there would be no upstream impoundments and diversions. Indirect impacts would be limited to the areas downstream of the Virden Valley project in the Virden Valley indirect area of analysis and the Lower Gila area of analysis.

Special Status Species Impacts on special status species would be as described under *Impacts Common to All Action Alternatives*. Alternative D would have minor impacts on special status species, because project activities would be restricted to the Virden Valley direct impacts area.

Threatened and Endangered Species Alternative D would have no impact on Federally listed species in the Cliff-Gila and San Francisco River areas of analysis. There would be adverse minor impacts on yellow-billed cuckoo, southwestern willow flycatcher, northern gartersnake, and narrow-headed gartersnake, due to short- and long-term impacts on habitat in the Virden area of analysis. There would be no or negligible impacts on the remaining species because they are not found in the area of analysis, nor would there be small hydrological alterations during the snowmelt/runoff and summer base flow periods (see **Table 3-20**).

Implementation of BMPs and mitigation measures (see **Appendix C**, Best Management Practices and Standard Operating Procedures) would minimize impacts on Federally listed species. Examples of these BMPs are minimizing potential disturbance to species and habitats, timing restrictions during migratory nesting season, pre-construction nesting surveys, pre-construction surveys for listed terrestrial species, and reducing the potential for sedimentation with stormwater pollution prevention plan regulations.

Conclusion Under Alternative D, project impacts would be limited to the Virden Valley. Impacts on vegetation and wildlife habitat would range from negligible to minor, given that there would be no new diversion structures, and storage ponds would be constructed in upland habitats. There would thus be negligible to minor impacts on riparian and wetland vegetation and minor impacts on upland vegetation. Impacts on wildlife populations would be negligible to minor, because the amount of habitat disturbed would be small, in comparison with the total amount of habitat available. Impacts on special status species and Federally listed species would be correspondingly minor, due to either the small amount of habitat disturbed or the lack of documented presence in the Virden Valley area of analysis.

Alternative E

Vegetation

Riparian and Wetland Areas Potential impacts on riparian and wetland areas are as described above in *Impacts Common to all Alternatives*. Project components unique to Alternative E are described below by area of analysis. Acres of disturbance to riparian and wetland in each area of analysis are given in **Table 3-27**, **Table 3-28**, and **Table 3-29**.

Upper Gila Area of Analysis Project components that would affect riparian and wetland areas would be lining irrigation ditches, unlined storage in Winn Canyon, and implementing ASR wells. Similar to Alternative B, seepage from lined ditches would be reduced, adversely affecting the stringers of native riparian and wetland vegetation next to lined sections. The potential impact would be minimal because locations for lining were selected to avoid wetland and riparian vegetation. There would be 67.9 (3.8 percent) acres of riparian and wetland vegetation affected in the short term and 56.8 acres (3.1 percent) acres of riparian and wetland vegetation affected in the long term due to storage in Winn Canyon. There would be minor to moderate impacts on riparian and wetland vegetation and all vegetation communities due to storage in Winn Canyon.

ASR wells are designed to recover water from unlined storage in Winn Canyon and to release water back to an unlined ditch (HDR 2019c). The wells are approximately 60 feet deep and may create a cone of depression. The impacts have not been modeled, but they may be similar to those described for the production wells and would be minor. There may be localized beneficial impacts due to increased recharge from the unlined ditches.

Under Alternative E, impacts arising from the construction of additional power lines would be as described in Alternative B.

Virden Valley Area of Analysis For the Virden Valley, the components proposed for Alternative E are the same as for Alternative B, so construction impacts would be the same.

San Francisco River Area of Analysis Impacts on riparian and wetland vegetation would be as described Section 5.2.1.6 in the Biological Evaluation. Alternative E includes constructing 36-inch pipelines and a siphon, reconstructing and widening the Pleasanton West Side Ditch, and constructing an unlined reservoir with an unlined earthen embankment at Weedy Canyon.

Constructing pipelines and the siphon would minimize seepage. These new components would not support riparian and wetland vegetation. To the extent these features are constructed in the riparian areas there would be a loss of riparian and wetland vegetation. Seepage from unlined storage and unlined ditches may have localized beneficial impacts on wetland and riparian vegetation. Project diversions do not affect spring runoff, allowing for downstream alluvial recharge.

There would be minor impacts on riparian and wetland areas and minor to moderate impacts on all vegetation communities due to storage in Weedy Canyon.

Springs, Seeps, and Water Improvements Potential impacts on seeps and springs from Alternative E would be as described under Alternative C.

Special Status Plant Species Acres of potential impacts and percent of habitat to be disturbed for special status plant species are given in **Table 3-21**, **Table 3-22**, and **Table 3-23**.

Upper Gila Area of Analysis Individual plants may be lost under Alternative E, but the overall impact on Pima Indian mallow would be minor. This would be due to the small percent of the available habitat to be disturbed in relation to that in the overall Upper Gila and San Francisco River areas of analysis.

Virden Valley Area of Analysis Potential disturbance to habitat for Wilcox's pincushion cactus in the Virden Valley and Upper Gila areas of analysis include short-term disturbance of 314.6 acres (2.1 percent) and long-term disturbance of 269.1 acres (1.2 percent).

Lower Gila Area of Analysis Pima Indian mallow has the potential to occur in the Lower Gila indirect impacts area, but no impacts on this species are anticipated in this area. This is because no disturbance is planned and changes to surface and groundwater hydrology would be negligible in this area.

Aquatic and Terrestrial Wildlife Potential impacts of Alternative E on general wildlife species would occur as described in *Impacts Common to All Action Alternatives*. The following discussion outlines specific impacts expected to occur under Alternative E, broken down by construction and operation and maintenance activities for each area of analysis.

Construction, Operation, and Maintenance

Upper Gila Area of Analysis Impacts on general and special status wildlife species within the construction footprint—diversions, storage ponds, conveyances, reservoirs, and temporary roads—would occur as described under Alternative B. (See **Table 3-21** for a breakdown of impacts on vegetation types occurring within the Upper Gila area of analysis.) Approximately 284.0 acres would be affected long term in the Upper Gila direct impacts area, with approximately 346.1 acres affected in the short term. Impacts on wildlife would be minor for populations of these species because many would flee the area of disturbance; impacts would be localized to only those areas within the project footprint or for a short distance downstream. Moreover, disturbance acreages represent less than 3 percent of the Upper Gila direct impacts area. Indirect, adverse impacts are expected on wildlife from habitat loss and habitat fragmentation resulting from the widening and lining of the Upper Gila Ditch and reconstruction of the McMillen Ditch. Because many of these impacts under Alternative E occur in existing conveyance ditches or involve installation of underground culverts, additional permanent impacts on habitat would be minor.

The beneficial wildlife impacts from reducing the number of maintenance activities required for the permanent diversion structure under Alternative E would be the same as discussed for Alternative B. Under Alternative E, construction of a permanent diversion on the Gila River would alter wildlife habitat by creating areas of deeper pool habitat that favor nonnative species, such as nonnative predatory fish and crayfish and American bullfrogs, upstream of the diversion. These adverse impacts would be similar to those discussed for Alternative B. One storage pond in the Cliff-Gila Valley and two unlined ASR basins in Winn Canyon would be created under Alternative E. Adverse impacts from creating nonnative predator habitat and beneficial impacts from creating habitat for native species would be similar as those discussed under Alternative B. Impacts on native species would be minor at the population level.

A minor reduction in wetland and riparian habitat may occur because some ditches would be lined under Alternative E; however, because this is a small area of impact, compared with the overall amount of riparian and wetland habitat in the area of analysis, impacts on wildlife populations would be minor.

Operation of the three ASR wells and the pumps would increase the level of noise in the Upper Gila direct impacts area. Impacts on wildlife would follow those discussed above in *Impacts Common to All Action Alternatives* and would be minor at the population level.

The potential for adverse impacts from birds striking additional electrical distribution lines would be minor at the population level.

Virden Valley Area of Analysis For the Virden Valley, the actions proposed under Alternative E are the same as under Alternative B; thus, construction impacts would be the same as discussed for Alternative B.

San Francisco River Area of Analysis Under Alternative E, a fixed crest weir would be constructed near the current Spurgeon push-up diversion. Alternative E would differ from Alternative B in that the Weedy Canyon Reservoir would be created (it would be smaller under Alternative C than under Alternative E), along with pumps and associated structures. Permanent access roads and additional power would be required.

Impacts on general and special status wildlife species within the construction footprint—diversions, conveyance ditch improvements, power line expansions, larger reservoir in Weedy canyon (compared with Alternative C), and permanent access roads—would occur as described in Section 5.3.2 in the Biological Evaluation. Impacts on wildlife would be minor for populations of these species. This is because many individuals would flee the area of disturbance and impacts would be localized to those areas within the project footprint or for a short distance downstream.

The expansion of Thomason Flat Ditch capacity could cause construction impacts, as outlined above. Because this conveyance ditch is already constructed, no habitat fragmentation or long-term loss of habitat is anticipated under Alternative E. While riparian habitat may be lost during expansion temporarily, impacts on wildlife would be minimal; vegetation would recover because this ditch would not be lined. The addition of a buried pipe and an elevated pipe over Pueblo Creek connecting the diversion structure to the Thomason Flat Ditch would cause temporary impacts on habitat and would cause construction impacts, as outlined in Section 5.3.2 in the Biological Evaluation; however, vegetation would recover, and impacts on wildlife from construction would be temporary and minimal or minor.

Under Alternative E, various extensions of the power lines from the existing lines would need to be made, in collaboration with local utility companies. Because the distance needed to extend the power lines is less than 0.5 miles for any given spur, impacts arising on wildlife from habitat loss, degradation, and fragmentation would be minor.

Special Status Species Impacts on special status species would be as described under *Impacts Common to All Action Alternatives*. Additional impacts on special status species specific to Alternative E are described below.

Alternative E would allow the river to flow in a more natural flow regime until irrigation season when one or more of the Obermeyer gates in the Cliff-Gila project location would be closed. This would create seasonal beneficial impacts on special status fish species. The fixed crest weir in the San Francisco project location would be as described under Alternative B above.

Threatened and Endangered Species Alternative E would have no impact on the Chiricahua leopard frog because it is not found in any direct impact area. Additionally, there is no proposed or designated critical habitat in the area of analysis. There would be minor to moderate adverse effects on the following species: southwestern willow flycatcher, interior least tern, northern Mexican gartersnake, and narrow-headed gartersnake due to direct short- and long-term impacts on proposed and designated critical habitat (see **Table 3-24**) and habitat (see **Table 3-25**). Indirect impacts due to surface water alteration would be minor for these species.

There may be minor beneficial impacts in the Upper Gila and San Francisco direct impact areas due to increased surface water flow during spring and summer (**Table 3-20**). There would be moderate direct impacts on listed fish species due to short- and long-term impacts on critical habitat (see **Table 3-24**). Reductions in surface water flows during periods of heavy diversion, such as during the winter base flow period, could affect overwintering habitat and would adversely affect fish populations. Fish passage structures incorporated into the design of the fixed crest weir on the San Francisco River would provide minor beneficial impacts on fish populations through enhancing the ability of fish passage upstream of the diversion. Similarly, the Obermeyer gates proposed in the Cliff-Gila project location could be operated to allow for fish passage. There would be no or negligible effects on other listed species.

The Obermeyer structure proposed under Alternative E would allow for fish passage upstream and downstream during all non-irrigation seasons because the gates would be open. When closed, the structure would allow for passage of loach minnow up to 752 cfs and spikedace up to 143 cfs (see Table 5-14 in the Biological Evaluation).

Impacts would be greater in the Cliff-Gila and San Francisco River areas of analysis than in the Virden Valley area of analysis. This would be due to the greater impacts from constructing the proposed diversion, conveyance, and storage components.

Implementation of BMPs and mitigation measures (see **Appendix C**, Best Management Practices and Standard Operating Procedures) would minimize impacts on Federally listed species. Examples are minimizing potential disturbance to species and habitats, timing restrictions during migratory nesting season, pre-construction nesting surveys, pre-construction surveys for listed terrestrial species, using a biological monitor for construction monitoring, stream block-netting to avoid impacts on aquatic species, and reducing the potential for sedimentation with stormwater pollution prevention plan regulations.

Conclusion Under Alternative E, there would be minor impacts on vegetation and wildlife habitat for all areas of analysis. Short-term construction would affect a small percentage of the available habitat in the direct impact areas and would be of short duration. Long-term impacts are associated with operations and maintenance. A small amount of available habitat would be affected.

Periodic disturbance in the form of noise and human presence would continue for the duration of the project. Localized minor adverse impacts on riparian and wetland vegetation would occur as a result of lining of irrigation ditches. Impacts on wildlife at the population level is generally minor, given the amount of habitat available in the area of analysis. Impacts on special status species and Federally listed threatened and endangered species range from adverse minor to moderate impacts. Impacts on riparian and terrestrial species are minor to moderate. This would be due to the small acreages disturbed relative to the total habitat available and the timing of diversions, which would maintain surface water flows during breeding and juvenile rearing periods. Impacts for aquatic species, such as fish, could rise to the level of moderate adverse impacts, due to habitat loss and overall reduction in surface water flows. Incorporating fish passage in the diversion structures provides beneficial impacts on fish populations by allowing for upstream and downstream passage.

Increased flows during the snowmelt/runoff and summer base flow periods would provide beneficial impacts on fish species in the direct area of analysis. Indirect impacts due to flow alterations would be negligible to minor, given that the proposed diversions are not anticipated to substantially affect river flows downstream in the indirect impact areas.

Cumulative Impacts

The affected environment conditions for biological resources, described above, represent the cumulative effects of past and present actions on those resources. Reasonably foreseeable future actions identified in **Section 3.2**, **Table 3-1**, would have construction and operational impacts that could affect biological resources; however, the reasonably foreseeable future actions would have minor adverse impacts and, for some projects, beneficial effects on biological resources. Under Alternative A, the NM Unit would not be constructed, and there would be no changes to or new conflicts with biological resources; therefore, Alternative A would not contribute additional cumulative effects on biological resources.

The action alternatives would have the direct and indirect effects on biological resources described in the sections above. Impacts on biological resources associated with all action alternatives would occur in the analysis areas; however, they would not change or contribute substantially to the overall effects of past, present, and reasonably foreseeable future actions on biological resources.

Mitigation Measures and Residual Impacts

Implementation of Best Implementation of Best Management Practices and Standard Operating Procedures (see **Appendix C**, Best Management Practices and Standard Operating Procedures) would minimize adverse impacts on resources. No additional avoidance, minimization, or mitigation measures have been identified.

3.5 Cultural Resources

The term cultural resources refers to archaeological and historic districts, sites, buildings, structures, objects, Native American sacred sites, natural resources, and other resources of tribal concern. NEPA requires a consideration of "important historic, cultural, and natural aspects of our natural heritage," which includes independent compliance with applicable requirements of other Federal and state laws, regulations, and executive orders.

The principal Federal law addressing cultural resources is the NHPA of 1966, as amended (54 U.S.C. 300101 et seq.), and its implementing regulations (36 CFR 800.3). Part of these regulations, commonly referred to as Section 106, describe procedures for identifying and evaluating historic properties, for assessing the impacts of Federal actions on historic properties, and for consulting with appropriate agencies and interested tribes to avoid, reduce, or minimize adverse effects on historic properties. The term historic properties refers to cultural resources that meet specific criteria for inclusion on the National Register of Historic Places (NRHP).

Cultural resources also include locations of traditional, religious, or cultural importance to contemporary Native Americans or other communities. Places that are important in maintaining community traditions or culturally important activities can be eligible for inclusion on the NRHP as traditional cultural properties (TCPs; Parker and King 1998). Places that are not eligible for inclusion on the NRHP may still receive protections as sacred sites under the American Indian Religious Freedom Act of 1978 or Executive Order 13007.

Many tribes consider land, water, animals, plants, resource gathering sites, geologic features, and landscapes sacred. They may include natural landscape features, ceremonial and worship places, plant gathering locations, eagle gathering sites, traditional hunting and fishing locations, ancestral archaeological sites, artisan material locations, rock art, and communal resources, such as community-maintained irrigation systems. The boundaries of these resources and impact areas are often difficult to assess.

Federal agencies rely on research, pedestrian surveys, and consultation with Tribal Historic Preservation Officers (THPOs) or other knowledgeable tribal representatives to identify resources that are of concern or sacred to tribal communities. While some TCPs and sacred sites are already known, information about many locations or resources may be restricted to specific practitioners, genders, or clans. For tribes, maintaining confidentiality and customs regarding traditional knowledge may take precedence over identifying and evaluating these resources, unless they are in imminent danger of damage or destruction.

NHPA requires that Federal agencies take into account the effects of their actions on historic properties using the following process:

- Determining if a project is a Federal undertaking.
- Determining the area of potential effect (APE) with the State Historic Preservation Officer[17] (SHPO), interested tribes, and other affected agencies.
- Identifying historic properties/TCPs and sacred sites in the APE, in consultation with the SHPO, interested tribes, and other affected agencies.
- Applying the criteria of adverse effect to historic properties and TCPs in consultation with the SHPO, interested tribes, and other affected agencies.
- Identifying ways to avoid, minimize, or mitigate adverse effects on historic properties/TCPs and sacred sites, in consultation with the SHPO, interested tribes, and other affected agencies.

The construction, operation, and maintenance of the proposed NM Unit is a Federal undertaking under the NHPA. The Joint Leads are preparing a programmatic agreement to address compliance with the Section 106 process for this undertaking. The programmatic agreement sets out the measures that the Joint Leads would implement to identify historic properties, TCPs, and sacred sites and resolve any adverse

[17] The New Mexico Historic Preservation Division functions as the SHPO in New Mexico. The SHPO is a state governmental function created under Section 101 of the NHPA to support federal historic preservation laws and processes. The purposes of a SHPO include surveying and recognizing historic properties, reviewing nominations for properties to be included in the NRHP, reviewing undertakings for the impact on the properties as well as supporting federal organizations, state and local governments, and private sector.

effects through avoidance, minimization, or mitigation. Negotiating and executing a programmatic agreement are appropriate in complex project situations or when effects on historic properties or the location of historic properties and their significance and integrity cannot be fully determined prior to approval of an undertaking (36 CFR 800.14(b)).

3.5.1 Affected Environment

Reclamation conducted a Class I cultural resources literature review and developed a research design for this EIS (Montgomery 2019a). Interim data from the Class I are summarized here, but the confidential full report provides substantially more detail, including maps and additional tables. The Class I was initiated prior to alternatives development and includes the context of the broad geographic area beyond the immediate areas that may be affected by construction and operation of the NM Unit.

For the Class I, Reclamation identified tentative APEs to identify the previous cultural resource investigation and recorded cultural resources in the general geographic locations where the various NM Unit undertakings are proposed. Reclamation conducted a literature review and files search of the APEs and buffer areas extending 1 kilometer in every direction from the edge of each APE for the three project locations: Cliff-Gila, Virden, and San Francisco. The San Francisco location included three noncontiguous sub-locations: Spurgeon, W-S Diversion, and Pleasanton. The Class I APE and buffer areas consist of approximately 40,530 acres combined (Montgomery 2019a).

Reclamation reviewed literature pertinent to the project areas from: the New Mexico Cultural Resource Information System, the Archaeological Records Management Section of the New Mexico Historic Preservation Division (NMPHD), the archival records at the Gila National Forest Office in Silver City, the archival records at the Las Cruces District Office of the BLM, the NRHP website, Government Land Office (GLO) historical-period maps, and various archaeological reports (Montgomery 2019a).

In addition to the literature review and records check, Reclamation initiated consultation with Native American tribes to begin identifying cultural resources that may be valued for their importance and critical role in Native American lifeways, or as sacred sites, or TCPs. The boundaries of these resources and impact areas are often difficult to assess. Some traditional cultural resources have values that do not refer to a direct property. They may not have distinguishable physical remains, but still are subject to consideration in planning. The significance and importance of these resources to contemporary Native Americans are derived from continuity and maintenance of traditions.

Subsequent to Reclamation conducting the research supporting the Class I, the Entity continued to refine the Proposed Action as more information became available. In order to address these changes, the Joint Leads altered the other alternatives and determined potential short- and long-term direct facility and construction disturbance areas for each location and alternative. These disturbance areas are defined to the extent possible; however, it is understood that in addition to further refinement and definition of the potential disturbance areas, the final project APE and identification of cultural resources are incomplete. The measures outlined under a programmatic agreement would address compliance with the Section 106 process for this undertaking, including defining the APE.

Based on ongoing tribal and SHPO consultation on the draft programmatic agreement, the final project APE will be larger than the facility and construction disturbance area used in this analysis. Therefore, it should be understood that estimates regarding the quantity and nature of historic properties that would be affected by the proposed NM Unit are based on disturbance boundaries that are not final, and have not been agreed upon by the parties of the programmatic agreement (see **Section 4.4.2**, Section 106 Consultation). The APE currently remains undefined.

Class I Overview Results

The Class I report provides a broad overview and context for discussing the cultural resource potential on approximately 40,530 acres of the three project locations. Only 19.3 percent of the Class I APE and its 1-kilometer buffer in each of the three locations had been previously surveyed. Of all previous investigations, 7.7 percent were conducted during the last 10 years. Comparing the percentages by location, it is apparent that survey coverage is much greater in the San Francisco location (58.5 percent) than in the Virden (1.6 percent) and Cliff-Gila (4.6 percent) locations. Likely, this is a result of the amount of USFS land in the San Francisco location APE and buffer. A large percentage of the surveys conducted in the San Francisco location were completed more than 10 years ago. These surveys may not meet modern standards, and the areas may possibly need to be resurveyed if they are in a disturbance area for final NM Unit construction (Montgomery 2019a).

A total of 19.3 percent of the Class I APE and buffer has been surveyed and 209 archaeological sites have been recorded. A high site density may be expected in these areas during future surveys. Although an imperfect predictor, 1,238 sites may be present in the Class I APE and its buffer based on the number of sites recorded per acre surveyed (Montgomery 2019a).

GLO maps were reviewed and referenced for locations of early settlement features and infrastructure. They provide background information on historical-period features that can support further field and archival investigation of structures and historical-period archaeological sites. The GLO maps for these areas range in age from 1881 to 1906. The most common features are, in order of most to least prevalent, historical-period roads (45), acequias[18] (22), fences (22), houses (12), and ranches (11) (Montgomery 2019a).

Traditional Cultural Properties and Sacred Sites

To date, Reclamation has contacted 22 tribes to determine interest in participating in government-to-government consultation under the NHPA Section 106 process, the Native American Graves Protection and Repatriation Act (NAGPRA), NEPA, and/or New Mexico State cultural resource/burial laws. Through follow-up contacts, 17 of the 22 tribes have responded to Reclamation’s invitation to participate in consultation under NEPA, but not all have indicated that they wish to be consulted under the NHPA Section 106 process and NAGPRA. Several of these Federally recognized Native American tribes have expressed numerous concerns about the impacts that the NM Unit could have on historic properties, natural resources, and places that hold significant cultural importance. While the proposed project locations are not on currently held tribal land, the ancestors of many Native American tribes traditionally occupied or used these areas for generations. To date, tribes that have expressed concerns about impacts on properties of cultural and religious importance are the Hopi Tribe, the Mescalero Apache, the Pueblo of Acoma, the Pueblo of Zuni, the San Carlos Apache Tribe, and the Tohono O'odham Nation. In consultation with interested tribes, Reclamation would undertake ethnographic research in the project area to facilitate identification of TCPs and sacred sites. Consultation with these and other tribes that have not yet commented on TCPs and sacred sites is ongoing and will continue throughout the duration of the

[18] A community-operated irrigation canal or ditch

NEPA analysis and subsequent development of the NM Unit project. An overview of the consultation process is provided in **Chapter 4**.

Water sources are fundamentally important to Native American tribes that have ancestral ties to the project area. Not only does water feature prominently in many traditional religious histories, rituals, songs, and prayers, but it is a necessary resource for the growth and propagation of other natural resources that are fundamental to Native American religious practices. For example, numerous plants and animals that these tribes use in religious ceremonies are found in riparian areas. While tribal members may not currently gather plants or animals in the project area, most of which is located on private land, they still have concerns because those plants and animals rely on the flow of water through the project area for successful propagation and spread within and outside of it. Additionally, the flow of water is inherently sacred, and the diversion or obstruction of the flow of water has been identified as potentially causing negative impacts on these tribes and the health of their communities.

The Gila River and its tributaries have been identified as a TCP. As a tributary of the Colorado River, the Gila River is tied to the identified place of emergence of at least two tribes. In consultation with Reclamation, one tribe has expressed concerns that obstructing the flow of water is equivalent to severing an umbilical cord to the place of emergence. Additionally, the Gila River served as an important resource to prehistoric peoples in the area, with whom tribes claim ancestral ties and cultural affiliation. Representatives of these tribes have affirmed that many archaeological sites, resource procurement areas, and human remains exist in the project area. These tribes are concerned that affecting or destroying these sites and removing human remains would have significant impacts on not only the sites, but the tribal communities themselves.

The Hopi Tribe, the Mescalero Apache, the Pueblo of Acoma, the Pueblo of Zuni, and the San Carlos Apache Tribe have unequivocally stated that there are many TCPs in the project area. Furthermore, the Mescalero Apache, the Pueblo of Acoma, the Pueblo of Zuni, and the San Carlos Apache Tribe have stated that there are places in the project area associated with traditional religious practices, including prayers.

During a consultation meeting, the Mescalero Apache stated that clay sources within the project area are potential TCPs. They also informed Reclamation that all springs and crevices are considered TCPs. Weedy Canyon, on the San Francisco River, contains numerous crevices, and given the height and depth of the proposed reservoir, it is highly likely that some crevices would be adversely affected. The Gila National Forest archaeologist also notified Reclamation that several tribes have identified multiple TCPs in Weedy Canyon.

Given the information already provided by these tribes it is clear that there are many TCPs and sacred sites in the project area, and tribes remain concerned the sites would be adversely affected by any of the action alternatives.

3.5.2 Environmental Consequences

Methods of Analysis

Impacts on cultural resources are assessed by applying the criteria of adverse effect, as defined in the implementing regulations for Section 106 (36 CFR 800). Actions that alter, degrade, or otherwise affect the integrity and condition of a historic property have a high potential to affect the values that contribute to traditional, cultural, scientific, or historic value of the property. Actions that protect, limit, or otherwise avoid impacts on the integrity or condition of the property would protect and maintain the attributes that contribute to those values.

The criteria of adverse effect can provide a general framework for determining the context and intensity of potential impacts on other categories of cultural resources. Examples of other categories are any Native American or other traditional community, cultural, or religious practices or resources. Additionally, assessing specific impacts involving Native American or other traditional community, cultural, or religious practices, resources, or areas requires focused consultation with the affected group, which would inform the impact analysis.

The impacts on areas or resources and the severity of those impacts depend on the perspective and context of the tribe or affected community. They also depend on defining what is environmentally, culturally, or spiritually important to its members. Cultural resources are considered nonrenewable, so in most cases a loss of physical integrity is considered a long-term or permanent impact. The factors of analysis for cultural resources include:

- The extent of ground-disturbing activities and their potential for affecting known or unknown cultural resources, sacred sites, or areas of importance to Native American or other communities
- The extent to which an action changes the potential for erosion or other natural processes that could affect cultural resources
- The extent to which an action alters the setting (including visual and audible factors) where such factors are relevant to certain types of cultural resources
- The extent to which an action may interfere with tribal lifeways, traditions, or religious practices, or the integrity of traditional tribal communities

Assumptions The analysis has the following assumptions:

- As described above, Reclamation is preparing a programmatic agreement to address Section 106 compliance for this undertaking because at this stage of project development, the Joint Leads cannot fully determine the location of historic properties and how the undertaking may affect historic properties. The programmatic agreement would address specific identification, evaluation, effects determination, and resolution of any anticipated adverse effects. Reclamation anticipates refining the APE for each project location as engineering details are finalized and as the consultation process progresses.
- The preliminary information derived from Class I inventory and potential disturbance areas provides data on what is known and unknown about the cultural resources baseline that can be used qualitatively to discuss and assess the potential for impacts and adverse effects by alternative; however, the project components and potential disturbance areas are dynamic, inventories are incomplete, and the significance and integrity of recorded resources are largely unknown.
- Locations of historical-period resources derived from GLO maps provide background information on features that can support further field and archival investigation of structures and historical-period archaeological sites. The inclusion of these features does not imply that these features exist now or meet the criteria as eligible historic properties.
- Native American tribes have identified concerns about the potential impacts on cultural resources, religious practices, and natural resources. Consultation would continue with potentially affected groups to identify the specific resources of concern, their importance to the tribe, and other values that may be considered when determining impacts, focusing on the three project locations.

- Baseline information on cultural resources is limited to previously recorded resources and past inventories. These data are geographically biased toward past project-oriented undertakings and locations on Federal land; they cannot accurately predict where and how many resources may exist in un-surveyed areas. There is a potential for unrecorded cultural resources throughout the APE. There is a higher probability of these resources in areas associated with water sources, lithic and mineral resources, and prehistoric and historical-period transportation corridors.
- Historic properties are protected by the Section 106 NHPA process, whether they are formally nominated or listed. In practice, cultural resources are treated as eligible for listing on the NRHP until their status for inclusion can be determined in consultation with the public, stakeholders, Federally recognized tribes, and the SHPO.
- Any activities that would disturb the surface would have direct and indirect impacts on cultural resources, including damaging, destroying, or displacing artifacts and features and building features out of character with a historic setting. Damaging, displacing, or destroying cultural resources could remove artifacts from their situational context and could break, shift, obliterate, or excavate them without appropriately recording them.
- Degradation of known and undiscovered cultural resources from natural processes such as erosion would continue even if human-caused impacts are avoided. Human visitation, recreation, vehicle use, trampling, and other activities can increase the rate of deterioration through natural processes.
- The potential for undiscovered buried cultural resources and human remains exists, despite previous archaeological surveys and investigations. Ground-disturbing activities would directly affect undiscovered cultural resources and human remains by exposing buried material, resulting in inadvertent destruction, loss of context, and damage to integrity.
- Indirect impacts on cultural resources would change the character of a property's use or physical features that contribute to its significance. Examples are isolating the property from its setting and introducing atmospheric or audible elements that diminish the integrity of its features. Additionally, the presence of construction workers increases the risk of illicit collection of surface artifacts, resulting in a loss of scientific information or objects of traditional cultural importance to tribes.
- Adverse effect on historic properties under Section 106 is a yes/no question based on whether the property meets the eligibility criteria and whether the undertaking would cause the loss of relevant aspects of integrity. Therefore, the impact intensity descriptors discussed in **Section 3.2** are not applied at this stage of analysis, in favor of providing descriptive and comparative information on the risk to resources. All action alternatives have the potential to cause adverse effects, and Reclamation would complete the Section 106 process through the programmatic agreement to resolve or avoid adverse effect to the extent practicable.
- Mitigation of adverse effects on historic properties resulting from the project could include avoidance, detailed site recordation, archival and/or oral historical research, artifact collection and analysis, excavation, development of public education materials, and performance of traditional ceremonies. Given the project location, anticipated site density, and concerns of Native American tribes, mitigation of adverse effects on historic properties would be a costly and time-consuming endeavor for all action alternatives.

Disturbance Area Analysis

As described in **Chapter 2**, standard direct disturbance calculations were developed for the proposed NM Unit components and construction at each location and for each alternative. For consistent analysis among the different resources, long-term estimated disturbance is defined for each facility with a 25-foot buffer, and short-term estimated disturbance for construction is a 50-foot buffer. These numbers are for alternatives comparison and do not imply that all these lands are currently undisturbed or that they represent the full extent of historical disturbance. In addition, construction may require up to 6 acres of upstream disturbance for river diversion, dewatering, and material stockpiling activities within the floodplain. All the calculations are estimates based on current information and mapping; they are subject to further refinement and updating. Estimated unbuffered disturbance footprints for existing infrastructure, diversion locations, ditches, and other features account for 114 acres in the Cliff-Gila location, 20 acres in the San Francisco location, and 95 acres in the Virden location.

GIS layers depicting estimated disturbance areas by location for the merged boundaries for Alternatives B–E were overlaid on confidential cultural resource site and survey data to determine survey coverage and the known resources that are present (Montgomery 2019b). Because these boundaries are merged and project components are different among the alternatives (except for Virden), the estimated extent of disturbance by location is larger than that of any individual action alternative. Survey coverage for the potential disturbance areas at the Cliff-Gila and Virden locations are 3.6 percent and 0.6 percent, respectively. Almost 90 percent of the potential disturbance area at the San Francisco location has been previously surveyed for cultural resources, although many of these surveys are over 10 years old and may not meet modern standards (**Table 3-30**).

Table 3-30. Percentage of the Disturbance Area Surveyed, by Location

Location	Disturbance Area Acreage*	Survey Acreage	Percentage Surveyed (%)	Acreage Surveyed < 10 Years	Percentage Surveyed < 10 Years (%)
Cliff-Gila	597.4	21.5	3.6	5.4	0.9
Virden	131.6	0.8	0.6	0.8	0.6
San Francisco	183.5	164.6	89.7	0.0	0.0
TOTAL	**912.5**	**186.9**	**20.5**	**6.2**	**0.7**

Sources: Montgomery 2019b; Reclamation GIS 2019

*Disturbance acreage is the acres within the merged boundaries for Alternatives B–E of the estimated long- and short-term facility and construction disturbance.

Cliff Gila Location The potential disturbance area for the Cliff-Gila location totals 597.4 acres (**Table 3-30**). At this location there are 6 recorded archaeological sites and 21 historical-period resources identified from GLO maps that overlap with the potential disturbance areas. The archaeological sites are portions of three large prehistoric villages, a prehistoric artifact scatter, and two historic archaeological sites. Three of these sites have been determined eligible for listing on the NRHP. The others are listed as "unknown," but based on the site description, the other two sites would likely be eligible for listing on the NRHP (**Table 3-31**).

The historical-period features that were identified as being present before 1906 from research of the GLO maps include the Frank Sigsby Ranch, 5 acequias, a fence, the Old Ore Road, and 14 roads. The LC Ranch Headquarters, a listed National Register property, is located outside the potential disturbance area. This property is associated with the Lyons and Campbell Ranch, which was a 1 million-acre cattle ranch in operation from the 1880s until 1917.

Virden Location The potential disturbance area for the Virden location totals 131.6 acres (**Table 3-30**). Less disturbance overall is proposed for the Virden location when compared with the other locations. Of the 131.6 acres of potential disturbance, only about 0.8 acres have been surveyed, all within the past 10 years. No archaeological sites have been recorded. Historical-period resources, as identified from the GLO mapping, are a fence, an unnamed road, and the Silver City to Clifton road.

San Francisco Location The potential disturbance area for the San Francisco location totals 183.5 acres (**Table 3-30).** The San Francisco location contains four archaeological sites, which have not been evaluated for listing on the NRHP, and no historical-period resources (**Table 3-32**).

Alternative A: No Action Alternative

Under Alternative A, the NM Unit project components would not be built at any of the three locations. There would be no impacts from ground disturbance or alterations to the setting on cultural resources from the construction, operation, and maintenance of the NM Unit. There would be no new impacts on cultural and traditional concerns raised in tribal consultation. There would be no anticipated cultural resource surveys or other assessments conducted to determine the presence of cultural resources resulting from planning the NM Unit project.

Conclusion for Alternative A As described under *Affected Environment*, cultural resources, including those that are eligible for listing on the NRHP, are present. The acres of previous survey and formal assessment of historical-period resources is low. There are likely ongoing or past impacts on unrecorded cultural resources from agricultural activities, including diversions, conveyance, operations, structural modifications, and road building. The potential for ground-disturbing and erosion impacts on cultural resources from constructing and maintaining push-up diversions, conveyance facilities, and other irrigation practices would continue primarily in previously disturbed areas; however, no new direct or indirect impacts would be anticipated.

Impacts Common to All Action Alternatives

Under all action alternatives, NM Unit components would be constructed, resulting in ground disturbance (**Table 3-30**), which could directly adversely affect cultural resources. Larger-scale ground disturbance and inundation would be associated with pond and reservoir construction and operation, borrow and disposal sites, construction staging, and access. Ground disturbance, including some deep excavations up to 20 feet, would also be required for conveyance systems improvements and pipelines, well and pumping locations, and new power connections. Inundation would result in the erosion of soils around the edges of storage sites, which could expose buried cultural resources along the shoreline.

For linear features, such as ditches, pond connections, pipelines, and power lines, and large features, such as reservoirs, there may not be options for avoidance of impacts. Some water conveyance features are or may be cultural resources, and alterations to them would need to be considered as impacts on historic properties. Generally, the integrity and significance of historical-period ditches or acequias are tied to historical use and location, and not adversely affected by maintenance or alterations that allow continued use. Existing diversion structures and push-up diversion areas in the rivers and floodplains are already disturbed, so intact cultural resources would likely not be present or affected in those sites. New facilities would be constructed, and existing facilities would be modified. Impacts on the visual or auditory setting of cultural resources may occur from these actions.

Table 3-31. Cliff-Gila Location: Previously Recorded Sites with Portions in Potential Disturbance Areas, by Alternative

LA No.	Site Name	Occupation Period	Site Function	Date Range	Cultural Affiliation	NRHP Eligibility Status	Alt B	Alt C	Alt D	Alt E
5421	Saige Site, Saige-McFarland Site	Late Pit House to Early Pueblo/Three Circle to Mangus	large village (Approximately 30,000 square meters)	AD 600–1175	Mogollon	unknown	X	–	–	X
34794	Villareal 2	Late Pueblo/ Animas-Black Mountain	large village (Approximately 30,000 square meters)	AD 1175–1400	Mogollon	unknown	X	–	–	–
34813	Winn Canyon #1	Early Pit House	large village (Approximately 30,000 square meters)	AD 200–600	Mogollon	Eligible (criterion unknown)	X	–	–	X
39310	none	Unspecified Mimbres	artifact scatter (Approximately 30,000 square meters)	AD 200–1400	Mogollon	unknown	X	–	–	–
103887	none	U.S. Territorial	historic structures	AD 1880–1912	Anglo	Eligible—Criterion D	X	–	–	–
103974	Fort West Ditch (acequia)	U.S. Territorial to Recent Historic	Acequia	AD 1880–1994	Anglo	Eligible—Criteria A, C	X	X	–	–

Source: Montgomery 2019b

Table 3-32. San Francisco Location: Previously Recorded Sites with Portions in Potential Disturbance Areas, by Alternative

LA No.	Site Name (Forest Service Number)	Occupation Period	Site Function	Date Range	Cultural Affiliation	NRHP Eligibility Status	Alt B	Alt C	Alt D	Alt E
29371	AR-03-06-99-00095	Late Pit House/San Francisco; Late Pueblo/Tularosa	large village (Approximately 30,000 square meters)	AD 600–1000 and AD 1175–1400	Mogollon	unevaluated	–	–	–	X
33693	AR-03-06-99-00471	Early Pueblo	village (size not specified)	AD 1000–1400	Mogollon	unevaluated	–	–	–	X
33695	AR-03-06-99-00473	Early Pueblo	Possible field house	AD 1000–1400	Mogollon	unevaluated	–	–	–	X
33696	AR-03-06-99-00474	Early Pueblo	village (size not specified)	AD 1000–1400	Mogollon	unevaluated	–	X	–	X

Source: Montgomery 2019b

Tribes have identified the Gila River as a TCP and raised specific concerns that the proposed undertaking would adversely affect the San Carlos Apache Tribe's sweat ceremonies as well as the connection of two other tribes to their place of emergence. Identification of specific TCPs, tribal use areas, sacred sites, or other tribal concerns is ongoing in relation to the three project locations. During a consultation meeting, the Mescalero Apache stated that clay sources within the project area are potential TCPs. They also informed Reclamation that all springs and crevices are considered TCPs. Reclamation acknowledges the strong beliefs and serious concerns raised in consultation regarding the presence of resources important to tribes, overall project impacts, and unavailability of acceptable mitigation options.

Reclamation would continue to refine disturbance areas and assess the potential for impacts on cultural resources. Location-specific APEs would be developed for NM Unit components, which would be appropriately larger than the short- and long-term disturbance areas defined for comparison purposes in this EIS. Reclamation would comply with 36 CFR 800, Section 106 (including Native American consultation) through the programmatic agreement process to identify, evaluate, assess, and resolve any adverse effects from constructing and operating the NM Unit.

Components proposed at the Virden location would be the same across all action alternatives, and anticipated disturbance would involve fewer acres than the other locations. The only new facilities would be two lined ponds and associated pumping facilities, pond connections, spoils, material and staging areas, new access routes, and power lines that would need rerouting. There are three historical-period resources that have been noted from the GLO maps, but there is limited survey information. Additional survey, ethnographic investigation, archival research, and consultation would be required when the location-specific APE for all the components is defined.

Alternative B: Proposed Action

The nature and type of impacts associated with Alternative B are the same as those described under *Impacts Common to All Action Alternatives.* Alternative B proposes ground disturbance at all three locations; thus, it would have more potential for additional ground disturbance and impacts on known and unrecorded cultural resources than Alternative A.

Cliff-Gila Location At the Cliff-Gila location, an estimated 382 acres of ground disturbance would be associated with the new proposed facilities, infrastructure modification and construction support. Cultural resource surveys have been conducted along portions of the Upper Gila and Fort West Ditches; however, much of the private land in the valley, where ponds are planned, has not been surveyed. Most recorded archaeological sites are along the ditches or above the valley floor. The Cliff-Gila location has been actively farmed for well over 130 years, and the land and structures have been subject to disturbance and alteration.

Under Alternative B, there would be at least six recorded sites that could be disturbed, including three sites that have been determined eligible for listing on the NRHP and two that appear to be eligible. Each of the four prehistoric sites is large with approximately 30,000 acres. Among the eligible resources is the Fort West Ditch itself. There are 20 historical-period resources identified in the Alternative B disturbance area from GLO maps in the Cliff-Gila location, including the Frank Sigsby Ranch. These indicate the potential presence and need to consider impacts on features and structures associated with farming and ranching from the late nineteenth and early twentieth centuries that may be affected (**Table 3-30** and **Table 3-31**). Because of the limited survey coverage (3.6 percent) for the Cliff-Gila disturbance area, there may be more cultural resources affected; additional survey, ethnographic investigation, archival research, and consultation would be required when the location-specific APE for all the components is defined.

Virden Location Components proposed at the Virden location are the same across all action alternatives. The nature and types of impacts would be the same as those described under *Impacts Common to All Action Alternatives.* Existing diversion facilities, canals, and access roads would be used. An estimated 132 acres would be disturbed for construction of two storage ponds with pumps adjacent to canal access roads and clay material acquired from a different location in the Virden area. There would be additional disturbance in the Virden location when compared with Alternative A, but the potential for cultural resources is not known. Surveys have been limited to adjacent road corridors, and no cultural resources have been recorded. Historical-period resources, as identified from the GLO mapping, are a fence, an unnamed road, and the Silver City to Clifton road.

San Francisco Location At the San Francisco location, an estimated 15 acres of ground disturbance would be associated with the new proposed facilities, infrastructure modifications, construction support. and a temporary access road with a river crossing.

Currently there are no recorded archaeological sites within the potential disturbance areas that could be affected. One historical-period road and Giron's Ranch were identified from GLO maps. There are no cultural resources that have been determined eligible or formally listed on the NRHP. Almost all the disturbance acreage in the vicinity of the Spurgeon Diversion and pipeline has been surveyed, although none has been surveyed during the past 10 years. Any resources present in the final location-specific APE would be evaluated for eligibility for listing on the NRHP and any adverse effects identified (**Table 3-30** and **Table 3-32**).

Conclusion for Alternative B Alternative B proposes ground disturbance at all three locations totaling 529 acres; thus, it would have more potential for additional ground disturbance and impacts on known and unrecorded cultural resources than Alternative A. Based on the standard short- and long-term disturbance areas defined for alternative comparison purposes, at least six recorded sites could be disturbed, including three sites that have been determined eligible for listing on the NRHP and two that appear to be eligible. The final location-specific APEs for compliance with the Section 106 process would be developed as part of the programmatic agreement and tribal consultation. It is anticipated that the final APE would be larger and estimates regarding the quantity and nature of historic properties and tribal resources that may be present would increase.

Alternative C

The nature and type of impacts associated with Alternative C are the same as those described under *Impacts Common to All Action Alternatives.* Alternative C proposes ground disturbance at all three locations; thus, it would have more potential for additional ground disturbance and impacts on known and unrecorded cultural resources than Alternative A.

Cliff-Gila Location At the Cliff-Gila location, an estimated 262 acres of ground disturbance would be associated with the new proposed facilities, infrastructure modifications and construction support. By replacing earthen push-up diversions in the Cliff-Gila Valley with rock vane weirs, there may be less frequent ground disturbance than Alternative A associated with maintaining diversion structures. The three diversion sites are likely are currently disturbed, and intact cultural resources are not anticipated, although there may be impacts on cultural resources in adjacent areas. The semi-permanent rock vane weirs would require maintenance and occasional reconstruction, but they would need less frequent work than the push-up diversions in Alternative A and would have a smaller short- and long-term construction footprint than permanent diversions.

Under Alternative C, very limited inventory has identified one recorded resource that may be disturbed: the Fort West Ditch. There are 10 historical-period resources identified from GLO maps in the Cliff-Gila location: one acequia, one fence, and eight roads; these indicate the potential presence and need to consider impacts on these features and structures (**Table 3-30** and **Table 3-31**). Because of the limited survey coverage, there may be many more cultural resources in the disturbance areas. Additional survey, ethnographic investigation, archival research, and consultation would be required when the location-specific APE for all the components is defined.

Virden Location Components proposed at the Virden location are the same across all action alternatives and are discussed under Alternative B. The nature and types of impacts would be the same as those described under *Impacts Common to All Action Alternatives*. The anticipated disturbance would involve fewer acres (131.6) than the other locations. There would be additional disturbance in the Virden location when compared with Alternative A, but the potential for cultural resources is not known.

San Francisco Location At the San Francisco location, an estimated 111 acres of ground disturbance would be associated with the new proposed facilities, infrastructure modifications, and construction support. Siting of an embankment dam and reservoir and support facilities at Weedy Canyon would create a large, contiguous disturbance areas, where avoidance of cultural resources, if present, would not be possible.

Under Alternative C, there is at least one unevaluated archaeological site recorded within the potential disturbance areas that may be affected, and one historical-period road was identified from GLO maps. There are no cultural resources that have been determined eligible or formally listed on the NRHP. Almost all of the disturbance acreage in the Spurgeon and Weedy Canyon area has been surveyed (**Table 3-30** and **Table 3-32**) although none has been surveyed during the past 10 years. In addition, tribal consultation has indicated that several tribes have identified TCPs in Weedy Canyon.

Conclusion for Alternative C Alternative C proposes ground disturbance at all three locations totaling 505 acres; thus, it would have more potential for additional ground disturbance and impacts on known and unrecorded cultural resources than Alternative A. Based on the standard short- and long-term disturbance areas defined for alternative comparison purposes, one recorded historic resource and one unevaluated archaeological site may be disturbed. The final location-specific APEs for compliance with the Section 106 process would be developed as part of the programmatic agreement and tribal consultation. It is anticipated that the final APE would be larger and estimates regarding the quantity and nature of historic properties and tribal resources that may be present would increase.

Alternative D

Alternative D does not propose any NM Unit components at the Cliff-Gila or San Francisco locations. As such, there would be no additional impacts from NM Unit construction or operations in those locations when compared with Alternative A.

Virden Location Components proposed at the Virden location are the same across all action alternatives and are discussed under Alternative B. The nature and types of impacts would be the same as those described under *Impacts Common to All Action Alternatives*. The anticipated disturbance would involve fewer acres (131.6) than the other locations. There would be additional disturbance in the Virden location when compared with Alternative A, but the potential for cultural resources is not known.

Conclusion for Alternative D Alternative D proposes ground disturbance at the Virden location. No cultural resources have been identified and there has been very little survey coverage. The final location-specific APEs for compliance with the Section 106 process would be developed as part of the programmatic agreement and tribal consultation.

Alternative E

The nature and type of impacts associated with Alternative E are the same as those described for *Impacts Common to All Action Alternatives.* Alternative E would incorporate components from other preliminary alternatives and components suggested by the San Francisco Soil and Water Conservation District. Alternative E proposes ground disturbance at all three locations. When compared with Alternative A, Alternative E proposes the most potential additional ground disturbance and potential for impacts on known and unrecorded cultural resources.

Cliff-Gila Location At the Cliff-Gila location, an estimated 346 acres of ground disturbance would be associated with the new proposed facilities, infrastructure modification and construction support. Although the proposed Winn Canyon storage ponds are generally located in a disturbed flood-sediment control basin, siting of embankment dams and ponds would create a large, contiguous disturbance areas, where avoidance of cultural resources, if present, would not be possible.

Under Alternative E, there would be at least two recorded sites that could be disturbed; both are large, prehistoric villages. One of the village sites (Winn Canyon #1) has been determined eligible for listing on the NRHP, and the other site (Saige-McFarland) appears to also be eligible. There are nine historical-period resources identified from GLO maps in the Cliff-Gila location: four acequias and five roads. These indicate the potential presence and need to consider impacts on these features and structures (**Table 3-30** and **Table 3-31**). Because of the limited survey coverage, there may be many more cultural resources in the disturbance areas. Additional survey, ethnographic investigation, archival research, and consultation would be required when the location-specific APE for all the components is defined.

Virden Location Components proposed at the Virden location are the same across all action alternatives and are discussed under Alternative B. The nature and types of impacts would be the same as those described under *Impacts Common to All Action Alternatives*. The anticipated disturbance would involve fewer acres (131.6) than the other locations. There would be additional disturbance in the Virden location when compared with Alternative A, but the potential for cultural resources is not known.

San Francisco Location At the San Francisco location, an estimated 111 acres of ground disturbance would be associated with the new proposed facilities, infrastructure modifications, and construction support. Siting of an embankment dam and a very large reservoir and support facilities at Weedy Canyon would create a large, contiguous disturbance areas, where avoidance of cultural resources, if present, would not be possible.

Under Alternative E, the San Francisco location would include at least four unevaluated archaeological sites recorded within the potential disturbance areas and one historical-period road identified from GLO maps. There are no cultural resources that have been determined eligible for or formally listed on the

NRHP. The archaeological sites in the Spurgeon and Weedy Canyon area include three prehistoric village sites and a possible field house. All survey information is over 10 years old. All identified sites in the final location-specific APE would be evaluated, and some of these sites may be eligible for listing on the NRHP (**Table 3-30** and **Table 3-32**). Tribal consultation has indicated that several tribes have identified TCPs in Weedy Canyon.

Conclusion for Alternative E Alternative E proposes ground disturbance at all three locations totaling 646 acres; thus, it would have more potential for additional ground disturbance and impacts on known and unrecorded cultural resources than Alternative A and the other alternatives. Based on the standard short- and long-term disturbance areas defined for alternative comparison purposes, at least six recorded archaeological sites could be disturbed, including one site that has been determined eligible for listing on the NRHP and one that appears to be eligible. The final location-specific APEs for compliance with the Section 106 process would be developed as part of the programmatic agreement and tribal consultation. It is anticipated that the final APE would be larger and estimates regarding the quantity and nature of historic properties and tribal resources that may be present would increase.

Cumulative Impacts

The direct analysis area for cultural and historic resource cumulative effects is the three proposed NM Unit locations at Cliff-Gila, San Francisco, and Virden. The cumulative impact assessment area is the San Francisco River and Gila River watersheds, which include public land and rural and semirural agricultural private and public land. Past and present agriculture, water development, transportation, utility rights-of-way, and grazing in the watersheds have likely affected cultural resources through direct impacts or degradation of resource values. Natural processes, such as erosion, drought effects, and weathering, will continue to affect the integrity of cultural resources. Despite overall trends, the resource base of cultural and historical-period resources, particularly archaeological sites, has not been as heavily affected as areas that have experienced more intensive development.

Under Alternative A, the NM Unit would not be constructed, and there would be no new impacts from construction and operation of the project components. The presence and current condition of cultural resources at the three locations has not been fully assessed, and identified resources are largely unstudied; however, any ongoing impacts would continue, as described above.

All the action alternatives would likely contribute to cumulative impacts on cultural resources, with Alternative E providing the most potential for adverse impacts due to the largest amount of ground disturbance, followed by Alternatives B and C, and then Alternative D. Compliance with Section 106 through the implementation of the programmatic agreement would reduce, but not eliminate, the potential for adverse effects or impacts on tribal resources.

The projects listed in **Table 3-1** would have some potential to disturb cultural resources in the watersheds. The GBIC diversions project involves similar features in the Cliff- Gila location; because of this, it is unlikely that all components of both the NM Unit Cliff-Gila location and GBIC project would be constructed and result in additional cultural resource impacts. Other projects are either subject to some level of cultural resource review or are unlikely to cause impacts on a large scale.

Mitigation Measures and Residual Impacts

When the programmatic agreement is fully executed, it is legally binding on Reclamation and the other signatory parties. The signatories will fully carry out all legal obligations to which they have agreed.

Completing the Section 106 process may resolve many adverse effects, but there would still be unavoidable impacts, such as those associated with data recovery, where preservation in place might have been preferred. Other examples are the loss of natural resources important to tribes, TCPs, or sacred sites, which cannot be adequately mitigated in any way, from the perspective of a tribe. At least one tribe has stated that the adverse effects to historic properties, TCPs, and sacred sites from any of the action alternatives could not be mitigated.

3.6 Geology and Soils

3.6.1 Affected Environment

This section provides a description of the existing conditions for geology and soils at the three project locations. The analysis area for geology and soils is the project area.

Geology

The project locations are in the Mogollon-Datil volcanic field. These geologic features are composed of characteristic igneous components, including ash and lahar flows, and rhyolites. Valley bottoms tend to be filled in with poorly sorted conglomerates, often cemented with carbonate, and with river deposits, consisting of uncemented silty gravel and sand deposits. Water storage capacity is spatially unpredictable and highly varied, based on the sorting and porosity of sands and gravels in unconsolidated areas (NMBGMR 2003).

Numerous faults are mapped in the greater Gila area; however, the area within and surrounding the project locations does not have a history of regular earthquakes. There have been two recorded earthquakes in the greater Gila area with a magnitude greater than 2.5: one with a 3.9 magnitude occurred at an epicenter approximately 15 miles south of Gila in 1979; and a second earthquake with a 2.9 magnitude occurred at an epicenter approximately 6 miles west of the San Francisco location in 2007 (USGS 2019a).

Areas of southwest New Mexico are prone to geologic hazards of mass wasting[19], subsidence[20], arroyo (or wash) erosion, erosion and sedimentation, and flooding. These types of geologic hazards can cause injuries and loss of life and can damage proposed and existing water storage and conveyance components.

Soils

The primary soils at the three project locations are gravely loam soils, with gravely clay loam and sandy loam soils as secondary soils. The erosion potential is mixed at the project locations; erosive soils are sensitive to erosion by wind, water, or both (NRCS 2016).

The Farmland Protection Policy Act (7 USC 4201) defines prime and unique farmlands, of which high-quality soils are an important element. The Act also defines other special status farmlands, including farmland of statewide importance and prime farmland if irrigated. There are no prime or unique farmlands

[19] A general term for the mass movement of landforms, such as rockfalls, landslides, and debris flows.
[20] Gradual caving in or sinking of an area of land.

at the project locations; however, there are areas of farmland of statewide importance[21] and areas of prime farmland if irrigated[22] (Reclamation GIS 2019; NRCS 2016, 2019).

Corrosive soils can corrode concrete or steel and may be considered inappropriate for buildings, pipelines, or other infrastructure, unless the soils are extensively amended, or other mitigation measures are employed. Steel is typically corroded by chloride solutions in the soil, and high sulfate levels are harmful to concrete (Colorado Geological Survey 2019). Approximately 5 to 10 percent of the soils at the project locations have moderate corrosiveness to concrete. Most of these soils have moderate corrosiveness to steel, with some areas of high corrosiveness.

Expansive clays are soil units that swell when wet and shrink while drying. They are generally considered inappropriate areas for developing buildings, pipelines, or other infrastructure, unless the soils are extensively amended (NRCS 2008). Expansive clay soils can damage pipes, canals, and other project features. There are no documented expansive clay soils at the three project locations (NRCS 2019).

Biological soil crusts are colonies of bacteria, lichen, and mosses that form on exposed soils primarily in arid to semiarid areas; they can help hold soil in place and reduce erosion. Any form of surface disturbance can damage or kill them. No data are available on soil crusts at the project locations. In the Final Assessment Report for the nearby Gila National Forest, the U.S. Department of Agriculture (USDA 2017) found that biological soil crusts existed across much of the Forest, but that those with thicknesses great enough to contribute to overall soil stability were not extensive.

3.6.2 Environmental Consequences

Methods of Analysis

The Joint Leads reviewed jurisdictional planning documents to determine current conditions and planning objectives for geology and soils at the three project locations. The data for this analysis were collected from both public and unpublished data provided by local, state, and Federal sources, including the US Forest Service, Natural Resources Conservation Service (NRCS), and U.S. Geological Survey. Limited soils data were available for Catron County, which encompasses the San Francisco location.

As stated previously, the analysis area for geology and soils is the three project locations (project area), including a narrower area of potential disturbance, using the standard disturbance estimates described in **Section 3.2**. However, the use of these disturbance estimates may portray higher disturbance calculations than are actually occurring from direct disturbance due to the placement of project components (e.g., physical structures). Therefore, the focus is on surface-disturbing activities that project components are likely to affect.

For corrosive soils, the analysis considers only the area of long-term project components, because corrosion due to soils is a long-term process. For special status farmlands, the analysis considers only the area of long-term project components, because these areas represent long-term loss of farmland.

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[21] The US Department of Agriculture (USDA) defines farmland of statewide importance as land that “nearly meet the requirements for prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods” (USDA 2019).
[22] The USDA defines prime farmland as: “Land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses” (USDA 2019).

Soil erodibility class data were not available for the three project locations; as a result, K factor was used to measure the potential for soil erosion. K factor is a measure of the resistance of a bare soil to erosion by water, expressed on a scale from approximately 0.02 (highly resistant to erosion) to 0.60 (low resistance to erosion). For this analysis, soil with a K factor of 0.30 or greater was considered to be highly erodible.

The factors of analysis for geology and soils include:

- Acres of short- and long-term soil disturbance
- On-site materials used in construction and no longer available for future use
- Long-term disturbance due to on-site material removal for use in project construction
- Construction of project components in areas with geological hazard risks
- Acres of overlap of project components with expansive or corrosive soils
- Acres of farmland of statewide importance or prime farmland if irrigated that would be lost due to the placement of long-term project components

Assumptions This analysis does not include any assumptions.

Alternative A: No Action Alternative

Under Alternative A, no project components would be constructed, and current water management at the project locations would continue. Current management and methods of diversion also would continue. Impacts on geology and soils would continue to occur in locations where push-up diversions are constructed and washed out, and where there are conveyance ditches and canals.

Using push-up diversions, surface water would continue to be diverted to ditches at the project locations. Impacts on geology and soils would continue to follow current trends. Push-up diversions contribute to soil erosion and compaction, in-stream sedimentation, and stream bed and stream bank damage. These activities would continue to expose erosive soils to wind and water as a result of the intentional or incidental removal or destruction of vegetation. Eroded soils could be transported from their present location, and their loss could inhibit post-construction revegetation and disturbed areas remediation. Moreover, pollution from releases of motor oil, gasoline, diesel or other contaminates would continue to be a concern when conducting this motorized work in the active river channel (USFS 2011).

Impacts Common to All Action Alternatives

Portions of southwestern New Mexico are prone to mass wasting events. Mass wasting is the movement of soils and rock on slopes, commonly referred to as landslides, rockslides, or rockfalls. Constructing earthen embankments and storing water could exacerbate the chances of mass wasting in these areas due to changes in groundwater flow patterns and the weight of stored water and earthen embankments. No proposed project disturbance overlaps any areas of deep-seated landslide susceptibility (Reclamation GIS 2019). Geotechnical studies of proposed embankment areas would be undertaken to mitigate the risk of mass wasting events.

During construction, project-related activities would disturb surface areas containing erosive soils by the physical presence of project components overlying these soils. In the short term, construction would expose erosive soils to wind and water as a result of the intentional or incidental removal of vegetation during site clearing. Eroded soils could be transported from their present location, and their loss could inhibit post-construction revegetation and disturbed areas remediation. Using best management practices during construction and reclamation can help mitigate these impacts (see **Appendix** C, Best Management Practices and Standard Operating Procedures).

Project components in areas where soils are corrosive to steel or concrete require special care during design and construction to mitigate potential corrosion. Areas of short-term disturbance are not considered for corrosion risks; this is because concrete or steel corrosion is a long-term process that would not be reasonably expected to occur in a significant way in the time span of short-term disturbances. Under all action alternatives, project components could be exposed to corrosive soils in some areas.

All action alternatives would impact more soil than Alternative A, due to the construction of project components. In the long-term, impacts on riverbed and riparian area soils would be reduced, compared with Alternative A, because the annual construction of push-up diversions would no longer be required.

Alternative B: Proposed Action

Table 3-33 shows the acres under Alternative B that would experience short- and long-term surface disturbance, the acres of long-term disturbance soils with a moderate potential for concrete corrosion (there are no proposed areas classified as high potential for concrete corrosion), and the acres of long-term disturbance soils with a moderate and high potential for steel corrosion. Impacts would range from short- to long-term, with short-term impacts occurring generally during construction, while long-term impacts would primarily occur during operation. Short-term impacts would be minor, given that these impacts would end after construction is complete. Long-term impacts would be moderate, given the level of existing disturbance at the project locations.

Table 3-33. Alternative B Soils Impacts in Acres

Disturbance Type	Cliff-Gila Location	Virden Location	San Francisco Location	Total
Total short-term disturbance	**382**	**132**	**15**	**529**
Total long-term disturbance	**294**	**116**	**8**	**418**
Long-term disturbance, with a moderate potential for soils corrosive to concrete	20	37	8	65
Long-term disturbance, with a moderate potential for soils corrosive to steel	240	29	0	269
Long-term disturbance, with a high potential for soils corrosive to steel	37	16	8	61
Long-term disturbance, farmland of statewide importance	147	18	0	165
Long-term disturbance, prime farmland if irrigated	29	0	0	29
Short-term disturbance in highly erodible soils	42	0	0	42
Long-term disturbance in highly erodible soils	30	0	0	30

Source: Reclamation GIS 2019

Alternative C

Table 3-34 shows the acres under Alternative C that would experience short-term and long-term surface disturbance, the acres of long-term disturbance soils with a moderate potential for concrete corrosion (there are no proposed areas classified as a high potential for concrete corrosion), and the acres of long-term disturbance soils with a moderate and high potential for steel corrosion. Under Alternative C, the Weedy Reservoir embankment would be constructed by the excavation of on-site materials, which would result in long-term impacts on local soil resources. Impacts would range from short- to long-term, with short-term impacts occurring generally during construction, while long-term impacts would primarily occur during operation. Short-term impacts would be minor, given that these impacts would end after construction is complete. Long-term impacts would generally be moderate to major given that Alternative C would include construction of the Weedy Reservoir.

Table 3-34. Alternative C Soils Impacts in Acres

Disturbance Type	Cliff-Gila Location	Virden Location	San Francisco Location	Total
Total short-term disturbance	**262**	**132**	**111**	**505**
Total long-term disturbance	**235**	**116**	**91**	**442**
Long-term disturbance, with a moderate potential for soils corrosive to concrete	19	37	91	147
Long-term disturbance, with a moderate potential for soils corrosive to steel	194	29	0	223
Long-term disturbance, with a high potential for soils corrosive to steel	31	16	91	138
Long-term disturbance, farmland of statewide importance	130	18	0	148
Long-term disturbance, prime farmland if irrigated	20	0	0	20
Short-term disturbance in highly erodible soils	22	0	0	22
Long-term disturbance in highly erodible soils	20	0	0	20

Source: Reclamation GIS 2019

Alternative D

Table 3-35 shows the acres under Alternative D that would experience short-term and long-term surface disturbance, the acres of long-term disturbance soils with a moderate potential for concrete corrosion (there are no proposed areas classified as a high potential for concrete corrosion), and the acres of long-term disturbance soils with a moderate and high potential for steel corrosion. Under Alternative D, impacts on soils and geology would occur only in the Virden project location, where two new clay-lined ponds would be constructed. Impacts would range from short- to long-term, with short-term impacts occurring generally during construction, while long-term impacts would primarily occur during operation. Short-term impacts would be minor or minimal, given that these impacts would end after construction is complete. Long-term impacts would generally be minor. This is because no project components would be constructed at two of the project locations.

Table 3-35. Alternative D Soils Impacts in Acres

Disturbance Type	Cliff-Gila Location	Virden Location	San Francisco Location	Total
Total short-term disturbance	**0**	**132**	**0**	**132**
Total long-term disturbance	**0**	**116**	**0**	**116**
Long-term disturbance, with a moderate potential for soils corrosive to concrete	0	37	0	37
Long-term disturbance, with a moderate potential for soils corrosive to steel	0	29	0	29
Long-term disturbance, with a high potential for soils corrosive to steel	0	16	0	16
Long-term disturbance, farmland of statewide importance	0	18	0	18
Long-term disturbance, prime farmland if irrigated	0	0	0	0
Short-term disturbance in highly erodible soils	0	0	0	0
Long-term disturbance in highly erodible soils	0	0	0	0

Source: Reclamation GIS 2019
N/A means data for the area were not available.

Alternative E

Table 3-36 shows the acres under Alternative E that would experience short-term and long-term surface disturbance, the acres of long-term disturbance soils with a moderate potential for concrete corrosion (there are no proposed areas classified as a high potential for concrete corrosion), and the acres of long-term disturbance soils with a moderate and high potential for steel corrosion.

Table 3-36. Alternative E Soils Impacts in Acres

Disturbance Type	Cliff-Gila Location	Virden Location	San Francisco Location	Total
Total short-term disturbance	**346**	**131**	**150**	**646**
Total long-term disturbance	**284**	**116**	**123**	**532**
Long-term disturbance, with a moderate potential for soils corrosive to concrete	20	37	132	189
Long-term disturbance, with a moderate potential for soils corrosive to steel	235	29	0	264
Long-term disturbance, with a high potential for soils corrosive to steel	37	16	132	185
Long-term disturbance, farmland of statewide importance	36	18	0	54
Long-term disturbance, prime farmland if irrigated	3	0	0	3
Short-term disturbance in highly erodible soils	8	0	0	8
Long-term disturbance in highly erodible soils	4	0	0	4

Source: Reclamation GIS 2019
N/A means data for the area were not available.

Under Alternative E, only one of the three current push-up diversions at the Cliff-Gila location would be replaced with an Obermeyer gate diversion. Impacts from the annual construction of the remaining two push-up diversions would continue to occur. Under this alternative, the Weedy Reservoir embankment would be constructed by the excavation of on-site materials, which would impact local soil resources. The proposed aquifer storage and recovery (ASR) wells under this alternative would be dependent on the area's soil having sufficient permeability and porosity for the needed storage and extraction rates. Other impacts would range from short- to long-term, with short-term impacts occurring generally during construction, while long-term impacts would primarily occur during operation. Short-term impacts would be minor, given that these impacts would end after construction is complete. Long-term impacts would generally be moderate to major given that Alternative E would include construction of the Weedy Reservoir.

Cumulative Impacts

Under Alternative A, the NM Unit would not be constructed, and there would be no NM Unit-related changes to or impacts on geology and soils at the three project locations. Consequently, except for the continued impacts from the annual re-construction of existing push-up diversions and maintenance of conveyance ditches, Alternative A would not contribute to cumulative impacts on geology and soils.

Many of the projects listed in **Table 3-1** could disturb soils. Project-related activities would disturb soils during facilities construction and by the physical presence of project components overlying these soils. During the short term, construction would expose erosive soils to wind and water by intentionally or incidentally removing vegetation during site clearing. Eroded soils could be transported, and their loss could inhibit disturbed area remediation and post-construction revegetation. Other possible impacts on soils from the other projects listed in **Table 3-1** include potential erosion at other locations or inundation outside their project areas during major storms. In the long-term, cumulative soil disturbance would be reduced due to the reduction or elimination of the use of push-up diversions and unlined ditches, which require frequent maintenance.

The potential changes in geological characteristics from the other cumulative projects that influence geologic hazard risks are largely unknown at this time. While certain construction activities may increase the risk of geologic hazards and impacts on soils, the extent of the risk is subject to factors that are unknown at this time.

Under all action alternatives, there could be additional cumulative impacts if the clay used for impermeable liners for storage ponds is mined outside the area of the NM Unit surface disturbance. Cumulative impacts on geology could also occur due to mining any gravel required for site preparation and road construction and from mining limestone and gravel required for the concrete used in project facilities. Topsoil would be removed and stockpiled while any mining is ongoing, and then replaced during reclamation. Further, mining would permanently remove the target geological material from the mine area.

Any possible relevant actions that require disturbing vegetation and soils could cumulatively contribute to soil erosion in the project area, in addition to soil disturbance from other projects listed in **Table 3-1**.

Mitigation Measures and Residual Impacts

Impacts on soils could be mitigated by following construction and reclamation best management practices to prevent erosion and quickly revegetating disturbed areas following construction. Mitigation measures are presented in **Appendix C**, Best Management Practices and Standard Operating Procedures. The measures detailed in **Appendix C**, Best Management Practices and Standard Operating Procedures requiring sediment and erosion control measures would minimize impacts on geology and soils at the project locations.

Additionally, construction should be conducted during periods of low flow in order to minimize sediment added to bed load. Conducting geotechnical studies before construction begins could also mitigate impacts on mass wasting hazards. Lastly, avoiding direct contact between corrodible materials and corrosive soils could help mitigate the impacts from corrosive soils.

3.7 Land Use

3.7.1 Affected Environment

The following section provides a description of the existing conditions for land use and ownership, recreation, and special designation areas at the three project locations. The area of analysis includes the Cliff-Gila, Virden, and San Francisco locations in Grant, Hidalgo, and Catron Counties.

Land Use and Ownership

Grant County is in southwestern New Mexico, next to the Arizona border, and has a population density of 7.4 persons per square mile (U.S. Census Bureau 2010). Federal agencies own and manage a significant portion of land in the county, with the USFS managing 34 percent (approximately 1,351 square miles) and the BLM managing 13 percent (approximately 530 square miles; Grant County 2017). The State of New Mexico oversees 14 percent (approximately 556 square miles) of Grant County land. Most of the remaining land in Grant County (38 percent [approximately 1,522 square miles]) is privately owned and consists mostly of agricultural and grazing land.

There are approximately 410 farms in Grant County and a total irrigated land area of about 3,980 acres (NASS 2014). From 2007 to 2012, the number of farms in Grant County increased, though the average size of farms and total acreage of farmland in Grant County both decreased (Grant County 2017). Ranchers in Grant County use both private land and land managed by the State, BLM, and USFS through grazing permits (Grant County 2017).

Grant County contains several large mining areas, including New Mexico's largest copper mines, although these mines are located miles from the Gila River (ISC 2017). While mining has fluctuated over time due to market conditions, it continues to be an important part of the regional economy. FMI, an international mining company based in Phoenix, Arizona, through its subsidiaries in New Mexico, owns land in Grant County that is used for mining operations and for grazing and agriculture.[23] For example, much of the area in the Cliff-Gila location is not directly used for mining operations, but is instead leased out for grazing and agriculture.

While Grant County does not have a zoning system, the County exercises influence over land use activities through code enforcement, subdivision standards, and its comprehensive plan. Water development is a

[23] This includes land owned by the following companies: FMI Chinos Mine Company, FMI Cobre Mining Company, FMI Tyrone Mining LLC, and Pacific Western Land Company.

major need addressed in the plan, which recognizes that a NM Unit of the CAP may prove critical in securing additional water resources for Grant County and southwest New Mexico (Grant County 2017).

Hidalgo County is directly south of Grant County, in the most southwestern part of New Mexico; it has traditionally been a farming, mining, and ranching area. The county is approximately 3,450 square miles, with a population density of 1.4 persons per square mile (Hidalgo County 2011). Private landowners own 42 percent of land in the county. Additionally, the BLM and the State of New Mexico (through its State Land Office) manage a significant percentage of land in the county (38 percent and 17 percent, respectively). The USFS also manages several relatively small parcels of land in the northeast and southwest parts of the county (3 percent of land in the county). Low-density, single-family housing and agriculture are the main private land uses in the county. Mining continues to be an important sector of the county's economy. FMI also owns land in Hidalgo County; however, this land is not actively used for mining operations.

Hidalgo County includes several traditional farming and ranching communities: Virden, Animas, Playas, Cotton City, and Rodeo. Virden and Animas are considered major farming and ranching centers. There are approximately 170 farms in Hidalgo County, with an average farm size of 5,440 acres. The total irrigated land in Hidalgo County is approximately 9,640 acres (NASS 2014).

Hidalgo County does not have a comprehensive set of land use regulations, and there are no county-wide zoning regulations; however, the county does have various regulations and ordinances related to land use and carries out land use planning according to its comprehensive plan (Hidalgo County 2011). Goals related to water development include securing, protecting, and maintaining safe and sustainable water quality and quantity through effective and coordinated watershed and aquifer management; promoting, protecting, and restoring open spaces and natural resources, such as rivers, riparian areas, and floodplains; and recognizing, honoring, and protecting historical water rights for future generations in the county.

Catron County is located in southwestern New Mexico, directly north of Grant County. Catron is the largest county in New Mexico but is also one of the least populated, with a population density of 0.5 persons per square mile (Catron County 2007). The USFS manages about 49 percent of the county, while the BLM manages approximately 13 percent. The State of New Mexico owns about 12 percent of land in the county. Lastly, about 26 percent of land in Catron County is privately owned. Ranches, agricultural land, dwellings, and limited commercial developments generally characterize private lands in Catron County. There are approximately 350 farms in Catron County, with an average farm size of about 5,432 acres (NASS 2014).

Catron County carries out land use planning according to its capital improvement plan/comprehensive plan, which recommends general strategies for achieving the county's land use planning goals (Catron County 2007). One of the plan's primary purposes is to ensure an adequate supply of water for residents, future development, and fighting fires. Water development is also a goal outlined in the plan, calling for the efficient use of water throughout Catron County, along with recommended objectives to achieve this goal, including preparing a 40-year water plan and drought management plan; reviewing and implementing relevant recommended alternatives from the Southwestern New Mexico Regional Water Plan; protecting water quality in Catron County; completing current water supply infrastructure projects; and planning for new improvements, such as wells and water reservoirs for underserved areas.

Cliff-Gila Location The Cliff-Gila location mostly consists of private land interspersed with some BLM, USFS, and State of New Mexico land. The BLM manages individual land parcels surrounding the Cliff-Gila location, with the closest parcel approximately 2.5 miles from the Gila River (see **Appendix A**, **Map 3-11** [Landownership—Cliff-Gila]). The USFS manages land surrounding and directly south of the existing Upper Gila push-up diversion at the Cliff-Gila location (approximately 800 acres). This USFS land is generally undeveloped, and public access to these lands is generally not restricted. The State of New Mexico owns about 1,900 acres at the Cliff-Gila location, which is mostly managed by the New Mexico State Land Office. This land primarily consists of agricultural leases used by a limited number of individuals.

At the Cliff-Gila location, TNC owns about 400 acres of land, some of which is used for commercial and grazing purposes. Reclamation holds several conservation easements on some of the TNC-owned lands in the Cliff-Gila location that are part of TNC's Gila Riparian Preserve program. Upstream of the Cliff-Gila location, TNC co-owns a portion of this preserve with the State of New Mexico under the Natural Lands Protection Act (the State of New Mexico owns 90 percent, while TNC owns the remaining 10 percent). There is another smaller jointly owned parcel downstream of the Cliff-Gila location.

Additionally, FMI owns about 5,800 acres at this location and leases out a large portion for cattle grazing. Various other private landowners (not including TNC or FMI) own the remaining land at the Cliff-Gila location (approximately 13,700 acres). This privately owned land consists mostly of farms and ranches for agriculture and grazing, along with some residential areas. Access to these private land areas is limited to landowners.

Virden Location The Virden location consists of private land along the Gila River surrounded by BLM-managed land (see **Appendix A**, **Map 3-12** [Landownership—Virden]). The main land use on BLM land (approximately 6,300 acres) consists of permitted grazing allotments and pastures. Additionally, the State of New Mexico owns about 500 acres at this location, managed by the State Land Office. These acres mostly consist of agricultural leases, along with some commercial leases, for use by a limited number of individuals.

Additionally, FMI owns around 175 acres at this location. The remaining land in the Virden location is private land (approximately 6,500 acres), mainly consisting of farms and ranches for agricultural and grazing, along with some residential areas. Access to these private land areas is limited to landowners.

San Francisco Location The San Francisco location generally consists of private land along the San Francisco River surrounded by USFS-managed land (see **Appendix A**, **Map 3-13** [Landownership—San Francisco]). The USFS-managed land (approximately 4,900 acres) is generally undeveloped, and public access to these lands is generally not restricted.

The privately-owned land at this location (approximately 2,200 acres) mostly consists of farms and ranches for agriculture and grazing, along with some residential areas. Access to these private land areas is limited to landowners.

Recreation

The USFS-managed land in and surrounding the Cliff-Gila and San Francisco locations is generally undeveloped and used mainly for dispersed recreation, such as hiking, picnicking, fishing, rockhounding, birding, wildlife viewing, and camping. There are various trailheads available to hikers throughout the

USFS-managed land surrounding the Cliff-Gila and San Francisco locations.[24] Additionally, there are Watchable Wildlife sites at the San Francisco Box/Dugway Canyon (managed by the USFS) near the San Francisco location and the Gila Riparian Preserve (managed by the TNC/State of New Mexico) near the Cliff-Gila location. There are also several eBird hotspots in and around the three project locations with a range of 120 to 190 species observed at these hotspots.[25]

The upper reaches and headwater tributaries of the Gila and San Francisco Rivers within the Gila National Forest offer trout fishing, while the lower reaches of both rivers offer quality warm-water fishing opportunities (USFS 2019). Most fishing in the region takes place upstream of the Cliff-Gila and San Francisco locations with the exception of Bill Evans Lake, owned and operated by the State of New Mexico, which is located immediately south of the Cliff-Gila location.[26] Additionally, there may be limited fishing at the Virden location.

Recreationists use the Gila River for river-based recreation (rafting, kayaking, and canoeing), subject to access limitations. However, the majority of this recreation takes place upstream of the project locations, beginning in the northern reaches of the Gila River in the Black Range of the Gila National Forest.[27] A number of stretches of the Gila River are runnable within the Gila Wilderness Area in the spring, starting with the 7-mile section from the visitor center of the Gila Cliff Dwellings National Monument to the confluence with the east fork. The following 38 miles of the Gila River, known as the Wilderness Run still within the Gila Wilderness Area, provide a few stretches that are boatable. However, from the Mogollon Creek confluence, where the Gila River intersects the Cliff-Gila location, many barbed-wire fences and irrigation diversions impede travel on the river. Continuing west, there are about 18 miles of the Gila River, along the Middle Box area upstream of the Virden location, that offer a few boatable stretches.

River recreationists have also been known to begin rafting trips on the Gila River at the Virden location, downstream of the Sunset and New Model Diversions, and continue through Arizona (American Whitewater 2017a); however, this stretch is likely only runnable in the spring. American Whitewater (2017b) estimates flow range for best river recreation as 200 to 10,000 cfs. The U.S. Geological Survey (2018a) manages an upstream gage that records an average peak stream flow during early spring at 385 cfs, and low flows during periods of high irrigation use at 45 cfs.

Recreationists also use the San Francisco River for rafting and kayaking, although it is less popular than the Gila River. American Whitewater (2017c, 2017d) cites the area upstream of the San Francisco location as runnable within 500 to 5,000 cfs and downstream within 200 to 10,000 cfs. Two U.S. Geological Survey (2018a, 2018b) stream gages upstream and downstream of the San Francisco location record average peak and low flows; during peak snowmelt in early spring, average stream flows are 60 cfs upstream and 174 cfs downstream of this location. Low flows during high irrigation months are recorded at 5.7 cfs upstream and 27 cfs downstream. The San Francisco River is characterized as having inconsistent flows, and recreationists generally only use it following rain, when flows are high enough to support recreation. Additionally, recreationists likely have to portage rivercraft when they encounter the existing W-S Ditch

[24] See USDA website: https://www.fs.usda.gov/recmain/gila/recreation
[25] See https://ebird.org/hotspots
[26] See http://www.emnrd.state.nm.us/spd/boatingweb/BillEvansLake.html; http://www.wildlife.state.nm.us/wp-content/uploads/2014/06/Bill-Evans-GAIN-WMA-NMDGF.pdf
[27] See https://www.newmexico.org/things-to-do/outdoor-adventures/rafting-kayaking/gila-river/

and Pleasanton East-Side Diversion Structures. Rafters typically enter the water above the San Francisco Hot Springs south of Glenwood, New Mexico (south of the San Francisco location), and exit at Martinez Ranch in the Apache-Sitgreaves National Forest in Arizona (USFS 2013b).

Special Designation Areas

Conservation Opportunity Areas Conservation opportunity areas (COAs) are areas considered to have superior potential for conserving species of greatest conservation need. COAs are places that contain significant ecological features, natural communities, or Species of Greatest Conservation Need habitat for which the State has a responsibility for protecting and conserving when viewed from a global, continental, regional or state perspective. COAs are a component of New Mexico's State Wildlife Action Plan. They provide a nonregulatory tool to help focus and prioritize statewide actions to locations where conservation actions may maximize opportunities to prevent future listings of species, and to promote recovery of species that have already been listed (NMDGF 2016). The analysis area for the Proposed Action encompasses central features for several of the 16 COAs that were identified statewide, including habitat for various Species of Greatest Conservation Need; the NMDGF indicated that the Proposed Action may potentially affect these features in its letter dated July 20, 2018.

Gila Lower Box Area of Critical Environmental Concern (ACEC) An ACEC is defined in the Federal Land Policy and Management Act, Section 103(a) as an area on BLM lands where special management attention is required to protect and prevent irreparable damage to important historic, cultural, or scenic values; fish and wildlife resources; or other natural systems or processes, or to protect life and ensure safety from natural hazards.

Located in northwest Hidalgo County approximately 30 miles north of Lordsburg, New Mexico, the Gila Lower Box is managed by the BLM as a biological ACEC. The ACEC is approximately 5 to 10 miles upstream of the Virden location and encompasses about 6,490 acres. There are several state-listed and Federal candidate animal species that occur or have habitat within the area. The area also provides seasonal habitat for numerous species of raptors (BLM 1993). The Gila Lower Box Special Recreation Management Area (SRMA) is located within this ACEC, as described in the 1993 Mimbres Resource Management Plan (BLM 1993). Additionally, there is an Audubon Society IBA (IBA) within the Gila Lower Box ACEC, which serves as a migration route for neotropical migratory birds and hosts more than 170 bird species throughout the year.

Gila Lower Box Canyon The Gila Lower Box Canyon is approximately 5 miles upstream of the Virden location. Home to approximately 200 species, the canyon has one of the highest bird diversities in New Mexico and provides some of the best birding opportunities in the state. Visitor activities include camping, fishing, hiking, hunting, and wildlife viewing.[28] Additionally, there are some opportunities for rafting and canoeing during spring runoff in the stretch of the Gila River that runs through the canyon.

Wilderness Study Areas (WSAs) Section 2(a) of the Wilderness Act established a National Wilderness Preservation System of Federally owned areas designated by Congress as wilderness. WSAs are BLM-administered areas that have wilderness characteristics: a minimum size, naturalness, and outstanding opportunities for solitude or primitive and unconfined recreation. A WSA is managed to not impair its wilderness characteristics until Congress designates it as wilderness or no longer considers the area for

[28] See BLM website: https://www.blm.gov/visit/gila-lower-box-canyon

wilderness designation and directs the BLM to manage it for other multiple uses (Federal Land Policy and Management Act Sections 201(a), 202(c)).

There are two WSAs located upstream of the Virden location (see **Appendix A**, **Map 3-14** [Wilderness Study Areas—Virden]). The Gila Lower Box WSA is located approximately 1 mile southeast of the Virden location, directly upriver of the existing Sunset Diversion. It contains various cultural features, including petroglyphs and rock shelters. Additionally, it is a popular bird-watching area in New Mexico and is mainly used by recreationists for hiking and wildlife viewing. There are also two BLM-developed trails leading to the Gila River, used for fishing and recreation access. The Blue Creek WSA is located approximately 0.5 miles northeast of the proposed project construction at the Virden location, north of the Gila River. This WSA includes a volcanic fault block mountain named Black Mountain and is mainly used by recreationists for hiking. Public access to these WSAs is generally not restricted.

Additionally, there is one WSA located approximately 5 miles downstream of the San Francisco location, the Lower San Francisco WSA. The Lower San Francisco WSA is approximately 8,800 acres in size. The main recreational activities in this WSA include picnicking, fishing, and hunting, as well as some rafting and kayaking when the water is high enough to support river-based recreation (USFS 2013). Again, public access to this WSA is generally not restricted.

Gila Box Riparian National Conservation Area (RNCA) The Gila Box RNCA is located between Morenci and Safford, Arizona, approximately 35 miles downstream of the Virden location and 45 miles downstream of the San Francisco location. The RNCA is managed to conserve, protect, and enhance the riparian and associated areas within the conservation area for aquatic, wildlife, archaeological, paleontological, scientific, cultural, recreational, educational, scenic, and other resources (BLM 1998). Visitor activities include rafting, canoeing, kayaking, picnicking, birdwatching, scenic drives, fishing, wildlife viewing, hiking, sightseeing, historic interpretation, camping, horseback riding, photography, swimming, wildflower viewing, four-wheel driving, and hunting (BLM 2019c). This area is a popular recreation destination for river recreationists, with numerous boat put-ins and developed recreation sites. River-based recreation primarily occurs during the spring runoff season, continuing into the summer season while river conditions support rafting.[29]

3.7.2 Environmental Consequences

Methods of Analysis

The Joint Leads reviewed jurisdictional planning documents to determine current conditions and planning objectives for land use and ownership at the three project locations. Personnel gathered information on recreation and special designation areas from commercial sources, as well as local, state, and Federal government (BLM and USFS) sources. The factors of analysis for land use and ownership, recreation, and special designation areas include:

- Land use and ownership
    - Acres that would be permanently acquired or altered for NM Unit project components
    - Linear miles (with variable widths) of ROWs acquired, where ownership or use changes temporarily or permanently

[29] See BLM website: https://www.blm.gov/national-conservation-lands/arizona/gilabox

    - Areas where land uses are altered or converted to new uses
    - Access availability
- Recreation
    - Changes to recreation opportunities and conditions
- Special designation areas
    - Changes to special designation characteristics or values

Assumptions The area of analysis for land use and ownership, recreation, and special designation areas is the three project locations, including a narrower area of potential disturbance, using the standard disturbance estimates described in **Section 3.2**. However, the use of these disturbance estimates may portray higher disturbance calculations than is actually occurring from direct disturbance due to the placement of project components (i.e., physical structures).

Land use and access may be affected if access to public or private property is compromised. Any action that would restrict access or provide undesirable access points to private property would also affect the ability of landowners to preserve the uses on the property. This analysis is based on the following assumptions:

- Recipients of the AWSA water would use project water in ways that would support general land use planning policies; accordingly, the analysis does not evaluate potential impacts on existing or future land uses from future water supply other than the AWSA water.
- Generally, there would be no public access to most NM Unit project components proposed under the action alternatives. As part of the NM Unit construction process, there would be structures, such as gates and fences, installed to prevent public access to various project components, namely proposed diversion structures, pumping stations, storage ponds, and wells. Signs would be installed to indicate that access to these structures would be for authorized use only.
- Any new or improved access roads would be made available for public access, recreation, or future development, where applicable.

Alternative A: No Action Alternative

Under Alternative A, the NM Unit would not be built, and the conditions and trends described under *Affected Environment* would continue. Consequently, there would be no changes to existing impacts on land use and ownership, recreation, or special designation areas. The continued maintenance of existing push-up diversion structures would create noise that could degrade the quality of dispersed recreation opportunities, such as hiking, on USFS-managed land within and surrounding the project locations. Additionally, during periods of the year when river stretches run dry or only run intermittently, some dispersed recreation opportunities on USFS-managed land within and surrounding the project locations, such as fishing and wildlife viewing, could be adversely affected due to reduced river flows. Existing push-up diversions would continue to indirectly affect river-based recreation by reducing flows in some areas (see **Section 3.3** for further information on potential flow reductions).

Impacts Common to All Action Alternatives

Land Use and Ownership Under all action alternatives, the NM Unit would be in conformance with existing land use plans in Grant, Hidalgo, and Catron Counties. Rights to use private property under all action alternatives would have to be obtained.

Under all action alternatives, the NM Unit would result in direct, short- and long-term impacts on land use. Direct, short-term impacts would primarily occur during the construction phase of the NM Unit by temporarily reducing access to some land areas; however, any limited access due to construction activities would end once construction is complete. Residential and public land use and access could also experience long-term impacts due to minor increases in vehicle traffic on access roads and property surrounding project components. Excavation of areas for borrow material would affect some areas in the short term; however, these areas would likely revert to a fairly natural state over time.

Installation and operation of project components would also result in direct, long-term impacts by converting land use types from open space[30] to industrial and agricultural. The creation of this new industrial-type land use would require mitigation to minimize the impacts on adjacent nonindustrial land uses over the long-term. Where project components are placed on public land, the NM Unit would cause direct, long-term impacts by permanently limiting public access.

Table 3-37 provides the acres of land required for construction of NM Unit project components by action alternative and landownership; **Table 3-38** provides the acres of land required for permanent NM Unit project components by action alternative and landownership. Again, it is important to note that the short- and long-term estimates were derived using GIS buffers; therefore, in some instances, the use of these buffers has resulted in higher disturbance calculations than is actually occurring from direct disturbance in the project area from the placement of project components (i.e., physical structures). As a result, the actual footprint of project components is generally less than the disturbance calculations provided below.

Table 3-37. Acres of Land Needed for Construction of NM Unit Project Components by Action Alternative and Landownership (Short-Term Disturbance)

Project Location	Landownership by Project Location	Alternative B	Alternative C	Alternative D	Alternative E
Cliff-Gila	*Private property	111	54	0	36
	FMI property	257	206	0	304
	TNC property	11	3	0	6
	USFS	2	0	0	0
	Subtotal	381	263	0	346
Virden	**Private property	127	127	127	127
	Subtotal	127	127	127	127
San Francisco	Private property	14	13	0	40
	USFS	2	98	0	128
	Subtotal	16	111	0	168
	Total	524	501	127	641

Source: Reclamation GIS 2019
*Private property does not include FMI property or TNC property acres. FMI and TNC acres have been separated from private property where applicable.
**These acres do not include BLM land, given that no project components would be placed on BLM land.

[30] Piece of land that is generally undeveloped or generally does not have any designated use

Table 3-38. Acres of Land Needed for Permanent NM Unit Project Components by Action Alternative and Landownership (Long-Term Disturbance)

Project Location	Landownership by Project Location	Alternative B	Alternative C	Alternative D	Alternative E
Cliff-Gila	*Private property	75	47	0	23
	FMI property	212	187	0	258
	TNC property	6	1	0	3
	USFS	1	0	0	0
	Subtotal	294	235	0	284
Virden	**Private property	114	114	114	114
	Subtotal	114	114	114	114
San Francisco	Private property	7	8	0	20
	USFS	1	83	0	112
	Subtotal	8	91	0	132
	Total	416	440	114	530

Source: Reclamation GIS 2019

*Private property does not include FMI property or TNC property acres. FMI and TNC acres have been separated from private property where applicable.

**These acres do not include BLM land, given that no project components would be placed on BLM land.

Under all action alternatives, power lines would be constructed. Direct impacts on land use would include localized detours or access delays to private property and public land, as well as short-term encroachment of construction in the form of temporary parking for loading and unloading employees and materials or vehicle maneuvering on private property; however, access limitations would be confined to the construction phase of the NM Unit.

While the construction of power lines in public ROWs would be prioritized, power lines may intersect private property areas, which would require Reclamation to obtain easements. These easements would not result in any permanent change to the underlying use of the private property, change in private property rights, or increase in trespass. Additionally, although power lines are inherently an industrial-type use, they are common features of urban, suburban, and rural landscapes. Accordingly, there would be no permanent changes in the underlying land uses of private properties as a result of power line installation.

Recreation Under all action alternatives, except Alternative D, the NM Unit could affect some dispersed recreation on USFS-managed land within and immediately surrounding the project locations. Heavy machinery and equipment used during construction would create noise that could cause a decline in the quality of dispersed recreation on public land. Restricted access to public land during construction would also cause direct, short-term impacts by temporarily reducing access to public land in the project locations; however, these impacts would generally be short-term and limited to initial construction and periodic maintenance. Consequently, because these impacts would be limited both temporally and geographically, their effect on dispersed recreation would be minor. Placement of some project components on public land would permanently displace some dispersed recreation, although this would likely be negligible given the limited amount of dispersed recreation in the vicinity of the project locations overall.

Under all action alternatives, river flows would decrease during certain months of the year downstream of the proposed diversions. Flow reductions would affect fish and other wildlife, indirectly affecting recreation on public land in and surrounding the project locations that depends on wildlife, such as fishing, birding, and wildlife viewing (see **Section 3.4** for further information on wildlife impacts).

However, these reductions are not anticipated to substantially affect river-based recreation downstream of the project locations, given that most river-based recreation takes place during spring runoff. Further, the majority of river-based recreation takes place upstream of the Cliff-Gila and San Francisco locations, and would not be affected.

Under all alternatives, there would be certain bypasses for downstream users and some project-influenced return flows that could increase river flows. Increases to river flows are assumed to remain in the river. These bypasses and return flows could benefit river-based recreation compared with Alternative A (see **Section 3.3** for further information on potential flow reductions).

Special Designation Areas Implementation of the NM Unit is not anticipated to result in substantial direct disturbance on any COAs within the analysis area, the Gila Lower Box ACEC, or the Gila Lower Box Canyon, given the limited amount of disturbance from project components at the three project locations. Additionally, reduced flows from proposed diversion structures are not anticipated to substantially affect the relevant or important characteristics of the Gila Lower Box ACEC, COAs within the analysis area, or any recreation in the Gila Lower Box Canyon (see **Section 3.3** for further information on potential flow reductions and **Section 3.4** for further information on impacts on wildlife).

The Blue Creek WSA would not experience any direct disturbance from implementation of the NM Unit, as no project components would be placed on WSA land. Additionally, roads at this location would serve as a barrier for any short-term disturbance from construction of the 11P storage pond. Further, the 10P storage pond is located on private land (Lazy B Ranch land), not BLM-managed land, while the spoils area would be located on disturbed land adjacent to the boundary of the Blue Creek WSA. As a result, any disturbance would not cross the boundary of the Blue Creek WSA and would not affect any identified wilderness characteristics.

Likewise, the Gila Lower Box WSA and Lower San Francisco WSA would not experience any direct disturbance from implementation of the NM Unit, as no project components would be placed on WSA land. While proposed upstream diversions would reduce flows in the Gila River and San Francisco River during certain times of the year, these reduced flows are not anticipated to affect the wilderness characteristics of these WSAs (see **Section 3.3** for further information on potential flow reductions). Further, proposed diversions at the Virden location would be located downstream of the Gila Lower Box WSA. Consequently, implementation of the NM Unit is not anticipated to substantially affect the Gila Lower Box WSA.

In Arizona, the Gila River would experience reductions in flows downstream of the project locations under all alternatives (ranging from 1 to 2 percent in wet conditions and 2 to 14 percent in dry conditions), which would affect some river-based recreation in the Gila Lower Box RNCA (see **Section 3.3** for further information on potential flow reductions under all alternatives, specifically at the U.S. Geological Survey stream gages on the Gila River near Clifton and Safford, Arizona). Again, these flow reductions would only occur during certain months of the year. River-based recreation in the Gila Lower Box RNCA takes place primarily during the spring runoff season. Consequently, the flow reductions from implementation of the NM Unit are not anticipated to substantially affect river-based recreation or the other resources and activities within the Gila Box RNCA. Further, any reductions resulting from the Proposed Action are expected to fall within historical flow fluctuations (see **Section 3.3** for further information on potential flow reductions).

Reductions in flow on the San Francisco River in Arizona are expected to be low across all alternatives (0 to 2 percent in wet and dry conditions); consequently, these reductions are not anticipated to substantially affect river-based recreation or other resources and activities within the Gila Box RNCA for the same reasons discussed above.

Alternative B: Proposed Action

Alternative B would result in direct and indirect impacts on land use and recreation, as described below.

Land Use and Ownership

Cliff-Gila Location Construction and installation of project components would result in direct, short-term impacts by temporarily limiting access to some land areas at this location during construction. Implementation of the NM Unit would also result in direct, long-term impacts by converting the functional use of some areas from open space to agricultural use at this location. These actions would affect residential, agricultural, and grazing land owned by a few private landowners, including TNC and FMI, as well as some land managed by the USFS. However, these areas would make up a small percentage of public and private land at this location overall (less than 10 percent for all landowners; see **Table 3-37** and **Table 3-38** for acreage impacts). The 45-foot-wide easement required through the USFS and private property for the Fort West Ditch extension (totaling 4,200 LF) and siphon (measuring 520 LF) would not affect underlying landownership.

Access to areas where project components are placed on public land would permanently affect public access to these areas, although these areas would be a small percentage of public land at this location overall. Where project components are located on private land, no effects on public access are anticipated, as access to this land is already restricted.

Virden Location Constructing two clay-lined, gravity-fed storage ponds and associated pumping facilities at this location would change the functional use of these areas from open space to agricultural. Most direct disturbance would be on a small amount of agricultural and grazing land owned by a limited number of private landowners; however, these areas would make up a small percentage of private land at this location overall (see **Table 3-37** and **Table 3-38** for acreage impacts).

San Francisco Location Construction of project components would result in direct, short-term impacts by temporarily limiting public access to USFS land and for various private landowners. These actions would also affect land use by permanently converting some areas from open space to industrial or transportation. Access to areas where project components are placed on public land would permanently affect public access, although these areas would be limited in size. Where project components are located on private land, no effects on public access are anticipated, as access to this land is already restricted.

Although the USFS manages a majority of the land surrounding the San Francisco River, only a small percentage would experience short- and long-term disturbance from the construction of conveyance structures (Reclamation GIS 2019). Additionally, a small percentage of private land along the San Francisco River would be affected from the construction and installation of project components (see **Table 3-37** and **Table 3-38** for acreage impacts); however, these areas would make up a small percentage of private land and USFS land at this location overall.

Recreation Dispersed recreation could be affected in the short-term due to limited access to public land areas during construction activities. The greatest potential for impacts on recreation would be from proposed diversions at all three project locations, which would reduce river flows downstream (average project-influenced flows in December at the U.S. Geological Survey gage on the Gila River near Clifton, Arizona, could be reduced 9 to 11 cfs). However, these reduced flows are not anticipated to substantially affect river-based recreation on the Gila River. The limited demand and lack of storage in the San Francisco location would result in no measurable change at the U.S. Geological Survey gage on the San Francisco River at Clifton, Arizona.

Conclusion for Alternative B Under Alternative B, a limited number of private and public landowners, as well as some recreationists, would experience adverse short- and long-term impacts due to construction and operation of project components. Impacts would range from short- to long-term, with short-term impacts occurring generally during construction, while long-term impacts would primarily occur during operation. Short-term impacts would be minor, given that these impacts would end after construction is complete. Long-term impacts would be moderate, given the level of existing disturbance at the project locations and the limited amount of land that would be affected. Impacts on river-based recreation downstream of proposed diversions would likely be minor, given that the proposed diversions are not anticipated to substantially affect river flows.

Alternative C

Alternative C would result in direct and indirect impacts on land use and recreation, given the construction of the Weedy Reservoir and multiple proposed diversions. Impacts would be as described below.

Land Use and Ownership

Cliff-Gila Location Construction and installation of project components would result in direct, short-term impacts by temporarily limiting access to some land areas during construction. These actions would also result in direct, long-term impacts by converting the functional use of some areas from open space to agricultural use. These actions would affect residential, agricultural, and grazing land owned by a few private landowners, including TNC and FMI, as well as some land managed by the USFS. However, these areas would make up a small percentage of public and private land at this location overall (less than 10 percent for all landowners; see **Table 3-37** and **Table 3-38** for acreage impacts).

Alternative C would use existing ditch configurations and capacities, and it would not include production wells, which would reduce disturbance to some land areas; however, because rock weirs are likely to shift or fail during times of high flow events, comprehensive repairs and rebuilding of structures would be necessary, resulting in direct short- and long-term impacts on land use and access in some areas due to required periodic maintenance and importation of rock to the site. The assumption is that most of the structures would need rebuilding every 5 years, while structural maintenance would be required three times per year; however, compared with existing conditions, where earthen push-up diversions require yearly maintenance, maintenance of proposed rock weir diversions would result in less impacts.

Virden Location Impacts on land use and access would be the same as those described under Alternative B, given that the components and operation of the NM Unit would be the same.

San Francisco Location Constructing one rock vane weir diversion to replace the earthen push-up diversion at the Thomason Flat Ditch location would result in direct, short-term impacts by temporarily limiting access to some land areas. The greatest impact on land use and access would be from construction of the Weedy Reservoir, which would affect USFS land and potentially limit public access to this area. However, overall this reservoir would affect a small percentage of total USFS land at this location (see **Table 3-37** and **Table 3-38** for acreage impacts).

Construction of other infrastructure under this alternative would affect land use by converting it in these areas from open space to agricultural or transportation use. These actions would mainly affect USFS land, along with some private land used mainly for residential, agricultural, and grazing purposes. Again, the areas affected by implementation of the NM Unit would make up a small percentage of private land at this location overall (less than 10 percent for all landowners; see **Table 3-37** and **Table 3-38** for acreage impacts).

Recreation Under Alternative C, the greatest impact on recreation would be due to the construction of the Weedy Reservoir on USFS lands, which would permanently displace some dispersed recreation, and potentially limit access to this area for recreationists. However, there is the potential for some recreation in the future at Weedy Reservoir if permitted by the USFS. Additionally, proposed diversions would affect river-based recreation downstream of diversions by reducing river flows (average project-influenced flows in December at the U.S. Geological Survey gage on the Gila River near Clifton, Arizona, could be reduced 8 to 11 cfs and around 2 to 4 cfs at the U.S. Geological Survey gage on the San Francisco River at Clifton, Arizona, in January). These reduced flows are not anticipated to substantially affect river-based recreation.

Conclusion for Alternative C Under Alternative C, a limited number of private and public landowners, as well as some recreationists, would experience adverse short- and long-term impacts due to construction and operation of project components at this location. The greatest impact on land use and recreation would be due to the construction of the Weedy Reservoir on USFS lands, which would affect access to public lands and permanently displace some dispersed recreation. Other impacts would range from short- to long-term, with short-term impacts occurring generally during construction, while long-term impacts would primarily occur during operation. Short-term impacts would be minor, given that these impacts would end after construction is complete. Long-term impacts would generally be moderate to major given that Alternative C would include construction of the Weedy Reservoir. Impacts on river-based recreation downstream of proposed diversions would likely be minor, given that the diversions are not anticipated to substantially affect river flows.

Alternative D

Of the action alternatives, Alternative D would involve the least amount of disturbance to land use and recreation. This is because no project components would be constructed at the Cliff-Gila or San Francisco locations. Impacts would be as described below.

Land Use and Ownership

Cliff-Gila Location Under Alternative D, no components would be constructed at the Cliff-Gila location. Consequently, there would be no new impacts on land use and ownership at this location.

Virden Location Land use and access impacts would be the same as those described under Alternative B, given that the components and operation of the NM Unit would be the same.

San Francisco Location Under Alternative D, no components would be constructed at the San Francisco location. Consequently, there would be no new impacts on land use and ownership at this location.

Recreation There would be no new impacts on recreation under Alternative D at the Cliff-Gila or San Francisco locations. Impacts on dispersed recreation at the Virden location would be the same as those described under Alternative B. This is because the components and operation of the NM Unit would be the same; however, given that no upstream diversions would be constructed, any river-based recreation occurring upstream of the Virden location would not be affected. The proposed diversion at the Virden location would reduce river flows downstream (average project-influenced flows in December at the U.S. Geological Survey gage on the Gila River near Clifton, Arizona, could be reduced 1 to 3 cfs); however, it is unlikely that river-based recreation downstream of the Virden location would be substantially affected.

Conclusion for Alternative D Under Alternative D, a limited number of private and public landowners, as well as some recreationists downstream of the Virden location, would experience adverse short- and long-term impacts due to construction and operation of project components. Impacts would range from short- to long-term, with short-term impacts occurring generally during construction, while long-term impacts would primarily occur during operation. Short-term impacts would be minor or minimal, given that these impacts would end after construction is complete. Long-term impacts would generally be minor. This is because no project components would be constructed at two of the project locations. Impacts on river-based recreation downstream of the proposed diversion at the Virden location would be minor, given that the proposed diversion is not anticipated to substantially affect river flows.

Alternative E

Alternative E would result in direct and indirect impacts on land use and recreation, given the construction of the Weedy Reservoir and multiple proposed diversions. Impacts would be as described below.

Land Use and Ownership

Cliff-Gila Location Construction and installation of project infrastructure would result in direct, short-term impacts by temporarily limiting access to some land areas during construction. These actions would also result in direct, long-term impacts by converting the functional use of some areas from open space to agricultural use. These actions would affect residential, agricultural, and grazing land owned by a few private landowners, including TNC and FMI, as well as some land managed by the USFS. However, the areas affected by implementation of the NM Unit would be a small percentage of public and private land at this location overall (less than 10 percent for all landowners; see **Table 3-37** and **Table 3-38** for acreage impacts).

Virden Location Land use and access impacts would be the same as those described under Alternative B, given that the components and operation of the NM Unit would be the same.

San Francisco Location Construction of a fixed crest weir diversion with riffle rundown and associated conveyance pipes and pumping stations, as well as the Weedy Reservoir and transportation infrastructure, would result in direct, long-term impacts on land use by converting these spaces from open space to industrial use. These actions would mainly affect USFS land, along with some private land (used mainly for residential, agricultural, and grazing purposes). However, the areas affected by implementation of the NM Unit would make up a small percentage of public and private land at this location overall (less than 10 percent for all landowners; see **Table 3-37** and **Table 3-38** for acreage impacts).

These actions would also result in direct, short-term impacts by temporarily limiting access to some land areas, ending once construction is complete. The greatest impact on land use and access would be from construction of the Weedy Reservoir, which would affect USFS land and potentially limit public access to this area. However, overall this reservoir would affect a small percentage of total USFS land at this location (see **Table 3-37** and **Table 3-38** for acreage impacts).

Recreation Under Alternative E, the greatest impact on recreation would be due to the construction of the Weedy Reservoir on USFS lands, which would permanently displace some dispersed recreation, and potentially limit access to this area for recreationists; however, there is the potential for some recreation in the future at Weedy Reservoir if permitted by the USFS. Additionally, the proposed diversions would affect river-based recreation downstream of diversions (average project-influenced flows in December at the U.S. Geological Survey gage on the Gila River near Clifton, Arizona, could be reduced 7 to 9 cfs and around 5 to 10 cfs at the U.S. Geological Survey gage on the San Francisco River at Clifton, Arizona, in January). These reduced flows, however, are not anticipated to substantially affect river-based recreation.

Conclusion for Alternative E Under Alternative E, a limited number of private and public landowners, as well as some recreationists, would experience adverse, short- and long-term impacts due to construction and operation of project components. The greatest impact on land use and recreation would be due to the construction of the Weedy Reservoir on USFS lands, which would affect access to public lands and permanently displace some dispersed recreation. Other impacts would range from short- to long-term, with short-term impacts occurring generally during construction, while long-term impacts would primarily occur during operation. Short-term impacts would be minor, given that these impacts would end after construction is complete. Long-term impacts would generally be moderate to major given that Alternative E would include construction of the Weedy Reservoir. Impacts on river-based recreation downstream of proposed diversions would likely be minor, given that the proposed diversions are not anticipated to substantially affect river flows.

Cumulative Impacts

Under Alternative A, the NM Unit would not be constructed, and there would be no NM Unit-related changes to or conflicts with land use and ownership, recreation, or special designation areas; therefore, Alternative A would not contribute to NM Unit-related cumulative impacts on land use and ownership, recreation, or special designation areas.

Many of the projects listed in **Table 3-1** could result in impacts on land use and recreation, and potentially some special designation areas. These impacts would primarily occur during construction, as construction activities would temporarily reduce access to some lands areas and would disrupt some recreation. In the long-term, land uses would be converted to other uses related to these projects, such as agricultural or industrial uses, which would permanently limit public access and recreation in these areas.

Under the action alternatives, implementing the NM Unit would provide an additional water supply to support agriculture. Overall, these alternatives would account for a minor incremental contribution to cumulative impacts on land use and ownership, recreation, and special designation areas. This is because implementing the NM Unit would affect a limited area and because of the limited number of various private landowners and recreationists taking part in dispersed recreation in the project area. Implementing the NM Unit would convert land uses into new types of uses, limit access to some land areas, and displace some dispersed recreation on public land during construction and operation of the NM Unit.

Mitigation Measures and Residual Impacts

Potential mitigation to minimize long-term impacts on land use and ownership and recreation under all action alternatives may include design features for pumping stations and storage ponds. This mitigation would be done to make these elements more compatible with existing land uses. Design features may include property line setbacks, landscaping, lighting requirements (for pumping stations and generators), and limitations on hours of operation for generators. Implementing these design features would minimize conflicts, such as light glare and noise, with other adjacent nonindustrial land uses; however, this mitigation is not mandatory.

Gates and fences around storage ponds, diversion structures, conveyance canals and ditches, pumping stations, and wells would prevent unauthorized access to these project structures. Erecting fences and gates on access roads could displace recreation and disrupt public access in the short- and long-term, with residual impacts on recreation in those areas; however, these residual impacts would be localized and would not reduce recreation opportunities overall within and surrounding the project locations.

Following construction, revegetating temporarily disturbed areas would mitigate the potential for any long-term residual impacts. The Joint Leads would implement mitigation measures to decrease the impacts of spoil sites on land use and recreation. For example, these measures would include revegetating spoil sites with native vegetation and using natural contours to decrease the height and slope of these sites so that they can be more compatible with existing land uses.

By implementing the above mitigation measures, there would be negligible residual, long-term impacts on existing land uses and ownership and recreation from the NM Unit under all action alternatives. Additionally, BMPs would be implemented to help reduce the impacts on existing land uses and ownership and recreation from implementation of the NM Unit (see **Appendix C**, Best Management Practices and Standard Operating Procedures).

3.8 Socioeconomic Resources

3.8.1 Affected Environment

This section is a description of the socioeconomic issues in the area of analysis, defined as Catron, Grant, Hidalgo, and Luna Counties in New Mexico (see **Appendix A**, **Map 3-15** [Socioeconomic Area of Analysis]). Although no project components are proposed in the area, Luna County is included because it could experience social or economic impacts as a result of project activities due to economic and social linkages with the directly affected project area. Deming is the largest municipality in the four-county region and could be expected to supply goods and services to the project region. Additional data for the socioeconomic area of analysis and secondary counties of analysis are included in **Section 3.10**, Environmental Justice.

New Mexico and U.S.-level data are provided for context, when appropriate. Data sources are the U.S. Census Bureau, U.S. Bureau of Economic Analysis, Reclamation, Headwaters Economics, the NMOSE, and the New Mexico Office of the State Auditor.

The PR&G report (**Appendix I**) provides detailed information on data sources, methods of data collection, and analysis. In addition, the socioeconomic report (EMPSi 2019) prepared in connection with this project provides additional details for the baseline socioeconomic conditions for the socioeconomic area of analysis.

Socioeconomic Area of Analysis Demographics

Population growth is an indicator of urbanization in a region and can affect the level of demand for public services. From 1990 to 2017, population growth was highest in Catron County and lowest in Grant County. Hidalgo County experienced a population decline from 1990 to 2017. From 2000 to 2017, Grant, Hidalgo, and Luna Counties experienced population decline, while only Catron County experienced population growth. Overall, the four-county region experienced negligible population change between 1990 and 2017. See **Table 3-39**, below.

Table 3-39. Socioeconomic Area of Analysis Population Totals (1990–2017)

Location	1990	2000	1990–2000 Percent Change	2010	2000–2010 Percent Change	2017	2010–2017 Percent Change	2000–2017 Percent Change	1990–2017 Percent Change
Catron County	2,563	3,543	38.2	3,752	5.9	3,587	-4.4	1.2	40.0
Grant County	27,676	31,002	12.0	29,514	-4.8	27,687	-6.2	-10.7	<0.1
Hidalgo County	5,958	5,932	-0.4	4,894	-17.5	4,305	-12.0	-27.4	-27.7
Luna County	18,110	25,016	38.1	25,095	0.3	24,078	-4.1	-3.7	33.0
4-County Region	54,307	65,493	20.6	63,255	<0.1	59,657	-0.06	-0.09	0.10
New Mexico	1,515,069	1,819,046	20.1	2,059,179	13.2	2,088,070	1.4	14.8	37.8
U.S.	248,709,873	281,421,906	13.2	308,745,538	9.7	325,719,178	5.5	15.7	31.0

Source: U.S. Census Bureau 1995, 2000, 2017a

Population Projections Population projections for the socioeconomic area of analysis vary based on data source. The ISC estimates for both low and high growth scenarios (ISC 2017) reflect higher growth estimates than those of University of New Mexico Geospatial and Population Studies (UNM 2019), which predict a population decline in all four counties by 2040. **Table 3-40**, below, describes the projections by decade. Given the variation in population projections, future population levels in the region are uncertain.

Table 3-40. Socioeconomic Area of Analysis Population Projections, 2020–2060

Location	Projection	Population					
		2010	2020	2030	2040	2050	2060
Catron County	ISC High	3,725	4,205	4,628	5,041	5,482	5,948
	ISC Low	3,725	3,909	4,000	4,012	4,012	4,012
	UNM	3,725	3,333	2,875	2,418	–	–

Location	Projection	Population					
		2010	2020	2030	2040	2050	2060
Grant County	ISC High	29,514	31,772	34,958	38,083	41,406	44,930
	ISC Low	29,514	29,457	29,310	29,102	28,869	28,635
	UNM	29,514	28,505	26,407	24,365	–	–
Hidalgo County	ISC High	4,894	5,538	6,093	6,601	7,174	7,792
	ISC Low	4,894	4,818	4,671	4,403	4,150	3,911
	UNM	4,894	4,612	4,072	3,535	–	–
Luna County	ISC High	25,095	27,717	32,168	37,335	43,331	50,289
	ISC Low	25,095	28,024	31,465	35,595	37,784	40,108
	UNM	25,095	25,283	24,795	24,348	–	–

Source: ISC 2017; UNM 2019
Note: – represents data not available. UNM projections are not provided for 2050 and 2060.

Housing and Development Housing availability is an indicator of the ability of a region to support temporary and full-time workers and their families, as an influx of labor could occur during large infrastructure projects.

From 2010 to 2016, Catron, Grant, and Hidalgo Counties experienced growth in their housing stock; Luna County was the only county in the socioeconomic area of analysis with a housing stock decline. Renter-occupied versus owner-occupied rates varied across the socioeconomic area of analysis. The owner-occupied rate was highest in Catron County (significantly higher than the state and national averages). Owner-occupied rates for Hidalgo and Luna Counties were similar to the state and national averages, while Grant County had slightly higher owner-occupied rates (U.S. Census Bureau 2016).

Residential home values varied across the socioeconomic area of analysis. In 2016, Hidalgo County had the lowest median residential home value, while Catron County had the highest. From 2010 to 2016, Catron and Grant Counties experienced an increase in median home values, while Hidalgo and Luna Counties experienced a decline. All counties in the socioeconomic area of analysis have median home values below those of the state and nation (U.S. Census Bureau 2016).

The availability of temporary housing is a significant factor in a region's ability to support temporary workers who need to relocate for project work. In 2010 and 2016, Grant County had the highest median rental rate, while Hidalgo County had the lowest. In 2010 and 2016, Catron County had the highest vacancy rates while Hidalgo County had the lowest. For all counties in the socioeconomic area of analysis, median rental rates were lower than the state and national averages, while vacancy rates were higher (U.S. Census Bureau 2016).

Income and Employment The economic sectors employing the largest portion of the population across the socioeconomic area of analysis were construction, manufacturing, retail trade, transportation and warehousing, and public administration (BEA 2016). Employment in the retail trade and public administration for the socioeconomic area of analysis was higher than the New Mexico and U.S. levels, while other sectors had employment below state and national levels.

Unemployment rates ranged from 5.2 percent in Hidalgo County to 14.2 percent in Luna County, based on 2017 annual averages. All counties in the socioeconomic area of analysis had unemployment rates higher than the U.S. rate, while only Hidalgo County had an unemployment rate below New Mexico's rate. Over the past 15 years, Catron and Grant Counties have followed state trends in unemployment, while Hidalgo County has generally been slightly below state averages. In contrast, Luna County unemployment rates have remained well above state averages.

In 2017, all counties in the socioeconomic area of analysis had per capita personal incomes lower than the reference areas of New Mexico and the United States. Grant County had the highest per capita income at $38,737, while Luna County had the lowest at $29,131. For reference, New Mexico had a per capita income of $39,811 in 2017, while the U.S. per capita income level was $51,640 (BEA 2017).

Fiscal Conditions Local fiscal conditions provide insight into the financial position of each county in the socioeconomic area of analysis. Revenue and expenses varied across counties and came from taxes, intergovernmental transfers such as grants, or miscellaneous sources of income. County expenditures came from current expenses, debt services, and capital outlays. Current expenses are county purchases of goods or services that assist general government purposes or social services, such as public works, safety, or welfare. Debt services are classified as principal, interest, and loan issue costs and provide a description of county debts. Capital outlays are county-level investments for future benefits or infrastructure.

Luna County had the highest portion, 71.4 percent, of revenue coming from taxes, while Catron County had the lowest portion, at 38.1 percent. Intergovernmental transfers were highest for Catron County, accounting for 56.7 percent of total governmental fund revenue, while Luna County had the lowest portion, at 20 percent. Tax revenue and government transfers in Catron County are affected by the substantial portion of the lands in the county administered by the USFS. Expenditures and expenses by county are detailed in the socioeconomic baseline report (EMPSi 2019).

Water Service and Demand The NM Unit would affect the water supply of the socioeconomic area of analysis. Water use was calculated by the New Mexico NMOSE in the New Mexico Water Use by Categories 2015, a report detailing water withdrawals (Magnuson et al. 2019; see **Table 3-41**, below).

Table 3-41. Total Regional Water Use by County in 2015 (Acre-Feet)

Area	Surface Water (Percentage by County)	Groundwater (Percentage by County)	Total (Percentage by County)
Catron County	20,840	567	21,407
	(33.5)	(0.4)	(9.8)
Grant County	31,900	23,249	55,149
	(51.3)	(14.8)	(25.1)
Hidalgo County	5,056	47,145	52,201
	(8.1)	(30.0)	(23.8)
Luna County	4,429	86,360	90,789
	(7.1)	(54.9)	(41.4)
Total	**62,225**	**157,320**	**219,545**

Source: Magnuson et al. 2019

All counties in the socioeconomic area of analysis are part of the Southwest New Mexico Water Planning Region, which includes several water basins. According to Magnuson et al. (2019), regional surface water use was highest in Grant County, accounting for 51.3 percent of surface water use in the four-county area. Use was lowest in Luna County, accounting for 7.1 percent of surface water use. Regional groundwater use was highest in Luna County, accounting for 55 percent of the four-county area groundwater use, and lowest in Catron County, accounting for less than one percent. Based on total water use in the region, Luna County used the most water (41.4 percent of four-county area water use), while Catron County used the least (9.8 percent; Magnuson et al. 2019).

Irrigated agriculture is the main source of surface water use in the socioeconomic area of analysis. For Grant, Hidalgo, and Luna Counties, irrigated agriculture (defined here to include alfalfa, pecans, chile, and other row crops) accounted for 99 percent of surface water use. Catron County also primarily used surface water for agriculture irrigation, accounting for 89 percent of surface water use, with the remainder of surface water use allocated for commercial and livestock purposes, including irrigated pasture (Magnuson et al. 2019).

Groundwater use varied more by county than surface water use. Irrigated agriculture was the predominant source of groundwater use for Hidalgo County and Luna County, accounting for 97 percent and 87 percent of county-level groundwater demand, respectively. Grant County had mining as its primary source of groundwater demand, accounting for 64 percent, with the remainder of groundwater demand used by irrigated agriculture (21 percent) and public water supply (12 percent) sources. Catron County had the most diverse groundwater demand; irrigated agriculture accounted for 33 percent of groundwater demand, followed by public water supply (32 percent), domestic use (31 percent), and commercial use (4 percent).[31]

Residential consumption is primarily from groundwater sources, including many rural drinking water systems, and constitutes a small share of overall water consumption. Private wells serve most rural areas; as such, the current costs associated with domestic water use are variable and depend on the depth of drilling to groundwater. The cost to pump and treat groundwater depends on the cost of installation and the electricity to pump the water to the surface, the depth of the groundwater, and any additional filtering or treatment needed to make the water safe to consume. Some municipalities provide municipal water systems, including the town of Silver City, which provides water to several surrounding communities through agreements with water associations (Grant County 2017; Catron County 2007; Hidalgo County 2011).

Adjudicated diversion of surface flows for irrigation is based on laws and agreements. Costs of water use for agriculture depend on costs for diversion construction and upkeep, as well as the efficiency of use, such as the loss of water due to evaporation. The cost to use groundwater, as an alternative to surface water, would likewise vary, based on the depth of wells required and geomorphology, among other site-specific variations.

Water demand over the next 40 years is variable, depending on projections examined (ISC 2017). The projected high estimate for total regional water demand in 2060 is 239,531 acre-feet, a 7.6 percent increase from 2010 levels based on withdrawals of water as reported in the New Mexico Water Use by Categories

[31] Public water supply is defined as the community water systems that rely on surface water and groundwater diversions. Domestic use is defined as self-supplied residencies with well permits issued by the NMOSE. Commercial use is defined as self-supplied businesses, institutions, and entities not covered by the public water supply.

2010 report (Longworth et al. 2013), while the projected low estimate in 2060 is 212,631 acre-feet, a 4.5 percent decrease from 2010 levels (ISC 2017). Among all use types, commercial demand is expected to grow the fastest, increasing by 231.2 percent in the high estimate and by 176.5 percent in the low estimate. Irrigated agriculture is expected to remain the primary source of water demand for the total region through 2060; however, the high estimate depicts only a 0.1 percent increase, while the low estimate depicts a 5.6 percent decrease between 2010 and 2060 (ISC 2017). At the county level, irrigated agriculture would remain the primary use of water for each county in the socioeconomic area of analysis through 2060.

For Catron County, domestic water demand is expected to grow the fastest, while livestock water demand is expected to decline. For Grant County, mining and commercial water demand is expected to grow the fastest of all categories. Livestock demand is expected to decline the fastest in Grant County. For Hidalgo County, commercial water demand is expected to grow the fastest, while mining is expected to experience the most significant decline. For Luna County, industrial water demand is expected to grow the fastest, while livestock is expected to have the most significant decline (ISC 2017).

Key Economic Sectors

Agriculture is the industry the NM Unit would be most likely to affect, and irrigated agriculture has the highest water demand by use type in each county. The number and types of farms serve as indicators of which areas in the socioeconomic area of analysis the Proposed Action and alternatives would be likely to affect most. Water users in the Gila Basin have faced a long history of water supply fluctuations, producing low-valued cropping patterns (Ward and Crawford 2016). Factors in the last decade that have influenced agriculture in the area include, but are not limited to, the conversion to drip agriculture, the economic recession, and drought (Ward 2014). Storage capacity development can lead to a higher-valued portfolio and higher-valued farm livelihoods (Ward and Crawford 2016); however, impacts may be dependent on cost and financing for storage capacity infrastructure. In 2012, Grant County had the most farms, but Luna County had the most irrigated land for farming (NASS 2014). The San Francisco location of the NM Unit primarily affects southwestern Catron County, where most employment is in agriculture.

Across all counties in the socioeconomic area of analysis, beef and cattle farms were the dominant farm type in 2012, with Catron County having the highest concentration (63.5 percent). Crop farms represented a significant portion of farming in the socioeconomic area of analysis, with fruit and nut tree farming accounting for 20.5 percent of farms in Luna County and 6.4 percent of farms in Hidalgo County. Other crop farming was also significant in those counties, with 28.4 percent in Luna County and 16.4 percent in Hidalgo County (Headwaters Economics 2018).

The market value of agricultural products sold by farms serves as an indicator of the importance of agricultural production to the regional economy. In 2012, Luna County had the highest average market sales per farm, at $328,852; Hidalgo County experienced the most growth in average market sales per farm from 2007 to 2012, at 57.5 percent (NASS 2014). Average market sales per farm in Hidalgo and Luna Counties were higher than the New Mexico average, while Catron and Grant Counties' average market sales per farm were lower than the New Mexico average (NASS 2014). When average market sales per acre in farmland were calculated by county, Catron ($11.83 per acre), Grant ($13.86 per acre), and Hidalgo ($31.66 per acre) were lower than the state average ($59.03 per acre). Luna County was well above the state average at $113.57 per acre.

The average government payments to farms help give some insight into government subsidies coming into the region, which represent agriculture-related injections to the local economy. Government payments consist of payments received from the Conservation Reserve Program, Wetlands Reserve Program, Farmable Wetlands Program, or Conservation Reserve Enhancement Program, loan deficiency payments, disaster payments, other conservation programs, and all other federal farm programs under which payments were made directly to farm operators (NASS 2014). In 2012, Grant County had the highest average government payments per farm, while Catron County had the lowest. Grant County also experienced the most growth in average government payments per farm from 2007 to 2012 (NASS 2014). Compared to the New Mexico average, all counties except for Catron received higher than average government payments per farm (NASS 2014).

Farm earnings varied by county in the socioeconomic area of analysis, with Luna County reporting the highest farm earnings and Catron County reporting the lowest. Farm proprietor earnings also varied by county, again with Luna County reporting the highest earnings and Catron County reporting the lowest (Headwaters Economics 2018). Farm wages and employment also varied by county. Luna County reported the highest average farm wages, and Catron County reported the lowest. For employment, the percentage of laborers employed in the farm industry was highest in Luna County and lowest in Grant County (Headwaters Economics 2018). See the socioeconomic report for more detail (EMPSi 2019).

Tourism and Recreation Tourism and recreational activities occur in association with the Gila River in the socioeconomic area of analysis. As noted in **Section 3.7**, Land Use, recreationists use the Gila River for river-based recreation (rafting, kayaking, and canoeing); however, the majority of this recreation takes place upstream of the project locations. In addition, the San Francisco River supports recreational fisheries, and it can influence area camping, hiking, and scenic recreation. The San Francisco River joins the Gila River in Arizona, where the BLM manages the Gila River Recreation Area outside the project area to support access to the river for angling and hiking (BLM 2019d). Additional details about area recreation are provided in **Section 3.7**, Land Use.

The ecological attributes of the Gila River ecosystem attract wildlife to the socioeconomic area of analysis (Baltosser 1986). Specifically, the river in New Mexico supports a great diversity of bird life, including populations of non-colonial breeding birds and a high diversity of raptors and endangered and threatened bird species (Gori et al. 2016). This ecosystem represents a potential attractor for wildlife viewing and tourism.

The tourism industry in the socioeconomic area of analysis is composed of lodging, food/beverage, retail, recreation, transport, and second homes. In a 2016 report, Tourism Economics (2016) analyzed the economic impact of tourism in New Mexico by estimating tourism visitor spending, tourism employment, tourism labor income, and tourism tax revenue from 2011 to 2015. Visitor spending in the tourism industry occurred mostly in the lodging and food/beverage sectors for Grant, Hidalgo, and Luna Counties, while second homes comprised most of the visitor spending in Catron County (Tourism Economics 2016).

In 2015, visitor spending in the recreation sector for each county in the socioeconomic area of analysis ranged from 3.2 percent to 8.9 percent of total tourism spending for that county (Tourism Economics 2016). While visitors may not spend directly on recreation, tourism spending in other sectors is driven by visitors recreating in the socioeconomic area of analysis and purchasing or renting gear, supplies, transport, and lodging. See the tourism and recreation section in the socioeconomic report for additional information on recreation associated with the Gila River (EMPSi 2019).

The NM Unit project could influence water sources for wildlife and could affect recreational angling/fishing, hunting, and wildlife viewing. The NMDGF evaluated the economic contribution of angling, hunting, and trapping for the state and all counties in 2013. In the socioeconomic area of analysis, hunting had more participants visit the region and provided a larger economic contribution to the statewide gross domestic product (GDP) than angling. The levels of use and the total regional economic contributions (i.e., direct retail spending as well as the indirect and induced effect from this use) for hunting and angling are summarized below.

In 2013, 24,528 hunters visited the counties in the socioeconomic area of analysis, accounting for 28.4 percent of New Mexico's hunting population; 19,075 hunters were residents of the socioeconomic area of analysis, and 5,453 were nonresidents. Catron County had the most resident and nonresident hunters, while Hidalgo County had the fewest (NMDGF 2014). Hunters in the socioeconomic area of analysis spent $30,776,972 on equipment-, license-, and travel-related expenditures based on statewide spending profiles and level of participation by county. This accounts for 9.0 percent of total hunter spending in New Mexico. Total hunter spending was highest in Catron County and lowest in Hidalgo County (NMDGF 2014). Hunting in the socioeconomic area of analysis supported 429 total jobs and $8,167,411 in total labor income in 2013. Hunting contributed $19,180,629 to the state GDP and produced $2,128,157 in Federal tax revenue and $2,655,745 in state and local tax revenue (NMDGF 2014). Catron County supported the most jobs and generated the most income by category, while Hidalgo County generated the least.

In 2013, 21,852 anglers visited the socioeconomic area of analysis, accounting for 13.6 percent of New Mexico's angling population. Grant County had the most resident and nonresident anglers, while Hidalgo County had the fewest (NMDGF 2014). Anglers in the socioeconomic area of analysis spent $15,466,798 in 2013, accounting for 5.8 percent of total angler spending in New Mexico. Angler spending was highest for residents and nonresidents in Grant County and lowest for both groups in Hidalgo County (NMDGF 2014). In 2013, angling in the socioeconomic area of analysis supported 113 total jobs and $2,788,842 in total labor income.

Angling in the socioeconomic area of analysis in 2013 generated $5,438,766 in state GDP, while producing $656,952 in Federal and $919,741 in state and local tax revenue. Grant County supported the most jobs (74), while generating the most labor income, state GDP, Federal revenue, and state and local revenue in 2013; Hidalgo County supported the fewest in all categories (NMDGF 2014).

Community and Social Characteristics

Social Setting The socioeconomic area of analysis counties are sparsely populated and rural, with population densities from less than one to eight people per square mile, as compared with the state population density of approximately 17 people.

Historically, the area has been based on an economy tied to agriculture, ranching, and mining. Some of the small towns in the area were established in the mid to late 1800s by Spanish settlers with ranching operations, and there are still close ties to agriculture. Mormon settlers also populated the Gila River valley, using the Gila, Salt, and San Pedro Rivers for irrigation and establishing settlements. Gold, silver, and copper mining and refining played a major role in the economy from the late 1800s, after the Southern Pacific Railroad completion, until the 1970s, with price decreases in copper and the eventual closure of copper smelters. Today, recreation is becoming increasingly important for the local economy, including off-road vehicle use, hunting, camping, and other activities on the public lands and national forests, including the Gila Wilderness Area.

Communities of Interest In addition to the geographically defined community, segments of the population in the socioeconomic area of analysis are defined by common interests or concerns. These groups are briefly described below.

Agricultural Water Users The purpose of the Proposed Action and alternatives is to provide irrigation water to improve agriculture in the Cliff-Gila, Virden, and San Francisco locations. As a result, agricultural water users in the socioeconomic area of analysis could benefit directly from the Proposed Action and alternatives. The San Francisco Basin in Catron County is primarily agricultural, and AWSA water provided to farmers there could have a localized economic benefit on the region.

Individuals and Groups Who Prioritize Nonconsumptive Water Use Some individuals and groups have concerns about direct and indirect impacts of the project on resources in the Gila River. Concerns received during project scoping included the potential impacts a diversion could have on natural recharge of the aquifer and plant and wildlife values in New Mexico and Arizona. Commenters also expressed concern that dewatering some sections of the river, or extending the dewatered periods, could negatively affect native fish and aquatic species in the Gila River region. There is also concern that the proposed project would degrade the tourism values for birders, hikers, boaters, anglers, and naturalists.

Groundwater Users Many individuals in the socioeconomic area of analysis own and operate their own groundwater wells. In many cases, they have incurred substantial upfront costs to install groundwater well systems, allowing for relatively low annual costs for water consumption. Based on input received during the public scoping period, members of this group are concerned about the potential for water tables to lower and water quality to degrade as a result of proposed activities.

Local Communities Water has historically been a key component of local settlement patterns, because agriculture was a basis for most land use. Local community members expressed concern with the impacts of project activities on community water supplies, at the expense of a small group of beneficiaries.

Downstream Water Users Concerns of water users downstream of the proposed diversion include impacts on availability, costs, and the quality of water for municipal and agricultural water use.

Ecosystem Services Ecosystem services describe the comprehensive set of benefits that people receive from nature, including both nonmarket and market components. Ecosystem valuation is a process that assigns a value to characteristics or services an ecosystem provides. Functioning ecosystems provide a range of services that are essential to support economic activity and improve environmental conditions. Ecosystems directly and indirectly support services that contribute toward social welfare. Some are essential for human survival (such as food), while others support services that contribute toward human enjoyment (such as recreation). The Millennium Ecosystem Assessment Classification System (Millennium Ecosystem Assessment 2005) developed a frequently referenced classification of ecosystem services into four categories: provisioning, supporting, regulating, and cultural services. Each is summarized below.

Provisioning services These are broadly described as products derived from ecosystems. They can include a broad spectrum of products from raw materials, minerals and energy products, water, food, and medicines. In the socioeconomic area of analysis, water resources and food produced by agriculture represent the primary provisioning services related to proposed project activities.

Supporting (habitat) services These are the underlying natural processes that sustain ecosystems and enable the production of all other ecosystem services, such as nutrient recycling and soil formation. These processes, in turn, support plants and animals, which support habitat and species diversity, abundance, and distribution. The ecosystem in the socioeconomic area of analysis supports a diverse array of plant and animal species.

Regulating services These are defined as benefits obtained from the regulation of ecosystem processes. Examples are carbon sequestration and climate regulation, waste decomposition and detoxification, and water and air purification. The Gila River provides a range of regulating services, such as those provided by riparian and wetland ecosystems.

Cultural services These are defined as the benefits that people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences. Water use in the socioeconomic area of analysis supports a variety of cultural services, including preservation of historic resources and traditional lifeways, such as ranching and acequia agriculture. In addition, the area supports recreation and preserves the viewshed for visitors and local residents.

3.8.2 Environmental Consequences

The proposed project would provide an additional water supply for irrigation. In addition, proposed project activities represent the potential for increased spending and employment in the project area, resulting in direct and indirect economic impacts for the region. These are examined for both the short-term construction period (approximately 5 years) and for the operations and maintenance period, which is assumed to be approximately 100 years for this analysis. This analysis also examines the proposed project impacts on local community social setting and ecosystem services provided. The assessment of the economic benefits of the increased water supply on farm revenue, as compared with the project costs, are summarized here and are reported in detail in the PR&G report (**Appendix I**).

Methods of Analysis

The analysis focuses on the socioeconomic area of analysis of Catron, Grant, Hidalgo, and Luna Counties in New Mexico. This analysis is supported by the PR&G report (**Appendix I**) and the socioeconomic report (EMPSi 2019).

The factors of analysis for socioeconomic resources include:

- Economic factors:
    - Benefits (e.g., irrigation water supply and ecosystem services supported by the Gila River in the socioeconomic area of analysis)
    - Costs (e.g., construction, operation, maintenance, and replacement [OM&R], interest during construction [IDC], and ecosystem costs)
- Financial factors: Cost per acre-foot of AWSA water applied, which represents the amount of water delivered and applied to irrigated acreage for crop production
- Regional factors: Agricultural production and construction and OM&R activities, which include:
    - Employment (full- and part-time jobs)
    - Labor income

  - Value added (where value added includes employee compensation, including benefits, proprietor income [i.e., payments received by self-employed individuals], other property related income [payments for rents, royalties, and dividends], and business taxes on production and imports less subsidies)
  - Total economic output (the total economic value of the action in the regional economy and calculated based on value added and intermediate expenditures)

  All regional impacts are reported for total impacts, including direct, indirect, and induced impacts.
- Social impact factors: Change to the social setting or values for area communities and communities of interest as a result of the proposed activities

Economic Analysis Methods and Assumptions An economic analysis is from a broad national perspective, where benefits and costs could be monetized or non-monetized and could accrue to those inside or outside the project area. Therefore, an economic analysis focuses on economic benefits and costs to the public as a whole. Two categories of benefits are quantified in the economic analysis of the NM Unit: irrigation water supply benefits and potential ecosystem services benefits. Project benefits are associated with increased irrigation water supplies and benefits from potential reduced soil erosion and increased soil fertility associated with cultivated irrigated crop production compared to non-irrigated land.

Cost categories include evaluation of costs for construction, OM&R (including Central Arizona Project [CAP] exchange costs); interest during construction, and potential ecosystem costs associated with short-term and long-term disturbance of existing lands associated with each alternative. Values for future years are discounted to adjust for the "time value of money," using the Federal water resources planning rate for fiscal year 2020 of 2.75 percent. Interest during construction is added to construction costs to represent the full economic cost of a project. More information about the methods of analysis and assumptions for the economic analysis can be found in the PR&G report (**Appendix I**). It should be noted that recreation-related costs and benefits were not included in the analysis due to a lack of sufficient data available to quantify these impacts.

Financial Analysis Methods and Assumptions The financial analysis of costs reflects the project costs potentially passed on to the water users. Two scenarios are used to analyze financial costs for each action alternative: (1) no public funding for the project; and (2) up to $60 million in public funding available for construction-related costs from the New Mexico Unit Fund.[32]

Regional Impacts Methods and Assumptions This EIS incorporates the results of the regional economic impact analysis, which identifies changes in regional output, wages, and employment as a result of expenditures from project activities. Direct project costs are described for construction, operation, and management, based on information developed by the Reclamation cost sheets (Reclamation 2019c). In addition, the gross value of irrigation-related agricultural production is estimated based on irrigated crops and cropping patterns, yields, prices, and water use estimates. The economic impact analysis then identifies the economic activity resulting from changes in expenditures tied to these direct costs to provide a regional economic impact by alternative for construction and agricultural production. For the purposes

[32] Distribution of funds from the New Mexico Unit Fund is under the discretion of the New Mexico Interstate Stream Commission in consultation with the NM CAP Entity. At this time, no decision has been made by the ISC on future use of the Unit Fund for construction of the NM Unit or for any additional non-NM Unit projects. Use of this funding scenario in the EIS in no way obligates the Commission to allocate any funding from the New Mexico Unit Fund to the NM Unit Project.

of this analysis, it is assumed that the employment, income, and output associated with each alternative represent economic impacts that would occur in addition to what would exist without the project.

To calculate the regional economic impact of construction and operation, an input-output model (IMPLAN) was used to calculate the increases in jobs, incomes, and output region-wide that would happen as money from direct NM Unit expenditures is spent in the local economy. The IMPLAN model estimates the effects of the expenditures on income and employment that follow from direct, indirect, and induced impacts, as discussed in detail in the PR&G report (**Appendix I**). The regional output and labor income impacts are described in U.S. dollars, while employment impacts are described in the form of jobs. These jobs are not described as full-time equivalents and can be full-time, part-time, or seasonal jobs. The regional economic impact analysis evaluates the short-term impacts from construction, the long-term impacts of OM&R expenditures, and the long-term impacts from changes in the value of crop production due to increased irrigation capability. Changes in the value of regional output associated with construction spending and increased agricultural production also would have impacts on State and Federal taxes paid, including income taxes. These impacts are discussed by alternative in **Appendix I**.

It should be noted that only those expenditures originating from outside the region and spent within the region would generate positive regional impacts. As such, estimates must be provided for the level of spending that occurs within and outside the region. Looking at short-term impacts from construction, the analysis assumes that half the construction expenditures on employees and materials would occur in the socioeconomic area of analysis. It is assumed that long-term OM&R-related impacts will be fully paid for by water supply beneficiaries; therefore, those expenditures represent a reallocation of spending within the region rather than an increase in new spending. Therefore, the regional impacts from OM&R spending are assumed to generate no regional impacts.

The regional impacts associated with construction-related expenditures for a New Mexico Unit project that is funded with public funds is complicated by the fact that some level of public funding associated with CAP Entity activities would continue without a project. Existing non-NM Unit project expenditures have occurred in the past, and any future expenditures would partially offset the loss of regional economic effects if a New Mexico Unit project was not built. Because of the unknowns associated with future potential non-NM Unit projects, the regional impacts presented below overstate the regional impacts associated with each alternative. These are not included in the analysis because assumptions on non-NM Unit projects would be speculative. See **Appendix I** for additional details.

For the agricultural analysis, crop production supported by AWSA water is assumed to be marketed in the year produced and sold outside the region. Therefore, these sales represent a change in final demand for agricultural production and an inflow of expenditures to the region.

Finally, it is recognized that secondary impacts may occur to recreation-related economic contributions. Regional impacts associated with changes in recreation attributable to the alternatives were not included in this analysis because data were not available as a basis for these effects.

Social Impacts Methods and Assumptions The examination of social impacts is based on the potential for impacts on the quality of life for area residents and particular communities of interest. The ecosystem service assessment includes the assessment of provisioning, regulating, supporting, and cultural services as a result of proposed project activities. Factors evaluated or discussed are the quality of life, cultural values, public safety, water quality and quantity, recreation, and ecological factors.

Alternative A: No Action Alternative

Under Alternative A, there would be no short-term or long-term changes to socioeconomics from construction of NM Unit project components. Furthermore, there would be no economic contributions associated with construction in the absence of NM Unit project construction. Existing socioeconomic conditions described in the *Affected Environment* section would persist for the socioeconomic area of analysis. Water users in the Gila River Basin would continue to face water supply fluctuations and likely continue with low-value cropping patterns (Ward and Crawford 2016).

Economic Analysis Without the NM Unit project, current agriculture-related economic conditions would persist. The economic costs for Alternative A would not be zero due to ongoing OM&R costs. The exact economic costs under Alternative A are unknown at this time.

Support, regulation, and cultural ecosystem services would likely persist, as described in *Affected Environment*. Current diversions would not enhance the provision of services locally; services, or lack thereof, would remain similar to current conditions. Current habitat disturbance would remain. Maintenance of ongoing push-up diversions would represent continued, potential, periodic erosion and pollution spills in the Gila and San Francisco Rivers, with potential short-term impacts on ecosystem services.

Financial Analysis Under Alternative A, there would be no additional financial costs to water users because AWSA water would not be available to them absent a NM Unit project. As noted under the economic analysis discussion, the annual OM&R costs for Alternative A would not be zero; however, the exact costs are unknown at this time.

Regional Impacts Under Alternative A, current economic conditions would persist. There would be no short-term economic injection into the area of analysis from construction and no long-term changes as a result of operations of new infrastructure. Jobs and wages would persist as described in *Affected Environment*. Summer flows in the Gila River would likely remain low or intermittent, and limited access to irrigation water would remain an issue that could affect irrigators and agricultural sector economic contributions. Assuming that historical cropping patterns and irrigation methods would continue without the project, irrigated cropland (i.e., row crops) would likely remain highest in Luna County and lowest in Catron County. Pasture and feed for cattle would remain the dominant farm type in the socioeconomic area of analysis. Average market sales per farm would be highest in Luna County and lowest in Catron County, and farm earnings would follow a similar distribution, with earnings highest in Luna County and lowest in Catron County. Under Alternative A, pastureland would likely remain the dominant irrigated land type, with irrigated pastureland highest in Catron County and lowest in Grant County. Recreation would likely remain at current levels, and contributions to the regional economy would remain similar to current levels.

Social Impacts Under Alternative A, social characteristics would likely persist, as described in *Affected Environment*. In the absence of construction, no short-term impacts would occur on communities. Population changes and economic trends would be expected to follow trends described in *Affected Environment*. Communities of interest of agricultural users would not have increased opportunities under Alternative A. Should land be converted from agriculture to other land uses, there would be potential for impacts on the social structure of the historically agriculture-based communities, and a loss of this historical land use. Communities of interest concerned with nonconsumptive use, groundwater, and local community and downstream impacts would not be negatively affected under Alternative A.

Action Alternatives Comparative Summary Tables

The tables below provide a summary of costs and benefits and financial costs, and as detailed in the PR&G report (**Appendix I**). In addition, information is provided on input into the regional model by alternative. A summary of regional economic impacts for construction and agriculture is also provided.

Annualized economic costs and benefits are presented by alternative in **Table 3-42** and costs per applied acre-foot of water **Table 3-43**, below. Under all action alternatives, estimated annual economic costs exceed estimated economic benefits.

Table 3-42. Economic Costs and Benefits Summary by Alternative

Alternative and Project Area	Estimated Annual Benefits[1]	Estimated Total Annualized Economic Costs[2]
Alternative B		
Cliff-Gila	$447,601	$1,740,090
Virden	$110,338	$357,715
San Francisco	$2,806	$179,052
Total	**$560,745**	**$2,276,858**
Alternative C		
Cliff-Gila	$410,416	$1,742,372
Virden	$110,338	$357,715
San Francisco	$60,940	$2,513,930
Total	**$581,694**	**$4,614,108**
Alternative D		
Cliff-Gila	$0	$0
Virden	$110,338	$357,715
San Francisco	$0	$0
Total	**$110,338**	**$357,715**
Alternative E		
Cliff-Gila	$304,012	$2,898,453
Virden	$110,338	$357,715
San Francisco	$64,206	$3,508,317
Total	**$478,556**	**$6,764,485**

Source: PR&G report (see **Appendix I**)
Notes: [1] Benefits include annual irrigation water supply benefits at $230 per acre-foot and annual ecosystem service benefits at $68.88 for each acre of cultivated land supported by the water provided.
[2] Annualized cost discounted using the Federal water resources planning rate for fiscal year 2020 of 2.75

Table 3-43. Cost Per Applied Acre Foot Summary By Alternative

Alternative and Project Area	Acre-feet of Water Applied	Cost per Applied Acre Foot
Alternative B		
Cliff-Gila	1,770	$950
Virden	439	$764
San Francisco	11	$16,117
Total	**2,220**	**$988**
Alternative C		
Cliff-Gila	1,623	$1,046
Virden	439	$764
San Francisco	241	$10,357
Total	**2,303**	**$1,966**
Alternative D		
Cliff-Gila	0	$0
Virden	439	$764
San Francisco	0	$0
Total	**439**	**$764**
Alternative E		
Cliff-Gila	1,202	$2,365
Virden	439	$764
San Francisco	254	$13,709
Total	**1,895**	**$3,515**

Source: PR&G report (see **Appendix I**)

Under all action alternatives, the economic costs represent the total resource cost of all project components, including IDC, and do not account for project funding sources that would reduce the financial cost of alternatives paid by project beneficiaries.

A summary of the financial costs is provided by alternative in **Table 3-44**, below. Costs are provided in total annual numbers and by acre-foot applied water. The financial cost estimates without public funding represents the case where project beneficiaries pay the full cost of each alternative, excluding IDC, and the estimates with public funding represent the costs paid by project beneficiaries after all or a portion of construction costs are paid from public funds. Therefore, the costs paid by water users with public funding do not fully cover project costs.

The gross value of agricultural production was estimated using the same cropping pattern, crop yield, and crop price, information used to estimate economic benefits. The data used to estimate the gross value of production are shown in **Table 3-45** and are detailed in the PR&G report (**Appendix I**).

The estimated gross value of agricultural production used to estimate the annual regional impacts from increased crop production for each alternative are shown in **Table 3-46**. The increased value of agricultural production represents a change in final demand for irrigated agricultural output.

Table 3-44. Financial Cost Summary by Alternative

Alternative and Project Area	Acre-feet of Water Applied	Total Annual Financial Costs paid by Water Users[1]		Total Financial Costs per Acre-Foot Applied	
		(No Public Funding)	(Public Funding)	(No Public Funding)	(Public Funding)
Alternative B					
Cliff-Gila	1,770	$2,962,207	$400,967	$1,674	$227
Virden	439	$320,461	$118,454	$730	$270
San Francisco	11	$167,267	$31,328	$15,206	$2,848
Total	**2,220**	**$3,449,935**	**$550,749**	**$1,554**	**$248**
Alternative C					
Cliff-Gila	1,623	$1,648,126	$981,344	$1,015	$605
Virden	439	$320,461	$118,454	$730	$270
San Francisco	241	$2,360,969	$1,404,800	$9,797	$5,829
Total	**2,303**	**$4,329,556**	**$2,504,598**	**$1,880**	**$1,088**
Alternative D					
Cliff-Gila	0	0	0	0	0
Virden	439	$320,461	$118,454	$730	$270
San Francisco	0	0	0	0	0
Total	**439**	**$320,461**	**$118,454**	**$730**	**$270**
Alternative E					
Cliff-Gila	1,202	$2,701,751	$1,136,327	$2,248	$945
Virden	439	$320,461	$118,454	$730	$270
San Francisco	254	$3,280,394	$3,280,394	$12,915	$12,915
Total	**1,895**	**$6,302,606**	**$4,535,175**	**$3,326**	**$2,393**

Source: PR&G report (see **Appendix I**)
Notes:
[1]Financial costs are not equivalent to economic costs. Financial costs can be used to assess the viability of project beneficiaries to cover their share of costs while economic costs represent full resource costs of a project to the nation and are used to evaluate economic feasibility.

Table 3-45. Irrigated Crop Yields, Prices, and Cropping Patterns Used For Estimating Crop Revenues

Crop	Yield	5-year average Price per unit	Cropping Pattern by Project Location		
			Virden Valley	San Francisco River Valley	Cliff – Gila Valley
Pasture	6 AUM/acre[1]	$72.00[1]	10%	70%	70%
Alfalfa (Cliff – Gila)	6.72 tons	$213.80	NA	NA	15%
Pecans	1,420 pounds	$2.37	25%	15%	15%
Cotton (lint)	1,326 pounds	$0.62	30%	NA	NA
Cotton (seed)	0.62 tons	$235.20	NA	NA	NA
Corn	183.7 bushels	$4.35	20%	NA	NA
Alfalfa (Virden)	6.93 tons	$213.80	15%	15%	NA

[1]Pasture revenues are based on a value of $6.00 per animal-unit-month (AUM) and 6 months of grazing for an annual value of $72. Yield represents an average of 6 AUM per acre for the 6-month period used to estimate the annual value. The value per AUM is based on information from the New Mexico State Land Office for grazing fees for ranches on State Trust land.

Table 3-46. Summarized Annual Estimated Gross Crop Revenues by Alternative

Region	Pasture	Alfalfa	Corn	Cotton	Pecans	Total Gross Revenues
Alternative B						
Cliff-Gila Valley	$192,024	$136,849	$0	$0	$320,554	$649,427
Virden Valley	$6,610	$34,004	$24,452	$44,428	$128,727	$238,221
San Francisco Valley	$1,210	$862	$0	$0	$2,019	$4,091
Total Gross Revenues	**$199,843**	**$171,715**	**$24,452**	**$44,428**	**$451,300**	**$891,739**
Alternative C						
Cliff-Gila Valley	$176,299	$125,643	$0	$0	$294,304	$596,246
Virden Valley	$6,610	$34,004	$24,452	$44,428	$128,727	$238,221
San Francisco Valley	$26,309	$18,749	$0	$0	$43,918	$88,976
Total Gross Revenues	**$209,218**	**$178,395**	**$24,452**	**$44,428**	**$466,949**	**$923,443**
Alternative D						
Cliff-Gila Valley	$0	$0	$0	$0	$0	$0
Virden Valley	$6,610	$34,004	$24,452	$44,428	$128,727	$238,221
San Francisco Valley	$0	$0	$0	$0	$0	$0
Total Gross Revenues	**$6,610**	**$34,004**	**$24,452**	**$44,428**	**$128,727**	**$238,221**
Alternative E						
Cliff-Gila Valley	$130,637	$93,100	$0	$0	$218,078	$441,815
Virden Valley	$6,610	$34,004	$24,452	$44,428	$128,727	$238,221
San Francisco Valley	$27,518	$19,611	$0	$0	$45,938	$93,067
Total Gross Revenues	**$164,765**	**$146,715**	**$24,452**	**$44,428**	**$392,742**	**$773,103**

Source: PR&G report (see **Appendix I**)

Costs used as inputs into the regional economic model for construction and operation are included below. **Table 3-47** summarizes the economic costs for construction by project location across all alternatives, and **Table 3-48** includes annual OM&R costs.

Table 3-47. Estimated Construction Costs by Alternative

Alternative	Area			Total Cost
	Cliff-Gila	Virden Valley	San Francisco Valley	
Construction Costs				
Alternative B	$40,336,358	$6,858,351	$4,615,257	$51,809,966
Alternative C	$19,736,616	$6,858,351	$62,256,847	$88,851,814
Alternative D	$0	$6,858,351	$0	$6,858,351
Alternative E	$65,076,229	$6,858,351	$92,969,496	$164,904,076

Source: PR&G report (see **Appendix I**)

Table 3-48. Annual Operations, Maintenance, and Replacement Costs by Alternative

Alternative	Area			Total Cost
	Cliff-Gila	Virden	San Francisco	
Annual OM&R				
Alternative B	$185,092	$64,359	$30,088	$279,539
Alternative C	$776,589	$64,359	$500,120	$1,341,068
Alternative D	$0	$64,359	$0	$64,359
Alternative E	$641,119	$64,359	$513,688	$1,219,166

Source: Reclamation 2019c

Note: Costs under Alternative A would not be zero; however, insufficient data are available to estimate costs under this alternative.

Construction expenditures and gross crop revenue for each alternative were input into the regional IMPLAN model. Output from economic modeling over the construction period is summarized in **Table 3-49** and annually for agricultural impacts in **Table 3-50** and described in detail in the alternative discussion.

Table 3-49. Summary of Short-Term Total Regional Economic Impacts from Construction over the 5-year Construction Period

Type of Impact	Employment	Labor Income	Value Added	Value of Output
Alternative B				
Direct	238	$7,852,215	$10,035,915	$25,904,983
Indirect	36	$856,116	$1,730,078	$3,915,723
Induced	28	$765,832	$1,739,699	$3,345,933
Total Impact	**302**	**$9,474,162**	**$13,505,691**	**$33,166,638**

Type of Impact	Employment	Labor Income	Value Added	Value of Output
Alternative C				
Direct	435	$12,843,960	$15,361,456	$44,425,907
Indirect	54	$1,129,014	$2,265,767	$6,218,627
Induced	33	$707,222	$1,939,154	$4,095,939
Total Impact	**522**	**$14,680,195**	**$19,566,377**	**$54,740,473**
Alternative D				
Direct	34	$858,630	$1,129,158	$3,429,176
Indirect	3	$100,382	$163,959	$360,595
Induced	2	$58,580	$124,883	$249,286
Total Impact	**40**	**$1,017,591**	**$1,418,000**	**$4,039,056**
Alternative E				
Direct	792	$24,348,089	$29,573,732	$82,452,038
Indirect	105	$2,258,780	$4,594,302	$11,966,843
Induced	67	$1,630,926	$4,189,964	$8,568,551
Total Impact	**963**	**$28,237,794**	**$38,357,997**	**$102,987,432**

Source: PR&G report (see **Appendix I**)

Table 3-50. Summary of Annual Long-Term Regional Economic Impacts from Agricultural Production by Alternative

Type of Impact	Employment	Labor Income	Value Added	Total Economic Output
Alternative B				
Direct	16	$363,116	$487,985	$872,310
Indirect	2	$71,223	$104,849	$184,661
Induced	1	$38,892	$86,771	$166,025
Total Impact	**19**	**$473,231**	**$679,605**	**$1,222,996**
Alternative C				
Direct	16	$381,446	$500,813	$896,594
Indirect	2	$68,632	$101,577	$183,634
Induced	1	$37,522	$85,161	$164,831
Total Impact	**19**	**$487,600**	**$687,551**	**$1,245,059**
Alternative D				
Direct	3	$70,379	$124,852	$229,068
Indirect	0	$12,984	$16,935	$32,522
Induced	0	$5,135	$10,946	$21,850
Total Impact	**3**	**$88,498**	**$152,733**	**$283,440**
Alternative E				
Direct	14	$314,348	$416,990	$748,206
Indirect	1	$54,913	$80,905	$148,136
Induced	1	$29,577	$67,403	$131,177
Total Impact	**16**	**$398,838**	**$565,298**	**$1,027,519**

Source: PR&G report (see **Appendix I**)

Alternative B: Proposed Action

Alternative B, the Proposed Action, builds on concepts, engineering components, and features developed through previous and current studies to fit within funding, environmental, and legal constraints. The Proposed Action would consist of project components in the Cliff-Gila, Virden, and San Francisco areas.

Alternative B would provide 2,220 acre-feet of applied water for irrigation. Total construction costs associated with the Proposed Action would reach $51,809,966. Annual OM&R costs would reach approximately $279,539. See **Table 3-49** and **Table 3-50** for summary information by project location and the PR&G analysis for a detailed breakdown of construction cost estimates (**Appendix I**).

Economic Analysis Two categories of benefits included in the economic analysis are the irrigation water supply benefits and the potential erosion reduction and soil fertility benefits associated with irrigated crop production. Cost categories include construction, OM&R, IDC, and potential ecosystem costs resulting from short-term and long-term disturbance of existing lands under each alternative.

Multiple methods were used to examine irrigation benefits values, including water transactions, land value-based irrigation water supply, cash rent, farm budget analysis, and incremental production from supplemental water supply. Based on these methods, the range of benefits for higher-valued crops is estimated to range from $153.25 to about $310 per acre-foot. The mid-point of the range is about $230 per acre-foot. The $230 value is used for analysis of economic benefits. Under Alternative B, benefits from irrigation are estimated at $510,600.

Benefits were also examined for ecosytem services. Provisioning services (e.g., material benefits that people obtain from ecosystems, such as water and food) could benefit in the long term based on the increase in water available for agricultural users after NM Unit project construction. In addition, an increase in cultivated lands could benefit some supporting services (i.e., reductions in erosion). Using an ecosystem benefit for cultivated land at $68.88 per acre,[33] project impacts would provide an estimated annual monetary benefit of approximately $50,145 under Alternative B (see **Appendix I**). The impact on downstream users is less certain; however, impacts would be minimized by requirements in the CUFA, the NM Unit Agreement, and related agreements to provide sufficient water to support downstream user water rights. A quantitative assessment of water impacts is addressed in **Section 3.3**, Water Resources.

Project costs examined include construction, operation and maintenance, replacement, CAP exchange, and IDC costs are presented in detail in **Appendix I**. All costs are discounted using the Federal water resources planning rate for fiscal year 2020 of 2.75 percent and include IDC assuming a 5-year construction period. Under Alternative B, total annualized economic project costs are estimated at $2,194,224.

In terms of ecosystem service costs, short-term construction impacts include the increased potential for erosion and disturbance, potentially affecting regulating services associated with riparian/wetland habitat. Supporting services could be affected because the Gila River in New Mexico supports an ecosystem of

[33] Based on the Economics of Ecosystems and Biodiversity database (TEEB), ecosystem service-related value from cultivated land (from benefits such as erosion prevention, maintenance of soil structure, and total economic value) ranged from $199.40 to a low of $28.30, with approximately $68.88 for habitat relevant to the project area. The TEEB database is in an Excel file format and available at https://www.es-partnership.org/services/data-knowledge-sharing/ecosystem-service-valuation-database/. Calculations in this analysis use the median ecosystem benefit value of $66.04 per acre of cultivated land supported by increased water provided from project operation.

non-colonial breeding birds and other unique species (Gori et al. 2016). The San Francisco and Gila Rivers also support plant and wildlife communities with social and economic value, such as habitat for sport fisheries and deer hunting. Impacts may be limited due to the site-specific nature of construction activity and the location of key habitat outside the project area. Impacts also would be mitigated by project design features to limit erosion. Alternative B would result in the short-term disturbance of approximately 529 acres. Short-term land disturbance habitat (for the 5-year construction period and 5-year recovery period) has been estimated at a monetary cost of $20,130 under Alternative B, based on an average value of $149.53 annually per disturbed acre[34] (**Appendix I**). Long-term ecosystem impacts are assumed to occur over a 100-year period so they are comparable to the period of construction and OM&R costs. Alternative B would result in the long-term disturbance of approximately 418 acres. Total monetary cost associated with this disturbance is $62,504 (see **Appendix I** for details).

Other non-quantified impacts may occur. Short-term impacts from construction could also occur for cultural services, due to impacts on the visual setting from construction. The socioeconomic area of analysis supports a variety of cultural services, including preservation of historic resources and traditional lifeways, such as ranching and acequia agriculture. In addition, the area supports recreation and preserves the viewshed for visitors and local residents. Should long-term changes in instream water quantity or quality occur, then changes could occur to long-term cultural services that depend on instream water, such as recreation; however, current variabilty in water flow may limit project-specific impacts.

Financial Analysis. Under scenario 1 (no public funding), the total annual financial costs paid by water users would be $3,449,935 for Alternative B. The total financial costs per acre-foot of applied water would be $1,554.

Under scenario 2 (up to $60 million in construction funding), the total annual financial costs paid by water users would be $550,749. The total financial costs per acre-foot of applied water would be $248.

It should be noted that financial costs are not equivalent to economic costs. Financial costs can be used to assess the viability of project beneficiaries to cover their share of costs, while economic costs represent the full resource costs of a project to the nation. For more information related to the financial analysis, see **Appendix I**.

Regional Impacts The analysis is based on assumed cropping patterns, irrigation requirements, and agricultural production for each project area, along with the estimated crop yields and value as detailed in the PR&G report (**Appendix I**). The basis for estimating agricultural-related regional impacts associated with increased irrigation water supplies is the increased gross value of crop production. It is assumed that alfalfa and pasture would remain the predominant crops in the Cliff-Gila and San Francisco locations, with a high-valued crop possible if a supplemental source of water and storage was available (based on studies examined, as reported in the PR&G report; **Appendix I**). San Francisco deliveries would be expected in Catron County, Cliff-Gila deliveries would occur in Grant County, and Virden deliveries would occur in Hidalgo County. For the Proposed Action, at the Cliff-Gila and San Francisco locations,

[34] This analysis assumes the average ecosystem benefit associated with the short- and long-term disturbed acres can be represented as the average of values for cultivated land ($68.88), forests ($194.83), and desert ($184.87), or $149.53 annually per disturbed acre. The annual short-term costs are assumed to occur for a 10-year period, which includes a 5-year construction period plus 5 years to recover and provide full ecosystem benefits. Long-term ecosystem impacts are assumed to occur over a 100-year period so they are comparable to the period of construction and OM&R costs. A 2.75 percent annual discount rate is applied over short and long-term periods.

the dominant water use would be for pasture; for the Virden location, the dominant water use would be for cotton. The price of forage, rather than the market price of beef, was used to estimate pasture production revenue. Beef production is the primary use of forage in the area; therefore, estimating the regional impacts of pasture production implicitly accounts for beef production farming revenue. Impacts could occur as a result of increases in farms or farm size, types of crops grown, or yields associated with crops grown. As displayed in **Table 3-46**, the Proposed Action would be expected to potentially yield $649,427 in gross farm revenue from the Cliff-Gila location, $88,976 from the San Francisco location, and $238,221 from project components developed at the Virden location. See the PR&G analysis for more detail on estimated potential gross crop revenue (**Appendix I**).

Construction expenditures associated with the Proposed Action would generate short-term regional impacts, assuming the source of funding originates from outside the region. Construction-related activities represent an increase in the final demand for goods and services required to build the features associated with the various NM Unit alternatives. The Proposed Action is estimated to generate $33,166,638 in the value of regional output[35] as a result of construction expenditures. This represents a 0.85 percent change in the value of regional output in the four-county region. Construction activities from the Proposed Action are estimated to support 302 direct, indirect, and induced jobs; this is an approximate 1.1 percent increase in the total area employment (see **Table 3-49**). A portion of regional output is associated with $9,474,162 generated in labor income. Impacts reported above include direct (i.e., construction and labor expenses), indirect (e.g., spending on supplies), and induced (i.e., spending by employees). Changes in the value of regional output associated with construction spending will also have impacts on state and federal taxes paid, including income taxes. This value is estimated at $1,982,777 for federal taxes and $1,135,026 for state taxes. A portion of these taxes would likely be used to support services in the local region.

Regional impacts from agricultural production would occur as a result of purchases of required inputs and income and revenues generated by agriculture. The Proposed Action is estimated to generate $1,222,996 in annual regional output from increased agricultural output resulting from increased irrigation supplies. The increased agricultural output due to the Proposed Action is estimated to support 19 annual direct, indirect, and induced jobs, and includes $473,231 in annual labor income (see **Table 3-50**). Contributions to the regional economy would be minor; the value of regional output represents a 0.03 percent increase and employment a 0.07 percent increase when compared to total economic activity in the region. Minor contributions to federal and state taxes would also occur as a result of economic activity, including contributions of $102,555 in federal taxes and $42,892 in state taxes.

Increased construction could affect the recreation and tourism sectors and related economic contributions from those sectors. This is based on the potential for a decrease in available accommodations during the construction period, changes to the visual setting along the river, and temporary restrictions on access for recreationists. The specific level of impacts cannot be quantified here and would vary, depending on the time of year of construction and specific activities affected. All impacts would be site specific and short term in nature.

For Alternative B and all action alternatives, OM&R activities would not represent additional economic contributions to the economic socioeconomic area of analysis. This is because it is assumed that OM&R

[35] Total regional economic output includes employee compensation (including benefits) and proprietor income (i.e., payments received by self-employed individuals), other property-related income (payments for rents, royalties, and dividends), and business taxes on production and imports less subsidies as well as intermediate expenditures.

activities would be provided by personnel within the socioeconomic area of analysis, with expenditures by entities within the socioeconomic area of analysis. As a result, this spending represents a shift in the different categories of spending within the region, and OM&R impacts would be negligible.

Social Impacts Under Alternative B, short-term impacts could occur on the social setting as a result of construction. Increased employment would occur over the construction period and would likely be supported by those currently in the construction industry and those who are unemployed. In addition, this number could represent workers temporarily relocating or commuting from counties outside the primary socioeconomic area of analysis. Short-term workers could benefit local businesses in the retail, food service, and accommodation industries in particular, as discussed under *Regional Economic Impacts*.

Depending on the exact percentage of workers employed locally and those temporarily relocating, there could be a strain on public services, housing, and temporary accommodations in the area. Some workers from outside the region could hold values different from those of some local residents. There would be potential social impacts from an influx of outside workers, although these impacts would likely be temporary in nature (Smith et al. 2001). The exact level of impact would be affected by the rate of development and the percentage of workers from outside the region at a given time. Local area employment increases are estimated at 1.1 percent for the 5-year construction period only; therefore, changes to the local community setting due to population increases from construction would likely be minimal.

In the direct vicinity of the project construction locations, increased noise from construction could affect local residents; however, impacts would be site specific and limited (see also **Section 3.7**, Land Use). Increased traffic from construction vehicles could affect traffic levels in and around construction sites, resulting in localized impacts for local residents' travel time on a short-term basis. In addition, increased road maintenance costs could be a concern for local governments.

Increased water storage from AWSA water may yield a significant and localized economic benefit for farmers in the region. Access to water storage would also support the continued presence of farming in the local community, and the associated way of life important for the agricultural community of interest. This can support social factors such as neighbor cooperation and a sense of community (Wu 2008). In addition, water storage would support the ability of farming communities to respond to changes in the level of precipitation, providing resilience to climate change. Other communities of interest concerned with nonconsumptive use (i.e., instream water use), groundwater, and local community and downstream impacts could have increased concern over potential impacts from the diversion of water and the resultant changes to the river volume and groundwater cost and availability.

Conclusion for Alternative B Under Alternative B, total annual economic costs would exceed annual economic benefits. Under scenario 1 (no public funding), the total annual financial costs paid by water users would be $3,449,935, and the cost per acre-foot of applied AWSA water would be $11,554. Under scenario 2 (up to $60 million for construction), the total annual financial costs paid by water users would be $550,749, and the cost per acre-foot of applied AWSA water would be $248. The regional impact from agricultural production would be $1,222,996 in total economic output, and the regional impact of construction activities would be $33,166,638. Short-term impacts on the social setting could occur as a result of construction. Access to water storage would also support the continued presence of farming and provide resilience to climate change.

Alternative C

Alternative C would provide 2,303 acre-feet of applied water for irrigation and result in direct and indirect impacts similar to those outlined under Alternative B. Direct construction costs associated with Alternative C would be $88,851,814. Annual OM&R costs would reach approximately $1,341,068. See **Table 3-49** and **Table 3-50** for details by project location. For further detail by cost category, see the PR&G analysis (**Appendix I**).

Economic Analysis Under Alternative C, benefits from irrigation are estimated at $529,690. Annual ecosystem service benefits associated with agricultural production were estimated at $52,004. Under Alternative C, total annualized economic project costs are estimated at $4,528,709, due to additional proposed construction. Impacts on ecosystem services from short-term disturbance of land by project construction activities would be similar in nature to those discussed under Alternative B. The monetary cost under Alternative C is estimated at $19,217. Long-term disturbance under Alternative C would include impacts from storage facilities and is estimated at a cost of 66,062.

Non-quantified impacts may occur to cultural services from short-term construction disturbance as discussed under Alternative B.

Financial Analysis Under scenario 1 (no public funding), the total annual financial costs paid by water users would be $4,329,556 for Alternative C. The total financial costs per acre-foot of applied water would be $1,880.

Under scenario 2 (up to $60 million in construction funding), the total annual financial costs paid by water users would be $2,504,598. The total financial costs per acre-foot of applied water would be $1,088.

For more information related to the financial analysis, see **Appendix I**.

Regional Impacts Under Alternative C, project construction would result in short-term, direct impacts on the regional economy, including supporting 522 direct, indirect, and induced jobs, and $14,680,195 in labor income. Compared with Alternative A, this represents a 1.9 percent increase in total area employment (**Table 3-49**). In total, Alternative C would generate an estimated $54,740,473 in regional output from project construction during the construction period; this is an estimated 1.4 percent increase in the value of regional economic output. Contributions to federal taxes under Alternative C would also occur, representing $2,791,395 in federal tax contributions and $2,127,591 in state tax contributions.

Alternative C is expected to yield $596,246 in gross crop revenue from the water available from project components developed at the Cliff-Gila location, $88,976 at the San Francisco location, and $238,221 at the Virden location. Agricultural production under Alternative C is expected to generate approximately $1,245,059 in annual regional output from increased agricultural output (**Table 3-50**). This is estimated to support approximately 19 direct, indirect, and induced jobs, and $487,600 in labor income. Contributions to the regional economy would be minor, as described under Alternative B. Minor contributions to federal and state taxes would also occur as a result of economic activity, including contributions of $105,610 in federal taxes and $44,687 in state taxes.

Social Impacts under Alternative C would be similar to those described under Alternative B. The increase in proposed construction activities at the Cliff-Gila and San Francisco locations would increase the short-term impacts from construction, including changes to the short-term influx of workers and disturbance, disruption, and traffic from construction. Increased storage under Alternative C along the Cliff-Gila and San Francisco locations would increase water for agricultural use in the regions surrounding those project locations. Increased storage capacity would support the benefits for local communities provided by agriculture, similar to Alternative B.

Conclusion for Alternative C Under Alternative C, total annual economic costs would exceed annual economic benefits. Under scenario 1 (no public funding), the total annual financial costs paid by water users would $4,329,556, and the cost per acre-foot of applied AWSA water would $1,880. Under scenario 2 (up to $60 million public funds for construction), the total annual financial costs paid by water users would $2,504,598, and the cost per acre-foot of applied AWSA water would $1,088. The regional impact from agricultural production would be estimated at $1,245,059 in total output, and the regional impact of construction activities would be $54,740,473 in total output. Short-term impacts on the social setting could occur as a result of construction. Access to water storage would also support the continued presence of farming and provide resilience to climate change.

Alternative D

Alternative D, as currently defined, does not propose any NM Unit components at the Cliff-Gila or San Francisco locations. This alternative would provide AWSA water at the Virden location, with components and operations as described under Alternative B.

Alternative D would provide 439 acre-feet of applied water for irrigation. Construction costs associated with Alternative D would be reduced as compared with other action alternatives due to a lack of components developed at San Francisco or Cliff-Gila. For the Virden component, construction costs would reach $6,858,351. Annual OM&R costs for Virden would reach approximately $64,359. For more information on construction costs, please see the PR&G analysis (**Appendix I**).

Economic Analysis Under Alternative D, benefits from irrigation are estimated at $100,970. Due to reduced storage and diversion compared with other action alternatives, the provisional ecosystem services contributions would be less than under the other action alternatives. It is estimated that increased water would provide approximately $9,368 in monetary benefits related to ecosystem services.

Under Alternative D, total annualized economic project costs are estimated at $335,347. This is reduced compared to other action alternatives due to the limited amount of construction at the Virden Valley location. Impacts on ecosystem services would be similar to current conditions due to minimal construction impacts. Due to decreased land disturbance, short-term impacts are estimated at $5,023 and long-term impacts at $17,345.

Non-quantified impacts may occur to cultural services from short-term construction disturbance as discussed under Alternative B; however, limited construction would minimize disturbance and associated impacts.

Financial Analysis Under scenario 1 (no public funding), the total annual financial costs paid by water users would be $320,461 for Alternative D. The total financial costs per acre-foot of applied water would be $730.

Under scenario 2 (up to $60 million in construction funding), the total annual financial costs paid by water users would be $118,454. The total financial costs per acre-foot of applied water would be $270.

For more information related to the financial analysis, see **Appendix I**.

Regional Impacts Project construction would result in short-term, direct impacts on the regional economy. The reduced construction would support fewer economic contributions than other action alternatives due to the decreased expenditures. Alternative D is estimated to generate an estimated $4,039,056 in the value of total regional output from project construction (**Table 3-49**); this is an estimated 0.10 percent increase in the total value of regional economic output for the four-county analysis area. This would include support of 40 direct, indirect, and induced jobs and $1,017,591 in labor income. Compared with Alternative A, this is a 0.15 percent increase in the total area employment. Tax contributions under Alternative D are also reduced compared to other action alternatives; contributions are estimated at $200,276 for federal taxes and $137,252 for state taxes.

Alternative D would be expected to yield $238,221 in gross crop revenue as a result of water available from project components developed, which is the same as Alternative B at the Virden location. For more information, please see the PR&G analysis (**Appendix I**). Output from agricultural production would be similarly reduced compared with other action alternatives. Alternative D is estimated to generate $283,440 in annual regional output from increased agricultural output at the Virden location (**Table 3-50**). This is estimated to include support of 3 direct, indirect, and induced jobs, and $88,498 in labor income. Contributions to the regional economy would be minor, representing less than 0.05 percent increase in total area jobs and economic value. Minor contributions to federal and state taxes would also occur as a result of economic activity, including contributions of $19,005 in federal taxes and $10,004 in state taxes.

Social Impacts under Alternative D would be similar in nature but reduced in scale compared with those described under Alternative B. The decrease in proposed construction activities at the Cliff-Gila and San Francisco locations would decrease the short-term impacts from construction, including changes in the short-term influx of workers and disturbance, disruption, and traffic. Similarly, the support for continued agricultural communities and associated social values would be reduced compared with the other action alternatives.

Conclusion for Alternative D Under Alternative D, total annual economic costs would exceed annual economic benefits. Under scenario 1 (no public funding), the total annual financial costs paid by water users would $320,461, and the cost per acre-foot of applied AWSA water would $730. Under scenario 2 (up to $60 million public funds for construction), the total annual financial costs paid by water users would $118,454, and the cost per acre-foot of applied AWSA water would $270. The regional impact from agricultural production would be $283,440 in total economic output, and the regional impact of construction activities would be $4,039,056 in total output. Short-term impacts on the social setting could occur as a result of construction. Access to water storage would also support the continued presence of farming and provide resilience to climate change in the Virden Valley.

Alternative E

Alternative E incorporates components proposed by the San Francisco Soil and Water Conservation District when refining the San Francisco location and provides a reduced number of ponds in the Cliff-Gila Valley. In Virden, components and operation would be the same as those under Alternative B.

Alternative E would provide 1,895 acre-feet of applied water for irrigation. Total construction costs associated with Alternative E would be the highest of all action alternatives. Total costs would equal approximately $164,904,076. Total annual OM&R costs are estimated at $1,219,166. See **Table 3-49** and

Table 3-50 for details by location. For more information on construction costs, see the PR&G report (**Appendix I**).

Economic Analysis Under Alternative E, annual benefits from irrigation are estimated at $435,850. The estimated monetary benefit from ecosystem services supported by additional cultivated lands would be $42,706.

Total annualized economic project costs are estimated at $6,660,353, the highest of all action alternatives. Impacts on ecosystem services provided by riparian and wetland habitat would occur as described under Alternative B and would be the highest of all action alternatives due to increased disturbance acres in the short and long term. Monetary impacts are estimated at $24,582 based on short-term land disturbance and $79,550 from long-term land disturbance. Similarly, non-quantified impact on cultural services would be the highest of all alternatives due to the greatest level of disturbance.

Financial Analysis Under scenario 1 (no public funding), the total annual financial costs paid by water users would be $6,302,606 for Alternative E. The total financial costs per acre-foot of applied water would be $3,326.

Under scenario 2 (up to $60 million in construction funding), the total annual financial costs paid by water users would be $4,535,175. The total financial costs per acre-foot of applied water would be $2,393.

For more information related to the financial analysis, see **Appendix I**.

Regional Impacts Under Alternative E, project construction would result in the highest level of short-term, direct impacts on the regional economy of any alternatives, generating an estimated $87,507,229 in total regional output as a result of project construction (**Table 3-49**). This includes support of 963 direct, indirect, and induced jobs and $28,237,794 in labor income. Compared with Alternative A, this is an approximate 3.6 percent increase in the total area employment and 2.7 percent increase in the total value of economic output. In addition, construction period economic activity would contribute approximately $5,526,274 to federal taxes and $3,888,171 to state taxes.

Alternative E would yield approximately $441,815 in gross crop revenue associated with component development at the Cliff-Gila location, $93,067 at the San Francisco location, and $238,221 at the Virden location. For more information see the PR&G report (**Appendix I**). Reclamation estimates that the regional economic impact from agricultural production under Alternative E would generate $1,027,519 in total regional output (**Table 3-50**). The increased agricultural output under Alternative E would include support of 16 direct, indirect, and induced jobs, for $398,838 in labor income. Contributions to the regional economy would be minor, with the value of regional output representing a 0.06 percent increase and employment a 0.03 percent increase when compared to total economic activity in the region. Minor contributions to federal and state taxes would also occur as a result of economic activity, including contributions of $86,331 in federal taxes and $37,135 in state taxes.

Social Impacts under Alternative E would be similar to those described under Alternative B. Under Alternative E, the increase in proposed construction at the Cliff-Gila and San Francisco locations could increase the short-term impacts from construction, including changes to the short-term influx of workers and disturbance, disruption, and traffic from construction. Communities surrounding the project locations would experience increased economic contributions from agricultural production, compared to Alternative A. Similarly, support for the agricultural heritage and related social values could be increased.

Conclusion for Alternative E Under Alternative E, total annual economic costs would exceed annual economic benefits. Under scenario 1 (no public funding), the total annual financial costs paid by water users would be $6,302,606, and the cost per acre-foot of applied AWSA water would be $3,326. Under scenario 2 (up to $60 million public funds for construction), the total annual financial costs paid by water users would be $4,535,175, and the cost per acre-foot of applied AWSA water would be $2,393. The regional impact from agricultural production would be $1,027,519 in total output. Total economic output and the regional impact of construction activities would be $102,987,432. Short-term impacts on the social setting could occur as a result of construction. Access to water storage would also support the continued presence of farming and provide resilience to climate change.

Cumulative Impacts

The cumulative impacts area of analysis is defined as the primary socioeconomic area of analysis of Catron, Grant, Hidalgo, and Luna Counties in New Mexico. In addition, the cumulative impacts analysis area is expanded to include a broader area downstream along the Gila River to the San Carlos Reservoir that past, present, and reasonably foreseeable events may indirectly influence in coordination with changes in water levels for the Proposed Action and alternatives. This expansion is Graham, Greenlee, Gila, and Pinal Counties in Arizona.

Climate change is an ongoing action that is anticipated to affect trends in social and economic contributions from the area of analysis economic sectors, namely recreation, tourism, agriculture, and ecosystem services. The potential impacts of climate change are to annual temperature, precipation, snowpack, and natural flow; these potential impacts are global, so they could have an effect under all alternatives.

The Gila River in New Mexico supports nonmarket values in wildlife viewing, recreation, and tourism; drought would have long-term impacts on the ability of the river to support these uses, although impacts in the project area are likely to be limited as compared with key habitat areas, such as wilderness, outside the project area. In the global circulation models and hydrologic models used by Reclamation (2011), Garfin et al. (2014), and Gutzler (2013 and 2016), projected climate trends through 2070 may lead to lower overall water supply, higher variability in floods and droughts, and higher uncertainty in monsoon seasons.

New Mexico's agricultural sector has been identified as the most vulnerable economic sector to climate change (Repetto 2019). Drought would have short- and long-term impacts on the agriculture industry and related economic contributions. In the short term, seasonal drought would affect the available supply for irrigated agriculture. In the long term, irrigated agriculture is anticipated to remain the highest portion of water demand in the cumulative area of analysis (ISC 2017). Using global circulation models and hydrologic models, Reclamation (2011), Garfin et al. (2014), and Gutzler (2013 and 2016) estimated a median streamflow decline of 15 percent for the Gila River between Gila and Blue Creek, and a median streamflow decline of 19 percent for the San Francisco River at Clifton. Estimated streamflow declines may result from reduced winter precipitation and higher temperatures causing more evaporation and infiltration and reduced runoff (HDR 2019a). Changes to the agricultural industry would also affect the ability to support the traditional farming lifestyle, resulting in additional social impacts (Repetto 2019).

Warming temperatures could cause longer growing seasons, increasing the demand for irrigation, while increasing reservoir and other open water evaporation and reducing supply recharge. As such, long-term drought would reduce the available water supply through 2060 (ISC 2017). Climate trends project increased thunderstorm intensity, increasing the potential for floods and wildfires from lightning. Drier conditions could also result in a higher potential for wildfire. Wildfire effects could disrupt the Gila River ecosystem by burning essential resources and altering hydrologic conditions, with or without the Proposed Action.

Precipitation is likely to be more concentrated and severe, increasing the potential for flooding in the region, with potential impacts on all populations, including those identified for further analysis as low-income and minority populations. While no long-term trend in annual precipitation has been identified, climate change may drive increased variability in precipitation. Winter precipitation is expected to decline, contributing to reduced snowpack, while thunderstorm intensity is projected to increase, potentially increasing the potential for floods.

Under Alternative A, no direct contributions to cumulative impacts would occur on the economy, population, or ecosystem in the cumulative impact area of analysis. This is because there would be no development of the NM Unit. Current trends would continue. Global climate change would continue to be a potential impact on the socioeconomic area of analysis, and associated changes to wildfire risk and hydrologic conditions related to climate change would persist.

In the long term, in the absence of the NM Unit, AWSA water would not be diverted from the Gila River and conveyed into off-stream storage sites. As such, increased water supply to improve agricultural use in the cumulative impact area of analysis would not be available. Irrigated agriculture would be subject to the impacts of climate change. The cumulative contribution from this economic sector could be decreased, should climate conditions affect crop yield or water availability. Impacts from climate change may be offset, in part due to other proposed water projects and conservation measures, as described in **Table 3-1**. Past, present, and reasonably foreseeable future projects, as described in **Table 3-1**, would affect trends in social and economic conditions in the cumulative impacts area of analysis.

Reasonably foreseeable future projects are presented in **Table 3-1**. These projects could increase the level of water maintained in the Gila River, compared with current conditions. For example, the 2017 Southwest New Mexico Regional Water Plan provides water supplies and projected demands to address the southwest New Mexico region's future water management needs and goals. Currently funded non-NM Unit projects could improve agricultural and municipal water conservation.

In addition, while county comprehensive plans do not represent specific actions, goals include securing and maintaining water quantity and quality for their respective communities. Should these goals be achieved, this would represent the potential for additional water availability for local use.

3.9 Indian Trust Assets

ITAs are legal interests in assets held in trust by the United States for the benefit of Federally recognized Indian tribes or individual tribal members. The United States, as trustee, protects and maintains the specific rights reserved by, or granted to, Indian tribes or individuals by treaties, statutes, and executive orders. This trust responsibility requires that all Federal agencies ensure their actions protect ITAs. Secretarial

Order 3175 (incorporated into the Departmental Manual [DM] at 512 DM 2) requires that the potential impacts of DOI actions on ITAs must be addressed in planning and decision documents.

Consistent with this, Reclamation's ITA policy states that it will carry out its activities in a manner that protects ITAs and avoids adverse impacts, when possible, or provides appropriate mitigation or compensation when avoidance is not possible.

Reclamation has consulted and continues to engage with Federally recognized tribes on the NM Unit EIS and the potential for impacts on ITAs. The San Carlos Apache Tribe Reservation and Gila River water rights held by tribes in Arizona have been identified as ITAs that are relevant to the operation of the NM Unit. No other ITAs have been identified as potentially affected by the NM Unit construction or operations.

3.9.1 Affected Environment

In 1935, the U.S. District Court for Arizona issued the Globe Equity No. 59 Decree (Globe Equity Decree). It recognized the right of the U.S. to demand and divert Gila River water for irrigating 50,546 acres of Indian farmland on the GRIC, a Federally recognized Indian tribe. The Gila River Indian Community Water Rights Settlement (PL 108-451, 118 Stat. 3478, 3499) was approved as part of the AWSA. Water rights are considered ITAs held in trust by the U.S. on behalf of the GRIC. Gila River water associated with these water rights is conveyed to the GRIC through the San Carlos Irrigation Project (SCIP) Joint Works and facilities. GRIC has a CAP entitlement and a direct connection to the CAP.

Additionally, the Globe Equity Decree recognized the San Carlos Apache Tribe's right to 6,000 AFY of Gila River water, with a priority date of 1846. Upon completion of the CAP, the San Carlos Apache Tribe also received an allocation of CAP water of 12,700 AFY. To settle water rights claims of the San Carlos Apache Tribe, Congress enacted the San Carlos Apache Tribe Water Rights Settlement Act of 1992, Title XXXVII of PL 102-575, as amended. This act added to the tribe's original CAP allocation. These tribal water rights are considered ITAs held in trust by the U.S. on behalf of the San Carlos Apache Tribe. Because the San Carlos Apache Tribe lacks a direct connection to the CAP, the Tribe must rely on water exchanges with entities that hold rights to local sources of water that can be used on the reservation or must lease its CAP water to realize a beneficial use of its CAP water entitlement. The San Carlos Apache Tribe's water rights recognized in the San Carlos Apache Tribe Water Rights Settlement Act of 1992 are ITAs held in trust by the U.S.

Coolidge Dam and San Carlos Reservoir are Federally owned facilities located on the San Carlos Apache Reservation, approximately 90 miles southeast of Phoenix. Coolidge Dam is operated by the BIA in tandem with Ashurst-Hayden Diversion Dam and a network of canals to convey water from the Gila River to the GRIC and SCIDD. These irrigation works comprise the BIA-managed SCIP.

Under the Globe Equity Decree, both the GRIC and SCIDD can divert a portion of natural Gila River flow, based on availability. The BIA stores water that is in excess of these calls behind Coolidge Dam to meet the irrigation demand of SCIP water users. The San Carlos Apache Tribe Water Rights Settlement Act of 1992 allows the San Carlos Apache Tribe to exchange its CAP water allocation in place of irrigation water releases from San Carlos Reservoir. It also grants the Tribe permission to conditionally store exchanged water. It should be noted that section 3704(g) of the San Carlos Apache Tribe Water Rights Settlement Act of 1992 specifically states that "[a]ny exchange pursuant to [the Act] of Gila River water for water supplied by the CAP shall not amend, alter or conflict with the exchanges authorized by section

304(f) of the Colorado River Basin Project Act (43 U.S.C. 1524(0).” Section 304(f) of the CRBPA allows the CAP water exchange, as discussed in **Section 2.4.2**.

As outlined in **Chapter 1**, the Secretary of the Interior is authorized to contract with water users in New Mexico for consumptive use of AWSA water in exchange for delivery of CAP water to downstream users in Arizona. The AWSA specifically authorized this consumptive use, over and above those uses provided by Article IV of the Decree of the Supreme Court of the United States in *Arizona v. California*, 376 U.S. 340 (1964). The AWSA ratified the CUFA, which was signed by downstream Gila River users in Arizona and New Mexico, including the GRIC and SCIDD.

Water quality is an ongoing concern for the San Carlos Apache Tribe. Salinity generally increases from upstream to downstream, with consistent exceedances of secondary water quality standards and irrigation guidelines[36] below the confluence of the San Francisco and Gila Rivers. Gila River waters above the confluence have average sodium concentrations of 70 mg/l, chloride concentrations of 30 mg/l, and total dissolved solids of 360 mg/l. These waters have generally no restrictions for irrigation use with respect to these constituents, although sodium can exceed 68 mg/l in summer months at Clifton. San Francisco River water has average sodium concentrations of 26 mg/l, chloride concentrations of 13 mg/l, and total dissolved solids of 240 mg/l, also suitable for irrigation.

Salinity conditions worsen considerably below the confluence. Calva water concentrations for sodium average 560 mg/l, chloride 770 mg/l, and total dissolved solids 2,100 mg/l. Water here has severe irrigation restrictions from April to July due to these constituents and slight to moderate irrigation restrictions in other months. Concentrations exceed secondary drinking water quality standards during low flows (approximately less than 1,000 cfs) for all months.

As a result of high salinity concentrations of water entering the San Carlos Apache Reservation, a Water Quality Injunction was issued in 1996.[37] The Water Quality Injunction provides that if the water quality deteriorates below certain thresholds when reaching the San Carlos Apache Reservation, the Gila Water Commissioner must take measures to limit the diversions of water right holders in the Safford Valley. A detailed summary of water quality in the Gila River is found in the NM Unit Water Quality Technical Memorandum (HDR 2019d).

3.9.2 Environmental Consequences

Methods of Analysis

The identification of ITAs and the potential for impacts on ITAs are determined through consultation with tribes, research, and modeling of project effects on surface water supply and water quality. The following information helped inform the analysis.

- The San Carlos Apache Tribe Reservation, and water rights affirmed by decree or settlement agreements and established for the GRIC and San Carlos Apache Tribe, are identified as ITAs. No other ITAs have been identified.
- All NM Unit operations and diversions would be conducted in compliance with the CUFA and other authorities described above.

[36] Guidelines for Interpretations of Water Quality for Irrigation (Ayers and Westcot 1994)
[37] United States v. Gila Valley Irrigation Dist., 920 F.Supp. 1444 (D. Ariz. 1996)

  - To protect downstream users in New Mexico and Arizona, New Mexico must allow certain minimum flows to bypass each day of each year. Additionally, New Mexico users cannot divert water unless the amount of water in San Carlos Reservoir has reached 30,000 AF that year.
- There are many existing diversions from segments of the Gila River in Arizona above the San Carlos Apache Tribe and the GRIC. The river experiences regular periods of drying before water reaches the San Carlos Apache Reservation, affecting tribal water supply and water quality.

The factor analyzed is whether and to what extent the action would adversely affect the value or use of the trust asset.

Assumptions This analysis does not include any assumptions.

Alternative A: No Action Alternative

Under Alternative A, the NM Unit project components would not be built. Current existing water agreements and Gila and San Francisco Rivers operations would continue. Ongoing concerns about water quality, water use, existing diversions, and groundwater withdrawal currently affecting tribal water rights and uses would continue. There would be no proposed NM Unit diversions, upstream storage or use of AWSA water, reduction or changes in water quality due to the NM Unit, deliveries of NM CAP water to the GRIC, or effects on ITAs from the NM Unit.

Impacts Common to All Action Alternatives

Negligible to minor impacts may be anticipated under the action alternatives.

ITAs Upstream of San Carlos Reservoir Operating the NM Unit under the terms of New Mexico diversions in the CUFA ensures that the downstream water users in New Mexico and Arizona are kept whole. All parties to the CUFA agreed that the diversion and consumptive use of Gila and San Francisco River water according to the terms of the CUFA would not impair water rights in those sources existing as of September 30, 1968, and would not cause economic injury or cost. The San Carlos Apache Tribe has the second-most senior water rights on the Gila River, but is not a signatory to the CUFA. However, the CUFA protects the water rights of downstream water users regardless of whether they signed the document. New Mexico must allow certain minimum bypass flows each day of the year and cannot divert unless San Carlos Reservoir reaches 30,000 AF during the year. Further, the role of the Secretary as authorized diverter under the CUFA helps assure compliance with its terms.

Due to changes in river flows from project operations, river water concentrations of three salinity measures - sodium, chloride, and total dissolved solids - would fluctuate under the action alternatives. In general, the action alternatives would increase the concentrations of the three salinity measures from November to February, with the potential to decrease salinity in the summer months. Alternative B could cause median increases in sodium salinity from 10 to 14 mg/L at Calva. This would be a 3 percent increase in salinity, compared with Alternative A. Under Alternative C, salinity at Calva could increase from 5 to 24 mg/L (a 5% change from Alternative A) due to the change in the flows. For Alternative D, there could be up to a 1 percent increase in salinity compared with Alternative A. Alternative E may result in median increases in salinity from 8 to 26 mg/L at Calva. This is up to a 5 percent increase over Alternative A. For Alternatives B, C, and E, some improvement in salinity may occur in summer months due to return flows generated by the project, assuming these return flows would continue past the Safford Valley without being diverted. Under all alternatives, the suitability of river water for irrigation use at Calva would remain severely restricted from April to July. Potential impacts to water quality from implementation of any of the action alternatives would be minor and adverse, however the impacts would not be expected to harm ITAs (see **Section 3.3** and HDR 2019d). Changes to San Carlos Reservoir storage due to the action alternatives would be within the normal range of water supply differences on this portion of the river and influenced more by existing withdrawals downstream of the NM Unit than by operation of the NM Unit.

ITAs Downstream of San Carlos Reservoir Operating the NM Unit under the CUFA would require the CAP water exchange for the GRIC and SCIDD in Arizona downstream of San Carlos Reservoir. In exchange for every AF of AWSA water consumptively used in New Mexico, the Secretary must deliver an equal amount of NM CAP water to downstream Gila River users. Under this exchange, the NM CAP water would be delivered to the GRIC and SCIDD. Pursuant to the CUFA, the purpose of this delivery of NM CAP water is to avoid impairment of water rights, and economic injury or cost to the GRIC and SCIDD. Before diverting water in New Mexico, the Entity must purchase credits equal to the amount of water it intends to consumptively use in the upcoming calendar year. Under all action alternatives, there would be an earlier transition from San Carlos Reservoir releases to NM CAP water by the GRIC and SCIDD. This transition would be earlier by a matter of a few days (see **Section 3.1**). These offsets and the diversion preconditions under the CUFA would not affect ITAs.

Cumulative Impacts

Under Alternative A, NM Unit project components would not be constructed. Current existing water agreements and Gila and San Francisco Rivers operations would continue. Ongoing concerns about water quality, water use, existing diversions, and groundwater withdrawal currently affecting tribal water rights and uses would continue. Consequently, this project would not contribute to potential cumulative impacts on ITAs under Alternative A.

Past and ongoing activities affecting the use and exercise of tribal water rights include existing upstream diversions that currently affect tribal water supply and water quality. These activities are expected to continue with additional water demand for agricultural and urban needs. With increased demand and water costs, measures to increase efficiency, improve water quality, and implement agreements would be anticipated to ensure that the value of water rights, including tribal ITAs, are honored. Negligible to minor potential impacts on the exercise of water rights, water supply, and water quality are anticipated under the action alternatives, and only negligible contributions to cumulative impacts on ITAs are anticipated from the NM Unit.

Mitigation Measures and Residual Impacts

To address the potential for impacts on ITAs, AWSA diversions would be conducted in compliance with the CUFA.

3.10 Environmental Justice

3.10.1 Affected Environment

This section provides a description of the existing environmental justice conditions in the project area.

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires Federal agencies to identify and address any disproportionally high and adverse human health or environmental impacts of their programs, policies, and activities on minority and low-income populations. Environmental justice refers to 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.

Guidance on environmental justice terminology developed by the CEQ (1997) provides the following definitions:

- Minority—These are the individuals who are American Indian, Alaskan Native, Asian, Pacific Islander, Black or African American, and/or of Hispanic/Latino origin.
- Minority population area—An area is so defined if either the aggregate population of all minority groups combined exceeds 50 percent of the total population or if the percentage of the population comprising all minority groups is meaningfully greater than the minority population percentage in the broader region. For this analysis, a meaningfully greater percentage is defined as 10 percentage points higher than the state reference population. A minority population may include individuals living in geographic proximity to one another or dispersed individuals.
- Comparison population—For the purpose of identifying a minority population or a low-income population concentration, the comparison population used is the state of New Mexico.
- Low-income population—A low-income population is based on annual statistical poverty thresholds that the U.S. Census Bureau develops. In 2017, the poverty level was based on a total income of $12,488 for an individual and $24,858 for a family of four (U.S. Census Bureau 2017b).
- Low-income population area—The CEQ does not provide a specific definition for a low-income population area. This analysis uses the same criteria as that defined for minority populations: an area where the number of individuals living below the poverty line exceeds 50 percent of the total population, or if the percentage of the low-income population is meaningfully greater than the low-income population percentage in the broader region (defined as at least 10 percentage points higher than the state reference population).

The environmental justice area of analysis is the same as the primary socioeconomic area of analysis, which is Catron, Grant, Hidalgo, and Luna Counties in New Mexico. The additional area of analysis includes Greenlee, Graham, Gila, and Pinal Counties in Arizona where indirect impacts may occur to water quality or quantity(see **Section 3.8**, Socioeconomic Resources). Information is included for the county level, as well as for census tracts in each county for additional geographic-specific information. The analysis includes data on Arizona, New Mexico, and the U.S. for comparison, when applicable.

Low-Income Populations

All counties in the area of analysis had higher poverty levels, compared with the state and national populations. In 2017, the poverty rate was lowest in Greenlee County, at 11.5 percent, and highest in Luna County, at 31.8 percent. Median household income was highest in Greenlee County, at $42,583, and lowest in Luna County, at $27,602 (U.S. Census Bureau 2017c). Catron, Grant, and Hidalgo Counties had poverty levels ranging from 21.5 percent to 26.0 percent. Based on the criteria defined above, Luna County, New Mexico, meets the definition of a population for further consideration for environmental justice analysis, based on poverty data.

The U.S. Census Bureau uses census tracts to split counties into smaller geographic regions that hold their boundaries (see **Map 3-16** [Populations Identified for Further Analysis based on Poverty and Minority Data]). The continuity of the census tract boundaries allows researchers to compare data over time. Poverty status by census tract for the area of analysis was obtained for 2017. Among all census tracts in the area of analysis, Luna County census tract (CT) 6 had the highest percentage of individuals living below the poverty line, at 41.0 percent, while Greenlee County CT 9602 had the lowest percentage of individuals living below the poverty line, at 3.6 percent (U.S. Census Bureau 2017d). Based on the defined criteria for populations for further consideration for environmental justice impacts, one tract in Hidalgo County (CT 9702), one in Grant County (CT 9644), and four in Luna County (CT 1, CT 2, CT 5, and CT 6) would be considered in further analysis, based on poverty data (U.S. Census Bureau 2017e).

Minority Populations

Based on the 2017 census data, all areas in the socioeconomic area of analysis have an aggregate minority population of 40,225. The largest minority population is Hispanic or Latino across all counties in the area of analysis, ranging between 15.8 and 65.9 percent (U.S. Census Bureau 2017d). Based on the criteria identified above for identifying populations for further environmental justice consideration, Grant, Hidalgo, and Luna Counties in New Mexico and Greenlee County in Arizona would qualify for further consideration in analysis, based on county-level minority data.

Analyzing minority populations at the census tract level gives more precise information into the minority communities living in the area of analysis. Luna County CT 6 had the highest percentage of an aggregate minority population, at 90.1 percent, while Catron County CT 9764 had the lowest percentage, at 16.7 percent (U.S. Census Bureau 2017f). Based on criteria defined above, two census tracts in Greenlee County (CT 9601 and CT 9602), one in Hidalgo County (CT 9702), five in Grant County (CT 9643, CT 9644, CT 9645, CT 9646, and CT 9648), and all six in Luna County (CT 1–6) meet the criteria for further consideration for environmental justice analysis.

Native American Tribes

Native American populations in the wider socioeconomic area of analysis, identified for the indirect and cumulative analysis, are the Native American population at the San Carlos Apache Tribe Reservation and the GRIC. **Table 3-51**, below, details the demographics for these populations.

Table 3-51. Indian Tribe Demographic Data (2017)

County	Population	Percentage of Population in Poverty 2017	Percentage of Aggregate Minority Population
San Carlos Apache Tribe Reservation	10,611	45.6	98.9
Gila River Indian Community	12,196	48.5	96.6

Source: U.S. Census Bureau 2017c, 2017d

Note: American Community Survey 5-year estimates are based on data collected by the U.S. Census over 5 years. They represent the average characteristics between January 2013 and December 2017 and do not represent a single point in time.

The San Carlos Reservoir on the San Carlos Apache Tribe Reservation relies on Gila River water and represents a source of revenue for the tribe from recreation license sales. Licenses associated with lake-based recreation are sold for fishing, boating, hiking, and camping. Variability in the reservoir volume affects economic contributions. The average amount of stored water in the San Carlos Reservoir on May

1 between 1980 and 2008 was 440,000 AF, and during this time the lowest recorded storage was 32,346 AF in 2004 (ADWR 2010). The reservoir has remained less than 20 percent full for most of the measurement points since 2015 (USGS 2019b).

As discussed in **Section 3.9**, Indian Trust Assets, the Globe Equity Decree recognized the San Carlos Apache Tribe's right to 6,000 AFY of Gila River water; however, current use of this water for agricultural irrigation purposes by the tribe is restricted due to high salinity downstream of Safford Valley from April to July. A detailed summary of water quality in the Gila River is found in the NM Unit Water Quality Technical Memorandum (HDR 2019d).

The GRIC traditionally used water from the Gila River for agricultural purposes. Coolidge Dam sits on Federal land on the San Carlos Apache Tribe Reservation and is operated by the BIA to convey water from the Gila River to GRIC and the SCIDD. The BIA stores water behind the dam to meet irrigation demand of the SCIP. Operations of the NM Unit under the CUFA would require diversions in New Mexico to be offset in Arizona; because of this, the Entity would purchase credits equal to the amount of water it intends to consumptively use in New Mexico. See **Section 3.9**, Indian Trust Assets, for additional details.

3.10.2 Environmental Consequences

This analysis examines the project impacts on the local community social setting and ecosystem services provided. Finally, the analysis examines the potential for impacts on minority, low-income, and tribal populations identified for further consideration for environmental justice impacts.

Methods of Analysis

The environmental justice analysis is based on the potential for disproportionate adverse impacts on low-income, minority, and tribal populations identified for further analysis. Impacts would result from how the varying alternatives would affect resources important to local communities and populations that have been identified for further environmental justice consideration. Impacts on the population at large from proposed actions, such as water quantity and quality, transportation and traffic, and public health and safety, are discussed in relevant resource sections. The potential for adverse and disproportionate impacts on identified minority and low-income populations are discussed in this section. The factors of analysis for environmental justice include:

- Access to or quality of resource and resource uses, which could limit the ability for traditional, subsistence, cultural, or economic use, disproportionately affecting the social and economic well-being of environmental justice populations
- The level of surface-disturbing or disruptive activities associated with construction under each alternative, which could disproportionately affect the social and economic well-being of environmental justice populations, including potential human health and safety concerns

Assumptions This analysis does not include any assumptions.

Alternative A: No Action Alternative

Under Alternative A, environmental justice impacts would be a continuation of environmental justice existing conditions, as described in *Affected Environment*. No NM Unit-related direct impacts would occur on populations identified for further environmental justice analysis, because no NM Unit project construction or operation would occur. No NM Unit-related indirect impacts would occur on downstream water users in populations identified for environmental justice consideration in the absence of project construction.

Under Alternative A, use of additional funding for existing non-NM Unit projects, or the solicitation of proposals for different projects, were not analyzed further here due to the uncertainty associated with these potential actions.

Impacts Common to All Action Alternatives

Although minority and low-income populations were identified in the socioeconomic area of analysis in Luna County, as described in *Affected Environment*, no project construction would occur in Luna County. Similarly, census tracts in Hidalgo and Grant County identified as meeting the criteria for further environmental justice consideration are not in the vicinity of proposed project locations. As a result, no direct disproportionate impacts would occur on these populations as a result of project construction under any of the action alternatives. Regional economic impacts could affect all counties in the primary analysis area, but they are anticipated to represent increased economic opportunities; therefore, they would not result in disproportionate adverse impacts on identified populations in Luna, Grant, or Hidalgo Counites.

Long-term indirect impacts could occur as a result of changes to the Gila River volume from proposed project activities. Populations downstream, including in Greenlee County in Arizona could be affected by changes in water volume should municipal water supply levels or costs be affected; however, impacts would be spread throughout the population and likely would not be disproportionately allocated to census tracts identified for further environmental justice consideration.

Requirements under Section 304(f) of the CRBPA, as amended by the AWSA, would provide NM CAP water to the GRIC, minimizing impacts on that population. The only negligible to minor impact of the action alternatives on San Carlos Reservoir releases for GRIC and SCIDD due to the change in storage would potentially be an earlier transition from San Carlos Reservoir releases to the NM CAP water by GRIC and the SCIDD.

Changes to San Carlos Reservoir storage due to the action alternatives would be within the normal range of water supply differences on this portion of the river and influenced more by existing withdrawals in Arizona downstream of the NM Unit than by operation of the NM Unit. In compliance with the CUFA, AWSA diversions would be conducted without economic injury or cost to ITAs. These requirements would minimize the potential for adverse impacts on the San Carlos Apache population, as a result of the Proposed Action. See **Section 3.9** for additional discussion.

Changes in the river flow from project operations would result in fluctuations of river water salinity. In general, the action alternatives would increase the concentrations of the three salinity measures from November to February and decrease the concentrations during the irrigation months. Due to the baseline conditions, these additional impacts would be negligible and would not represent disproportionate adverse impacts on the San Carlos Apache Tribe.

Cumulative Impacts

The cumulative impacts area of analysis is defined as the primary socioeconomic area of analysis, which is Catron, Grant, Hidalgo, and Luna Counties in New Mexico and Greenlee, Graham, Gila, and Pinal Counties in Arizona. Pinal County contains a portion of the Phoenix-Scottsdale metropolitan area, and the county-wide data may not be representative of the rural area in which the project is located.

Climate change is an ongoing action. Precipitation is likely to be more concentrated and severe, resulting in an increased potential for flooding in the region. Drought is a major concern; temperatures are predicted to continue to increase and contribute to reductions in streamflow and other limitations to water availability. Potential impacts would occur on all populations, including those identified as low-income and minority populations.

Climate change is anticipated to affect trends in social and economic contributions from the socioeconomic area of analysis's economic sectors, including recreation, tourism, agriculture, and ecosystem services. There is a potential for impacts on all populations, including low-income and minority populations, as well as tribal populations that depend on Gila River water.

A decreased flow as a result of climate change is also likely to exacerbate existing conditions of high salinity downstream of Safford Valley. This affects the San Carlos Apache Tribe's ability to use water for irrigation, potentially resulting in negligible adverse impacts on this community.

Under Alternative A, no contributions to cumulative impacts would occur in the cumulative impacts area of analysis on the economy, population, or ecosystem. This is because there would be no development of the NM Unit at the Cliff-Gila, Virden Valley, and San Francisco Valley locations. Current trends would be anticipated to continue.

In the long-term, in the absence of the NM Unit, water would not be diverted from the Gila River to be conveyed into the proposed off-stream storage sites. Water would continue to be diverted for the current purposes. Irrigated agriculture would be subject to the impacts of climate change, and cumulative contributions from this economic sector could be decreased, should climate conditions affect crop yield or water availability.

Past, present, and reasonably foreseeable future projects, as described in **Table 3-1**, would affect trends in social and economic conditions in the cumulative impacts area of analysis. Ongoing concerns about water quality, water use, existing diversions, and groundwater withdrawal currently affecting tribal water rights and uses would continue. Under the Proposed Action and the other action alternatives, proposed project activities are not anticipated to contribute to disproportionate adverse impacts on environmental justice communities.

3.11 Public Health and Safety

3.11.1 Affected Environment

This section provides a description of the existing conditions for public health and safety at the three project locations. The analysis area for public health and safety is the project area. It includes each project location's floodplain, tributaries, and residential areas near proposed infrastructure and future construction of the NM Unit.

Cliff-Gila Location

Generally, the topography at the Cliff-Gila location is a low-lying floodplain along the Gila River, with side-canyons that discharge into the floodplain. The FEMA has designated the area of analysis with the following flood zones (FEMA 2018):

- Zone A indicates areas of high risk and is found primarily along the floodplain of the Gila River; it covers approximately 4,880 acres of the Cliff-Gila location
- Zone D is defined as an undetermined risk area with possible but undetermined flood hazards; this zone is least prevalent in the Cliff-Gila location, covering approximately 770 acres
- Zone X covers approximately 14,030 acres and is the predominant zone outside of the Gila floodplain; it is a moderate- or low-risk area outside the 500-year floodplain

The Rules and Regulations Governing Dam Design, Construction, and Dam Safety (NMOSE 2010) define the low, significant, and high hazard potential classifications. These rules and regulations state that the classifications are based on the potential consequences of dam failure. Factors include loss of life and property and environmental damage that are likely to occur in the event of dam failure. No allowances for evacuation or other emergency actions by the population would be considered (the hazard potential classification is not a reflection of the condition of the dam).

There are 12 jurisdictional flood control dams within the greater Gila watershed, upstream of the project area. A number of these dams are rated as high hazard by the New Mexico Office of the State Engineer, and may have undersized spillway capacity and be recorded as being in fair or poor condition. A failure of any of these dams in a flood could threaten project components and increase flood-water levels.

Local irrigators manage the Upper Gila, Fort West, and Gila Farms Diversions (push-up diversions) with heavy equipment at the Cliff-Gila location with minimal regulations in place for environmental or public safety. Potential public health and safety issues associated with maintenance of diversions are environmental contamination from equipment and operational safety hazards to the local irrigators.

Currently, the Gila River does not meet EPA water quality standards for water bodies and is included on the EPA's 303(d) impaired waters list. Causes of impairment are temperature, nutrients, turbidity, naturally occurring and mining-related mercury, naturally occurring aluminum, and pH (NMED 2009, 2018). The common source of nutrient pollution is from manure and fertilizers used in agricultural activities, which surround the Gila River upstream and downstream of the Cliff-Gila location (EPA 2017). Domestic water supply is a designated use of Gila River surface water, which presents a risk to the public if the water is not treated correctly (NMAC 2005). For more information on water quality, see **Section 3.3**, Water Resources.

There are three existing push-up diversions and three permanent diversion structures (the Bill Evans Lake, Clark, and Riverside diversions) at the Cliff-Gila location. This permanent diversion infrastructure maintains water elevation for gravity flow conveyance. Due to the sudden elevation change, these diversions could be hazardous if recreationists are not aware of them. For more information on recreation, see **Section 3.7**, Land Use.

Additionally, during the scoping period, commenters raised concerns over potential increased mosquito populations associated with the proposed storage ponds (EMPSi 2018). Stagnant water is a known breeding site for mosquitoes, which can be carriers of diseases such as malaria, yellow fever, and Zika and West Nile viruses (New Mexico Department of Health [NMDOH] no date). Counties in New Mexico are responsible for controlling mosquito populations. Between 2003 and 2018, Grant County had three reported cases of West Nile virus, while Hidalgo and Catron Counties had no reported cases (NMDOH 2018).

Virden Location

The topography at the Virden location is flat and primarily floodplain along the Gila River. The FEMA has not determined flood risk at the Virden location.

The existing Sunset, New Model and Virden #3 diversions are stand-alone structures. Due to the sudden elevation change, these structures could be hazardous if recreationists are not aware of them, although recreation along this portion of the Gila River is uncommon.

As discussed previously, the Gila River does not meet EPA water quality standards for water bodies and is included on the EPA's 303(d) impaired waters list. The designated uses and associated risks are the same at the Virden location as they are at Cliff-Gila location (NMAC 2005). For more information on water quality, see **Section 3.3**, Water Resources.

San Francisco Location

The San Francisco location topography is similar to that of the Cliff-Gila location; as such, the analysis area is primarily in a floodplain along the San Francisco River and is surrounded by tributaries. The FEMA has not determined flood risk at the San Francisco location. Given the topography and number of canyons in the area, it is likely that flood risk could be significant.

Local irrigators manage the earthen push-up diversions for Spurgeon Ditch #2 and Thomason Flat Ditch with heavy equipment, with minimal regulations in place for environmental or public safety. Due to the sudden elevation change, the W-S Ditch and Pleasanton East-Side Diversion structures could be hazardous to river recreationists if they are not aware of them.

The San Francisco River is also identified as not meeting water quality standards and is included on the EPA's 303(d) impaired waters list. Causes of impairment are *E. coli*, nutrients, sedimentation and siltation, specific conductance, temperature, turbidity, dissolved oxygen, and temperature (NMED 2018). The most common source of nutrient pollution is from manure and fertilizers used in agricultural activities, which surround the San Francisco River upstream and downstream of the San Francisco location (EPA 2017). Domestic water supply is a designated use of the San Francisco River surface water, which presents a risk to the public if the water is not treated correctly (NMAC 2005). For more information on water quality, see **Section 3.3**, Water Resources.

Obstructions reported on the San Francisco River include loose sections of fencing and natural debris (American Whitewater 2017a). There are diversion structures in the riverway which could be hazardous if recreationists are not aware of them. For more information on recreation, see **Section 3.7**, Land Use.

3.11.2 Environmental Consequences

The main potential impacts on public health and safety from construction and operation of the NM Unit are flooding, the introduction of standing water, proposed instream infrastructure, injury or death from encounters with large machinery or access to construction sites by the public and construction workers, and the increased release of agricultural contaminants.

Methods of Analysis

As stated previously, the area of analysis for public health and safety is the project area, including its floodplain, tributaries, and residential areas near proposed infrastructure and future construction of the NM Unit. The factors of analysis for public health and safety include:

- Introduction of hazards to the river
- Change in mosquito populations carrying diseases
- Changes in contaminants from agricultural runoff
- The dam hazard potential of current and proposed facilities

Assumptions This analysis is based on the following assumptions:

- Construction and operation plans would be developed after designs are finalized.
- The Proposed Action would be designed, constructed, and operated to meet or exceed the requirements of the U.S. Department of Labor, the Occupational Safety and Health Administration (OSHA), and local and state requirements for safety and protection of residents and workers.
- Counties would continue to uphold mosquito-control programs, and the State would enforce the programs.

Alternative A: No Action Alternative

Under Alternative A, the current diversion management would continue. Due to minimal regulations in place currently, there is a risk of safety and environmental contamination to the public due to earthen push-up diversion structure maintenance by local irrigators with heavy equipment.

On the rivers, recreationists would continue to be exposed to potential natural safety hazards, including low stream flows, natural debris obstructions, and manmade obstructions, such as barbed wire and diversion structures. Although unlikely, injury or death is possible from public and construction worker encounters with large machinery at construction sites during re-construction of existing push-up diversions.

Increased sediment load from the construction of push-up diversions can reduce the efficacy of drinking water treatment plants that utilize river water, potentially increasing the treatment cost and waterborne illness danger.

Failure of flood control dams with undersized spillways or poor maintenance in the Gila Watershed could wash out push-up diversions and increase sediment flow.

Impacts Common to All Action Alternatives

Under all action alternatives, the proposed NM Unit would result in both direct and indirect impacts on public health and safety. Direct impacts would primarily occur during construction and operation of project components. Risks associated with construction would be short-term, ending once construction is complete; operation risks would be more long-term, lasting as long as the project components are functioning.

Again, although unlikely, injury or death is possible from public and construction worker encounters with large machinery and construction sites. Additionally, construction workers may encounter health and safety issues associated with temporary access roads or river crossings. To minimize these risks, contractors would implement safety plans, in accordance with all applicable requirements, including restricting public access to the construction areas, notifying the public of construction, and implementing other construction site safety practices. If contractors adhere to applicable laws and regulations, such as those under OSHA, and construction BMPs, risks would be minimized under all action alternatives.

During operation of the NM Unit, storage ponds could create a risk of drowning and flooding to the general public if accessible, particularly in areas near recreation sites. Diversions would be designed and operated according to Reclamation standards and BMPs to avoid conditions hazardous to river recreationists for all foreseeable flow conditions (see **Appendix C**, Best Management Practices and Standard Operating Procedures for a full list of BMPs).

Additionally, under all action alternatives, construction of the NM Unit would affect public exposure to disease from mosquitoes, to increased levels of agricultural contaminants, and to increased flood risk from potential embankment failure.

Failure of flood control dams with undersized spillways or poor maintenance during flooding in the Gila Watershed could threaten the integrity of project components.

The proposed storage of water would generate standing water, indirectly increasing the risk of public exposure to disease-carrying mosquitoes; however, this risk could be mitigated or prevented under all action alternatives if the counties follow the mosquito control guidelines outlined by the New Mexico Department of Health (NMDOH 2009).

A similar increase in available AWSA water to receiving waterways under the various action alternatives could increase levels of agricultural production, potentially increasing the amount of nutrients in agricultural runoff and further affecting the water quality of the San Francisco and Gila Rivers. As a result, there may be an increased risk to public health and safety if water is not treated correctly. Currently, the San Francisco and Gila Rivers are identified as not meeting EPA water quality standards for water bodies and are on the EPA's 303(d) impaired waters list (NMED 2018).

To reduce this risk, designers and operators of the NM Unit must refer to Reclamation Standards, in accordance with the NM Unit Agreement and BMPs, as stated in **Chapter 2** and **Appendix C**, Best Management Practices and Standard Operating Procedures.

Alternative B: Proposed Action

Cliff-Gila Location If filled to maximum capacity, proposed storage ponds could release up to 1,890 AF of water if all four storage ponds were to fail (Reclamation GIS 2019).

Virden Location At the Virden location, potential embankment failure also presents a hazard to nearby residents and the public. A total of 551 AF of water could be released if both proposed storage ponds at this location were to fail.

San Francisco Location There are no proposed reservoirs or above-grade earthen embankments that could fail at the San Francisco location under Alternative B, so there are no potential impacts of embankment failure at this location. Under this alternative, the construction and use of a narrow temporary access road built on top of the Thomason Flat Ditch could increase the risk of vehicular accidents for residents who use it to access their properties. Additionally, the use of temporary river crossings constructed using low box culverts could present a risk to crossing users during periods of high water or flash flooding.

Alternative C

Cliff-Gila Location The impacts of potential embankment failure on public health and safety would be the same as those described under Alternative B.

Virden Location The impacts of potential embankment failure on public health and safety would be the same as those described under Alternative B.

San Francisco Location Under Alternative C, potential dam and embankment failure from the proposed Weedy Reservoir presents a hazard to nearby residents and the public. A maximum 600 AF of water could be released at the San Francisco location if the reservoir embankment were to fail (Reclamation GIS 2019). The use of temporary river crossings constructed using low box culverts could also present a risk to crossing users during periods of high water or flash flooding.

Alternative D

Cliff-Gila Location Under Alternative D, no AWSA diversions or components are proposed for the Cliff-Gila location. As a result, there would be no NM Unit-related impacts on public health and safety.

Virden Location The impacts of potential embankment failure on public health and safety are the same as those described under Alternative B.

San Francisco Location Under Alternative D, no AWSA diversions or components are proposed for the San Francisco location. As a result, there would be no NM Unit-related impacts on public health and safety.

Alternative E

Cliff-Gila Location If filled to maximum capacity, proposed storage ponds could release up to 2,170 AF of water if all three storage ponds were to fail (Reclamation GIS 2019). The existing Winn Canyon flood control dam and basin would be incorporated into one of the proposed ponds under this alternative. The dam would be upgraded to meet current dam safety standards as part of the construction which would reduce danger posed by the current structure which has a high hazard rating.

Virden Location The impacts of potential embankment failure on public health and safety would be the same as those under Alternative B.

San Francisco Location The Weedy Reservoir could release a maximum of 1,610 AF of water if the embankment were to fail, posing a potential risk to public health and safety (Reclamation GIS 2019). The use of temporary river crossings constructed using low box culverts could present a risk to crossing users during periods of high water or flash flooding.

Cumulative Impacts

The cumulative impacts analysis area is the watersheds of the San Francisco and Gila Rivers.

Under Alternative A, NM Unit project components would not be constructed, and there would be no impacts on public health and safety, except for the impacts associated with the need to annually rebuild existing push-up diversions.

Under all action alternatives, the risks to public health and safety could increase due to the increased flood risk of dam or embankment failure. Additionally, water quality degradation due to the possibility for increased agricultural runoff enabled by the action alternatives could offset water quality improvements from other projects in the project area, such as the Luna Restoration Project and Gila River Basin Native Fishes Conservation Program.

Factors that improve water quality and availability would result in a cumulative improvement to public health by providing cleaner drinking water sources. Factors that reduce water quality or availability, that could damage project components, or that increase levels of public exposure to harmful chemicals or particulates would result in a cumulative deterioration of public health and safety.

Restoring grasslands and forests under the USFS Luna Restoration Project and improving fish habitat and restoring natural ecosystems under the Gila River Basin Native Fishes Conservation Program would improve watershed health and natural water filtering capacity. This would improve water quality and reduce the potential for exposing the public and private drinking water supply to agricultural chemicals.

Under the 2017 Southwest New Mexico Regional Water Plan, proposed infrastructure projects, conservation programs, watershed management policies, and other types of strategies may help balance water supplies and projected demands (ISC 2017). Additionally, many of the proposed projects in the 2017 Plan could improve the water quality and water availability in the basin and, thereby, improve public health.

Mitigation Measures and Residual Impacts

Mitigation includes the mosquito control programs outlined by the NMDOH. Additionally, to mitigate direct and indirect impacts on public health and safety, all construction waste, including trash and litter, garbage, other solid waste, petroleum products, and other potentially hazardous materials, would be removed to an authorized disposal facility. Project components would be fenced off during construction and operation, which would restrict public access. Conveyances and storage systems would be designed, constructed, and operated to meet or exceed the requirements of the U.S. Department of Labor, OSHA, and local and state requirements for safety.

3.12 Short-Term Uses and Long-Term Productivity

NEPA requires consideration of "the relationship between short-term uses of man's environment and the maintenance and enhancement of long-term productivity" (40 CFR 1502.16). This involves using all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare; create and maintain conditions under which humans and nature can exist in productive harmony; and fulfill the social, economic, and other requirements of present and future generations of Americans. "Short-term" refers to the temporary phase of construction of the NM Unit, while "long-term" refers to the operational life of the NM Unit and beyond.

All action alternatives analyzed in this EIS would result in short- and long-term disturbance to the natural environment in the project area, as described in **Chapter 3**. Impacts would be mitigated to the extent possible to lessen or eliminate these impacts. Mitigation measures are described at the end of each **Chapter 3** resource section as applicable. See also **Appendix C**, Best Management Practices and Standard

Operating Procedures for a full list of BMPs and standard operating procedures that would be applied during construction of the NM Unit to help reduce impacts.

Potential benefits of the action alternatives include the delivery of water allotted under the AWSA to users in southwestern New Mexico for increased agricultural productivity. The NM Unit project would provide water for improvements and diversification of agricultural products and uses in the Cliff-Gila, Virden, and/or San Francisco River Valleys, particularly addressing the availability of stored water during the irrigation season and for drought protection in the project area. The NM Unit project would provide a supply of irrigation water for agricultural uses in these areas, which would have a direct benefit both in the near term and to future generations.

3.13 Unavoidable Adverse Impacts

Unavoidable adverse impacts are those on natural and human resources that could not be avoided and would remain after mitigation measures have been applied. After consideration of actions, operations, and features to avoid, mitigate, or compensate for adverse effects, the action alternatives would likely result in the following types of unavoidable direct and indirect impacts.

Water Resources The commitment of water to the NM Unit would unavoidably prevent using this water for other uses for the duration of the project. Part of the water could be used for other uses concurrently, or later in time. Proposed surface water diversions would decrease surface water levels and may lessen groundwater recharge in other locations through reduced streamflow downstream of diversion structures.

Vegetation Implementation of the NM Unit would result in disturbance to and the direct loss of vegetation and wildlife habitat. These actions would also result in an increased potential for noxious and invasive weed establishment and spread, soil compaction, changes to habitat from modifications to surface flow regimes, and changes to riparian and wetland plant communities from changes in groundwater levels.

Aquatic and Terrestrial Wildlife Construction and operation of the NM Unit would result in direct mortality or injury to some individuals; the potential loss, degradation, and/or fragmentation of breeding, rearing, foraging, and dispersal habitats; increased potential for nonnative predatory fish species; and changes to animal behavior from increased noise levels. Hydrological changes due to implementation of the NM Unit also would affect wildlife and special status wildlife species, as well as wildlife habitat.

Threatened or Endangered Species Unavoidable adverse impacts on threatened or endangered species from implementation of the NM Unit would be similar to those described for aquatic and terrestrial wildlife. They may also include an increase in nonnative predators that could prey upon threatened or endangered species, and a loss of critical habitat for threatened or endangered species.

Cultural Resources Unavoidable adverse impacts on cultural resources after completion of the Section 106 process could result in data recovery, where preservation in place might have been preferred. Other examples are the loss of natural resources important to tribes, TCPs, or sacred sites, which cannot be adequately mitigated in any way, from the perspective of a tribe.

Geology and Soils The NM Unit would disturb surface areas containing erosive soils during the construction of project components and by the physical presence of project components overlying these soils.

Land Use The NM Unit would change the existing land use types of some areas. Under Alternatives C and E, public access for recreation would be restricted in portions of Weedy Canyon.

3.14 Irreversible and Irretrievable Commitments of Resources

Irreversible and irretrievable resource commitments involve the use of nonrenewable resources and the effects of use on future generations. Irreversible effects primarily result from the use or destruction of specific resources that cannot be replaced within a reasonable time frame, such as energy and minerals. Irreversible commitments can also be those that are only lost for a period of time but are unlikely to revert to their former use. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored as a result of the action, such as extinction of a threatened or endangered species or the disturbance of a cultural resource.

The action alternatives would result in the irreversible and irretrievable commitment of the following resources during construction and operation of the NM Unit:

- Construction materials, including resources such as soil and rocks
- The land area committed to new and expanded project components
- Electricity, gasoline, diesel fuel, and oil expended for equipment and transportation vehicles needed for construction and operations

Nonrenewable resources are expected to account for a minimal portion of the region’s resources; the project’s use of nonrenewable resources would not affect the availability of these resources for other needs in the region. Construction activities would not result in the inefficient use of energy or natural resources. The selected construction contractors would use best available engineering techniques, construction and design practices, and equipment-operating procedures.

The irreversible and irretrievable commitment of these resources is offset by the benefits associated with the NM Unit. These benefits include less disturbance of riparian vegetation and habitat from the construction and maintenance of the proposed diversions compared to the disturbance generated due to the ongoing construction and maintenance of the existing push-up diversions. In addition, the additional supply of irrigation water for agricultural uses within the Cliff-Gila, Virden, and/or San Francisco River Valleys could have a direct benefit both in the near term and to future generations.

Chapter 4. Consultation and Coordination

4.1 Introduction

This chapter describes the consultation and coordination between the Joint Leads and other Federal, state, and local agencies; Native American tribes; and the public in preparing this EIS. Additionally, it details the public scoping process, identification and designation of cooperating agencies, and the consultation process with applicable Federal, state, and tribal governments.

4.2 Public Involvement

Public involvement is being conducted throughout the course of the EIS process in accordance with CEQ regulations implementing NEPA (40 CFR 1501.7 for scoping and 1506.6 for public involvement). Specifically, the public has had and will have the opportunity to comment during the following three phases:

1. Public scoping before NEPA analysis began, to determine the scope of issues and alternatives to address in the EIS; this occurred during the June through July 2018 scoping period and was summarized in a scoping report published in August 2018 (EMPSi 2018).
2. Public review of and comment on the Draft EIS following publication of the Notice of Availability of the Draft EIS in the *Federal Register* (anticipated Spring 2020, 45-day comment period).
3. Public review of the Final EIS (anticipated in Fall 2020).

Additional information on Reclamation's requirements for public involvement can be found in its NEPA handbook at https://www.usbr.gov/nepa/docs/NEPA_Handbook2012.pdf.

4.2.1 Public Scoping

Public outreach during the public scoping period included a *Federal Register* notice, a press release announcing the scoping period, newspaper advertisements, a project newsletter, eight open houses throughout New Mexico and southeastern Arizona, and a project website: www.NMUnitEIS.com. The website provides access to background material and project area maps.

The scoping period began on June 12, 2018, with the publication in the *Federal Register* of the Notice of Intent to Prepare an Environmental Impact Statement, New Mexico Unit of the Central Arizona Project; Catron, Grant, and Hidalgo Counties, New Mexico. During the scoping period, the Joint Leads sought public comments on the following topics:

- What data sources are available for each resource topic?
- What resources, such as cultural resources and plant and animal species, are known to occur in the project area?

- What are the current resource uses and activities, such as agriculture and recreation, in the project area?
- How would the NM Unit affect the resources or resource uses?

The Joint Leads held eight open house public scoping meetings, one each in Albuquerque, Silver City, Cliff, Glenwood, and Virden, New Mexico, and Chandler, San Carlos, and Safford, Arizona.

The purpose of these meetings was to provide the public with opportunities to become involved; to learn about the Proposed Action and planning process; to meet with Reclamation, ISC, and team members from other agencies; and to offer comments. Reclamation summarized the public input received during the scoping period in a report (EMPSi 2018), which is available at www.NMUnitEIS.com.

The Joint Leads took these comments into consideration when developing the EIS and incorporated this feedback, as appropriate, when they developed the alternatives and performed surveys, modeling, and impact analyses. Further information regarding scoping meetings, comments received, comment analysis, and issues development for the EIS can be found at the project website, www.NMUnitEIS.com/documents.

The Joint Leads will conduct public outreach during the 45-day public review period for the Draft EIS. Specific dates for the review period will be posted in the Federal Register and further information will be posted on the project website.

4.3 Cooperating Agencies

Reclamation and the ISC are the Joint Lead agencies for preparing the NM Unit EIS. NEPA implementing regulations (43 CFR 46) require lead agencies to request the participation of cooperating agencies early in the NEPA process. Accordingly, the Joint Leads invited parties that have jurisdiction by law or special expertise to collaborate on the EIS. This included participation in some or all of the following activities: scoping comments, preliminary draft input, Draft EIS comments, and participation in briefings, meetings, and work sessions. To date, the cooperating agencies include the USFWS, U.S. Army Corps of Engineers, U.S. Geological Survey, BLM, NMDGF, SCIDD, Catron County, and San Francisco Soil and Water Conservation District.[1]

Cooperating agencies play an important role in the planning process by providing information and expertise to supplement analysis and by reviewing working documents; however, their participation does not constitute their approval of the analysis, conclusions, or alternatives presented in this EIS. The Joint Leads will continue to meet with interested agencies and organizations throughout the planning process and will continue coordinating closely with the cooperating agencies.

[1] The USFS is actively participating in the EIS analysis but has not formally accepted the invitation to be a cooperating agency, nor has it signed a memorandum of understanding with the Joint Leads.

4.4 Formal Consultation Efforts

Various Federal laws require Reclamation to consult with Native American tribes and certain Federal and state agencies during the NEPA decision-making process, namely the NMHPD/SHPO and the USFWS. The Joint Leads have coordinated with tribes and cooperating agencies and are working closely with the affected tribes, THPOs, and the NMHPD/SHPO. This section documents the specific consultation efforts undertaken to comply with applicable Federal laws throughout the EIS development.

4.4.1 Tribal Consultation

Various Federal laws require Reclamation to consult with Native American tribes during the processes for planning, NEPA, and Section 106 of the NHPA. Under its trust responsibility to tribes, the Federal government has an obligation to protect ITAs and uphold the rights of indigenous peoples to govern themselves on tribal lands. Additionally, pursuant to Executive Order 13175, Federal agencies are required to conduct government-to-government consultation with tribes that might have an interest in the proposed NM Unit project. Reclamation carries out tribal consultation for the proposed NM Unit pursuant to NEPA, the NHPA, and the NAGPRA.

In recognition of this responsibility and pertinent executive orders, regulations, and policies, Reclamation initiated tribal consultation in July 2017. Reclamation reached out to 22 potentially affected Native American tribes and tribal organizations with interests in the planning area by mail, requesting initiation of government-to-government consultation, which has and will continue throughout the EIS development. These tribes included Ak-Chin Indian Community, Fort McDowell Yavapai Nation, Fort Sill Apache Tribe, Gila River Indian Community, Havasupai Tribe, Hualapai Tribe, Hopi Tribe, Mescalero Apache Tribe, Navajo Nation, Pascua Yaqui Tribe, Pueblo of Acoma, Pueblo of Isleta, Pueblo of Laguna, Pueblo of Zuni, Salt River Pima-Maricopa Indian Community, San Carlos Apache Tribe, San Juan Southern Paiute, Tohono O'odham Nation, Tonto Apache Tribe, White Mountain Apache Tribe, Yavapai-Apache Nation, and Ysleta del Sur Pueblo.

This is to ensure that management actions are consistent with tribal rights and that the Joint Leads consider the concerns identified by tribal groups. Reclamation is consulting with Native American tribes with ITAs potentially affected by the Proposed Action, as well as with THPOs and other tribal government representatives regarding potential impacts on cultural resources including TCPs. To date, 17 tribes have responded to the consultation requests and follow-ups calls to participate in government-to-government consultation under NEPA. Below are examples of tribal perspectives on the NM Unit that Reclamation has received.[2]

In a July 20, 2018, letter the San Carlos Apache Tribe stated that it ". . . has ancient and complex cultural and religious practices which are dependent upon the use and engagement of the water of the Gila River. These include, without limitation, water for cleansing and healing practices, and water necessary for the seasonal renewal, maturation and other ceremonies relating to the general well-being of the Earth and all of the plants, animals and peoples." In a letter dated October 7, 2019, the tribe also stated that ". . . the proposed undertaking is likely to alter the quality, quantity and timing of Gila River water delivery in

[2] Quotations excerpted from government-to-government consultation files and communications on file with Reclamation.

ways that harm the Tribe and cultural resources the Tribe relies upon for inspiration, guidance, and cultural perpetuation."

In an August 8, 2018, letter, the Pueblo of Zuni emphasized that ". . . the Zuni people have a deep time cultural, historic, and spiritual connection to the entire area of southwestern New Mexico, in which the proposed project is located, and therefore we are concerned about all natural and cultural resources within the project area that may be adversely affected by this proposed project . . . ." In a subsequent letter, dated October 2, 2019, the tribe stated that, "These places are psychologically and emotionally significant to Zuni because this is where Zuni ancestors lived, loved, struggled, endured pain and suffering, and passed on their knowledge of and connection to the landscape to contemporary Zunis as our inheritance. These places today remain alive with the spiritual presence of our Zuni ancestors and represent physical manifestations that validate Zuni migrations, traditional histories and our deep time connections to this landscape."

In an April 5, 2019, letter, the Hopi Tribe stated that a NM Unit "will adversely affect many, many archaeological and cultural resources significant to the Hopi Tribe, including the disturbance of many, many human remains." They stated that they do not consider it possible to mitigate adverse effects on these resources.

4.4.2 Section 106 Consultation

Section 106 of the NHPA and its implementing regulations (36 CFR 800) provide the requirements and procedures for Reclamation to consult with the NMHPD/SHPO, Native American tribes, and the public on identifying historic properties and assessing the potential for an undertaking to have adverse effects on those properties. Reclamation solicited input from, and will continue consulting with, the NMHPD/SHPO, interested Native American tribes, and the public throughout the planning and Section 106 processes.

The exact scope of the current undertaking is not known and various project components may or may not be implemented; because of this, there is a potential for adverse effects on historic properties that cannot be fully determined prior to approval; therefore, the Joint Leads are preparing a programmatic agreement in compliance with 36 CFR 800.14(b)(1)(ii) to address these issues in the event that one or more of the components of the Action Alternatives is implemented.

Reclamation mailed a preliminary draft of the programmatic agreement for consultation and received comments from several Federal and state agencies and affected Native American tribes. It received substantive comments from the New Mexico NMHPD, the San Carlos Apache Tribe, the Hopi Tribe, and the Pueblo of Zuni. Some of the many concerns raised by these affected groups involve the definition of the APE for direct and indirect effects, consultation timelines and protocols, the assurance that government-to-government consultation continues undiluted, the process by which TCPs and sacred sites will be identified, protections for TCP and sacred sites information, and tribal monitoring of cultural resource investigations.

Reclamation is considering all comments and will review them with ISC before scheduling further consultation meetings. The Hopi Tribe and the Pueblo of Zuni commented that while the proposed 100-meter buffer may encapsulate direct effects, this buffer was insufficient to determine indirect effects and cumulative effects on historic properties, particularly TCPs that could be affected by auditory or visual adverse effects. Additional information on the Section 106 consultation with the NMHPD/SHPO, tribes, and members of the public will be added to the Final EIS. The Joint Leads intend to complete and sign the programmatic agreement before the ROD is signed.

4.4.3 U.S. Fish and Wildlife Service Consultation

In accordance with Section 7(a)(2) of the ESA and 50 CFR 402, the Joint Leads are consulting with the USFWS and preparing a biological assessment to address the potential impacts on any Federally listed threatened or endangered species or its habitat from the proposed development of a NM Unit. The Joint Leads will submit the biological assessment to the USFWS and consultation will be finalized before the ROD is signed.

The Fish and Wildlife Coordination Act of 1958 (16 U.S.C. 661–666c) provides that "wildlife conservation shall receive equal consideration and coordination with other features of water resource development programs." The Joint Leads and the USFWS are using the planning, analysis, and findings in the EIS to comply with the Coordination Act, instead of issuing a separate Coordination Act report.

4.4.4 U.S. Army Corps of Engineers, CWA Section 404 Consultation

The Joint Leads held meetings with the U.S. Army Corps of Engineers Albuquerque District, and Las Cruces Regulatory Office, to assess potential permitting requirements for the Proposed Action. On October 28, 2019, the Corps determined that the project qualifies as an exempted activity under Section 404 of the Clean Water Act (33 CFR 323.4(a)(3)) and no permits will be required.

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