BUREAU OF RECLAMATION

Big Sandy Reservoir Enlargement Project, Final Environmental Assessment and Finding of No Significant Impact

Sublette and Sweetwater Counties, Wyoming

PRO-EA-16-012
Interior Region 7 – Upper Colorado Basin
Provo Area Office
Provo, Utah

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U.S. Department of the Interior June 2020

U.S. Department of the Interior
Bureau of Reclamation
Provo Area Office
Provo, Utah

FINDING OF NO SIGNIFICANT IMPACT

Environmental Assessment
Big Sandy Reservoir Enlargement Sublette and Sweetwater Counties, Wyoming

EA-16-012

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I. Introduction

In compliance with the National Environmental Policy Act of 1969, as amended (NEPA), the Bureau of Reclamation, Provo Area Office (Reclamation) has conducted an Environmental Assessment (EA; attached) to determine the potential effects to the human and natural environment of enlarging Big Sandy Reservoir (Proposed Action) in Sublette and Sweetwater counties, Wyoming. Under the Proposed Action, Reclamation would authorize modifications to Big Sandy Dam and Dike, and the Big Sandy Feeder Canal.

Two draft EAs were published prior to issuing the final EA and this Finding of No Significant Impact (FONSI). One public meeting and 44-day comment period were conducted for the first draft EA. Fifteen individuals attended a public meeting for the draft EA on November 7, 2017. Comments received on the first draft EA and responses to those comments are in Appendix H of the final EA. A total of 21 individuals attended a public meeting held on March 26, 2019 for the second draft EA. Comments on the second draft EA and responses to those comments are in Appendix I of the final EA.

II. Alternatives

The EA analyzed two alternatives: the No Action and the Proposed Action.

No Action

Under the No Action Alternative, Reclamation would not authorize the modifications needed to enlarge Big Sandy Reservoir. Irrigators serviced by the Eden Valley Irrigation and Drainage District (EVIDD) would continue to run into water shortages averaging 2,936 acre-feet annually.

Proposed Action

Under the Proposed Action, Reclamation would authorize the following modifications: raise the spillway crest of Big Sandy Dam by 5 feet; install a toe drain and filter trench at the left abutment; install a filter diaphragm around the existing outlet works; install a cement-bentonite wall through the Big Sandy Dike embankment and foundation; replace the headworks of the Big Sandy Feeder Canal; and replace the 6 drop structures below the headworks of the Big Sandy Feeder Canal. Chapter 2 of the final EA describes the Proposed Action in detail.

III. Environmental Commitments

The
commitments found in chapter 5 of the final EA are incorporated into this FONSI by reference and considered part of the Proposed Action. The environmental commitments must be implemented as outlined in the final EA.

IV. Summary of Impacts

A total of 20 resources were initially considered in the final EA, but eight were eliminated from detailed analysis in order to limit the discussion to potentially-significant issues. Twelve resources were analyzed in detail under a No Action Alternative and a Proposed Action Alternative. Effects to the remaining resources are summarized below.

- Hydrology – Frequency of spills from the reservoir into Big Sandy River would be reduced along with minimal effect on peak flows as measured at the U.S. Geological Survey's Big Sandy gage below Farson. Hydrology of the Green River due to new depletions would be

minimally affected.

- Water Quality – There would be no overall negativeimpact to water quality.
- Wetlands and Riparian Areas – There would be no net loss of wetland and riparian areas in and around the reservoir with minimal changes in composition of some wetland vegetation from grasses to sedges.
- Wildlife Resources – Disturbance-related habitat loss would occur but would be minimal in the scope of the surrounding available habitat.
- Threatened, Endangered, and Sensitive Species – A "no effect" determination was made for all species identified in the U.S. Fish and Wildlife Service's Information, Planning, and Conservation (IPaC) report except the four endangered Colorado River fish. The Proposed Action "may affect, and is likely to adversely affect" the four fish based on depletions to the Green River system. Reclamation will implement the reasonable and prudent measures as described in the biological opinion issued by the FWS (Appendix B of the final EA).
- Water Rights – The Proposed Action would not adversely affect other water rights holders. Reclamation would need to apply for a current day storage right prior to storing additional water in Big Sandy Reservoir.
- Grazing – In years favorable for forage growth, there would be up to 13 animal unit months (AUMs) lost on grazed private lands. In unfavorable years, up to 6 AUMs would be lost. This represents a very small portion of the 1,857 AUMs on the grazing allotment. The enlarged reservoir would also provide a benefit to forage along the perimeter of the reservoir. Therefore, the effect to grazing would be negligible.
- Socioeconomics – Short-term economic effects would be minimal while long-term economic effects would be beneficial but not significant.
- Paleontology – Four fossil localities were discovered during surveys, none of which would be impacted by the enlarged reservoir.
- Cultural – The Proposed Action would have an adverse effect on cultural resources. These impacts will be mitigated through a memorandum of agreement (MOA) that has already been signed by interested parties. Stipulations in the MOA will be completed in a timely fashion per environmental commitment number 6.

V. Finding of No Significant Impact

Based on a review of the final EA and its supporting documents, implementing the Proposed Action will not significantly affect the quality of the human or natural environment, individually or cumulatively with other actions in the area. No environmental effects meet the definition of significance in context or intensity as defined in 40 CFR 1508.27. Consequently, an Environmental Impact Statement is not required for this Proposed Action.

VI. Decision

The Proposed Action, to authorize modifications to Big Sandy Dam, Dike, and Feeder Canal, will not significantly affect the human or natural environment as summarized above. Furthermore, the Proposed Action meets the purpose and need of the Big Sandy Reservoir Enlargement Project (Project), to increase storage in Big Sandy Reservoir thereby meeting irrigation demands in lands serviced by EVIDD. The No Action alternative does not meet the purpose or need for the Project. Based on the lack of significant effects to the human environment and because the No Action alternative does not meet the purpose and need of the Project, it is Reclamation's decision, therefore, to implement the Proposed Action as described in the attached EA.

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1 Introduction

1.1 Background

This Environmental Assessment (EA) was prepared to examine the potential environmental impacts of the Big Sandy Enlargement Project (Project or Proposed Action) in Sweetwater and Sublette counties, Wyoming. The Project, originally proposed by the Wyoming Water Development Commission (WWDC), is sponsored by the Bureau of Reclamation (Reclamation). If the Project is approved, Reclamation would modify, install, or replace the following: the Big Sandy Dam spillway crest, outlet works, toe drain and filter trench; the Big Sandy Dike; and the Big Sandy Feeder Canal headworks and drop structures.

Big Sandy Dam is a major storage facility of the Eden Project (Figure 1-1) which was authorized by the Colorado River Storage Project Act of April 11, 1956 (70 Stat. 105), as amended. Big Sandy Dam, Dike, and Reservoir are located on Big Sandy Creek approximately 45 miles northwest of Rock Springs and approximately 10 miles north of Farson, Wyoming. The reservoir provides storage for irrigation, flood control, and recreation. The reservoir is typically operated to maintain as much storage as possible for irrigation use. Big Sandy Dam is not specifically operated for flood control; however, some flood control capacity can be provided if needed. Irrigation flows are released directly into the Means Canal for irrigation of Eden Project lands. The Means Canal has a capacity of approximately 600 cubic feet per second (cfs).

An additional outlet from the reservoir diverts flows to Eden Reservoir. The Big Sandy Feeder Canal Headworks is a 42-inch-diameter gated turnout structure and conduit through the left side of Big Sandy Dike, approximately 1.06 miles north of the dam. The purpose of this turnout is to control the delivery of up to 80 cfs of surplus water to Eden Reservoir from Big Sandy Reservoir via the Big Sandy Feeder Canal when Big Sandy Reservoir approaches the spillway crest elevation of 6,757.5 feet. Big Sandy Reservoir has a total storage capacity of 38,600 acre-feet (based on a 2010 bathymetric survey and 2015 LIDAR survey data) and a surface area of approximately 2,510 acres at water surface elevation 6,757.5 feet (Figure 1-1).

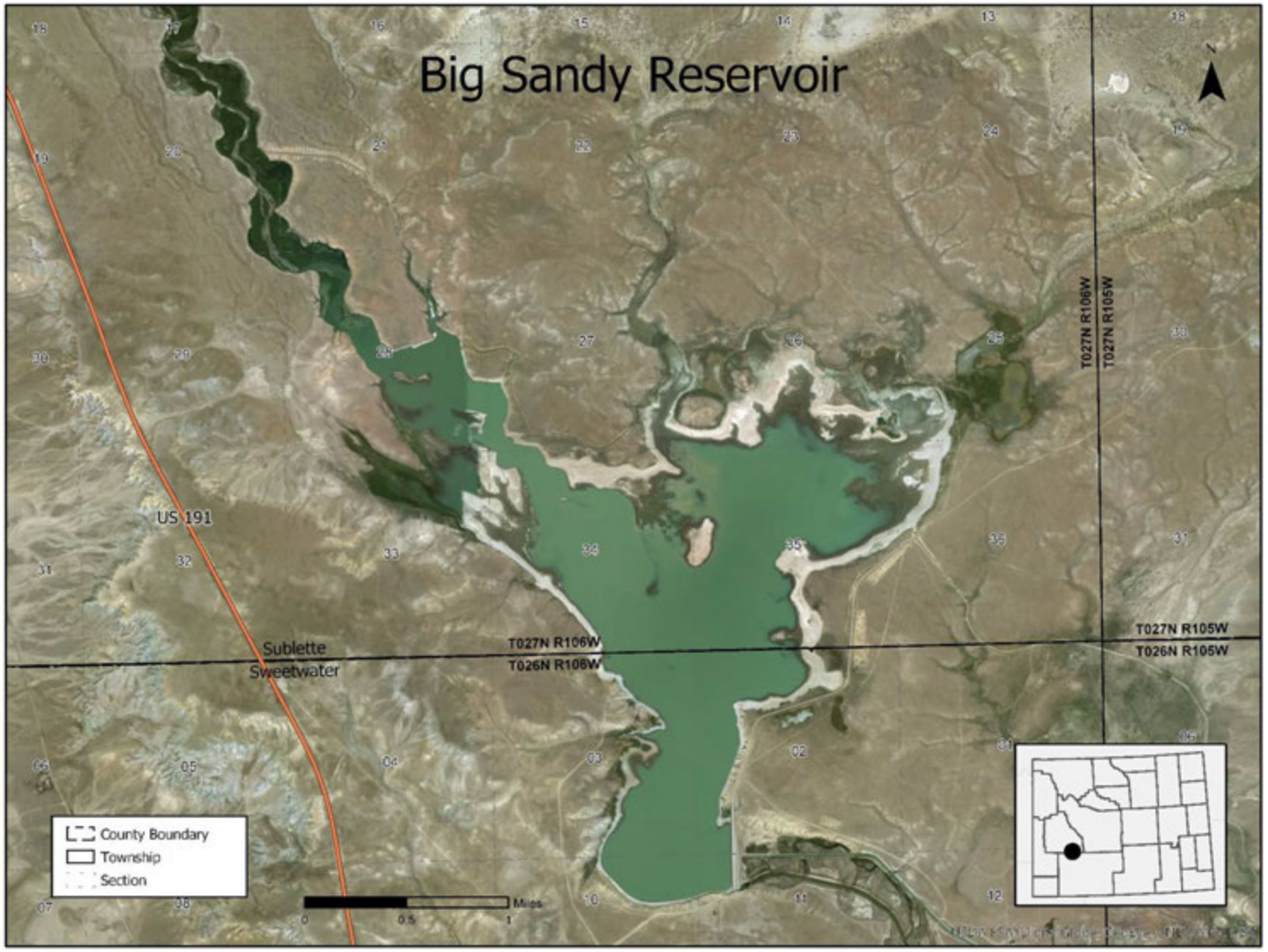

Figure 1-1 Big Sandy Reservoir in Southwest Wyoming

The Proposed Action is to increase the storage of Big Sandy Reservoir. Reclamation proposes to increase water storage by raising the spillway crest by 5 feet (Figure 1-2). Raising the spillway crest by 5 feet would increase the inundation area by approximately 500 acres and the capacity of the reservoir by 12,900 acre-feet. Reclamation completed Phase 1 of this study in 2014, which included a Risk Analysis, a Value Planning Study, and development of appraisal level design alternatives. The Proposed Action was based on the recommendations of these studies and analyses. Reclamation's Dam Safety Office has concluded that a reservoir enlargement would be approved if the dam safety risks remained neutral.

Reclamation has prepared this EA to comply with procedural requirements of the National Environmental Policy Act of 1969 (NEPA) and regulations outlined by the Council on Environmental Quality and Department of the Interior. This EA analyzes the potential impacts of the Proposed Action in comparison with the No Action Alternative. Under the No Action Alternative, the reservoir would not be enlarged, and the Big Sandy Dike, Dam, and Feeder Canal would remain unchanged. As required by the NEPA implementing regulations, if significant impacts to the human environment are identified, an Environmental Impact Statement will be prepared. If no significant impacts are identified, Reclamation will issue a Finding of No Significant Impact (FONSI).

1.2 Statement of Purpose and Need

The purpose of the Proposed Action is to comply with section 5(c) of CRSPA (43 U.S.C. § 620d), which provides that revenues in the Basin Fund shall be available for defraying the costs of operation, maintenance, and replacements of all facilities of the Colorado River Storage Project and participating projects, which include the Eden Project.

The need for the Proposed Action is to meet a portion of the existing irrigation demand and firm up the water supply within the EVIDD by reducing annual irrigation shortages by 3,600 acre-feet (under median hydrologic scenarios) to lands in the Eden Valley Irrigation and Drainage District (EVIDD). The additional storage would improve the operation of Big Sandy Reservoir because it would allow for more carryover water from wet years into future (drier) years, ensuring more consistent water deliveries throughout the irrigation season. Normally, the reservoir is filling up to May 15, at which time irrigation releases begin. On approximately September 15, no more releases from the reservoir are made. At the beginning of the irrigation season, the emergency slide gate is opened and kept in the fully open position until about September 15. During this timeframe, only the regulating slide gate is adjusted. At the end of the irrigation season both the emergency and regulating gates are completely closed.

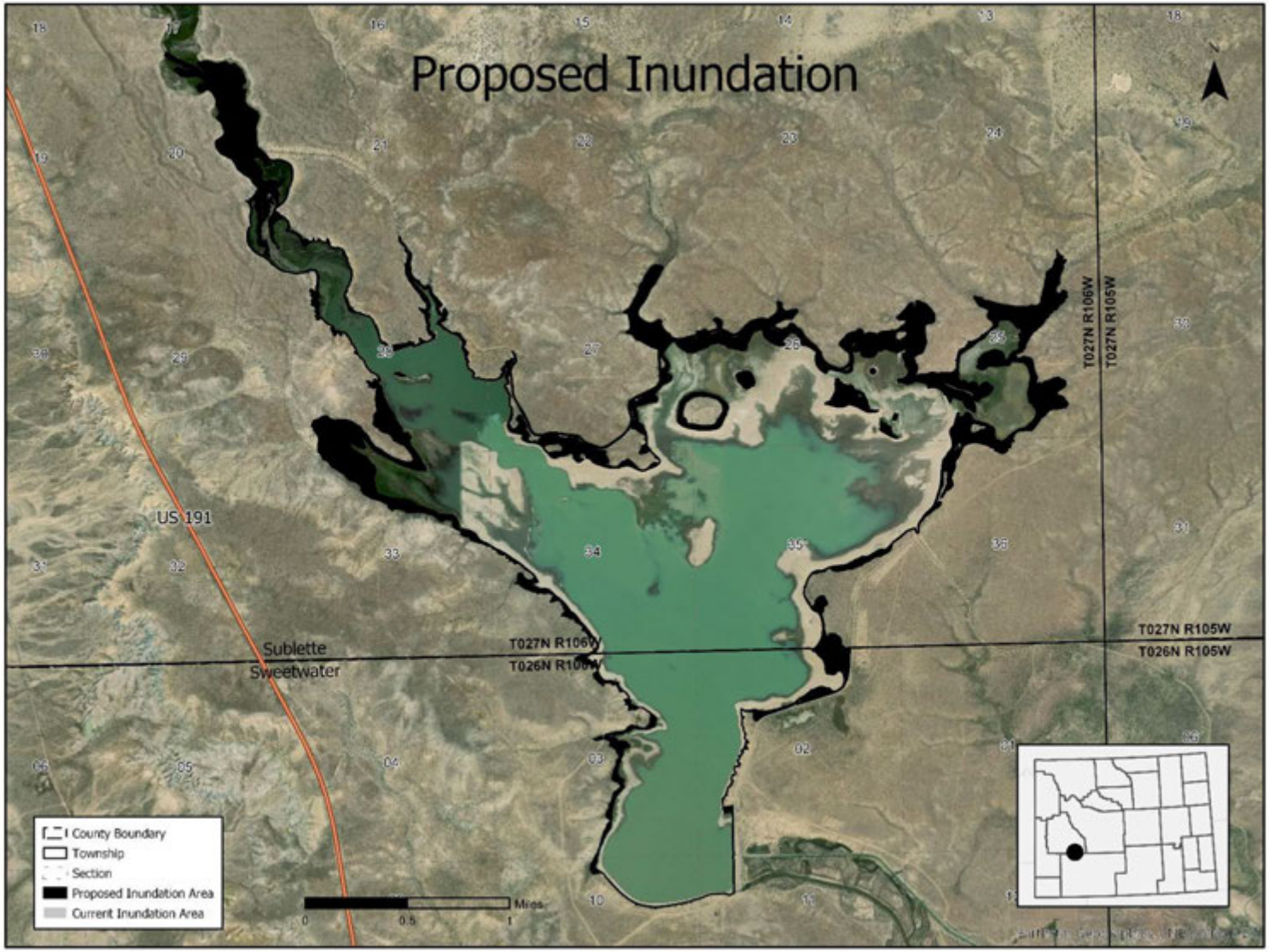

Figure 1-2 Inundation from Proposed Reservoir Enlargement

1.3 Federal Decision

The federal decision to be made is whether to implement the Proposed Action.

1.4 Permits and Authorizations

Implementation of the Proposed Action may require a number of authorizations or permits from state and Federal agencies. Reclamation (or its contractor) would be responsible for obtaining all permits and authorizations required for the Project. Potential authorizations or permits may include those listed in Table 1-1.

Table 1-1 List of Permits and/or Authorizations for the Big Sandy Reservoir Enlargement

Agency/Department	**Purpose**
Wyoming Division of Water Quality	Wyoming Pollution Discharge Elimination System (WPDES) Permit for dewatering.
Wyoming Division of Water Quality	Storm Water Discharge Permit under Section 402 of the Clean Water Act (CWA) if water is to be discharged as a point source into natural streams or creeks.
State of Wyoming Department of Natural Resources, Division of Water Rights	Stream Alteration Permit under Section 404 of the CWA and Wyoming statutory criteria of stream alteration described in the Wyoming Code. This would apply for impacts to natural streams or creeks during Project activity.
State of Wyoming Department of Natural Resources, Division of Water Rights	A new Reservoir Storage Permit would be required to obtain a water right for the additional storage. A secondary permit attaching the new storage to irrigated grounds is not necessary but may be desired.
Wyoming State Historic Preservation Office	Consultation pursuant to Section 106 of the National Historic Preservation Act (NHPA), 16 USC 470 and implementation of the MOA.

Agency/Department	Purpose
United States Army Corps of Engineers	A USACE permit in compliance with Section 404 of the CWA may be required if dredged or fill material is to be discharged into waters of the United States, including wetlands.
Sweetwater County, Wyoming	To ensure compliance with the Sweetwater County Comprehensive Plan and Development Codes, Sweetwater County will require the following plans, permits and authorizations: Grading, Drainage, Dust Control Plans, Construction/Use Permits, Conditional Use Permits for lay down yards, man camps, batch plants, and Authorizations for county road accesses, utility crossing, and overweight loads.

2 Alternatives

2.1 Introduction

This chapter describes the features of the No Action and Proposed Action Alternatives and includes a description of each alternative considered. It presents the alternatives in comparative form, defining the differences between each alternative.

2.2 No Action

Under the No Action Alternative, the Proposed Action would not be implemented. Big Sandy Reservoir would continue to be operated at the existing storage capacity of 38,600 acre-feet.

2.3 Proposed Action (Preferred Alternative)

The individual components of the Proposed Action are listed below, followed by detailed descriptions of each component. Figure 2-1 illustrates the proposed disturbance areas and Appendix D contains engineering drawings of some of the features.

- Raise to the existing spillway crest
- Toe drain and filter trench at the left abutment
- Filter diaphragm around the existing outlet works

- CB wall through the existing dike embankment
- Slope protection along the upstream dike
- Replace Big Sandy Feeder Canal headworks and drop structures

2.3.1 Raise to the Existing Spillway Crest

The existing spillway crest would be raised 5 feet using conventional concrete. The spillway discharge capacity would be controlled by the new higher crest for passage of floods with estimated return periods greater than 1,000,000 years. The base of the concrete section would rest upon bedrock upstream of the existing crest structure. The bottom elevation of the structure would vary between elevation 6,747 and 6,751 feet. The USACE has determined that the ordinary high water mark is at elevation 6,755.5 feet. The existing soil and rock material in front of the current spillway is approximately 6,754.5 feet. This material would be excavated and replaced with concrete to ensure the new spillway concrete is founded upon competent bedrock. A total of approximately 40 cubic yards of concrete and structural backfill would be placed between the ordinary high water mark and the existing ground level.

2.3.2 Toe Drain and Filter Trench at the Left Abutment

A toe drain and filter trench would be installed along the left abutment of the dam. The filter trench would be backfilled with material that is filter compatible with the embankment and foundation soils. The trench would extend 15 feet into bedrock to intercept the most open joints and would be 12-feet-wide at the bottom of the trench. Above the filter trench, a toe drain surrounded in gravel would be installed to collect seepage from the filter trench along with any seepage that may daylight above the filter trench.

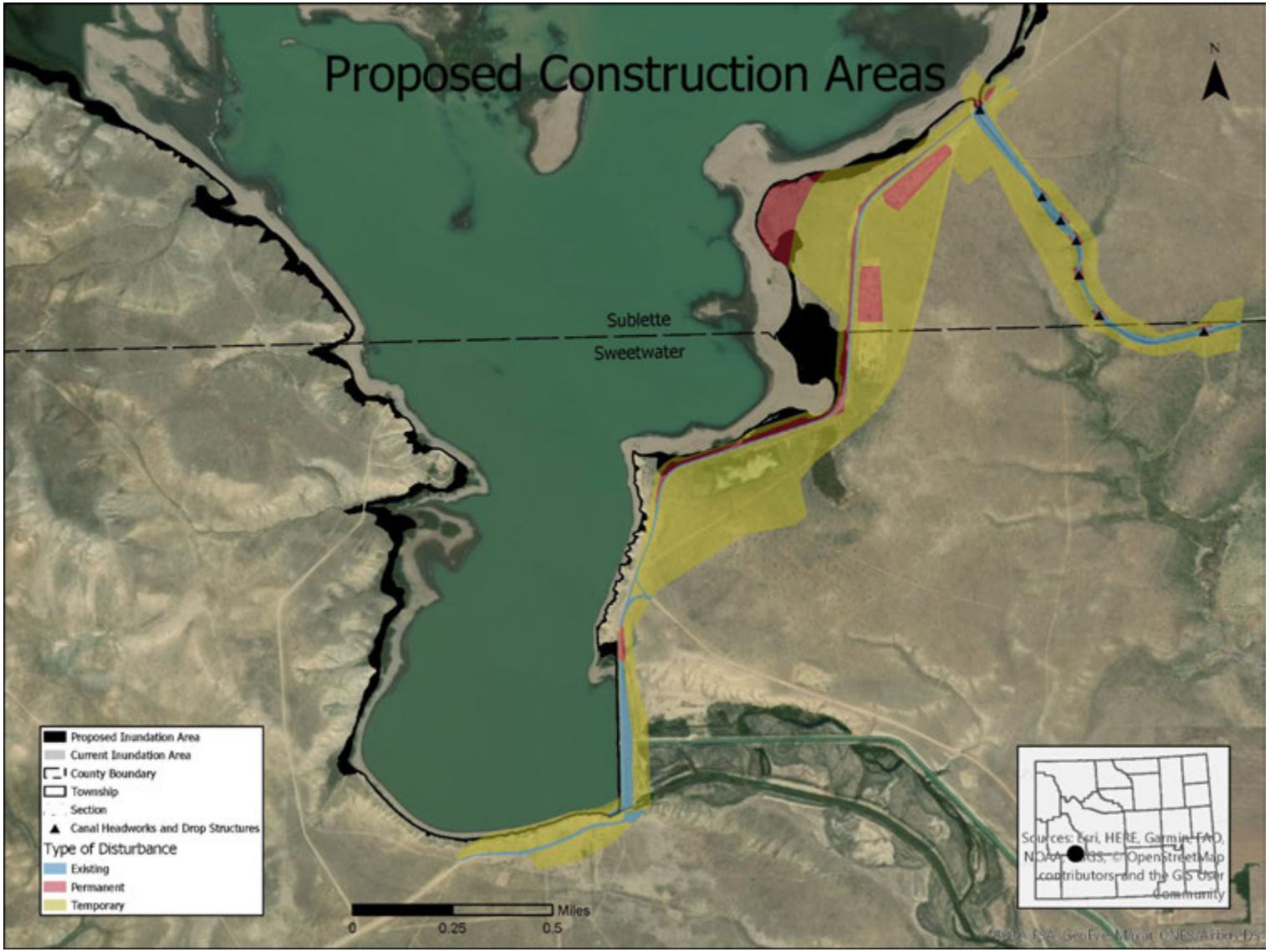

Figure 2-1 Proposed Project Areas

2.3.3 Filter Diaphragm Around the Existing Outlet Works

A filter diaphragm would be installed around the outlet works. The filter diaphragm would extend a minimum of 8 feet beyond the cutoff collars. A gravel chimney drain would be installed downstream of the filter to provide drainage and release excess pore pressures. A 6-inch perforated High-Density Polyethylene (HDPE) pipe would be installed directly upstream of the existing stilling basin to collect seepage along the conduit and to discharge the seepage into the outlet canal.

2.3.4 Cement-bentonite (CB) Wall through the Dike Embankment and Foundation

In order to reduce seepage through the dike embankment on the southeast side of Big Sandy Reservoir, a CB wall would be installed through the crest of the dike to approximately elevation 6,735 feet. The excavation would penetrate at least 5 feet into lower permeability rock. The spoils from the trench would be graded into the upstream slope of the dike as slope protection to reestablish the slope to its original design slope of 8H:1V. Additionally, the open borrow pits just downstream of the dike would need backfill placed inside the pits. The fill would be placed in the pits to approximately 150 feet downstream from the dike crest along the length of each pit.

2.3.5 Slope Protection along the Upstream Dike

The reservoir raise would increase the height of water on the dikes. Currently, the dikes have experienced some erosion. The original design of the dikes resulted in the normal reservoir water surface being against an 8:1 slope. The reservoir raise would increase the reservoir water surface above the 8:1 slope. It has been determined that either riprap would be required or the 8:1 slope would have to be carried to the top of the existing dike. The CB wall excavation would result in excess spoils containing cement, bentonite, and rock that could be used to grade the upstream slope to 8:1. Where the 8:1 slope would encroach upon the ordinary high water mark, riprap would be placed above the ordinary high water mark to prevent erosion.

2.3.6 Replace Big Sandy Feeder Canal Headworks and Drop Structures

The condition of the existing embankment adjacent to the canal headworks located on the left abutment of the dike is unknown.

The Big Sandy Feeder Canal Headworks would be replaced in its existing location, and the six drop structures in the canal would be replaced. The headgate, headwall, 42-inch-diameter concrete pipe, and downstream impact basin would all be removed. The excavation to remove these features would be at a 4:1 slope. The existing channel from the headgate to the reservoir has been partially filled in with sediment. This channel from the headwall out to the reservoir would be excavated to restore a direct connection of the gate to the reservoir. The channel would be lined with riprap to prevent potential erosion under the raised reservoir level. The headwall and headgate would be replaced and 42-inch-diameter HDPE pressure pipe would be installed. The pipe would be encased in concrete. A filter diaphragm would be installed up to elevation 6762.5 feet and a gravel drain would be installed downstream of the filter.

The existing concrete drop structures in the canal are in extremely poor condition and would be removed. New drop structures would be designed similar to existing drop structures and placed in the same locations.

2.3.7 Project Activity Procedures

2.3.7.1 *Project Activity Sequence – Modification, Replacement, and Installation*

Modification, Replacement, and Installation would likely occur in the following sequence:

- Clear and Grade
- Develop Borrow Area
- Excavation
- Install CB Cutoff Wall
- Install Left Abutment Toe Drain
- Replace Canal Headwork and Drop Structures
- Install Filter Diaphragm around Outlet Works
- Reservoir Drawdown
- Modify Spillway Crest
- Cleanup and restore areas disturbed by Project activities

2.3.7.2 *Clear and Grade*

The areas needed for the Project would be cleared of vegetation as needed to allow access to the various locations. Haul roads to the Borrow Area and Staging Areas (Figure A-3) would be graded to allow transport of fill materials to each area. It is anticipated much of the required hauling would be along the existing county road with a short spur to the borrow area.

2.3.7.3 *Develop Borrow Area*

The borrow area would have the boundary staked and material screening equipment brought in to screen the material to the designed sizes. An articulated loader would be utilized to excavate and place the material into stockpiles as needed for the Project.

2.3.7.4 *Excavation*

There would be excavation needed for the raise of the spillway crest as the bottom of the concrete extends to bedrock. Excavation would take place to remove the canal headworks and around the existing canal drop structures.

Excavation around the existing outlet works and at the left abutment would take place concurrently to allow for placement of the required filter material. The excavation around the outlet works is anticipated to have the top of the cut slope extend to the top of the dam.

2.3.7.5 *Install CB Wall*

The top of the dike would be excavated with a long-stick trackhoe. The trench would be supported by the replaced material of cement-bentonite slurry at the same time as the trench is excavated. Slurry placement and excavation would take place in a continuous operation to allow excavation to continue prior to the solidification of the slurry. The old borrow pits would be filled as described with material from either the excavated CB wall spoils or fill from the new borrow pit.

2.3.7.6 *Install Left Abutment Toe Drain*

This proposal consists of the installation of a downstream filter trench with a toe drain at the toe of the left abutment of the main dam. The filter trench would be backfilled with material that is filter-compatible with the embankment and foundation soils. The trench would be 12-feet-wide at the bottom and extend 15 feet into bedrock to intercept the most open joints. Beyond this depth the seepage paths become long, the joints are tighter, and the seepage may no longer be in contact with the dam embankment. Above the filter trench, a toe drain surrounded in gravel would be installed to collect seepage from the filter trench along with any seepage that may daylight above the filter trench. A small berm would be installed above the toe drain to protect it from freeze-thaw and contamination issues. The toe drain would contain a cleanout at the left side and would daylight into a single outfall location. The outfall location would contain a weir to collect and monitor the seepage.

2.3.7.7 *Replace Canal Headworks and Drop Structures*

This proposal consists of removal of the headgate, headwall, 42-inch-diameter concrete pipe, and downstream impact basin. The excavation to remove these features would be at a 4:1 slope. The headwall and headgate would be replaced and 42-inch-diameter HDPE pipe would be installed. The pipe would be fully encased in concrete. A filter diaphragm would be installed up to elevation 6,762.5 feet, and a gravel drain would be installed downstream of the filter. The existing concrete drop structures in the canal would be removed. New drop structures would be designed similar to existing drop structures in the existing locations.

2.3.7.8 *Install Filter Diaphragm around Outlet Works*

For the conceptual design, the filter was assumed to be C-33 fine sand aggregate supplied from Rock Springs, Wyoming. The actual filter design will be fully developed during the next phase of final design.

2.3.7.9 *Reservoir Drawdown*

The reservoir would be drawn down beginning in August 2021. The reservoir elevation would reach 6730 feet by October, after which no more water would be allowed through the outlet works. Drawing down the reservoir mitigates safety concerns during modification of the spillway crest.

2.3.7.10 *Modify Spillway Crest*

The crest would be a concrete ogee shaped crest overlaid on the existing crest. The curved crest of the existing spillway would be removed. The base of the new concrete section would rest upon

bedrock upstream of the existing crest structure. The bottom elevation of the structure would be between elevation 6,747 and 6,751 feet.

2.3.7.11 *Cleanup and Restore Areas Disturbed by the Project*

All Project areas would be graded to uniform slopes. Haul routes that are no longer necessary would be rehabilitated in preparation for re-seeding. Roads that remain would be graded to remove any rutting that was caused by Project activity. Other disturbed areas would be planted and restored with native vegetation.

2.3.7.12 *Materials Requirements*

Table 2-1 lists major material requirements for the Proposed Action. All materials would be developed from the borrow area or delivered from Rock Springs, Wyoming.

Table 2-1 Estimated Material Requirements

Type of Material	Use of Material	Quantity
Concrete	Spillway Crest	620 cubic yards
Concrete	Canal Headworks and Drop Structures	330 cubic yards
Backfill	Canal Headworks	280 cubic yards
Riprap	Canal Headworks	240 cubic yards
Backfill	Open Borrow Pits	47,000 cubic yards
Backfill	Drop Structures	600 cubic yards
Gravel Surface	Drop Structure Road	1,000 cubic yards
Sand	Filter	2,500 cubic yards
Cement-Bentonite	Dike Cutoff	1,800 cubic yards
Gravel Surface	Dike Road	3,000 cubic yards

2.3.7.13 *Standard Operating Procedures*

Standard Operating Procedures (SOPs) would be developed and followed (except for unforeseen conditions that would require modifications) during Project activity to avoid or minimize adverse impacts on people and natural resources. The SOPs and features of the Proposed Action would be formulated to avoid or minimize adverse impacts.

2.3.7.14 *Project Timeline*

The current proposed timeline for the Project would have the Project begin in 2020. It is anticipated that Project activities would take place between January 2020 and February 2021. Increased storage would occur in the spring of 2021.

2.4 Alternatives Considered and Eliminated from Further Study

The following alternatives were evaluated but eliminated because they would not successfully meet the need for the project (make available approximately 3,600 acre-feet of water) or were more expensive than the Proposed Action.

2.4.1 Establish a Seepage Berm Downstream of the Dike

A weighted seepage berm would be established on the downstream slope to minimize risks of scour of the embankment from seepage through the bedrock. The downstream improvements would be large enough to resist blowout or heave and to prevent a seepage exit point. This alternative did not reduce the annualized failure probability compared to the existing conditions and was therefore unacceptable from a risk standpoint.

2.4.2 Install a Geomembrane Liner on the Upstream Slope of the Dike

This alternative included reestablishing the upstream slope to an 8:1 slope but utilized a geomembrane liner on the upstream slope to minimize seepage through the dike embankment (as compared to the cement-bentonite (CB) wall through the dike). This alternative, while viable, did not reduce the annualized failure probability as well as the CB wall alternative. Additionally, it was estimated to be more expensive.

2.4.3 Install a Downstream Filter Trench at the Dike

A chimney filter along with a vertical filter trench would be installed at the existing downstream toe of the dike. The chimney drain and vertical filter trench would be backfilled with material that is filter compatible with the embankment, foundation soils, and bedrock joints. This alternative, while viable, did not reduce the annualized failure probability as well as the CB wall alternative. Additionally, it was estimated to be more expensive.

2.4.4 Remove and Replace Big Sandy Feeder Canal

Two alternatives were studied for replacement of the canal headworks which involved relocating the upper outlet works lower in the reservoir, diverting the water through a conduit, and connecting to the existing irrigation canal below existing drop structures to more efficiently deliver water to Eden Reservoir. The conduit would be 42-inch-diameter HDPE pressure pipe and 42-inch-diameter welded steel within the tunnel section. These design alternatives were not selected due to being significantly more costly than replacing the canal headworks in the existing location and replacing the concrete drop structures in the canal.

3 Affected Environment and Environmental Consequences

This chapter describes the environment that could be affected by the Proposed Action, including those that were considered but eliminated from detailed study. For those resources that were analyzed in detail, the present condition or characteristics of each resource are discussed first, followed by a discussion of the predicted impacts caused by the No Action and the Proposed Action.

3.1 Resources Considered but Eliminated from Detailed Analysis

The following resources were considered but eliminated from further analysis because they did not occur in the Project area or because their effect is so minor (negligible) that it was discounted (Table 3-1).

Table 3-1 Resources Considered but Eliminated from Detailed Analysis

Resource	Rationale for Considering but Eliminating from Detailed Analysis
Geology and Soils	There are no important geological features in the Project area and soils would be managed following the environmental commitments in chapter 5. Therefore, there would be no significant impact to geology and soil resources.
Wilderness, and Wild and Scenic Rivers	There are no designated wilderness areas or Wild and Scenic Rivers within the Project area; therefore, there would be no impact to these resources from the Proposed Action.
Prime and Unique Farmlands	There is no Prime and Unique Farmland within the Project area; therefore, there would be no impacts to this resource from the Proposed Action.
Recreation	The Project would have a negligible effect on recreation, including visitation rates and/or visitor experience due to the remote nature of the area (i.e., Big Sandy is not a "recreation destination") and because recreation amenities would not be upgraded beyond ensuring facilities function properly.
Visual	The Project would have negligible impacts to visual aesthetics because temporary impacts would be localized and not incompatible with the current aesthetics in the area, with no discernable long-term effects to the viewshed.
Health, Safety, Air Quality, Noise	Effects to these resources would be negligible, minimal, and/or mitigated where necessary through environmental commitments in chapter 5 or through standard industry practices required in the specifications to the contractor. Such practices include but are not limited to dust abatement, traffic control plans, coordination with local emergency responders, limiting work hours to daytime only during certain seasons, etc. Therefore, this resource was not considered in more detail in this EA.

3.2 Hydrology

3.2.1 Hydrologic Setting

The Big Sandy River (also called Big Sandy Creek) originates on the west side of the continental divide in the southern Wind River Range, in the Bridger Wilderness Area of the Bridger-Teton National Forest and flows roughly 140 river-miles (~60 miles as the crow flies) in a generally southwesterly direction before joining the Green River. Big Sandy Reservoir, a major storage facility of the Eden Project, is located on the Big Sandy River—approximately 45 miles north of Rock Springs and 10 miles north of Farson, Wyoming—near the river's midpoint. The reservoir collects and stores water from the roughly 400 square-mile drainage area above Big Sandy Dam for irrigation use on Eden Project lands. While the Big Sandy River does have year-round base streamflows of roughly 5-15 cfs, inflows to the reservoir are primarily a result of spring snowmelt runoff when peak inflows regularly exceed 600 cfs. The normal runoff volume entering Big Sandy Reservoir is 52,000 acre-feet (mean total April 1–July 31 runoff for years 1981-2010).

The basin upstream of the reservoir is essentially in its unaltered, natural condition. Streamflows of the Big Sandy River downstream of the reservoir have, since the 1950s, been altered by the presence and operation of the reservoir for irrigation. Spring runoff flows in excess of the storage capacity of the reservoir are spilled to the river below the dam. The years from 1990 to 2019 saw the Big Sandy spillway used in 16 out of the 30 years, with the total volume spilled of 193,900 acre-feet, or an average of 6,500 acre-feet annually. Outside of spring runoff, releases to the river are only made to meet water rights senior to Big Sandy Reservoir, there is no minimum flow requirement.

Historically, the Eden Valley Irrigation and Drainage District has not been able to meet crop irrigation demands during drought and dry cycles. An enlargement of Big Sandy Reservoir would help alleviate this issue.

Groundwater conditions immediately downstream of the dam and dike are monitored through observation wells. Readings from the wells are recorded periodically by the local dam tender and recorded in a database maintained by Reclamation. There is some fluctuation in the observed levels based on reservoir elevation, however, some wells do not directly fluctuate with reservoir levels thus indicating groundwater at that particular location is not directly influenced by the reservoir. The primary area of concern for potential impacts to groundwater is the movement of groundwater originating from Big Sandy Reservoir to private land southeast of the reservoir, closer to the Big Sandy Feeder Canal and Eden Reservoir than Big Sandy Reservoir. Groundwater can move through soil and bedrock dissolving naturally occurring salts into the groundwater. This saline groundwater can then rise to the surface and saturate the soil with saline groundwater. After the groundwater has evaporated, salts are left behind creating saline soil. Saline soil can inhibit certain plants that are favorable for livestock forage.

3.2.2 Reservoir Operations Model

To quantify the likely impacts of enlarging Big Sandy Reservoir on irrigation releases, reservoir storage, and spillway discharge and its impacts on the hydrology of the Big Sandy and Green Rivers downstream of the reservoir, Reclamation created a daily-timestep mass-balance spreadsheet model of Big Sandy Reservoir operations from 1990 thru 2019. A summary of the model is presented

below. For more detailed information about the model and results including tables and graphics see Appendix A.

3.2.2.1 *Model Setup*

Given a spillway crest elevation, a reservoir elevation-storage table, an initial historic end-of-day reservoir elevation for December 31, 1989, daily historic reservoir inflow data (see Reservoir Inflow Data section below), and irrigation demand data from January 1, 1990 to December 31, 2019, the model computes daily reservoir release, unmet irrigation demand, spillway discharge, reservoir storage, and reservoir elevation data for January 1, 1990 to December 31, 2019.

Reservoir Inflow Data

Historic Big Sandy Reservoir daily inflow data were computed by mass balance of historic daily release data, daily storage data, and computed historic spillway discharge data. Gaps in historic release data and reservoir elevation data were interpolated to obtain 30 years of complete, continuous historic reservoir inflow, release, spill, elevation, and storage data from January 1, 1990 to December 31, 2019. The computed Big Sandy Reservoir inflow data were validated by comparing to USGS gage data (USGS 09213500 Big Sandy River near Farson, WY).

3.2.2.2 *Model Validation*

To validate the model, the model was run with the current spillway crest elevation (6757.5 feet), the reservoir elevation-storage table used in the historic reservoir operations data, and historic release data. The model-computed reservoir elevation and spillway discharges correlated very closely with historic data.

3.2.2.3 *Enlarged Reservoir Model Run*

Once validated, the model was run with the raised spillway crest elevation (6762.5 feet), the reservoir elevation-storage table developed from the 2015 lidar data, and what is assumed to be a likely future irrigation demand if the dam raise is to be implemented (see Irrigation Demand section below).

Irrigation Demand

The irrigation demand assumed in the model was selected based on a review of discussions with EVIDD operators, historic release data, the Big Sandy Reservoir Enlargement Level II Phase I Study Final Report (Wenck 2017), and the May 1953 Definite Plan Report for the Eden Project (Reclamation 1953). Considering consumptive use, precipitation, and farm losses, the Definite Plan Report estimated a farm delivery requirement of 2.26 acre-feet per acre with an estimated 30 percent conveyance loss, which closely matches what EVIDD independently noted as a desired irrigation volume (two and a quarter acre-feet per acre) and conveyance loss (historically approximately 30 percent). The Definite Plan Report values were considered a reasonable approximation of the irrigation water that would be used if reliably available. Assuming operation of Eden Reservoir similar to historic operations—relatively constant, relatively low releases that primarily mitigate some conveyance loss—the full irrigation demand for the 17,010 acres served by the project was applied as a 54,918 acre-feet annual irrigation demand (17,010 acres, 2.26 acre-feet per acre, 30 percent conveyance loss) at Big Sandy Reservoir. Daily irrigation demand used in the model was estimated by computing the percent of annual historic releases that were made each month with some adjustment to increase May releases due to EVIDD expressing interest in providing water earlier in May if reliably available.

In wet years, outlet works releases have historically exceeded the 54,918 acre-feet annual irrigation demand assumed in the model. The primary reason for the releases was to operate the reservoir to mitigate against excessive spillway discharge and downstream flows in excess of the safe channel capacity. For the series of wet years of 1995 to 1999, and 2017 to 2019 it was assumed that reservoir operators would make decisions like those made historically, *i.e.*, the same releases made historically were made in the model.

3.2.3 Impacts to Hydrology

3.2.3.1 No Action

Under the No Action Alternative, the Project would not be built, and therefore there would be no effect on hydrology. The conditions in the basin above and the river downstream of Big Sandy Reservoir would remain as they are.

3.2.3.2 Proposed Action

Effects of the Proposed Action Alternative on surface water and groundwater are presented in the sections below.

3.2.3.2.1 Model Results

The results of the Enlarged Reservoir model run—representing likely operations of the proposed enlarged Big Sandy Reservoir given the 1990 to 2019 historic reservoir inflows—were compared with historic 1990 to 2019 reservoir operations and streamflow data to quantify the likely impacts of the reservoir enlargement on irrigation releases, reservoir storage, and spillway discharge and its impacts on the Big Sandy and Green Rivers downstream. A summary of results is presented below. For more detailed information about the model and results including tables and graphics see Appendix A.

Big Sandy Irrigation Release Impacts

If water was available, the model released 54,918 acre-feet per year during the irrigation season, except in the wet years of 1995, 1996, 1997, 1998, 1999, 2017, 2018, and 2019 when the model releases matched historic releases.

The 50 percent exceedance values show a release increase of 3,604 acre-feet from historic releases (50 percent exceedance of 51,314 acre-feet) with the enlarged reservoir (50 percent exceedance of 54,918 acre-feet).

The model shows the largest differences in release volume coming in 2001 (16,000 acre-feet) and 2013 (17,000 acre-feet), both of which were the second dry year following a wet year (1999 and 2011, respectively), highlighting the ability of the enlarged reservoir to store excess water from wet years for use in dry years.

Overall, the model indicates positive impact to the Big Sandy irrigation releases as a result of the reservoir enlargement. Considering 54,918 acre-feet per year to be the desired irrigation release volume, the model was able to meet the desired irrigation release in 18 of the 30 years (60%) from 1990-2019, an improvement over the 12 of 30 years (40%) the desired volume was released historically.

Big Sandy Storage Impacts
Both the historic and model storage volumes are high in March following a wet year (*e.g.*, 1996, 2012, 2018) or within or following a series of relatively wet years (*e.g.*, 1997 to 2000, 2019) with the model storing water in the additional, enlarged storage volume. The model computation for reservoir release prioritizes meeting current day irrigation demands—where operators may choose to decrease irrigation releases in favor of higher storage—resulting in lower than historic end of March reservoir storage following dry years or series of relatively dry years (*e.g.*, 2002-2004, 2007-2011, 2014-2016).

Overall, the model indicates positive impact to the Big Sandy storage as a result of the reservoir enlargement. The model indicates that during high storage years (10 percent exceedance) the enlarged reservoir would likely store 11,500 acre-feet more than what has been historically stored on March 30. In normal and low storage years, storage in the enlarged reservoir would largely depend on reservoir operator priorities for any given year or series of years. The model indicates that in normal (50 percent exceedance) and dry (90 percent exceedance) storage years, the enlarged reservoir storage could, respectively, be as much as 3,000 and 2,500 acre-feet ***lower*** than historic March 30 storage volumes. However, if operators prioritize preserving reservoir storage, normal and dry year enlarged reservoir storage would likely be similar to or perhaps higher than historic March 30 storage volumes.

Annual maximum and September 30 (approximating the annual minimum) reservoir water surface elevations from the model were compared with historic elevations. The enlarged reservoir, allowing for elevations 5.0 feet higher, combined with the model assumption of prioritizing irrigation releases led to the spread of maximum and September 30 elevations in the model being larger than the spread of the historic data. The model maximum elevations extended 4.7 feet higher (10 exceedance) and 4.1 feet lower (90 percent exceedance) than historic maximum elevations.: the model 90 percent exceedance is 4.1 feet lower and the 10 percent exceedance is 4.7 feet higher. The modeled September 30 elevations extended 5.6 feet higher (10 percent exceedance) and 6.2 feet lower (90 percent exceedance) than historic September 30 elevations. If actual operations do not prioritize irrigation releases to the extent assumed in the model, low end (90 percent exceedance) of enlarged reservoir maximum and September 30 reservoir water surface elevations would likely trend near or slightly higher (not lower) than historic elevations.

Big Sandy Spillway Discharge and River Impacts
As would be anticipated, the model indicates that the enlarged Big Sandy Reservoir would capture some of the water that has historically discharged through the spillway.

Big Sandy Reservoir spilled in 16 of the 30 years (53%) from 1990 thru 2019. Spill volumes varied greatly from year to year (from 200 to 45,900 acre-feet) as did peak discharges (from 10 to 990 cfs), with a 30-year total spillway discharge volume of approximately 193,900 acre-feet and 50 percent exceedance volume of 237 acre-feet.

The model indicates that with the reservoir enlargement, Big Sandy would likely spill (volumes from 200 to 34,100 acre-feet and peak discharges from 20 to 790 cfs) in 8 out of 30 years (27%) with a total spillway discharge volume of approximately 105,400 acre-feet and 50 percent exceedance volume of 0 acre-feet. The model shows that in a series of wetter than average years, the enlarged reservoir would likely capture much of the historic spill in the first wet year (*e.g.*, 1995 and 2017) but having filled the additional storage in the first wet year would essentially spill the historic spill in

subsequent wet years (*e.g.*, 1996, 1997, 1998, 1999, 2018, and 2019). The spill historically seen in or following individual wet years (*e.g.*, 2011) or the generally small spills in or following slightly wetter than typical years (*e.g.*, 1991, 2005 and 2006 (following wet 2004 and 2005), 2009, 2015 (following wet 2014), 2016) would very likely not be seen with the enlarged reservoir. Large (10 percent exceedance) spillway discharges would decrease approximately 4,400 acre-feet in volume (from 23,000 to 18,600 acre-feet, a 20% decrease) and 220 cfs in flow rate (from 700 to 480 cfs a 31% decrease).

The impact of these potential changes in spillway discharge on rivers downstream were analyzed. For daily flow records at USGS stream gages on the Big Sandy River (USGS 09215550 Big Sandy River below Farson, WY) and Green River (USGS 09217000 Green River near Green River, WY) the computed historic Big Sandy Reservoir daily spillway discharge was subtracted from recorded USGS gage flows, then the model-computed daily spillway discharge for the reservoir enlargement were added back in and the resulting river flows were compared to historic flows. This approach does not account for additional return flows to the river from the increased irrigation releases from the enlarged reservoir in order to estimate worst-case impacts to downstream rivers.

Overall, the model indicates fairly minor impact to the Big Sandy River from the reservoir enlargement. The total flow volume from 1990 thru 1998 (flow data for the USGS Big Sandy River gage were only measured up to September 1999) would likely decrease by approximately 7% (from 261,750 to approximately 242,180 acre-feet) and peak flows would generally be unimpacted. Impacts to the Big Sandy River would be limited to years where much of what would historically spill would be captured by the enlarged reservoir like the first of a series of wet years, 1995. In 1995, the model indicates, that the Big Sandy River would likely see approximately 15,600 acre-feet (25%) less water due to the reservoir enlargement. In 1995, the Big Sandy River reached its peak flow of 900 cfs on March 12 before any Big Sandy Reservoir spillway discharge historically or in the model. The flows in the Big Sandy River during the high spillway discharge years of 1997 and 1999 would be essentially unchanged under the reservoir enlargement due to the reservoir in both the historic and modeled cases being relatively full due to the series of consecutive wet years.

The model indicates negligible impact to the Green River from the reservoir enlargement. Due to the relatively small size and hydrologic contribution of the Big Sandy River basin to the Green River basin, the proposed enlargement of Big Sandy Reservoir and the resulting impacts to spillway discharge volumes and peak flows would have essentially negligible impacts to the flows of the Green River. The model indicates that the 30-year flow volume of the Green River near Green River, Wyoming (~31,573,000 acre-feet) would be decreased by less than one-third of one percent (0.3% or ~91,600 acre-feet) due to the enlargement. The 50 percent exceedance impacts indicate the enlargement would decrease Green River peak flows by less than one percent (0.74%); the greatest model impact to Green River peak flows (by decrease and percent decrease) was the reduction of the 1991 historic peak flow (9,070 cfs) by 3.0% (or 276 cfs).

3.2.3.3 *Model Conclusions*

The enlarged reservoir would be able to release an additional 3,600 acre-feet (difference between 50 percent exceedance model and historic release volumes), store 11,500 acre-feet more water on March 30 in high storage (10 percent exceedance) years (and store less or roughly the same in low and normal storage years), and decrease the frequency of spillway use from 16 in 30 years (53%) to 8 in 30 years (27%). The decrease in spillway discharge would result in an approximately 7% decrease in flow volumes (not accounting for additional return flows from additional irrigation water use which would increase the flow volumes) with only minor impacts to peak river flows in the Big Sandy River (based on modeled and historic 1990 to 1999 USGS 09215550 Big Sandy River below Farson, WY data), and a negligible 0.3% decrease in flow volume and 0.74% decrease in 50 percent exceedance peak flows in the Green River (based on modeled and historic 1990-2019 USGS 09217000 Green River near Green River, WY data). Thus, modeling indicates that the impacts of the enlarged Big Sandy Reservoir on surface water are anticipated to be minimal and local to Big Sandy Reservoir and the already heavily regulated Big Sandy River below the reservoir.

3.2.3.4 *Groundwater*

Based on seepage models, the CB wall at Big Sandy is anticipated to offset the increased seepage that would occur from the raised reservoir. The flow computed at the downstream end of the model was about $3*10^{-6}$ cfs/ft for the baseline condition and about $2.7*10^{-6}$ cfs/ft for the raised reservoir pool and CB wall condition. While the actual amount of seepage downstream of the CB wall will ultimately depend on the final depth of the CB wall, the net change in seepage downstream of the CB wall is anticipated to be minimal.

Beyond the limits of the CB wall, the reservoir raise is anticipated to increase seepage because of the higher head. For the dike as a whole, the net result of the CB wall and reservoir raise would be a minimal overall change to groundwater recharge into bedrock as the increased seepage outside the limits of the CB wall is offset by the reduced seepage along the CB wall.

Based on historical observation well data, the groundwater levels downstream of Big Sandy Reservoir are tied to reservoir levels but are less responsive to fluctuations in reservoir levels further away from the dike. Adjacent to the dike, the water levels in downstream observation wells (OWs) change at almost a 1:1 ratio with reservoir levels. At OW-14 (Appendix E), which is greater than 2,000 feet from the dike, a 5-foot change in reservoir level corresponds to about a 2-foot change in observation well water levels. At the area of interest (private land at NE1/4 Section 12 R106W T26N), the influence of reservoir fluctuations on regional groundwater levels is anticipated to be even less than at OW-14.

One reason that OW-14 is less responsive to reservoir levels than other wells is that seepage from Big Sandy Reservoir likely flows radially away from the reservoir. Another reason is that, farther away from the dike, groundwater levels likely become more influenced by operation of the Big Sandy Feeder Canal, Means Canal, Eden Reservoir, and groundwater recharge from precipitation.

The ability to operate the feeder canal over a longer period of the year is another reason that the reservoir raise could likely result in a small increase in groundwater levels downstream of the dike.

Based on the results from the analysis and water level data available, the impacts to groundwater would be minimal because the reservoir raise and CB wall installation at Big Sandy Reservoir would result in almost no change with a potential of a slight increase in groundwater levels at the area of interest southeast of the Reservoir.

3.3 Water Quality

Presently the water quality of the Big Sandy river below the Big Sandy reservoir meets the State of Wyoming's surface water quality standard criteria and is listed as a 2AB water (Wyoming DEQ, Wyoming's 2016/2018 Integrated 305(b) and 303(d) Report). Class 2AB waters are those known to support game fish populations or spawning and nursery areas at least seasonally and all their perennial tributaries and adjacent wetlands and where a game fishery and drinking water use is otherwise attainable. Class 2AB waters include all permanent and seasonal game fisheries and can be either "cold water" or "warm water" depending upon the predominance of cold water or warm water species present. All Class 2AB waters are designated as cold water game fisheries unless identified as a warm water game fishery by a "ww" notation in the *Wyoming Surface Water Classification List*. Unless it is shown otherwise, these waters are presumed to have sufficient water quality and quantity to support drinking water supplies and are protected for that use. Class 2AB waters are also protected for nongame fisheries, fish consumption, aquatic life other than fish, recreation, wildlife, industry, agriculture and scenic value uses.

The water quality of the Big Sandy reservoir has not been directly assessed, however, because the Big Sandy river has the largest flow contribution in the Big Sandy basin. If the water held and used discharged from the Big Sandy reservoir did not meet state water quality standards, the Big Sandy river below the reservoir would not meet the state water quality standards. The USGS gage above the Big Sandy reservoir has a 20 year record of water quality analyses and shows an average salinity (TDS) value of 86 mg/L for the Big Sandy River inflow into the Big Sandy reservoir demonstrating that the inflow contains low TDS and is of good water quality regarding TDS.

The TDS of the Green River below the Fontenelle Reservoir USGS gage to the USGS gage near Green River, Wyoming shows an increase in the TDS levels by less than 150 mg/L.

3.3.1 Water Quality Model

A model-based analysis was performed to assess water quality in the Project area. The analysis compared water quality before and after modification of the reservoir. Because the data availability does not reach the level required by a detailed model, a simpler model approach was more appropriate.

The model assumptions were:

1. The reservoir is well-mixed and stratification would not affect Total Suspended Solids (TSS) concentrations prior to settling,

2. Most of the TSS and Total Dissolved Solids (TDS) are carried into the reservoir by the upstream inflow from the Big Sandy River and tributary watershed sources,
3. TSS and TDS contributed by aeolian deposition and precipitation into the reservoir are negligible,
4. Evaporation will cause a minimal increase of TSS and TDS in-reservoir concentrations,
5. Outflow through controlled releases and emergency overflow will contain the same concentrations of TSS and TDS as those in the reservoir,
6. The reservoir provides a significant amount of residence time, which promotes internal settling of TSS,
7. Internal settling rate was 0.7 m/day average based on literature value (Thomann 1987),
8. Chemical flocculation of TSS is negligible,
9. The anion and cation constituents of TDS are unlikely to attach to other charged particles, and thus, settling of TDS in this manner is negligible,
10. The TDS removal by biogeochemical processes in the reservoir is negligible,
11. Groundwater discharge and recharge was assumed to be negligible,
12. Overland runoff between upstream gaging station and the reservoir was assumed to be minor,
13. No steady state assumption was made due to the change of water level and reservoir storage,
14. The shape of the reservoir was assumed to be truncated cone for depth-area calculations,
15. With adequate water conditions, the ideal irrigation season would begin on April 1 and shut down on September 15.

A depth-storage and depth-area curve was established for the reservoir using daily U.S. Geological Survey (USGS) gaging station 09213700 storage and stage data from 2011 to 2016. The surface area of the reservoir was estimated under the assumption of truncated cone shaped reservoir. The surface area at the Normal High Water Level (NHWL) used by the existing model was 2,500 acres. The same surface area was used in the model prior to enlargement. The regression established between depth and area is

y= -0.1012x^3+15.716x^2-715.67x+10579

with a goodness of fit r-squared of 0.996. Monthly average surface area calculated was used in the calculation of water budget components.

Precipitation data was available year-round from Station USC00483170 in Farson, WY. The annual average rainfall at the station was 6.65 inches (2011 through 2016). This number is comparable to data from the University of Wyoming website (Wyoming Climate Atlas 2004). Only the precipitation that fell directly on the reservoir surface area was calculated. Precipitation falling onto the other parts of the watershed were assumed to be part of the upstream inflow. The enlargement of the reservoir would directly affect the precipitation amount received on the reservoir surface.

3.3.2 Impacts on Water Quality

3.3.2.1 No Action

Under the No Action Alternative, the Project would not be built, and therefore would have no effect on water quality. The Reservoir would not be modified, nor would any ground disturbance occur under the No Action alternative.

3.3.2.2 Proposed Action

The proposed action of increasing the crest of the spillway 5 feet and updating the associated structures was modeled and the model results below show no net negative impact to the water quality of the reservoir or the Big Sandy river below the reservoir.

3.3.2.2.1 Water Balance

Table 3-2 shows the water balance from year 2011 to 2015, before and after enlargement. Years 2014 and 2016 were not included due to the missing elevation and storage data from the USGS gage station number 09213500 (Big Sandy River Near Farson). This period of record was used rather than the entire period of record utilized for the hydrologic model because it provided the most recent and most reliable water quality data available.

Table 3-2 Water Balance Result for Years 2011, 2012, 2013, and 2015

Year	Precipitation (AF)		Inflow (AF)		ET (AF)		Outflow (AF)	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
2011	7	9	92,466	92,466	5,181	6,134	62,081	65,107
2012	536	696	47,177	47,177	4,196	5,132	62,081	65,107
2013	433	622	34,279	34,279	2,675	3,668	62,081	65,107
2015	1,623	1,904	57,365	57,365	5,228	6,169	62,081	65,107

The changes in precipitation and evaporation volumes noted in Table 3-2 were caused by an increase in the surface area of the reservoir after modification of the dam. However, inflow from the river would not be affected and outflow was assumed to be constant.

3.3.2.2.2 Water Quality in Big Sandy Reservoir

The adjusted TSS concentration ratio, R, was calculated for years with water quality data (2011, 2012, 2013, and 2015 from USGS station 09213500). The results are shown in Table 3-3.

Table 3-3 Reservoir TSS concentration ratio and percent. A Ratio R > 1.0 indicates greater TSS concentration in the Reservoir pre-enlargement

-	2011	2012	2013	2015	Average
Ratio R	1.28	1.31	1.48	1.27	1.34
Reduction	21.9%	23.7%	32.4%	21.3%	24.8%

A ratio value (R) greater than 1.00 indicates that the pre-modification TSS concentrations are higher than predicted post-modification TSS concentrations. On average, the in-reservoir TSS concentrations were predicted to be reduced by approximately 25 percent after the enlargement. In short, the modification of the dam would improve TSS water quality.

The adjusted TDS concentration ratio, R, was calculated for the same years (see Table 3-4).

Table 3-4 Pre- and Post-enlargement in Reservoir TDS Concentration Ratio and Percent Increase

-	2011	2012	2013	2015	Average
Ratio R	1.1	1.09	1.10	1.08	1.09
Reduction	9.1%	8.3%	9.1%	7.4%	8.5%

The TDS ratio value (R) is greater than 1.00. This indicates that the pre-modification TDS concentrations were predicted to be higher than the post-modification concentration, meaning TDS water quality would be improved. On average, the in-reservoir TDS concentration was predicted to decrease by approximately 8.5 percent after modification of the dam and after any salt leach out of newly inundated lands.

3.3.2.2.3 Water Quality Protection during Project Activities

During the Project, potentially minimal impacts to water quality within the reservoir around the Project area would be caused by an increase in the turbidity in the water from the movement of material. The impacts would be further minimized by following the environmental commitments in Chapter 5.

Based on the model-based analysis and the environmental commitments (see chapter 5), the Proposed Action would have minimal, if any, effects on water quality – specifically existing TDS conditions – in the reservoir or in the river below the reservoir. However, the change of surface elevations during various hydrologies and demands could result in an increase in the water temperature and reduced dissolved oxygen content in the reservoir by the end of the irrigation season, when the reservoir is at its lowest elevation. However, modifying the reservoir would have a net benefit of reducing the TDS and TSS concentrations in the Reservoir by a predicted 24.8 percent and 8.5 percent, respectively.

3.3.2.3 *Water Quality Conclusions*

The amount of this increase caused by the Project is unknown because there is not a gage on the lower Big Sandy River but most likely minimal since this stretch of the Big Sandy river has been assessed and meets Wyoming DEQ water quality standards, and that stretch of the Green River flows through fairly salty geology. However, at the average TDS at the Green River gage of 380 mg/L it is still well within water quality standards of 500 mg/L.

The present water quality of the Big Sandy river meets the State of Wyoming's water quality standards, and the reservoir water quality, although not assessed by the state, should also meet state water quality standards regarding the TDS because it is part of the whole system. The modeling of

the proposed Project shows that the impact to the TDS concentration of the reservoir would actually be decreased over present levels with the additional storage capacity. Therefore, no net negative water quality impact to the Big Sandy river or the reservoir would be projected to occur with the proposed Project.

3.4 Wetlands and Riparian Resources

Wetlands

Wetland areas were delineated by Western EcoSystems Technology Inc. in accordance with the 1987 Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987) and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West (Version 2.0) (USACE 2010). The 1987 manual outlines a three parameter approach for an area to be considered a wetland, in which all three parameters must be met. Hydrophytic plants must be the dominant vegetative cover; hydric soils must be present; and wetland hydrology must be present.

In some locations, the survey area presented a problematic hydrology situation because of the reservoir influence and fluctuation. The Arid West Manual (USACE 2010) recommends additional monitoring for problematic situations and provides technical standards. The standard requires 14 or more consecutive days of flooding or ponding during the growing season at a minimum frequency of 5 out of 10 years (USACE 2010). Hydrology data and aerial imagery were reviewed to support this standard. In addition, discussions with the Cheyenne – USACE office occurred to guide these determinations. Sample locations that relied primarily on aerial imagery as the hydrologic indicator were determined to not meet the hydrology standards of the USACE. Sample locations that used saturation, biotic crust, or other primary indicators were determined to appropriately meet the hydrology standards.

Field surveys concluded that 182 acres of wetlands occur along the reservoir margins, including broad meadows/depressions. Also, 154 acres of wetlands occur in the terrace/riparian corridors along the Big Sandy River, for a total of 336 acres. Fringe wetlands were primarily palustrine scrub-shrub (PSS) dominated by sandbar willow (*Salix exigua*) with limited herbaceous understory. Small palustrine emergent (PEM) fringes were also present. The large PEM meadow wetland areas were dominated by foxtail barley (*Hordeum jubatum*) and Douglas' sedge (*Carex douglasii*), both of which are considered facultative wetland species. Some wetland areas had a high percentage of non-desirable annual species including tumbleweed (*Salsola tragus*) and halogeton (*Halogeton glomeratus*). In general, the meadow wetland areas were low quality, marginal wetlands. Based on a review of aerial photos using GoogleEarth, these wetland areas appeared to be inundated only when the reservoir was filled to maximum capacity. Wetland areas located along the Big Sandy River inflow were mixed community PEM/PSS wetlands. These wetlands had clear hydrology, hydric soil indicators, and hydric vegetative diversity. The river corridor was well defined and contained high quality wetland characteristics.

Riparian

Big Sandy Reservoir is located in an arid west landscape. The surrounding land cover is sagebrush steppe; however, riparian vegetation exists within the Project area along the banks of the Big Sandy River. This riparian community is primarily dominated by sandbar willow (*Salix exiqua*) and shining

willow (*Salix lucida*). Other riparian species include: Northwest Territory sedge (*Carex utriculata*), Nebraska sedge (*Carex nebrascensis*), tufted hairgrass (*Deschampsia caespitosa*), Baltic rush (*Juncus balticus*), American licorice (*Glycyrrhiza lepidota)*, water sedge (*Carex aquatilus*), and Kentucky bluegrass (*Poa pratensis*).

3.4.1 Impacts on Wetlands

3.4.1.1 No Action

Under the No Action Alternative, the Project would not be built, and therefore there would be no negative effect on wetlands and riparian vegetation.

3.4.1.2 Proposed Action

It is anticipated that implementation of the Proposed Action would cause temporary inundation of 336 acres of wetlands and riparian areas during periods when the reservoir would be at full water pool elevation. This inundation would be temporary in nature based upon annual hydrology and continuous water pool fluctuations. The inundation is not anticipated to be of sufficient duration as to cause mortality of current wetland vegetation. The inundation may, however, be of sufficient duration to cause an expansion of fringe wetlands into areas that are currently classified as uplands. Any loss of upland habitat would be minimal in comparison to the amount of upland habitat currently available to upland wildlife species.

The USACE has determined that maintenance activities such as installation of the toe drain and filter, lower outlet works filter diaphragm, and cutoff wall in a portion of the dike are exempt from requiring a dredge and fill permit as defined in Section 404(f)(B) of the Clean Water Act. See 33 CFR 323.4(a)(2). Fill below the OWHM at the spillway and canal headworks would require a dredge and fill permit from the USACE as required by Section 404 of the Clean Water Act. The amount of fill would be the minimum required for the installation, modification, and replacement of existing facilities.

3.5 Wildlife Resources

Wildlife resources within the general area of the Project include mammals, birds, reptiles and amphibians, and fish. The Wyoming Natural Diversity Database was consulted to determine species potentially in the area.

Mammals

Mule deer (*Odocoileus hemionus*), Rocky Mountain elk (*Cervus canadensis nelsoni*), and pronghorn (*Antilocapra americana*) are found in the general surrounding area. Pronghorn and Rocky Mountain elk have crucial habitat within the Project area (Figure 3-1).

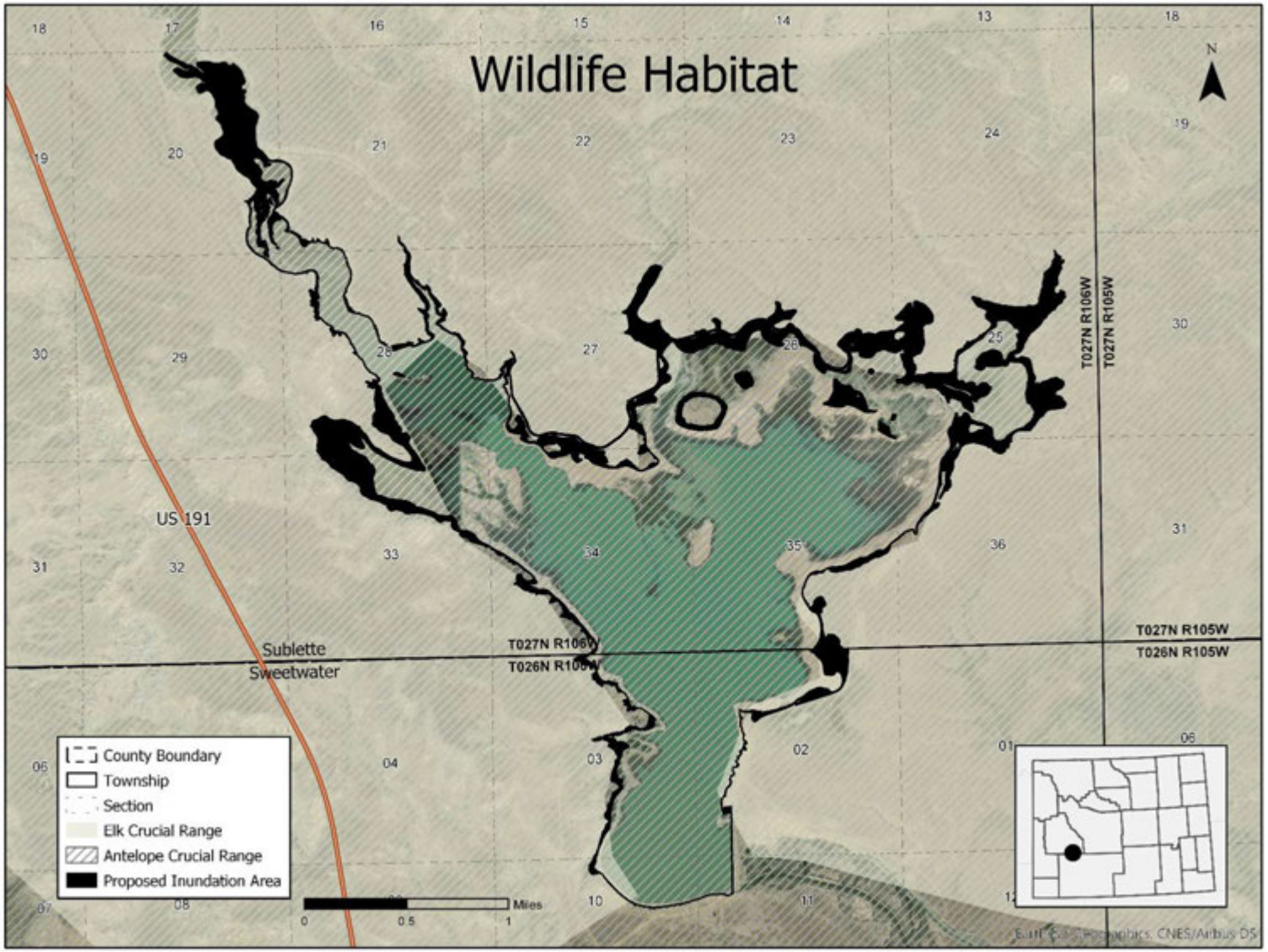

Figure 3-1 Crucial Habitat for Elk and Antelope (Pronghorn)

Birds (including raptors)
Migratory songbirds, upland gamebirds, raptors, and owls occur in the Project area. Two sensitive species with records of observation within or near the Project area are the burrowing owl (*Athene cunicularia*) and greater sage-grouse (*Centrocercus urophasianus*). Two raptor species were identified in the Project area: golden eagle (*Aquila chrysaetos*) and great horned owl (*Bubo virginianus*), indicating adequate habitat (large trees, especially cottonwoods) is present in the area. One raptor nest near the dam was occupied by a great horned owl when Reclamation biologists visited the Project area on April 11-12, 2017. Golden eagles were also identified in the area, on the April 2017 visit and again in January 2018. Several raptor nests were identified on an island on the northeast side of the reservoir. These nests were assumed to be used by golden eagles.

Reptiles and Amphibians
A number of reptiles and amphibians occur in the general area including the western rattlesnake (*Crotalus viridis*), western chorus frog (*Pseudacris triseriata*), and tiger salamander (*Ambystoma tigrinum*).

Fish
The Reservoir supports multiple fish species, most of which are not native to the river basin (Table 3-5). Four of the fish species occurring in the Reservoir and downstream include brown trout (*Salmo trutta*), catfish (*Ictalurus punctatus*), cutthroat trout (*Oncorhynchus clarkii*), and rainbow trout (*Oncorhynchus mykiss*). Most anglers visit the Reservoir to catch brown trout and rainbow trout, both of which have been stocked in recent years by Wyoming Game and Fish Department (WGFD) (John Walrath, WGFD 2019, pers. comm.). In 2018, the WGFD stocked 7,000 brown trout and 8,000 rainbow trout (Table 3-6). Cutthroat trout were last stocked in 2004.

Table 3-5 Fish Species Occurrence in Big Sandy Reservoir

Species	Native	Abundance
Burbot	N	3 - Abundant
Brook Trout	N	1 - Rare
Brown Trout	N	2 - Common
Channel Catfish	N	1 - Rare
Cutthroat Trout	N	1 - Rare
Flannelmouth Sucker	Y	1 - Rare
Mountain Sucker	Y	0 - Unknown
Mountain Whitefish	Y	1 - Rare
Rainbow Trout	N	1 - Rare
Redside Shiner	N	3 - Abundant
White Sucker	N	3 - Abundant

Flannelmouth sucker (*Catostomus latipinnis*), mountain sucker (*Catostomus platyrhynchus*), and mountain whitefish (*Prosopium williamsoni*) are the only native fish in the reservoir. Two particularly invasive species are present in the reservoir, including burbot (*Lota lota*) and white sucker (*Catostomus commersonii*). Burbot were illegally introduced to the Reservoir in 2001 and have since invaded Fontenelle and Flaming Gorge Reservoirs. Both burbot and white sucker have reduced the quality of

the fishery at Big Sandy Reservoir, making it a less desirable fishing destination (John Walrath, WGFD, pers. comm. 2017).

Table 3-6 Fish Stocking in Big Sandy Reservoir 2013-2018

Year	Species	Number Stocked
2013	Brown Trout	45K
2014	Brown Trout	24K
2015	Brown Trout	20K
2015	Rainbow Trout	25K
2016	Brown Trout	11K
2016	Rainbow Trout	21K
2017	Brown Trout	25K
2017	Rainbow Trout	10K
2018	Brown Trout	7K
2018	Rainbow Trout	8K

3.5.1 Impacts to Wildlife Resources

3.5.1.1 No Action

Under the No Action Alternative, the Project would not be built, and therefore there would be no negative effects on wildlife. Free water and habitat conditions would remain the same.

3.5.1.2 Proposed Action

General Effects

Under the Proposed Action there would be no significant effects to wildlife. In the short term, especially during and immediately after Project activities, animals would temporarily have to find unfamiliar habitat where they could be more susceptible to exposure to the elements and predation. Project activity would cause temporary stress to some wildlife species from noise, dust, displacement, and temporary loss of habitat. Trees and shrubs that used to be occupied by birds and other wildlife may die if they are inundated for extended periods of time. This could affect nesting habitat, and thermal cover for a variety of species. However, these impacts are expected to be minimal because of the gradual habitat transition (see section 3.4, Wetlands and Riparian Resources) that would occur as a result of the modification of the reservoir. Wetland/riparian vegetation along the perimeter of the reservoir may increase with the enlargement of the reservoir. During Project activities, water availability is unlikely to change from typical conditions below the dam and on the north side of the reservoir because Project activities would coincide with typical seasonal hydrology.

Big Game

Approximately 266 of the 500 acres that would be inundated under the Proposed Action would be considered upland habitat, primarily dominated by big sagebrush. Depending on length and depth of the inundation, this habitat that is designated as crucial for elk and pronghorn may be lost (see section 3.6.1.7 for full discussion of upland habitat lost). However, the loss of habitat is minimal

because there would continue to be thousands of acres of contiguous habitat available to elk and pronghorn in the area.

Raptors
GIS analysis indicates that the golden eagle nests were greater than 0.5 miles away from the nearest Project area, which would be on the Big Sandy Feeder Canal headworks. This meets the distance buffer requirements posted on the website of the Wyoming Ecological Services Field Office (USFWS 2018a). Therefore, there would be no to minimal effect on golden eagles.

Based on GIS analysis and using the same raptor guidelines cited above (USFWS 2018a), modification of the dam would occur within the distance buffer for great horned owls (0.125 miles) and their seasonal buffer (December 1 to September 30). Raptors are protected under the Migratory Bird Treaty Act of 1918 (MBTA). The MBTA prohibits "take", which in summary consists of harming, harassing, killing, etc., of raptors and other bird species. Reclamation first reviewed the potential for "take" from Project activities in conjunction with the Solicitor's opinion from the U.S. Department of Interior (USDOI 2017; hereafter, "M-Opinion") and guidance from USFWS (USFWS 2018b; hereafter "M-Opinion memo'). The M-Opinion memo interprets "the M-Opinion to mean that the MBTA's prohibitions on take apply when the *purpose* of an action is to take migratory birds, their eggs, or their nests. Conversely, the take of birds, eggs, or nests occurring as the result of an activity, the purpose of which is not to take birds, eggs or nests, is not prohibited by the MBTA." The purpose of Project activities on the dam is not to harm, harass, or kill any raptors potentially occupying the nest during Project activity. Thus, the Project activities would not result in "take" under the Migratory Bird Treaty Act of 1918. Therefore, there would be minimal impacts to raptors in the Project area.

Fish
The Project activity with the most potential to affect the fishery is drawing the reservoir down to 6730 feet elevation. However, the volume of water at this elevation would be about 4,000 acre-feet, which is a sufficient amount of water for fish to over-winter. Therefore, the Proposed Action would have no measurable effect on the fishery.

3.6 Threatened, Endangered, and Sensitive Species

During the environmental review process for the Project area, several sources were reviewed to determine the impact of the proposed Project on the Threatened, Endangered, and Sensitive Species. By reviewing the U.S. Fish and Wildlife Service's IPaC website, it was determined there was potential for eight listed species to occur in the Project area: yellow-billed cuckoo (*Coccyzus americanus*), bonytail chub (*Gila elegans*), Colorado pikeminnow (*Ptychocheilus lucius*), humpback chub (*Gila cypha*), razorback sucker (*Xyrauchen texanus*), Ute ladies'-tresses (*Spiranthes diluvialis*), and gray wolf (*Canis lupus*). The gray wolf was removed in an updated list acquired on January 26, 2018 but was still included in this analysis. Wyoming Game and Fish Department's 2016 list of Species of Greatest Conservation Need and the Wyoming Natural Diversity Database were consulted to determine species distribution and occupancy for these and other Sensitive Species. On June 22, 2015, and April 12-13, 2017, Reclamation biologists surveyed the Project area for potential impacts to listed and sensitive species.

3.6.1 Impacts on Threatened, Endangered, and Sensitive Species

3.6.1.1 No Action
Under the No Action Alternative, the Project would not be built, and therefore there would be no effect on Threatened, Endangered, and Sensitive Species.

3.6.1.2 Proposed Action
The proposed Project would not adversely affect Threatened and Endangered Species, and would not significantly impact either Sensitive Species. Individual analyses for each of the species follows, and a full impact summary of all species can be viewed in Table 3-9 below.

3.6.1.3 *Gray Wolf*
The gray wolf is listed as an endangered species under the Endangered Species Act of 1973. Gray wolves were reintroduced to Yellowstone National Park in 1995, and have since spread into northwest Wyoming, with packs also found in Washington, Oregon, Idaho, and Montana. Non-breeding individuals have exhibited exploratory behavior through Utah, Colorado, and Arizona. In Wyoming, gray wolves are considered an experimental, non-essential population (ESA Section 10(j)). There is no designated critical habitat in Wyoming.

The likelihood of a gray wolf occurring within the Project area is low, but possible. The greatest chance of an occurrence is through exploratory dispersal to the northern fringes of the Reservoir, away from areas they already avoid due to human activity such as campers, boaters, fishermen, vehicle traffic, etc. Therefore, no impacts on wolves would be expected as a result of the Proposed Action.

3.6.1.4 *Ute Ladies'-tresses*
Ute ladies'-tresses are a vascular plant species related to orchids. Ute ladies'-tresses flowers every 1-3 years in late summer, with a spiral-type white blossom. Ute ladies'-tresses were federally listed as a threatened species in 1992. The species was petitioned to be de-listed in 2004. Ute ladies'-tresses are not known to occur in western Wyoming, and there are no known populations within ~100 miles of the Project area. The species is unlikely to occur in the Project area. Therefore, the Proposed Action would not impact Ute ladies'-tresses.

3.6.1.5 *Yellow-billed Cuckoo*
The yellow-billed cuckoo uses dense, wooded habitat where water is available nearby. The main prey of the yellow-billed cuckoo is caterpillars. Due to low numbers and the designation of a distinct population segment in the western portion of its range, the species was federally listed as threatened in 2014. There is no suitable habitat in the Project area. Therefore, the Proposed Action would have no impact on the yellow-billed cuckoo.

3.6.1.6 *Four Colorado River Fish*

Four fishes were listed on the IPaC Report (Colorado pikeminnow, humpback chub, razorback sucker, bonytail) in Colorado and/or Utah below Flaming Gorge Dam. The four listed fish species are adapted to a hydrologic cycle characterized by large spring peaks of snowmelt runoff and low, relatively stable base flows (U.S. Fish and Wildlife Service 2002a-d). High spring flows maintain channel and habitat diversity, flush sediments from spawning areas, rejuvenate food production, form gravel and cobble deposits used for spawning, and rejuvenate backwater nursery habitats (U.S. Fish and Wildlife Service 2002a-d).

Colorado Pikeminnow

The Colorado pikeminnow was first included in the List of Endangered Species issued by the Office of Endangered Species on March 11, 1967, and subsequently received protection under the Endangered Species Act of 1973. Critical habitat was designated on March 21, 1994 and includes the entire Green River downstream from the confluence of the Yampa River. Threats to the species include streamflow regulation, habitat modification, competition with and predation by nonnative fish species, and pesticides and pollutants (U.S. Fish and Wildlife Service 2002a).

This large, predatory fish is widely distributed throughout the Upper Colorado River Basin, and recent estimates of abundance indicate the population in the Green River subbasin is on the rise. The largest, most productive and most robust population of Colorado pikeminnow occurs in the mainstem Green River (combining the lower Green River, Desolation/Gray Canyon, and middle Green River populations). Colorado pikeminnow spawn in two principal sites: Gray Canyon in the lower Green River, and the lower Yampa River (U.S. Fish and Wildlife Service 2002a). Bestgen et al. (2018) recognized that the mechanism driving frequency and strength of recruitment events was likely the strength of age-0 Colorado pikeminnow production in backwater nursery habitats. Bestgen and Hill (2016) discovered that declines in summer base flow magnitude were correlated with declining densities of age-0 Colorado pikeminnow.

Humpback Chub

The humpback chub was first included in the List of Endangered Species issued by the Office of Endangered Species on March 11, 1967 and received protection as endangered under the Endangered Species Act of 1973. Critical habitat was designated on March 21, 1994, and included stretches of the Yampa, Colorado, and Green rivers in the Upper Colorado River Basin. The canyon-bound reaches of the Green River between its confluence with the Yampa and Colorado Rivers (Reaches 2 and 3) were designated. Threats to the species include streamflow regulation, habitat modification, predation by nonnative fish species, parasitism, hybridization with other native chubs, and pesticides and pollutants (U.S. Fish and Wildlife Service 2002b). This species is highly adapted to life in canyon environments and shows high site fidelity to cayon-bound reaches of the mainstem river. The Service's 5-year status review of humpback chub completed in 2018 recommended that their listing be reclassified to "Downlist to Threatened" because they were no longer a threat to go extinct throughout all of its range. Current resource conditions are adequate to support the upper and lower basin populations.

Razorback Sucker

The razorback sucker was federally listed as endangered on October 23, 1991 with critical habitat designated March 21, 1994. The entire Green River from its confluence with the Yampa River downstream to its confluence with the Colorado River (Reaches 2 and 3) was included in this designation. There is no critical habitat above the confluence with the Yampa River (Reach 1).

Threats to the species include streamflow regulation, habitat modification, predation by nonnative fish species, and pesticides and pollutants (U.S. Fish and Wildlife Service 2002c). It is found in warm water reaches of the Green River and the lower portions of its major tributaries. It occurs primarily in the low gradient reaches between the confluences of the Yampa and Duchesne Rivers in Reach 2.

Declines in the abundance and distribution of razorback suckers in the Upper Colorado River Basin have been noted for decades (Wiltzius 1978). However, the Service's 5-year status review of razorback sucker completed in 2018 recommended that their listing be reclassified to "Downlist to Threatened" based on the current condition of the eight populations under recent management efforts.

Bonytail

The bonytail was listed as endangered under a final rule published on April 23, 1980. Critical habitat was designated on March 21, 1994 and includes Reaches 2 and 3 of the Green River. Threats to the species include streamflow regulation, habitat modification, predation by nonnative fish species, hybridization, and pesticides and pollutants (U.S. Fish and Wildlife Service 2002d).

Life history requirements of the bonytail are poorly understood; it is considered adapted to main stem rivers where it has been observed in pools and eddies. Bonytail are rarely found in the Green and Upper Colorado River sub-basins and are the rarest of all the endangered fish species in the Colorado River Basin. In fact, no wild, self-sustaining populations are known to exist upstream of Lake Powell. Natural reproduction of bonytail was last documented in the Green River in 1959, 1960, and 1961 (U.S. Fish and Wildlife Service 2002d). However, the middle Green River is currently part of the stocking program area (along with the Yampa River in Dinosaur National Monument). The first reproduction by stocked bonytail was confirmed in floodplain habitats in the Green River in 2015 and again in 2016 (Bestgen et al. 2017).

The Upper Colorado River Endangered Fish Recovery Program is a partnership working to recover the endangered fish of the Upper Colorado River Basin (Recovery Program 1999). The goal of recovery is to achieve natural, self-sustaining populations of the endangered fish so that they no longer require protection under the ESA. Under the Recovery and Implementation Program (RIP) for Endangered Fish Species in the Upper Colorado River Basin, "any water depletions from tributary waters within the Colorado River drainage are considered as jeopardizing the continued existence of these fish." Tributary water is defined as water that contributes to instream flow habitat. Depletion is defined as water that would contribute to the river flow if not intercepted and removed from the system.

Because the four species do not occur in the Project area, no direct effects would be expected as a result of implementing the Proposed Action. However, depleting water in the Green River and its tributaries such as Big Sandy River is a major threat to the recovery of the four endangered fish. Depletions greater than 0.1 AF in the Upper Colorado River Basin are considered to jeopardize the species. Based on the analysis in section 3.3.2.2.1, approximately 955 AF would be lost to evaporation. See Table 3-2 for a summary of predicted evaporation.

Depletions would also be expected due to increased irrigation. Direct irrigation benefits would accrue to local irrigators through a reservoir enlargement as additional supplemental water supply would be available on existing irrigated acreage. The enlargement of Big Sandy Reservoir would have an average annual yield of 2,936 AF.

Applying the conveyance efficiency and on-farm application efficiency, an overall efficiency of 50.4 percent can be expected from the Big Sandy system (Wenck 2017). Applying this efficiency to the average annual yield of 2,936 AF (see section 3.2.3.3), results in 1,480 AF of useable water at the crop through the enlargement of Big Sandy Reservoir. A total of 2,435 AF would be the full average annual depletion (Table 3-7).

Table 3-7 Estimated Water Depletions

Type	Amount (AF)
Evaporation	955
Additional On-farm Use	1,480
Total	2,435

Because the depletions exceed 0.1 AF, Reclamation determined that the Proposed Action may affect, and is likely to adversely affect, the four endangered Colorado River fish. The USFWS issued a Biological Opinion on May 9, 2018 (Appendix B) agreeing with Reclamation's determination of effect. The USFWS determined that the project is not likely to jeopardize the continued existence of the four endangered fish species. In conclusion, although the proposed Project would have an adverse effect on the four endangered Colorado River fish, the Project would not jeopardize the species and therefore would not be significant.

3.6.1.7 *Greater Sage Grouse*

The proposed Big Sandy Reservoir enlargement would raise the existing normal high water mark from 6,757.5 feet to 6,762.5 feet, which would increase the surface area inundated from 2,420.25 to 2,919.32 acres. Of the new area inundated (about 500 acres), 266 acres are currently undisturbed uplands dominated primarily by big sagebrush (*Artemisia tridentata*), a key shrub in the southwest Wyoming's high elevation sagebrush-steppe. Additional acres would be permanently (about 37 acres) or temporarily (up to 265 acres) disturbed during Project activity. Greater sage-grouse are ground-nesting birds that rely on sagebrush (*Artemisia* spp.) in all phases of their life cycle. Sage-grouse nest in thick sagebrush cover but utilize wetlands during much of the brood-rearing period. Wyoming supports the greatest number of sage-grouse of all the states or Canadian provinces in which they occur.

The Wyoming Governor's office developed a map of greater sage-grouse Core Population Areas. Greater Sage-Grouse Executive Order (EO) 2015-4 and supplement EO 2017-2 state that new development or land uses within Wyoming that were designated Core Population Areas should be authorized or conducted only when it can be demonstrated that the activity will not cause declines in greater sage-grouse populations. The entire Big Sandy Reservoir is located within a greater sage-grouse Core Population Area, which required that impacts to greater sage-grouse caused by enlarging the reservoir be evaluated in accordance with the EO.

The EO included a method for determining compliance with the EO for new projects, referred to as the Density and Disturbance Calculation Tool (DDCT). A DDCT analysis conducted for enlarging Big Sandy Reservoir showed that the Project would be in full compliance with the Governor's EO,

as the total proposed and existing disturbance of 3,235 acres would be 3.69 percent of the DDCT analysis area, well below the threshold of 5 percent disturbance. The DDCT analysis conservatively assumed that the 266 acres of sagebrush-dominated uplands around the perimeter of the reservoir would be permanently lost once the reservoir is enlarged (*i.e.*, this area would become devoid of all vegetation). This would be unlikely based on the following analysis.

Current operation of the Big Sandy Reservoir has not resulted in creation of large areas devoid of vegetation around the perimeter of the reservoir. Instead, wetlands occupy much of this area. It is assumed that inundated uplands along the perimeter of the expanded reservoir may also convert to wetlands (beneficial to sage-grouse during the brood-rearing period), rather than become devoid of vegetation. It is also assumed that an analysis of how operation of the existing reservoir, which has allowed wetlands along the perimeter of the reservoir to persist, would relate to operation of the expanded reservoir. The length of inundation as well as the depth of water for existing wetlands under normal high water conditions for a period of record of 21 years (1990-2010) were used in the analysis.

The maximum length of inundation of these wetlands in any given year was 211 days, while the average length of inundation was 53 days. However, if the seven years that wetlands were never inundated are removed, the mean length of inundation was 79 days during years that inundation occurred. The mean length of inundation varied among the 14 years from 16 to 211 days. The approximate depths of inundation also were examined. The average length of time that water was at or above the elevation of 6,754 feet was 53 days. The mean length of time that wetlands at the bottom elevation (6,754 feet) were inundated with 1, 2, 3 and 4 feet of water was 37, 28, 20 and 4 days, respectively. The maximum number of days the wetlands were inundated with 1, 2, 3 or 4 feet of water in any given year was 147, 128, 116 and 48 days, respectively.

Scientific literature (Amlin 2000, Anderson 2008, Brink 1954, CNPS n.d., Dionigi et al. 1985, Hoag et al. 2011, Israelsen 2009, Jeglum 1971, Kuzovkina et al. 2004, Rains et al. 2004, River Partners 2008, St. John et al. 2011, Tilley et al. 2011, USDA 2005, USDA 2006a-b, USDA 2012, USDA 2016) indicates that dominant plant species in the wetlands along the margin of the reservoir would tolerate periodic flooding during times of normal high water levels. Existing wetlands at Big Sandy Reservoir between 6,754 and 6,758 feet have persisted despite an average of up to 79 days of inundation per year, including an average of 20 days per year under > 3 feet of water. Based on analysis of existing wetlands in relation to past high water levels and a review of the literature, all of the wetlands around the reservoir are likely to persist. No loss of PSS wetlands is expected. PEM wetlands also would likely persist, although some changes in species composition would likely occur (*e.g.*, change from grass-dominated to sedge-dominated species). Based on this literature review and analysis, it is likely that new wetlands would form both within and above the new normal high water line of the expanded reservoir, as they would likely be subjected to similar inundation regimes as existing wetlands.

In addition to habitat disturbance described above, sage grouse may be temporarily displaced during Project activities, particularly along the Big Sandy Feeder Canal. Although work would occur using areas that were previously disturbed, noise from machinery may deter sage grouse from using the area adjacent to the canal. However, it would not be expected that sage grouse would leave the area entirely as suitable habitat is found throughout the whole Project area. Conservation measures for sage grouse also include maintaining and stacking topsoil that is removed; re-contouring using the collected topsoil; staging in areas that were previously disturbed; reseeding with an appropriate mix

following recommendations of range specialists (Reclamation, BLM, WGFD, etc.); and control of noxious and/or invasive species such as cheatgrass and/or others listed as nuisance species in Sublette and Sweetwater counties. Reclamation received concurrence from WGFD for the Project (see Appendix C). Based on the minimal loss in sagebrush habitat and the conservation measures that would be implemented to minimize impacts to sage grouse, impacts to sage grouse would be minimal.

Based on the foregoing information, the Project would have minimal effect on sage grouse because 1) the DDCT analysis demonstrated compliance with Wyoming sage grouse executive orders, 2) even the 266 acres that were presumed lost for the DDCT analysis would not actually be entirely converted from upland habitat to wetlands, and 3) other habitat lost through construction disturbance would be mitigated through habitat restoration efforts.

3.6.1.8 *Burrowing Owl*

The Burrowing Owl uses a wide variety of arid and semiarid environments, with well-drained, level to gently sloping areas characterized by sparse vegetation and bare ground. It prefers open prairie, grassland, desert, and shrub-steppe habitats, and may also inhabit agricultural areas. It depends on mammals that dig burrows, particularly prairie dogs and ground squirrels, which it uses for nesting, roosting, and escape. In Wyoming, the highest concentrations of Burrowing Owls are in the south and east, although they occur and breed throughout most of the State. The Burrowing Owl is considered an uncommon summer resident in Wyoming.

Surveys by Reclamation biologists on April 12, 2017, indicated there was no suitable habitat in the Project area. Therefore, the Proposed Action would have no effect on Burrowing Owls.

3.7 Water Rights

The Eden Valley Project uses both direct flow and storage water rights to irrigate 17,009.44 acres of land in the Eden-Farson Area. The direct flow diversions are covered under the Wyoming State Water Right, Permit No. P5718, which has a priority date of November 24, 1903. The water storage in Big Sandy Reservoir is covered under the Wyoming State Water Right, Permit No. P947 Res, which has a priority date of November 9, 1906. Permit No. P947 Res. was originally filed to allow for 104,630 acre-feet of storage, but this water right was reduced when Notice of Completion of Construction was submitted in 1961 showing a reservoir capacity of 39,700 acre-feet.

There is also a secondary Wyoming Water Right, P21403 that ties the water stored under P947 Res to the Eden Valley Project lands. This secondary permit is not required to store or use water in or use water from Big Sandy Reservoir, but instead makes this reservoir's storage water and storage capacity appurtenant to the Eden Valley Project lands.

3.7.1 Impacts on Water Rights

3.7.1.1 No Action
Under the No Action Alternative, the Project would not be built, and therefore there would be no effect on water rights.

3.7.1.2 Proposed Action
The Proposed Action would increase the storage capacity of Big Sandy Reservoir to 52,600 acre-feet which is 12,900 acre-feet above the allowable storage of 39,700 acre-feet under Water Right P947 Res. Therefore, a new application to store water would need to be filed with the Wyoming State Engineer to allow this additional storage volume.

This new water right would have a current day priority date which would make it junior to all existing water rights on the Big Sandy Creek. This subordination would provide legal protection to all existing senior water right holders on Big Sandy Creek from potential impairment that the additional storage in Big Sandy Reservoir may cause. If any interference between senior water right holders and the additional storage is identified, the impaired water users can request the Wyoming State Engineer to put the river system in regulation. Once the Big Sandy Creek is in regulation, water rights would be regulated by priority date and junior storage rights would be curtailed as needed to fully satisfy the senior water rights. This is according to Wyoming water law, which entitles a permitted reservoir to be filled once in priority each year as water is available.

3.8 Grazing

Livestock grazing (mostly cattle and sheep) is common throughout the rangelands of the western U.S. There is currently one livestock operator in the Project area. In 1950, Reclamation obtained a perpetual easement of 380 acres on the private land to "…submerge, seep, flow, silt, flood or otherwise affect with water from whatever source, impounded by the Big Sandy Dam…together with rights of ingress or egress to utilize said rights." (Figure 3-2). Of Reclamation's 380-acre easement, 300 acres are on the northwest side of the reservoir along the river channel. The river channel that could be inundated by the proposed Project (approximately 180 of the 300 acres) is not grazed until ground is frozen (Peter Arambel, pers. comm. 2018), and the remaining acreage on the northwest side of the reservoir (approximately 120 acres) that are outside the river channel would not be inundated. Therefore, the 300 acres on the northwest side of the reservoir are not included in this analysis. At this time, the livestock operator mainly grazes livestock on two 40-acre quarter sections of private land on the northeast side of the reservoir (Peter Arambel, pers. comm. 2018) (Figure 3-3) which is what the analysis in this section will cover. It is important to note that the area surrounding the northeastern edge of the reservoir is currently used heavily by the livestock operator because the forage there is among the most palatable in the area. This is due to the seasonal reservoir levels that provide water for plant communities.

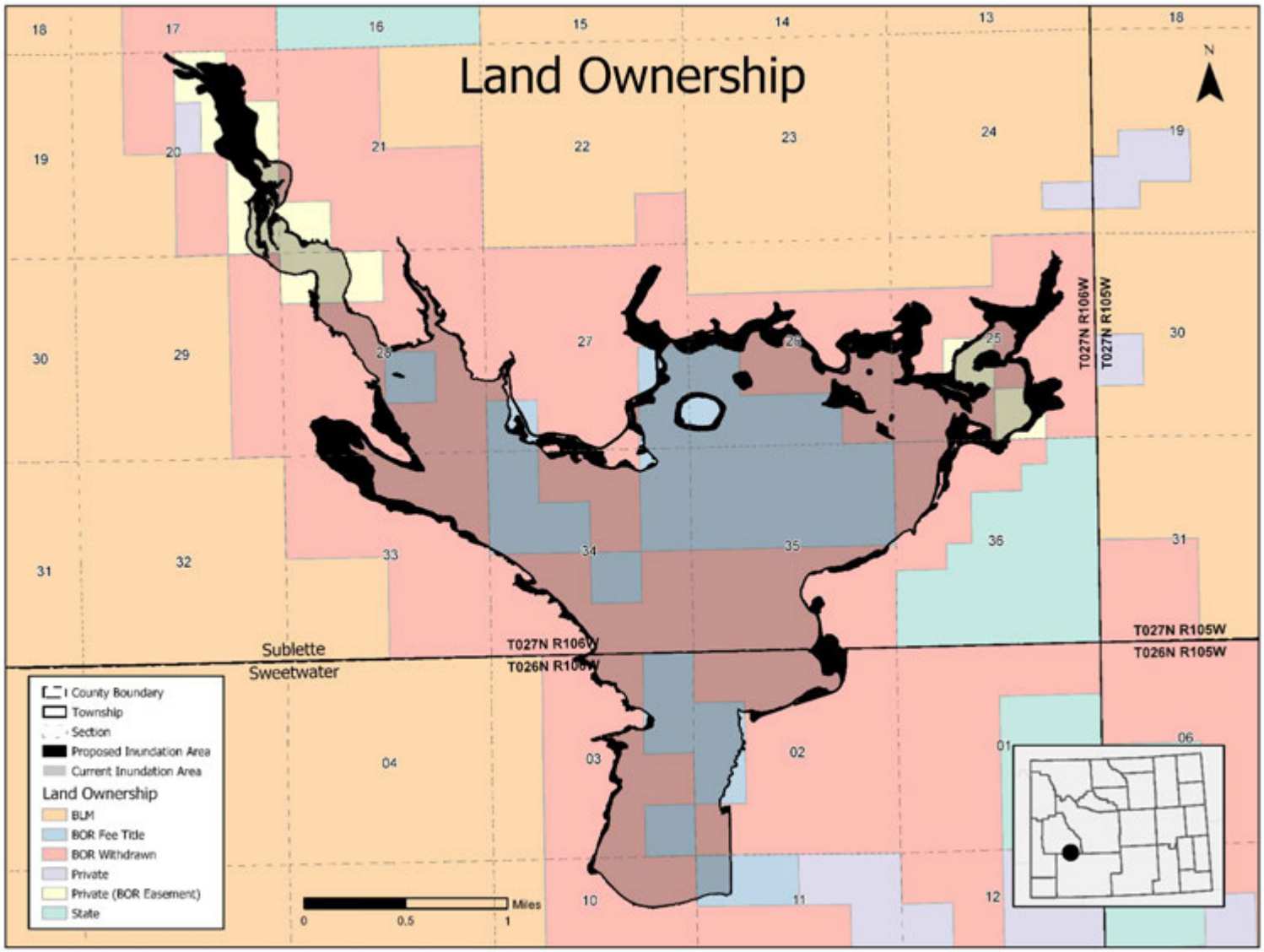

Figure 3-2 Land Ownership of the Project Area

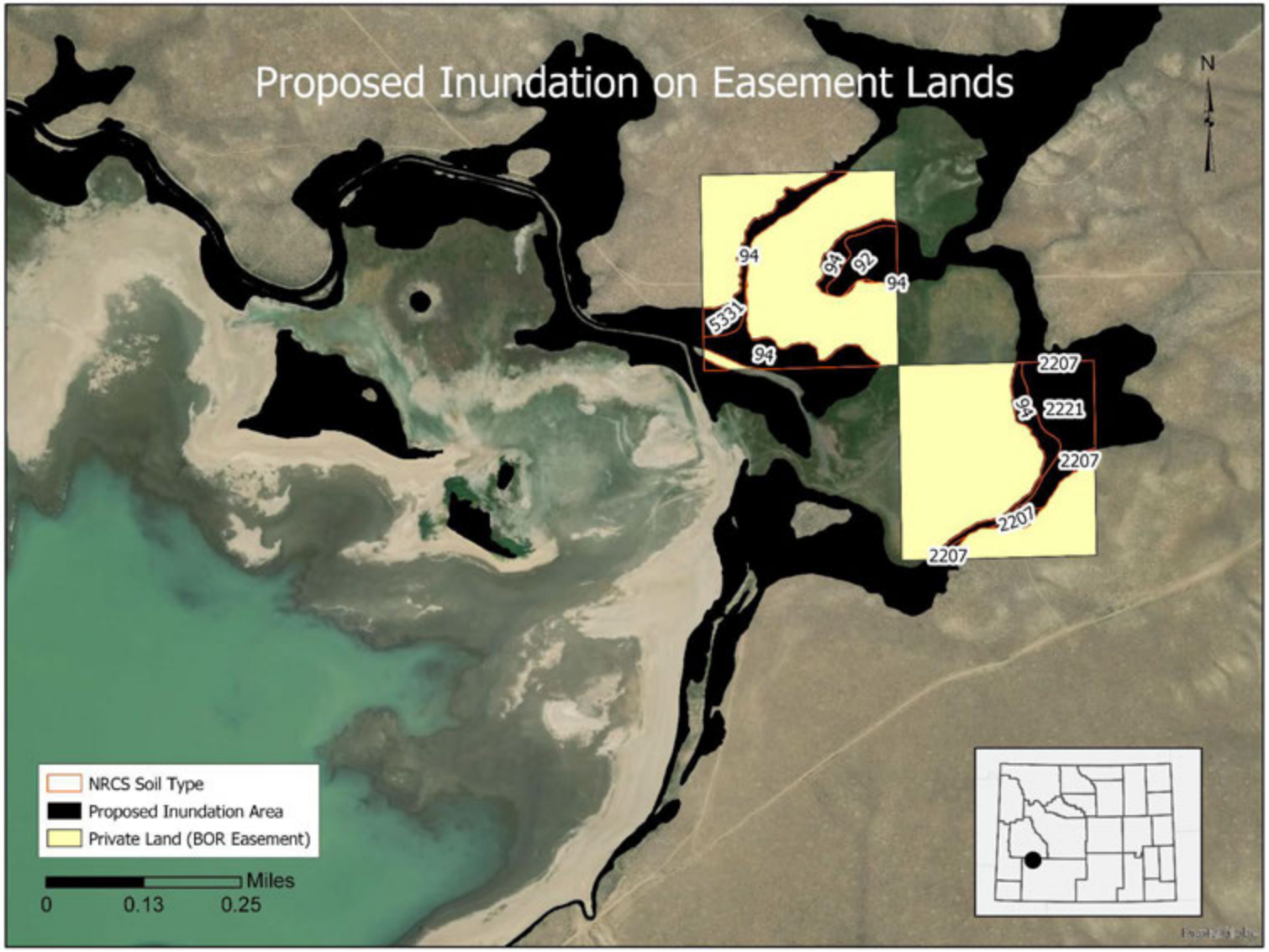

Figure 3-3 Soil Types on Reclamation Easements Partially Inundated by Big Sandy Reservoir

3.8.1 Impacts on Grazing

3.8.1.1 No Action

Under the No Action Alternative, the Project would not be built, and therefore there would be no impact to current grazing operations.

3.8.1.2 Proposed Action

Implementing the Proposed Action has the potential to minimally impact grazing operations. The following analysis quantifies the impacts the Proposed Action could have on the private land. A maximum of 22.2 of the 80 acres would be inundated by raising the spillway crest (Figure 3-3). The period of time that this land would be inundated would vary each year based on water levels. This analysis assumes that the land would be completely submerged all year long, thus inaccessible to grazing. The Natural Resource Conservation Service's (NRCS) web soil survey website was accessed March 20, 2018 to determine what soils occurred in the 22.2 acres (NRCS 2018). Table 3-8 shows the soil name and corresponding map unit symbol, and acres. The NRCS's mapping tool showed 7.96 acres were water, however, 2015 LIDAR data confirmed those areas were in fact not inundated at the current spillway crest elevation of 6757.5 ft.

Table 3-8 shows the estimated amount of dry forage per acre for each soil type based on favorable, normal, and unfavorable water years. To avoid being conservative in estimating potential loss of animal unit months (AUMs), 1) the soil type "water" was assigned the highest productive value of the other soil types, which corresponded to the Sandbranch sandy loam, and 2) the areas that would be inundated by raising the spillway crest were assumed to be permanently lost, i.e., all 22.2 acres. Additional assumptions were taken from Montana State University's Extension Service in order to estimate AUMs (Montana State University, no date). These assumptions included:

1) Only half of the dry forage would be grazed ("take half, leave half" rule)
2) Daily dry matter intake of 150 lb ewe with lamb < 2 months old was 4.5 lbs, totaling 135 lbs per month
3) 0.2 animal unit equivalent for sheep

Table 3-8 Calculating Animal Unit Months (AUMs) on Easement Lands

	A	B	C	D	E	F	G	H	I
1	Soil name	Map unit symbol	Acres	Favorable	Normal	Unfavorable	Favorable	Normal	Unfavorable
2				Estimated lbs dry forage per ac			Actual lbs dry forage per acres by soil type		
3	Ryark-Hawkstone-Cotha complex, 0 to 5 percent slopes	2207	1.18	700	500	300	824	589	353
4	Sandbranch sandy loam, 0 to 2 percent slopes	2221	6.68	850	650	400	5676	4341	2671
5	Sandbranch-Alcova family complex, 1 to 6 percent slopes	5331	3.18	700	500	300	2223	1588	953

6	Worfman-Diamondville sandy loams, 0 to 6 percent slopes	92	3.19	575	425	250	1833	1355	797
7	Water	94	7.96	850	650	400	6770	5177	3186
8	Total	-	22.19	-	-	-	17327	13050	7960
9	AUMs	-	-	-	-	-	12.8	9.7	5.9

There were three steps to the analysis:

1) Calculate lb dry forage for each soil type and climate condition. Results from this step are in Table 3-8, rows 3-7 of columns G-I.
2) Calculate total lb dry forage for the 22.2 acres under each climate condition. Results from this step are in Table 3-8, row 8 of columns G-I.
3) Calculate AUMs by multiplying the result of step 2 by 0.5 (take half leave half), 0.2 (sheep animal unit equivalent), and dividing by 135 (lb dry forage per month for 150 lb ewe). These results are in Table 3-8, row 9 of columns G-I.

Approximately 13 AUMs could be lost under the most favorable climate conditions, or 0.58 AUMs/acre. In the most unfavorable climate scenario, up to 6 AUMs could be lost, or 0.27 AUMs/acre. To compare, a total of 1,857 AUMs are permitted on 18,239 acres of public land surrounding Big Sandy Reservoir (BLM grazing allotment WY13006 Reservoir), equating to 0.10 AUMs/acre (BLM 2018). All 1,857 AUMs are allotted to the single livestock operator whose grazing operations could be affected by the Proposed Action analyzed in this EA. If this analysis had used the 0.10 AUMs/acre used by the BLM for the areas surrounding the reservoir, a maximum of only 2.2 AUMs could be lost due to inundation.

In summary, a maximum of 13 AUMs could be lost if: 1) climate conditions are the most favorable for forage production, 2) the area that would be inundated was permanently lost to grazing, and 3) 7.96 acres currently designated as "water" by the NRCS had the highest forage production value of the nearby soil types. Thus, under the most favorable conditions for forage growth, the current livestock operator would have a decrease of up to 60 sheep in a maximum permitted herd size of more than 9,000 sheep in the surrounding BLM grazing allotment. Therefore, based on this analysis, there could be a minimal overall effect to grazing operations if the Proposed Action were implemented.

3.9 Socioeconomics

The analysis in this section is broken into short- and long-term economic effects. Short-term economic effects are addressed first, on a local and relatively qualitative basis due to the lack of details available on the economy of the Farson/Eden area. Long-term economic effects covers the long-term direct and indirect irrigation benefits relative to Project costs, resulting in a simple cost-benefit ratio for the Project. Long-term economic effects are considered at more of a regional scale than a local scale.

The Project area covers two counties: Sublette and Sweetwater. "County Region" in Table 3-9 and Table 3-10 combines statistics from Sublette and Sweetwater Counties.

Table 3-9 Population in Sublette and Sweetwater Counties, Wyoming

Population, 2010*-2015*

	Sweetwater County, WY	Sublette County, WY	County Region	U.S.
Population (2015*)	44,772	10,117	54,889	316,515,021
Population (2010*)	42,266	9,322	51,588	303,965,272
Population Change (2010*-2015*)	2,506	795	3,301	12,549,749
Population Percent Change (2010*-2015*)	5.9%	8.5%	6.4%	4.1%

* ACS 5-year estimates used. 2015 represents average characteristics from 2011-2015; 2010 represents 2006-2010.

The estimated population of Sublette County in 2015 was 10,117 individuals (Table 3-9) (U.S. Department of Commerce 2016). Median household income in 2015 was $81,772 with per capita income estimated to be $33,193, and 8.1 percent of individuals in poverty. Approximately 95 percent of people in Sublette County obtained a high school degree or higher (U.S. Department of Commerce 2016). The largest type of employment in Sublette County in 2016 was government-related positions at 17.7 percent, followed by mining (15.0 percent) and construction (10.1 percent) (U.S. Department of Commerce 2017; see Table 3-10).

Table 3-10 Employment by Industry in Sublette County

Employment by Industry, 2001-2016

	2001	2005	2010	2016	Change 2010-2016
Total Employment (number of jobs)	4,192	5,771	8,155	6,398	-1,757
Non-services related	~1,395	2,274	3,611	~2,262	-~1,349
Farm	409	392	428	480	52
Forestry, fishing, & ag. services	81	93	119	~100	-~19
Mining (including fossil fuels)	431	846	1,905	961	-944
Construction	467	847	1,074	647	-427
Manufacturing	~7	96	85	74	-11
Services related	~1,890	~2,458	~3,140	~2,727	-~413
Utilities	na	30	36	26	-10
Wholesale trade	~40	29	73	33	-40
Retail trade	427	494	535	508	-27
Transportation and warehousing	85	141	341	261	-80
Information	46	74	45	29	-16
Finance and insurance	63	105	113	140	27
Real estate and rental and leasing	173	290	431	452	21
Professional and technical services	224	263	328	254	-74
Management of companies and enterprises	~4	~4	~9	~7	-~2
Administrative and waste services	~158	~201	~292	~208	-~84
Educational services	na	na	na	na	na
Health care and social assistance	na	na	na	na	na
Arts, entertainment, and recreation	85	82	113	~100	-~13
Accommodation and food services	385	499	527	~429	-~98
Other services, except public administration	200	246	297	280	-17
Government	702	851	1,123	1,135	12
Percent of Total					% Change 2010-2016
Total Employment					-21.5%
Non-services related	~33.3%	39.4%	44.3%	~35.4%	-~37.4%
Farm	9.8%	6.8%	5.2%	7.5%	12.1%
Forestry, fishing, & ag. services	1.9%	1.6%	1.5%	~1.6%	-~16.0%
Mining (including fossil fuels)	10.3%	14.7%	23.4%	15.0%	-49.6%
Construction	11.1%	14.7%	13.2%	10.1%	-39.8%
Manufacturing	~0.2%	1.7%	1.0%	1.2%	-12.9%
Services related	~45.1%	~42.6%	~38.5%	~42.6%	-~13.2%
Utilities	na	0.5%	0.4%	0.4%	-27.8%
Wholesale trade	~1.0%	0.5%	0.9%	0.5%	-54.8%
Retail trade	10.2%	8.6%	6.6%	7.9%	-5.0%
Transportation and warehousing	2.0%	2.4%	4.2%	4.1%	-23.5%
Information	1.1%	1.3%	0.6%	0.5%	-35.6%
Finance and insurance	1.5%	1.8%	1.4%	2.2%	23.9%
Real estate and rental and leasing	4.1%	5.0%	5.3%	7.1%	4.9%
Professional and technical services	5.3%	4.6%	4.0%	4.0%	-22.6%
Management of companies and enterprises	~0.1%	~0.1%	~0.1%	~0.1%	-~22.2%
Administrative and waste services	~3.8%	~3.5%	~3.6%	~3.3%	-~28.8%
Educational services	na	na	na	na	na
Health care and social assistance	na	na	na	na	na
Arts, entertainment, and recreation	2.0%	1.4%	1.4%	~1.6%	-~11.5%
Accommodation and food services	9.2%	8.6%	6.5%	~6.7%	-~18.6%
Other services, except public administration	4.8%	4.3%	3.6%	4.4%	-5.7%
Government	16.7%	14.7%	13.8%	17.7%	1.1%

All employment data are reported by *place of work*. Estimates for data that were not disclosed are indicated with tildes (~).

The estimated population of Sweetwater County in 2015 was 44,772 individuals (U.S. Department of Commerce 2016). Median household income in 2014 was $69,022 with per capita income estimated to be $30,568, and 8.6 percent of individuals in poverty. The civilian labor force accounts for 72.6 percent of all individuals in Sweetwater County. Approximately 91 percent of people in Sweetwater County obtained a high school degree or higher (U.S. Department of Commerce 2016). The largest industry (by number of jobs) in Sweetwater County is mining, which accounted for 17.3 percent of jobs in 2016, closely followed by government positions which accounted for 17.2 percent of all jobs in Sweetwater County (Table 3-11) (U.S. Department of Commerce 2017).

Table 3-11 Employment by Industry in Sweetwater County

Employment by Industry, 2001-2016

	2001	2005	2010	2016	Change 2010-2016
Total Employment (number of jobs)	24,199	27,180	29,316	27,917	-1,399
Non-services related	~8,463	8,947	~9,685	~8,596	-~1,089
Farm	201	222	266	279	13
Forestry, fishing, & ag. services	~35	39	~61	~43	-~18
Mining (including fossil fuels)	~5,011	5,158	5,784	4,827	-957
Construction	1,798	2,284	2,204	1,960	-244
Manufacturing	1,418	1,244	1,370	1,487	117
Services related	~11,516	~12,826	~13,533	~13,277	-~256
Utilities	na	na	na	na	na
Wholesale trade	na	na	na	na	na
Retail trade	2,846	3,044	2,877	2,804	-73
Transportation and warehousing	1,123	1,469	1,655	1,432	-223
Information	253	257	247	181	-66
Finance and insurance	548	563	711	704	-7
Real estate and rental and leasing	721	1,008	1,238	1,280	42
Professional and technical services	581	665	862	762	-100
Management of companies and enterprises	72	75	92	126	34
Administrative and waste services	795	814	743	600	-143
Educational services	89	129	124	135	11
Health care and social assistance	1,105	1,177	1,286	1,526	240
Arts, entertainment, and recreation	254	~228	260	234	-26
Accommodation and food services	2,094	2,314	2,275	2,404	129
Other services, except public administration	1,035	1,083	1,163	1,089	-74
Government	4,213	4,266	4,821	4,790	-31
Percent of Total					% Change 2010-2016
Total Employment					-4.8%
Non-services related	~35.0%	32.9%	~33.0%	~30.8%	-~11.2%
Farm	0.8%	0.8%	0.9%	1.0%	4.9%
Forestry, fishing, & ag. services	~0.1%	0.1%	~0.2%	~0.2%	-~29.5%
Mining (including fossil fuels)	~20.7%	19.0%	19.7%	17.3%	-16.5%
Construction	7.4%	8.4%	7.5%	7.0%	-11.1%
Manufacturing	5.9%	4.6%	4.7%	5.3%	8.5%
Services related	~47.6%	~47.2%	~46.2%	~47.6%	-~1.9%
Utilities	na	na	na	na	na
Wholesale trade	na	na	na	na	na
Retail trade	11.8%	11.2%	9.8%	10.0%	-2.5%
Transportation and warehousing	4.6%	5.4%	5.6%	5.1%	-13.5%
Information	1.0%	0.9%	0.8%	0.6%	-26.7%
Finance and insurance	2.3%	2.1%	2.4%	2.5%	-1.0%
Real estate and rental and leasing	3.0%	3.7%	4.2%	4.6%	3.4%
Professional and technical services	2.4%	2.4%	2.9%	2.7%	-11.6%
Management of companies and enterprises	0.3%	0.3%	0.3%	0.5%	37.0%
Administrative and waste services	3.3%	3.0%	2.5%	2.1%	-19.2%
Educational services	0.4%	0.5%	0.4%	0.5%	8.9%
Health care and social assistance	4.6%	4.3%	4.4%	5.5%	18.7%
Arts, entertainment, and recreation	1.0%	~0.8%	0.9%	0.8%	-10.0%
Accommodation and food services	8.7%	8.5%	7.8%	8.6%	5.7%
Other services, except public administration	4.3%	4.0%	4.0%	3.9%	-6.4%
Government	17.4%	15.7%	16.4%	17.2%	-0.6%

All employment data are reported by *place of work*. Estimates for data that were not disclosed are indicated with tildes (~).

Long-term Economic Analysis

A comprehensive economic analysis for the Big Sandy Enlargement is contained in Big Sandy Reservoir Enlargement Level II, Phase I Study Final Report prepared by Wenck Associates for the Wyoming Water Development Commission in 2017 (Wenck 2017). This study was updated in a technical memo by Wenck in March 2020 (Wenck 2020) to reflect Reclamation's finding that implementing the Project would have no discernible effect on recreation activities in the Project area, thus indicating that the Project would have no measurable economic benefit from recreation activities. This portion of the socioeconomic analysis is therefore limited to long-term economic effects to direct and indirect irrigation benefits.

Direct Irrigation Benefits
Included in the evaluation of direct irrigation benefits in the Wenck (2020) technical memo is delivery efficiency consideration, cropping patterns, anticipated increased production quantities, valuation of increased crop production, and the marginal increase in production costs. It should be noted that in addition to the enlarged storage, more carry-over storage through the winter to allow earlier and more reliable irrigation start-up is also expected. Because of the difficulty in determining the economic value of this benefit, it was not calculated, but it would likely have a positive impact.

Indirect Irrigation Benefits
Indirect benefits, often referred to as secondary benefits, stem from the multiplier effect of new sources of income in a regional economy. For the Project, the availability of additional irrigation water would allow irrigators to increase crop production, thus increasing their income. Much of that increased income would be spent in the region, causing income to grow in other sectors of the local economy. This indirect income growth would also be a benefit attributable to the Project.

3.9.1 Impacts on Socioeconomics

3.9.1.1 No Action
Under the No Action Alternative, the Project would not be built, and therefore there would be no effects to socioeconomics.

3.9.1.2 Proposed Action

3.9.1.2.1 Short-Term Economic Effects
Under the Proposed Action short-term economic effects are anticipated to occur in the local area. Project activity is expected to last from July or August until completion in April or May of the following year. This action would bring an influx of Project activity and would provide opportunities for the community to meet the demands of the individuals engaged in the Project activities.

During Project activity there would be an uptick in economic activity as contractors purchase food, fuel, and other amenities from local vendors. Because local lodging options may be inadequate in number to accommodate the influx of workers needed to complete the Project, local trailer courts may see additional activity, or additional traffic on Highway 191 between the Project site and Rock Springs.

There are limited sources for a broad range of materials in the area, but earthen materials may be taken from local borrow areas or trucked in from other areas, based on suitability and economic viability of these resources. There may also be positions on Project crews that could be filled by local individuals, but this socioeconomic analysis does not mandate the use of local resources.

3.9.1.2.2 Long-Term Economic Effects
The annual benefit for direct and indirect irrigation was estimated at $241,662 and $393,909, respectively. The present value of the direct irrigation benefits was calculated to be $8.5 million, and the present value of the indirect irrigation benefits was calculated to be $13.8 million. With a total

estimated Project benefit of $22.2 million and an estimated Project cost of $14.1 million, the Project benefit/cost ratio is approximately 1.57.

3.9.1.3 *Conclusion*

As stated above, there would be no significant economic effects, whether short- or long-term. However, what economic effects there are would be beneficial.

3.10 Paleontological Resources

The Area of Potential Effect (APE) is located within the Green River Formation, which is a sedimentary geologic unit known to have a very high potential for paleontological material. Paleo Solutions, Inc. (Paleo Solutions) was hired to assess the Project's impact on paleontological resources within the APE. Kate D. Zubin-Stathopoulos, M.S., and Madeline M. Kelley, M.S., led by principal investigator Paul C. Murphey, Ph.D., performed a field assessment of the direct APE from June 22 – 24, 2018 (Zubin-Stathopoulos 2018). A total of three non-significant fossil localities and one significant fossil locality were identified during the field assessment.

The non-significant localities included partial fish fossils (*Actinopterygii* undetermined) and petrified wood. The significant locality, located outside the direct APE, included 11 different individual partial fish skeletons preserved on a single bedding plane comprising *Clupeomorpha*, *Diplomystus,* and *Knightias* species. The fossils, located on Reclamation withdrawn lands, were collected during the field assessment and have been sent to the Utah Field House Museum of Natural History to be curated with Reclamation's other collections.

3.10.1 Impacts on Paleontological Resources

3.10.1.1 No Action

Under the No Action Alternative, there would be no adverse effects to paleontology. There would be no need for ground disturbance associated with Project activities at the dike or Dam, and there would be no inundation of new areas. Existing conditions would continue.

3.10.1.2 Proposed Action

Under the Proposed Action Alternative, ground disturbing activities would have a low potential to disturb subsurface fossil material. First, because the most extensive ground disturbance, by the proposed borrow area, occurs in an area without bedrock exposure. The borrow area is made up of sand lying on the re-worked Green River Formation to about four feet under present ground surface, which is not conducive for significant, intact fossils (Zubin-Stathopoulos 2018: 17). Second, visual inspection of the cliff face by the proposed spillway modification did not indicate fossils were present. Only a single fossil local was located near the spillway modification, and it was not significant. Third, the non-significant fossil localities were isolated occurrences and not extensive sites.

Thus, "No further paleontological surveys or monitoring are recommended based on the current Project description and known construction impacts" (Zubin-Stathopoulos 2018: 25). No mitigation measures were recommended for the significant fossil locality because the locality is

sufficiently distant from the APE, including the proposed borrow area where ground disturbing activities may occur, and the fossils at the locality have been collected. Consequently, the potential for effects is minimal.

3.11 Cultural Resources

Under 36 CFR Part 800 cultural resources are defined as physical or other expressions of human activity or occupation that are over 50 years in age. Such resources include culturally significant landscapes, prehistoric and historic archaeological sites as well as isolated artifacts or features, traditional cultural properties, Native American and other sacred places, and artifacts and documents of cultural and historic significance.

Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA), mandates that Reclamation take into account the potential effects of a proposed Federal undertaking on historic properties. Section 106 defines historic properties as any prehistoric or historic district, site, building, structure, or object included in, or eligible for, inclusion in the National Register of Historic Places (NRHP). Potential effects of the described alternatives on historic properties are the primary focus of this analysis.

In compliance with the regulations specified in Section 106 of the NHPA (36 CFR 800.16), the affected environment for cultural resources is identified as the APE. The APE is defined as the geographic area within which federal actions may directly or indirectly cause alterations in the character or use of historic properties. The APE for the Proposed Action includes the area that could be physically affected by any of the proposed alternatives (the maximum limit of disturbance). The indirect APE includes areas where changes in the visual setting of historic properties could be caused by the Project. This is often assessed through a view shed analysis. A view shed analysis examines whether the project makes a significant change to a historic property's setting due to changes in the surrounding visible from the historic property.

A Class I literature review, a Class III cultural resource inventory (*i.e.*, pedestrian field survey), a shovel-testing program for subsurface deposits, and a visual analysis for affected sites were completed by Reclamation archaeologist, Dr. Zachary Nelson as part of Reclamation's good faith effort to identify historic properties. A total of 1,154.42 acres were inventoried during the Class III inventory to determine if the Proposed Action would affect cultural resources and the nature of the effect.

In general, cultural resources around the Big Sandy Reservoir consist of prehistoric and historic sites situated along the Big Sandy River. Some previously identified prehistoric sites were located immediately adjacent to the river and were flooded when the reservoir was initially filled. Other prehistoric sites were located on the upper terraces of the river basin and have been marginally impacted by the reservoir, primarily because of erosion related to wave action as the sandy soil erodes into the reservoir bringing the archaeological site with it. Prehistoric peoples were attracted to the basin because of the presence of water, fish, and game; but also because of natural outcrops of cobbles exposed along the southern side of the extent reservoir. These river-worn cobbles consist of medium to high-grade tool material that was used for making arrowheads, scrapers, and other tools.

Historic use of the area includes emigrants moving through the area, sheep and cattle grazing, and farming. Emigrants moving through Wyoming to Oregon (or other locales) could cross the Big

Sandy River four miles south of the reservoir via the Oregon-California-Mormon Pioneer-Pony Express trails or they could take the Sublette Cutoff immediately south of the reservoir. Settlers of Eden and Farson, Wyoming, grazed herds and/or farmed the sagebrush steppe and acquired goods via wagon roads, such as the New Fork Wagon Road, that connected the small communities. Because of the lack of rainfall in the area, large irrigation networks were created to move water to farms. The Eden Canal diverts off the Big Sandy River north of the APE and brings water to the Eden-Farson irrigation network, but it does not have water reserves for drought years.

Consequently, Reclamation was authorized by Congress to "reclaim" the land for agricultural purposes under the Colorado River Storage Project Act of April 11, 1956 (70 Stat. 105), as amended. Accordingly, the Eden Project (servicing the towns of Eden and Farson, Wyoming) was built by Reclamation which includes the Big Sandy Dam and Dike, the Eden Reservoir, a network of canals, drains, and other facilities. Work began on the project in 1941 with labor from the Civilian Conservation Corps (CCC) but was halted during World War II. After the war, the project was completed, and the responsibility to operate and maintain the project was transferred to the EVIDD.

3.11.1 Impacts on Cultural Resources

3.11.1.1 No Action

Under the No Action Alternative, the Project would not be built, and therefore there would be no adverse effects to cultural resources. Existing conditions would continue.

3.11.1.2 Proposed Action

The proposed action would cause an alteration to the characteristics of the eligible sites that make them important and would, therefore, have an adverse effect on historic properties according to 36 CFR 800.16(i). However, the adverse effect would not be considered significant under NEPA with implementation of mitigation developed through the Memorandum of Agreement (MOA; see Appendix G). The Class I and Class III inventories identified the prehistoric and historic sites in Table 3-12.

Table 3-12 Historic and prehistoric sites from the Class I and III inventories

ID	Description	Evaluation	Project Effect under NHPA
48SU1	Open Camp	Inundated by Reservoir	None
48SU2	Lithic Landscape/Open Camp	Eligible	Possible Adverse Effect- Long-term erosion;
48SU3	Open Camp	Unevaluated	None – Outside
48SU4	Open Camp	Inundated by Reservoir	None
48SU5	Open Camp	Not Eligible	No Adverse Effect- Long-term erosion
48SU6	Open Camp (=48SU5327)	Not Eligible	No Adverse Effect- Long-term erosion
48SU7	Open Camp	Not Eligible	None

ID	Description	Evaluation	Project Effect under NHPA
48SU101	Davis 1950's Survey Unit 2 (includes sites 48SU5, 48SU6, 48SU7, 48SU5214, 48SU5328, and 48SU5327)	Not Eligible	None
48SU102	Lithic Landscape/Open Camp	Not Eligible	None
48SU103	Davis 1950's Survey Unit 4 (includes sites 48SU1 and 48SU102)	Not Eligible	None
48SU104	Davis 1950's Survey Unit 3 (includes sites 48SU2, 48SU5322, 48SU5326, and 48SU5202)	Not Eligible	None
48SU105	Davis 1950's Survey Unit 5 (no sites)	Not Eligible	None
48SU106	Davis 1950's Survey Unit 1 (includes site 48SU5325)	Not Eligible	None
48SU1334	Yellow Point Ridge Archaeological Landscape Area	Not Eligible	None
48SU3546	Eden Canal (=48SW9110)	Eligible	Adverse
48SU5325	Historic debris	Not Eligible	None
48SU5328	Prehistoric Open Camp	Eligible	No Adverse Effect-Long-term erosion
48SU7646	Big Sandy Dam and Dike (=48SW19744)	Eligible	Adverse
48SU7670	Prehistoric Lithic Scatter	Not Eligible	None
48SW1	Lithic Scatter	Inundated by Reservoir	None
48SW2	Lithic Scatter	Inundated by Reservoir	None
48SW3	Open Camp	Destroyed by reservoir	None
48SW4	Open Camp	Inundated by Reservoir	None
48SW6	Burial – Previously removed	Location Destroyed by initial dam construction	None
48SW103	Davis 1950's Survey Unit 6 (includes site 48SW3)	Not Eligible	None
48SW104	Paleontological – Previously removed	Location Destroyed by initial dam construction	None
48SW9110	Eden Canal (=48SU3546)	Eligible	Adverse
48SW19744	Big Sandy Dam and Dike (=48SU7646)	Eligible	Adverse

In accordance with 36 CFR 800.4, these sites were evaluated for significance in terms of NRHP eligibility. The significance criteria applied to evaluate cultural resources are defined in 36 CFR 60.4 as follows:

The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association and

1. that are associated with events that have made a significant contribution to the broad patterns of our history; or

2. that are associated with the lives of persons significant in our past; or

3. that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

4. that have yielded, or may be likely to yield, information important in prehistory or history.

Based upon these considerations, Reclamation has determined that Site 48SU2 and 48SU5328 are eligible for inclusion into the NRHP under Criterion D because of the presence of intact subterranean features which can potentially provide important information about the past.

Against this background of prehistoric and historic uses, the Proposed Action would result in generally minimal adverse effects to cultural resources because most of the effects are outside of the proposed inundation area. The Project could cause erosion along the edges of a few prehistoric sites, but this is potentially a minimal effect because no known features have been identified along those edges. However, as part of the stipulations of the MOA with the SHPO to avoid, minimize, or mitigate these adverse effects, Reclamation would monitor these sites for ten years at the end of the irrigation season to determine whether the sites were being damaged. In addition, Reclamation would monitor other nearby sites including 48SU5, 48SU6, 48SU7 and 48SU7670 for a period of 10 years. Should archaeological features, such as hearths, be noticed during monitoring, then individual treatment plans would be developed to mitigate the feature. Site 48SU2 could be impacted by erosion caused by the higher water level, therefore Reclamation would develop and implement a treatment plan for this site as detailed in the MOA.

Historic sites 48SU3546/48SW9110 (Eden Canal) and Site 48SU7646/48SW19744 (Big Sandy Dam and Dike) are also determined to be eligible for inclusion into the NRHP under Criterion A because they are associated with broad patterns in regional history (irrigation). The Project would replace portions of the historic features of the Eden Canal, such as an intake and drop structures. The MOA details stipulations to avoid, minimize, and mitigate the adverse effect of the Project on these eligible sites.

The modification of the Big Sandy spillway, including a five foot raise, is a noticeable change in the visual aspects of the historic dam, but this adverse effect to Site 48SU7646/48SW19744 will be mitigated through the application of the stipulations in the MOA.

In order to assess the eligible historic linear sites of the project, individual linear sites were analyzed for possible disruption in their view sheds. The linear sites identified as being close to the project include: Site 48SU1408 (New Fork Wagon Road), 48SU3508 (Historic Automobile Road), 48SW827 (Emigrant Trail), 48SW1841 (Sublette Cutoff-California Trail), and a road noted as the "Abandoned Rock Springs – Pinedale Highway" on historic maps (which was not recorded by Reclamation due to being well outside of the APE and inventory area).

The view shed analysis shows that the increased water level will not be readily discernible from the linear sites. The additional water is only appreciable at the edges of the reservoir, approximately one mile and more from the closest mapped location of the sites. Even though more water could be added to the reservoir, this is a potentially minimal impact because the difference in view is slight,

even for the closest site, Site 48SW1841. The Project would therefore have no adverse effect on Site 48SW1841, Site 48SU1408 (New Fork Wagon Road), 48SU3508 (Historic Automobile Road), 48SW827 (Emigrant Trail), and the "Abandoned Rock Springs – Pinedale Highway".

As required by 36 CFR Part 800, the cultural resource report detailing these finding was submitted to the Wyoming SHPO. The Wyoming SHPO concurred with Reclamation's determinations on September 28, 2018 (see Appendix F). As mentioned above, a MOA was developed to detail the steps to mitigate the adverse effects to the Big Sandy Dam (Site 48SU7646/48SW19744) and 48SU2. The MOA was signed by Reclamation, SHPO, and interested parties (see Appendix G.

In addition, in compliance with 36 CFR 800.4(dX2) and 36 CFR 800.11(e), a copy of the cultural resource inventory report and a determination of historic properties affected was submitted to the Wyoming SHPO, the Advisory Council on Historic Preservation (ACHP), and tribes which may attach religious or cultural significance to historic properties possibly affected by the Proposed Action for consultation.

3.12 Indian Trust Assets

Indian Trust Assets (ITAs) are legal interests in property held in trust by the United States for Indian tribes or individuals. The Department of the Interior's policy is to recognize and fulfill its legal obligations to identify, protect, and conserve the trust resources of federally recognized Indian tribes and tribal members, and to consult with tribes on a government-to-government basis whenever plans or actions affect tribal trust resources, trust assets, or tribal safety (see Departmental manual, 512 DM 2). Under this policy, as well as Reclamation's ITA policy, Reclamation is committed to carrying out its activities in a manner which avoids adverse impacts to ITAs when possible, and to mitigate or compensate for such impacts when it cannot. All impacts to ITAs, even those considered to not be significant, must be discussed in the trust analyses in NEPA compliance documents and appropriate compensation or mitigation must be implemented.

Trust assets may include lands, minerals, hunting and fishing rights, traditional gathering grounds, and water rights. Impacts to ITAs are evaluated by assessing how the action affects the use and quality of ITAs. Any action that adversely affects the use, value, quality or enjoyment of an ITA is considered to have an adverse impact to the resources.

Dr. Zachary Nelson conducted a review of the Current American Indian/Alaska Native/Native Hawaiian Areas (AIANNH) National Shapefile which indicated that no Indian Trust Assets (ITAs) were located near the Project area. This review occurred on August 10, 2018.

There are no known ITAs in the Project area vicinity and the tribes that were consulted did not indicate the presence of any ITAs. Therefore, there could not be any effect on ITAs from the No Action or Proposed Action alternatives.

3.13 Environmental Justice

Executive Order 12898 established Environmental Justice as a Federal agency priority to ensure that minority and low-income groups or Indian tribes are not disproportionately affected by Federal

actions. The Environmental Protection Agency (EPA) generally suggests that a minority, low-income, or American Indian group (collectively, "EJ populations") is present in the Project area if one or more of the groups represents at least 50 percent of the larger population or if the group is more than 10 percentage points higher than the reference population.

Big Sandy Reservoir is located in Sweetwater and Sublette Counties. The estimated population in both counties together totaled 54,889 in 2015 (U.S. Department of Commerce 2016). Those identifying as white accounted for 92.8 percent of the populations. Those who identified as two or more races accounted for the next highest percentage (3.4 percent), followed by those identifying as some other race not listed Table 3-13.

Table 3-13 Population by Race in Sublette and Sweetwater Counties, Wyoming

Population by Race, 2015*

	Sweetwater County, WY	Sublette County, WY	County Region	U.S.
Total Population	44,772	10,117	54,889	316,515,021
White alone	41,250	9,681	50,931	232,943,055
Black or African American alone	±388	±0	±388	39,908,095
American Indian alone	±269	±3	±272	2,569,170
Asian alone	±384	±53	±437	16,235,305
Native Hawaiian & Other Pacific Is. alone	±229	±2	±231	546,255
Some other race alone	±754	±12	±766	14,865,258
Two or more races	1,498	366	1,864	9,447,883
Percent of Total				
White alone	92.1%	95.7%	92.8%	73.6%
Black or African American alone	±0.9%	±0.0%	±0.7%	12.6%
American Indian alone	±0.6%	±0.0%	±0.5%	0.8%
Asian alone	±0.9%	±0.5%	±0.8%	5.1%
Native Hawaiian & Other Pacific Is. alone	±0.5%	0.0%	±0.4%	0.2%
Some other race alone	1.7%	±0.1%	1.4%	4.7%
Two or more races	3.3%	3.6%	3.4%	3.0%

* The data in this table are calculated by ACS using annual surveys conducted during 2011-2015 and are representative of average characteristics during this period.

In 2015, approximately 11.5 percent of individuals and 8.6 percent of families were living below the Federal poverty level, both of which were lower than the U.S. averages of 15.5 percent (individuals) and 11.3 percent (families). Of those individuals below the poverty level in Sweetwater County, 12.1 percent self-identified as a minority race compared to 39.4 percent for the U.S. (U.S. Department of Commerce 2016) (Table 3-14).

Table 3-14 Poverty by Race and Ethnicity in Sublette and Sweetwater Counties, Wyoming

Poverty by Race and Ethnicity^, 2015*

	Sweetwater County, WY	Sublette County, WY	County Region	U.S.
Total Population (all races) in Poverty	5,058	¨812	5,870	47,749,043
White alone	4,445	¨812	5,257	28,923,918
Black or African American alone	¨**108**	¨**0**	¨**108**	10,321,254
American Indian alone	¨**185**	¨**0**	¨**185**	702,127
Asian alone	¨**33**	¨**0**	¨**33**	2,000,884
Native Hawaiian & Oth.Pacific Is. alone	¨**0**	¨**0**	¨**0**	111,137
Some other race	¨**64**	¨**0**	¨**64**	3,865,363
Two or more races	¨223	¨**0**	¨223	1,824,360
All Ethnicities in Poverty				
Hispanic or Latino (of any race)	¨1,678	¨**33**	¨1,711	12,915,617
Not Hispanic or Latino (of any race)	3,107	¨779	3,886	20,750,471
Percent of Total**				
White alone	87.9%	¨100.0%	89.6%	60.6%
Black or African American alone	¨**2.1%**	¨**0.0%**	¨**1.8%**	21.6%
American Indian alone	¨**3.7%**	¨**0.0%**	¨**3.2%**	1.5%
Asian alone	¨**0.7%**	¨**0.0%**	¨**0.6%**	4.2%
Native Hawaiian & Oth.Pacific Is. alone	¨**0.0%**	¨**0.0%**	¨**0.0%**	0.2%
Some other race	¨**1.3%**	¨**0.0%**	¨**1.1%**	8.1%
Two or more races	¨4.4%	¨**0.0%**	¨3.8%	3.8%
Hispanic or Latino (of any race)	¨33.2%	¨**4.1%**	¨29.1%	27.0%
Not Hispanic or Latino (of any race)	61.4%	¨95.9%	66.2%	43.5%

^ Percent of total population in poverty by race and ethnicity is calculated by dividing the number of people in poverty in each racial or ethnic category by the total population.

* The data in this table are calculated by ACS using annual surveys conducted during 2011-2015 and are representative of average characteristics during this period.

** Total equals all individuals in poverty.

As described in section 3.12, there are no ITAs in the Project vicinity nor Indian reservations. Based on Table 3-14, approximately 0.5 percent of the county region was comprised of individuals identifying as American Indian alone. Based on the foregoing information, there are no EJ populations present and therefore, the Project would not have an adverse effect on EJ populations.

4 Cumulative Effects

In addition to Project-specific impacts, Reclamation analyzed the potential for significant cumulative effects to resources affected by the Project and by other past, present, and reasonably foreseeable activities within the watershed. The Council on Environmental Quality's regulations for implementing NEPA (50 CFR 1508.7) state that a cumulative impact "is an impact on the environment which results from the incremental effect of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." A cumulative effects analysis focuses on whether the Proposed Action, considered together with any known or reasonably foreseeable actions by Reclamation, other Federal or state agencies, or some other entity combined to cause an effect. There is no defined area for potential cumulative effects.

4.1 Methodology

The majority of the lands surrounding the Project area are managed by the BLM, with some private and State-managed lands also in the area. Therefore, Reclamation searched agency websites and performed online searches to identify past, present, or reasonably foreseeable projects with potential for cumulative effects. Three Federal agencies were identified with projects or activities in the Project area: Reclamation, BLM, and the NRCS.

- BLM—Reclamation searched BLM's ePlanning website for projects in any stage of implementation--from preliminary planning stages to full construction/implementation of the project.
- NRCS—Reclamation searched NRCS's website and also performed online searches
- Reclamation—Reclamation internally reviewed Reclamation projects and activities

For the surrounding State-managed lands, Reclamation searched the website (lands.wyo.gov) of Wyoming's Office of State Lands and Investments for potential projects or authorized actions. For private actions, Reclamation found the private lands near the reservoir are owned by the same livestock operator as mentioned in section 3.8, Grazing, and no specific projects have been identified on these lands. Therefore, no actions on private lands were included in this cumulative effects analysis.

4.2 Past, Present, and Reasonably Foreseeable Actions

4.2.1 BLM

4.2.1.1 *Riley Ridge to Natrona Project (NEPA Completed)*

The BLM High Desert District prepared an EIS to analyze the impacts of Riley Ridge to Natrona Project. Under the Proposed Action, the BLM would issue the grants to Denbury for rights-of-way across BLM-administered lands and permit drilling of two hydrogen sulfide (H2S) injection wells associated with the Riley Ridge Sweetening Plant. The BLM also would issue a grant to PacifiCorp for right-of-way across BLM-administered land for a 230-kilovolt overhead transmission line. The preferred alignment for the right-of-way passes by the northeast corner of Big Sandy Reservoir, staying at least 1 mile from the proposed Big Sandy Reservoir Enlargement.

BLM Project Website: https://eplanning.blm.gov/eplanning-ui/project/64342/570
FEIS:
https://eplanning.blm.gov/public_projects/nepa/64342/163985/200076/01_Volume_I_Front_through_Appendix_H_(except_A3).pdf

4.2.1.2 *Big Sandy Federal #2-34 (NEPA Completed)*

The proposal is to construct one well pad to drill a new gas well in Sublette County, Wyoming and include accommodations for associated production equipment and facilities. The proposed well, well pad, access road and drilling water haul route (20.3 miles) are located approximately 16.5 miles north of the city of Farson, Wyoming.

BLM Project Website: https://eplanning.blm.gov/eplanning-ui/project/108498/570
EA:
https://eplanning.blm.gov/public_projects/nepa/108498/147388/181142/Big_Sandy_Federal_2-34_EA.pdf

4.2.2 NRCS

4.2.2.1 *Livestock/Wildlife Watering Troughs/Guzzlers*

Personal communication with Pete Arambel in November 2019 indicated there were potentially several projects near the Project area that would provide water for livestock and/or wildlife. These types of projects are intended to reduce damage to streams and riparian areas. Reclamation could not find any information regarding these projects or any other projects within 5 miles of Big Sandy Reservoir on the NRCS's website (https://www.nrcs.usda.gov/wps/portal/nrcs/site/wy/home/).

4.2.3 Reclamation

4.2.3.1 *EVIDD Piping/Lining Projects (Project(s) being implemented)*

The EVIDD has piped or lined portions of Eden Canal and multiple laterals in the Eden Project, including the E-5, E-6, E-7, E-8, E-13, F-1, F-2, F-5, M-1, and M-1B laterals. Some, but not all, of these projects were funded by grants from Reclamation's Salinity Control Program. These projects have reduced the contribution of the Eden Project to the salinity of the area. This reduction has not been totally quantified. They have also reduced the amount of free water available to wildlife.

F2-F5 EA: https://www.usbr.gov/uc/DocLibrary/EnvironmentalAssessments/20190700-EdenValleyIrrigationDrainageDistrictFarsonF2F5LateralsSalinityControlProject-FinalEA-508-PAO.pdf

4.2.4 State

No active oil or gas wells were within about 5 miles of the Project area (http://gis.statelands.wyo.gov/osligis/oilandgas/). Reclamation identified three active oil and gas leases (Nos. 07-00131, 16-00246, and 19-00325) within 3 miles of the Project area using http://gis.statelands.wyo.gov/osligis/oilandgas/. All three leases were acquired via auction and are in the "prospecting" phase (Wyoming State Lands 2020). The likelihood that these projects will develop into "on-the-ground" disturbance appears to be minimal. Therefore, Reclamation concluded that these projects were not reasonably foreseeable. In addition, no special use permits or other authorizations could be found, except for grazing by the livestock operator discussed in Section 3.8, Grazing. Therefore, there were no projects on state lands that were included in this cumulative effects analysis.

4.3 Cumulative Effects Analysis

Reclamation reviewed the potential for there to be additive or interactive effects from this Project in combination with the Projects listed above. Only those resources described below were determined to have the potential to contribute to cumulative effects.

4.3.1 Wildlife (including Sensitive Species)

Depending on seasonality and timing of project implementation, the proposed enlargement could contribute to cumulative effects on wildlife such as greater sage-grouse, pronghorn when considered together with the Riley Ridge to Natrona Project and the EVIDD piping projects. Both projects have the potential to temporarily disrupt movements of these species, with smaller permanent effects due to habitat loss, similar to this proposed Project. This combined effect would not be significant because movement patterns would likely return to pre-project conditions and habitat loss would be insignificant in comparison to the amount of existing habitat available in the surrounding area. In addition, some habitat loss would be mitigated through post-project restoration efforts. This Project may benefit some wildlife species that previously lost access to free water from the EVIDD piping project by increasing the surface acres of water available to these wildlife species, especially in the more shallow areas on the north end of the reservoir. This would be a beneficial, but minimal, effect because it would not affect population-level dynamics.

4.3.2 Cultural Resources

The project would not contribute in a meaningful way to cumulative impacts for historic properties. This portion of Wyoming has had few major infrastructure projects that destroy historic properties. Most other projects have discretion about modifying the proposed actions around historic properties. Consequently, few historic properties have been disturbed. The pattern of adverse effect is toward not harming historic properties. This project is an anomaly in that the project cannot modify itself around identified historic properties and thus requires mitigation measures.

4.4 Conclusion

The Project would not have significant cumulative effects when combined with other past, present, and reasonably foreseeable projects, as described in the sections above.

5 Environmental Commitments

Environmental Commitments, along with Minimization Measures in Section 2.5 have been developed to further lessen the potentially minimal effects of the Proposed Action. The following environmental commitments will be implemented as an integral part of the Proposed Action.

1. **Additional Analyses** - If the Proposed Action were to change significantly from that described in this EA because of additional or new information, or if other spoil, or work

areas beyond those outlined in this analysis are required outside the defined Project area, additional environmental analyses will be completed as may be necessary.

2. **Standard Reclamation Best Management Practices** - Standard Reclamation Best Management Practices will be applied during Project activities to minimize environmental effects and will be implemented by Project work forces or included in Project activity specifications. Such practices or specifications include erosion control, public safety, dust abatement, air pollution, noise abatement, water pollution abatement, waste material disposal, archaeological and historical resources, vegetation, wildlife, and flood control. Excavated material and debris may not be wasted in any stream or river channel in flowing waters. This includes material such as grease, oil, joint coating, or any other possible pollutant. Excess materials must be wasted at a Reclamation approved upland site well away from any channel. All materials, including bedding material, excavation material, etc. may not be stockpiled in riparian or water channel areas. If necessary, silt fencing will be appropriately installed and left in place until after revegetation becomes established, at which time the silt fence can then be carefully removed. Machinery must be fueled and properly cleaned of dirt, weeds, organisms, or any other possibly contaminating substances offsite prior to commencing the Project.

3. **WYPDES Permit** - A Wyoming Pollution Discharge Elimination System Permit will be required from the State of Wyoming before any discharges of water, if such water is to be discharged at a point source into a regulated water body. Appropriate measures will be taken to ensure that Project activity related sediments will not enter the stream either during or after Project activity. Settlement ponds and intercepting ditches for capturing sediments will be constructed, and the sediment and other contents collected will be hauled off the site for appropriate disposal upon completion of the Project. A Storm Water Pollution Prevention Plan (SWPPP) is required in order to obtain a WYPDES Permit. A SPCC Plan will also be prepared as part of the Permit application process.

4. **Site Restoration -** A site restoration and revegetation plan will be developed to reclaim the areas disturbed by Project activity and prevent erosion and sedimentation in "Wyoming Surface Waters".

5. **Fugitive Dust Control Permit** - The Division of Air Quality regulates fugitive dust from Project activity sites, requiring compliance with rules for sites disturbing greater than one-quarter of an acre. Sensitive receptors include those individuals working at the site or motorists that could be affected by changes in air quality due to emissions from the Project activity. The BMP's will be followed to mitigate for temporary impacts on air quality caused by Project related activities. These may include the application of dust suppressants and watering to control fugitive dust; minimizing the extent of disturbed surface; during times of high wind, restricting earthwork activities; and limiting the use of, and speeds on, unimproved road surfaces.

6. **Cultural Resources** - If any cultural resources, either on the surface or subsurface, are discovered during Project activities, Reclamation's Provo Area Office archaeologist shall be notified and all activity in the area of the inadvertent discovery will cease until an assessment of the resource and recommendations for further work can be made by a professional archaeologist.

a. If any person who knows or has reason to know that he/she has inadvertently discovered possible human remains on Federal land, he/she must provide immediate telephone notification of the discovery to the police and Reclamation's Provo Area Office archaeologist. Work will stop until the proper authorities are able to assess the situation onsite. This action will promptly be followed by written confirmation to the responsible Federal agency official. The Wyoming SHPO and interested Native American Tribal representatives will also be promptly notified. Consultation with SHPO and Native American Tribal representatives will begin immediately. This requirement is prescribed under the Native American Graves Protection and Repatriation Act (43 CFR Part 10); and the Archaeological Resources Protection Act of 1979 (16 U.S.C. § 470).
b. The terms of the historic resources Memorandum of Agreement will be implemented by Reclamation (or contractor) in a timely fashion and concluded prior to its expiration date.

7. **Paleontological Resources** - Should vertebrate fossils be encountered during ground disturbing actions, Project activity must be suspended until a qualified paleontologist can be contacted to assess the find.

8. **Wildlife Resources** -
    a. Bald and Golden Eagles – If bald and/or golden eagles are observed within the Project area and vicinity, Reclamation's Provo Area Office wildlife biologist shall be notified and Project activities in the area shall cease until an assessment of eagle presence can be made by a professional wildlife biologist. The Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d) prohibits anyone, without a permit issued by the Secretary of the Interior, from "taking" eagles, including their parts, nests, or eggs. "Take" means "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." "Disturb" means "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior." In addition to immediate impacts, this definition also covers impacts that result from human-induced alterations initiated around a previously used nest site during a time when eagles are not present, if, upon the eagle's return, such alterations agitate or bother an eagle to a degree that interferes with or interrupts normal breeding, feeding, or sheltering habits, and causes injury, death or nest abandonment.
    b. Migratory Birds - New guidance pertaining to the MBTA was issued on December 22, 2017 by DOI under Secretarial Order 3345. Furthermore, the USFWS issued guidance in accordance with Solicitor's M-Opinion (m-37050). That guidance states that the MBTA's prohibitions on take apply when the purpose of an action is to take migratory birds, their eggs, or their nests. Therefore, the take of birds, eggs or nests resulting from an action in which the purpose is to not take birds, eggs or nests, is not prohibited by the MBTA.
    c. Greater Sage Grouse - Conservation measures for sage grouse include:
        i. maintaining and stacking topsoil that is removed; re-contouring using the collected topsoil;

ii. staging in areas that were previously disturbed;
iii. reseeding with an appropriate mix following recommendations of range specialists (Reclamation, BLM, WGFD, etc.); and
iv. controlling noxious and/or invasive species such as cheatgrass and/or others listed as nuisance species in Sublette and Sweetwater counties.

9. **Wetland Resources** - Any and all wetlands will be avoided where practical. In the event that impacts to wetlands are unavoidable, a U.S. Army Corps of Engineers 404 Permit will be obtained prior to any dredged or fill material being discharged into jurisdictional wetlands. Surveys will be conducted to evaluate temporary and permanent impacts to wetlands.

10. **Public Access** – Project activity sites will be closed to public access. Temporary fencing, along with signs, will be installed to prevent public access.

11. **Previously Disturbed Areas** – Project activities will be confined to previously disturbed areas where possible.

12. **Disturbed Areas** - All disturbed areas resulting from the Project will be smoothed, shaped, contoured, and rehabilitated to as near the pre-Project condition as practicable. After completion of the Project and restoration activities, disturbed areas will be seeded at appropriate times with weed-free, native seed mixes having a variety of appropriate species (especially woody species where feasible) to help hold the soil around structures, prevent excessive erosion, and to help maintain other riverine and riparian functions. The composition of seed mixes will be coordinated with wildlife habitat specialists and Reclamation biologists. Weed control on all disturbed areas will be required. Successful revegetation efforts must be monitored and reported to Reclamation, along with photos of the completed Project.

13. **Recreation Areas** - Reclamation will be responsible for the following improvements as part of the Proposed Action: The boat ramp will be replaced to match the proposed reservoir level; fire pits and picnic tables will be replaced and installed to match the proposed reservoir levels; the artesian well piping and valving will be extended to higher ground to maintain access to the well water for recreation and irrigation purposes; the irrigation piping will be replaced to continue irrigation of the west camping loop; and the vault restrooms in the west camping loop and southeast camping areas will be replaced at a higher elevation following Project completion, as funding is available.

14. **Traffic Control Plan**—A Traffic Control Plan would be developed in coordination with Sublette and Sweetwater County officials to protect public health and safety.

15. **Health, Safety, Noise and Dust**—The Contractor would be responsible during Project activity for safety measures, noise control, dust control, and air and water pollution.

6 Scoping, Coordination, and Public Involvement

Scoping, as defined in 40 CFR 1501.7, is "an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action." Scoping includes all types of information-gathering activities and can occur throughout the NEPA process. The Proposed Action was presented to the public and interested agencies as outlined below.

6.1 Eden Valley Irrigation and Drainage District

A shareholders meeting was held in November 2016. Approximately 20 people attended the meeting. The Proposed Action was presented to the shareholders. No formal vote was taken, but the majority supported the Project. One shareholder opposed it.

6.2 Comment Periods and Public Meetings on Draft EAs

A 44-day comment period ended on December 6, 2017. A total of 132 letters notifying interested parties of the comment period and public meeting were sent to shareholders, landowners, and local, state, and Federal agencies. A public meeting was held on November 7, 2017, in Farson, Wyoming. Fifteen people attended the meeting.

A second comment period was conducted from March 12, 2019 to April 15, 2019. A second public meeting was held on March 26, 2019 from 6-7:30pm at the Eden Valley Community Center in Farson, Wyoming. Letters were sent to all addresses in the 82923 zip code, along with 87 letters to other individuals, organizations, and agencies. The letters contained information about the availability of the draft EA, the comment period, and the public meeting.

6.3 Wyoming Game and Fish Department

Reclamation contacted WGFD to identify potential impacts to fish and wildlife resources at Big Sandy Reservoir. Biologists from the Rock Springs and Pinedale offices were contacted, as well as a habitat protection specialist with WGFD.

6.4 U.S. Army Corps of Engineers

Reclamation coordinated with Mr. Tom Johnson, Project Manager, Wyoming Regulatory Office. Mr. Johnson visited Big Sandy Reservoir on September 23, 2015, to determine the ordinary high water mark (OHWM) of Big Sandy Reservoir for regulatory purposes. An Approved Jurisdictional Determination was received on May 18, 2016, identifying the limits of USACE regulatory jurisdiction.

6.5 U.S. Fish and Wildlife Service

A request was made to USFWS Information for Planning and Consultation (IPaC) program on March 9, 2017 and updated on September 8, 2017. This request was made to identify threatened and endangered species with potential to occur in the Project area. Reclamation requested initiation of formal consultation on March 23, 2018, pursuant to Section 7 of the Endangered Species Act of 1973, for the four Colorado River endangered fish (see section 3.3.12 of this EA). The USFWS issued a Biological Opinion on May 9, 2018 (see Appendix B).

6.6 Wyoming State Historic Preservation Office

A copy of the Class III Cultural Resource Inventory Report and a determination of historic properties affected for the Proposed Action was submitted to the Wyoming SHPO. The Wyoming SHPO concurred with Reclamation's determinations on September 28, 2018 (see Appendix F). A Memorandum of Agreement (MOA) was developed to detail the steps to mitigate the adverse effect to Big Sandy Dam (Site 48SU7646/48SW19744) and 48SU2, a prehistoric site which might be impacted due to erosion. The MOA was signed by Reclamation, SHPO, and interested parties.

6.7 Wyoming State Geological Survey

On September 12, 2017, Dr. Zachary Nelson requested information from WSGS and the University of Wyoming about potential paleontological resources in the Project area. WSGS responded that the Project does not occur on Wyoming State Lands, and therefore had no comment. The University of Wyoming responded that the strata underlying the Project area is known to have high potential for fossiliferous materials.

Consequently, Paleo Solutions, Inc. was hired to determine the nature and extent of paleontological resources within the APE. A field assessment of 555 acres, including the potential borrow area, was conducted. Four fossil localities were identified, one of which was significant. See section 3.10 for additional information.

6.8 Native American Consultation

Reclamation conducted Native American consultation throughout the public involvement process. A consultation letter and copy of the Class III Cultural Resource Inventory Report was sent to Tribes with known interests in the Project vicinity on September 24, 2018. This included the Apache Tribe of Oklahoma; Arapaho Tribe of the Wind River Reservation, Wyoming; Cheyenne and Arapaho Tribes, Oklahoma; Comanche Nation, Oklahoma; Crow Tribe of Montana; Fort Belknap Indian Community of the Fort Belknap Reservation of Montana; Shoshone Tribe of the Wind River Reservation; and the Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho. Consultation complied with 36 CFR 800.2(c)(2) on a government-to-government basis. Through this effort each tribe is given a reasonable opportunity to identify any concerns about historic properties; to advise on the identification and evaluation of historic properties, including those of traditional religious and

cultural importance; to express their views on the effects of the Proposed Action on such properties; and to participate in the resolution of adverse effects.

7 Preparers

The following is a list of preparers who participated in the development of the EA. They include environmental summary preparers, Reclamation team members, and Federal, State and District members.

Engineering and Environmental Preparers

Name	Title	Affiliation
Mike Carnevale	Senior Water Resources Project Manager	Wenck Associates
Greg Johnson	Research Biologist	WEST, Inc.
Pamela Massaro, PE	Water Resources Engineer	Wenck Associates

Reclamation Team, Environmental Preparers

Name	Title	Contribution
Jared Baxter	Fish and Wildlife Biologist	Wildlife, Threatened, Endangered, and Sensitive Species, ESA Compliance
Rick Baxter	Manager, Water, Environmental, and Lands Division	Project Oversight
Peter Crookston	Chief, Environmental Group	NEPA Compliance
Preston Feltrop	ESA Specialist	Fisheries, ESA
Gary Henrie	Hydrologist	Hydrology
Linda Morrey	Secretary	Visual Identity, Editing
Zachary Nelson	Archaeologist	Cultural, Paleontological, Indian Trust Assets
James Olsen	Civil Engineer	Groundwater
Robert Radtke	Engineer	Water Quality
Dustin Woodbury	Civil Engineer	Water Rights
Scott Winterton	Group Chief, Design and Contract Administration	Project Manager, Project Design

Federal, State, or Local Entity

Name	Title	Company
Jason Mead	Deputy Director – Dams and Reservoirs	Wyoming Water Development Office

8 Acronyms and Abbreviations

Acronyms	Meaning/Description
ACHP	Advisory Council on Historic Preservation
APE	Area of Potential Effect
BLM	Bureau of Land Management
BMP	Best Management Practice
CB	Cement-Bentonite
CFR	Code of Federal Regulations
CLSM	Controlled Low Strength Material
cfs	Cubic Feet Per Second
CWA	Clean Water Act
DDCT	Density Disturbance Calculation Tool
EA	Environmental Assessment
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FIRM	Flood Insurance Rate Map
FONSI	Finding of No Significant Impact
HDPE	High-Density Polyethylene
IPaC	Information for Planning and Conservation
ITA	Indian Trust Asset
LIDAR	Light Detection and Ranging
MOA	Memorandum of Agreement
MSL	Mean Sea Level
NEPA	National Environmental Policy Act
NRCS	Natural Resource Conservation Service
NHPA	National Historic Preservation Act
NHWM	Normal High Water Mark
NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
OHWM	Ordinary High Water Mark
OW	Observation Well
O&M	Operation and Maintenance
PEM	Palustrine Emergent

PSS	Palustrine Scrub-Shrub
Reclamation	U.S. Bureau of Reclamation
SGIT	Sage-Grouse Implementation Team
SHPO	State Historic Preservation Office
SOP	Standard Operating Procedure
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USACE	U.S. Army Corps of Engineers
WGFD	Wyoming Game and Fish Department
WPDES	Wyoming Pollution Discharge Elimination System Permit
WSGS	Wyoming State Geological Survey
WWDC	Wyoming Water Development Commission

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10 Appendices

Appendix A – Reservoir Operations Model Report

BUREAU OF RECLAMATION

Model Report

Big Sandy Reservoir Enlargement Project
Reservoir Operation Model

Eden Project, Wyoming
Interior Region 7 – Upper Colorado Region

U.S. Department of the Interior June 2020

Mission Statements

The Department of the Interior (DOI) 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.

Model Report

Big Sandy Reservoir Enlargement Project
Reservoir Operation Model

Eden Project, Wyoming
Interior Region 7 – Upper Colorado Region

prepared by

Gary Henrie, P.E., Civil Engineer (Hydrologic), Upper Colorado Region, Provo Area Office

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Cover Photo: Big Sandy Dam Spillway, June 09, 2017. (Reclamation/Gary Henrie)

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Introduction

The Wyoming Water Development Commission (WWDC) has proposed enlarging Big Sandy Reservoir to help alleviate issues with Eden Valley Irrigation and Drainage District (EVIDD) not meeting crop irrigation demands during drought and dry cycles.[1] The Bureau of Reclamation (Reclamation) is currently preparing an Environmental Assessment to determine if enlarging Big Sandy Reservoir will or will not have significant environmental impacts. To support the Big Sandy Reservoir Enlargement Project Environmental Assessment, Reclamation created a reservoir operations model of Big Sandy Reservoir to quantify the impacts that raising the Big Sandy Dam spillway crest five-feet would likely have on irrigation releases, reservoir storage, and spillway discharge (and its impacts on the Big Sandy and Green Rivers downstream). This report documents the model objective; approach, assumptions, and limitations; and results.

Eden Project Description

The Eden Project furnishes an irrigation water supply for 17,010 acres. Project lands are in the vicinity of the towns of Farson and Eden in southwestern Wyoming about 40 miles north of Rock Springs. Project features are Big Sandy Dam and Reservoir, Eden Dam and Reservoir, Little Sandy Diversion Dam, Little Sandy Canal, Means Canal, Eden Canal, and a lateral and drainage system.[2]

Big Sandy Dam and Reservoir

Big Sandy Dam is a major storage facility of the Eden Project. Big Sandy Dam, Dike, and Reservoir are located on Big Sandy Creek approximately 45 miles northwest of Rock Springs and approximately 10 miles north of Farson, Wyoming. The reservoir provides storage for irrigation, flood control, recreation, and fish and wildlife benefits. The reservoir has a total storage capacity of 39,700 acre-feet and a surface area of approximately 2,510 acres at water surface elevation 6757.5.[3]

Big Sandy Dam is a zoned earthfill embankment with a structural height of 85 feet, and a crest elevation of 6769.0 feet. The dam includes a low permeability Zone 1 core, upstream and downstream semi-pervious Zone 2 shells, and a downstream Zone 3 toe section of selected rock.

Big Sandy Dike is north of, and adjacent to, Big Sandy Dam. The dike is a homogeneous earthfill structure with a maximum height of 22 feet, a crest width of 16 feet, and a crest length of 8,300 feet at elevation 6769.

An uncontrolled concrete side-channel spillway is located at the right abutment of Big Sandy Dam. The inlet to the spillway consists of an unlined approach channel, a 170-foot-long concrete side-channel overflow crest at elevation 6757.50, and a 170-foot-long concrete plunge pool with a 15-foot-wide bottom width along the upstream right abutment. The spillway structure has a discharge capacity of 8,800 cfs at elevation 6764.0.

The outlet works is located near the midpoint of the dam. The outlet works consists of an 11-foot by 11-foot concrete trashrack intake structure, an upstream 5-foot by 6-inch-diameter horseshoe-shaped pressure conduit that begins directly below the intake tower, a gate chamber housing a 3 ½ ft

-square high-pressure emergency slide gate and a 3 ½ ft -square high-pressure regulating slide gate, an access shaft and gate house, a downstream 5 ½ ft horseshoe-shaped conduit, and a concrete stilling basin. The discharge capacity is 620 cfs at elevation 6762.8.

A secondary outlet works, which supplies water to the Big Sandy Feeder Canal, is located at the north end of Big Sandy Dike. Releases are made through the secondary outlet works only when the reservoir elevation approaches the spillway crest, at elevation 6757.5.[4]

Big Sandy Operations

Big Sandy Dam, Dike, and Reservoir are operated and maintained by the Eden Valley Irrigation & Drainage District (EVIDD). District personnel visit the dam daily during the irrigation season and weekly during the winter months when releases are not being made. The reservoir is typically operated to maintain as much storage as possible for irrigation use. No exclusive flood control capacity is provided at Big Sandy Dam; however, some flood control capacity can be provided if needed. Normally, the reservoir is filled by May 15 for irrigation releases, and on approximately September 15 no more releases from the reservoir are made.[4]

Model Objective

To support the Big Sandy Reservoir Enlargement Project Environmental Assessment, Reclamation created a reservoir operations model of Big Sandy Reservoir to quantify the impacts that enlarging Big Sandy Reservoir by approximately 13,600 acre-feet (based on findings of the 2015 lidar survey of the reservoir) by raising the Big Sandy Dam spillway crest five-feet (from elevation 6757.5 feet to elevation 6762.5 feet) would likely have on irrigation releases, reservoir storage, and spillway discharge and its impacts on the Big Sandy and Green Rivers downstream.

Model Approach, Assumptions, and Limitations

To model the likely impacts of the enlargement, a daily-timestep mass-balance spreadsheet model of Big Sandy Reservoir was created.

Model Setup

Given a spillway crest elevation, a reservoir elevation-storage table, an initial historic end-of-day reservoir elevation for December 31, 1989, and daily historic reservoir inflow data (described below) and irrigation demand data from January 1, 1990 to December 31, 2019 the model computes daily reservoir release, unmet irrigation demand, spillway discharge, reservoir storage, and reservoir elevation data for January 1, 1990 to December 31, 2019:

- Reservoir release: If the given current day irrigation demand is less than the previous day end-of-day storage plus the current day inflow the current day release equals the given

current day irrigation demand. If not, the current day release equals the previous day end-of-day storage plus the current day inflow. This approach prioritizes meeting current day irrigation demands if possible and allows the reservoir to be drained down to the top of dead storage (elevation 6720.0 feet). In reality, reservoir operators may at times choose to decrease irrigation releases in favor of higher storage for use later in the irrigation season or future years.

- Unmet irrigation demand: Current day unmet irrigation demand equals the current day irrigation demand minus the current day reservoir release.
- Spillway discharge: If the previous day end-of-day reservoir elevation is greater than the given spillway crest elevation, current day spillway discharge is computed using the weir equation: $Q=CLH^{3/2}$[5] where Q is current day spillway discharge in cfs, C is 3.33, L is 170 feet, and H is previous day end-of-day reservoir elevation minus the given spillway crest elevation.
- Reservoir storage: Current day end-of-day reservoir storage equals previous day end-of-day reservoir storage plus current day inflow minus current day release and current day spillway discharge.
- Reservoir elevation: Current day reservoir elevation is interpolated from the given reservoir elevation-storage table based on the current day storage.

Reservoir Inflow Data

Historic Big Sandy Reservoir daily inflow data were computed by mass balance of historic daily release data (reported by the dam tender), daily storage data (computed, from elevation data reported by the dam tender or telemetry equipment, using elevation-storage tables developed from bathymetry data collected in 2010), and computed historic spillway discharge data (computed, in the same manner as in the model, using the weir equation $Q=CLH^{3/2}$, with C=3.33, L=170 feet, and H=Reservoir elevation minus 6757.5, for elevations above 6757.5 feet). Gaps in historic release data and reservoir elevation data were interpolated to obtain 30 years of complete continuous historic reservoir inflow, release, spill, elevation, and storage data from January 1, 1990 to December 31, 2019. The computed Big Sandy Reservoir inflow data were validated by comparing to stream flow data reported at the upstream USGS gage (USGS 09213500 Big Sandy River near Farson, WY), where stream flow data were available. A summary of the computed Big Sandy historic inflow data used as model input is presented in Table 1 and Figure 1.

Table 1: Big Sandy Reservoir Total Annual Inflow Volume

Year	Model Inflow	Historic Inflow	Model - Historic
	acre-feet	acre-feet	acre-feet
1990	59,514	59,514	0
1991	55,370	55,370	0
1992	35,006	35,006	0
1993	72,348	72,348	0
1994	34,024	34,024	0
1995	114,946	114,946	0
1996	54,022	54,022	0
1997	84,358	84,358	0
1998	70,230	70,230	0
1999	80,446	80,446	0
2000	41,866	41,866	0
2001	28,033	28,033	0
2002	38,801	38,801	0
2003	39,840	39,840	0
2004	58,724	58,724	0
2005	60,208	60,208	0
2006	44,077	44,077	0
2007	38,984	38,984	0
2008	50,472	50,472	0
2009	57,403	57,403	0
2010	42,257	42,257	0
2011	86,008	86,008	0
2012	41,853	41,853	0
2013	35,576	35,576	0
2014	56,000	56,000	0
2015	44,760	44,760	0
2016	55,907	55,907	0
2017	121,839	121,839	0
2018	71,118	71,118	0
2019	68,733	68,733	0
Total	1,742,725	1,742,725	0
10% Exceedance	84,523	84,523	0
50% Exceedance	55,638	55,638	0
90% Exceedance	35,519	35,519	0

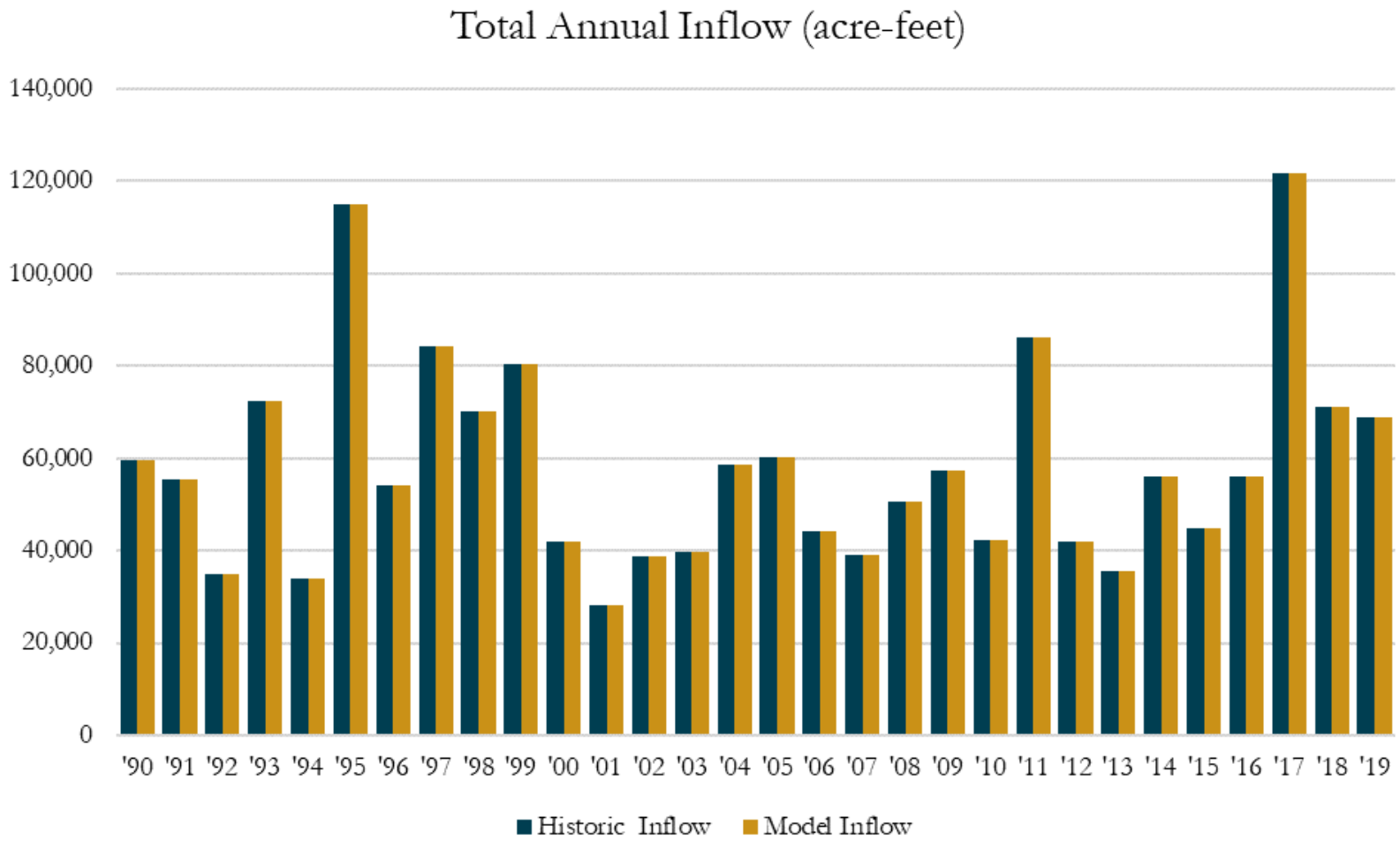


Figure 1. Big Sandy Reservoir Total Annual Inflow Volume

Model Validation

To validate the model, the model was run with the current spillway crest elevation (6757.5 feet), the reservoir elevation-storage table used in the historic reservoir operations data (table developed from 2010 survey data), and daily irrigation demand data set to match historic release data. The model-computed reservoir elevation and spillway discharges correlated very closely with historic data. Over the 30-year model run, the median difference between model and historic data was only 0.08 foot (model data slightly lower than historic) and the total model and historic spill volumes were nearly identical (within 0.02%).

Enlarged Reservoir Model Run

Once validated, the model was run with the raised spillway crest elevation (6762.5 feet), the reservoir elevation-storage table developed from the 2015 lidar data, and what is assumed to be a likely future irrigation demand if the dam raise is to be implemented (see Irrigation Demand section below).

Three portions of the enlarged reservoir model run showing initial, spillway discharge, and unmet irrigation demand computations are shown (separated by thick horizontal black lines) in Figure 2.

Model Run: Enlarged Reservoir

Spillway Crest Elevation: 6762.5
Releases: Definite Plan Report (mo
Capacity: 2015

Wet Releases: Historic Releases
(1995, 1996, 1997, 1998, 1999, 2017, 2018, 2019)

	Model Inputs				Model Outputs							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Date	Inflow	Inflow	Demand	Demand	Release	Release	Unmet Demand	Unmet Demand	Spill	Spill	Storage (Live)	Elevation
	cfs	acre-feet	cfs	acre-feet	cfs	acre-feet	cfs	acre-feet	cfs	acre-feet	acre-feet	feet
12/31/1989											9,987	6741.41
1/1/1990	18	35	0	0	0	0	0	0	0	0	10,022	6741.45
1/2/1990	18	36	0	0	0	0	0	0	0	0	10,058	6741.48
1/3/1990	21	41	0	0	0	0	0	0	0	0	10,099	6741.52
5/21/1997	432	857	318	631	318	631	0	0	0	0	50,270	6762.28
5/22/1997	485	961	369	732	369	732	0	0	0	0	50,499	6762.36
5/23/1997	502	996	386	766	386	766	0	0	0	0	50,729	6762.44
5/24/1997	498	988	380	754	380	754	0	0	0	0	50,963	6762.51
5/25/1997	519	1028	380	754	380	754	0	0	1	1	51,237	6762.61
5/26/1997	538	1066	364	722	364	722	0	0	21	41	51,540	6762.71
5/27/1997	600	1189	348	690	348	690	0	0	54	108	51,931	6762.84
5/28/1997	460	912	353	699	353	699	0	0	112	223	51,921	6762.84
7/19/2002	38	75	241	478	241	478	0	0	0	0	1,223	6725.48
7/20/2002	42	84	241	478	241	478	0	0	0	0	829	6723.93
7/21/2002	35	70	241	478	241	478	0	0	0	0	421	6722.13
7/22/2002	41	80	241	478	241	478	0	0	0	0	23	6720.12
7/23/2002	39	78	241	478	51	101	190	378	0	0	0	6720
7/24/2002	42	83	241	478	42	83	199	396	0	0	0	6720
7/25/2002	41	81	241	478	41	81	200	397	0	0	0	6720
7/26/2002	49	98	241	478	49	98	192	381	0	0	0	6720

Figure 2. Enlarged reservoir spreadsheet model showing representative initial, spill, and unmet irrigation demand computations

Irrigation Demand

The irrigation demand assumed in the model was selected based on a review of discussions with EVIDD operators, historic release data (1990-2019 median annual release volume of 51,300 acre-feet, 90% exceedance of 37,500 acre-feet, and 10% exceedance of 62,400 acre-feet), the Big Sandy Reservoir Enlargement Level II Phase I Study Final Report[1], and the May 1953 Definite Plan Report for the Eden Project[6] (which is formal documentation of project design). Considering consumptive use, precipitation, and farm losses, the Definite Plan Report estimated a farm delivery requirement of 2.26 acre-feet per acre with an estimated 30 percent conveyance loss. The Definite Plan Report values closely match what EVIDD independently noted as a desired irrigation volume (two and a quarter acre-feet per acre) and conveyance loss (historically approximately 30 percent), and thus, the Definite Plan Report values were considered a reasonable approximation of the irrigation water that would be used if reliably available. Assuming operation of Eden Reservoir similar to historic operations—relatively constant, relatively low releases that primarily mitigate some conveyance loss—the full irrigation demand for the 17,010 acres served by the project was applied as a 54,918 acre-feet annual irrigation demand (17,010 acres, 2.26 acre-feet per acre, 30 percent conveyance loss) at Big Sandy Reservoir. Daily irrigation demand used in the model was estimated by computing the percent of annual historic releases that were made each month with some adjustment to increase May releases due to EVIDD expressing interest in providing water earlier in May if reliably available. The estimated monthly and daily irrigation demand used in the model is shown below in Table 2 and plotted with historic daily release exceedance percentiles in Figure 3.

Table 2. Irrigation Demand

Month	Monthly Demand		Daily Demand
	Percent	acre-feet	acre-feet
May	10%	5,492	177.15
June	30%	16,475	549.18
July	27%	14,828	478.32
August	25%	13,730	442.89
September (1-15)	8%	4,393	292.90
Total	100%	54,918	

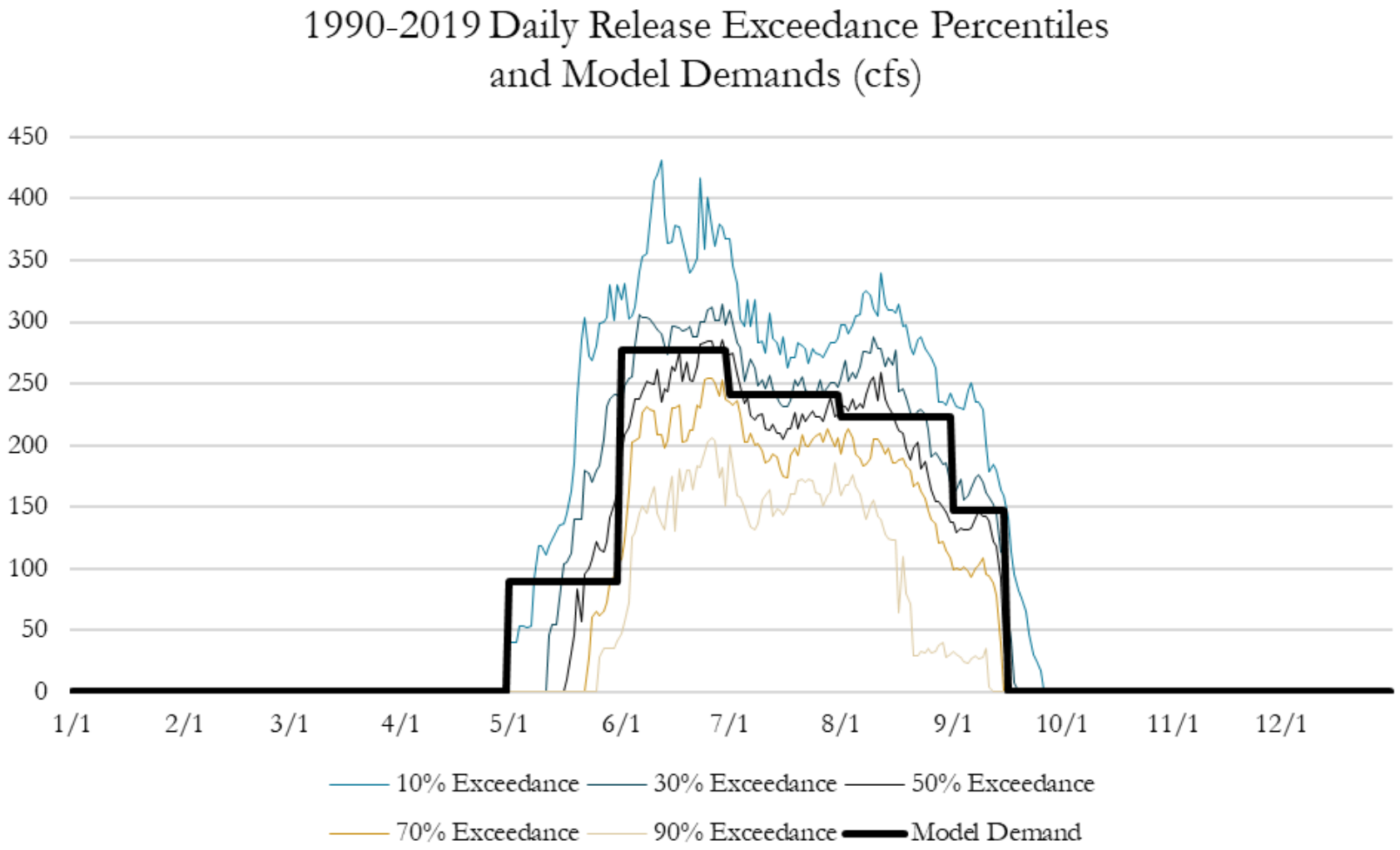


Figure 3. Irrigation demand and 1990-2019 daily release exceedance

Historically, in wet years, outlet works releases have exceeded the 54,918 acre-feet annual irrigation demand assumed in the model. While some of these excess releases may have been used for irrigation, the primary reason for the releases was to operate the reservoir to mitigate against excessive spillway discharge and downstream flows in excess of the safe channel capacity. For the series of wet years of 1995, 1996, 1997, 1998, 1999, 2017, 2018, and 2019 it was assumed that reservoir operators would make decisions like those made historically: the same releases made historically were made in the model (by setting irrigation demand equal to historic release).

Model Results

The results of the Enlarged Reservoir model run—representing likely operations of the proposed enlarged Big Sandy Reservoir given the 1990 thru 2019 historic reservoir inflows—were compared with historic reservoir operations and streamflow data to quantify the likely impacts of the reservoir enlargement on irrigation releases, reservoir storage, and spillway discharge and its impacts on the Big Sandy and Green Rivers downstream. Results are presented in the sections below.

Big Sandy Irrigation Release Impacts

If water was available, the model released 54,918 acre-feet per year during the irrigation season, except in the wet years of 1995, 1996, 1997, 1998, 1999, 2017, 2018, and 2019 when the model made the same releases that were made historically. The annual total releases made in the model and those made historically are presented in Table 3 and Figure 4.

The 50 percent exceedance values show a release increase of 3,604 acre-feet from historic releases (50 percent exceedance of 51,314 acre-feet) with the enlarged reservoir (50 percent exceedance of 54,918 acre-feet).

The model shows the largest differences in release volume coming in 2001 and 2013, both of which were the second dry year following a wet year (1999 and 2011, respectively), highlighting the ability of the enlarged reservoir to store excess water from wet years for use in dry years.

Overall, the model indicates positive impact to the Big Sandy irrigation releases as a result of the reservoir enlargement. Considering 54,918 acre-feet per year to be the desired irrigation release volume, the model was able to meet the desired irrigation release in 18 of the 30 years (60%) from 1990-2019, an improvement over the 12 of 30 years (40%) the desired release was met historically. The annual release is shown in Figure 5 as the volume of annual irrigation release short of the desired 54,918 acre-feet per year volume. The respective 16,000 and 17,000 acre-feet of additional release in the dry 2001 and 2013 are, again, especially noteworthy.

Table 3. Total Annual Reservoir Irrigation Releases, Historic and from the Enlarged Reservoir Model

Year	Model Release	Historic Release	Model - Historic
	acre-feet	acre-feet	acre-feet
1990	54,918	54,568	350
1991	54,918	48,786	6,132
1992	46,598	47,816	-1,218
1993	54,918	52,470	2,448
1994	50,949	53,338	-2,389
1995	70,339	70,339	0
1996	66,002	66,002	0
1997	56,560	56,560	0
1998	60,543	60,543	0
1999	57,220	57,220	0
2000	54,918	56,075	-1,157
2001	45,747	29,457	16,290
2002	37,115	37,785	-670
2003	38,953	38,820	133
2004	54,918	43,274	11,644
2005	54,918	46,490	8,428
2006	53,376	55,441	-2,065
2007	38,762	42,612	-3,850
2008	52,285	48,634	3,651
2009	54,918	46,120	8,798
2010	45,200	43,805	1,395
2011	54,918	61,503	-6,585
2012	54,918	56,570	-1,652
2013	50,910	33,781	17,129
2014	54,918	44,112	10,806
2015	48,850	42,776	6,074
2016	49,513	50,158	-644
2017	68,041	68,041	0
2018	62,003	62,003	0
2019	61,566	61,566	0
Total	1,609,711	1,536,664	73,047
10% Exceedance	62,403	62,403	0
50% Exceedance	54,918	51,314	3,604
90% Exceedance	44,575	38,716	5,859

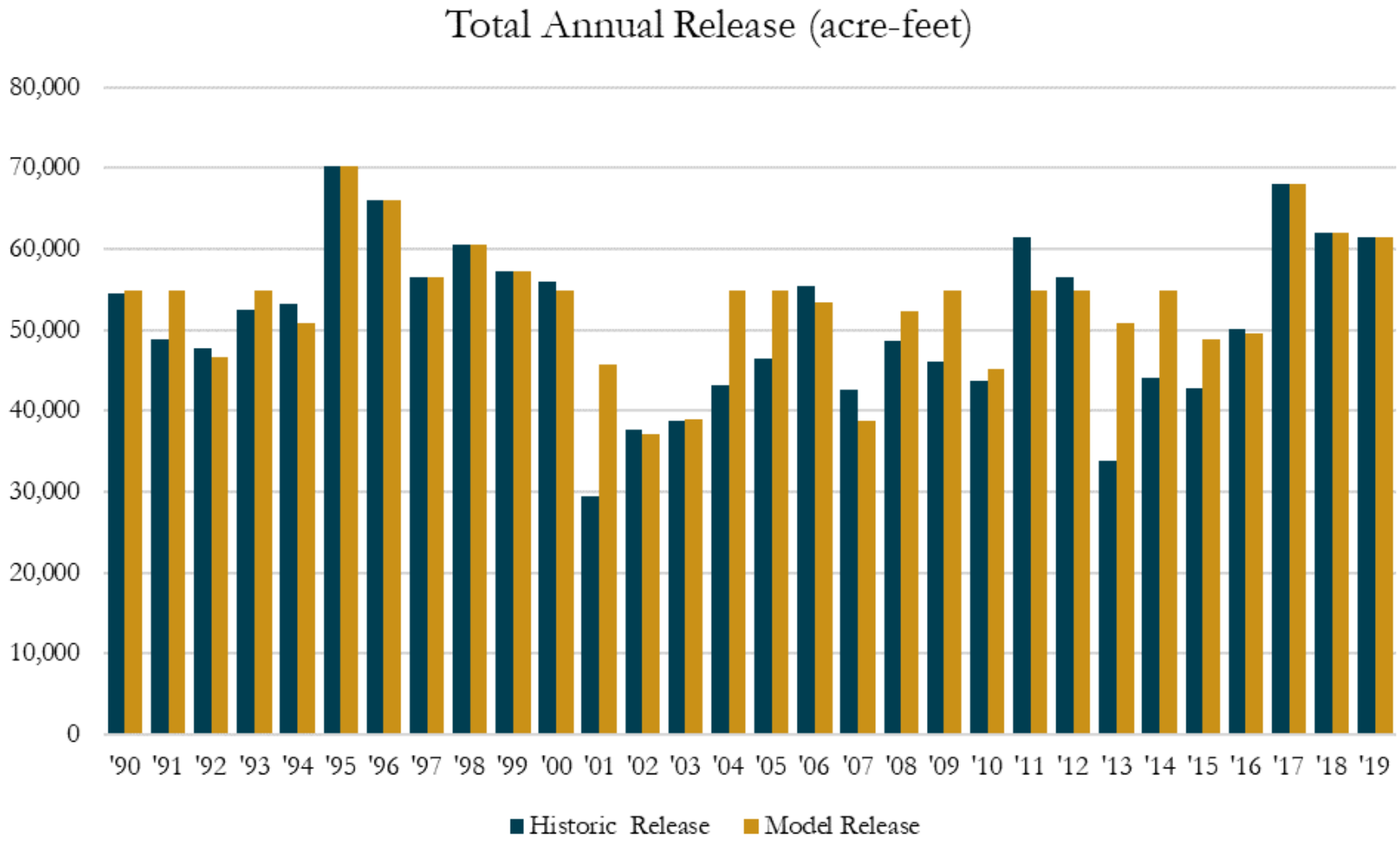


Figure 4. Total annual reservoir irrigation releases, historic and from the enlarged reservoir model

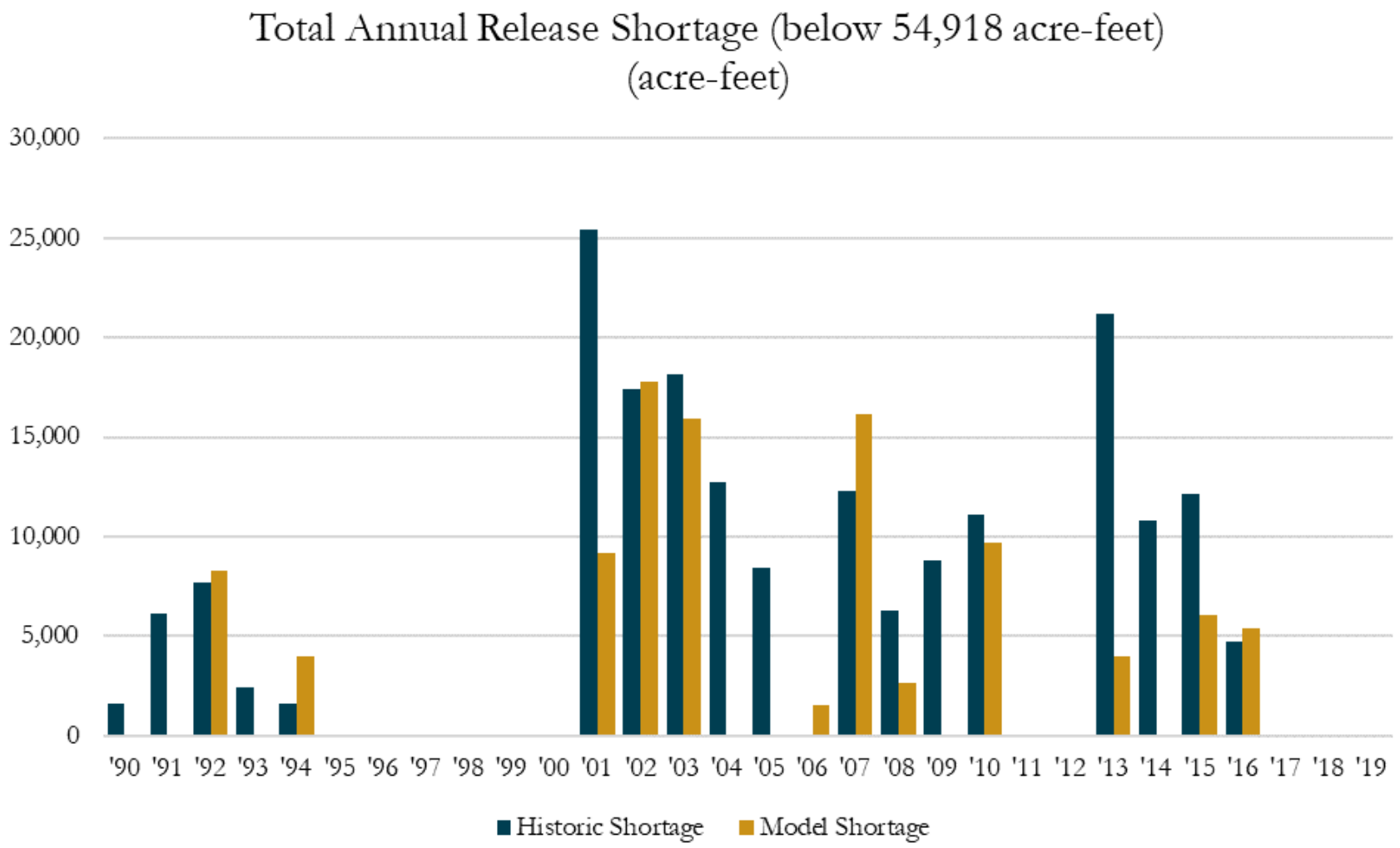


Figure 5. Total annual irrigation release volume below 54,918 acre-feet, historic and from the enlarged reservoir model

Big Sandy Storage Impacts

Historic and model-computed end of March reservoir storage is shown in Figure 6. Based on the 2015 lidar survey of the upper portions of the reservoir, the reservoir enlargement will allow for storage of an additional 13,600 acre-feet in the five vertical feet between the current (elevation 6757.5 feet) and raised (elevation 6762.5 feet) spillway crest elevations. As would be anticipated, both the historic and model storage volumes are high in March following a wet year (*e.g.*, 1996, 2012, 2018) or within or following a series of relatively wet years (*e.g.*, 1997 to 2000, 2019) with the model storing water in the additional, enlarged storage volume. The model computation for reservoir release prioritizes meeting current day irrigation demands—where operators may choose to decrease irrigation releases in favor of higher storage—resulting in lower than historic end of March reservoir storage following dry years or series of relatively dry years (*e.g.*, 2002-2004, 2007-2011, 2014-2016).

Overall, the model indicates positive impact to the Big Sandy storage as a result of the reservoir enlargement. The model indicates that during high storage years (10 percent exceedance) the enlarged reservoir will likely store 11,500 acre-feet more than what has been historically stored on March 30. Normal and dry year storage in the enlarged reservoir will largely depend on reservoir operator priorities for any given year or series of years. The model indicates that in normal (50 percent exceedance) and low (90 percent exceedance) storage years, the enlarged reservoir storage could, respectively, be as much as 3,000 and 2,500 acre-feet ***lower*** than historic March 30 storage volumes. However if operators prioritize preserving reservoir storage, normal and dry year enlarged reservoir storage would likely be similar to or perhaps higher than historic March 30 storage volumes.

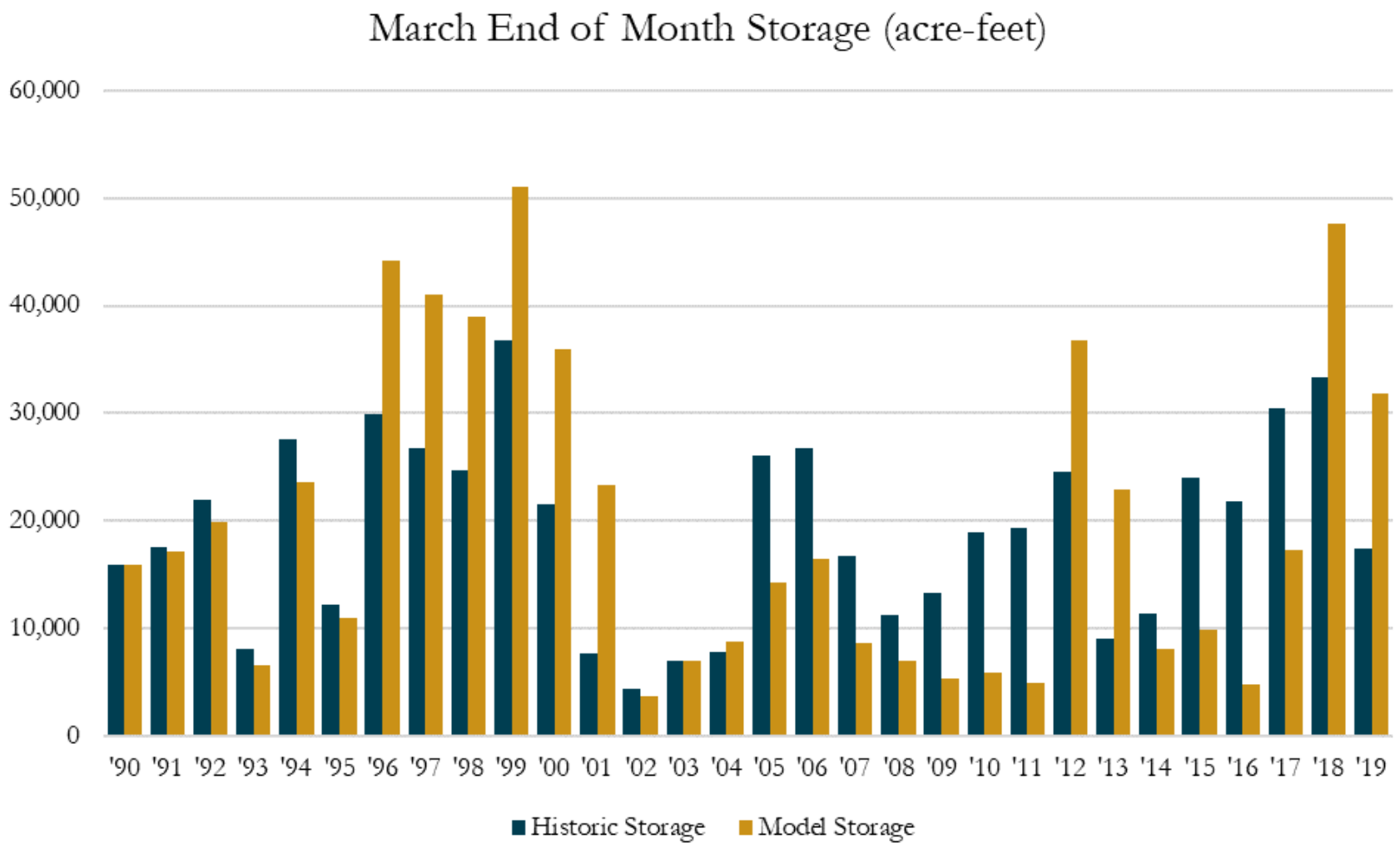


Figure 6. March end of month storage, historic and from the enlarged reservoir model

Annual maximum and September 30 (approximating the annual minimum) reservoir water surface elevations, historic and from the model, are compared in Table 4 and Figure 7. Model 50 percent exceedance maximum reservoir water surface elevations were two feet lower than historic. The enlarged reservoir, allowing for elevations 5.0 feet higher elevations, combined with the assumption of prioritizing irrigation releases led to the spread of maximum elevations in the model being larger than the spread of the historic data: the model 90 percent exceedance is 4.1 feet lower and the 10 percent exceedance is 4.7 feet higher. Model 50 percent exceedance September 30 elevations were 7.8 feet lower than historic, with a larger spread: the model 90 percent exceedance is 6.2 feet lower and the 10 percent exceedance is 5.6 feet higher. If actual operations do not prioritize irrigation releases to the extent assumed in the model, 50 and 90 percent exceedance enlarged reservoir elevations would likely trend near or slightly higher than historic elevations.

Table 4. Maximum and September 30 (representing minimum) Reservoir Water Surface Elevations, Historic and from the Enlarged Reservoir Model

Year	Model Maximum Elevation feet	Historic Maximum Elevation feet	Model - Historic feet	Model Sep. 30 Elevation feet	Historic Sep. 30 Elevation feet	Model - Historic feet
1990	6,755.4	6,753.3	2.1	6,743.1	6,743.4	-0.3
1991	6,757.1	6,758.1	-1.0	6,743.9	6,746.0	-2.1
1992	6,751.8	6,752.9	-1.1	6,722.9	6,728.9	-6.1
1993	6,753.4	6,755.6	-2.2	6,747.9	6,750.4	-2.5
1994	6,756.5	6,757.7	-1.2	6,722.5	6,727.8	-5.3
1995	6,763.3	6,758.7	4.6	6,757.8	6,750.9	6.9
1996	6,762.7	6,757.6	5.0	6,751.8	6,742.4	9.4
1997	6,763.7	6,758.7	5.0	6,755.8	6,748.1	7.7
1998	6,762.9	6,757.9	5.0	6,758.3	6,751.7	6.7
1999	6,763.6	6,758.5	5.1	6,754.7	6,746.6	8.1
2000	6,762.2	6,756.5	5.7	6,746.6	6,725.7	20.9
2001	6,756.2	6,750.2	6.0	6,721.2	6,725.3	-4.2
2002	6,742.1	6,748.3	-6.3	6,726.5	6,728.2	-1.8
2003	6,745.4	6,749.9	-4.5	6,725.8	6,732.5	-6.7
2004	6,748.0	6,753.0	-5.1	6,731.1	6,745.6	-14.5
2005	6,755.1	6,758.3	-3.2	6,743.3	6,750.3	-7.0
2006	6,755.9	6,757.7	-1.7	6,723.8	6,740.4	-16.6
2007	6,746.7	6,753.7	-7.0	6,722.5	6,734.6	-12.1
2008	6,748.2	6,754.6	-6.5	6,722.1	6,739.7	-17.6
2009	6,752.5	6,758.0	-5.5	6,731.2	6,746.4	-15.2
2010	6,745.1	6,757.2	-12.1	6,720.2	6,745.2	-24.9
2011	6,759.6	6,758.7	0.9	6,754.8	6,748.1	6.7
2012	6,762.4	6,757.0	5.4	6,747.6	6,733.9	13.7
2013	6,754.8	6,750.7	4.2	6,724.9	6,733.9	-9.0
2014	6,751.3	6,754.0	-2.7	6,727.5	6,746.2	-18.7
2015	6,751.2	6,757.9	-6.7	6,721.4	6,747.1	-25.7
2016	6,749.2	6,758.1	-8.9	6,723.5	6,744.8	-21.3
2017	6,763.8	6,758.9	4.9	6,758.4	6,751.7	6.7
2018	6,763.4	6,758.4	5.0	6,752.7	6,743.8	8.9
2019	6,762.6	6,757.6	5.0	6,755.6	6,747.8	7.8
10% Exceedance	6,763.4	6,758.7	4.7	6,756.0	6,750.4	5.6
50% Exceedance	6,755.7	6,757.6	-2.0	6,737.2	6,745.0	-7.8
90% Exceedance	6,746.5	6,750.6	-4.1	6,722.0	6,728.2	-6.2

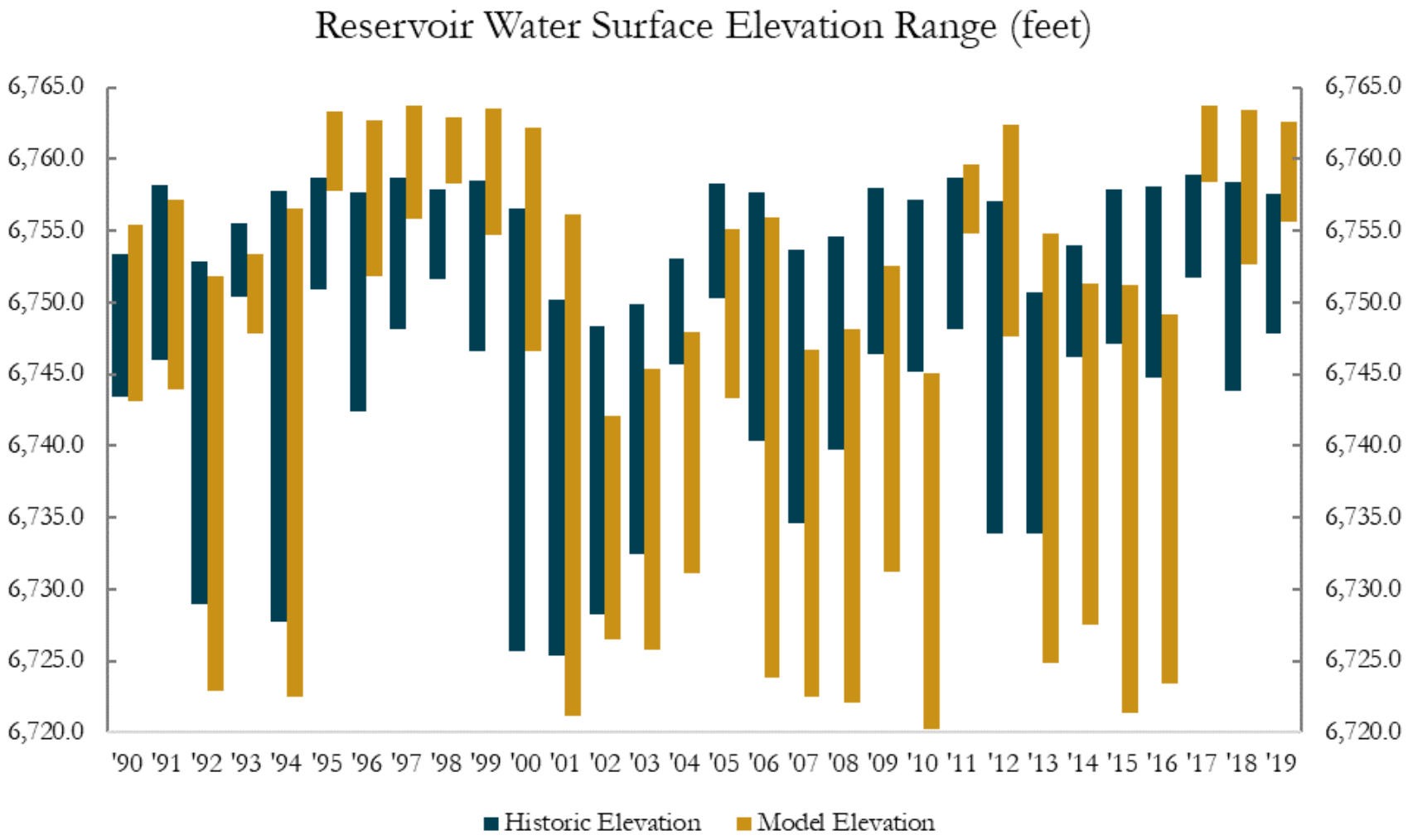


Figure 7. Maximum (top of bar) and September 30 (bottom of bar) reservoir water surface elevations, historic and modeled

Big Sandy Spillway Discharge and River Impacts

As would be anticipated, the model indicates that the enlarged Big Sandy Reservoir would capture some of the water that has historically discharged through the spillway. Table 5, Figure 8, and Figure 9 show the annual spillway discharge volumes and peak flows of the model compared to historic spillway discharge.

Big Sandy Reservoir spilled in 16 of the 30 years (53%) from 1990 thru 2019. Spill volumes varied greatly from year to year (from 200 to 45,900 acre-feet) as did peak discharges (from 10 to 990 cfs), with a 30-year total spillway discharge volume of approximately 193,900 acre-feet and 50 percent exceedance volume of 237 acre-feet.

The model indicates that with the reservoir enlargement, Big Sandy may likely spill (volumes from 200 to 34,100 acre-feet and peak discharges from 20 to 790 cfs) in 8 out of 30 years (27%) with a total spillway discharge volume of approximately 105,400 acre-feet and 50 percent exceedance volume of of 0 acre-feet. The model shows that in a series of wetter than average years, the enlarged reservoir would likely capture much of the historic spill in the first wet year (*e.g.*, 1995 and 2017) but having filled the additional storage in the first wet year would essentially spill the historic spill in subsequent wet years (*e.g.*, 1996, 1997, 1998, 1999, 2018, and 2019). The spill historically seen in or following individual wet years (*e.g.*, 2011) or the generally small spills in or following slightly wetter than typical years (*e.g.*, 1991, 2005 and 2006 (following wet 2004 and 2005), 2009, 2015 (following wet 2014), 2016) will very likely not be seen with the enlarged reservoir. Large (10 percent exceedance) spillway discharges will decrease approximately 4,400 acre-feet in volume (from 23,000 to 18,600 acre-feet, a 20% decrease) and 220 cfs in flow rate (from 700 to 480 cfs a 31% decrease).

Table 5. Total Annual Spillway Discharge Volumes and Peak Flows, Historic and from the Enlarged Reservoir Model

Year	Model Spill acre-feet	Historic Spill acre-feet	Model - Historic acre-feet	Model Spill cfs	Historic Spill cfs	Model - Historic cfs
1990	0	0	0	0	0	0
1991	0	3,549	-3,549	0	332	-332
1992	0	0	0	0	0	0
1993	0	0	0	0	0	0
1994	0	384	-384	0	47	-47
1995	7,285	22,903	-15,618	397	868	-471
1996	245	259	-14	33	30	3
1997	21,060	21,021	39	772	772	0
1998	1,532	1,573	-42	127	143	-16
1999	34,112	34,033	79	618	662	-44
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	9,925	-9,925	0	475	-475
2006	0	304	-304	0	27	-27
2007	0	0	0	0	0	0
2008	0	0	0	0	0	0
2009	0	3,711	-3,711	0	225	-225
2010	0	0	0	0	0	0
2011	0	19,956	-19,956	0	763	-763
2012	0	0	0	0	0	0
2013	0	0	0	0	0	0
2014	0	0	0	0	0	0
2015	0	3,192	-3,192	0	182	-182
2016	0	3,198	-3,198	0	297	-297
2017	18,363	45,878	-27,515	791	988	-197
2018	23,840	23,815	25	467	483	-16
2019	196	216	-19	21	13	8
Total	106,632	193,917	-87,285			
10% Exceedance	18,632	22,994	-4,362	482	764	-281
50% Exceedance	0	237	-237	0	20	-20
90% Exceedance	0	0	0	0	0	0

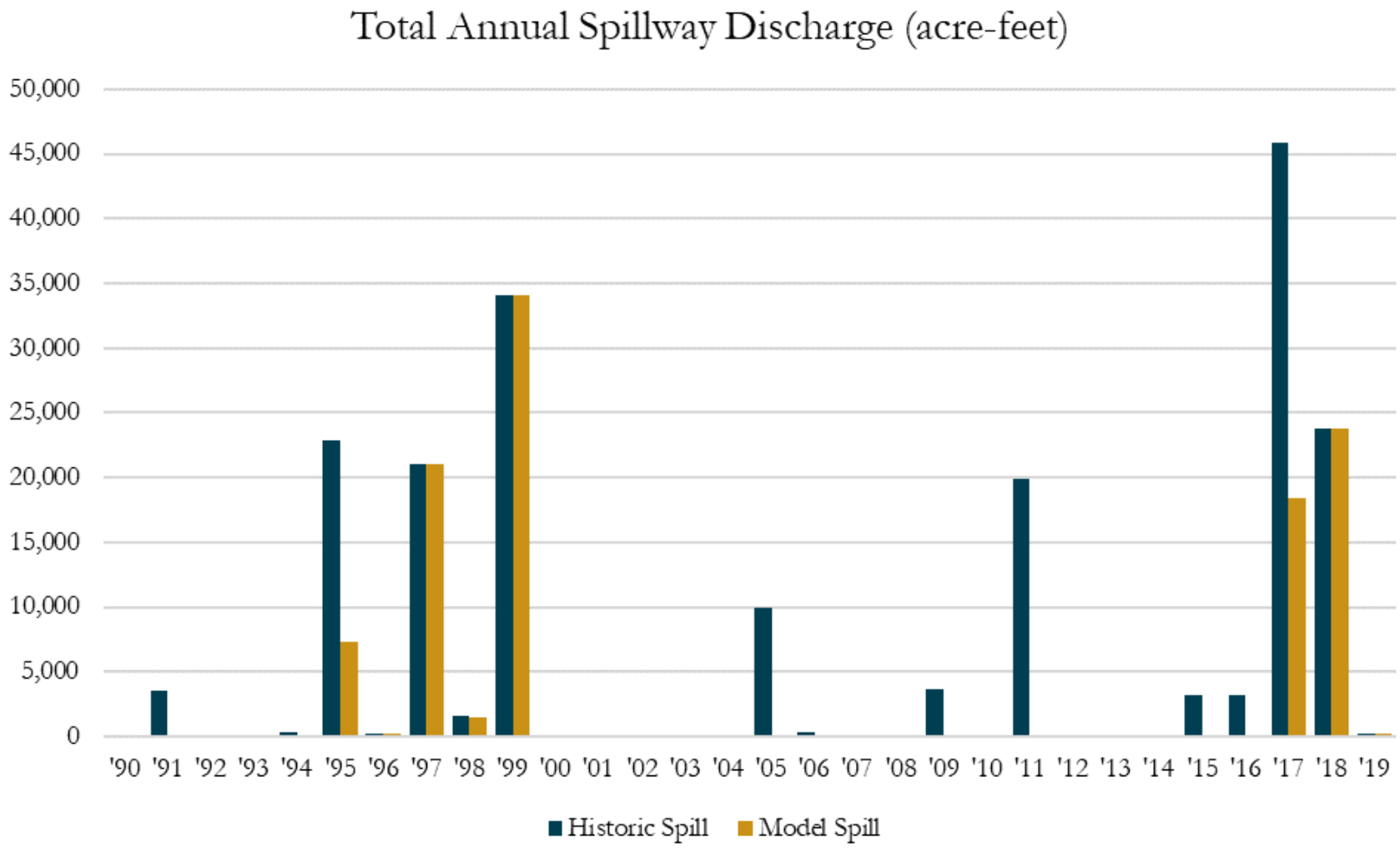


Figure 8. Total annual spillway discharge volumes, historic and from the enlarged reservoir model

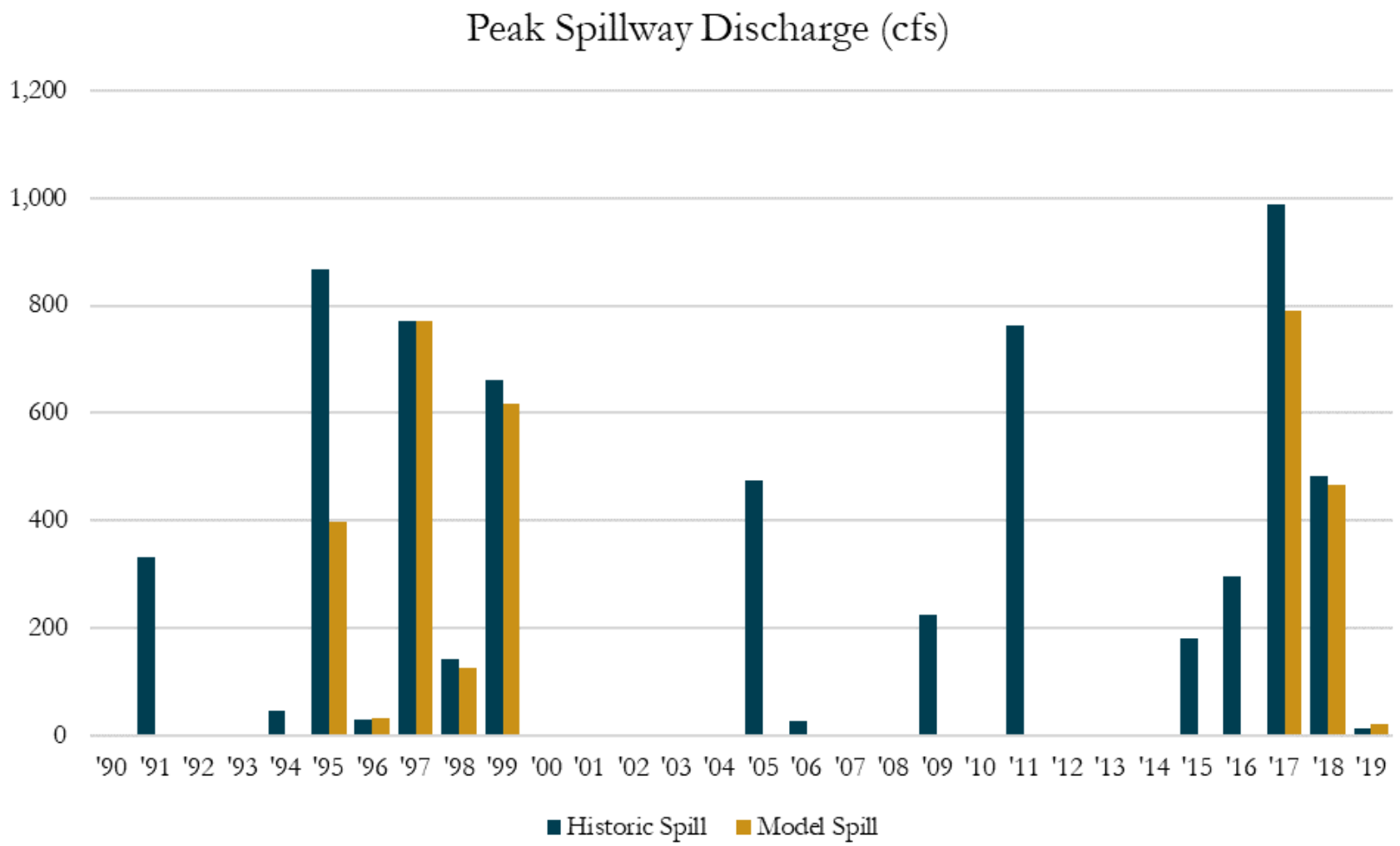


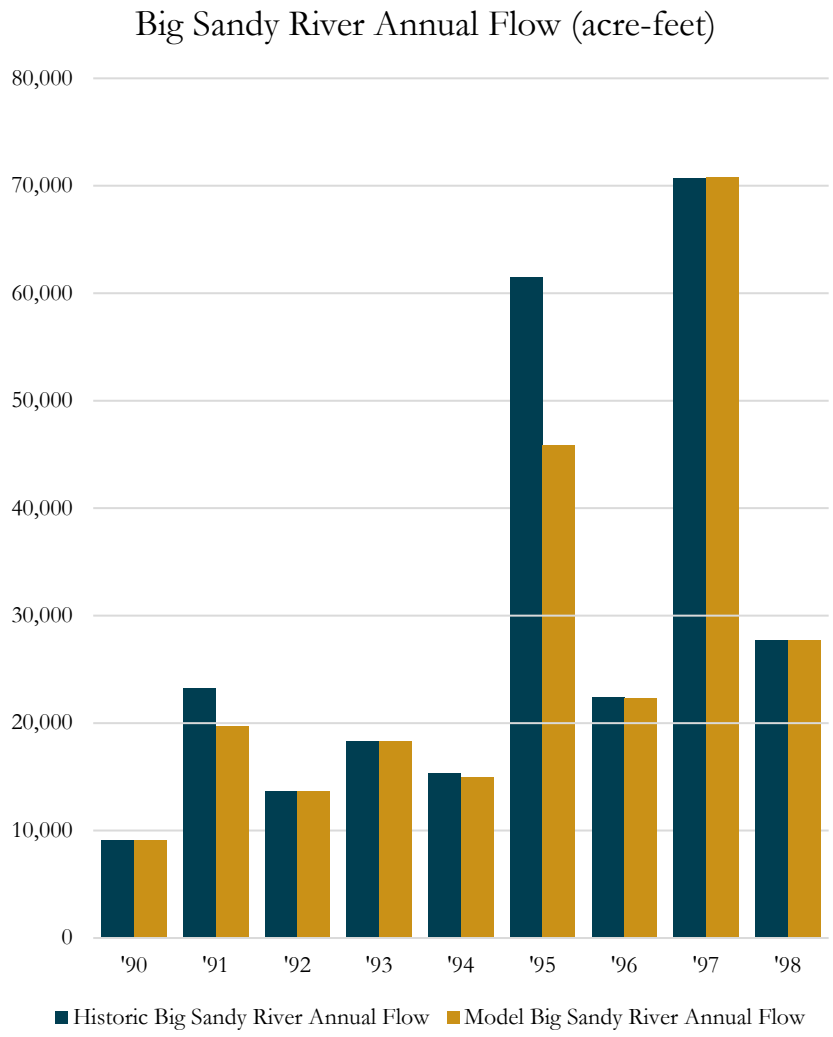
Figure 9. Annual peak daily average spillway discharge, historic and from the enlarged reservoir model

The impact of these potential changes in spillway discharge on rivers downstream were analyzed. For daily flow records at USGS stream gages on the Big Sandy River (USGS 09215550 Big Sandy River below Farson, WY) and Green River (USGS 09217000 Green River near Green River, WY) the computed historic Big Sandy Reservoir daily spillway discharge was subtracted from recorded USGS gage flows, then the model-computed daily spillway discharge for the reservoir enlargement were added back in and the resulting river flows were compared with historic flows. This approach does not account for additional return flows to the river from the increased irrigation releases from the enlarged reservoir in order to estimate worst-case impacts to downstream rivers.

Overall, the model indicates fairly minor impact to the Big Sandy River from the reservoir enlargement (see Table 6 and Figure 10). The total flow volume from 1990 thru 1998 (unfortunately, flow data for the USGS Big Sandy River gage were only measured until September 1999) would likely decrease by approximately 7% (from 261,750 to approximately 242,180 acre-feet) and peak flows would generally be unimpacted. Impacts to the Big Sandy River would be limited to years where much of what would historically spill would be captured by the enlarged reservoir like the first of a series of wet years, 1995. In 1995, the model indicates, that the Big Sandy River would likely see approximately 15,600 acre-feet (25%) less water due to the reservoir enlargement. In 1995, the Big Sandy River reached its peak flow of 900 cfs on March 12 before any Big Sandy Reservoir spillway discharge historically or in the model. The flows in the Big Sandy River during the high spillway discharge years of 1997 and 1999 would be essentially unchanged under the reservoir enlargement due to the reservoir in both the historic and modeled cases being relatively full due to the series of consecutive wet years. While Big Sandy River data was not measured for the 20 modeled years following 1999, it can reasonably be extrapolated that there would be some river flow impact in seven of the nine years that the reservoir spilled in the 20 years from 2000 to 2019. The impacts in 2011 and 2017 would likely be similar to the impact seen in 1995 (likely with some impact to peak flows), with a somewhat lesser impact in 2005. Impacts in 2009, 2015, and 2016 would likely be similar to the impact seen in 1991. The impact in 2006 would likely be similar to the minor impact seen in 1994. There would have been no impacts in 2000, 2001, 2002, 2003, 2004, 2007, 2008, 2010, 2012, 2013, 2014, 2018, or 2019 as the reservoir either didn't spill (historically or in the model) or spilled the same in the model as historically (in 2018 and 2019).

Table 6. Reservoir Enlargement Impacts on the Big Sandy River Annual Flow Volume and Peak

Year	Model Big Sandy River Annual Flow	Historic Big Sandy River Annual Flow	Model - Historic	Model Big Sandy River Peak Flow	Historic Big Sandy River Peak Flow	Model - Historic
	acre-feet	acre-feet	acre-feet	cfs	cfs	cfs
1990	9,107	9,107	0	40	40	0
1991	19,682	23,231	-3,549	220	510	-290
1992	13,683	13,683	0	160	160	0
1993	18,246	18,246	0	102	102	0
1994	14,898	15,282	-384	99	99	0
1995	45,846	61,463	-15,618	900	900	0
1996	22,335	22,349	-14	260	260	0
1997	70,734	70,695	39	1,410	1,410	0
1998	27,653	27,695	-42	190	190	0
1999				692	706	-14
Total	242,184	261,752	-19,567			
10% Exceedance	50,823	63,310	-12,486	951	951	0
50% Exceedance	19,682	22,349	-2,667	205	225	-20
90% Exceedance	12,768	12,768	0	93	93	0



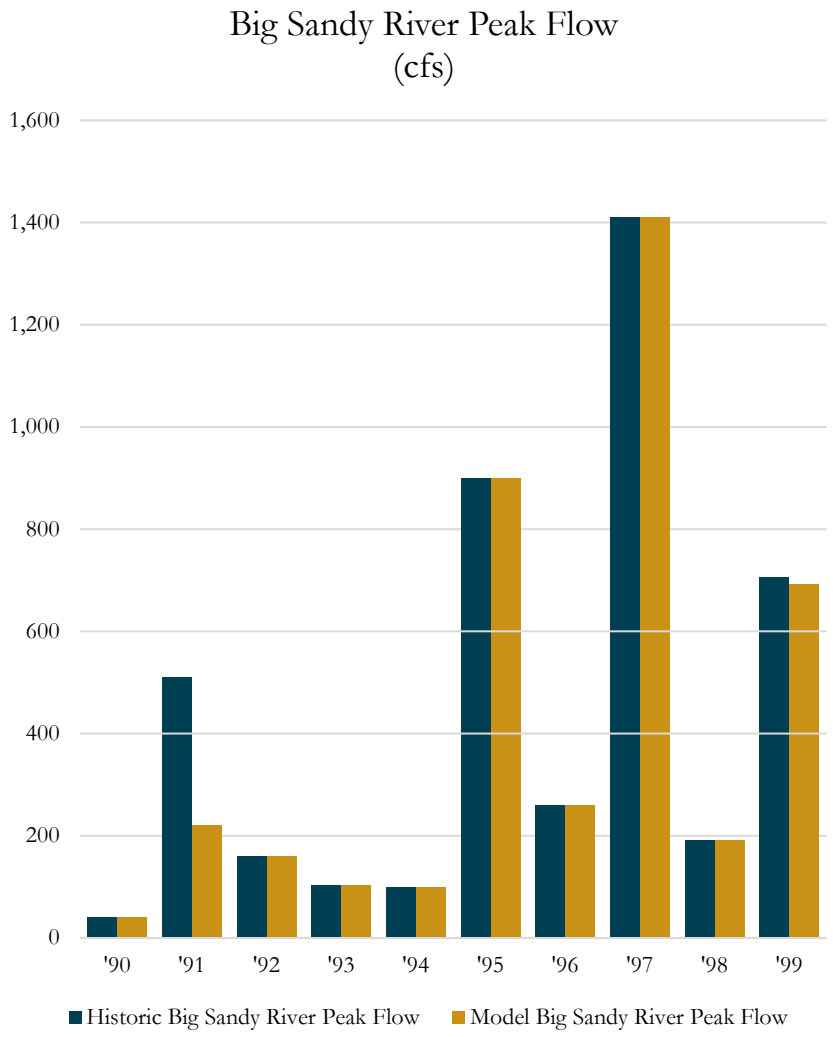


Figure 10. Reservoir enlargement impacts on the Big Sandy River annual flow volume (left) and peak (right)

The model indicates negligible impact to the Green River from the reservoir enlargement. Due to the relatively small size and hydrologic contribution of the Big Sandy River basin to the Green River basin, the proposed enlargement of Big Sandy Reservoir and the resulting impacts to spillway discharge volumes and peak flows would have essentially negligible impacts to the flows of the Green River (see Table 7, Figure 11, and Figure 12). The model indicates that the 30-year flow volume of the Green River near Green River, Wyoming (~31,573,000 acre-feet) would be decreased by less than one-third of one percent (0.3% or ~91,600 acre-feet) due to the enlargement. The 50 percent exceedance impacts indicate the enlargement would decrease Green River peak flows by less than one percent (0.74%); the greatest model impact to Green River peak flows (by decrease and percent decrease) was the reduction of the 1991 historic peak flow (9,070 cfs) by 3.0% (or 276 cfs).

Table 7. Reservoir Enlargement Impacts on the Green River Annual Flow Volume and Peak

Year	Model Green River Annual Flow acre-feet	Historic Green River Annual Flow acre-feet	Model - Historic acre-feet	Model Green River Peak Flow cfs	Historic Green River Peak Flow cfs	Model - Historic cfs
1990	757,905	762,269	-4,364	2,370	2,370	0
1991	995,325	998,874	-3,549	8,794	9,070	-276
1992	544,085	544,085	0	1,650	1,650	0
1993	1,127,942	1,127,942	0	4,610	4,610	0
1994	610,059	610,443	-384	1,540	1,540	0
1995	1,308,486	1,324,104	-15,618	7,073	7,100	-27
1996	1,453,560	1,453,574	-14	7,660	7,660	0
1997	1,805,427	1,805,388	39	11,785	11,800	-15
1998	1,432,016	1,432,057	-42	7,010	7,010	0
1999	1,711,229	1,711,150	79	9,191	9,220	-29
2000	783,589	783,589	0	1,660	1,660	0
2001	482,691	482,691	0	1,600	1,600	0
2002	444,180	444,180	0	1,480	1,480	0
2003	628,110	628,110	0	1,800	1,800	0
2004	760,139	760,139	0	3,220	3,220	0
2005	1,207,568	1,217,493	-9,925	6,434	6,510	-76
2006	864,559	864,863	-304	4,089	4,090	-1
2007	548,514	548,514	0	1,090	1,090	0
2008	783,976	783,976	0	4,400	4,400	0
2009	1,252,584	1,256,295	-3,711	8,707	8,860	-153
2010	718,199	718,199	0	2,820	2,820	0
2011	1,599,647	1,619,603	-19,956	9,383	9,620	-237
2012	733,396	733,396	0	3,040	3,040	0
2013	571,099	571,099	0	1,420	1,420	0
2014	1,413,462	1,413,462	0	8,120	8,120	0
2015	1,196,791	1,199,983	-3,192	7,301	7,450	-149
2016	965,097	968,295	-3,198	6,417	6,550	-133
2017	2,347,970	2,375,486	-27,515	10,528	10,500	28
2018	1,382,081	1,382,056	25	7,540	7,550	-10
2019	1,051,869	1,051,888	-19	6,498	6,500	-2
Total	31,481,554	31,573,202	-91,649			
10% Exceedance	1,610,805	1,628,758	-17,953	9,210	9,260	-50
50% Exceedance	980,211	983,584	-3,373	5,514	5,555	-41
90% Exceedance	548,071	548,071	0	1,534	1,534	0

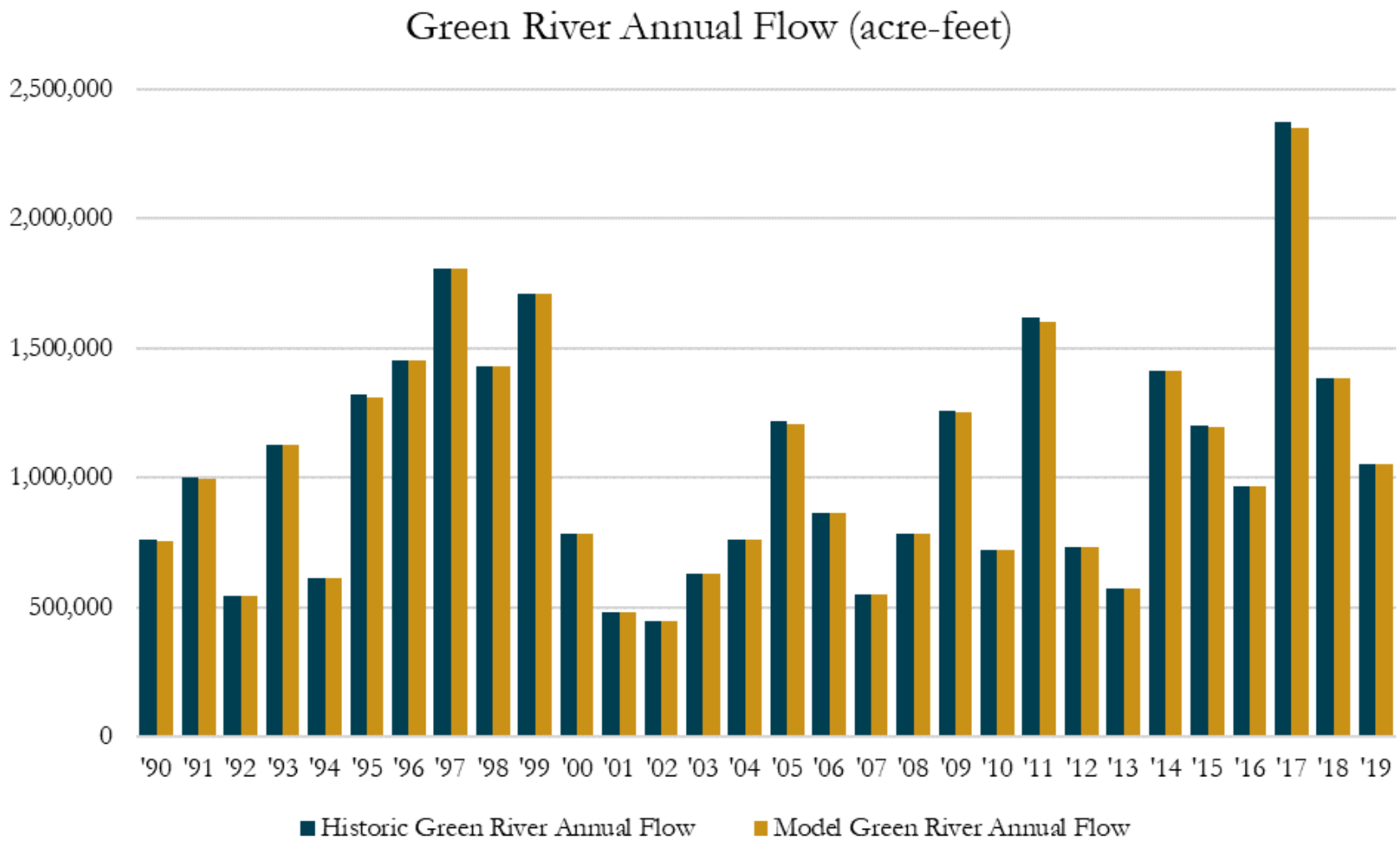


Figure 11. Reservoir enlargement impacts on the Big Sandy River annual flow volume

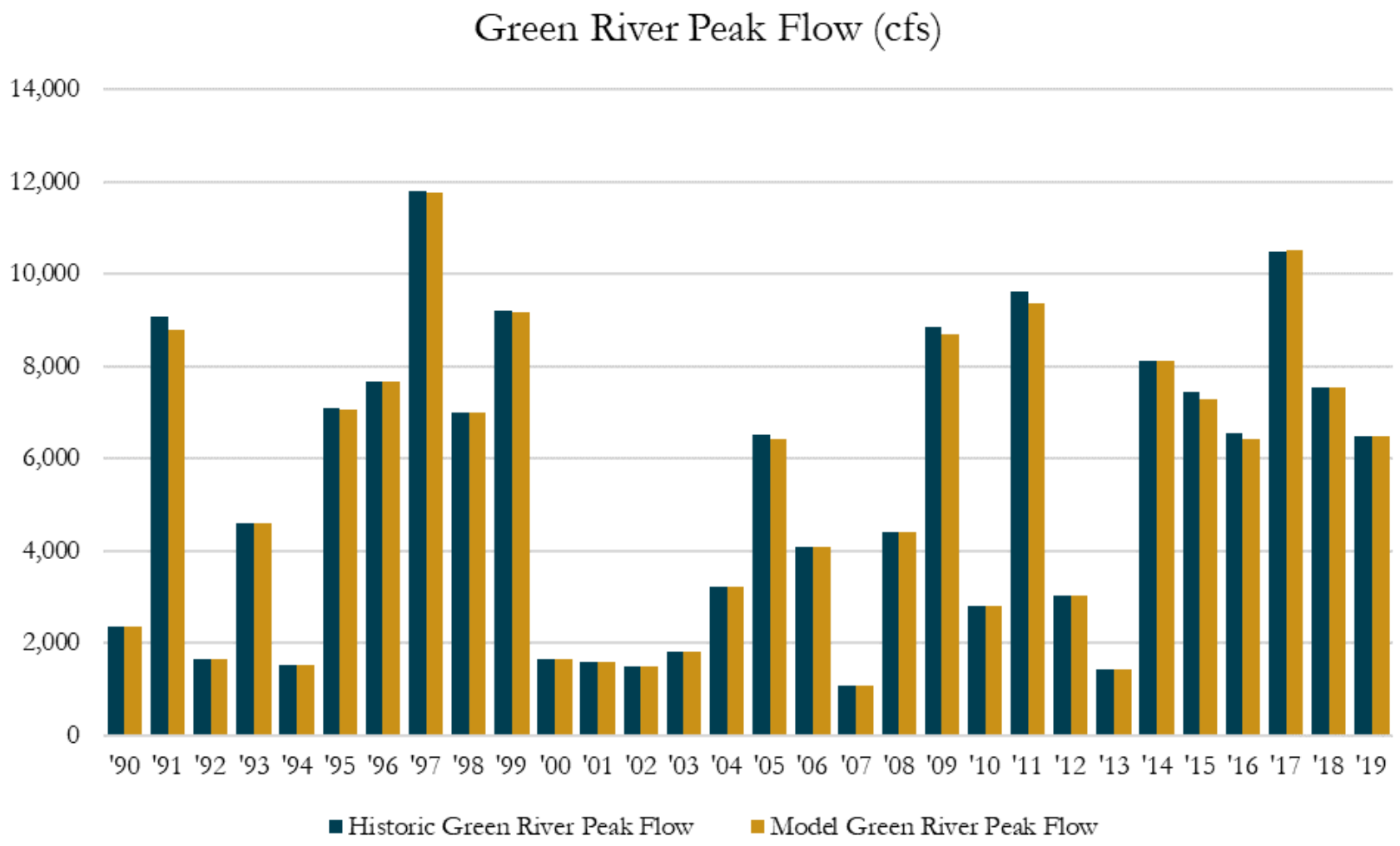


Figure 12. Reservoir enlargement impacts on the Big Sandy River annual flow peak

Conclusions

The basin and hydrology upstream of the enlarged Big Sandy Reservoir would remain in its essentially unaltered, natural condition. Based on the 2015 lidar survey data, the enlargement of Big Sandy Reservoir would allow for an additional 13,600 acre-feet of reservoir storage, a 35% increase from the current 38,700 acre-feet total storage. The enlarged reservoir would be able to release an additional 3,600 acre-feet (difference between 50 percent exceedance model and historic release volumes), store 11,500 acre-feet more water on March 30 in high storage (10 percent exceedance) years (and store less or roughly the same in low and normal storage years), and decrease the frequency of spillway use from 16 in 30 years (53%) to 8 in 30 years (27%). The decrease in spillway discharge would result in an approximately 7% decrease in flow volumes (not accounting for additional return flows from additional irrigation water use) with only minor impacts to peak river flows in the Big Sandy River (based on modeled and historic 1990-1999 USGS 09215550 Big Sandy River below Farson, WY data), and a negligible 0.3% decrease in flow volume and 0.74% decrease in 50 percent exceedance peak flows in the Green River (based on modeled and historic 1990-2019 USGS 09217000 Green River near Green River, WY data). The impacts of the enlarged Big Sandy Reservoir on surface water are anticipated to be minimal and local to Big Sandy Reservoir and the already heavily regulated Big Sandy River below the reservoir.

References

[1] Big Sandy Reservoir Enlargement Level II, Phase I Study Final Report, Wyoming Water Development Commission, Prepared by WENCK Associates, Inc., March 2017.

[2] Project Data, Water and Power Resources Service (Bureau of Reclamation), 1981.

[3] Comprehensive Facility Review, Big Sandy Dam, Bureau of Reclamation, Technical Service Center, Denver, CO, December 6, 2012.

[4] Annual Site Inspection, Big Sandy Dam, Bureau of Reclamation, Provo Area Office, Provo, UT, June 20, 2018.

[5] Design of Small Dams, third edition, Bureau of Reclamation, 1987

[6] Definite Plan Report, Eden Project Wyoming, Bureau of Reclamation, May 1953.

Appendix B – USFWS Biological Opinion

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
5353 Yellowstone Road, Suite 308A
Cheyenne, Wyoming 82009

MAY 0 9 2018

In Reply Refer To:
06E13000-2018-F-0174

Memorandum

To: Area Manager, Bureau of Reclamation, Provo Area Office, Provo, Utah

From: for Field Supervisor, U.S. Fish and Wildlife Service, Wyoming Field Office, Cheyenne, Wyoming

Subject: Big Sandy Reservoir Enlargement Project: Colorado River Depletions

In accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*), and the Interagency Cooperation Regulations (50 CFR 402), this document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion based on our review of the proposed Big Sandy Reservoir Enlargement Project (Project) located in Sublette and Sweetwater Counties, Wyoming, and its effects on the endangered Colorado pikeminnow (*Ptychocheilus lucius*), humpback chub (*Gila cypha*), bonytail (*Gila elegans*), and razorback sucker (*Xyrauchen texanus*) and their designated critical habitat. This Biological Opinion is in response to the Bureau of Reclamation's (Reclamation) March 23, 2018, request to initiate formal consultation for the Project.

The Reclamation proposes raising the reservoir spillway crest by 5 feet, increasing storage capacity. Reservoir enlargement would inundate an additional 500 acres of land. Associated Project actions include installing a toe drain and filter trench, installing a filter diaphragm, constructing a cement-bentonite wall, enlarging the headworks, and replacing the 6 drop structures. The storage rights and manages the water use contracts will be held by Reclamation. The action includes depletions of up to 2,435 acre-feet of water from the Colorado River Basin through evaporation and consumptive uses. The Service concurs that the proposed Project may adversely affect the endangered Colorado pikeminnow, humpback chub, bonytail, and razorback sucker, and their designated critical habitat.

On March 23, 2018, Reclamation requested formal consultation for the Project. A draft Biological Opinion was sent to Reclamation May 2, 2018. The Reclamation reviewed the draft Biological Opinion and provided comments on May 8.

We appreciate your efforts to ensure the conservation of endangered, threatened, and candidate species. If you have questions regarding this letter or your responsibilities under the ESA, please contact Lynn Gemlo of my office at the letterhead address or phone (307) 772-2374 extension 228.

Sincerely,

Tyler A. Abbott
Field Supervisor
Wyoming Field Office

Enclosure (Biological Opinion)

cc: BOR, Fish and Wildlife Biologist, Provo, UT (J. Baxter) (jbaxter@usbr.gov)
FWS, Acting Deputy Director Colorado River Recovery Program, Lakewood, CO (K. McAbee) (kevin_mcabee@fws.gov)
WGFD, Statewide Nongame Bird and Mammal Program Supervisor, Lander, WY (Z. Walker) (zack.walker@wyo.gov)
WGFD, Statewide Habitat Protection Program, Cheyenne, WY (wgfd.hpp@wyo.gov)

BIOLOGICAL OPINION

FOR BUREAU OF RECLAMATIONS'

BIG SANDY RESERVOIR ENLARGEMENT

PROJECT

06E13000-2018-F-0174

Prepared by:

U.S. Fish and Wildlife Service
Wyoming Ecological Services Field Office

For **Tyler A. Abbott**
Field Supervisor
Wyoming Field Office

May 9, 2018

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CONSULTATION HISTORY

On January 21-22, 1988, the Secretary of the Department of the Interior; the Governors of Wyoming, Colorado, and Utah; and the Administrator of the Western Area Power Administration signed a Cooperative Agreement to implement the "Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin" (USFWS 1987). In 2009, the Recovery Program was extended until September 30, 2023. The objective of the Recovery Program is to recover the listed species while water development continues in accordance with federal and state laws and interstate compacts.

In order to further define and clarify processes outlined in sections 4.1.5, 4.1.6, and 5.3.4 of the Recovery Program, a section 7 Agreement (Agreement) and a Recovery Implementation Program Recovery Action Plan (RIPRAP) was developed (USFWS 1993). The Agreement establishes a framework for conducting all future section 7 consultations on depletion impacts related to new projects and all impacts associated with historic projects in the Upper Basin. Procedures outlined in the Agreement are used to determine if sufficient progress is being accomplished in the recovery of the endangered fishes to enable the Recovery Program to serve as a reasonable and prudent alternative (RPA) to avoid jeopardy. The RIPRAP was finalized on October 15, 1993, and has been reviewed and updated annually.

In accordance with the 1993 Agreement, the Service annually assesses progress of the implementation of recovery actions to determine if progress toward recovery has been sufficient for the Recovery Program to serve as a RPA for projects that deplete water from the Colorado River. In the last review the Service determined that the Program has made sufficient progress to offset water depletions from individual projects up to 4,500 acre-feet/year. Therefore, it is appropriate for the Recovery Program actions to serve as Conservation Measures in the Project description for projects up to 4,500 acre-feet/year.

After many years of successful implementation of the Recovery Program and Agreement, federal action agencies have come to anticipate Recovery Program activities and a requirement of a financial contribution (for new depletions greater than 100 acre-feet) toward these activities serving as RPAs that must be included in their project planning to avoid jeopardy to listed species. Thus, the RPA has essentially become part of the proposed action. The Recovery Program activities will now serve as conservation measures within the proposed action and minimize adverse effects to listed species or critical habitat. The following excerpts summarize portions of the Recovery Program that address depletion impacts, section 7 consultation, and Project proponent responsibilities:

> "All future section 7 consultations completed after approval and implementation of this program (establishment of the Implementation Committee, provision of congressional funding, and initiation of the elements) will result in a one-time contribution to be paid to the Service by water Project proponents in the amount of $10.00 per acre-foot based on the average annual depletion of the Project . . . This figure will be adjusted annually for inflation [the current figure for FY2018 is $21.17 per acre-foot] . . . Concurrently with the completion of the Federal action which initiated the consultation, e.g., . . . issuance of a 404 permit,

> 10 percent of the total contribution will be provided. The balance . . . will be . . . due at the time the construction commences . . . ."

It is important to note that these provisions of the Recovery Program were based on appropriate legal protection of the instream flow needs of the endangered Colorado River fishes. Because Reclamation provides substantial funding for the Recovery Program, Reclamation projects are exempt from depletion fees.

The Recovery Program further states:

> ". . . it is necessary to protect and manage sufficient habitat to support self-sustaining populations of these species. One way to accomplish this is to provide long term protection of the habitat by acquiring or appropriating water rights to ensure instream flows. Since this program sets in place a mechanism and a commitment to assure that the instream flows are protected under State law, the Service will consider these elements under section 7 consultation as offsetting Project depletion impacts."

On March 23, 2018, the Bureau of Reclamation (Reclamation) requested formal consultation for the Project. A draft Biological Opinion was sent to Reclamation on May 2, 2018. The Reclamation reviewed the draft Biological Opinion and provided comments on May 8.

BIOLOGICAL OPINION

This biological opinion addresses an average annual depletion of 2,435 acre-feet (includes 955 acre-feet due to evaporation and 1,480 acre-feet for irrigation) of water from the Upper Colorado River Basin. Water depletions in the Upper Basin have been recognized as a major source of impact to endangered fish species. Continued water withdrawal has restricted the ability of the Colorado River system to produce flow conditions required by various life stages of the fishes.

Critical habitat has been designated for the Colorado pikeminnow (*Ptychocheilus lucius*), humpback chub (*Gila cypha*), bonytail (*Gila elegans*), and razorback sucker (*Xyrauchen texanus*) within the 100-year floodplain in portions of their historic range (59 FR 13374). On February 11, 2016, the Service published a final rule establishing a new regulatory definition (FR Feb. 11, 2016, Vol. 81, No.28) for destruction and adverse modification of critical habitat, which means a direct or indirect alteration that appreciably diminishes the value of critical habitat. In considering the biological basis for designating critical habitat, the Service focused on the primary physical and biological elements that are essential to the conservation of the species without consideration of land or water ownership or management. The Service has identified water, physical habitat, and biological environment as the primary constituent elements (PCE). This includes a quantity of water of sufficient quality that is delivered to a specific location in accordance with a hydrologic regime that is required for the particular life stage for each species. Water depletions reduce the ability of the river system to provide the required water quantity and hydrologic regime necessary for recovery of the fishes. The physical habitat includes areas of the Colorado River system that are inhabited or potentially habitable for use in spawning and feeding, as a nursery, or serve as corridors between these areas. In addition, oxbows,

backwaters, and other areas in the 100-year flood plain, when inundated, provide access to spawning, nursery, feeding, and rearing habitats.

DESCRIPTION OF THE PROPOSED ACTION

ACTION AREA

Our regulations define the action area as all areas directly or indirectly affected by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). Water depletions associated with the proposed Big Sandy Reservoir Enlargement Project (Project) will result in a loss of water from the Upper Colorado River Basin.

PROJECT DESCRIPTION

The Reclamation as the Project proponent, proposes raising the reservoir spillway crest by 5 feet, increasing the reservoir's storage capacity. Reservoir enlargement would inundate an additional 500 acres of land. Associated Project actions include installing a toe drain and filter trench, installing a filter diaphragm, constructing a cement-bentonite wall, enlarging the headworks, and replacing the 6 drop structures. The storage rights and manages the water use contracts will be held by Reclamation. The action includes depletions of up to 2,435 acre-feet of water from the Colorado River Basin through evaporation (955 acre-feet) and consumptive use for irrigation (1,480 acre-feet). The Service concurs that the proposed Project may adversely affect the endangered Colorado pikeminnow, humpback chub, bonytail, and razorback sucker, and their designated critical habitat.

CONSERVATION MEASURES

Conservation measures are actions that the action agency and applicant agree to implement to further the recovery of the species under review. The beneficial effects of conservation measures are taken into consideration for determining both jeopardy and adverse modification analyses. As explained in the Consultation History section, the Recovery Program is intended to implement actions that are needed to recover the endangered fishes and avoid jeopardy and adverse modification of critical habitat. Included in the Recovery Program is a requirement for project proponents of projects that cause water depletions greater than 100 acre-feet per year to make monetary contributions to the Recovery Program. Because Reclamation provides substantial funding for the Recovery Program, Reclamation projects are exempt from depletion fees.

The following are conservation measures for this Project: The Recovery Program will serve as conservation measures to minimize adverse effects to the endangered fishes and their critical habitat caused by the Project's water depletions. Depletion impacts can be offset by completing activities necessary to recover the endangered fishes as specified under the Recovery Implementation Program Recovery Action Plan (RIPRAP) and the Project proponent's one-time contribution to the Recovery Program for new depletions greater than 100 acre-feet per year.

NEW DEPLETION

As the Project's average annual new depletion of 2,435 acre-feet is below the current sufficient progress threshold of 4,500 acre-feet, the Recovery Program will serve as conservation measures to minimize adverse effects to the Colorado pikeminnow, razorback sucker, humpback chub, and bonytail and designated critical habitat caused by the Project's new depletion.

STATUS OF THE SPECIES AND CRITICAL HABITAT

The purpose of this section is to summarize the best available information regarding the current range wide status of the listed fish species. Additional information regarding listed species may be obtained from the sources of information cited for these species[1].

COLORADO PIKEMINNOW

SPECIES DESCRIPTION

The Colorado pikeminnow (*Ptychocheilus lucius*) is the largest cyprinid fish (minnow family) native to North America and evolved as the main predator in the Colorado River system. Individuals begin consuming other fish for food at an early age and rarely eat anything else (Sigler and Sigler 1996). It is a long, slender, cylindrical fish with silvery sides, greenish back, and creamy white belly (Sigler and Sigler 1996). Historically, individuals may have grown as large as 6 feet long and weighed up to 100 pounds (estimates based on skeletal remains) (Sigler and Miller 1963), but today individuals rarely exceed 3 feet or weigh more than 18 pounds (Osmundson et al. 1997).

The species is endemic to the Colorado River Basin, where it was once widespread and abundant in warm water rivers and tributaries from Wyoming, Utah, New Mexico, and Colorado downstream to Arizona, Nevada, and California (multiple citations in U.S. Fish and Wildlife Service 2002b). Currently, wild populations of pikeminnow occur only in the Upper Colorado River Basin (above Lake Powell) and the species occupies only 25 percent of its historic range-wide habitat (U.S. Fish and Wildlife Service 2002b). Colorado pikeminnow are long distance migrators, moving hundreds of miles to and from spawning areas, and requiring long sections of river with unimpeded passage. They are adapted to desert river hydrology characterized by large spring peaks of snow-melt runoff and low, relatively stable base flows.

The Office of Endangered Species first included the Colorado pikeminnow (as the Colorado squawfish) in the List of Endangered Species on March 11, 1967 (32 FR 4001). It is currently protected under the Endangered Species Act of 1973 as an endangered species throughout its range, except the Salt and Verde River drainages in Arizona. The Service finalized the latest recovery plan for the species in 2002 (U.S. Fish and Wildlife Service 2002b) but is currently drafting an updated revision.

The Service designated six reaches of the Colorado River System as critical habitat for the Colorado pikeminnow on March 21, 1994 (59 FR 13374). These reaches total 1,148 miles as measured along the center line of each reach. Designated critical habitat makes up about 29 percent of the species' historic range and occurs exclusively in the Upper Colorado River Basin. Portions of the Colorado, Gunnison, Green, Yampa, White, and San Juan Rivers are designated critical habitat. The PCEs of the critical habitat are water, physical habitat, and the biological environment (59 FR 13374).
Water includes a quantity of water of sufficient quality delivered to a specific location in accordance with a hydrologic regime required for the species. The physical habitat includes

[1] The latest recovery goals for all four endangered fish, which provide information on species background, life history, and threats, can be found on the internet at: http://www.coloradoriverrecovery.org/documents-publications/foundational-documents/recovery-goals.html

areas of the Colorado River system that are inhabited or potentially habitable for use in spawning and feeding, as a nursery, or serve as corridors between these areas. This includes oxbows, backwaters, and other areas in the 100-year floodplain that provide access to spawning, nursery, feeding, and rearing habitats when inundated. The biological environment includes food supply, predation, and competition from other species.

Recovery of Colorado pikeminnow in the Colorado River Basin is considered necessary only in the Upper Colorado River Basin (above Glen Canyon Dam, including the San Juan, and Green River sub-basins) because of the present status of populations and because existing information on Colorado pikeminnow biology supports application of the metapopulation concept to extant populations (U.S. Fish and Wildlife Service 2002b). As a result, this biological opinion will focus on the status of the Colorado pikeminnow in that unit.

LIFE HISTORY

The Colorado pikeminnow requires relatively warm waters for spawning, egg incubation, and survival of young. Males become sexually mature at approximately 6 years of age, which corresponds to a length of about 400 millimeters (mm) (17 inches), and females mature one year later (Sigler and Sigler 1996).

Mature adults migrate to established spawning areas in late spring as water temperatures begin to warm, with migration events up to 745 river kilometers (km) round-trip on record (463 miles) (Bestgen et al. 2005). Spawning typically begins after peak flows have subsided and water temperatures are above 16° Celsius (°C) (60.8° Fahrenheit (°F)) (multiple references in Bestgen et al. 2005). Mature adults deposit eggs over gravel substrate through broadcast spawning and eggs generally hatch within 4 to 6 days (multiple references in Bestgen et al. 2005). River flows then carry emerging larvae fish (6.0 to 7.5 mm long (0.2 to 0.3 inches)) downstream 40 to 200 km (25 to 125 miles), to nursery backwaters, where they remain for the first year of life (U.S. Fish and Wildlife Service 2002b).

Colorado pikeminnow reach lengths of approximately 70 mm by age 1 (juveniles) (2.8 inches), 230 mm by age 3 (subadults) (9 inches), and 420 mm by age 6 (adults) (16.5 inches), with mean annual growth rates of adult and subadult fish slowing as fish become older (Osmundson et al. 1997). The largest fish reach lengths between 900 and 1000 mm (35 to 39 inches); these fish are quite old, likely being 47 to 55 years old with a minimum of 34 years (Osmundson et al. 1997). Reproductive success and recruitment of Colorado pikeminnow is pulsed, with certain years having highly successful productivity and other years marked by failed or low success (U.S. Fish and Wildlife Service 2002b). The most successful years produce a large cohort of individuals that is apparent in the population over time. Once individuals reach adulthood, approximately 80 to 90 percent of adults greater than 500 mm (20 inches) survive each year (Osmundson et al. 1997; Osmundson and White 2009). Strong cohorts, high adult survivorship, and extreme longevity are likely life history strategies that allow the species to survive in highly variable ecological conditions of desert rivers.

POPULATION DYNAMICS

Population dynamics of the Colorado pikeminnow are measured separately in the Green, upper Colorado, and San Juan River basins, because distinct recovery criteria are delineated for each of these three basins (U.S. Fish and Wildlife Service 2002b). In the 2002 recovery plan, initial abundance estimates for wild adults in the basins were: upper Colorado River, 600 to 900;

Green River, 6,000 to 8,000; and San Juan River, 19 to 50 (circa 2000 references for individual rivers found in U.S. Fish and Wildlife Service 2002b).

UPPER COLORADO RIVER – To monitor recovery of the Colorado pikeminnow, the Recovery Program conducts multiple-pass, capture-recapture sampling on two stretches of the upper Colorado River which are roughly above and below Westwater Canyon (Osmundson and White 2009). In the most recent summary of the data (Osmundson and White 2014) the principal investigators conclude that during the 19-year study period [1992-2010], the population remained self-sustaining. The current downlisting demographic criteria for Colorado pikeminnow (U.S. Fish and Wildlife Service 2002b) in the Upper Colorado River Subbasin is a self-sustaining population of at least 700 adults maintained over a 5-year period, with a trend in adult point estimates that does not decline significantly. Secondarily, recruitment of age-6 (400-449 mm Total Length (TL)), naturally produced fish must equal or exceed mean adult annual mortality (estimated to be about 20 percent). The average of all adult estimates (1992-2010) is 644. The average of the five most recent annual adult population estimates is 658. Osmundson and White (2014) determined that recruitment rates were less than annual adult mortality in six years and exceeded adult mortality in the other six years when sampling occurred. The estimated net gain for the 12 years studied was 32 fish >450 mm TL. Whereas the Colorado River population appears to meet the trend or 'self-sustainability' criterion, it has not met the abundance criteria of 'at least 700 adults' during the most recent five year period (Service 2015a).

Elverud and Ryden (2015) report that of the 203 individual Colorado pikeminnow collected in 2015, 81 (40%) were juvenile fish (<399 mm TL), indicating a pulse of sub-adults recruiting into the adult portion of the population. All of the 81 individual juvenile Colorado pikeminnow were between 300–399 mm TL. Twenty (10%) of the 203 individual Colorado pikeminnow were sub-adults (400-449 mm TL). The remaining 102 individual Colorado pikeminnow captured in 2015 were adult size (>450 mm TL). The adult Colorado pikeminnow ranged from 451 mm TL to 928 mm TL. No Colorado pikeminnow were collected in 2015 that were below the minimum size (150 mm TL) to be PIT-tagged. A healthy number of Colorado pikeminnow spawned 4-5 years ago are poised to enter the adult cohort. These recruit-sized Colorado pikeminnow present in the system today have largely made it through the gauntlet of troublesome densities of smallmouth bass and the relatively recent influx of nonnative walleye in the lower Colorado River. However, Recovery Program researchers can only speculate how much stronger the current pulse of recruitment would have been in the absence of these nonnative predators. Nonnative predation and competition is currently considered the greatest threat to the Colorado pikeminnow population in the Colorado River Subbasin.

Elverud and Ryden (2015) cautioned that the absence of Colorado pikeminnow less than 300 mm TL in the collections from 2015 suggests spawning success and/or recruitment has been poor the previous three years. Osmundson and White (2014) also expressed concern that pulses of recruitment in this population are too infrequent to provide the recruitment needed to offset adult mortality in the long term. However, some encouraging captures of age-0 Colorado pikeminnow in recent years, particularly in 2015, are discussed below.

To summarize, in the Upper Colorado River Subbasin, the Colorado pikeminnow subpopulation may be self-sustaining, but the number of adults is below the level needed for recovery.

Recruitment is quite variable over time, but has exceeded adult mortality in approximately half of the years when measured over the past two decades. The number of age-0 (young of year) Colorado pikeminnow is also quite variable over time, but appears to be less, on average, since the year 2000 than prior to 2000. Colorado pikeminnow are also generally distributed throughout the Colorado River now to the same extent that they were when they became listed.

GREEN RIVER – Population estimates for adult Colorado pikeminnow in the Green River subbasin began in 2000. Sampling occurs on the mainstem Green River from the Yampa confluence to the confluence with the Colorado River and includes the Yampa and White Rivers. The initial year of sampling did not include the lower Green River (near the confluence of the White River to the confluence with the Colorado River). Beginning in 2001, the sampling regime has consisted of three years of estimates followed by two years of no estimates (Bestgen et al. 2005). The first set of estimates showed a declining trend (2000-2003); however, the most recent interpretation (Bestgen et al.; in review) of estimates collected in 2006-2008 and 2011-2013 reveal a gradual but persistent decline in the adult population. Data from the third round (2011-2013) of population estimates for the Green River subbasin are still being analyzed (Bestgen et al. 2013). Preliminary results from Bestgen (2013) analysis indicate adults and sub-adults are decreasing throughout the entire Green River subbasin (U.S. Fish and Wildlife Service 2014b).

The downlisting demographic criteria for Colorado pikeminnow in the Green River Subbasin require that separate adult point estimates for the middle Green River (including the Yampa and White river sub-populations) and lower Green River do not decline significantly over a 5-year period, and each estimate for the Green River Subbasin exceeds 2,600 adults (estimated minimum viable population [MVP] number). The average of all estimates (1991-2013; including the CPUE-derived estimates) is 3,083 adult Colorado pikeminnow. The average of the more robust M/R population estimates (2000-2013) is 2,859 adults. The average of the three most recent M/R population estimates (2011-2013) is 1,999 adults. Despite a positive trend in the subbasin population in the early years of the Recovery Program (1991-2000), the most recent trend is clearly negative (causes for this recent decline and the Recovery Program's responses are discussed below).

Population estimation resumed throughout the Green River Sub-basin in 2016 and will continue in 2017 and 2018. Another demographic requirement in the 2002 Recovery Goals is that recruitment of age-6; naturally-produced fish must equal or exceed mean annual adult mortality. Estimates of recruitment age fish (subadults; 400-449mm TL) have averaged 1,455 since 2001, but have varied widely. Recruitment exceeded annual adult mortality only during the 2006-2008 periods. The numbers of recruits throughout the Green River Subbasin were high in 2011, but declined in subsequent years.

Bestgen et al. 2016 recognized that the mechanism driving frequency and strength of recruitment events was likely the strength of age-0 Colorado pikeminnow production in backwater nursery habitats. More specifically, they recognized the importance of considering multiple consecutive years of age-0 densities to describe adult densities 7-10 years later. Osmundson and White (2014) saw a similar relationship between a strong age-0 cohort in 1986 and subsequent recruitment of late juveniles five years later, but that relationship was more tenuous in later years. Researchers are particularly concerned with what appears to be very weak age-0 representation in the Middle Green reach (1994 through 2008) and in the lower Colorado River

(2001 through 2008). Bestgen and Hill (2016) reviewed fall densities of age-0 Colorado pikeminnow collected in the middle and lower Green River that date back to 1979. They compared those densities to August and September base flows and discovered that declines in summer base flow magnitude were correlated with declining densities of age-0 Colorado pikeminnow in both reaches. As a result, they recommended new base flow magnitudes to support increased age-0 production. Specifically, base flows between 1,700-3,000 cfs in the middle Green River, and 1,700-3,800 cfs in the lower Green River, increase the frequency and magnitude of age-0 Colorado pikeminnow production.

BASIN-WIDE STATUS AND DISTRIBUTION

In the upper Colorado and Green river sub-basins, Colorado pikeminnow exist as wild populations with no support from stocking hatchery-reared fish. The Recovery Program monitors the adult abundance of this species under a number of independent projects. Adult Colorado pikeminnow abundance in the Colorado River sub-basin increased from 1992 – 2005, but has declined since 2005; similarly, adult abundances in the Green River sub-basin increased from 1991 to 2000 but has declined since 2000 (Table 1). Although populations have declined over the past 10-20 years, this species still supports itself through wild reproduction and recruitment. In the Colorado River sub-basin, recruitment appears adequate to support a sustainable population. However, in the Green River sub-basin, recruitment has declined over the past 15 years and does not appear sufficient to support a sustainable population.

Table 1. Summary of Colorado pikeminnow status and trends.

Subbasin	Life Stage	2002 Recovery Goal Downlisting Criteria[2]	Long-term[3] abundance / trend	Short-term abundance / trend; 5 most recent data points	Summary
Colorado River	**Adults (≥450 mm TL)**	N = >700 individuals.	N = 596.	N = 446.	Population increased from 1999–2005; declined since 2005.
	Recruits (400–449 mm TL)	Estimates exceed annual adult mortality.	Criteria met in roughly 50% of years, consistent with indications of long-term stability in the adult population.	Criteria likely not met in recent years, consistent with recent declines in the adult population.	Criteria appear to have been met in many but not all years, consistent with a fluctuating population that demonstrates general long-term stability.
	Age-0	N/A (no specific recovery goal criteria for this life stage).	Densities dropped in 2001 and remained low through 2008.	Relatively low since mid-1990s, but a record high catch in 2015 and above average in 2016.	Pulses of recruitment may not be frequent enough to support stability in the adult populations in the long term.
Green River	**Adults (>450 mm TL)**	N = >2,600 individuals.	N = 2,859 (average of 10 point estimates since 2000).	N = 2,267 (average of 5 estimates 2007–2012).	Incorporating earlier CPUE data: population increased 1991–2000; declined since 2000.
	Recruits (400–449 mm TL)	Estimates exceed annual adult mortality.	Number of recruits has fluctuated greatly since 2000, but averages near 400 individuals. Average annual abundances of recruits not sufficient to offset adult		Precision of estimates varies greatly; recruitment appears insufficient to offset overall adult

1 Please see Recovery Goals (USFWS 2002a) for a complete description of demographic requirements.

2 "Long-term" refers to all Recovery Program monitoring information, which varies between subbasins and by life stage.

RAZORBACK SUCKER

SPECIES DESCRIPTION

The largest native sucker to the western United States, the razorback sucker (*Xyrauchen texanus*) is a robust, river catostomid endemic to the Colorado River Basin (Sigler and Sigler 1996; U.S. Fish and Wildlife Service 2002d). The species feeds primarily on algae, aquatic insects, and other available aquatic macroinvertebrates using their ventral mouths and fleshy lips (Sigler and Sigler 1996). Adults can be identified by olive to dark brown coloration above, with pink to reddish brown sides and a bony, sharp-edged dorsal keel immediately posterior to the head, which is not present in the young (Sigler and Sigler 1996). The species can reach lengths of 3 feet and weights of 16 pounds (7.3 kilogram), but the maximum weight of recently captured fish is 11 to 13 pounds (5 to 6 kilogram) (Sigler and Sigler 1996; U.S. Fish and Wildlife Service 2002d). Taxonomically, the species is unique, belonging to the monotypic genus *Xyrauchen*, meaning that razorback sucker is the only species in the genus (U.S. Fish and Wildlife Service 2002d).

Historically, the razorback sucker occupied the mainstem Colorado River and many of its tributaries from northern Mexico through Arizona and Utah into Wyoming, Colorado, and New Mexico (U.S. Fish and Wildlife Service 2002b). In the late 19th and early 20th centuries, it was abundant in the Lower Colorado River Basin and common in parts of the Upper Colorado River Basin, with numbers apparently declining with distance upstream (U.S. Fish and Wildlife Service 2002b). Bestgen (1990) reported that this species was once so numerous that it was commonly used as food by early settlers and that a commercially marketable quantity was caught in Arizona as recently as 1949. Distribution and abundance of razorback sucker declined throughout the 20th century across its historic range, and the species now exists naturally only in a few small, unconnected populations or as dispersed individuals. Specifically, razorback sucker are currently found in small numbers in the Green River, upper Colorado River, and San Juan River sub-basins; the lower Colorado River between Lake Havasu and Davis Dam; Lakes Mead and Mohave; in small tributaries of the Gila River sub-basin (Verde River, Salt River, and Fossil Creek); and in local areas under intensive management such as Cibola High Levee Pond, Achii Hanyo Native Fish Facility, and Parker Strip (U.S. Fish and Wildlife Service 2002b).

The razorback sucker is listed as endangered under the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 et. seq.), under a final rule published on October 23, 1991 (56 FR 54957). The Service finalized the latest recovery plan for the species in 2002 (U.S. Fish and Wildlife Service 2002d) but is currently drafting an updated revision.

The Service's 5-year status review of razorback sucker completed in 2012 reported that 85% of the downlisting recovery factor criteria (U.S. Fish and Wildlife Service 2002c) have been addressed to varying degrees. The Recovery Program (in coordination with the San Juan River Basin Recovery Implementation Program, the Glen Canyon Dam Adaptive Management Program, and the Lower Colorado River Multi-Species Conservation Program) initiated a Species Status Assessment in 2015, which may be completed in FY18. This SSA will serve as the basis for a 5-year status review to be completed the same year.

Fifteen reaches of the Colorado River system were designated as critical habitat for the razorback sucker on March 21, 1994 (59 FR 13374). These reaches total 2,776 kilometer (1,724 miles) as measured along the center line of the river within the subject reaches. Designated critical habitat makes up about 49% of the species' original range and occurs in both the Upper and Lower

Colorado River Basins. In the Upper Basin, critical habitat is designated for portions of the Green, Yampa, Duchesne, Colorado, White, Gunnison, and San Juan Rivers. Portions of the Colorado, Gila, Salt, and Verde Rivers are designated in the Lower Basin. The PCEs are the same as those described for Colorado pikeminnow.

Separate, objective recovery criteria were developed for each of two recovery units (the Upper Colorado and Lower Colorado River Basins as delineated at Glen Canyon Dam) to address unique threats and site specific management actions necessary to minimize or remove those threats. This biological opinion's focus is on the Upper Colorado River Basin recovery unit and will therefore describe the status of the razorback sucker in that unit.

LIFE HISTORY

Except during periods before and after spawning, adult razorback sucker are thought to be relatively sedentary and have high fidelity to overwintering sites (U.S. Fish and Wildlife Service 2002d). Adults become sexually mature at approximately 4 years and lengths of 400 mm (16 inches) (Zelasko et al. 2009), at which time they travel long distances to reach spawning sites (U.S. Fish and Wildlife Service 2002d). Mature adults breed in spring (mostly April-June) on the ascending limb of the hydrograph, congregating over cobble/gravel bars, backwaters, and impounded tributary mouths near spawning sites (multiple in U.S. Fish and Wildlife Service 2002d; Snyder and Muth 2004; Zelasko et al. 2009). Flow and water temperature cues may play an important role prompting razorback adults to aggregate prior to spawning (Muth et al. 2000).

Razorback sucker have high reproductive potential, with reported average female fecundity of approximately 50,000 to 100,000 eggs per fish (U.S. Fish and Wildlife Service 2002d). They are broadcast spawners that scatter adhesive eggs over gravel-cobble substrate (Snyder and Muth 2004). High springs flows are important to egg survival because they remove fine sediment that can otherwise suffocate eggs. Hatching is limited at temperatures less than 10°C (50° F) and best around 20°C (68° F) (Snyder and Muth 2004). Eggs hatch 6 to 11 days after being deposited and larval fish occupy the sediment for another 4 to 10 days before emerging into the water column. Larval fish occupy shallow, warm, low-velocity habitats in littoral zones, backwaters, and inundated floodplains and tributary mouths downstream of spawning bars for several weeks before dispersing to deeper water (U.S. Fish and Wildlife Service 2002d; Snyder and Muth 2004). It is believed that low survival in early life stages, attributed to loss of nursery habitat and predation by non-native fishes, causes extremely low recruitment in wild populations (Muth et al. 2000).

Razorback sucker in the Upper Basin tend to be smaller and grow slower than those in the Lower Basin, reaching 100 millimeters (4 inches) on average in the first year (U.S. Fish and Wildlife Service 2002b). Based on collections in the middle Green River, typical adult size centers around 510 mm (20 inches) (Modde et al. 1996). Razorback suckers are long-lived fishes, reaching 40+ years via high annual survival (U.S. Fish and Wildlife Service 2002d). Adult survivorship was estimated to be 71 to 73 percent in the Middle Green River from 1980-1992 (Modde et al. 1996; Bestgen et al. 2002) and 76 percent from 1990 to 1999 (Bestgen et al. 2002).

POPULATION DYNAMICS

Population estimates during the 1980 to 1992 period were on average between 300 and 600 wild fish (Modde et al. 1996). By the early 2000s, the wild population consisted of primarily aging adults, with steep decline in numbers caused by extremely low natural recruitment (U.S. Fish and

Wildlife Service 2002d). Although reproduction was occurring, very few juveniles were found (U.S. Fish and Wildlife Service 2002d).

In the early part of the 2000s, population numbers were extremely low. Population estimates from sampling efforts in the Middle Green River had declined to approximately 100 by 2002, with researchers hypothesizing that wild fish in the Green River Basin could become extirpated because of lack of recruitment (Bestgen et al. 2002). Similarly, in the upper Colorado River, razorback sucker were exceedingly rare. In the 2002 recovery plan, razorback sucker were considered extirpated in the Gunnison River, as fish were last captured in 1976 (U.S. Fish and Wildlife Service 2002d). Similarly, in the Grand Valley, only 12 fish were collected from 1984 to 1990, despite intensive sampling (Osmundson and Kaeding 1991 in U.S. Fish and Wildlife Service 2002d). No young razorback suckers were captured in the Upper Colorado River since the mid-1960s (Osmundson and Kaeding 1991 in U.S. Fish and Wildlife Service 2002d).

Because of the low numbers of wild fish and lack of recruitment, augmenting the remaining wild populations with hatchery-raised fish is a key step to creating self-sustaining populations. The Recovery Program is rebuilding razorback sucker populations with hatchery stocks. As populations increase, the Program expects to generate mark-recapture population estimates on adult razorback sucker comparable to the data reported for Colorado pikeminnow and humpback chub. Many stocked razorback sucker are being recaptured as part of other studies. Razorback sucker stocked in the Green and Colorado Rivers have been recaptured in reproductive condition and often in spawning groups. Captures of larvae in the Green, Gunnison, and Colorado Rivers document reproduction is occurring. Survival of larvae through their first year remains rare, largely due to a decrease in the availability of warm, food-rich floodplain areas and predation by a suite of nonnatives when the flood plain nursery habitats are available (Bestgen et al. 2011). However, occasional captures of juveniles (just over age-1) in the Green and Gunnison Rivers suggest that survival of early life stages is occurring. Larval captures in the Green, Gunnison, and Colorado rivers document reproduction. Collections of larvae by light trap in the middle Green River have generally been increasing since 2003; in 2013, the largest collection of light trapped larvae occurred.

Major advancements over the last decade have addressed the bottleneck to a self-sustaining wild population of razorback suckers which is larval recruitment to juvenile life stages. By tailoring peak spring releases from Flaming Gorge dam to overlap with larval razorback sucker drift under the Larval Trigger Study Plan (LTSP ad hoc Committee 2012); flows have been high enough in recent years to connect the Green River to off-channel wetland nursery habitats for larval razorback sucker. Picket weirs and similar devices exclude most large-bodied nonnative fishes from certain wetlands, improving water quality and reducing predation pressure on razorback sucker larvae during their most vulnerable first weeks. At Stewart Lake, a gated wetland near Jensen, Utah, managed by the Utah Division of Wildlife Resources, these management practices have made possible releases of wild-spawned young-of-year razorback suckers to the Green River during annual autumn draining every year since 2013.

BASIN-WIDE STATUS AND DISTRIBUTION

Hatchery-produced stocked fish form the foundation for reestablishing naturally self-sustaining populations of razorback sucker in the upper Colorado and Green river systems. The Recovery Program has been implementing an integrated stocking plan (Integrated Stocking Plan Revisions Committee 2015) with the goal of establishing self-sustaining populations of razorback sucker in

the upper Colorado River basin. The Recovery Program has been largely successful in meeting the plan's annual stocking targets. Stocked razorback sucker are surviving in the wild, expanding their range into previously unoccupied areas, and annually reproducing in both the Green and Colorado River sub-basins; wild juvenile razorback sucker (ages 0, 1, and 2) are starting to be captured in small numbers (Table 2).

Table 2. Summary of razorback sucker status and trends.

Subbasin	Life Stage	2002 Recovery Goal Downlisting Criteria[1,7]	Long-term abundance[8]	Short-term abundance; 5 most recent data points	Summary
Colorado River	**Adults (≥400 mm TL)**	N = >5,800 individuals.	Population of stocked adults increased steadily since 2005.	N = 3,356 adults and juveniles (average of 4 estimates collected 2005–2010).	Estimate for 2014 - 2016 in preparation. Population of stocked adults now expected to exceed 5,800 adults. Observations of spawning congregations have increased in recent years.
	Recruits (300–399 mm TL)	Estimates exceed annual adult mortality.	No wild-produced recruits have yet been detected.		Wild-produced recruits have not been captured. Criterion has not been met.
	Age-0	N/A (no specific recovery goal criteria for this life stage).	Wild-produced larvae have been detected in the Gunnison and Colorado River – new information pending.		Small numbers of wild-produced juveniles (age-2, 3) collected in 2013.
Green River	**Adults (>400 mm TL)**	N = >5,800 individuals.	Population of stocked adults increased steadily since 2006.	Most recent (preliminary) estimates greatly exceed 5.800 stocked adults.	Stocked adults well distributed throughout subbasin; observations of spawning congregations have increased in recent years.
	Recruits (300–399 mm TL)	Estimates exceed annual adult mortality.	No wild-produced recruits have yet been detected.		Wild-produced recruits have not been captured. This criterion has not been met.
	Age-0	N/A (no specific recovery goal criteria for this life stage).	Larvae consistently captured in middle and lower Green River.	Generally increasing with a record high catch of larvae in 2013 in the middle Green River.	Over-summer survival of age-0 greatly improved since 2012; highest number of fall age-0 documented in 2016.

1 Please see Recovery Goals (USFWS 2002c) for a complete description of demographic requirements.

2 "Long-term" refers to all Recovery Program monitoring information, which varies between subbasins and by life stage (discussed in text).

HUMPBACK CHUB

SPECIES DESCRIPTION

The humpback chub (*Gila cypha*) is a medium-sized freshwater fish of the minnow family endemic to the Colorado River basin. The species evolved around 3 to 5 million years ago (Sigler and Sigler 1996). The pronounced hump behind its head gives the humpback chub a striking, unusual appearance. It has an olive-colored back, silver sides, a white belly, small eyes, and a long snout that overhangs its jaw (Sigler and Sigler 1996). This fish can grow to nearly

500 mm (20 inches) and may survive more than 30 years in the wild (U.S. Fish and Wildlife Service 2002c). The humpback chub does not have the swimming speed or strength of species such as the Colorado pikeminnow. Instead, it uses its large fins to "glide" through slow-moving areas, feeding on insects. Examination of otoliths (Hendrickson 1993) and recapture data indicate that Humpback Chub frequently reach an age of over 20 years, with longevity of ~40 years (Coggins et al. 2006; STReaMS July, 2016).

The historical range includes the Colorado River from the Black Canyon near present-day Hoover Dam, Arizona/Nevada, upstream to Debeque Canyon, Colorado; the Green River to the Blacks Fork River, Wyoming; and the Yampa River through Cross Mountain Canyon, Colorado (Kolb and Kolb 1914; Miller 1946, 1955; McDonald and Dotson 1960; Smith 1960). The current range is ~1,353 kilometers, or 62% of historical range. Range reduction has occurred largely from inundation by large man-made reservoirs. Inundated habitat includes the Black Canyon and western Grand Canyon covered by Lake Mead in 1935; lower Cataract Canyon covered by Lake Powell in 1963; and Flaming Gorge/Hideout Canyon covered by Flaming Gorge Reservoir in 1962.

The species is currently found as five populations, including four in the upper basin (Black Rocks, Westwater Canyon, Desolation/Gray canyons, and Cataract Canyon), and one in the lower basin in the Grand Canyon. A sixth upper basin population in Dinosaur National Monument (DNM), comprised of Yampa and Whirlpool canyons, is below detection limits and is now considered functionally extirpated. The six populations occupy 598 kilometers of river, or ~78% of the historical 764 kilometers. Each population consists of a discrete, geographically separate group of fish, with a few individuals moving among populations at a decadal scale, based on genetic evidence (Douglas and Douglas 2007). The lower basin population became isolated from the five upper basin populations with completion of Glen Canyon Dam in 1963. Small enclave groups of fish are also present in localized canyon-like reaches of the upper basin, such as Beavertail Bend and Elephant Canyon in the upper Colorado River (Valdez 1990); and the Little Snake River, a tributary of the Yampa River in Colorado (Wick et al. 1991).

The Office of Endangered Species first included the humpback chub in the List of Endangered Species on March 11, 1967 (32 FR 4001). Subsequently, it was considered endangered under provisions of the Endangered Species Conservation Act of 1969 (16 U.S.C. 668aa) and was included in the United States List of Endangered Native Fish and Wildlife issued on June 4, 1973 (38 FR No. 106). It is currently protected under the Endangered Species Act of 1973 as an endangered species throughout its range (ESA; 16 U.S.C. 1531 et. seq.). The U.S. Fish and Wildlife Service (Service) recently completed a species status assessment (SSA) and a 5-year status review that concluded the current risk of extinction is low, such that the species is not in danger of extinction throughout all of its range. The SSA explained that the largest population of humpback chub, which is found in the Colorado and Little Colorado rivers in the Grand Canyon of Arizona, is a stable population of about 12,000 adults. Our SSA also explained that four smaller populations in the Green and Colorado rivers of the upper Colorado River basin have persisted and do not appear to be in immediate danger of extinction. All five populations are wild, persisting without the need for hatchery stocking. These population-monitoring results, when coupled with ongoing flow management and nonnative predatory fish control, mean that the humpback chub will be considered for reclassification from endangered to threatened in the next year.

Critical habitat was designated as six reaches total 610 kilometers of the Colorado River System on March 21, 1994 (59 FR 13374), including 319 kilometers in the upper basin and 291 kilometers in the lower basin. Designated critical habitat makes up about 28 % of the species' original range and occurs in both the Upper and Lower Colorado River Basins. In the Upper Colorado River Basin, critical habitat includes portions of the Yampa, Green, and Colorado Rivers, primarily including canyon habitats, such as Yampa, Desolation and Gray, Westwater, and Cataract Canyons. Although humpback chub life history and habitat use differs greatly from the other endangered Colorado River fish, the PCEs (water, physical habitat, and biological environment) of their critical habitat are the same (see above).

Separate, objective recovery criteria were developed for each of two recovery units (the Upper Colorado and Lower Colorado River Basins as delineated at Glen Canyon Dam) to address unique threats and site-specific management actions necessary to minimize or remove those threats. This Biological Opinion's focus is on the Upper Colorado River Basin recovery unit and will therefore describe the status of the humpback chub in that unit.

LIFE HISTORY

Like other large desert river fishes, the humpback chub is an obligate warm-water species that requires relatively warm temperatures for spawning, egg incubation, and survival of larvae. Unlike Colorado pikeminnow and razorback sucker, which are known to make extended migrations of up to several hundred miles to spawning areas, humpback chubs do not appear to make extensive migrations. Instead, humpback chub live and complete their entire life cycle in canyon-bound reaches of the Colorado River mainstem and larger tributaries characterized by deep water, swift currents, and rocky substrates (U.S. Fish and Wildlife Service 2002c). Individuals show high fidelity for canyon reaches and move very little.

Mature humpback chub typically spawn on the descending hydrograph between March and July in the Upper Basin (Karp and Tyus 1990). Humpback chub are broadcast spawners who may mature as young as 2 to 3 years old. Eggs incubate for three days before swimming up as larval fish (U.S. Fish and Wildlife Service 2002c). Egg and larvae survival are highest at temperatures close to 19 to 22 ^{0}C (U.S. Fish and Wildlife Service 2002c). Unlike larvae of other Colorado River fishes (e.g., Colorado pikeminnow and razorback sucker), larval humpback chub show no evidence of long-distance drift (Robinson et al.1998).

POPULATION DYNAMICS

Five wild populations of humpback chub inhabit canyon-bound sections of the Colorado, Green, and Yampa Rivers: Yampa Canyon; Desolation and Gray Canyons; Cataract Canyon; Black Rocks; and Westwater Canyon. Recovery goal downlisting demographic criteria (U.S. Fish and Wildlife Service 2002c) for humpback chub require each of five populations in the upper Colorado River basin to be self-sustaining over a 5-year period, with a trend in adult point estimates that does not decline significantly. Secondarily, recruitment of age-3 (150–199 mm TL) naturally produced fish must equal or exceed mean adult annual mortality. In addition, one of the five populations (e.g., Black Rocks/Westwater Canyon or Desolation/Gray Canyons) must be maintained as a core population such that each estimate exceeds 2,100 adults (estimated minimum viable population number).

Since 2007, mean sum of adults in the three upper basin populations with robust estimates is about 3,800, which is a period of apparent stability; the remaining two populations do not have recent robust estimates to report. The three largest populations in the upper basin supported 404

and 1,315 adults for Black Rocks and Westwater Canyon in 2012, respectively, and 1,672 adults in Desolation/Gray canyons in 2015. The smallest population is Cataract Canyon that ranged from 468 adults in 2003 to 295 in 2005. The Dinosaur National Monument population is below detection limits and considered functionally extirpated. No Humpback Chub have been collected since 2004 and four of the five upper basin populations are persisting.

BASIN-WIDE STATUS AND DISTRIBUTION

Humpback chub exist in five core populations, three in the Colorado River and two in the Green River (numbered 1 – 5 in Table 3, below). In the Colorado River, adult abundance estimates of the two core populations (Black Rocks and Westwater Canyon) indicate stability since 2007 but remain below recovery criteria levels. The Cataract Canyon population appears stable at low densities. In the Green River, adult abundance estimates in Desolation Canyon indicate stability since 1985, but captures of recruits have been low in recent years. It appears as though humpback chub are extirpated from the fifth population, Dinosaur National Monument (Yampa/Whirlpool), as no individuals have been detected since the early 2000s. The Recovery Program is evaluating the feasibility of and strategies for reintroducing fish to this area via translocation. The 2002 recovery goals require maintenance of all five populations.

Table 3. Summary of humpback chub status and trends.

	Population	Life Stage	2002 Recovery Goal Downlisting Criteria[4]	Long- term[5] abundance (average) / trend	Short-term abundance (average) / trend; 5 most recent data points	Summary
Colorado River	**1. Black Rocks (BR)**	**Adults (≥200 mm TL)**	Point estimates do not decline significantly for 5 years.	N = 579 adults (average of 9 BR-specific point estimates since 1998).	N = 403 (average of 5 WW-specific point estimates 2004–2012).	Steep decline in the late 1990s. Stable at low levels since 2007; adult survival appears stable since 1998.
		Recruits (150–199 mm TL)	Estimates exceed annual adult mortality.	Not enough mark / recapture information to estimate abundance of recruits.		We assume criterion not met 1998 – 2004 because number of adults dropped over this time period; likely has been met since 2007.
	2. Westwater Canyon (WW)	**Adults (≥200 mm TL)**	Point estimates do not decline significantly for 5 years.	N = 2,490 (average of 10 point estimates since 1998).	N = 1,426 (average of 5 estimates 2004–2012).	Steep decline in the late 1990s. Stable at low levels since 2007; adult survival appears stable since 1998.
		Recruits (150–199 mm TL)	Estimates exceed annual adult mortality.	Not enough mark / recapture information to estimate abundance of recruits.		We assume criterion was met sporadically through 2004 because number of adults declined; likely has been met since 2007.
	Core Population[6] - (Black Rocks + Westwater)	**Adults (≥200 mm TL)**	N = >2,100.	N = 3,124 (average of 9 combined (BR+WW) point estimates since 1998).	N =1,975 (average of 5 combined (BR+WW) estimates 2004–2012).	Steep decline in the late 1990s; adult numbers appear stable since 2007, but below core criteria level until 2016.
	3. Cataract Canyon	**Adults (≥200 mm TL)**	Point estimates do not decline significantly for 5 years.	Population too small to generate reliable mark/recapture point estimates. Monitoring consists of catch / effort (CPUE) metrics.		CPUE since 1991 indicates the population appears stable at low levels.
		Recruits (150–199 mm TL)	Estimates exceed annual adult mortality.			

Green River	**4. Desolation Canyon**	**Adults (≥200 mm TL)**	Point estimates do not decline significantly for 5 years.	N = 1,711 (average of 7 point estimates collected 2001–2011). Abundance sampling program has changed over time, complicating long-term comparisons.	CPUE estimates since 1985 indicate long-term stability in adults; captures of recruits have been low in recent years.
		Recruits (150–199 mm TL)	Estimates exceed annual adult mortality.	Not enough mark / recapture information to estimate abundance of recruits.	
	5. Dinosaur National	**Adults (≥200 mm**	Point estimates have not declined	From 1998 to 2000, researchers estimated ~400 adults occupied Yampa Canyon. Density has declined below level of detection since	

[1]Please see Recovery Goals (USFWS 2002b) for a complete description of demographic requirements.
[2]"Long-term" refers to all Recovery Program monitoring information, which varies by population (discussed in text)
Core populations must meet minimum viable population criteria metrics (e.g., N = 2,100 adults) as well as demonstrating long-term stability. Non-core populations must demonstrate long-term stability.

BONYTAIL

SPECIES DESCRIPTION

The bonytail (*Gila elegans*) is a medium-sized freshwater fish in the minnow family, endemic to the Colorado River Basin. The species evolved around 3 to 5 million years ago (Sigler and Sigler 1996). Individuals have large fins and a streamlined body that typically is very thin in front of the tail. They have a gray or olive-colored back, silver sides, and a white belly (Sigler and Sigler 1996). The mouth is slightly overhung by the snout and there is a smooth low hump behind the head that is not as pronounced as the hump on a humpback chub. A very close relative to the roundtail chub (*Gila robusta*), bonytail can be distinguished by counting the number of rays in the fins, with bonytail having 10 dorsal and anal fin rays (Sigler and Sigler 1996). The fish can grow to be 600 mm (24 inches) and are thought to live as long as 20 to 50 years (Sigler and Sigler 1996). Little is known about the specific food and habitat of the bonytail because the species was extirpated from most of its historic range prior to extensive fishery surveys, but it is considered adapted to mainstem rivers, residing in pools and eddies, while eating terrestrial and aquatic insects (U.S. Fish and Wildlife Service 2002a).

Bonytail were once widespread in the large rivers of the Colorado River Basin (multiple historic references in U.S. Fish and Wildlife Service 2002a). The species experienced a dramatic, but poorly documented, decline starting in about 1950, following construction of mainstem dams, introduction of nonnative fishes, poor land-use practices, and degraded water quality (U.S. Fish and Wildlife Service 2002a). Population trajectory over the past century and reasons for decline are unclear because lack of basin-wide fishery investigations precluded accurate distribution and abundance records.

Bonytail are now rarely found in the Green and Upper Colorado River sub-basins and are the rarest of all the endangered fish species in the Colorado River Basin. In fact, no wild, self-sustaining populations are known to exist upstream of Lake Powell; this fish is nearly extinct. In the last decade only a handful of bonytail were captured on the Yampa River in Dinosaur National Monument, on the Green River at Desolation and Gray canyons, and on the Colorado River at the Colorado/Utah border and in Cataract Canyon.

The bonytail is currently listed as endangered under the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 et. seq.), under a final rule published on April 23, 1980 (45 FR 27710). The Service finalized the latest recovery plan for the species in 2002 (U.S. Fish and Wildlife Service 2002a), but is currently drafting an updated revision.

The Service designated seven reaches of the Colorado River as critical habitat for the bonytail on March 21, 1994 (59 FR 13374). These reaches total 499 kilometers (312 miles) as measured along the center line of each reach. Portions of the Green, Yampa, and Colorado Rivers are designated as critical habitat, representing about 14 % of the species' historic range. The primay constituent elements (PCE) are the same as those described for Colorado pikeminnow, razorback sucker, and humpback chub.

LIFE HISTORY

Natural reproduction of bonytail was last documented in the Green River in 1959, 1960, and 1961 at water temperatures of 18°C (U.S. Fish and Wildlife Service 2002a). Similar to other closely related *Gila* species, bonytail in rivers probably spawn during spring over rocky substrates. While age at sexually maturity is unknown, they are capable of spawning at 5 to 7 years old. Recruitment and survival estimates are currently unknown because populations are not large enough for research to occur. Individuals in Lake Mohave have reached 40 to 50 years of age (U.S. Fish and Wildlife Service 2002a), but estimates for river inhabiting fish are not available.

The first reproduction by stocked bonytail was confirmed in floodplain habitats in the Green River in 2015 and again in 2016 (Bestgen et al. 2017). In 2002, the Service developed Recovery Goals (USFWS 2002 a–d) to supplement the individual endangered species recovery plans. The Recovery Goals contain specific demographic criteria to maintain self-sustaining populations and recovery factor criteria to ameliorate threats to the species.

POPULATION DYNAMICS

Bonytail are so rare that it is currently not possible to conduct population estimates. In response to the low abundance of individuals, the Recovery Program is implementing a stocking program to reestablish populations in the Upper Basin; stocking goals were met or exceeded the past three years (Upper Colorado River Endangered Fish Recovery Program and San Juan River Basin Recovery Implementation Program 2010). Since 1996, over 490,000 tagged bonytail subadults have been stocked in the Green and upper Colorado River subbasins.

To date, stocked bonytail do not appear to be surviving as well as stocked razorback sucker. Researchers continue to experiment with pre-release conditioning and exploring alternative release sites to improve their survival. Since 2009, an increasing number of bonytail have been detected at several locations throughout the Upper Colorado River Basin where stationary tag-reading antennas are used. During high spring flows in 2011, more than 1,100 bonytail (16.6 % of the 6,804 stocked in early April of that year) were detected by antenna arrays in the breach of the Stirrup floodplain on the Green River. The Price Stubb antenna array on the Colorado River detected 356 bonytail between November 2010 and September 2014. The fish detected in fall 2011 had been stocked above Price-Stubb in Debeque Canyon, but in spring 2012, some of those fish were moving upstream through the fish passage. In 2015, 22 were detected and 59 % were moving upstream, the others were either moving downstream or direction could not be determined (Francis and Ryden 2015a). In addition, 44 bonytail used the Redlands fish ladder and were moved above the diversion for further upstream access to the Gunnison River (Francis and Ryden 2015b).

BASIN-WIDE STATUS AND DISTRIBUTION

Hatchery-produced stocked fish form the foundation for reestablishing naturally self-sustaining populations[1] of bonytail in the upper Colorado and Green river systems. The Recovery Program has been implementing an integrated stocking plan (Integrated Stocking Plan Revisions Committee 2015) with the goal of establishing self-sustaining populations of bonytail in the upper Colorado River basin. The Recovery Program has been largely successful in meeting the plan's annual stocking targets.

Recaptures of stocked bonytail are rarer. However, increasing numbers of bonytail have been detected by stationary passive integrated transponder (PIT)-tag reading antennas and traditional sampling methods throughout the upper Colorado River basin (Table 4). The first reproduction by stocked bonytail was confirmed in floodplain habitats in the Green River in 2015 and again in 2016 (Bestgen et al. 2017). In 2002, the Service developed Recovery Goals (USFWS 2002 a–d) to supplement the individual endangered species recovery plans. The Recovery Goals contain specific demographic criteria to maintain self-sustaining populations and recovery factor criteria to ameliorate threats to the species.

Table 4. Summary of bonytail status and trends.

Subbasin	Life Stage	2002 Recovery Goal Downlisting Criteria[1,9]	Long-term[10] abundance	Short-term abundance; 5 most recent data points	Summary
Colorado River	**Adults (≥250 mm TL)**	N = >4,400 individuals.	N/A	No estimates; beginning to see some return of stocked individuals.	Stocking program began in 1996 on an experimental basis; full stocking program implemented in 2003. Observations of stocked adults increasing since 2013.
	Recruits (150–249 mm TL)	Estimates exceed annual adult mortality.	N/A	N/A	No wild recruitment has been detected.
	Age-0	N/A	N/A	N/A	N/A
Green River	**Adults (>250 mm TL)**	N = >4,400 individuals.	N/A	No estimates; beginning to see some returns of stocked individuals.	Stocked adults increasing since 2013.
	Recruits (150–249 mm TL)	Estimates exceed annual adult mortality.	N/A	N/A	No wild recruitment has been detected.
	Age-0	N/A	N/A	N/A	Successful reproduction in the wild (in floodplain habitats) in 2015 and 2016.

[1]To achieve naturally self-sustaining populations, adults must reproduce and recruitment of naturally spawned young fish into the adult population must occur at a rate to maintain the population at a minimum that meets the demographic criteria identified in the recovery goals. Also, because of their longevity, hatchery produced adult razorback sucker and bonytail (and Colorado pikeminnow in the San Juan River) will contribute toward recovery.

DESIGNATED CRITICAL HABITAT FOR LISTED COLORADO RIVER FISHES

HABITAT DESCRIPTION

In the Upper Colorado River Basin, portions of the White, Yampa, Gunnison, Green, Colorado, and San Juan Rivers and their 100-year floodplain are designated as critical habitat for one or more of the federally listed species described above. Critical habitat is defined as specific geographic areas, whether occupied by a listed species or not, that are essential for its conservation and that are formally designated by rule. In the state of Utah, immediately downstream of Wyoming, many of these critical habitat reaches overlap. Critical habitat for the humpback chub and bonytail are primarily canyon-bound reaches, while critical habitat for the Colorado pikeminnow and razorback sucker include long stretches of river required for migration corridors and larval fish drift.

Concurrently with designating critical habitat, the Service identified PCEs of the habitat. PCEs are physical or biological features essential to the conservation of a species for which its designated or proposed critical habitat is based on, such as: space for individual and population growth, and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and habitats that are protected from disturbance or are representative of the species historic geographic and ecological distribution.

The Service has identified water, physical habitat, and the biological environment as the PCEs of critical habitat for listed Colorado River fish species (59 FR 13374). Water includes a quantity of water of sufficient quality delivered to a specific location in accordance with a hydrologic regime required for the particular life stage for each species. The physical habitat includes areas of the Colorado River system that are inhabited or potentially habitable for use in spawning and feeding, as a nursery, or serve as corridors between these areas. In addition, oxbows, backwaters, and other areas in the 100-year floodplain, when inundated, provide access to spawning, nursery, feeding, and rearing habitats. Food supply, predation, and competition are important elements of the biological environment.

HABITAT USAGE

The four listed fish species are adapted to a hydrologic cycle characterized by large spring peaks of snowmelt runoff and low, relatively stable base flows (U.S. Fish and Wildlife Service 2002b). High spring flows maintain channel and habitat diversity, flush sediments from spawning areas, rejuvenate food production, form gravel and cobble deposits used for spawning, and rejuvenate backwater nursery habitats (U.S. Fish and Wildlife Service 2002b).

Throughout most of the year, juvenile, subadult, and adult Colorado pikeminnow use relatively deep, low-velocity eddies, pools, and runs that occur in near-shore areas of main river channels (multiple references in U.S. Fish and Wildlife Service 2002b). Adults require pools, deep runs, and eddy habitats maintained by high spring flows. In spring, however, adults use floodplain habitats, flooded tributary mouths, flooded side canyons, and eddies that are available only during high flows (multiple references in U.S. Fish and Wildlife Service 2002b). Newly hatched larval fish drift downstream to backwaters in sandy, alluvial regions, where they remain through most of their first year of life (multiple references in U.S. Fish and Wildlife Service 2002b). Because of their mobility and environmental tolerances, adult Colorado pikeminnow are more widely distributed than other life stages.

Similar to Colorado pikeminnow, razorback sucker use a variety of habitats throughout their life cycle. Outside of the spawning season, adult razorback suckers occupy a variety of shoreline and main channel habitats including slow runs, shallow to deep pools, backwaters, eddies, and other relatively slow velocity areas associated with sand substrates (U.S. Fish and Wildlife Service 2002d). In spring and winter adult razorback sucker require deeper, low-velocity habitat, but are known to occupy shallow sandbars in summer (McAda and Wydoski 1980 in Zelasko et al. 2009). Reproductive activities are believed to take place in off-channel habitats and tributaries because razorback sucker aggregations were reported in these areas. Off-channel habitats are much warmer than the mainstem river and razorback suckers presumably move to these areas for spawning and other activities, such as, feeding, resting, or sexual maturation.

Off channel and floodplain habitat is also important to young razorback sucker. After hatching, razorback sucker larvae drift downstream to low-velocity floodplain or backwater nursery habitat. The absence of seasonally flooded riverine habitats is believed to be a limiting factor in the successful recruitment of razorback suckers in their native environment. Starvation of larval razorback suckers due to low zooplankton densities in the main channel and loss of floodplain habitats which provide adequate zooplankton densities for larvae food is one of the most important factors limiting recruitment.

Unlike Colorado pikeminnow and razorback sucker, humpback chub show high site fidelity for canyon-bound reaches of mainstem rivers. Past captures of adults were associated with large boulders and steep cliffs. Reproductive habitat is not defined because although humpback chub are believed to broadcast eggs over mid-channel cobble and gravel bars, spawning in the wild has not been observed for this species. It is believed that upon emergence from spawning gravels, humpback chub larvae remain in the vicinity of bottom surfaces near spawning areas. As larval fish mature, backwaters, eddies, and runs were reported as common capture locations for young-of-year humpback chub.

While bonytail are closely related to humpback chub, their habitat usage may be slightly different. Bonytail are observed in pools and eddies in mainstem rivers, but recent information collected by the Recovery Program suggests that floodplain habitats may be more important to the survival and recovery of the bonytail than originally thought. Although spawning events in river habitat has not been documented, bonytail probably spawn in rivers over rocky substrates because spawning is observed in reservoirs over rocky shoals and shorelines. Recent hypotheses surmise that flooded bottomlands may provide important bonytail nursery habitat.

ENVIRONMENTAL BASELINE

Regulations implementing the ESA (50 CFR 402.02) define the environmental baseline as the past and present impacts of all federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed state or federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation process.

STATUS OF THE SPECIES IN THE ACTION AREA

While the Project occurs in Wyoming, depletions associated with the Project from the Green River, a tributary to the Colorado River, adversely affect all four endangered fish species within

the Upper Colorado River Basin Recovery Unit. The use of water from the Upper Colorado River Basin affects the habitat quantity and quality downstream of the Project location, for many miles.

Within this Recovery Unit, specific recovery criteria are established for the Green River sub-basin for all four species, including population demographics. Self-sustaining and stable populations of these species in the Green River sub basin are required for full species recovery (U.S. Fish and Wildlife Service 2002a, 2002b, 2002c, 2002d). The entire length of the Green River and its 100 year floodplain are designated as critical habitat for at least one species between the Yampa River confluence and the Colorado River confluence (59 FR 13374).

The largest, most productive and most robust population of Colorado pikeminnow occurs in the mainstem Green River (combining the lower Green River, Desolation/Gray Canyon, and middle Green River populations). Higher abundance of Colorado pikeminnow juveniles and recruits in the 2006 to 2008 sampling period is attributed to a relatively strong year class of age-0 Colorado pikeminnow produced in the lower Green River in 2000 (Bestgen et al. 2010). Length frequency histograms, especially in the Desolation-Gray Canyon and lower Green River reaches, indicate that abundance of Colorado pikeminnow recruits was much higher in period 2006 to 2008 than from 2000 to 2003 (Bestgen et al. 2010). The importance of Green River populations is also evident because increased abundance of adult Colorado pikeminnow in the White River and middle Green River through 2008 almost certainly derived from upstream movement (high transition rates) of large numbers of juvenile and recruit-sized Colorado pikeminnow that originated in downstream reaches of the Green River in 2006 and 2007 (Bestgen et al. 2010). Colorado pikeminnow spawn in two principal sites: Gray Canyon in the lower Green River, and the lower Yampa River (U.S. Fish and Wildlife Service 2002b).

The action area includes the largest concentration of razorback suckers in the Upper Colorado River Basin, found in low-gradient flat-water reaches of the middle Green River between and including the lower few miles of the Duchesne River and the Yampa River. Known spawning sites for razorback sucker are located in the lower Yampa River and in the Green River near Escalante Ranch, but other, less-used sites are probable, such as Desolation Canyon (U.S. Fish and Wildlife Service 2002d). Both Colorado pikeminnow and razorback sucker are migratory spawners, whose young emerge as larval fish from spawning locations and drift downstream. Because Colorado pikeminnow and razorback sucker spawning locations occur downstream of the Project, all life stages are present within the action area.

Humpback chub occur in Westwater Canyon, Desolation/Gray Canyons and Cataract Canyon, but not in other river reaches in the action area. Preliminary population estimates in 2002 approximate 2,000 to 5,000 humpback chub in Westwater Canyon, 1,500 in Desolation/Gray Canyons, and 500 in Cataract Canyon (U.S. Fish and Wildlife Service 2002c).

Bonytail are so rare that it is currently not possible to conduct population estimates. However, the action area includes the middle Green River, which is part of the current stocking program area (along with the Yampa River in Dinosaur National Monument).

STATUS OF CRITICAL HABITAT IN THE ACTION AREA

The action area includes critical habitat units, which are identified as essential for the species' recovery (U.S. Fish and Wildlife Service 2002a, 2002b, 2002c, 2002d). While historical water

depletions do not occur within all critical habitat units, historical changes in Green River and Colorado River water volume have nonetheless affected critical habitat by changing the amount of water flowing into these designated habitat units. The action area includes critical habitat units on the mainstem Green River and Colorado River below the Green River confluence.

As previously described, all four of the listed Colorado River fish require the same PCEs essential for their survival. Water, physical habitat, and the biological environment are the PCEs of critical habitat. This includes a quantity of water of sufficient quality that is delivered to a specific location in accordance with a hydrologic regime that is required for the particular life stage for each species. The physical habitat includes areas of the Colorado River system that are inhabited or potentially habitable for use in spawning and feeding, as a nursery, or serve as corridors between these areas. In addition, oxbows, backwaters, and other areas in the 100-year floodplain, when inundated, provide access to spawning, nursery, feeding, and rearing habitats. Food supply, predation, and competition are important elements of the biological environment.

Historically, the Green River produced high spring turbid flows that maintained critical habitat by inundating floodplains, maintaining side channels, flushing fine sediment, and creating backwaters (Muth et al. 2000). However, with the completion of Flaming Gorge Dam in 1962, the mainstem Green River became highly regulated. The dam and reservoir physically altered the Green River and surrounding terrain and modified the pattern of flows downstream (Muth et al. 2000). Most notably, the construction of the dam created a fish passage barrier and transformed miles of riverine habitat into lacustrine habitat. These two changes isolated fish populations and decreased the amount of native habitat.

Operation of the dam also results in effects to native fish communities. Historically, water releases from Flaming Gorge Dam did not mimic natural flow patterns and introduced colder water into the river from the deep pool behind the dam (Muth et al. 2000). Alteration of the natural flow regime affects stream vegetation communities and channel morphology, which modify native fish habitat (Muth et al. 2000). Natural flow regimes may act as cues for important life history events, like spawning. Life history events are similarly affected by water temperature, with colder temperatures disrupting the temporal spawning regime of native fish.

Additionally, Flaming Gorge Dam created new water resource impacts, such as irrigation potential, municipal use, and recreational fisheries of introduced non-native species. Water storage provided by the dam allowed local communities to increase water usage for agriculture and municipal purposes. Increased water depletion from the Green River decreases native fish habitat and limits the amount of backwater nursery habitat for juvenile fish. Also, increased water supply for agriculture and municipal purposes increases the likelihood of degraded water quality from agricultural runoff (pesticides, fertilizers, etc.) and wastewater inputs.

All four federally listed species evolved in desert river hydrology, relying on high spring flows and stable base flows for habitat conditions essential to their survival (see STATUS OF THE SPECIES AND CRITICAL HABITAT). In addition to main channel migration corridors, Colorado pikeminnow, bonytail and razorback sucker rely on floodplain and backwater habitats for various stages of their life history. High spring flows also act as spawning queues. In contrast, humpback chub rely on canyon-bound reaches with swift currents and white water.

Currently, two primary reaches of Colorado pikeminnow nursery habitat are present in the Green River system. The lower reach occurs from near Green River, Utah, downstream to the Colorado River confluence. The upper reach occurs from near Jensen, Utah, downstream to the Duchesne River confluence. Larvae from Desolation Canyon colonize flooded backwater areas in the lower Green River area. These backwaters are especially important during the Colorado pikeminnow's critical first year of life. The Project is located upstream of both nursery habitat reaches and floodplain habitat.

Bottomlands, low-lying wetlands, and oxbow channels flooded and ephemerally connected to the main channel by high spring flows appear to be important habitats for all life stages of razorback sucker. These areas provide warm water temperatures, low-velocity flows, and increased food availability.

Humpback chub occur in Desolation/Gray Canyons, and within the action area. Adults require eddies and sheltered shoreline habitats maintained by high spring flows. These high spring flows maintain channel and habitat diversity, flush sediments from spawning areas, rejuvenate food production, and form gravel and cobble deposits used for spawning. Flow recommendations were developed that specifically consider flow-habitat relationships in habitats occupied by humpback chub in the upper basin, and were designed to enhance habitat complexity and to restore and maintain ecological processes.

PRIMARY CONSTITUENT ELEMENT – WATER - The quality and quantity of water in the action area of the Green River has decreased from water projects, most notably Flaming Gorge Dam and the Central Utah Project. A number of tributaries to the Green River appear on the State of Utah's 303(d) list of impaired streams for various reasons (Utah Division of Water Quality 2004). Tributaries and sections of the Price, San Rafael, and Duchesne Rivers are listed for elevated salinity, total dissolved solids, and chlorides, as are portions of Ashley and Pariette Draw Creeks. Brush, Pariette Draw, and Lower Ashley Creeks are listed for elevated selenium. Willow and Indian Canyon Creeks are listed for elevated total dissolved solids. Ninemile Creek is listed for elevated temperature. Lake Fork Creek is listed for elevated sediments. Lastly, Pariette Draw Creek is listed for elevated boron. These elevated pollutants pose a risk to this PCE. As these tributaries reach the main stem, these pollutants are introduced to the Green River as well. Currently the Green River acts as a dilution for these pollutants, as is evident by the Green River not appearing on the State of Utah's impaired water list. However, these pollutants still occur in the river and as new water depletions occur, these pollutants will be found in higher concentrations.

Large water diversion projects, large-scale agricultural water use, and climate change have all altered the water quantity in the Green River over the past 150 years. Most notably, Flaming Gorge Dam has altered the magnitude and timing of flows in endangered fish habitat. Peak spring flows in the Green River at Jensen, Utah, have decreased 13 to 35 percent and base flows have increased 10 to 140 percent due to regulation by Flaming Gorge Dam (Muth et al. 2000). However, since 2006 changes were made in the operation of Flaming Gorge Dam that provide flow and meet temperature requirements for native fish. The next major step in providing adequate habitat for the endangered fish is determining how to protect flows to consistently meet demands and endangered fish flow recommendations (see Flow Protection in the Green River, below). As part of this effort, researchers have created hydrologic models to determine how

often the flow recommendations would be met using current operations and past water supplies.

PRIMARY CONSTITUENT ELEMENT – PHYSICAL HABITAT- The completion of Flaming Gorge Dam created a fish passage barrier. Native Colorado pikeminnow, razorback sucker, humpback chub, and bonytail can no longer migrate into Wyoming from the lower Green River. Fish barriers isolate populations, decreasing the ability of individuals to interact, and hinder the transfer of genetic material. The quantity and timing of flows influence how the channel and various habitats are formed and maintained. Channel narrowing is a problem because as the channel width decreases, water velocity increases, and the amount of low velocity habitats, important to the early life stages of the fish, decreases. Habitat below Flaming Gorge Dam has historically been shaped by an artificial flow regime which decreased low flow habitats, disrupted vegetative communities, and altered channel morphology. However, recent operation changes have made this flow regime match more natural conditions. These changes affect temperature, channel morphology, and habitat conditions.

PRIMARY CONSTITUENT ELEMENT – BIOLOGICAL ENVIRONMENT- This PCE is impaired by the presence of non-native fishes common in the Green River. Non-native fishes occupy the same backwaters that are very important for young Colorado pikeminnow and razorback sucker. Specifically, largemouth (*Micropterus salmoides*) and smallmouth bass (*Micropterus dolomieu*), walleye (*Sander vitreus*), northern pike (*Esox lucius*), and channel catish (*Ictalurus punctatus*) are present in this system and predate upon juvenile native fish. Programs are ongoing to remove bass, walleye and northern pike from this system. Other non-natives found in the Green River include centrarchids and non-native cyprinids. Reduction in flows contributes to further habitat alterations that support nonnative fish species, such as increased temperatures, reduced habitat availability, and reduced turbidity.

FACTORS AFFECTING THE SPECIES ENVIRONMENT IN THE ACTION AREA

This baseline includes state, tribal, local, and private actions already affecting the species or that will occur contemporaneously with the consultation in progress. Unrelated federal actions affecting the same species or informal consultation are also part of the environmental baseline, as are federal and other actions within the action area that may benefit listed species or critical habitat.

UPPER COLORADO RIVER ENDANGERED FISH RECOVERY PROGRAM - The Upper Colorado River Endangered Fish Recovery Program was established in 1988 to help recover the four endangered fish species (see Consultation History). The Recovery Program implements management actions within seven Program elements, as dictated from species' recovery goals, with the focus of down-listing and de-listing the species. Five of these actions impact the species in the action area: instream flow identification and protection; habitat restoration; non-native fish management; propagation and stocking; and research and monitoring.

Current management actions performed by the Recovery Program in the Project action area include, but are not limited to:

- Overseeing non-native fish removal activities in the Green River Basin, downstream of the Project. Nonnative fishes of immediate primary concern and currently explicitly targeted for management are northern pike, smallmouth bass, walleye, and burbot (*Lota lota*). These nonnative fish species pose significant threats to the endangered fishes because of their high

or increasing abundance and range expansion, their habitat and resource requirements overlap with those of the endangered fish species, and their predatory impact;
- Participating in the Flaming Gorge Technical Workgroup, which manages releases from Flaming Gorge Dam to benefit endangered fish species while meeting other legal purposes of the dam. This technical team establishes base flow and spring peak release criteria from Flaming Gorge that meet the Flow Recommendations (Muth et al. 2000); and
- Stocking of bonytail and razorback sucker into the middle and lower Green River.

FLOW PROTECTION IN THE GREEN RIVER - Recovery cannot be accomplished without securing, protecting, and managing sufficient habitat to support self-sustaining populations of the endangered fishes. Identification and protection of instream flows are key elements in this process. The first step in this process, identifying instream flows needed for recovery, was completed for the action area with the publication of the Flow Recommendations (Muth et al. 2000). However, there is no legal protection of flows in the Utah portion of the Green River. The process for meeting this recovery goal is ongoing, as described below.

Several approaches may be taken under Utah water law to protect instream flows, including:
- Acquiring existing water rights and filing change applications to provide for instream flow purposes
- Withdrawing unappropriated waters by governor's proclamation;
- Approving presently filed and future applications subject to minimum flow levels;
- With proper compensation, preparing and executing contracts and subordinating diversions associated with approved and perfected rights.

Although Utah water law may not fully provide for all aspects of instream-flow protection, the State believes they can provide an adequate level of protection. Utah examined available flow protection approaches in the 1990's and determined that their primary strategy will be to condition the approval of presently filed and new applications, making them subject to predetermined streamflow levels. To accomplish this, the State Engineer adds a condition of approval to post-1994 water right applications above Jensen filed after the policy is adopted. The condition states that whenever the flow of the Green River (or other streams) drops below the predetermined streamflow level, then diversions associated with water rights approved after the condition is imposed are prohibited. Based on past legal challenges to the State's authority to impose conditions associated with new approvals, it was determined that this is within the authority of the State Engineer.

ENDANGERD FISH STOCKING - Each year tens of thousands of bonytail and razorback sucker are stocked into the main stem Green River. Two primary stocking locations are in the middle Green River near Ouray National Wildlife Refuge and in the lower Green River at Green River State Park. Stocking these fish in the main stem river is designed to supplement the population and eventually create a self-sustaining population.

EFFECTS OF THE ACTION

EFFECTS TO ENDANGERED SPECIES

The Project will adversely affect Colorado pikeminnow, razorback sucker, bonytail, and humpback chub by reducing the amount of water in the river system upon which they depend by up to 2,435 acre-feet per year. The effects to all four species primarily result from the effects of

the action upon their habitats. In general, the proposed action will adversely affect the four listed fish by reducing the amount of water available to them, increasing the likelihood of water quality issues, increasing their vulnerability to predation, and reducing their breeding opportunities by shrinking the amount of breeding and nursery habitat within their range.

Removing 2,435 acre-feet per year from the Colorado River Basin will alter the natural hydrological regime that creates and maintains important fish habitats, such as spawning habitats, and reduces the frequency and duration of availability of these habitats of the four endangered fish. The reduction of available habitats will directly affect individuals of all four species by decreasing reproductive potential and foraging and sheltering opportunities. Many of the habitats required for breeding become diminished when flows are reduced. As a result, individual fish within the action area may not find suitable breeding locations or will deposit eggs in less than optimal habitats more prone to failure or predation. In addition, reduction in flow rates lessens the ability of the river to inundate bottomland, a source of nutrient supply for fish productivity. Water depletions also exacerbate competition and predation by nonnative fishes by altering flow and temperature regimes toward conditions that favor non-natives.

The proposed depletions affect the water quality in the action area by increasing concentrations of heavy metals, selenium, salts, pesticides, and other contaminants. Increases in water depletions will cause associated reductions in assimilative capacity and dilution potential for any contaminants that enter the river. The Project depletions will cause a proportionate decrease in dilution, resulting in an increase in heavy metal, selenium, salts, pesticides, and other contaminant concentrations in the Colorado River system. An increase in contaminant concentrations in the river can result in an increase in the bioaccumulation of these contaminants in the food chain which could adversely affect the endangered fishes. Selenium is of particular concern due to its effects on fish reproduction and its tendency to concentrate in low velocity areas that are important habitats for Colorado pikeminnow and razorback sucker.

The proposed Project will affect the physical condition of habitat for the four listed fish by resulting in a reduction of water. This reduction will contribute to the cumulative reduction in high spring flows, which are essential for creating and maintaining complex channel geomorphology and suitable spawning substrates, creating and providing access to off-channel habitats, and possibly stimulating Colorado pikeminnow spawning migrations. Adequate summer and winter flows are important for providing a sufficient quantity of preferred habitats at a duration and frequency necessary to support all life stages of viable populations of all endangered fishes. To the extent that the proposed Project will reduce flows, the ability of the river to provide these functions will be reduced. This reduction of water affects habitat availability and habitat quality.

To the extent that it will reduce flows and contribute to further habitat alteration, the proposed Project may contribute to an increase in nonnative fish populations. The modification of flow regimes, water temperatures, sediment levels, and other habitat conditions caused by water depletions has contributed to the establishment of nonnative fishes. Endangered fishes within the action area will experience increased competition and predation as a result.

EFFECTS TO CRITICAL HABITAT

All four of the listed Colorado River fish require the same PCEs essential for their survival. Therefore, we are combining our analysis of all four species into one section. Because the

amount of designated critical habitat varies for each of the four species, the amount of critical habitat will vary; however, the effects will be the same for all critical habitats within the action area.

PRIMARY CONSTITUENT ELEMENT – WATER - The Project will deplete up to 2,435 acre-feet per year from the Colorado River Basin. Removing water from the river system changes the natural hydrological regime that creates and maintains important fish habitats, such as spawning habitats, and reduces the frequency and duration of availability of these habitats of the four endangered fish. In addition, reduction in flow rates lessens the ability of the river to inundate bottomland, a source of nutrient supply for fish productivity and important nursery habitat for razorback sucker. Water depletions change flow and temperature regimes toward conditions that favor nonnative fish, thus adding to pressures of competition and predation by these nonnative fishes as discussed above.

Changes in water quantity would affect water quality, which is a PCE of critical habitat. Contaminants enter the Colorado River from various point and non-point sources, resulting in increased concentrations of heavy metals, selenium, salts, pesticides, and other contaminants. Increases in water depletions will cause associated reductions in assimilative capacity and dilution potential for any contaminants that enter critical habitat in the Colorado River. The subject depletions will cause a proportionate decrease in dilution, which in turn would cause a proportionate increase in heavy metal, selenium, salts, pesticides, and other contaminant concentrations in the Upper Colorado River Basin, affecting water quality.

Water, physical habitat, and the biological environment are the PCEs of critical habitat. This includes a quantity of water of sufficient quality that is delivered to a specific location in accordance with a hydrologic regime that is required for the particular life stage for each species. The physical habitat includes areas of the Colorado River system that are inhabited or potentially habitable for use in spawning and feeding, as a nursery, or serve as corridors between these areas. In addition, oxbows, backwaters, and other areas in the 100-year floodplain, when inundated, provide access to spawning, nursery, feeding, and rearing habitats. Food supply, predation, and competition are important elements of the biological environment.

PRIMARY CONSTITUENT ELEMENT – PHYSICAL HABITAT - The Project will affect the physical condition of habitat for the four listed fish by resulting in a reduction of water. This reduction will contribute to the cumulative reduction in high spring flows, which are essential for creating and maintaining complex channel geomorphology and suitable spawning substrates, creating and providing access to off-channel habitats, and possibly stimulating Colorado pikeminnow spawning migrations. Adequate summer and winter flows are important for providing a sufficient quantity of preferred habitats for duration and at a frequency necessary to support all life stages of viable populations of all endangered fishes. To the extent that the subject action will reduce flows, the ability of the river to provide these functions will be reduced. This reduction of water affects habitat availability and habitat quality.

PRIMARY CONSTITUENT ELEMENT – BIOLOGICAL ENVIRONMENT - To the extent that it will reduce flows and contribute to further habitat alteration, the Project may contribute to an increase in nonnative fish populations. The modification of flow regimes, water temperatures, sediment levels, and other habitat conditions caused by water depletions has contributed to the

establishment of nonnative fishes. Endangered fishes within the action area would experience increased competition and predation as a result.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future state, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. In Wyoming, most water depletions within the Colorado River Basin include a federal nexus and will be addressed in future section 7 consultations.

CONCLUSION

After reviewing the current status of the Colorado pikeminnow, humpback chub, bonytail, and razorback sucker, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the Project, as described in this biological opinion, will not reduce the reproduction, numbers, or distribution of endangered fish in a manner that would be expected to reduce appreciably the likelihood of survival and recovery of endangered fish in the wild, and that the Project, as described, is not likely to destroy or adversely modify designated critical habitat.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury of wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass means an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

Colorado pikeminnow, humpback chub, bonytail, and razorback sucker are harmed from the reduction of water in their habitats resulting from the subject action in the following manner: (1) individuals using habitats diminished by the proposed water depletions could be more susceptible to predation and competition from non-native fish, and (2) habitat conditions may be rendered unsuitable for breeding because reduced flows would impact habitat formulation and maintenance as described in the biological opinion.

Estimating the number of individuals of these species that would be taken as a result of water depletions is difficult to quantify for the following reasons: (1) determining whether an individual forwent breeding as a result of water depletions versus natural causes would be

extremely difficult to determine; (2) finding a dead or injured listed fish would be difficult, due to the large size of the action area and because carcasses are subject to scavenging; (3) natural fluctuations in river flows and species abundance may mask depletion effects, and (4) effects that reduce fecundity are difficult to quantify. However, we believe the level of take of these species can be monitored by tracking the level of water reduction and adherence to the Recovery Program. Specifically, if the Recovery Program (and relevant RIPRAP measures) is not implemented, or if the current anticipated level of water depletion is exceeded, we fully expect the level of incidental take to increase as well. Therefore, we exempt all take in the form of harm that would occur from the removal of 2,435 acre-feet of water per year. Water depletions above the amount addressed in this biological opinion would exceed the anticipated level of incidental take and are not exempt from the prohibitions of section 9 of the ESA.

The implementation of the Recovery Program is intended to minimize impacts of water depletions; therefore, support of Recovery Program activities by Reclamation as described in the proposed action exempts Reclamation as the Project proponent from the prohibitions of section 9 of the ESA. The Reclamation is responsible for reporting to the Service if the amount of average annual depletion is exceeded.

REASONABLE AND PRUDENT MEASURES

In addition to the conservation measures identified earlier in this document, we believe the following reasonable and prudent measure is necessary and appropriate to minimize the impacts of incidental take of Colorado pikeminnow, humpback chub, bonytail, and razorback sucker:

1. The Reclamation must implement a monitoring and reporting program to ensure that the annual depletion does not exceed 2,435 acre-feet.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the ESA, Reclamation must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary. In order to implement a monitoring and reporting program:

1. For the first three years of operation, Reclamation will provide an annual written report to the Service of water used from Big Sandy Reservoir for irrigation (and other consumptive) uses.

2. Reclamation must report any substantial changes in operation of Big Sandy Reservoir that could result in increasing the annual depletion, including but not limited to: an increase in use; and a change in the type, location, or timing of use.

3. If the water used for irrigation (and other non-evaporative uses) exceeds 1,480 acre-feet, or if there is a substantial change in the operation of Big Sandy Reservoir, the Reclamation will report this change to the Service.

REINITIATION NOTICE

This concludes formal consultation on the action outlined in the request. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

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Appendix C – WGFD Concurrence Letter

WYOMING GAME AND FISH DEPARTMENT

5400 Bishop Blvd. Cheyenne, WY 82006

Phone: (307) 777-4600 Fax: (307) 777-4699

wgfd.wyo.gov

February 28, 2019

WER 12508.03
State of Wyoming's Sage Grouse Executive Order 2015-4
Density Disturbance Calculation Tool
U.S. Bureau of Reclamation
Big Sandy Reservoir Enlargement
Reservoir Enlargement
Sublette and Sweetwater Counties

Jared Baxter
Bureau of Reclamation
302 E. 1860 S.
Provo, UT 84606

Dear Mr. Baxter:

The staff of the Wyoming Game and Fish Department (Department) has reviewed the proposed project for compliance with the State of Wyoming's Sage Grouse Executive Order 2015-4 (SGEO). **Please note this letter is for sage-grouse recommendations only, and additional wildlife concerns may need to be addressed within the project area.**

It is the responsibility of the state permitting agency(s) to accept or deny the permit based on the following recommendations.

Project Description: The project proposes raising the spillway crest of Big Sandy Dam by 5 feet, installing filter diaphragm around existing outlet work, constructing a cement-bentonite wall through the Big Sandy Dike embankment and foundation, replacing the headworks of the Big sandy Feeder Canal, and replacing the 6 drop-structures below the headworks of the Big Sandy Feeder Canal. The Bureau of Reclamation (BOR) is seeking an exception to the SGEO timing stipulations in 2020 to construct between March 15 to June 30.

Avoidance and Minimization Measures:

- Current roads and previously disturbed areas will be used as much as possible, with the potential for some road improvements.
- A site south of the dam previously used for construction remains mostly barren soil material. This site will be used mainly during construction of the spillway crest and will be reclaimed.
- Approximately 15.6 acres of new disturbance would be co-located in areas that will be inundated.

- Certain areas calculated as disturbed in the DDCT will be marked as "Temp-Incentive" and might not be disturbed. These areas will include a stipulation to the contractor that use of the areas would require reclamation with sagebrush, native grasses and forbs at their own cost.
- All disturbed areas outside the inundation areas will be re-contoured with topsoil and re-vegetated with sagebrush, native grasses and forbs.
- Construction between March 15 and May 15 will only occur between the hours of 8:00 AM and 6:00 PM to reduce disturbance to breeding sage-grouse.

Project Disturbance: 456.43 acres

COT Threat: Infrastructure

Project Location: T26N R106W Sec1, 2, 3, 10, 11; T27N R106W Sec 20, 21, 25, 26, 27, 28, 29, 33, 34, 35, 36

Core Area: Greater South Pass

County: Sublette and Sweetwater

Surface/Mineral Ownership: Bureau of Reclamation, Private

Permitting Agencies: DEQ-WQD, DEQ-AQD, SEO, BOR

Density/Disturbance Calculation Tool (DDCT): The DDCT process was conducted per Executive Order 2015-4 guidelines using the DDCT web application and reviewed by the Department. DDCT results for the project are as follows:

- Project Disturbance = 0.52%
- Total Disturbance = 3.69%
- Density = 0.07/640 acres

Compliance: This project meets the 5% and 1/640 thresholds in the SGEO.

Stipulations and Recommendations for Development:
In addition to meeting SGEO disturbance/density guidelines, all stipulations outlined in Attachment B of the SGEO should be required by the permitting agency or agencies, and included in the conditions of the associated permit(s). These include general stipulations on surface disturbance, surface occupancy, seasonal use, geophysical exploration, transportation, overhead power lines, noise, vegetation removal, sagebrush treatment, monitoring/adaptive response, and reclamation, and specific stipulations pertaining to oil and gas, mining, connectivity area, underground rights-of-way, and wind energy development. All projects in

core area should be sited and designed to avoid and minimize impacts to sage-grouse and sagebrush habitat.

The following are areas where the submitted worksheet indicates implementation of the proposed project may deviate or not comply with Attachment B stipulations for development, and our subsequent recommendations:

- The project proposes construction during the SGEO timing stipulations between March 15 and June 30.
- The Department recommends granting a one-time seasonal exception to the SGEO to allow construction from March 15 to June 30, 2020. The State of Wyoming Greater Sage-Grouse Compensatory Mitigation Framework considers this a short-term impact to be assessed as a one-time requirement of 10 credits.
- All credits are required to meet the State of Wyoming Greater Sage-Grouse Compensatory Mitigation Framework definitions. The exception request for the Big Sandy Reservoir Enlargement Project is for the calendar year 2020. If the BOR chooses to conduct construction activity during this seasonal exception period, documentation of qualified credits must be provided to the permitting agencies.

Thank you for the opportunity to comment. If you have any questions or concerns, please contact Mark Conrad, Habitat Protection Biologist, at (307) 777-4509.

Sincerely,

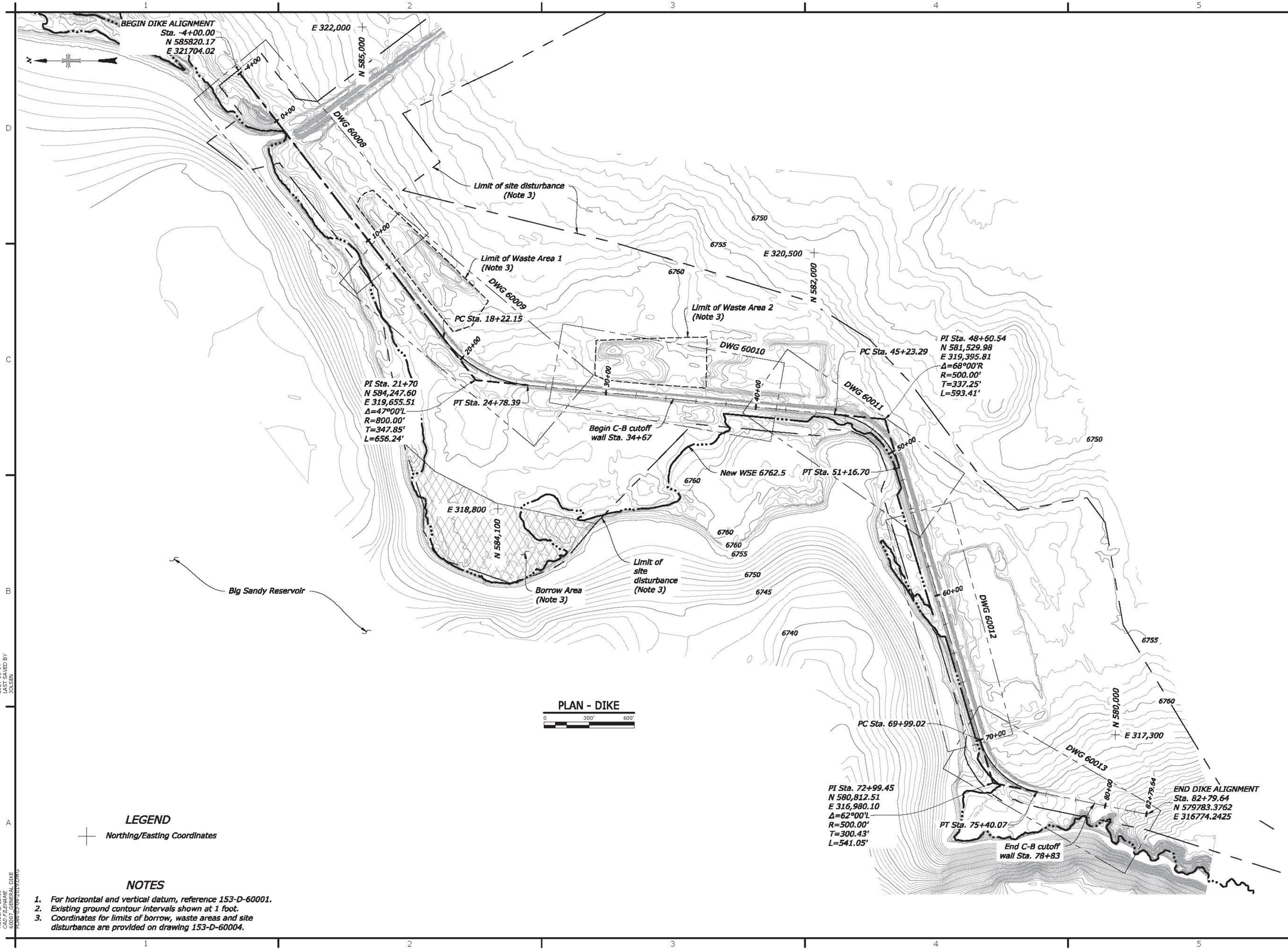
Angi Bruce
Habitat Protection Supervisor

AB/mc/ml

Enclosures
1) Sage-Grouse Executive Order 2015-4 Worksheet
2) DDCT Final Results

cc: U.S. Fish and Wildlife Service
Dean Clause, Wyoming Game and Fish Department
Brandon Scurlock, Wyoming Game and Fish Department
Nick Meeker, Wyoming Department of Environmental Quality
Barb Sahl, Wyoming Department of Environmental Quality
Bill DiRienzo, Wyoming Department of Environmental Quality
Patrick Tyrell, Wyoming State Engineer
Rick Deuell, Wyoming State Engineer's Office
Nicholas Graf, Wyoming Geographic Information Science Center
Chris Wichmann, Wyoming Department of Agriculture, Cheyenne

Appendix D – Engineering Drawings



PLAN - DIKE

LEGEND

Northing/Easting Coordinates

NOTES

1. For horizontal and vertical datum, reference 153-D-60001.
2. Existing ground contour intervals shown at 1 foot.
3. Coordinates for limits of borrow, waste areas and site disturbance are provided on drawing 153-D-60004.

RECLAMATION
Managing Water in the West

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U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
ED EN PROJECT

BIG SANDY DAM

RESERVOIR ENLARGEMENT

DESIGNED		2019.03.06 09:57:10 -07'00'
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CHECKED		2019.03.06 10:14:29 -07'00'
TECH. APPR.		2019.03.06 12:19:45 -07'00'
APPROVED FOR RECLAMATION -	RYAN WOODRUFF, P.E. 10-10211	
DENVER, CO		2019-03-04

DIKE MODIFICATIONS

GENERAL DIKE PLAN AND ALIGNMENT

153-D-60007

SHEET 1 OF 9

LAST SAVED DATE 2019.03.06
LAST SAVED BY JOLSEN

CAD SYSTEM MicroStation V8i
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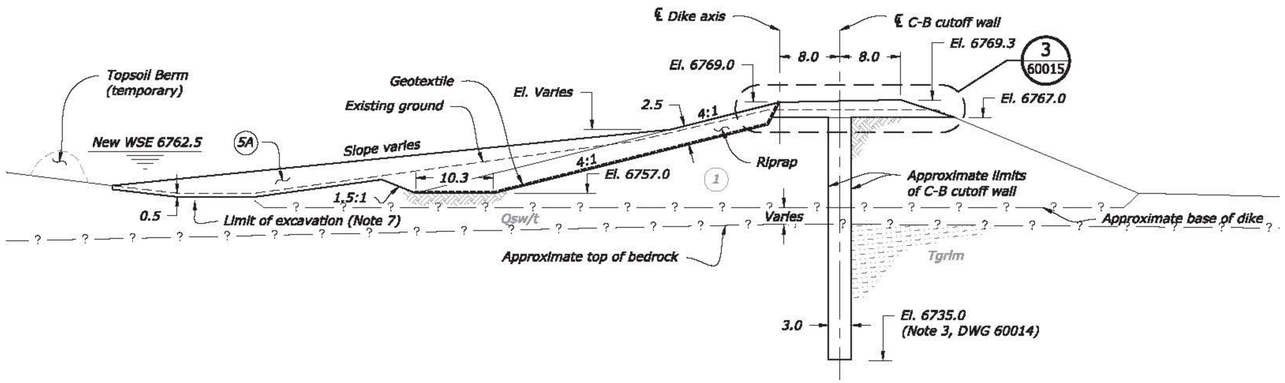
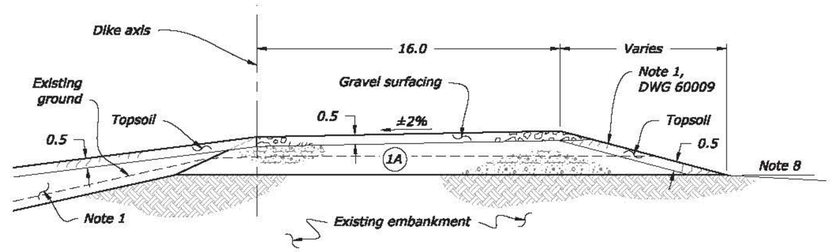
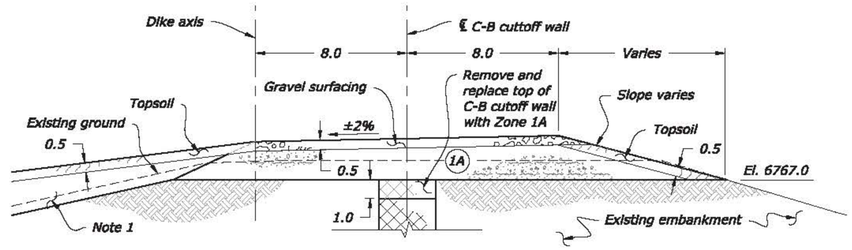


F 60011 SECTION STA. 43+70

0 10 20



1 60014 DETAIL N.T.S



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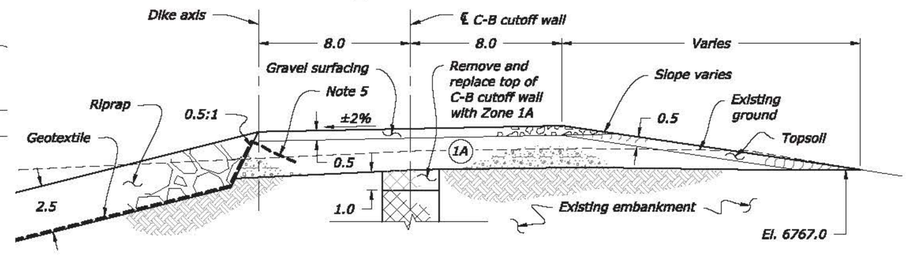
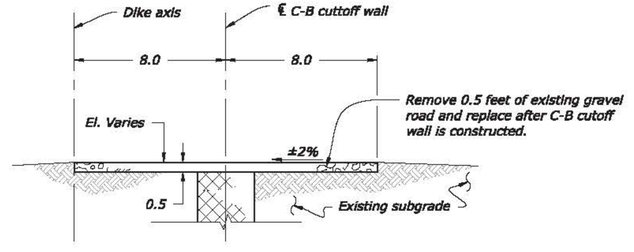


3 60015 DETAIL N.T.S



W 60013 SECTION STA. 78+50 N.T.S.

G 60011 SECTION STA. 48+50

0 10' 20'

Dike Sections	
Section ID	Relavant Stations
A	2+30 to 7+34
A (note 2)	7+34 to 10+45
Transition A to B (note 3)	10+45 to 12+00
B	12+00 to 18+80
C	18+80 to 29+00
B	29+00 to 34+67
B (note 4)	34+67 to 36+00
Transition B to D	36+00 to 36+50
D	36+50 to 41+00
E	41+00 to 43+50
F	43+50 to 44+00

Dike Sections	
Section ID	Relavant Stations
G	44+00 to 52+30
F	52+30 to 52+80
E	52+80 to 61+10
F	61+10 to 61+60
G	61+60 to 70+55
F	70+55 to 71+05
E	71+05 to 73+93
D	73+93 to 74+07
C (Note 4)	74+07 to 78+11
W	78+11 to 78+83 (End C-B Wall)

EXISTING MATERIALS DESCRIPTIONS

(1) Impervious fill comprised of clay, sand and gravel.

Qsw/t Undifferentiated Quaternary Slopewash and Terrace Deposits

Tgrim Tertiary Green River Formation: Laney Member, LaClede Bed.

MATERIALS DESCRIPTIONS

(1A) Impervious fill, containing a select mixture of clay, silt and sand.

(5A) Cement, bentonite and cuttings from C-B wall excavation.

NOTES

1. Backfill with zone 1A, zone 5A, or a combination of zone 1A and zone 5A as shown on typical sections.
2. Dike configuration is similar to Section A, but downstream waste area configuration is similar to Section B.
3. Dike configuration transitions from Section A to Section B. Downstream waste area is similar to Section B.
4. C-B wall configuration is similar to Section D.
5. Anchor geotextile by embedding a minimum of 2 feet into fill.
6. Backfill area above riprap with Zone 1A or excess Zone 5A. Zone 5A shall be considered excess only after all 10:1 slopes have been backfilled with a minimum 2.5-foot thick layer of Zone 5A.
7. Selectively strip and excavate topsoil and gravel road surfacing before excavating underlying Zone 1 fill. Contractor shall be responsible for selectively excavating and segregating various existing fill zones in a manner that reduces the potential for unintended mixing and contamination. Selectively excavated materials shall be stockpiled and protected until materials are re-used for fill placement..
8. Elevation of downstream slope catch point varies down-station of Sta. 12+00 and is fixed at elevation 6767.0 up-station of Sta. 12+00.

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EDEN PROJECT

BIG SANDY DAM
RESERVOIR ENLARGEMENT

DESIGNED 2019.03.06 10:05:45 -07'00'
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TECH. APPR. 2019.03.06 12:26:22 -07'00'
APPROVED PER REVIEWER - RYAN WOODRUFF, P.E. 80-68111
DENVER, CO 2019-03-04

DIKE MODIFICATIONS

SECTIONS AND DETAILS

153-D-60015

SHEET 9 OF 9

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JOLSEN

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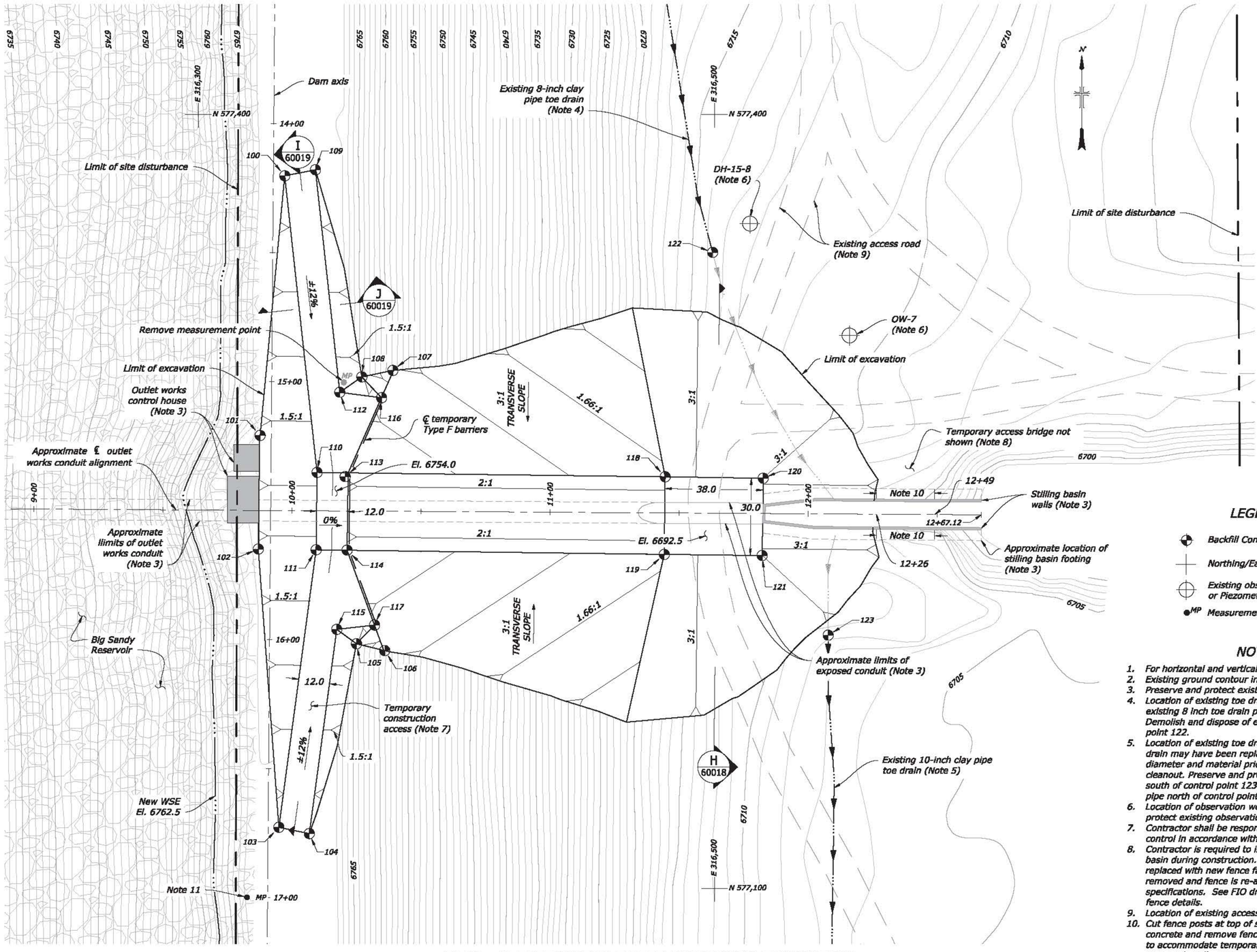

Excavation Control Points

Point #	Northing	Easting	Elevation
100	577376.11	316333.54	6768.0
101	577275.50	316324.01	6769.0
102	577231.43	316323.29	6769.0
103	577123.58	316331.28	6768.1
104	577121.16	316343.08	6768.1
105	577194.75	316361.31	6764.6
106	577192.08	316372.30	6759.3
107	577300.70	316375.44	6758.8
108	577298.20	316363.40	6764.5
109	577378.47	316345.44	6768.0
110	577261.14	316346.08	6754.0
111	577231.14	316345.69	6754.0
112	577292.21	316354.85	6757.6
113	577259.51	316356.93	6754.0
114	577230.99	316357.70	6754.0
115	577200.33	316353.69	6758.5
116	577290.10	316371.02	6757.6
117	577201.98	316368.33	6758.5
118	577259.45	316480.94	6692.5
119	577229.36	316480.56	6692.5
120	577258.90	316518.93	6692.5
121	577228.92	316518.53	6692.5
122	577346.41	316499.33	N/A
123	577198.07	316544.08	N/A

LEGEND

- Backfill Control Point
- Northing/Easting Coordinates
- Existing observation well or Piezometer
- MP Measurement Point

NOTES

1. For horizontal and vertical datum, reference 153-D-60001.
2. Existing ground contour intervals shown at 1 foot.
3. Preserve and protect existing structures.
4. Location of existing toe drain is approximate. Preserve and protect existing 8 inch toe drain pipe shown in bold, north of control point 122. Demolish and dispose of existing 8 inch toe drain pipe south of control point 122.
5. Location of existing toe drain is approximate. Portions of existing toe drain may have been replaced with 12-inch concrete pipe. Confirm pipe diameter and material prior to ordering fittings and couplings for cleanout. Preserve and protect existing toe drain pipe shown in bold, south of control point 123. Demolish and dispose of existing toe drain pipe north of control point 123.
6. Location of observation well or piezometer is approximate. Preserve and protect existing observation wells and piezometers.
7. Contractor shall be responsible for providing site access and traffic control in accordance with specifications.
8. Contractor is required to install temporary access bridge over stilling basin during construction. Existing chain link fence fabric shall be replaced with new fence fabric, in-kind, after temporary bridge is removed and fence is re-assembled. Additional requirements are in the specifications. See FIO drawings 153-D-31 and 153-D-299 for existing fence details.
9. Location of existing access road is approximate.
10. Cut fence posts at top of stilling basin walls a minimum of 1 foot above concrete and remove fence between about OW Sta. 12+26 and 12+49 to accommodate temporary bridge. A total of 8 fence posts can be cut, 4 on each wall. Save and reuse cut fence posts by reattaching to portion of fence post embedded in concrete with couplers after temporary bridge is removed.
11. Unless otherwise shown, preserve and protect embankment measurement points.

PLAN - OUTLET WORKS FILTER DIAPHRAGM EXCAVATION

0 20' 40'

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EDEN PROJECT

BIG SANDY DAM
RESERVOIR ENLARGEMENT

DESIGNED		2019.03.06 10:08:21 -07'00'
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TECH. APPR.		2019.03.06 12:27:00 -07'00'
APPROVED	PEER REVIEWER - RYAN WOODRUFF, P.E. 86-68311	
DENVER, CO		2019-03-04

OUTLET WORKS FILTER DIAPHRAGM

EXCAVATION PLAN

153-D-60016

SHEET 1 OF 6

LAST SAVED DATE AND TIME: 3/6/2019 12:27:00 PM
LAST SAVED BY: JOLSEN

CAD SYSTEM: AutoCAD Civil 3D
CAD FILENAME: 60016-60021_OW-FILTER_03-04-2019.DWG

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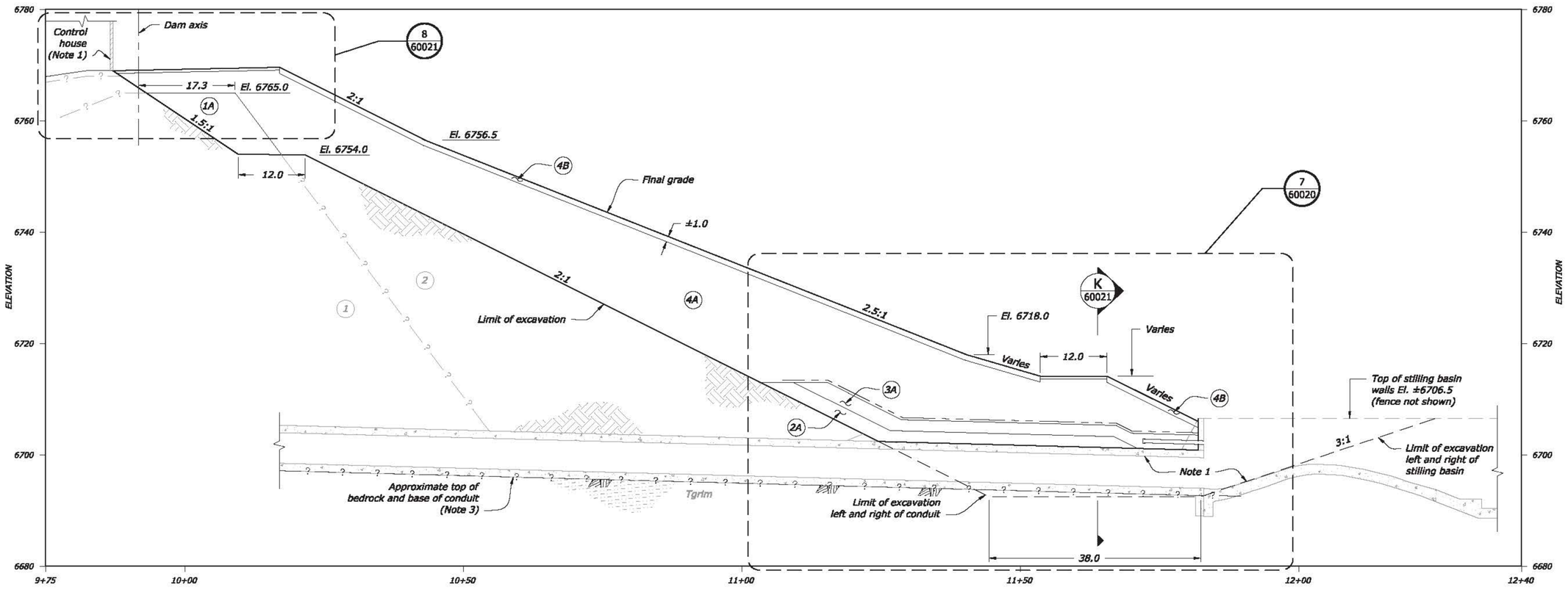
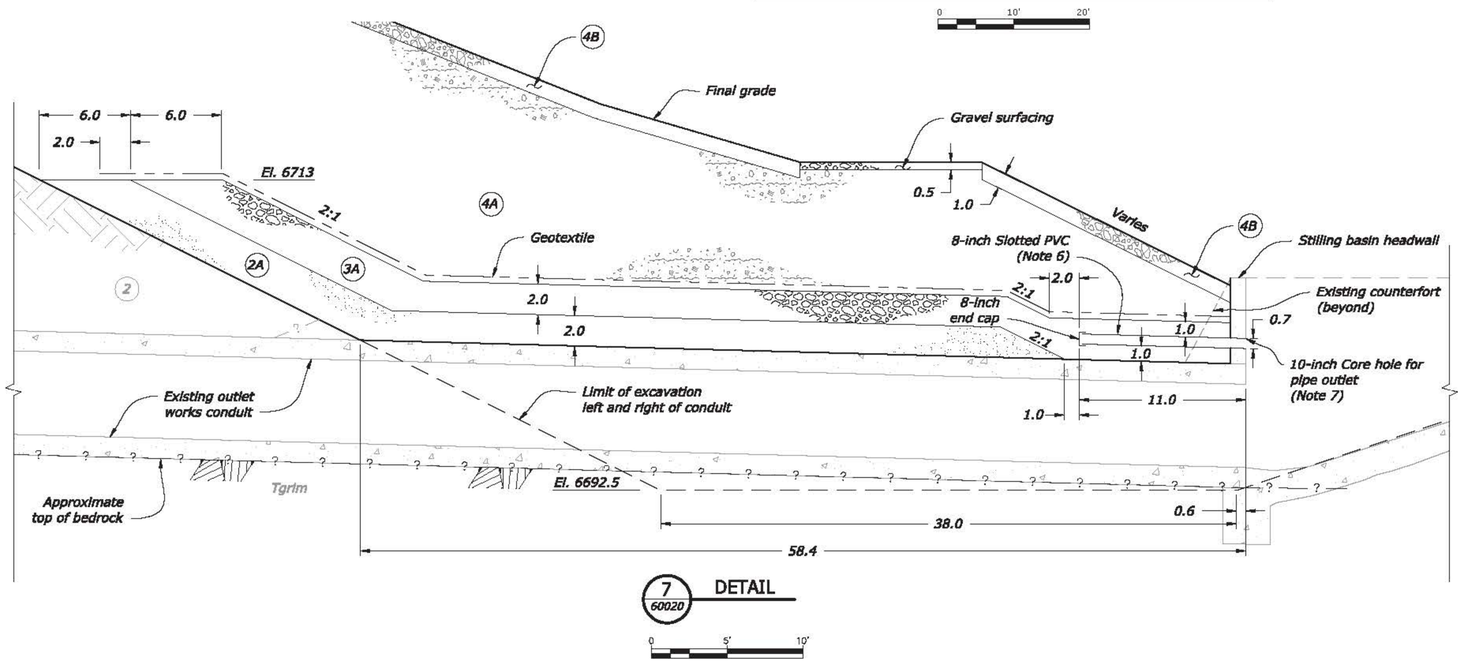


PROFILE - OUTLET WORKS FILTER DIAPHRAGM BACKFILL



7 / 60020 DETAIL

0 5' 10'

EXISTING MATERIALS DESCRIPTIONS

(1) *Impervious fill comprised of clay, sand and gravel.*

(2) *Granular fill comprised of sand and gravel.*

(3) *Rockfill comprised of excavated bedrock fragments.*

Tgrlm *Tertiary Green River Formation: Laney Member, LaClede Bed.*

MATERIALS DESCRIPTIONS

(1A) *Impervious fill containing a select mixture of clay, silt and sand.*

(2A) *Processed sand filter.*

(3A) *Processed gravel drain.*

(4A) *Miscellaneous fill containing a select mixture of sand and gravel.*

(4B) *Gravel slope protection removed from existing dam and supplemented with excavated bedrock from the left abutment filter trench.*

NOTES

1. *Preserve and protect existing structures*
2. *Not used.*
3. *Approximate foundation contact. See Drawing 153-D-24 for additional information.*
4. *Not used.*
5. *Not used.*
6. *Slot configuration for 8-inch PVC pipe is shown on Drawing 153-D-60024. Transition to solid PVC pipe within 1 foot of the stilling basin headwall.*
7. *Advance core hole after locating reinforcement in existing headwall (both sides) with ground penetrating radar. Center core hole between reinforcement. Do not core though existing reinforcement. Grout annulus between 8-inch pipe and and core hole with non-shrink grout.*

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BUREAU OF RECLAMATION
EDEN PROJECT

BIG SANDY DAM
RESERVOIR ENLARGEMENT

DESIGNED	2019.03.06 10:10:31 -07'00'
DRAWN	2019.03.06 10:10:50 -07'00'
CHECKED	2019.03.06 10:59:15 -07'00'
TECH. APPR.	2019.03.06 10:59:31 -07'00'
APPROVED	2019.03.06 12:29:35 -07'00'
PEER REVIEWER - ROBIN WOODRUFF, P.E. 06-08111	
DENVER, CO	2019-02-25

OUTLET WORKS FILTER DIAPHRAGM

FINAL GRADE PROFILE AND DETAILS

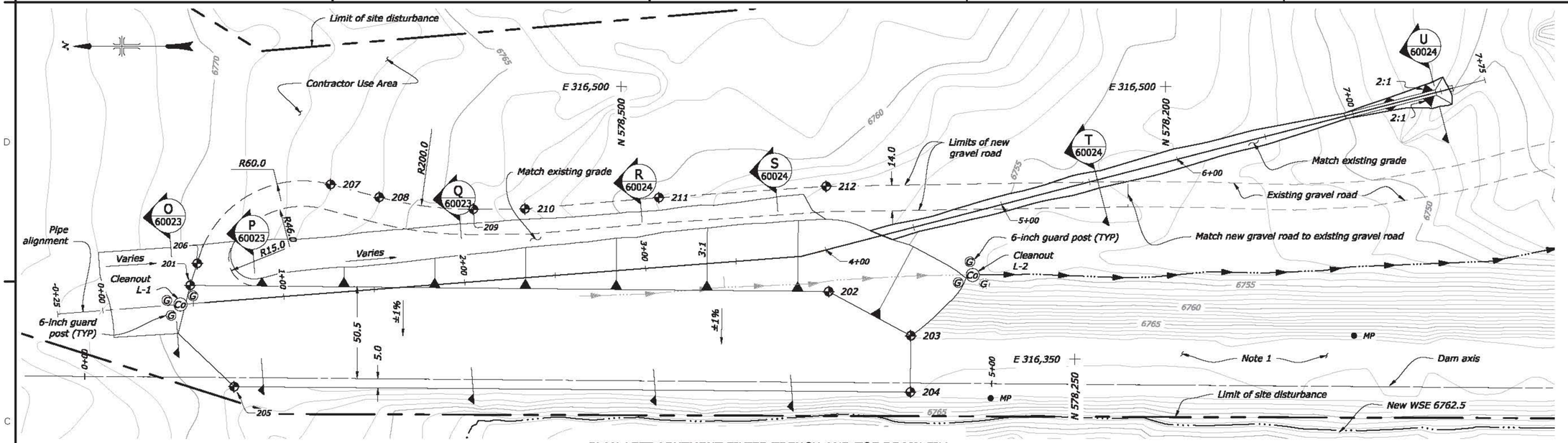
153-D-60020

SHEET 5 OF 6

T:\DRBSTUC\BIG SANDY DAMS AND DIKES\2017-PDC-RESERVOIR ENLARGEMENT\DWG\8311-SPEC B160016-60021_OW-FILTER_03-04-2019.DWG

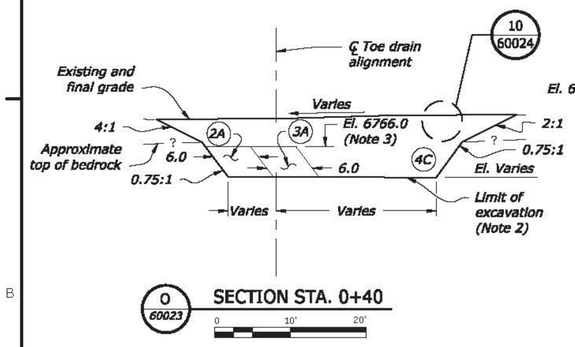
LAST SAVED DATE
LAST PLOTTED
LAST SAVED BY
JOLSEN

CAD SYSTEM
AutoCAD Civil 3D
CAD FILENAME
60016-60021_OW-FILTER_03-04-2019.DWG



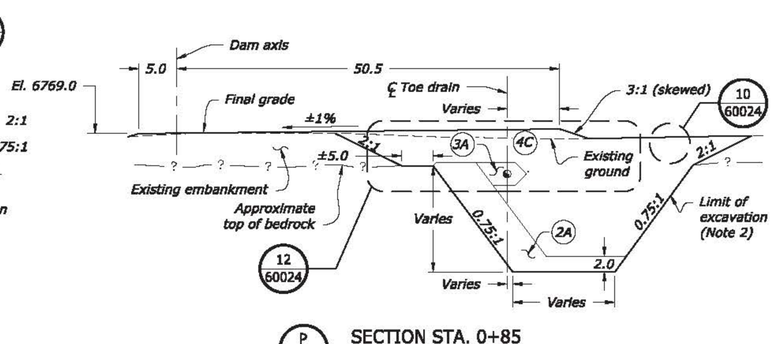
PLAN-LEFT ABUTMENT FILTER TRENCH AND TOE DRAIN FILL

0 30' 60'



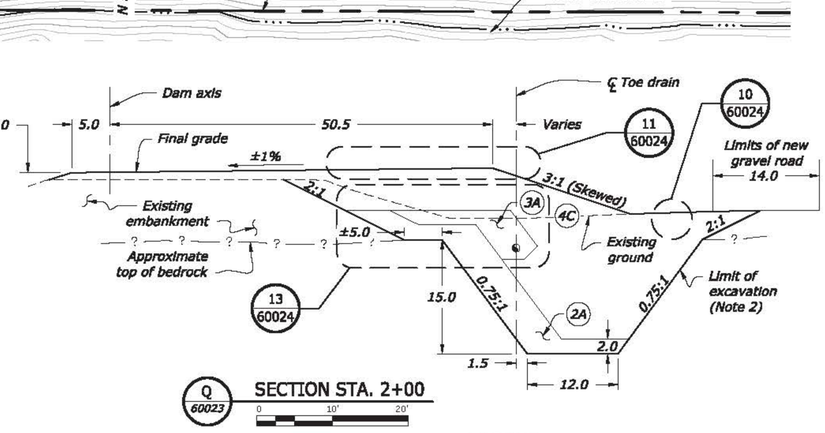
O 60023 **SECTION STA. 0+40**

0 10' 20'



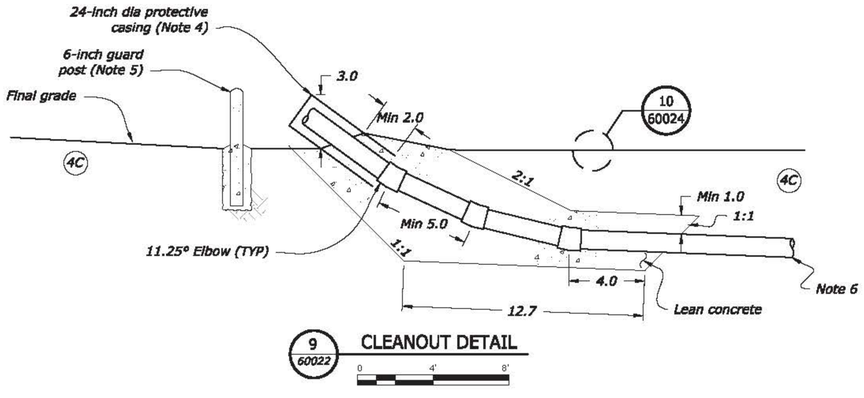
P 60023 **SECTION STA. 0+85**

0 10' 20'



Q 60023 **SECTION STA. 2+00**

0 10' 20'



9 60022 **CLEANOUT DETAIL**

0 4' 8'

Control Points

Point	Northing	Easting	Elevation
201	578737.48	316390.60	6769.60
202	578385.72	316387.22	6769.60
203	578340.43	316362.86	6769.60
204	578340.68	316331.86	6769.00
205	578713.27	316334.79	6769.00
206	578733.60	316402.67	N/A
207	578660.17	316446.17	N/A
208	578633.25	316439.11	N/A
209	578581.46	316432.57	N/A
210	578553.01	316432.72	N/A
211	578479.15	316438.93	N/A
212	578387.02	316445.11	N/A

Relevant Cross-Section Stations

Section ID	Station Range
O	0+05 to 0+65
P	0+65 to 1+14
Q	1+14 to 2+04
R	2+04 to 3+25
S	3+25 to 3+88
T	3+88 to 6+95
U	6+95 to 7+55

LEGEND

- Northing/Easting Coordinates
- Control point
- Co Cleanout
- G Guard post
- MP Measurement point (Note 5, DWG 60022)

MATERIALS DESCRIPTION

- (2A) Processed sand filter.
- (3A) Processed gravel drain.
- (4A) Miscellaneous fill containing a select mixture of sand and gravel.
- (4B) Gravel slope protection removed from existing dam and supplemented with excavated bedrock.

NOTES

1. See DWG 153-D-60025 for crest modifications south of dam Sta.4+55.
2. Coordinate foundation inspection, treatment and approval with COR prior to fill placement.
3. Top elevation of zones 2A and 3A shown is for material placed down-station (north) of cleanout L1.
4. Protective steel casing with locking lid.
5. Install three guard posts at each cleanout location (six total). Guard posts shall be constructed in accordance with Type I guard posts shown on standard drawing 40-D-60002.
6. Connect cleanout L2 to existing dissimilar 8-inch clay pipe with flexible coupling and two stainless steel straps on each side of joint. Encase a minimum of 2-feet beyond joint between dissimilar pipes in all directions with lean concrete.

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BIG SANDY DAM
RESERVOIR ENLARGEMENT

DESIGNED 2019.03.06 10:18:19 -07'00'
DRAWN 2019.03.06 11:01:36 -07'00'
CHECKED 2019.03.06 11:01:51 -07'00'
TECH. APPR. 2019.03.06 12:30:43 -07'00'
APPROVED
PEER REVIEWER - KIRK MCCORMICK, P.E. 86-68311
DENVER, CO 2019-03-04

LEFT ABUTMENT FILTER TRENCH

FILL PLAN, SECTIONS AND DETAILS

153-D-60023

SHEET 2 OF 3

T:\DOBS\UC\BIG SANDY DAMS AND DIKES\2017-PDC-RESERVOIR ENLARGEMENT\FIN\DWG\6311-SPEC B\60022_60023_60024_L_ABUT_FILTER_03-04-2019.DWG

LAST SAVED DATE 03-04-2019
LAST SAVED BY JOLSEN

CAD SYSTEM MICROSTATION
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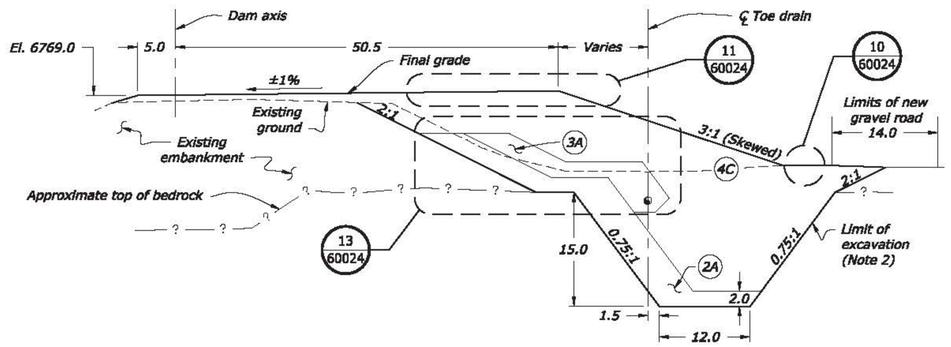
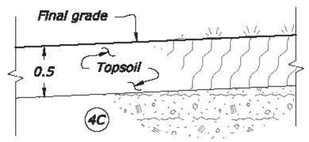
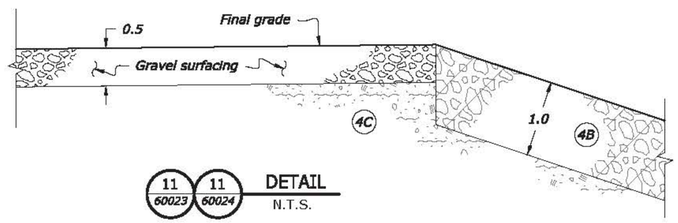


R 60023 SECTION STA. 3+00

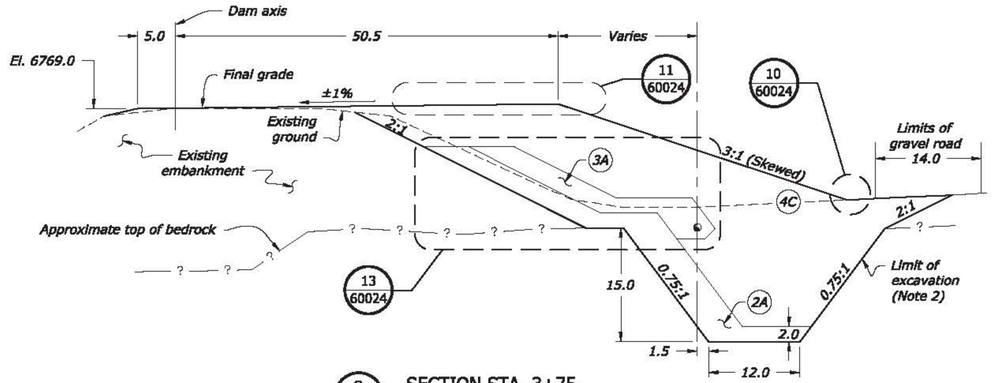
0 10' 20'



10 60023 10 60024 DETAIL N.T.S.

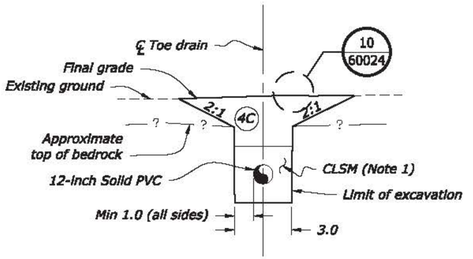


11 60023 11 60024 DETAIL N.T.S.



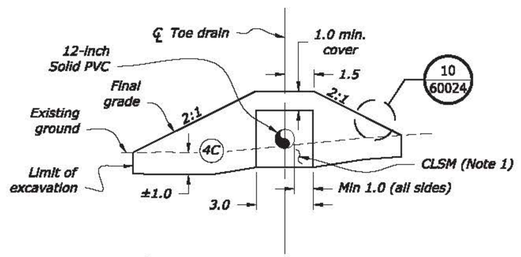
S 60023 SECTION STA. 3+75

0 10' 20'



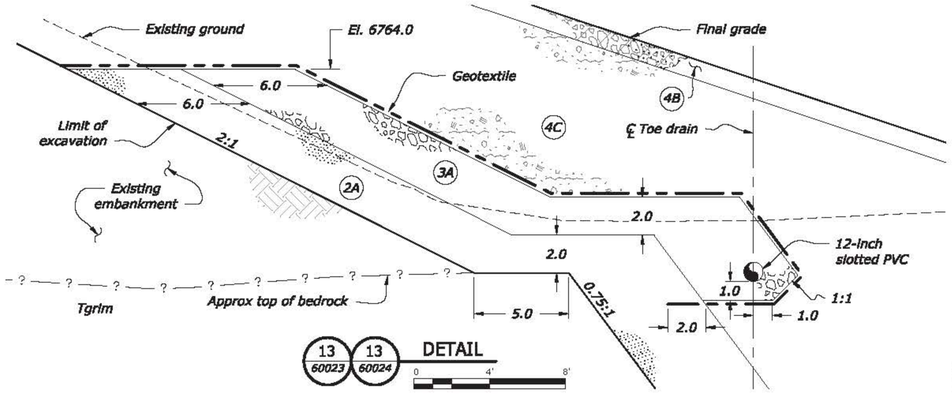
T 60023 SECTION STA. 5+54.5

0 4' 8'



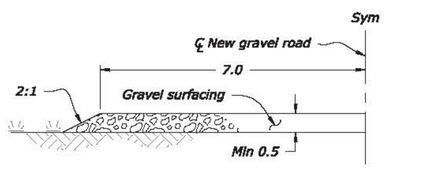
U 60023 SECTION STA. 7+47

0 4' 8'



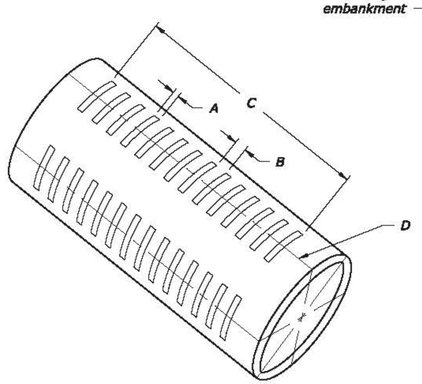
13 60023 13 60024 DETAIL

0 4' 8'



TYPICAL NEW GRAVEL ROAD DETAIL

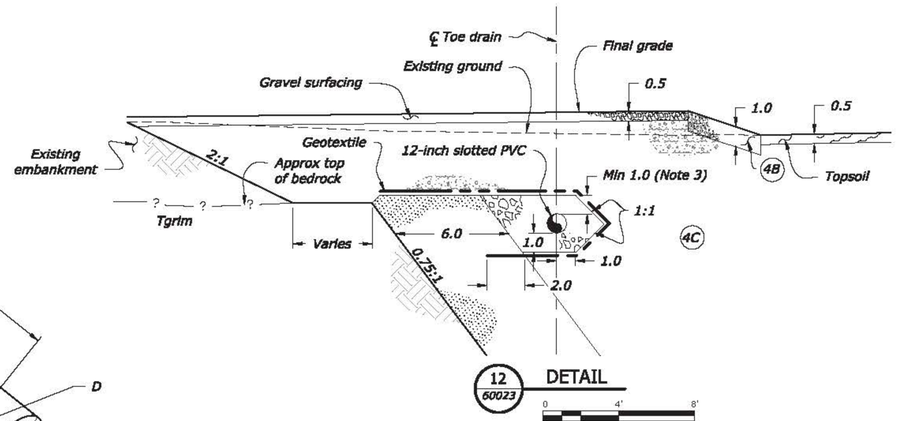
0 2' 4'



Pipe Dia (Nominal)	(A) Slot Width	(B) Slot Spacing	(C) Slots Per Row-Foot	(D) No. of Rows
8-inch	0.125-inch	0.75-inch	14	4
12-inch	0.125-inch	0.75-inch	14	6

SLOTTED PVC PIPE DETAIL

N.T.S



12 60023 DETAIL

0 4' 8'

MATERIALS DESCRIPTION

- **2A** Processed sand filter.
- **3A** Processed gravel drain.
- **4A** Miscellaneous fill containing a select mixture of sand and gravel.
- **4B** Gravel slope protection removed from existing darn and supplemented with excavated bedrock.

NOTES

1. Place CLSM in a manner to avoid flotation of pipe. Additional requirements are in the specifications.
2. Coordinate foundation inspection, treatment and approval with COR prior to fill placement.
3. Except where otherwise noted, Zones 2A and 3A to extend a minimum of 1 foot above crown of slotted pipe.

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BIG SANDY DAM
RESERVOIR ENLARGEMENT

DESIGNED	2019.03.06 10:18:52 -07'00'	
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CHECKED	2019.03.06 11:02:16 -07'00'	
TECH. APPR.	2019.03.06 11:02:32 -07'00'	
APPROVED	2019.03.06 12:31:22 -07'00'	
PEER REVIEWER -	KARI WOODRUFF, P.E. 86-68311	
DENVER, CO	2019-03-04	

LEFT ABUTMENT FILTER TRENCH

SECTIONS AND DETAILS

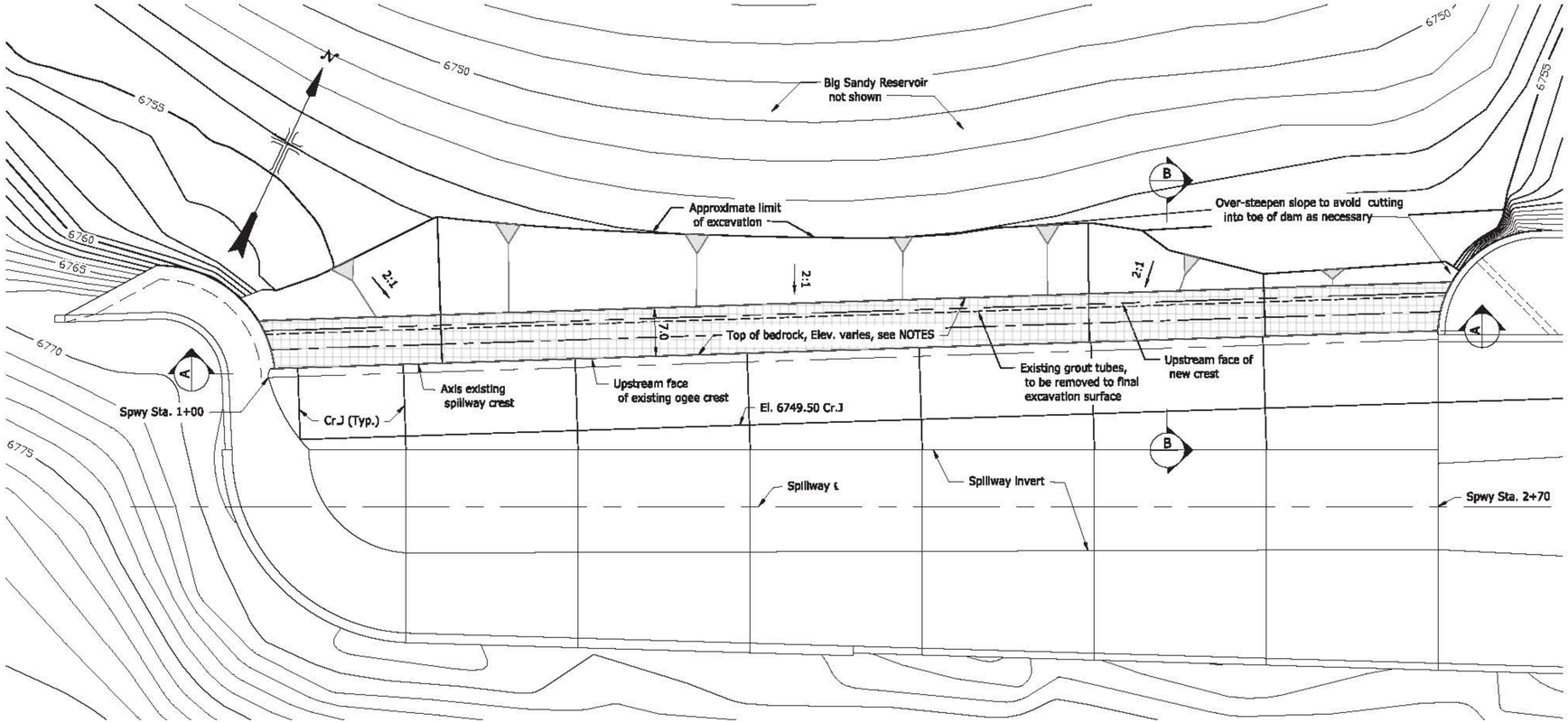
153-D-60024

SHEET 3 OF 3

T:\JOBS\UC\BIG SANDY DAMS AND DIKES\2017-PDC-RESERVOIR ENLARGEMENT\[FINDWG\8311-SPEC B\60022_60023_60024_L_ABUT_FILTER_03-04-2019.DWG

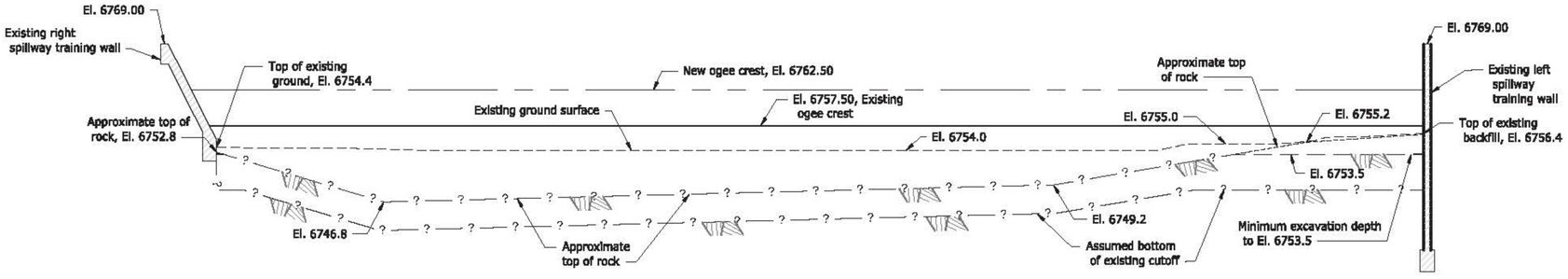
LAST SAVED DATE 2019-03-05
LAST SAVED BY JOLSEN

CAD SYSTEM AutoCAD 22.0s
ACAD FILENAME 60022_60023_60024_L_ABUT_FILTER_03-04-2019.DWG



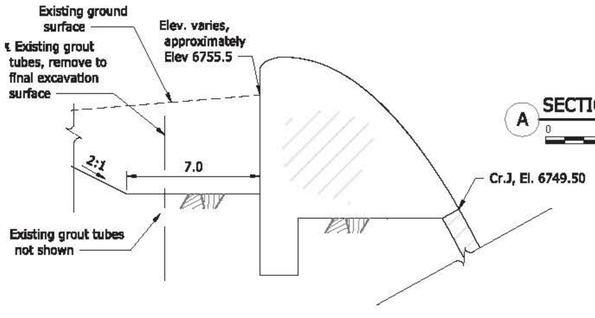
EXCAVATION PLAN

0 10' 20'



A SECTION

0 10' 20'



B SECTION - GENERAL EXCAVATION SECTION

0 2' 4' 8'

REFERENCE DRAWINGS

GENERAL PLAN OF EXISTING CONDITIONS	153-D-60002
GENERAL PLAN, SITE ACCESS, CONTRACTOR USE AREAS AND MODIFICATIONS	153-D-60004
EXISTING SPILLWAY CREST - CONCRETE REMOVAL PLAN AND SECTIONS	153-D-60049
SPILLWAY CREST RAISE - ISOMETRIC, PLAN, PROFILE, AND ANCHOR TABLE	153-D-60026

NOTES

1. For details of the spillway, see (60026).
2. Excavate to the top of bedrock or El. 6753.5, whichever is deeper.

KEY

BEDROCK FOUNDATION SURFACE

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EDEN PROJECT

BIG SANDY DAM

RESERVOIR ENLARGEMENT

REV NO	DATE	DESCRIPTION
1	2019-06-17	D Updated linetypes for assumed features. Minor label edits.

Miguel Hernandez — DESIGNED
Jonathan East, P.E. — DRAWN
Jonathan East, P.E. — CHECKED
Jonathan East, P.E. — TECH. APPR.
Walter Heyder, P.E. — APPROVED
PEER REVIEWER - WALTER HEYDER, P.E.

DENVER, CO 2019-03-04

SPILLWAY CREST RAISE

EXCAVATION PLAN AND SECTIONS

153-D-60028

SHEET 1 OF 1

LAST SAVED DATE
2019-06-17
LAST SAVED BY
CSTARK

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AutoCAD 22.0s
AUTOCAD FILENAME
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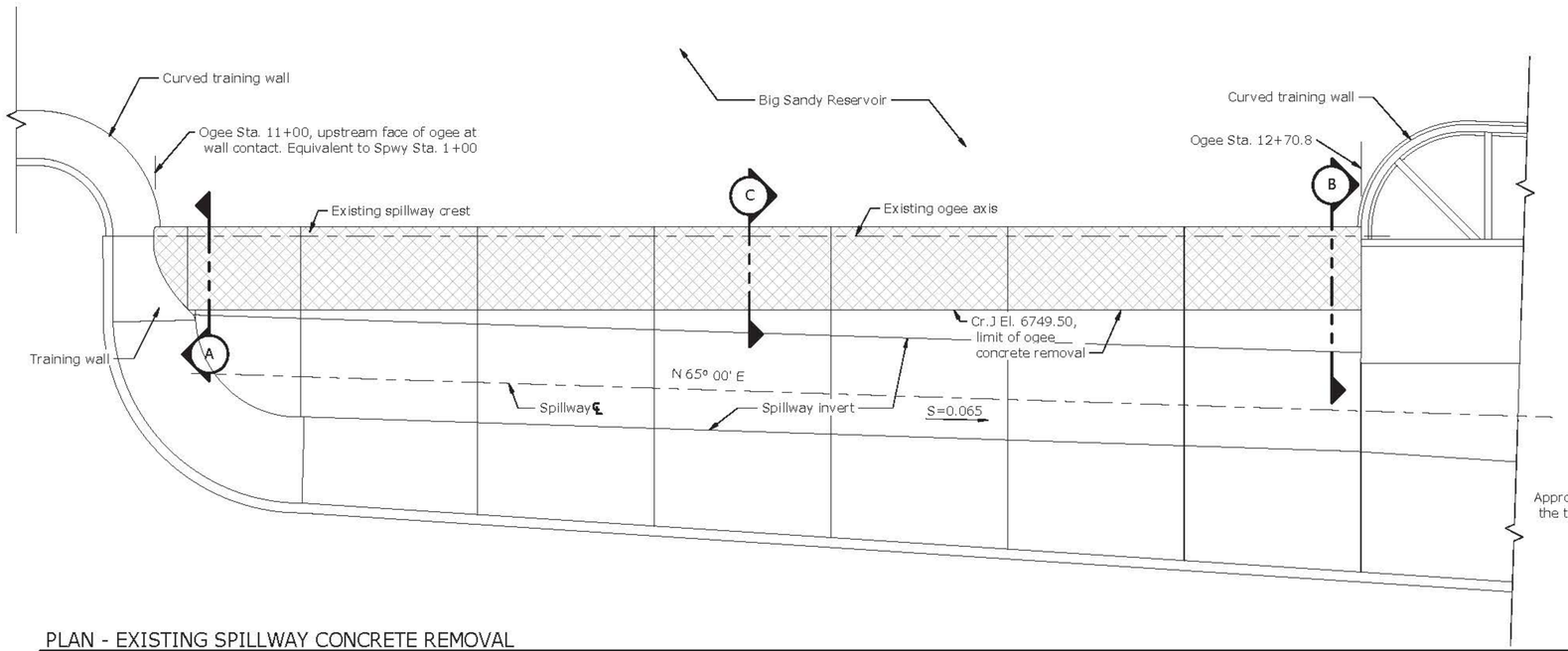
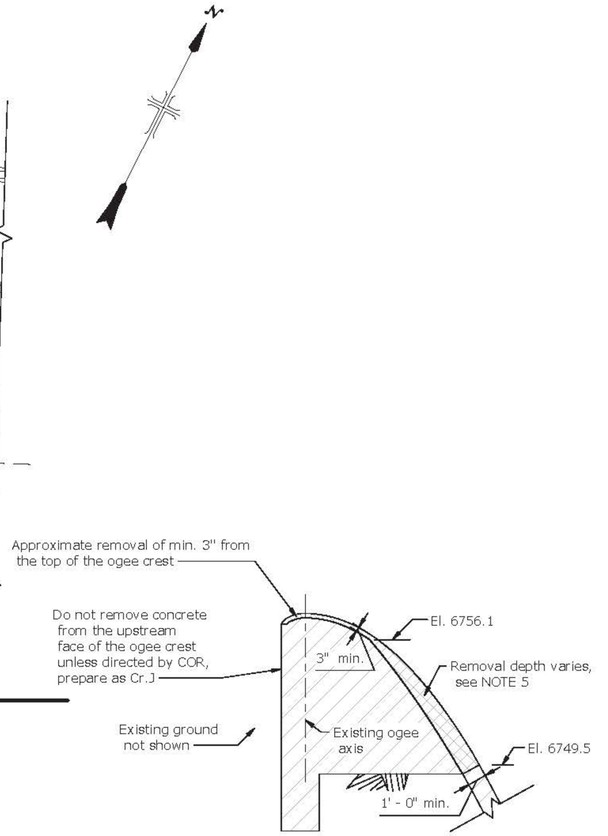


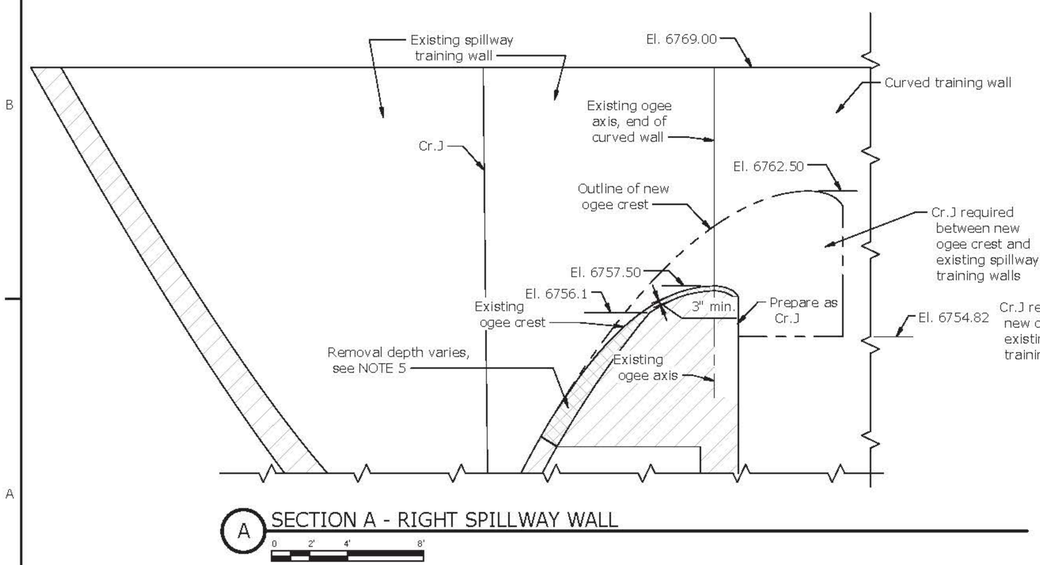
PLAN - EXISTING SPILLWAY CONCRETE REMOVAL

0 10' 20'



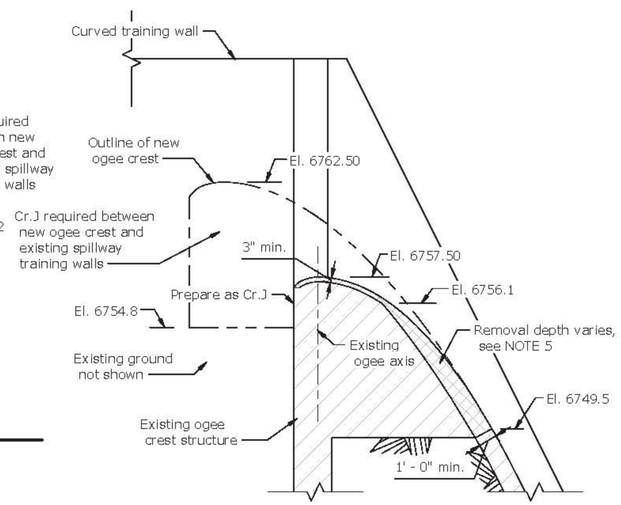
C SECTION C - OGEE CONCRETE REMOVAL

0 2' 4' 8'



A SECTION A - RIGHT SPILLWAY WALL

0 2' 4' 8'



B SECTION B - LEFT SPILLWAY WALL

0 2' 4' 8'

KEY

Area of concrete removal

NOTES

1. For general concrete outline and reinforcement, see 40-D-60003.
2. For minimum requirements for detailing reinforcement, 40-D-60004 (Table 4.5-60).
3. Refer to Specifications for concrete removal, repair, and preparation.
4. Repair any damaged concrete that the new ogee will be placed against as directed by the COR.
5. Removal depth varies uniformly from 3" min. at El. 6756.1 to 1'-0" min. at El. 6749.5. Increase depths as directed to remove damaged concrete.

REFERENCE DRAWINGS

SPILLWAY CREST RAISE - ISOMETRIC, PLAN, PROFILE, AND ANCHOR TABLE _____ 153-D-60026
SPILLWAY CREST RAISE - EXCAVATION _____ 153-D-60028
GENERAL PLAN OF EXISTING CONDITIONS _____ 153-D-

RECLAMATION
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EDEN PROJECT

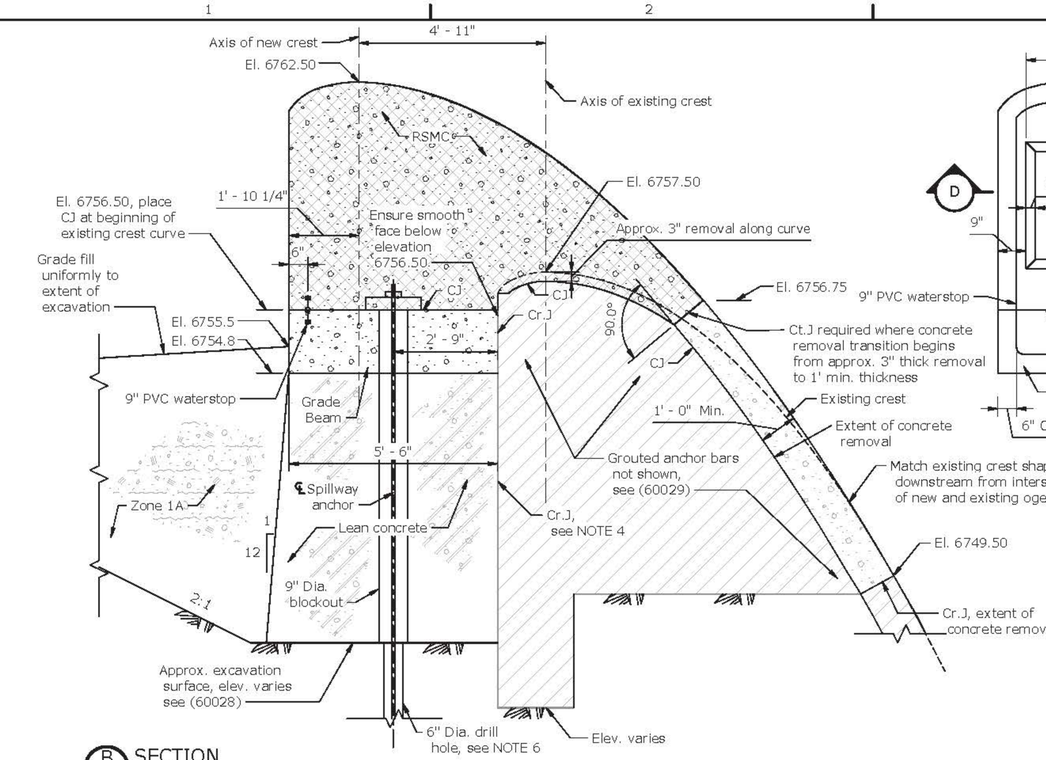
BIG SANDY DAM
RESERVOIR ENLARGEMENT

DESIGNED	MIGUEL HERNANDEZ
DRAWN	JONATHAN EAST
CHECKED	MIGUEL HERNANDEZ
TECH. APPR.	JONATHAN EAST, P.E.
APPROVED	WALTER HEYDER, P.E.
DENVER, CO	2019-03-11

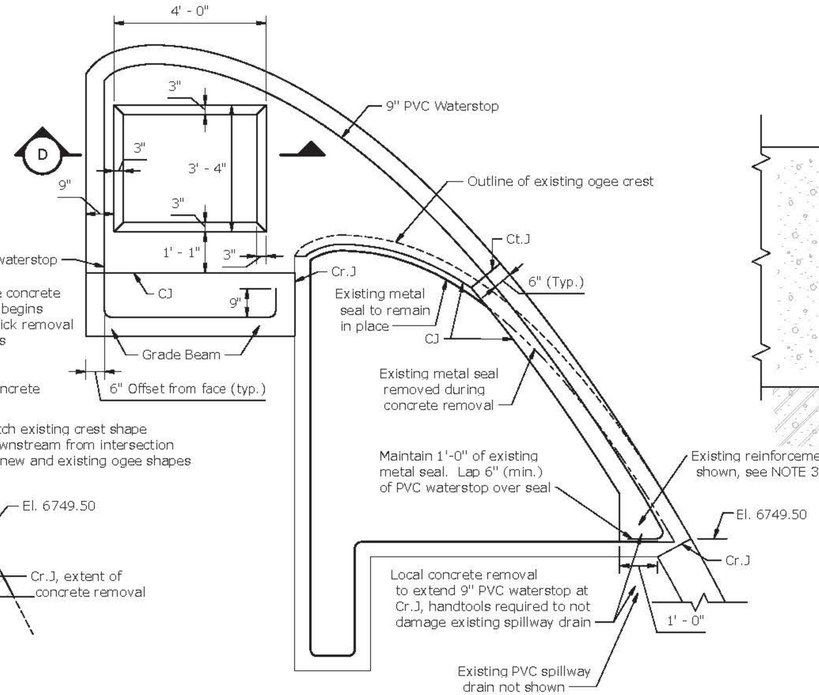
EXISTING SPILLWAY CREST

CONCRETE REMOVAL PLAN AND SECTIONS

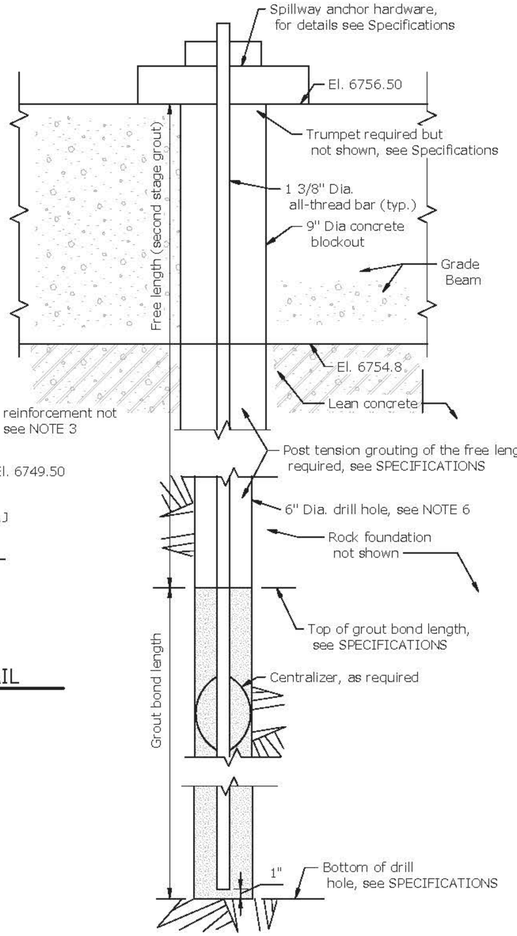
153-D-60049



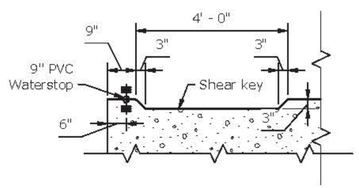
B SECTION
60026
0 1' 2' 4'



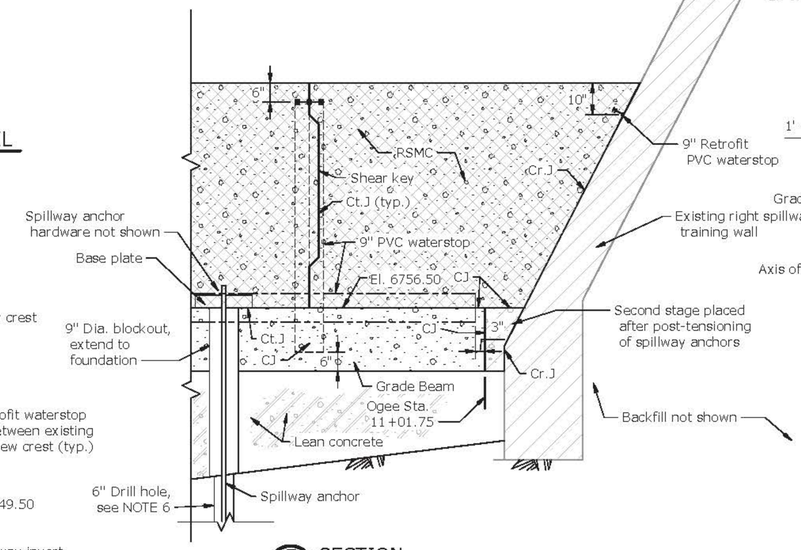
C SECTION - CONTRACTION JOINT DETAIL
60026
0 1' 2' 4'



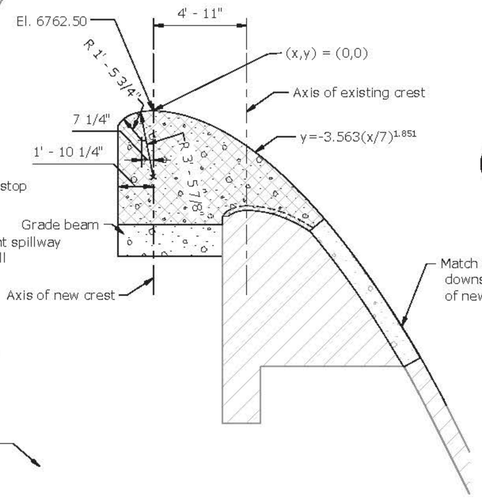
2 TYPICAL ANCHOR DETAIL
60026
(NOT TO SCALE)



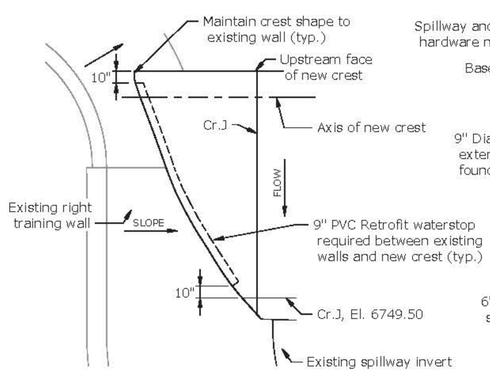
D SECTION - SHEAR KEY DETAIL
0 1' 2' 4'



E SECTION
60026
0 1' 2' 4'



F SECTION - NEW OGEE CURVE DETAIL
60026
0 2' 4' 8'



1 DETAIL 1 - EXISTING WALL AND NEW CREST CONNECTION
60026
0 5' 10'

KEY

Reinforced Structural Mass Concrete (RSMC)

NOTES

1. For additional NOTES and REFERENCE DRAWINGS, see (60026)
2. Place lean concrete in maximum 7-foot lifts, minimum 1.3-foot lifts.
3. Existing bars may be removed or be left in place, see FIO drawing (153-D-280).
4. Prepare existing ogee crest upstream face as Cr.J prior to lean concrete placement.
5. RSMC represents Reinforced Structural Mass Concrete. For details, see Specifications.
6. 6" Diameter hole to be drilled after placement of the Grade Beam, see Specifcation for details.
7. Additional details related to spillway anchor installation and requirements are provided in Specifications Section 31 33 13.
8. Grade Beam refers to the structural concrete placement that will be initially anchored with the spillway anchors.
9. Class 1 Post Tensioning Institute encapsulated anchor bar corrosion protection required, see Specifications.

RECLAMATION
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U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

EDEN PROJECT

BIG SANDY DAM
RESERVOIR ENLARGEMENT

REV NO	BY	DATE	DESCRIPTION
1	JE	2019-06-19	Revised pile w anchor base plate and references to PTI Class 1 Corrosion Protection.

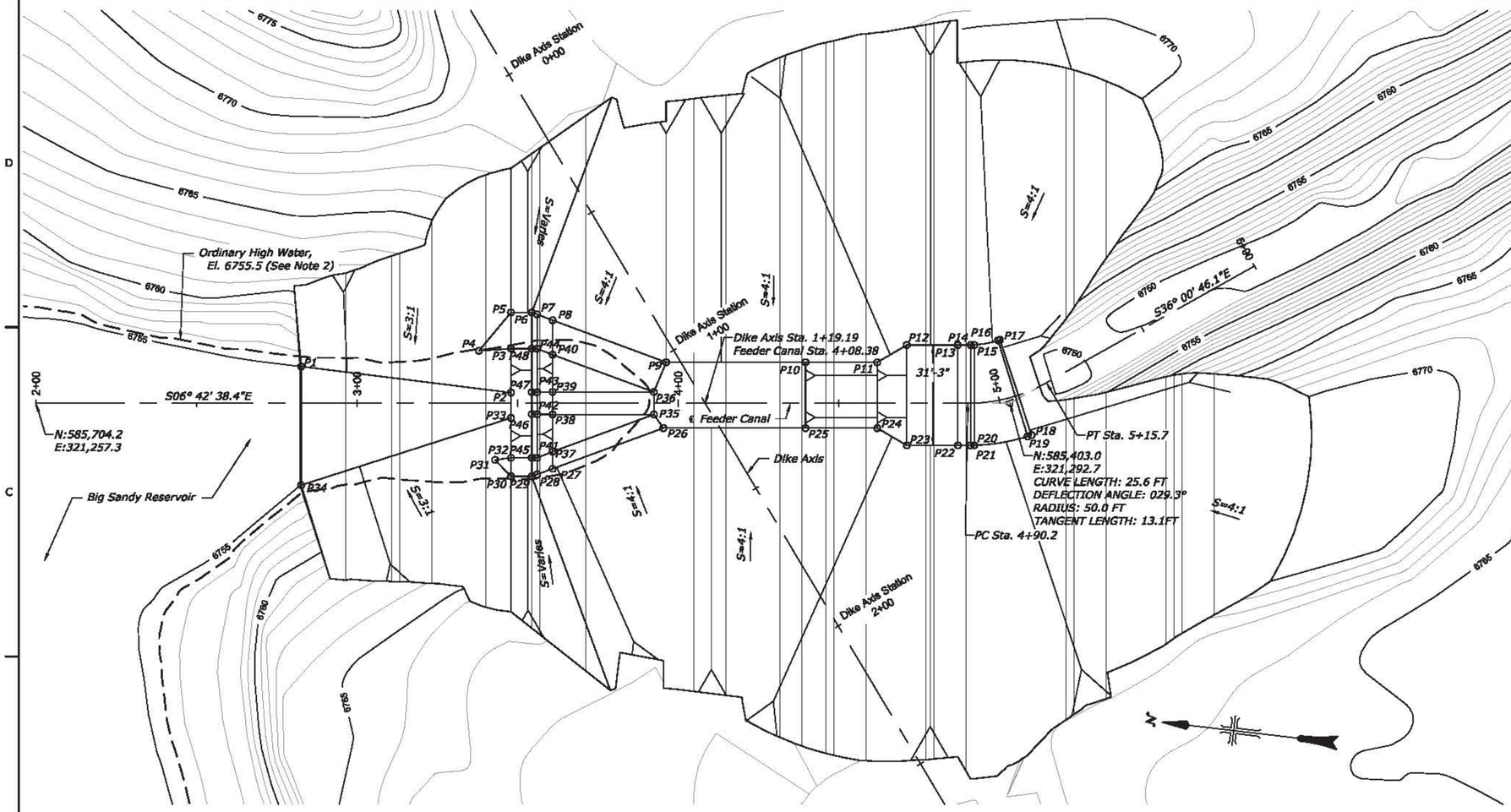
MIGUEL HERNANDEZ
DESIGNED
JONATHAN EAST
DRAWN
MIGUEL HERNANDEZ
CHECKED
JONATHAN EAST, P.E.
TECH. APPR. JONATHAN EAST, P.E.
WALTER HEYDER, P.E.
APPROVED WALTER HEYDER, P.E.

DENVER, CO 2019-03-01

SPILLWAY CREST RAISE

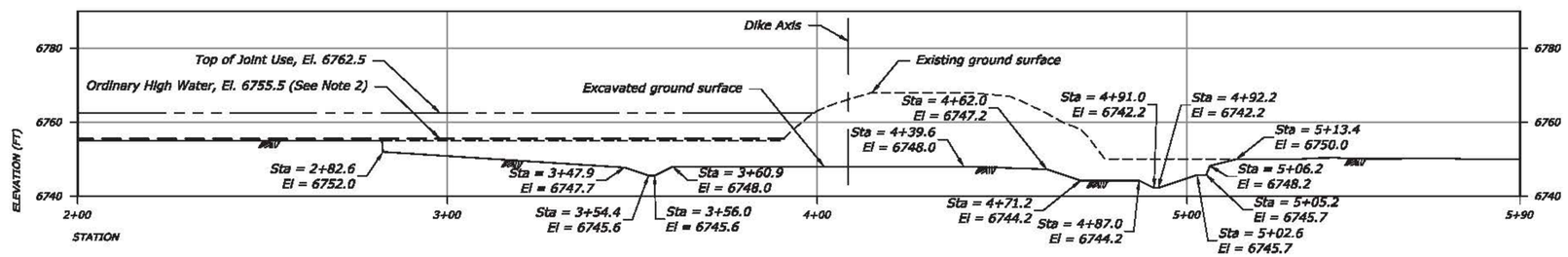
SECTIONS AND DETAILS

153-D-60027
SHEET 2 OF 2



PLAN - EXCAVATION

0 10' 20' 40'



PROFILE ALONG CENTERLINE OF CANAL HEADWORKS

0 10' 20' 40'

EXCAVATION POINT TABLE			
POINT	STATION	℄ OFFSET (FT)	ELEVATION (FT)
1	2+82.6	-11.5	6752.0
2	3+47.9	-3.3	6747.7
3	3+47.9	-17.0	6752.4
4	3+37.9	-16.3	6752.4
5	3+47.9	-28.3	6752.4
6	3+54.4	-28.3	6750.2
7	3+56	-27.7	6750.2
8	3+60.9	-25.9	6752.4
9	3+96.2	-12.8	6748.0
10	4+39.6	-12.8	6748.0
11	4+62	-12.8	6747.3
12	4+71.2	-18.1	6744.2
13	4+87	-18.1	6744.2
14	4+91.5	-18.1	6742.2
15	4+93.3	-18.1	6742.2
16	5+05.2	-18.1	6745.7
17	5+06.2	-18.1	6748.2
18	5+06.2	13.1	6748.2
19	5+05.2	13.1	6745.7
20	4+91.7	13.1	6742.2
21	4+90.9	13.1	6742.2
22	4+87	13.1	6744.2
23	4+71.2	13.1	6744.2
24	4+62	7.8	6747.3
25	4+39.6	7.8	6748.0
26	3+95.3	7.8	6748.0
27	3+60.9	20.4	6752.4
28	3+56	22.2	6750.2
29	3+54.4	22.8	6750.2
30	3+47.9	22.8	6752.4
31	3+42.9	17.6	6752.4
32	3+47.9	17.0	6752.4
33	3+47.9	4.6	6747.7
34	2+82.6	25.5	6752.0
35	3+92.4	3.5	6748.0
36	3+92.4	-3.5	6748.0
37	3+60.9	15.1	6752.4
38	3+60.9	3.5	6748.0
39	3+60.9	-3.5	6748.0
40	3+60.9	-15.1	6752.4
41	3+56	17.0	6750.2
42	3+56	3.4	6745.6
43	3+56	-3.4	6745.6
44	3+56	-17.0	6750.2
45	3+54.4	17.0	6750.2
46	3+54.4	3.4	6745.6
47	3+54.4	-3.4	6745.6
48	3+54.4	-17.0	6750.2

NOTES:

1. All stations are Feeder Canal stations, unless otherwise noted.
2. Ordinary high water as defined by US Army Corps of Engineers.

REFERENCE DRAWINGS

Survey Control.....153-D-60001
General Plan of Existing Conditions.....153-D-60002
Feeder Canal Outlet Works Backfill.....153-D-60033
Feeder Canal Headworks.....153-D-60035

RECLAMATION
Managing Water in the West

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U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
EDEN PROJECT

BIG SANDY DAM
RESERVOIR ENLARGEMENT PROJECT

REV NO	DATE	DESCRIPTION
1	2019-06-27	D Updated excavation for lowered inlet structure. Eliot, Jonathon J. P.E.

Carly M. Stark
DESIGNED
Carly M. Stark
DRAWN
Mike Hiebert
CHECKED
Jonathan East,P.E.
TECH. APPR.
Walter Heyder, P.E.
APPROVED
RSS REVIEW- Walter Heyder, P.E.

DENVER, CO

FEEDER CANAL
HEADWORKS EXCAVATION

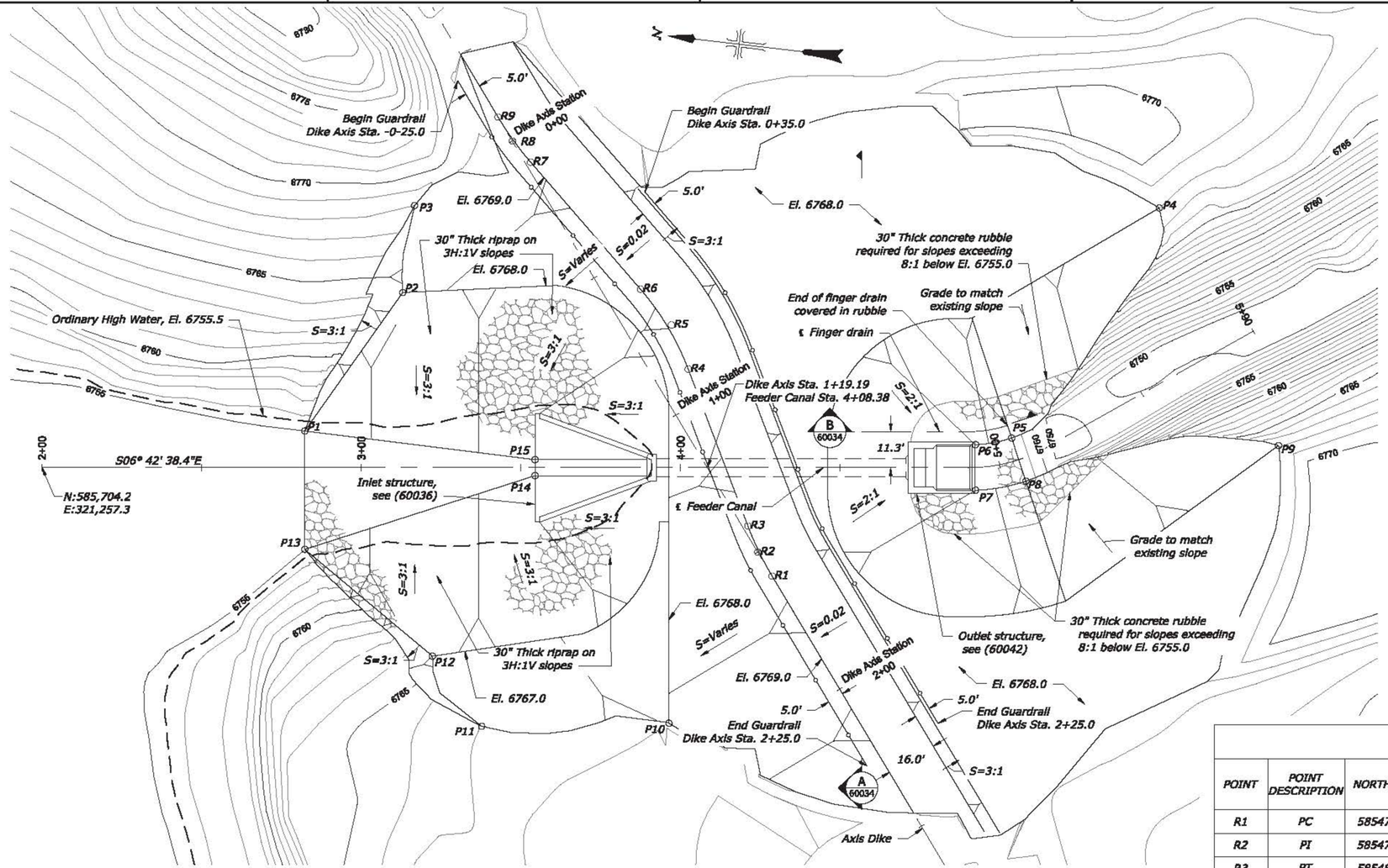
EXCAVATION PLAN AND PROFILE

153-D-60032

SHEET 1 OF 1

DATE AND TIME PLOTTED
JUNE 27, 2019 14:52
PLOTTED BY
CSTARK

CAD SYSTEM
AutoCAD Rel. 22.0s
CAD FILENAME
153-D-60032-RD-1.DWG



BACKFILL POINT TABLE

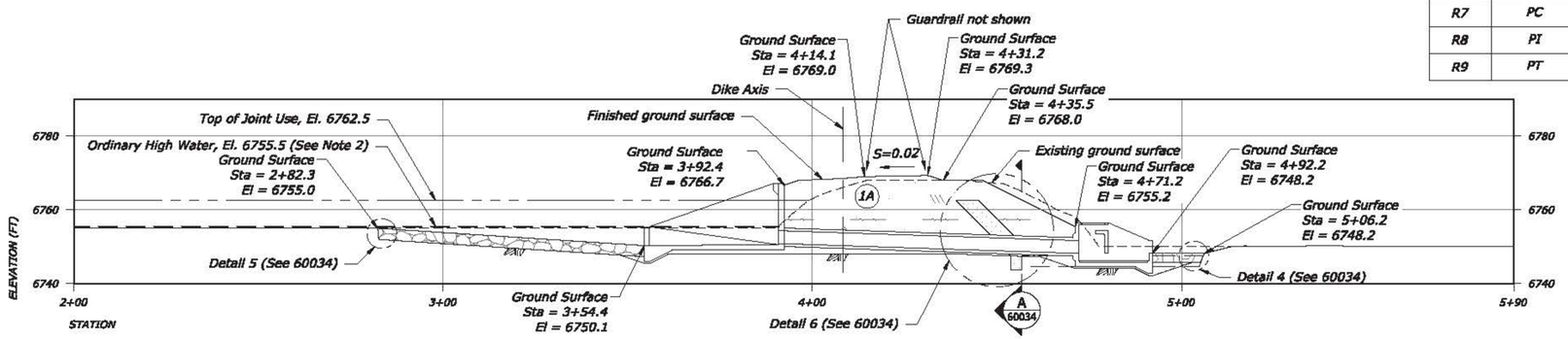
POINT	STATION	℄ OFFSET (FT)	ELEVATION (FT)
1	2+82.3	-11.5	6755.0
2	3+13	-54.9	6768.0
3	3+16.7	-82.1	6768.0
4	5+83.2	-48.1	6768.0
5	5+06.2	-7.1	6748.2
6	4+92.7	-7.1	6748.2
7	4+92.1	7.1	6748.2
8	5+06.2	7.1	6748.2
9	5+79.3	35.1	6768.0
10	3+96.3	80.1	6768.0
11	3+37.7	81.0	6767.0
12	3+22.3	59.1	6767.0
13	2+82.3	25.6	6755.0
14	3+54.4	2.5	6750.3
15	3+54.4	-2.5	6750.3

FINAL GRADE MATERIAL DESCRIPTIONS

- (1A) Low-permeable fill
- (2A) Processed sand filter
- (3A) Processed gravel drain

PLAN - BACKFILL

0 10' 20' 40'



PROFILE ALONG CENTERLINE OF CANAL HEADWORKS

0 10' 20' 40'

ROAD CURVE POINT DATA

POINT	POINT DESCRIPTION	NORTHING	EASTING	CURVE LENGTH (FT)	DEFELCTION ANGLE	RADIUS (FT)	TANGENT LENGTH (FT)
R1	PC	585473.1	321250.3				
R2	PI	585478.5	321257.2	17.5	10°0'0"	100.0	8.7
R3	PT	585482.5	321264.9				
R4	PC	585506.8	321311.6				
R5	PI	585513.7	321324.7	29.3	20°0'0"	84.0	14.8
R6	PT	585524.6	321334.7				
R7	PC	585563.4	321370.2				
R8	PI	585569.9	321376.1	17.5	10°0'0"	100.0	8.7
R9	PT	585575.2	321383.1				

NOTES

1. All stations are Feeder Canal stations, unless otherwise noted.
2. Ordinary high water as defined by US Army Corps of Engineers.
3. Backfill at 3:1 unless otherwise noted.
4. 30-inch depth of riprap required on upstream face of dike for slopes steeper than 8:1.
5. 30-inch depth concrete rubble required on downstream face of dike on modified slopes below El. 6755.0. If there is not suffident concrete rubble, use riprap.
6. Geotextile required beneath concrete rubble and riprap.

REFERENCE DRAWINGS

Survey Control.....153-D-60001
General Plan of Existing Conditions.....153-D-60002
Feeder Canal Outlet Works Excavation.....153-D-60032
Feeder Canal Headworks.....153-D-60035

RECLAMATION
Managing Water in the West

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U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
EDEN PROJECT

BIG SANDY DAM
RESERVOIR ENLARGEMENT PROJECT

REV NO 1 | 2019-06-27 | D | Updated backfill for lowered inlet structure. | East, Jonathon J. P.E.

Carly M. Stark
DESIGNED
Carly M. Stark
DRAWN
Mike Hiebert
CHECKED
Jonathan East, P.E.
TECH. APPR.
Walter Heyder, P.E.
APPROVED
DENVER, CO

FEEDER CANAL HEADWORKS BACKFILL

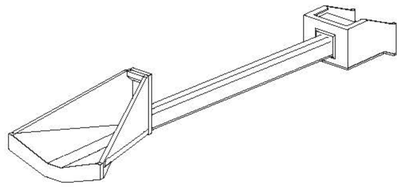
BACKFILL PLAN AND PROFILE

153-D-60033

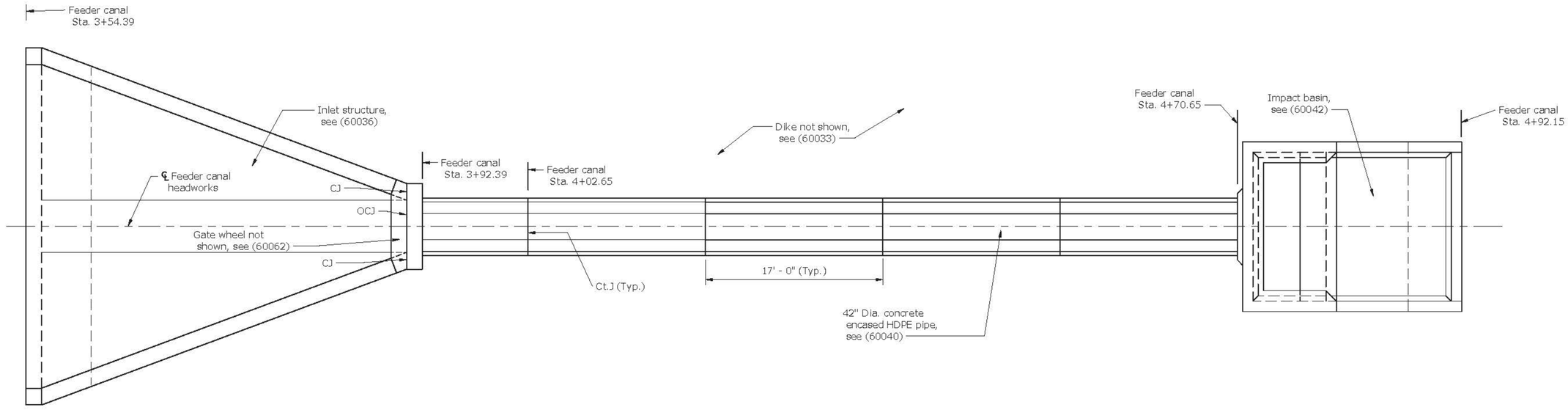
SHEET 1 OF 2

DATE AND TIME PLOTTED
JUNE 27, 2019 17:27
PLOTTED BY
CSTARK

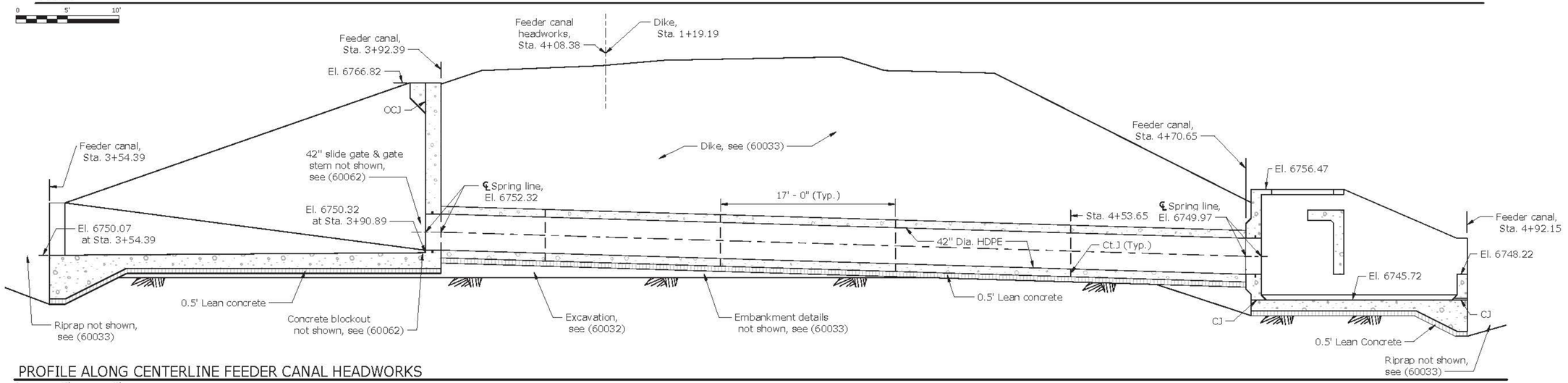
CAD SYSTEM
AutoCAD Rel. 22.0i
CAD FILENAME
153-D-60033-TOP-LOWG



ISOMETRIC
(NOT TO SCALE)



PLAN



PROFILE ALONG CENTERLINE FEEDER CANAL HEADWORKS

NOTES

1. For general notes for concrete outline and reinforcement, see 40-D-60003.
2. For minimum requirements for detailing reinforcement, see 40-D-60004 (Table 4.5-60).
3. Design of reinforcement is based on reinforcing steel having a minimum specified yield strength of 60,000 psi and having a minimum compressive strength of 4,500 psi @ 28 days.
4. Reinforcement required but not shown.
5. Chamfer all exposed edges 3/4" unless otherwise shown.
6. Waterstop and reinforcement required but not shown.
7. Special compaction required along structures, see SPECIFICATIONS.

REFERENCE DRAWINGS

FEEDER CANAL HEADWORKS EXCAVATION	153-D-60032
FEEDER CANAL HEADWORKS BACKFILL	153-D-60033
FEEDER CANAL HEADWORKS INLET STRUCTURE PLAN AND SECTIONS	153-D-60036
FEEDER CANAL HEADWORKS CONDUIT PLAN AND SECTIONS	153-D-60040
FEEDER CANAL HEADWORKS IMPACT BASIN PLAN AND SECTION	153-D-60042
FEEDER CANAL HEADWORKS 42"x42" SLIDE GATE	153-D-60062

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BUREAU OF RECLAMATION

EDEN PROJECT

BIG SANDY DAM
RESERVOIR ENLARGEMENT

REV NO	STA	
1	D	2019-05-25 Jonathan East, P.E.

Revised inlet structure and conduit elevations based on as-built survey data. Adjusted thrust restraint thickness and location.

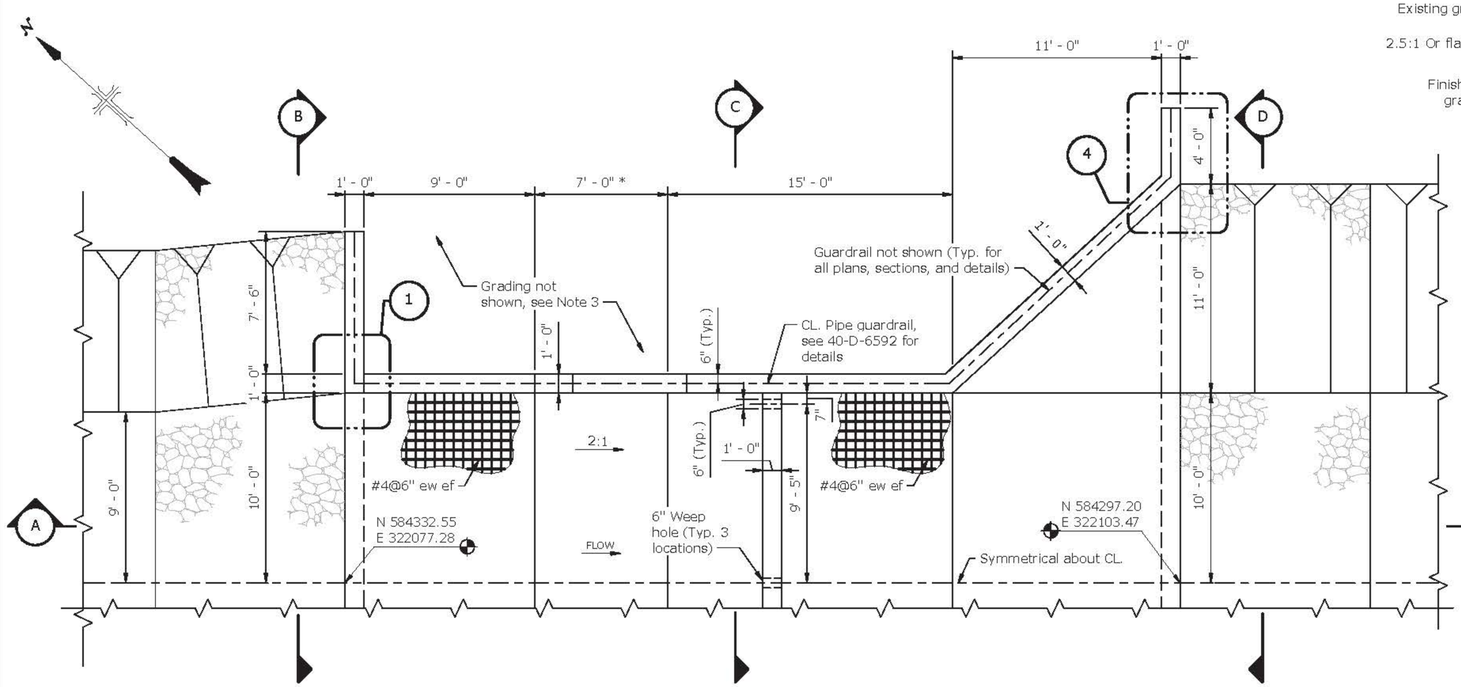
MICHAEL HIEBERT
DESIGNED
MICHAEL HIEBERT
DRAWN
CARLY STARK
CHECKED
JONATHAN EAST, P.E.
TECH. APPR.
WALTER HEYDER, P.E.
APPROVED
Peer Reviewer - WATERWAYS AND CONCRETE DAMS GROUP 2

DENVER, CO 2019-03-11

FEEDER CANAL HEADWORKS

PLAN AND PROFILE

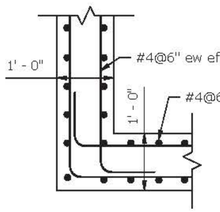
153-D-60035
SHEET 1 OF 1



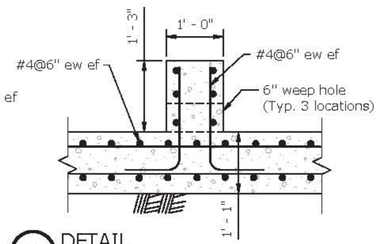
PLAN

A SECTION

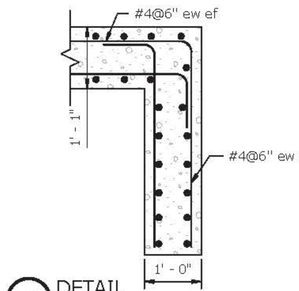
Staff Gage Table	
Flow Rate (cfs)	Gage Reading (ft)
10	0.24
20	0.36
30	0.45
40	0.54
50	0.63
60	0.68
70	0.74
80	0.81
90	0.87
100	0.93



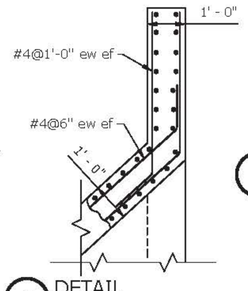
1 DETAIL



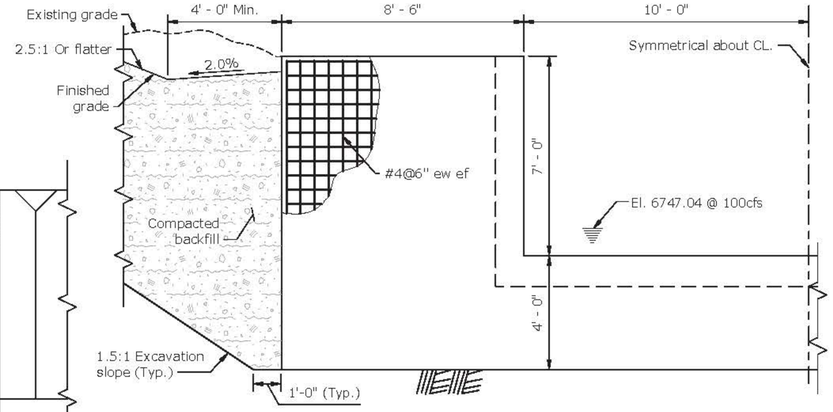
2 DETAIL



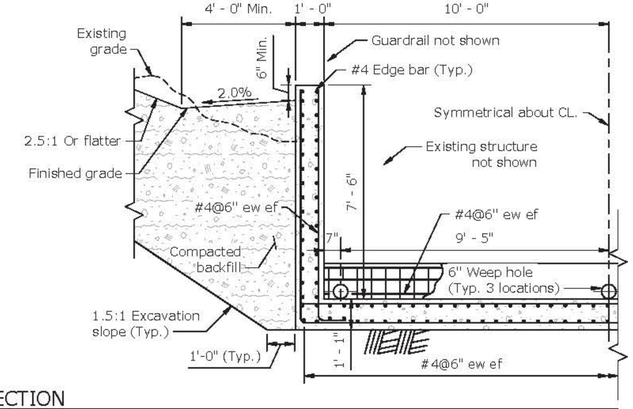
3 DETAIL



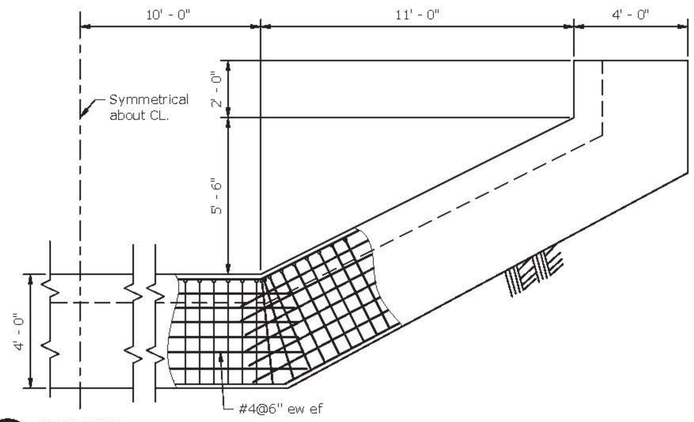
4 DETAIL



B SECTION



C SECTION



D SECTION

NOTES

1. For General Notes, see 60001.
2. Field verify and match existing grade and elevations before removal of the existing structures. Dimension with * may vary depending on verified elevation.
3. Grade surrounding area to drain away from structure.
4. Any crane outriggers or heavy construction equipment wheels/tracks must be located 5 feet from the edge of drop structure walls.

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U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
EDEN PROJECT

BIG SANDY DAM
RESERVOIR ENLARGEMENT PROJECT

DESIGNED	CLARK LARSEN
DRAWN	DANIEL GIBAS
CHECKED	GABRIEL LEDEZMA
TECH. APPR.	JOSEPH GIBERLINE P.E.
APPROVED	JASON WAGNER P.E.
	Peer Reviewer - CIVIL ENGINEER
DENVER, CO	03/11/2019

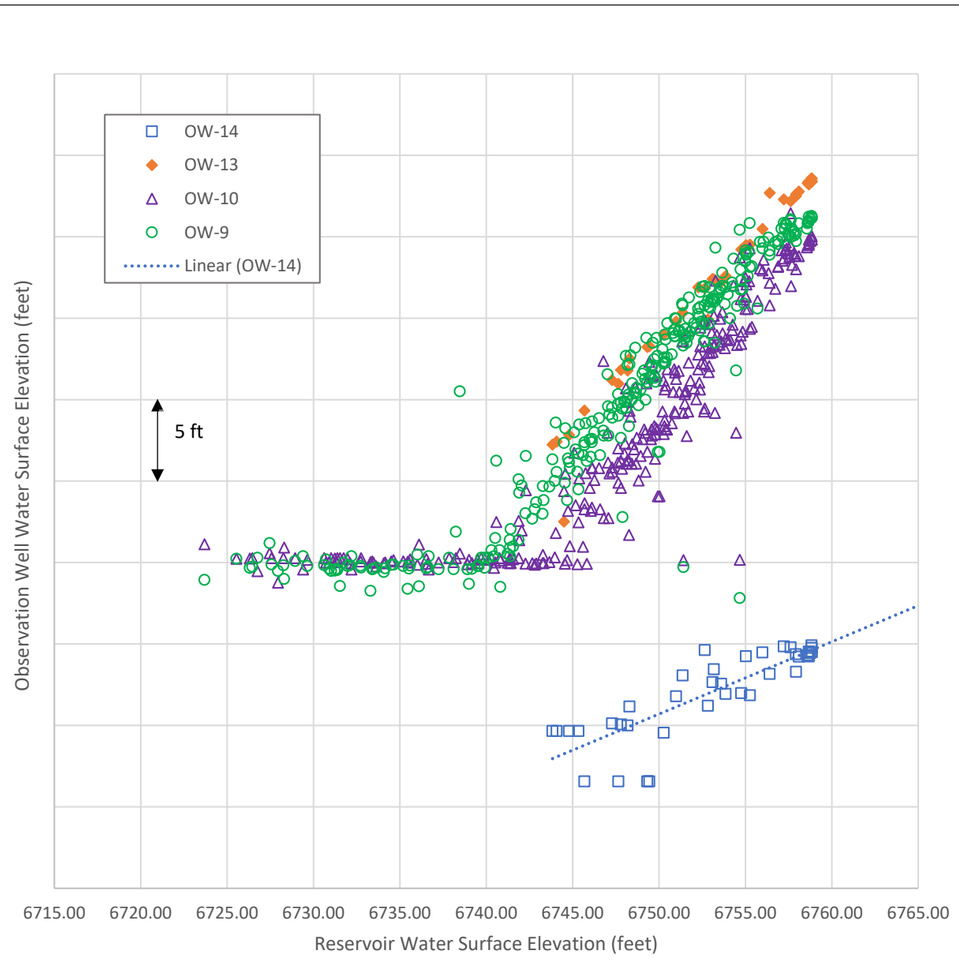
FEEDER CANAL DROP STRUCTURE #1 - CONCRETE OUTLINE AND REINFORCEMENT

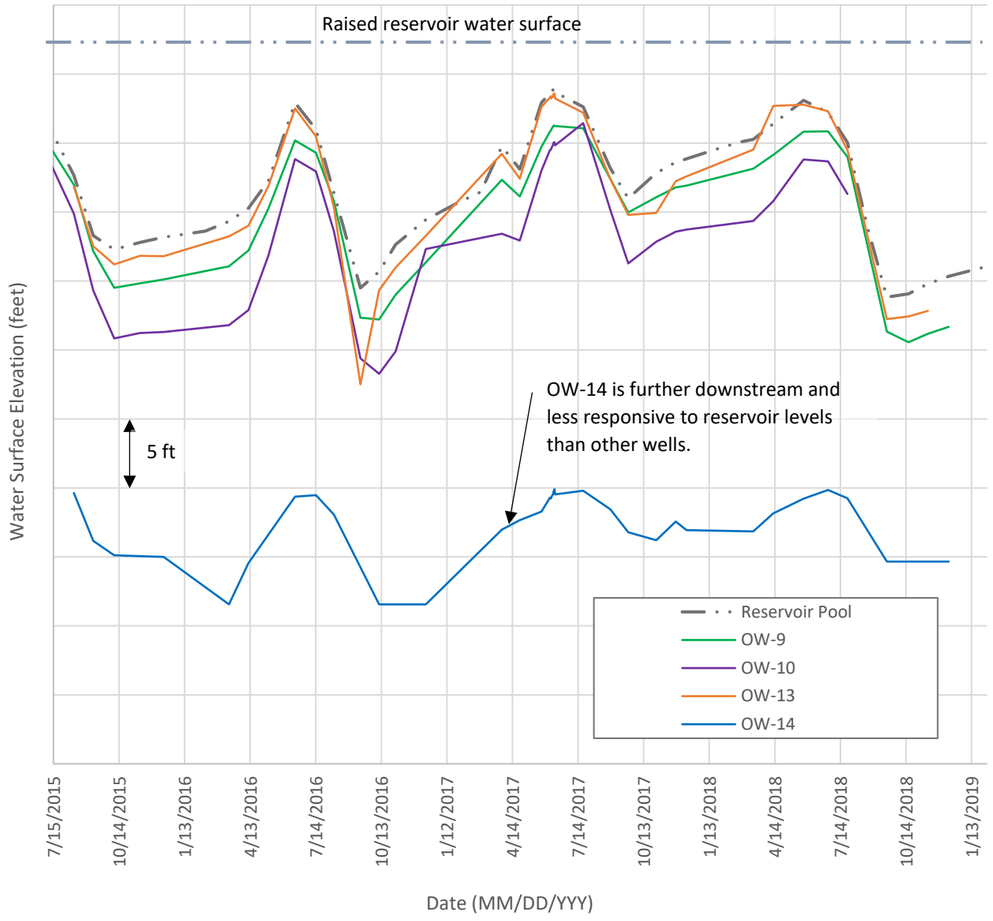
PLAN, SECTIONS, AND DETAILS

153-D-60055

Appendix E – Groundwater Figures


Eden Reservoir
Feeder Canal
Area of Interest
Means Canal
Observation Well (Typical)
OW 14
Big Sandy River
OW 10
Seepage from reservoir within limits of CB wall is anticipated to remain about the same because the CB wall offsets increased flows from a higher reservoir pool.
Proposed CB Wall
OW 9
OW 13
Seepage from reservoir beyond limits of CB Wall is anticipated to increase
Big Sandy Reservoir
Google Earth


OW-14
OW-13
OW-10
OW-9
Linear (OW-14)
5 ft
Observation Well Water Surface Elevation (feet)
6715.00
6720.00
6725.00
6730.00
6735.00
6740.00
6745.00
6750.00
6755.00
6760.00
6765.00
Reservoir Water Surface Elevation (feet)


Raised reservoir water surface
OW-14 is further downstream and less responsive to reservoir levels than other wells.
5 ft
Water Surface Elevation (feet)
Reservoir Pool
OW-9
OW-10
OW-13
OW-14
7/15/2015
10/14/2015
1/13/2016
4/13/2016
7/14/2016
10/13/2016
1/12/2017
4/14/2017
7/14/2017
10/13/2017
1/13/2018
4/14/2018
7/14/2018
10/14/2018
1/13/2019
Date (MM/DD/YYY)

Appendix F – Wyoming SHPO Concurrence Leter

WYOMING
STATE Historic Preservation OFFICE

September 28, 2018

Wayne G. Pullan
Bureau of Reclamation
302 East 1860 South
Provo, UT 84606-7317

re: Big Sandy Reservoir Enlargement Project (PRO-EA-16-012) (SHPO File #1017EMD017)

Dear Mr. Pullan:

Thank you for consulting with the Wyoming State Historic Preservation Office (SHPO) regarding the referenced undertaking. We have reviewed the associated report and find the documentation meets the Secretary of the Interior's Standards for Archaeology and Historic Preservation (48 FR 44716-42). We concur with the following findings of eligibility for listing in the National Register of Historic Places and effect:

Site #	Eligibility	Effect	Site #	Eligibility	Effect
SU1	Not Eligible	No Effect	SW1	Not Eligible	No Effect
SU2	Eligible	No Adverse Effect	SW2	Not Eligible	No Effect
SU3	Unevaluated	Outside APE	SW3	Not Eligible	No Effect
SU4	Not Eligible	No Effect	SW4	Not Eligible	No Effect
SU5	Not Eligible	No Effect	SW6	Destroyed	No Effect
SU6	Not Eligible	No Effect	SW104	Destroyed	No Effect
SU7	Not Eligible	No Effect	SW9110	Eligible	Adverse Effect
SU102	Not Eligible	No Effect	SW19744	Eligible	Adverse Effect
SU3546	Eligible	Adverse Effect	SW19750	Not Eligible	No Effect
SU5328	Eligible	No Adverse Effect	SW19751	Not Eligible	No Effect
SU7646	Eligible	Adverse Effect	SW19753	Not Eligible	No Effect
SU7670	Not Eligible	No Effect			

We concur that 48SU3546/48SW9110 and 48SU7646/48SW19744 will be adversely impacted by the undertaking as planned. We also concur that adverse effects to 48SU3546/48SW9110 are being mitigated through an existing agreement between our offices. In accordance with 36 CFR § 800.6, we recommend the Bureau of Reclamation develop a Memorandum of Agreement

(MOA), specifying the terms under which the adverse effects to 48SU7646/48SW19744 will be minimized or mitigated. The agency official, SHPO, and the Advisory Council (should they choose to participate) are the signatories and consulting parties to the MOA. The agency official and the SHPO, in agreement with the agency official, may choose to invite additional parties to be signatories and to concur in the MOA. Invited signatories and consulting parties may include Native American tribes and any party that assumes a responsibility under the MOA.

Please refer to SHPO project #1017EMD017 on any future correspondence regarding this undertaking. If you have any questions, please contact Brian Beadles at 307-777-8594 or brian.beadles@wyo.gov.

Sincerely,

Erica Duvic
Historic Preservation Specialist

100 635
105 636
106
600
630

Action
Project
Classificaton
Control
Folder

Notice if you detach enclosure insert code here:

Appendix G – Cultural (NHPA) Memorandum of Agreement

MEMORANDUM OF AGREEMENT
BETWEEN
THE BUREAU OF RECLAMATION
AND
THE WYOMING STATE HISTORIC PRESERVATION OFFICE,
REGARDING
THE BIG SANDY RESERVOIR ENLARGEMENT PROJECT,
SUBLETTE AND SWEETWATER COUNTIES, WYOMING

WHEREAS, the Bureau of Reclamation (Reclamation) is providing federal monies to enlarge the Big Sandy Dam (Undertaking) which will occur in Sublette and Sweetwater counties, Wyoming, north of the town of Farson; and

WHEREAS, Reclamation, in consultation with the Wyoming State Historic Preservation Office (WYSHPO), has established the Undertaking's area of potential effects (APE), as defined in 36 CFR 800.16(d), to include the Big Sandy Dam and its proposed reservoir footprint; and

WHEREAS, the Big Sandy Dam (48SW19744) is eligible for inclusion in the National Register of Historic Places (NRHP) under Criterion A, and the WYSHPO has concurred with this determination; and

WHEREAS, the site 48SU2 is eligible for inclusion in the NRHP under Criterion D, and the WYSHPO has concurred with this determination; and

WHEREAS, Reclamation determined, in consultation with WYSHPO, that the Undertaking will have an adverse effect on these sites, as defined in 36 CFR 800.5(a)(1); and

WHEREAS, Reclamation notified the Advisory Council on Historic Preservation (ACHP) of the adverse effect associated with the Undertaking in accordance with 36 CFR 800.6(a)(1)(i), and the ACHP did not respond; and

WHEREAS, the regulations at 36 CFR Part 800.6(c)(1-3) recognizes three types of signatories to this agreement: **Signatories**, **Invited Signatories** and **Concurring Parties,** which are referred to collectively as **the Parties**. Signatories and Invited Signatories include any party who assumes responsibilities under this agreement. Concurring Parties have a demonstrated interest in the historic properties but do not assume responsibilities under the agreement. Concurring Parties may participate in development of the document and may concur with this agreement. The refusal of any Invited Signatory or Concurring Party to sign does not invalidate the MOA. Concurring Parties cannot terminate this agreement; and

WHEREAS, in accordance with 36 CFR 800.6(b)(1)(i), Reclamation invited the Apache Tribe of Oklahoma, Arapaho Tribe of the Wind River Reservation, Wyoming, Cheyenne and Arapaho Tribes, Oklahoma, Comanche Nation, Oklahoma, Crow Tribe of Montana, Fort Belknap Indian Community of the Fort Belknap Reservation of Montana, Shoshone Tribe of the Wind River Reservation, and the Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho to participate in the consultation to resolve the adverse effects associated with the Undertaking, and received no response; and

WHEREAS, pursuant to 36 CFR 800.6(c)(2) Reclamation invited as **Concurring Parties** Alliance for Historic Wyoming, Bonneville Archaeology, Eden Valley Improvement District, Green River Historic Preservation Commission, Kail Consulting Archaeology, Ltd., Rock Springs Historic Preservation Committee, Sublette County Government, Sublette County Historic Preservation Board, Sweetwater County Commission, Sweetwater County Historical Museum, Sweetwater County Museum Board, Wyoming

Archaeological Society: Sweetwater Chapter, Wyoming Archaeological Society: Upper Green River Basin, and the Wyoming State Historical Society: Sweetwater County Chapter, and none have responded save Eden Valley Improvement District, Sweetwater County Commission, Sublette County Historic Preservation Board, Bonneville Archaeology, and Kail Consulting Archaeology, Ltd.; and

WHEREAS, in accordance with 36 CFR 800.6(b)(1)(iv), Reclamation shall submit this MOA, along with the documentation specified in 36 CFR 800.11(f), to the ACHP prior to approving the Undertaking in order to meet the requirements of Section 106 of the National Historic Preservation Act of 1966 and 36 CFR 800.6(b)(1); and

NOW, THEREFORE, Reclamation, WYSHPO, and the OTHER CONSULTING PARTIES agree that the undertaking shall be implemented in accordance with the following stipulations in order to take into account the effects of the undertaking on historic properties.

Reclamation will ensure that the following Stipulations are implemented.

I. STIPULATIONS

A. Prehistoric Sites

1. Reclamation shall ensure that all historic preservation work conducted pursuant to this MOA is conducted by, or under the direct supervision of, persons meeting qualifications set forth in the Secretary of the Interior's Professional Qualification Standards (36 CFR 61) or equivalent experience and who have been permitted for such work on public lands by Reclamation.
2. Reclamation shall surface inspect Sites 48SU2, 48SU5, 48SU6, 48SU7, and 48SU7670 each year for the next ten (10) years to ensure that no adverse effects occur to these sites. Should adverse effects occur, then Reclamation will consult with WYSHPO on methods to resolve said adverse effect.
3. Reclamation shall develop a treatment plan to resolve adverse effects to Site 48SU2 in consultation with WYSHPO. WYSHPO will have thirty (30) days to provide comments.
4. Reclamation shall ensure that proposed inundation areas are adequately tested for archaeological deposits prior to their inundation and will make a determination of their National Register eligibility if such are found.
5. Reclamation shall have an unanticipated discovery plan approved by WYSHPO and in place prior to ground-disturbing activities for this project. WYSHPO will have thirty (30) days to provide comments.

B. Historic Sites

1. Reclamation shall collect oral histories about the Big Sandy Dam and Eden Project.
2. Reclamation shall make an exhibit on the Eden Project for the Eden Community Center.
3. Reclamation shall create a brochure and map detailing certain historic properties within and near Farson as an automotive tour. This brochure shall be approved by WYSHPO prior to dissemination to the Eden Valley Improvement District. WYSHPO has thirty (30) days to provide comments.
4. Reclamation shall make a good faith effort to scan historic photographs held by Farson community members for the purpose of including them in the above exhibit.

5. Reclamation shall document the present condition of the dam via small unmanned aerial systems (sUAS or drone).

II. CONFIDENTIALITY OF CULTURAL RESOURCE DATA

To the extent consistent with the National Historic Preservation Act, Section 304, and the Archaeological Resources Protection Act, Section 9(a), cultural resources data will be treated as confidential by all Signatories and will not be released to any party not a Signatory to this agreement. Duplication or distribution of cultural resource data by any Signatory requires written authorization from Reclamation.

III. DISPUTE RESOLUTION

A. Should any Signatory to this MOA provide notice to Reclamation of its objection to an action under this MOA, or implementation of the measures stipulated in this MOA, within thirty (30) days of becoming aware of an action, Reclamation shall consult with the Parties to this MOA to resolve the objection, unless otherwise specified in this document. If Reclamation determines that the objection cannot be resolved, Reclamation shall forward all documentation relevant to the dispute to the ACHP. The objecting party must provide reasons for, and a justification of, its objection at the time it initially submits its objection to Reclamation. Within thirty (30) days after receipt of all pertinent documentation, the ACHP shall either:

1. Provide Reclamation with recommendations, which Reclamation shall take into account in reaching a final decision regarding the dispute; or

2. Notify Reclamation that it will comment within an additional thirty (30) days, in accordance with 36 CFR 800.7(c)(4). Any ACHP comment provided in response to such a request will be taken into account, and responded to, by Reclamation in accordance with 36 CFR 800. 7(c)(4) with reference to the subject of the dispute.

B. Any recommendation or comment provided by the ACHP will be understood to pertain only to the subject of the dispute. Reclamation's responsibility to carry out all actions under this MOA that are not the subject of the dispute will remain unchanged.

IV. AMENDMENT

Any Signatory to this agreement may request that the other Signatories consider amending it if circumstances change over time and warrant revision of the stipulations. Except in the case of amendments addressing resolution of disputes pursuant to Section V of this MOA, amendments shall be executed in writing and shall be signed by all Signatories in the same manner as the original MOA.

V. TERMINATION

Any Signatory to this MOA may initiate termination by providing written notice to the other Signatories of their intent. After notification by the initiating Signatory, the remaining Signatories shall have ninety (90) business days to consult to seek agreement on amendments or any other actions that would address the issues and avoid termination. In the event of termination, Reclamation shall refer to 36 CFR Part 800 to address any remaining adverse effects to historic properties.

VI. SUNSET TERMS

This MOA shall remain in effect for ten (10) years after the date of execution hereof. Reclamation and WYSHPO shall re-evaluate the MOA every 10 years. Reclamation shall ensure the MOA will be re-evaluated and amended, to accommodate any changes to the terms. All Signatories will be consulted during the amendment process (See Section V).

General Provisions

A. **Entirety of Agreement.** This MOA, consisting of seven (7) pages, represents the entire and integrated agreement between the Parties and supersedes all prior negotiations, representations and agreements, whether written or oral, regarding compliance with Section 106 of the National Historic Preservation Act.

B. **Prior Approval.** This MOA shall not be binding upon any party unless this MOA has been reduced to writing before performance begins as described under the terms of this MOA, and unless the MOA is approved as to form by the Attorney General or his representative.

C. **Severability.** Should any portion of this MOA be judicially determined to be illegal or unenforceable, the remainder of the MOA shall continue in full force and effect, and any party may renegotiate the terms affected by the severance.

D. **Sovereign Immunity**. The State of Wyoming, the WYSHPO, and the Tribes expressly reserve their sovereign or governmental immunity by entering into this MOA and each fully retains all immunities and defenses provided by law with respect to any action based on or occurring as a result of the MOA.

E. **Liability.** Each signatory to this MOA shall assume the risk of any liability arising from its own conduct. Each Signatory agrees they are not obligated to insure, defend, or indemnify the other Signatories to this MOA.

Execution of this MOA and implementation of its terms evidence that Reclamation has taken into account the effects of the undertaking on historic properties.

Signatures. In witness whereof, the Parties to this MOA through their duly authorized representatives have executed this MOA on the dates set out below, and certify that they have read, understood, and agreed to the terms and conditions of this MOA as set forth herein.

The effective date of this MOA is the date of the last Signatory signature affixed to the signature pages that follow.

THE REMAINDER OF THIS PAGE WAS INTENTIONALLY BLANK.

SIGNATORIES:

Bureau of Reclamation, Provo Area Office

Kent Koford Date 3/18/19

Wayne G. Pullan
Area Manager ACTING FOR

Wyoming State Historic Preservation Office

Mary Hopkins Date 4/1/19
Mary Hopkins, State Historic Preservation Officer

Approval as to Form:
Wyoming Attorney General's Office

Tyler M. Renner #190887 Date 3-4-19
Tyler M. Renner
Assistant Attorney General

CONCURRING PARTY:

Sweetwater County, Wyoming

Date 2/5/19

Wally J. Johnson, Member
Sweetwater County Board of County Commissioners

Appendix H – Responses to Comments on First Draft EA

Bureau of Reclamation
Public Comments with Responses
Re: Big Sandy Enlargement Project (PRO-EA-16-012)

1. **Commenter:** Rodney Mines
   Comment:

This letter is in reference to the proposed Big Sandy Enlargement Project in Sweetwater County, Wyoming. I object to the enlargement project until such time that the Bureau of Reclamation, the Eden Valley Irrigation District, and I reach an agreement insuring that my water rights on the Big Sandy River will not be impeded by the enlargement proposal.

Please be advised of my intent to fully exercise my water rights in the Mines Sprinkler System, Permit No. 26141, diverting from Big Sandy River this coming and in subsequent seasons. This original supply water right carries a priority date of June 10, 1977 and serves 200.0 acres of my land.

I am letting the United States Department of Interior – Bureau of Reclamation know so it may anticipate my use of this water in its future water management decisions, including the passage of the appropriate amounts of Big Sandy River water through the Eden Valley District's system downstream to my pump diversion, which is situated in the SW¼NW¼ of Section 35, T.26N., R.106W.

Also, be advised that since this is a private water right, I am entitled to this water whenever it is available by priority date. My period of use of this water is not limited by the District's irrigation season. As such, please be aware that I may be irrigating when the District is storing water.

Response: In administration of Reclamation's Water Rights, Reclamation relies on the Hydrographer-commissioners that are responsible for the river system as appointed by the Governor on recommendation of the State Engineer to regulate the waters by priority. The Hydrographer-commissioner will ensure that the water rights entitled to water below Big Sandy that are senior in priority get met and Eden Valley Irrigation and Drainage District, the operating entity, will work with the Hydrographer-commissioner to release waters downstream to these senior water rights.

2. **Commenter:** Board of County Commissioners, Sweetwater County, Wyoming
   Comment:

Project Support: Sweetwater County strongly supports the Big Sandy Reservoir Project. We believe that the 5 foot raise of the spillway crest and the resulting 13,700 acre-foot expansion in reservoir capacity will benefit both Sweetwater and Sublette Counties by:

- Ensuring sufficient water supplies for crop production during periods of drought
- Providing additional water to potentially open up additional lands for irrigation and crop production
- Enhancing recreational opportunities related to the Big Sandy Reservoir
- Increasing and protecting the agricultural economic base of the Eden Valley and affected counties
- Protecting Wyoming waters by expanding the beneficial use of waters within the Big Sandy River.

Response: Thank you for your comment.

3. **Commenter:** Board of County Commissioners, Sweetwater County, Wyoming
   Comment:

Permits and Authorizations: Please amend the Draft EA Table 1-1 (Permits and Authorizations) by adding the following:

Agency/Department	Purpose
Sweetwater County, Wyoming	To ensure compliance with the Sweetwater County Comprehensive Plan and Development Codes, Sweetwater County will require the following plans, permits and authorizations: Grading, Drainage, Dust Control Plans, Construction/Use Permits, Conditional Use Permits for lay down yards, man camps, batch plants, and Authorizations for county road accesses, utility crossings, and overweight loads.

Response: Suggested amendment to Table 1-1 was incorporated.

4. **Commenter:** Board of County Commissioners, Sweetwater County, Wyoming
   Comment:

Recreation: Sweetwater County requests that the BOR strongly considers enhancing and expanding the recreational facilities at the Big Sandy Reservoir Project. The Big Sandy Reservoir is frequently utilized by Sweetwater and Sublette County residents. Improving and expanding the reservoir will increase recreational opportunities for area residents and will help strengthen the growing recreational economic base of the region.

Response: The following recreation improvements are commitments incorporated into the Proposed Action. The boat ramp will be replaced to match the proposed reservoir level; fire pits and picnic tables will be replaced and installed to match the proposed reservoir levels; the artesian well piping and valving will be extended to higher ground to maintain access to the well water for recreation and irrigation purposes, or a new well will be drilled; the irrigation piping will be replaced to continue irrigation of the west camping loop; and the vault restrooms in the west camping loop and southeast camping areas will be replaced at a higher elevation following construction, pending funding availability.

5. **Commenter:** Board of County Commissioners, Sweetwater County, Wyoming
   Comment:

Wyoming Game and Fish Department: Sweetwater County strongly encourages the BOR to work closely with the Wyoming Game and Fish Department to address any game and non-game wildlife issues – especially sage grouse. We also encourage the BOR to work with the WGFD to incorporate plans for improving the fisheries within the Big Sandy Reservoir and River.

Response: Reclamation has worked with Wyoming Game and Fish Department (WGFD) to assess the impacts to wildlife, especially sage-grouse. WGFD provided a letter of concurrence for the impacts to sage grouse (see Appendix E of the Draft EA).

6. **Commenter:** US Fish and Wildlife Service, Wyoming Field Office
   Comment:

Memorandum

To: Area Manager, U.S. Bureau of Reclamation, Provo Area Office, Provo, Utah

From: For Field Supervisor, U.S. Fish and Wildlife Service, Wyoming Field Office, Cheyenne, Wyoming

Subject: Draft Environmental Assessment (DEA), U.S Bureau of Reclamation (Bureau), Big Sandy Reservoir Enlargement Project, Sweetwater County, Wyoming

We have reviewed the DEA for the Big Sandy Enlargement Project (Project) and provide the following comments pursuant to the Endangered Species Act of 1973, as amended (ESA), 16 U.S.C. 1531 *et seq*. The Project will raise the spillway by 5 feet to increase the total storage capacity of the Big Sandy Reservoir by 13,700 acre-feet. The additional water storage is needed to firm up the water supply for lands irrigated in the Farson/Eden area through the Eden Project and to allow for more carryover water from wet years into future years so water deliveries can be made later in the summer. In addition to enlarging the Big Sandy Reservoir, the Project will modify the Big Sandy spillway crest and outlet works, Big Sandy Dike, the Big Sandy Feeder Canal.

The DEA concludes the Project will have no effect on the four Colorado River fish species, because the species do not occur in the Project area (p. 33). However, consultation under section 7 of the ESA is required for projects in Wyoming that may lead to water depletions or have the potential to impact water quality in the Colorado River system. In general, depletions include evaporative losses and/or consumptive use of surface or groundwater, often characterized as diversions minus return flows. The Project will increase the surface area of the Big Sandy Reservoir by 499 acres (p. 29) and increase evaporative losses by approximately 955 acre-feet per year (Table 3-2). In addition to new evaporative losses, the Project may create opportunities for additional consumptive use of Colorado River water, perhaps as a result of water deliveries made later in the summer (p. 2). We recommend the Bureau calculate the amount of evaporative losses and/or consumptive use associated with the Project and consult on that amount. In addition to the four Colorado River fish species, depletions adversely affect designated critical habitat of the four species; therefore, we recommend the consultation and the DEA also include and analyze effects to designated critical habitat.

Response: A Biological Assessment (BA) was prepared to formally consult on impacts (water depletions) to the four Colorado River endangered fish. Reclamation initiated consultation pursuant to Section 7 of the Endangered Species Act of 1973 at the end of March 2018. The Wyoming Ecological Services Field Office issued a Biological Opinion in May 2018 that is included as Appendix C in the Draft EA.

7. **Commenter:** Carmel Kail
   Comment:

- p. 16 Please more specifically define the project APE, Class III inventory area and "maximum limit of disturbance" *(For example, "0.25 mi beyond the proposed flood pool line or project-related earth disturbance, whichever is more, regardless of surface ownership". A 7.5' map depicting this would be very helpful.)*

Response: The direct APE includes 508.16 acres of proposed inundation between elevation 6757.5 and 6762.5 feet above mean sea level. However, a total of 1,114.33 acres were surveyed for cultural resources for this project to provide a buffer around the proposed inundation and for other project components.

8. **Commenter:** Carmel Kail
   Comment:

- p. 17 48.SW.1841, (Sublette Cut Off of the Oregon Trail), is eligible for the National Register and should have been so identified in the EA. *(It is identified as being in the APE, but is not listed among sites which Reclamation recommends as eligible for inclusion in the NRHP.)*

Response: Site 48SW1841 is not located in the direct APE. This was an error in the document. It is located within the indirect APE and was analyzed for visual effects for the cultural resource report.

9. **Commenter:** Carmel Kail
   Comment:

- pp. 42, 48 References to the Utah SHPO should be changed to Wyoming SHPO.

Response: The references to Utah SHPO were changed to Wyoming SHPO.

10. **Commenter:** US Environmental Protection Agency, Region 8
    Comment:

1. Reduced peak flows can impact channel functions including sediment transport. We recommend the Final EA include an estimate of the percent decrease in spring runoff that would spill over into the Big Sandy River after reservoir enlargement, the volumes that would spill over and for what length of time, the flow that would be present in the river below the dam throughout the year as a result of the decreased spillover, and any expected impacts of these flow changes on riverine functions.

Response: The reservoir spilled in 10 of the 22 years from 1989-2010 (45 percent), passing a mean volume of 4800 acre-feet per year over that period. Outside of the three or so weeks of spring runoff spills, releases to the river are not typically made. Depending on the actual operations of the reservoir and water deliveries, spills could occur as infrequently as 3 in every 20 years (15 percent), with a mean annual spill volume up to 60% lower than the historic mean.

11. **Commenter:** US Environmental Protection Agency, Region 8
    Comment:

2. We recommend the Final EA assess whether the project has the potential to affect attainment or maintenance of water quality standards commonly associated with flow reductions or reservoir operation (e.g. temperature, dissolved oxygen), including beneficial uses, of the Big Sandy River below the Big Sandy dam. We suggest working with the Wyoming Department of Environmental Quality to complete this analysis.

Response: Water is released from a low level outlet in Big Sandy Dam to the Means Canal. Any water use requirements in the Big Sandy River below the Big Sandy Dam is diverted from the Means Canal into the Big Sandy River approximately 500 feet downstream of the Big Sandy Dam. Eden Valley Irrigation and Drainage District (EVIDD) operates the system and determines how much flow is diverted to the Big Sandy River based on water use demands. These diversions to the Big Sandy River are minimal and not expected to change with an enlarged reservoir; therefore, any water quality standards in the Big Sandy River downstream of the reservoir are not expected to change.

12. **Commenter:** US Environmental Protection Agency, Region 8
    Comment:

3. We note that a goal of the project is to extend the irrigation season beyond September 15, the period analyzed in the water quality assessment in the EA. We recommend the Final EA assess a lengthened irrigation season in the water quality model (vs April 1 to September 15, as indicated in the Draft EA) or explain why that late season information would not be relevant. We also suggest supporting the model results by briefly explaining why TSS and TDS would decrease as a result of reservoir enlargement.

Response: There is no proposal to extend the irrigation season beyond September 15, thus late season modeling is not relevant. A water quality analysis was performed and predicted the in-reservoir TSS concentrations would be reduced by approximately 25% and TDS concentrations would be reduced by approximately 8.5% after the enlargement. The reduction in TSS and TDS can be contributed to a couple of factors. The additional hydraulic residence time allows for more settling in the reservoir (decrease in TSS), and the enlargement allows for the storage of better quality of water (decrease in TSS and TDS). While baseline water quality data is limited on the Big Sandy River, USGS Station 09213500, located upstream of the Big Sandy Reservoir measures water quality data such as turbidity, specific conductance, and TSS. TDS was derived from specific conductance data, and this data was used in the water balance model. The average monthly TSS and TDS concentrations determined from the USGS station had peak concentrations during the high runoff months of March, April, and May. TSS and TDS concentrations dropped off significantly during the summer months of June (TDS dropped, TSS remained high), July and August. The enlargement of the reservoir allows for more storage of higher quality of water during the summer months and could be contributed to the decrease in in-reservoir TSS and TDS.

13. Commenter: US Environmental Protection Agency, Region 8

Comment:

4. In many cases, wetlands that experience inundation for a significant portion of the growing season lose much of their function due to loss of wetland vegetation and associated animal species. Typically, reservoir enlargements result in extended duration of existing wetland inundation around the reservoir margins; therefore, similar to the analysis completed for years 1990–2010, we recommend the Final EA include an estimate of the duration and depth of inundation of existing wetlands that would occur due to the proposed enlargement, and assess impacts by comparing those estimates to the referenced scientific literature. Alternatively, the Final EA could explain how the analysis of current wetland inundation and corresponding wetland quality and function relates to future inundation and quality of existing wetlands under operation of the enlarged reservoir.

Response: The wetlands adjacent to Big Sandy Reservoir and in the proposed inundation area of the expanded reservoir pool do not appear to be natural features, but rather were likely formed and sustained by periodic reservoir inundation. Wetlands in the survey area were comprised of fringe wetlands along the reservoir margins, broad meadows/depressions, and terrace/riparian corridors along the Big Sandy River. Fringe wetlands were primarily palustrine scrub-shrub (PSS) dominated by sandbar willow (Salix exigua) with limited herbaceous understory. Small palustrine emergent (PEM) fringes were also present. Three large PEM meadow wetlands were dominated by foxtail barley (Hordeum jubatum) and Douglas' sedge (Carex douglasii), both of which are considered facultative wetland species. Some areas within the wetlands had a high percentage of non-desirable annual species including tumbleweed (Salsola tragus) and halogeton (Halogeton glomeratus). The meadow wetlands were low quality, marginal habitats.

An inundation analysis on the wetlands at the Big Sandy Reservoir site was completed in the Level II feasibility study (Wenck, 2017). The maximum length of inundation of the existing wetlands in any given year was 211 days, while the average length of inundation was 53 days. However, if the seven years that wetlands were never inundated are removed, the mean length of inundation was 79 days during years that inundation occurred. The average length of time that water was at or above the elevation of 6,754 feet (bottom elevation of wetlands) was 53 days. The approximate depths of inundation also were examined. The mean length of time that wetlands at the bottom elevation (6,754 feet) were inundated with 1, 2, 3 and 4 feet of water was 37, 28, 20 and 4 days, respectively. The maximum number of days the wetlands were inundated with 1, 2, 3 or 4 feet of water in any given year was 147, 128, 116 and 48 days, respectively.

A literature review was conducted to determine the inundation duration tolerances of the dominant plant species found in wetlands at the Big Sandy Reservoir site. Rains et al. (2004) studied changes in vegetation distributions under different reservoir operation scenarios and found that the vegetation distributions on their study site were largely in equilibrium with depth to groundwater. Rains et al. (2004) also used modeling to predict vegetation community changes under various reservoir operation scenarios, including an expanded pool scenario. Rains' study indicates that the palustrine scrub-shrub (PSS) wetlands found at the upper end of the reservoir along Big Sandy River are likely to persist with the periodic flooding and drawdown that would occur if the reservoir is enlarged. PSS wetlands at the upper end of the reservoir are dominated primarily by sandbar willow (Salix exigua). Willows are well known

for their tolerance for flooding. River Partners (2008) found sandbar willow, along with other willow species, to be highly tolerant of long-duration flood conditions when they were flooded for 105 to 119 days during the growing season. Water depths ranged from 3.3 to 9.5 feet. Numerous other studies and websites note that sandbar willow has high tolerance of flooding (e.g., Dionigi et al. 1985; the USDA Plants Database; the U.S. Forest Service Fire Effects Information System Plants Database). Other studies have documented sandbar willow adaptations to flooding (Kuzovkina et al., 2004). Several studies report a tolerance of flooding for sedges (Carex spp.). Many of the palustrine emergent (PEM) wetland communities around the reservoir have Douglas sedge (Carex douglasii), Northwest Territory sedge (C. utriculata), Nebraska sedge (C. nebrascensis), Baltic rush (Juncus balticus), or creeping spikerush (Eleocharis palustris) (Hoag et al. 2011, CNPS no date, USDA NRCS 2005b). Based on these data, it seems reasonable to assume that all wetlands dominated by Northwest Territory sedge, Nebraska sedge, clustered field-sedge, Baltic rush or creeping spikerush would persist, with periodic inundation under normal high-water conditions. The length of time many of the dominant species found within project area wetlands are likely to tolerate flooding is provided in Appendix B of the Level II Report (Wenck, 2017) and a more detailed analysis of this summary and the references cited herein may be found in Sections 5.21-5.24 of the Level II Report.

The wetland species found at the Big Sandy Reservoir site appear tolerant of flooding for all or most of the growing season, particularly willows and sedges. Thus, sedges and rushes are likely to increase in dominance. No change in willow composition is anticipated. Based on this analysis, it is likely that wetlands would form both within and above the new normal high-water line of the expanded reservoir, as they would likely be subjected to similar inundation regimes as existing wetlands. These areas are currently uplands dominated by big sagebrush and rabbitbrush (Ericameria spp.).

14. **Commenter:** US Environmental Protection Agency, Region 8
    Comment:

5. We recommend the cumulative effects section describe the past effects to the Big Sandy River due to placement and operation of the dam, including effects on downstream wetland and riparian functions. This information will provide context for the effects associated with enlarging the reservoir.

Response: Thank you for your comment and recommendation.

15. **Commenter:** US Environmental Protection Agency, Region 8
    Comment:

6. We recommend giving consideration to whether mitigation is warranted to offset the impacts of further reduced downstream flows as well as for impacts associated with wetland and stream channel inundation. For example, some water supply projects have included an 'environmental pool' to enable flow release from the reservoir to support riverine functions below the dam as mitigation for the effects of reservoir enlargement.

Response: Thank you for your comment.

16. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

1. The Bureau of Reclamation (Bur. Rec.) and Wyoming Water Development Commission ("WWDC" or "Commission") failed to follow proper processes to involve affected private property owners. For example, WWDC is mandated to provide notice by Wyo. Stat. § 40-2-122, which requires the Commission to notify all affected landowners during the planning process during Level I. Further, the same statute requires the Commission to consult with affected landowners during the Level II planning process. Neither notification nor consultation occurred. It was not until Dunton Sheep Company and Midland Live Stock Company (commentors) notified the Commission of the failure to notify and consult with the affected landowners that any discussion has occurred between the commentors and Commission staff. Further, the Bur. Rec's November 20 letter advises that the draft was available online for review. However, it was only after commentors notified WWDC that the Draft EA was not available online that Bur. Rec. finally made the Draft EA available online.

Response: Notification of the project mandated by Wyo. Stat. §40-2-122 applies to WWDC, not Reclamation's NEPA process. Reclamation has followed NEPA standards for public involvement specified in 40 CFR 1500-1508 and 43 CFR 46. The Draft EA was made available as soon as staff were able to post it. Because the process of sending the notification letters and publishing the Draft EA online were not simultaneous, the comment period was extended by 2 weeks to account for the delay.

17. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

2. The cover letter seeking comment from "Interested Persons, Organizations, and Agencies" (but not sent to Sublette County government) notes that Bur. Rec. has already determined that an environmental impact statement is not required. However, in reality, the Draft EA does not provide sufficient information for determining whether to prepare an environmental impact statement or finding of no significant impact. Bur. Rec. must take action to rectify the deficiencies identified herein.

Response: The analysis in the Draft EA showed no significant impacts to the human or natural environment. Therefore, Reclamation did not need to prepare an Environmental Impact Statement (EIS). Further analysis, including analysis based on comments received on the Draft EA, did not show a significant impact to the human or natural environment.

18. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

3. As mentioned at the public meeting, notice of the Draft EA and FONSI was not posted at the Post Office or in any publication in the local area; therefore, sufficient notice was not provided. Further, no notice was provided to Sublette County and said County was not consulted at any time during the process despite the fact that more than half of the reservoir – and the vast majority of the land to be inundated – is located in Sublette County. Bur. Rec. failed to consult with Sublette County in any stage of the planning process for this project, in violation of the National Environmental Policy Act and the Council on Environmental Quality regulations, and the Bur. Rec's own guidelines. In addition to its failure to consult with the Sublette County Board of Commissioners, Bur. Rec. also failed to review its plans for compliance with the Sublette County Federal and State Land Use Policy, which states, in part, "Federal land management must facilitate cooperative conservation by fully involving local governmental entities, including the Sublette County Commission and Sublette County Conservation District; take appropriate account of and respect the interests of persons with ownership or other legally recognized interests in land and other natural resources; properly accommodate local participation in federal decision-making; and provide that the programs, projects, and activities are consistent with protecting public health, safety and welfare. Sublette County will not support projects where the federal agency has excluded local government entities and landowners." (SCFSLUP, P09: http://www.sublettewyo.com/DocumentCenter/Home/View/437)

Bur. Rec. has excluded local government entities and landowners in proceeding with this project. The Draft EA at 1.3 states: "The Proposed Action was presented to the public and interested agencies as outlined below." Most of the items on the list were actions that Bur. Rec. *intended* to undertake in the future. In addition, there was no public notice of the release of the Draft EA to the general public in Sublette County, and one directly impacted private property owner was not notified or consulted.

Response: As more than one participant noted in the public meeting, notice of the Draft Environmental Assessment (EA) was posted in the Post Office in Farson, Wyoming as a public notice. No Finding of No Significant Impact (FONSI) has been drafted or published.

According to 40 CFR §1506.6(a), agencies shall "make diligent efforts to involve the public in preparing and implementing their NEPA procedures." Subparts (i) through (ix) of 40 CFR §1506.6(b)(3) provide examples of public involvement when effects are "primarily of local concern". Reclamation mailed 132 letters to local residents, shareholders, and governmental organizations. Reclamation did not include Sublette County, Wyoming, on the mailing list. Reclamation has included Sublette County, Wyoming in all future correspondence and consultation concerning the EA, in addition to responding to comments of the Sublette County Board of County Commissioners that they provided on the Draft EA.

According to 43 CFR §46.305(a), "The bureau must, to the extent practicable, provide for public notification and public involvement when an environmental assessment is being prepared. However, the methods for providing public notification and opportunities for public involvement are at the discretion of the Responsible Official." Further, part (b) of the same section states "Publication of a "draft" environmental assessment is not required. Bureaus may seek comments on an environmental assessment if they determine it to be appropriate, such as when the level of public interest or the

uncertainty of effects warrants, and may revise environmental assessments based on comments received without initiating another comment period." No decision document (i.e. FONSI) has been prepared or signed, and revisions of the EA have continued beyond the initial Draft EA that was published.

The Draft EA was posted simultaneously with the process of mailing notification letters, which is why the Draft EA did not detail how many letters were sent.

19. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

4. The Draft EA summarily states that there are no private landowners in the area who will be adversely affected. Nothing could be farther from the truth. Commentors own 800 acres of land bordering the reservoir, bordering the Big Sandy River, and immediately below the reservoir, more particularly described as follows:

a. T27N, R106W, Sec. 20, E½SE¼, SE¼NE¼ &W½NE¼ (approx. 200 acres northwest of reservoir);
b. T27N, R106W, Sec. 21, SW¼SW¼ (approx. 40 acres northwest of reservoir);
c. T27N, R106W, Sec. 28, N½NW¼ (approx. 80 acres northwest of reservoir);
d. T27N, R106W, Sec. 25, NE¼SW¼ & SW¼SE¼ (approx. 80 acres on east shore of reservoir);
e. T26N, R105W, Sec. 7, SW¼, NW¼SE¼ & SW¼NE¼ (approx. 240 acres on Dewey Place owned by Midland Live Stock Company); and
f. T26N, R106W, Sec. 12, NE¼ (approx. 160 acres on Dewey Place).

Further, commentors own other property interests, including mineral interests, below the reservoir. The proposed project would inundate commentors' land and cause groundwater percolation to significantly damage their lands, resulting in an unconstitutional taking of commentors' lands. Commentors have worked with the State of Wyoming to attempt to reach an agreement to exchange lands. At this time, there is not been an approved agreement for flooding and otherwise damaging their private property. Unless and until such an agreement has been finalized, permitting for this project should not move forward.

Response: Reclamation recognizes there is currently privately-owned land that is partially inundated based on the current Big Sandy spillway crest elevation of 6757 ft. Reclamation was aware that a land exchange between the State of Wyoming and the private landowner was being considered. For this reason, Reclamation prepared the Environmental Assessment under the assumption that the land exchange would have to occur before the project would be implemented. Under this assumption, there would be no impacts to private land. Analysis regarding grazing and impacts to private land has now been described in the EA. The analysis showed there would be very little to no effect on grazing.

Under Land Purchase Contract I77r-502 and Warranty Deed, both signed on June 21, 1950 and recorded in both Sublette and Sweetwater Counties, authorize Reclamation to flood or otherwise affect with water the private lands in the reservoir basin. Furthermore, in the contract, it is understood that grazing/agricultural purposes may not interfere with Eden Project purposes.

20. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

5. The Draft EA does not accurately describe the capacity of the existing reservoir. The storage capacity of Big Sandy Reservoir has been reduced significantly over time due to siltation. The proposed enlargement seeks to replace the lost storage capacity by raising the elevation of the dam. In short, EVIDD is not authorized under Wyoming law to enlarge the reservoir and retain its 1903 water right for the new storage capacity created by a present day reservoir enlargement.

Response: A bathymetry survey was completed in 2010 and a LiDAR survey was completed in 2015. Using bathymetry surveys and LiDAR to digitally capture topography is an established and well-accepted geospatial technique.

21. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

6. The proposed enlargement of the reservoir would destroy vertebrate and invertebrate fossils contained in the areas proposed to be inundated by the proposed enlargement. Section 423.2 of Bur. Rec's Rules and Regulations defines "natural resources" to include paleontological resources. Congress has recognized that, under current public laws, including the Federal Land Management Policy Act of 1976, federal land management agencies are given the authority and mandate to protect public resources, including those of scientific value. These resources include fossilized paleontological specimens, which provide valuable clues to the earth's history." Sen. Report 105-227, p. 60. See also *Board of Regents of the University of Oklahoma,* 165 IBLA 231, April 13, 2005. The Draft DA states that paleontological resources will not be adversely affected so long as they do not dig into the bedrock. However, this completely ignores the fact that the proposed reservoir enlargement would inundate many acres of land. It is irrelevant whether the project digs into the fossilized remains or whether the reservoir inundates the surface of the lands containing the paleontological resources. The result is the same -- the paleontological resources would be lost. Both the public land and the commentors' private land surrounding the reservoir contain significant fossilized remains. Even if the federal government were to determine that there is no interest in excavating the fossilized remains underlying public lands, the commentors' lands contain fossils and they have been approached by private parties who would like to explore and or mine for fossilized remains on their deeded property, for both scientific and commercial purposes. The proposed reservoir enlargement would inundate these lands and cause groundwater percolation to make their lands too heavily saturated and alkaline to be used, therefore, it would destroy their lands' use for those purposes and for agricultural purposes.

Response: The Draft EA has been updated following a field assessment by Paleo Solutions, Inc. They found four fossil localities, one of which was considered significant. However, 1) this locality was located outside the direct APE away from ground disturbing activities, 2) the fossils (located on Reclamation withdrawn lands) were collected, and 3) the fossils were curated at the Utah Field Museum of Natural History. For these reasons, Paleo Solutions, Inc. did not recommend further mitigation measures. No localities were identified on private lands over which Reclamation has a perpetual easement.

Under Land Purchase Contract I77r-502 and Warranty Deed, both signed on June 21, 1950 and recorded in both Sublette and Sweetwater Counties, authorize Reclamation to flood or otherwise affect with water the private lands in the reservoir basin. Furthermore, in the contract, it is understood that grazing/agricultural purposes may not interfere with Eden Project purposes.

22. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

7. The Draft EA argues the proposed enlargement will not affect grazing. This is not accurate. Commentors own a sheep and cattle operation and are the grazing permittee/lessee on the BLM and State lands adjacent to the reservoir. Commentors' grazing operation would be significantly impacted by the enlarged reservoir in several ways. First, it would inundate commentors' grazing lands, which have lush green forage that they have previously used for grazing. In fact, the proposed enlargement would inundate their best riparian lands. Second, the proposed enlargement would cause the development of quicksand along the boundaries of the reservoir and Big Sandy River, which are dangerous to livestock, wildlife, people, guard dogs, and pets. The quicksand occurring at the Wyoming Game and Fish's fish barrier upstream of the proposed project demonstrates what will happen along the river corridor and the shore of the reservoir if the reservoir is enlarged. Commentors use the north end of the reservoir for lambing and calving in the spring and early summer and could no longer use it for birthing if there is quicksand between their livestock and their stock water supply. Third, it would cause the water table to rise, thus causing their fee lands below the reservoir and federal lands north and west of commentors' fee lands to become alkaline and muddy from ground water percolation. This percolation would occur within an alkali-based soil type. Groundwater percolation would cause alkali to rise up through the soils and kills the vegetation that their livestock graze and would instead grow vegetation that their livestock would not eat. Commentors are not aware of any water or soil sampling done in the existing percolation area – if it has been done on their fee lands, it was done without notice or permission. Also, the higher water table would cause the lands below the reservoir to become too muddy access by livestock, wildlife, people, horse or motor vehicle. We understand WWDC believes this will be addressed by building a 10-foot retaining wall, which WWDC believe would extend down to the bedrock. However, commentors do not believe this will work because the bedrock in this area is significantly deeper than 10 feet. Even if the wall extended down to bedrock, the bedrock in the area is a sandstone, which is permeable and would still allow percolation. Also, the increased percolation will effect existing fences downstream of the proposed project area. Fourth, there is an existing artesian well that will be submerged by the proposed enlargement. That well would need to be replaced or replicated to provide water access when the reservoir is frozen. The location of the well west of the existing reservoir. If the project mores forward, commentors believe a replacement groundwater well would need to be drilled in the R106W, T26N, Sec. 16, on the east side of Highway 191. Fifth, 2 allotment fences would be submerged by the proposed enlargement by the higher water levels. Those fences would need to be addressed. In light of the above, it is difficult to see how the agency has taken a hard look at the effects the proposed enlargement would have on grazing.

Response: Reclamation recognizes there is currently privately-owned land that is partially inundated based on the current Big Sandy spillway crest elevation of 6757 ft. Reclamation was aware that a land exchange between the State of Wyoming and the private landowner was being considered. For this reason, Reclamation prepared the Environmental Assessment under the assumption that the land exchange would have to occur before the project would be implemented. Under this assumption, there would be no impacts to grazing.

In response to the first portion of this comment, some riparian areas may be lost due to a spillway crest raise. However, based on the wetland analysis performed for the EA, the majority of the wetlands would persist, leaving much of the same forage available to livestock.

Second, there is the possibility that there would be additional areas of quicksand. Based on communications with Mr. Arambel, the area adjacent to the Big Sandy River on the inlet of the reservoir is not grazed or used for lambing/calving. Based on responses from Mr. Arambel to inquiries on annual revenue losses due to quicksand, it would be nearly impossible to accurately quantify those losses. Based on one response, a general statement was included regarding the possibility of revenue losses.

Third, again based on responses from Mr. Arambel, the area adjacent to the Big Sandy River is not grazed or used for lambing, so an increased water table would not affect livestock operations on the northwest side of the reservoir. Reclamation has no outstanding grazing permits on Reclamation withdrawn lands around Big Sandy Reservoir that would be affected by an increased water table. Soils on the north side of the reservoir are classified by the Natural Resource Conservation Service (NRCS) as 9203—Diamondville-Cushool-Edlin complex, 0 to 4 percent slopes. These types of soils are slightly saline to moderately saline. Therefore, little change in salinity would be expected.

Geotechnical work was completed to verify depth to bedrock. That information will be used to inform the construction of the cement-bentonite wall in the dike, which would prevent more seepage into areas on the southeast side of the reservoir.

Fourth, the artesian well is part of Reclamation's recreation facilities at Big Sandy Reservoir. The well would be extended or a new well drilled at a higher elevation as part of the Proposed Action (already stated in section 3.3.13.2 of the Draft EA).

Fifth, based on responses from Mr. Arambel to inquiries on where the fences are, the minimum distance from the enlarged reservoir to the closest corner portion of the Section the fence is located in (Sec 7 R105W T26N) is 1.5 miles. Based on this information and the fact that the proposed inundation area would move the reservoir <100ft closer to the fence, it is unlikely a spillway crest raise would affect the fences.

23. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

8. As the Bur. Rec. and the WWDC are aware, the wetlands issue was identified as one of the fatal flaws in the proposed project. With respect to the Draft EA's analysis of wetlands, the Draft EA claims the "duration of inundation would not be long enough" to kill wetland plants. This statement is based on a number of assumptions, which may be accurate some years and not others. First, it will only take one year of longer high water levels to kill the wetland vegetation and create a beach effect. Second, it assumes water would be drained from the enlarged reservoir fast enough to prevent such issues. However, in wet springs such as have been experienced the last few years, reservoirs fill completely and the water level remains at the high water line for a significant period of time. Commentors also question the math and the appropriateness of the numbers chosen for this analysis. Further, the loss of the wetland vegetation will cause a "beach effect," which will lead to blowing soils and sand, erosion, noxious weeds, and sand dunes.

Response: The response to Comment 13 addresses the concerns expressed in Comment 23. A hydrologic model was developed in the Level II study that simulated reservoir elevations and irrigation releases of the enlarged reservoir based on historic hydrologic data and irrigation releases. This model was used to assess inundation depth and duration tolerances for the species of wetlands located at Big Sandy Reservoir. A literature review of inundation tolerances for the species of wetlands at Big Sandy Reservoir was reviewed and based on this review of previous studies and the inundation limits determined from the hydrologic model, it is unlikely there will be any dramatic loss of wetlands due to the enlargement of Big Sandy Reservoir.

24. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

9. As the Bur. Rec. and the WWDC are aware, the sage grouse issue was identified as another of the fatal flaws in the proposed project. With the respect to the Draft EA's analysis of the sage grouse issues, the Draft EA contains some creative mathematics suggesting that only a 2.91% disturbance would occur. However, this is assuming that the agency's numbers are correct and that the tool is a valid measurement of wildlife disturbance. For example, the Draft EA appears to "compare apples and oranges." First, it describes the entire area of the project to include the entire surface area that would be inundated, but then uses only the surface area that would be inundated as the affected area, thus leading to the low percentage reported. The agency cannot have it both ways. Either the areas previously inundated need to be removed from the total project area or the area previously inundated needs to be added to the area affected by the proposed reservoir enlargement. The agency cannot have it both ways.

Response: The analysis performed using the State of Wyoming's Density Disturbance Calculation Tool (DDCT) is required for all projects that may affect sage grouse or their habitat in Wyoming. It was developed by the State of Wyoming to protect the species from large reductions in its habitat. The DDCT is not only the best available scientific method to estimate disturbance to sage grouse habitat, but is also what is required by Wyoming State law. Per the DDCT guidelines and WGFD personnel, the existing disturbance footprint of the reservoir was not included in the DDCT analysis. The inundation area was estimated based on well-accepted GIS tools and data (TIN tool in ArcGIS Pro v2.4 using LiDAR data collected in 2015).

25. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

10. The proposed plan to mine borrow from an area where there is currently standing water is infeasible. Further, to mine borrow from this particular area would exacerbate the problem of water standing below the reservoir. Borrow is available in other locations close to the project that would be much easier to mine and which would not further contribute to the issue of standing water below the reservoir.

Response: The area that is being described, an original borrow source south of the southern portion of the dike that has ponded water in low areas, is going to be partially filled in. The area being considered for a borrow source is inside the reservoir defined by the dike, being west and north of the dike, as the dike outlines the southeastern corner of the reservoir.

26. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

11. Further, the Draft EA proposes building a house of cards by building directly upon the existing dam, which is already in a state of disrepair. There are lateral and horizontal cracks in the existing spillway/dam and there is a 3-foot section of the structure that is missing. Commentors own land below the reservoir that would be devastated by a breach or failure of the Big Sandy Reservoir. Further, there were no drawings in the Draft EA for the structure proposed to elevate the water level and no proposed start date for the project. Further, commentors question the wisdom of the proposed toe drain on the other side of the reservoir and the proposed use of soil/shale on the reservoir banks rather than a gravel rip rap.

Response: Reclamation inspects Big Sandy Dam and Dike on an annual basis and there are currently no outstanding Category 1 recommendations which could indicate a potential threat to dam safety. There are some Category 2 maintenance recommendations that the Eden Valley Irrigation and Drainage District are responsible for completing but do not compromise the safety of the facility. An in-depth risk analysis has been performed previously by Reclamation's Technical Service Center which indicates that with the proposed modifications, the project would not increase failure risk with the increased reservoir level. Appraisal level drawings showing the proposed modifications to the spillway, dam, and dike have been incorporated in the EA as Appendix G.

The proposed toe drain on the left abutment of the dam alleviates potential pore pressures at the higher elevation thus increasing the safety of the dam. The proposal to utilize soil/shale on the dike banks to re-establish the original design slope of 8H:1V will result in a risk neutral design without the costly import of riprap. The embankment with this shallow of a slope results in a stable embankment to safely dissipate wave run-up and prevent severe erosion without the use of riprap.

Draft drawings have been included as Appendix G in the revised EA.

27. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

12. There is no indication in the Draft EA as to how the agency proposes to reclaim and seed the area and protect disturbed areas until vegetation recovers in the area. Commentors insist that all sites disturbed by the proposed project must be fenced until vegetation recovers in the area. However, that fencing cannot occur without first providing commentors' livestock with an alternative source of stock water.

Response: Reclaiming and seeding disturbed areas will be developed and incorporated into the construction contract in coordination with WGFD, BLM, NRCS, the Counties, etc. Disturbed areas do not need to be fenced.

28. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

13. The Draft EA claims that there are no man-made structures above the existing reservoir. This is inaccurate. There are 2 man-made structures on the river system: the Chinese weir and the Wyoming Game and Fish's new fish barrier.

Response: References to man-made structures was removed.

29. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

14. The Draft EA states that the consultation with the Wyoming State Geological Survey is not complete and its impacts are unknown. Therefore, the agency has clearly not taken a hard look at this area.

Response: In response to this and other comments regarding paleontological resources, Paleo Solutions, Inc. was hired to assess the project area for fossiliferous potential. Four fossil localities were identified, one of which was considered significant. Fossils were collected from that locality and will be curate at the Utah Field Museum of Natural History. Please see section 3.3.4 of the Draft EA for more information.

30. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

15. Commentors' family has farmed and ranched in the area for over 100 years and they are intimately familiar with the area. In fact, the land underlying the existing reservoir was their family's land. Commentors believe remains of paleo-Indian camps exist on the federal lands to be affected by the proposed enlargement that the Draft EA has not addressed.

Response: This topic is covered within the Class III cultural survey report. All prehistoric sites within the APE, whether previously identified by archaeologists or newly discovered, were evaluated for their significance against the criteria established for inclusion on the National Register of Historic Places. Reclamation determined that two prehistoric sites are eligible for inclusion thereon. Any adverse effects to these sites will be covered under a Memorandum of Agreement with the Wyoming State Historic Preservation Office.

31. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

16. The Draft EA fails to evaluate the impact of the that lack of flushing flows, which will no longer occur as frequently, or at all, on the Big Sandy River below the reservoir. These flushing flows have helped to enhance the health of fish habitat below the dam.

Response: Not all spills will have the volume and flow rate to have an impact on the channel - move gravels, cut the outside of river bends and deposit on the inside - but the decrease in "flushing flows" will probably align pretty directly with the decrease in spill frequencies and volumes. The reservoir spilled in 10 of the 22 years from 1989-2010 (45 percent), passing a mean volume of 4800 acre-feet per year over that period. Outside of the three or so weeks of spring runoff spills, releases to the river are not typically made. Depending on the actual operations of the reservoir and water deliveries, spills could occur as infrequently as 3 in every 20 years (15 percent), with a mean annual spill volume up to 60% lower than the historic mean. Because water is not released into Big Sandy River outside of the spills, Big Sandy River below the dam is dry or nearly dry for much of the year. The river would be recharged with return flows, seepage from nearby canals, and/or springs. Reduced flushing flows would not have an impact on a river that is only seasonally wet.

32. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

17. The Draft EA does not include the proposed timeline for the project; duration for construction; project costs; project construction diagrams; assessment of impacts to private landowners in Sublette County; and impacts to livestock operations and other existing uses. The Draft EA also failed to include the required distribution list. The Draft EA at page 2 notes that Bur. Rec's Dam Safety Office "has concluded that a reservoir enlargement would be approved if the dam safety risks remained neutral." Yet the Draft EA did not include a dam safety risk assessment. Without a firm timeline and plans for the construction project, there is no way to assess the environmental impact of the proposed action.

Response: The current proposed timeline for the project would have construction begin in the fall of 2019. It is anticipated construction would take place after irrigation season and be completed through in 2020. Increased storage would then be allowed to take place in 2021. While some construction costs have been estimated for budget planning purposes, an in-depth estimate has not been prepared. Once a final cost estimate has been prepared, a cost range will be posted with the solicitation for bidders to be aware of the potential construction costs.

A dam safety risk assessment was completed in the fall of 2013. This assessment indicated the risks of the enlargement would remain risk neutral with the proposed modifications.

33. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

18. The socio-economic section of the Draft EA includes a few statements about residents of Sweetwater County, but no mention of Sublette County is made. In fact, no "analysis" is made. The Draft EA should answer the following questions:

a. What is the anticipated impact for the period of construction?
b. How many workers and equipment will be on site, for how long, and where will they be housed?
c. Will the materials and labor come from local workforces and sources?
d. What is the anticipated economic impact?
e. What is the cost/benefit ratio for the project?
f. What are the direct and indirect economic benefits of the project?
g. What is the anticipated increase in agricultural production from added stored water?
h. Will increased storage result in added recreation days on the reservoir?
i. Will the construction phase result in negative consequences for other land users, and what measures will be taken to mitigate those impacts?
j. Will road closures be in effect during construction, and will recreational users and livestock producers be provided alternative access during the construction period?

Response:

a) During the construction period to enlarge Big Sandy Reservoir there would be an uptick in economic activity as contractors purchase food, fuel, and other amenities from local vendors. Earthen materials may be taken from local borrow areas (discussed in 2.3.7 of this EA) or trucked in from other areas. Due to the lack of significant industry in the local area, long-term/significant economic benefits of the construction activities would likely be minimal.

b) The construction period to enlarge Big Sandy Reservoir is expected to last from July or August until completion in April or May of the following year. The quantity of workers and equipment on site will be at the discretion of the contractors performing the construction work. As local lodging options are probably inadequate in number to accommodate the influx of workers needed to complete the construction activities, local trailer courts may see additional activity, or additional traffic on Highway 191 between the construction site and Rock Springs may occur. Ultimately, where engineers, surveyors, truck drivers, construction workers, etc. choose to be housed will be at their own discretion.

c) Whether materials and labor come from local sources or other locations will depend on suitability and economic viability of these resources. There may be vacancies on construction crews that could be filled by local individuals, but this socio-economic analysis does not pretend to mandate the use of local resources.

d) The total benefits of the Big Sandy Enlargement can be summarized as follows:

Table 8-1: Benefits of Big Sandy Enlargement

Summary of Benefits		
Benefit Type	**Annual Benefit**	**Present Value of Benefit**
Direct Irrigation	$ 283,423	$ 6,095,118
Indirect Irrigation	$ 461,980	$ 9,935,042
Recreation	$ 325,248	$ 6,994,580
Total	**$ 1,070,651**	**$ 23,024,740**

See responses to parts f, g, and h of this comment for a breakdown of these benefits.

e) The estimated present value of direct and indirect irrigation benefits and flat-water recreation benefits would be $23.02 million for the Big Sandy Reservoir Enlargement. When compared to an estimated construction cost of $8.4 million for the required enhancements, the benefit-cost ratio for the overall project is 2.74.

f) Direct irrigation benefits would accrue to local irrigators through a spillway raise/reservoir enlargement as additional supplemental water supply would be available on existing irrigated acreage. As stated, the enlargement of Big Sandy Reservoir would have an average annual yield of 2,936 acre-feet.

Applying the conveyance efficiency and on-farm application efficiency, an overall efficiency of 50.4% can be expected from the Big Sandy system. Applying this efficiency to the average annual yield of 2,936 acre-feet, results in 1,480 acre-feet of useable water at the crop through the enlargement of Big Sandy Reservoir.

Wyoming Agricultural Statistics publications between 2003 and 2014 were consulted to evaluate the cropping patterns and ratios for this area of the State, known as the South-Central Region. In 2014, approximately 59.5% of the crops reported in the County were Alfalfa Hay while 40.5% were reported as being Other Hay (Wyoming Agricultural Statistics Service 2015).

Crop-water production functions for alfalfa and other hay from the Upper Green River Basin were obtained for the Farson and Seedskadee areas and used to project crop production increases. The production functions were developed for the Upper Green River Basin within a report developed for the WWDC (Pochop and Burman 1987). The estimates presented in that report indicate that for every additional inch of evapotranspiration (ET) water available to the crops, an additional 0.142 tons/acre of alfalfa and 0.126 tons/acre of other hay can be generated. Estimating the additional crop production which would result from an enlargement to Big Sandy Reservoir yields an increase of 1,516 tons of alfalfa and 915 tons of other hay production every year.

The annual value of production increases was estimated using average crop prices in Wyoming from 2010-2014, as reported in Wyoming Agricultural Statistics (Wyoming Agricultural Statistics Service 2015). The average price for alfalfa was reported to be $156.20 per ton, and the average price for hay was reported to be $139.80 per ton. Applying these average prices to the production estimates derived above results in a total value of $364,716 annually.

Marginal unit production cost estimates for alfalfa were developed as part of a previous study prepared for the Torrington, Wyoming Region (Watts and Brookshire 2000). Those unit production cost estimates were updated to current (2016) dollars using a farm production cost index published in the current issue of Wyoming Agricultural Statistics. Those costs are $33.44 per ton of alfalfa and hay. The total marginal cost increase associated with the project is calculated by multiplying the unit marginal

production cost estimates by the amount of increased production, resulting in a marginal increase of $81,293.

Subtracting the marginal increase in production costs from the production value increases, yields an estimated annual net benefit of $283,423 for the Big Sandy Enlargement project. The present value of annual irrigation benefits would be $6.10 million for the project, assuming a 50-year project life and a four percent discount rate.

g) Wyoming Agricultural Statistics publications between 2003 and 2014 were consulted to evaluate the cropping patterns and ratios for this area of the State, known as the South-Central Region. In 2014, approximately 59.5% of the crops reported in the County were Alfalfa Hay while 40.5% were reported as being Other Hay (Wyoming Agricultural Statistics Service 2015).

Crop-water production functions for alfalfa and other hay from the Upper Green River Basin were obtained for the Farson and Seedskadee areas and used to project crop production increases. The production functions were developed for the Upper Green River Basin within a report developed for the WWDC (Pochop and Burman 1987). The estimates presented in that report indicate that for every additional inch of evapotranspiration (ET) water available to the crops, an additional 0.142 tons/acre of alfalfa and 0.126 tons/acre of other hay can be generated. Estimating the additional crop production which would result from an enlargement to Big Sandy Reservoir yields an increase of 1,516 tons of alfalfa and 915 tons of other hay production every year.

h) An enlargement at the Big Sandy Reservoir would result in a reservoir with a maximum surface area of 2,919 acres, a surface area increase of 500 acres. Although detailed studies have not been conducted, the enlargement has the potential to provide additional flat-water recreational opportunities in the summer and ice fishing in the winter.

For the purpose of this analysis, a usage rate of 10 activity days per acre per year has been used for purposes of benefit estimation. Using an increased average surface area of 500 acres, this equates to an added 5,000 activity days per year at the site.

The value of these visitor days was estimated from numerous studies at other recreational facilities. Assuming two fishing days for each boating/water skiing day implies an average activity day value of $65.18. Multiplying 5,000 activity days/year by $65.18/activity day, results in an annual recreational benefit estimate of $325,900 annually. The present value of that annual stream of benefits would be $7.0 million for the enlargement of Big Sandy Reservoir using a four percent discount rate and a 50-year project life.

i) Traffic across the dam would be restricted during certain phases of construction, subject to the contractor's schedule. Quantifying the impact is not feasible, as there is no data available for traffic across the dam.

j) Road closures would be in effect during construction. Alternate access across the dam would not be provided.

Literature Cited

Wyoming Agricultural Statistics Service. 2015. Wyoming Agricultural Statistics.

Pochop, L. and R. Burman. 1987. Development of evapotranspiration crop coefficients, climatological data, and evapotranspiration models for the upper Green River. WWDC Publication #87-06

Watts, Gary L. and David Brookshire. 2000. An economic analysis of impacts to Nebraska and Wyoming from post-1945 changes in North Platte River Basin Water Use. Report to the Wyoming Attorney General.

34. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

19. Since the Draft EA failed to identify the construction season, there is no way to identify the impacts to local wildlife resources. The Draft EA should hve answered the following questions and ignored them altogether, including:

a. Will there be impacts to wintering wildlife herds in the area (since this is crucial winter range)?
b. Will there be impacts to or wintering or nesting raptors?
c. What stipulations or mitigation will be put in place to protect these resources?

The Wyoming Game & Fish Department has requested the project comply with all the stipulations outlined in Attachment B of the Sage Grouse Executive Order, and those stipulations should be included in the Draft EA. They were not included or even mentioned. Among other provisions, the stipulations restrict construction activity during important seasons and hours for grouse.

Response: The EA has been updated to include a construction timeline (see response to comment 32 and Section 2.3.7.13 of the EA).

Wintering wildlife herds that occupy habitat near the dam and Big Sandy Feeder Canal would likely be displaced during construction. Pronghorn (Antilocapra americana), mule deer (Odocoileus hemionus), and elk (Cercus elaphus nelsoni) would move to adjacent, similar habitat.

A survey was performed by a wildlife biologist on January 31, 2018. One raptor nest was found near the dam where work would occur. No other nests were discovered near the dam or within 0.5 miles (the suggested distance buffer for golden eagles) of other proposed areas of disturbance. Reclamation has consulted with the U.S. Fish and Wildlife Service Wyoming Ecological Services Field Office to ensure compliance with the Migratory Bird Treaty Act of 1918. No mitigation measures were required.

The Draft EA did not include the Sage Grouse Executive Order (EO) in full, but did include it as reference for the reader. The EO was not included in order to reduce the length of the document (see 40 CFR §1500.4(j)). The EO, as well as other documents related to sage grouse conservation, can be found on the website of Wyoming Game and Fish Department at https://wgfd.wyo.gov/Habitat/Sage-Grouse-Management/Sage-Grouse-Executive-Order.

35. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

20. Golden eagles are known to inhabit the area and the Draft EA does not address the impacts on them.

Response: The EA has been updated to reflect this new information. See section 3.3.11.2 of the EA.

36. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

21. There was no cultural analysis pertaining to the effect of jobs (gain or loss) within the scope of the proposed project.

Response: No loss or gain of jobs would be expected as a result of implementing the Proposed Action (see response to comment 33).

37. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

22. There were no data in the Draft EA pertaining to evaporation of water off the surface area of the reservoir.

Response: This was addressed in the Draft EA, under the water quality section. An estimated 955 acre-feet would be lost annually due to evaporation.

38. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

23. Bur. Rec's own NEPA Handbook notes: "Compliance with NEPA is a Federal responsibility and involves the participation of Federal, State, tribal, and local agencies, as well as concerned and affected public in the planning process. NEPA requires full disclosure of the potential effects of major actions proposed by Federal agencies and accompanying alternatives, impacts, and possible mitigation. NEPA also requires that environmental concerns and impacts be considered during planning and decision-making so that steps may be more easily taken to correct or mitigate the impacts of an action." See *Handbook,* at 2.3.1.

Response: Thank you for the comment.

39. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

24. In summary, The Draft EA lacks sufficient information to assess environmental impacts of the proposed action; therefore, the Bur. Rec's statement that there are "no significant impacts" is not supported.

Response: Thank you for your comment. Based on the updated EA and analysis therein, Reclamation still finds there are no significant impacts associated with the Proposed Action. Therefore, an Environmental Impact Statement is not required.

40. **Commenter:** Peter R. Arambel, President of Dunton Sheep Company and Midland Live Stock Company

Comment:

25. Thank you for the opportunity to comment. Commentors retain the right to supplement these comments as other issues become known and/or file additional comments.

Response: Thank you for your comment.

41. **Commenter:** Wyoming Game and Fish Department
    Comment:

Terrestrial Considerations:

The uplands which will be inundated are considered crucial winter range for elk and crucial winter-yearlong range for pronghorn, yet the EA does not discuss this or evaluate the impacts to this habitat. This project will reduce the available sagebrush community habitat for these species. Habitat treatments such as forb seeding, burning, spraying, or mowing within the general area could help offset this habitat loss. We recommend working with the Department's local wildlife and habitat biologists to design and conduct sagebrush habitat treatments in the vicinity of the project area.

Response: The EA has been updated to reflect the impacts on elk and pronghorn habitat.

42. **Commenter:** Wyoming Game and Fish Department

Comment:

Aquatic Considerations:

Based on our present understanding of this project as described in the EA, we perceive no potentially significant negative effects from the project, nor do we anticipate significant fishery benefits that warrant the project claiming credit for.

Response: It is unclear what benefits the EA is claiming for the fishery. Reclamation cannot find reference in the EA that the Proposed Action would benefit the fishery.

43. **Commenter:** Board of County Commissioners, Sublette County, Wyoming
Comment:

Generally, Sublette County supports this project as it will increase the agricultural economic base of the affected area as well as enhance recreational opportunities by expanding the reservoir. It is an opportunity to increase the beneficial use of Wyoming's water within Wyoming and within the Big Sandy watershed. Although Sublette County supports the project, we have major concerns with how the Bureau of Reclamation (BOR) has proceeded with the EA.

Response: Thank you for your comment.

44. **Commenter:** Board of County Commissioners, Sublette County, Wyoming

Comment:

In spite of the fact that over half of the Big Sandy reservoir is located in Sublette County, the County was not even notified about the project or offered any opportunity to become a cooperating agency.

Response: Reclamation did not send a letter to Sublette County, Wyoming notifying them of the proposed project. Reclamation did send a letter for the second Draft EA to the Sublette County Board of Commissioners.

45. **Commenter:** Board of County Commissioners, Sublette County, Wyoming

Comment:

The Big Sandy Reservoir Project will impact nearly 500 acres of property, yet the EA does not discuss impacts to private property or how those impacts will be mitigated. Furthermore, the most affected private property owner, Mr. Arambel, was not even notified of the project.

Response: The proposed project would impact an additional 98 acres of private land on which Reclamation already has an easement for flooding. The second Draft EA addresses the impacts to private land.

A letter was sent to Mr. Arambel notifying him of the Draft EA. "Notification of the project" is not part of the NEPA process.

46. **Commenter:** Board of County Commissioners, Sublette County, Wyoming
Comment:

This project could impose unintended consequences for sage grouse habitat, yet there is no discussion in the EA describing the impact or actions to be taken to mitigate the impacts to sage grouse. Please work with Wyoming Game and Fish to define these impacts and develop a mitigation strategy.

Response: An entire section in the Draft EA covered impacts to sage grouse, including use of Wyoming Game and Fish Department's (WGFD) Density Disturbance Calculation Tool (DDCT). Also included was a letter from WGFD approving the DDCT analysis.

47. **Commenter:** Board of County Commissioners, Sublette County, Wyoming
Comment:

In the cumulative effects section of the EA, there is no discussion of impacts to livestock grazing on agricultural operations in Sublette County. Please describe the loss of grazing AUMs and what is being done to compensate for that loss.

Response: There would be no loss of grazing AUMs on Federal public lands as there are no grazing permits on Reclamation withdrawn lands around the reservoir. Impacts to grazing on private lands is covered in Section 3.3.17 of the second Draft EA.

48. **Commenter:** Board of County Commissioners, Sublette County, Wyoming

Comment:

It has been reported to Sublette County by Mr. Arambel, that his private property was illegally trespassed on by BOR officials working on this project. What is being done to rectify this situation? Private property located immediately downstream and owned by Mr. Arambel will likely become nonproductive because of additional salinity. What is being done to mitigate this impact?

Response: Reclamation did not trespass because Reclamation has an easement on Mr. Arambel's land that allows for ingress and egress on said easement. The warranty deed conveying the easement is available on pages 280-283 of the pdf found on Sublette County's website at http://gwmap.s3.amazonaws.com/sublette/landrec/wd/006WD.pdf. An updated version of the land ownership map displaying this information is in the new Draft EA.

It is unclear what property is being referenced nor the expected manner in which soil salinity would increase under the Proposed Action. Except for the annual maximum of 955 acre-feet of evaporation, the amount of water released from the reservoir would be the same as in the past. The timing of the releases may be altered; however, this would not affect soil salinity.

49. **Commenter:** Board of County Commissioners, Sublette County, Wyoming
Comment:

Overall, there has been a severe lack of communication between the BOR and Sublette County as well as between the BOR and Mr. Arambel, the affected property owner, who lives in Sublette County. Please address this situation, both with Sublette County and with Mr. Arambel.

Response: Reclamation sent a letter to Sublette County notifying them of the new Draft EA. Reclamation has been in contact with Mr. Arambel since the beginning of the NEPA process. Communication between WWDC and Mr. Arambel is unrelated to NEPA as mentioned in comment 16.

50. Commenter: David Vlcek, Bonneville Archaeology

Comment:

First, under Purpose and Need, the EA states that flood control is one purpose of the project. Yet the document also states that "no exclusive flood control capacity is provided at Big Sandy Dam". The contradictions are obvious. EA at page one also states that a Risk Analysis, a Value Planning Study and other studies have previously been completed by BuRec. These efforts are not summarized, nor do they appear as appendices to the EA. In reality, the only purpose of the project seems to be to provide additional water storage for irrigation.

Response: The statements are not incongruous. Big Sandy Dam was not built to provide flood control. However, a secondary benefit of the dam is the ability to provide some flood control. The studies are not fully summarized in the cited paragraph, but the Proposed Action was developed from the studies, so the results of the studies is the Proposed Action.

51. **Commenter:** David Vlcek, Bonneville Archaeology

Comment:

1.3 is titled Scoping, Coordination and Public Involvement. BuRec has failed to scope the project with the Sublette County Commissioners, the general public, affected interests such as Mr. Pete Arambel, BLM, or announced a public meeting, at least in Pinedale, the Sublette County seat. Too, I have attended Wyoming Water Development Commission (WWDC) meetings in Pinedale and have no recollection of this project ever having been mentioned. At 1.3.2 BuRec states that public meetings "will be conducted". They have not been and BuRec and WWDC have failed to adequately inform the public, county officials and other potentially interested parties of the NEPA effort. 1.36. states that a Class III cultural resources survey was conducted (see also Ch. 3) but no report exists for WySHPO or other interested parties to review1.3.8 states that Native American Consultation will be done through the public involvement process, yet no public involvement process has been forthcoming. And which Tribes are envisioned for some vague future consultation? The document is silent upon this.

Response: Reclamation did not send a letter to the Sublette County Commissioners, but did so on the second Draft EA. The general public was notified of the first Draft EA, including a note at the Farson Post Office. Mr. Arambel was sent a letter notifying him of the NEPA process, as was the BLM Rock Springs field office. Reclamation's NEPA process is separate from any presentations of the WWDC. A public meeting was conducted on November 7th, 2017 in Farson, Wyoming. A cultural resource report has been prepared and submitted to Wyoming SHPO. Wyoming SHPO concurred with Reclamation's determination of effects. An MOA will be completed prior to issuing a decision document. Inter-governmental consultation with Native American Tribes is an important portion of the NEPA process that Reclamation takes seriously. Any Tribes with potential interest in the proposed project are being consulted.

52. **Commenter:** David Vlcek, Bonneville Archaeology

Comment:

1.5.1 mentions the BLM Rock Springs RMP revision. In a phone conversation I had with you (Mr. Baxter) on November 29th, you indicated a single letter was sent to BLM Rock Springs. Any reply was not articulated and it appears that BLM overall has been largely left in the dark concerning the project.

Response: A letter was sent to the BLM Rock Springs field office notifying them of the project. They were previously made aware of the project when Jared Baxter called the office to find out who the letter should be addressed to. He explained who he was, where the proposed project was, and who would be the best contact for the letter. Reclamation received no response from the BLM, whether formal or informal comments.

53. Commenter: David Vlcek, Bonneville Archaeology

Comment:

1.6 states that the EA is to determine of BuRec should authorize and provide funding and in concert with WWDC implement then project. Considering the many outstanding efforts neither BuRec or WWDC have done to date a FONSI is totally premature at this time. For example, 2.3.7.2 and 7.3 mentions haul roads and borrow areas. They are not identified within the EA, so the reader does not know where they will be, nor can one assess their potential impact. 2.3.7.10 involves restoration and rehabilitation. I was shocked and appalled when BuRec and the Wyoming Department of Transportation (WDOT) upgraded U,S, Highway 189 at Fontenelle Reservoir. The magnificent Eocene cliff face along the highway was flat bladed, destroying the thousands of years of exposed sediment and no attempt was made to restore the cliff face to its prior condition. BuRec's "track record" in reclamation and restoration is not satisfactory.

Response: Thank you for your comment. No new haul roads would be created as part of the Proposed Action. The borrow area was identified after the Draft EA was published, and is included in the second Draft EA.

54. **Commenter:** David Vlcek, Bonneville Archaeology

Comment:

2.5 is vague in the extreme. Surface disturbance will be confined to previously disturbed areas "to the extent possible" Where? If five feet of additional dam height is constructed and large quantities of additional water storage result, certainly previously nonflooded lands will be inundated. Dust control is mentioned in passing, yet no specifics are offered. Existing improvements such as fire pits benches, out houses (no mention is made of the requisite access roads and parking areas) and the like will be moved, but to where? How can these facilities be placed in "previously disturbed areas"?

Response: Confining surface disturbance to previously disturbed areas is a Reclamation best management practice. Surface disturbance generally refers to disturbance created by equipment necessary to implement the Proposed Action. The county road to the dam from Highway 189 would be the access road. Staging areas are identified in Figure A-3 in Appendix A of the Draft EA. Recreation facilities would be moved a short distance (<50m) in order to stay close to the reservoir, remaining in disturbed areas.

55. **Commenter:** David Vlcek, Bonneville Archaeology

Comment:

Table 3-1 suggests no prime and/or unique farmlands will be affected. This seems contradictory to Mr. Pete Arambel, who claims his lambing grounds will be inundated. He also suggests compensation via land transfer. Where will these lands come from? What of Mr. Arambel's concerns? He has indicated he was not consulted during development of the project. Why not?

Response: Prime and unique farmland refers to the lands designated by the Natural Resource Conservation Service (NRCS) as prime and/or unique farmland under the Farmland Protection Policy Act (contained in the Agriculture and Food Act of 1981).

The land exchange is negotiated between Mr. Arambel and the State of Wyoming. Reclamation is not party to the negotiations, and no Federal land is part of the swap.

Mr. Arambel was notified when the Draft EA was available to the public. The NEPA process is separate from the processes for the State of Wyoming. See response to comment 16 for more information.

56. **Commenter:** David Vlcek, Bonneville Archaeology

Comment:

Section 3.3.3 is the Cultural Resources section. Zachary Nelson, your archaeologist has apparently inventoried a large amount of space around the reservoir in what is described as the Area of Potential Effect (APE). Yet the APE is not defined or illustrated. And as of this writing (Dec. 6, 2017), no inventory report is available for review. While many previously recorded sites are within the project area, many of them were recorded several decades ago. It has been my experience that sites recorded in the 1960's, 70's, 80's and 90's will not stand up to the standards in the twentieth century. I understand that Zack Nelson is in the process of re-recording some of this data, yet the results are not available as of this writing. Old determinations of Not Eligible will need to be revisited. While the Oregon Trail is mentioned in passing, actually the affected resource is the Sublette Cutoff, 48SW1841, an integral part of the Nation's National Historic Trail system and a long standing National Register Eligible Historic Property. Reclamation excludes it from the short list of Eligible properties (N=5) and thus adds it to the lengthy Not Eligible list. This is totally unacceptable. Modern evaluation requirements of potentially affected segments of the National Historic Trails system require visibility assessments, viewshed studies condition assessments and documentation. All this is lacking. The MOA suggested does not include mention of the Oregon California Trails Association (OCTA), either the Sublette County or Sweetwater County Historic Preservation Commissions (CLGs), the Wyoming Association of Professional Archaeologists (WAPA), or the Wyoming Historical Society. These groups, at a minimum, include potentially "interested parties". I sit on the executive boards of WAPA and the Sublette County CLG and no outreach was made to these bodies. Clearly, Adverse Effects are envisioned to National Register historic properties (as the document indicated) so this alone should eliminate a FONSI, as a FONSI can only be supported by No Effect determinations to National Register Eligible historic properties. No mitigation is offered in the EA. And, of course, the Class III report is not yet available for review. It is totally premature to suggest that no Eligible archaeological sites will be impacted by reservoir expansion. Too, no mention is made of past illegal artifact collecting which is rampant at Big Sandy Reservoir and how such impact may make surface expressions of sites difficult or impossible.

Response: (1) The direct APE includes 508.16 acres of proposed inundation between elevation 6757.5 and 6762.5 feet above mean sea level. However, a total of 1,114.33 acres were surveyed for this project including a buffer (as appropriate) in particular areas. (2) Sites identified in the APE and additional inventory area were re-evaluated. (3) Site 48SW1841 was incorrectly identified as being in the APE. It is not. It is located near the APE and a viewshed analysis occurred. (4) The organizations mentioned were invited to participate in the Section 106 process that occurred after the draft EA was published for public comment. (5) A FONSI can be reached with a mitigation document in place, which will occur. (6) SHPO and Reclamation concurred on determinations of effect for all sites located in the direct APE and inventory area and will sign an MOA for mitigation. (7) The level of illegal artifact collecting is difficult to evaluate. As archaeologists, we rely heavily on surface manifestations of artifacts to determine site type and density. In this case, archaeologists surveyed Big Sandy prior to its use for recreation (Metcalf [SHPO project no. 52-1] and Davis [SHPO project no. 53-1]) and collected artifacts from across the reservoir basin and surrounding areas. Thus, significant loci of artifacts were discovered,

excavated, and important artifacts collected prior to wide-spread use of the area for recreational purposes.

57. **Commenter:** David Vlcek, Bonneville Archaeology

Comment:

I visited the reservoir on Dec. 1st, 2017, took several pictures, and examined the perimeter of the extant reservoir. I did note surfaces suggestive of poor buried prehistoric site potential but I also observed and photographed cut banks containing over a meter of soils. A large dune system exists on the northeast portion of the reservoir and such eolian deposits are known to contain abundant, buried archaeological deposits. Has Zack Taylor conducted evaluative testing is the dune field? If not, why not? Too, both the east and west sides of the existing reservoir contain low bays (willow habitats) with significant deposits of recent A and B horizon soils With thick vegetative comer, surficial examination alone is insufficient to assess presence of buried archaeological materials. In such settings, evaluative testing should be conducted to assess buried site potential. It remains to be seen if any of this work was performed by Dr. Taylor or other qualified archaeologists. As published I consider the EA's Cultural Resources section inadequate, incomplete, misleading and currently unverifiable.

Response: The cultural resources inventory was completed to the standards of the State Historic Preservation Office. Most of the eolian deposits are well outside of the proposed inundation area on the northeast side of the reservoir. The areas to be flooded were examined for surface manifestations of cultural material.

58. **Commenter:** David Vlcek, Bonneville Archaeology

Comment:

3.3.9.2 confuses me. It states that there are no structures within the proposed expanded boundary of the 100 year floodplain. Then why are picnic tables, fire pits, outhouses, parking and etc. being moved? And what of wildlife? My Dec. 1st visit involved location of a red fox scurrying out of a willow bottom on the west reservoir side, and a jack rabbit in the same area. Such meadow wetlands are described as "low quality, marginal wetlands". I beg to differ.

Response: References to the structures was removed from the EA. The determination of "low quality, marginal wetlands" came from the wetland delineation approved by the USACE.

59. **Commenter:** David Vlcek, Bonneville Archaeology

Comment:

3.3.10.2 seems to suggest that no Corps of Engineers 404 Permit will be required for this project. How can inundating over 300 acres of new land be covered by a nationwide Permit? Is this in error?

Response: The first Draft EA clearly stated that minor discharges associated with the spillway modification can be authorized by the Army Corp of Engineers NWP 18. The paragraph in the EA comes directly from the Army Corps letter Reclamation received specifically for this project. The EA never suggested that the whole project is exempt from Army Corps permitting. Only certain aspects of the project fall under an Army Corps exemption, which is clearly stated in the paragraph. A NWP will be required for the project.

60. **Commenter:** David Vlcek, Bonneville Archaeology

Comment:

3.3.11 incorrectly describes brown and rainbow trout as native fish species. They are not. The fish section identifies Big Sandy as a less desirable fishing destination. Thus expansion of the reservoir has little fishing recreational potential. Page 30, paragraph 2 states that "Current operation of the Big Sandy Reservoir has not resulted in creation of large areas devoid of vegetation around the perimeter". This is false. My Dec. 1st visit noted and I photographed large areas devoid of vegetation, low water conditions and cut bank erosion. Not to mention the parking areas, vehicle paths camping spots and the like that are devoid of vegetation.

Response: The EA was updated to reflect the fact that brown and rainbow trout are not native fish species to Big Sandy. Some areas are devoid of vegetation; however, these areas are generally either below the high water mark (created by the reservoir) or above it (parking areas, etc.). Other areas appear devoid of vegetation, but in fact grasses and sedges grow during the spring and summer. These species may be difficult to see in December. Therefore, the statement that the "Reservoir has not resulted in creation of large areas devoid of vegetation around the perimeter" is accurate.

61. **Commenter:** David Vlcek, Bonneville Archaeology
    Comment:

Table 3.8 lists adverse effects to cultural resources, "minor effects" to recreation and T and E species (what are "minor effects"?) and effects to wetlands and wildlife. Thus, assessing project cumulative effects as No Effect" is inappropriate, premature and not supported by data contained in the EA.

Response: "Minor effects" means the effects are expected to be short-term, localized, and/or do not rise to a level of significance (as defined in NEPA and CEQ regulations). If impacts are not expected to continue much beyond the duration of construction, a "no effect" is appropriate.

62. **Commenter:** David Vlcek, Bonneville Archaeology
Comment:

4.1.2 mentions silt fencing "if necessary" Who decides this?

Response: Silt fencing would be necessary in situations where siltation is avoidable by using fencing. Whether it is necessary is determined by conditions expressed in the construction contract.

63. Commenter: David Vlcek, Bonneville Archaeology

Comment:

4.6. mentions cultural resources discovered during construction. My 40 years of archaeological work in SW Wyoming clearly indicates that such discoveries are only reported and evaluated if a qualified archaeologist is present during construction, i.e. monitoring. No mention is made of this well entrenched and highly successful technique. Obviously notifying the Utah SHPO is a glaring error, as the project takes place in Wyoming. Also, the mention of discovering human remains in the project area excludes involvement of the appropriate law enforcement entities. Virtually all discoveries of human remains made during or subsequent to construction qualify as Unattended Death scenarios, thus the discovery is considered as a potential crime scene until so released by law enforcement authorities. My 40+ years of experience in such matters in Wyoming indicates: You call the police first.

Response: (1) Construction monitoring is an excellent technique, but not necessary for watching the reservoir fill. (2) The Utah SHPO reference is corrected in the final EA. (3) Yes, the police should be called first.

64. **Commenter:** David Vlcek, Bonneville Archaeology

Comment:

Figures A 2 and A 3 are of poor quality yet they are essential to assessing the project impact area. Too no mention is made of a Cumulative Impact Assessment Area, though NEPA indicates the CIAA should be part of the evaluation process.

Response: The Draft EA was accessed online at Reclamation's website (https://www.usbr.gov/uc/envdocs/ea/pdf/BigSandyEnlargeDraftEA.pdf) as recently as January 30, 2018. The images appear very readable.

A CIAA is not mentioned in NEPA/CEQ regulations nor in Reclamation NEPA guidance. Therefore, it is not required in assessing cumulative impacts.

65. **Commenter:** David Vlcek, Bonneville Archaeology

Comment:

Finally, it is eminently apparent that the benefits of this project are exclusively the Eden Valley Irrigation District users. I see no overall public benefit of the project. Thus I strongly object to spending federal and state dollars, my tax dollars, on such a narrowly focused effort. If the Eden Valley Irrigation District wants this project to proceed, then the Eden Valley Irrigation District themselves should foot the entire cost of the project, including all construction, mitigation, reclamation and evaluation studies. It appears to me as one big Pork Barrel project that no public monies should support.

Response: During spring of 2016, an application was submitted to WWDC for funding the reservoir enlargement and associated modifications (including Big Sandy Feeder Canal reconstruction) through the Upper Colorado River Basin Fund Memorandum of Agreement (MOA). The MOA provides funding through a percentage of collected hydropower revenues generated by Colorado River Storage Projects (CRSP) for participating projects within the Upper Colorado River Basin. The application was approved by the WWDC at their June 2017 meeting. Reclamation reviewed the application and approved the project near the beginning of 2017 for funding.

66. **Commenter:** David Vlcek, Bonneville Archaeology
Comment:

Thank you for the opportunity to comment. I wish to be identified as an Interested Party with standing in this and future related NEPA efforts, informed of any scheduled public meetings, on-site fieldwork and additional project documentation.

Response: Thank you for your comment.

67. **Commenter:** Gary Wockner, PhD, Director, Save the Colorado
Comment:

First, the DEA completely fails to identify or analyze the streamflow reduction in the Big Sandy River, downstream of the dam, due to the proposed reservoir enlargement. The "hydrology" section of the DEA (Section 3.3.5) is ridiculously facile and non-technical. The section completely fails to:

- Identify the amount, in acre feet or cubic feet per second, of additional water diverted from the Big Sandy River below the proposed expanded dam.
- Analyze the impacts of the additional water diversion on the hydrology of the river below the dam.

Then, absurdly, in Section 3.7 (page 40), in the "Summary of Environmental Effects" table, the DEA says there is "No Effect" on the hydrology of the Proposed Action.

Of course, there has to be an effect on the hydrology of the river, because the reservoir is proposed to be expanded precisely to take more water out of the river. In fact, the DEA identifies that the reservoir is proposed to be expanded – Section 1.2, the "Purpose and Need", states exactly that:

> "The current storage capacity is 38,600 acre-feet. A 5 foot raise of the spillway crest would allow a total storage capacity of 52,300 acre-feet or an increase of 13,700 acre-feet."

And then says,

> "The additional water stored in the reservoir is needed to firm up the water supply for lands irrigated in the Farson/Eden area through the Eden Project."

The streamflow reduction must be identified, and then the environmental impacts of that reduction must be analyzed on the downstream:

- Wetlands
- Water Quality
- Fishery
- Aquatic Life
- Other Wildlife Resources.

Response: Only spills from the reservoir enter the Big Sandy River below the dam. Water from the outlet works is released into the Means Canal, not the river. Hydrology, wetlands, the fishery, and aquatic life would be minimally affected because the river is dry or nearly dry for most of the year. This would not change if the reservoir were enlarged.

68. **Commenter:** Gary Wockner, PhD, Director, Save the Colorado
Comment:

Second, because the DEA completely fails to identify or analyze the reductions in streamflow in the river, and the total acre-feet reduced, the DEA completely fails to identify and analyze any cumulative impacts that may occur on the flow in the Green River downstream and the Colorado River further downstream.

As the Bureau of Reclamation is well aware, the entire Colorado River system – including its tributaries in Wyoming which includes the Big Sandy River – is extremely stressed with threats of shortages, compact calls, and other types of "contingency plans" to address the likely and looming water shortages. The Bureau itself has spent considerable resources studying the "water supply and demand" problem on the Colorado River[4]. The amount of new water

[4] https://www.usbr.gov/lc/region/programs/crbstudy.html

diverted from the proposed expansion of Big Sandy Reservoir must be identified, and then the cumulative impact of that new diversion must by analyzed in the face of the threats to water supply in the Colorado River basin.

Further, climate change scientists predict that the amount of water in the Colorado River system is going to decrease even further due to the impacts of climate change[5]. Any new diversion of water from the entire system must analyze its cumulative impact coupled with climate change reductions.

Response: Thank you for the comment, and for your concern for the future of the Colorado River system. Additional text quantifying the local flow impact has been added to sections 3.3.5 and 3.3.7. Hydrologic modelling for the Ultimate Phase – Green River Block water exchange contract between Reclamation and the State of Utah shows negligible impacts to water resources based on the development of 24 times the amount of depletions proposed in this EA (Patno 2018; Draft EA available at https://www.usbr.gov/uc/envdocs/ea/GreenRiverBlockWaterExchangeContract-DraftEA.pdf). Therefore, the cumulative effects of enlarging the reservoir on the overall Colorado River system would be negligible. Executive Order 13783 "Promoting Energy Independence and Economic Growth" rescinds the CEQ's guidance on including climate change in NEPA analyses.

Appendix I – Responses to Comments on Second Draft EA

Comment Number	Commentor(s)	Corresponding Entity(ies)	Comment (or Summary of Comment)	Response
1	Angi Bruce	WGFD	Chapter 3, Page 38: The EA should cite Greater Sage-Grouse Executive Order (EO) 2015-4 and its supplement EO 2017-2, rather than EO 20 11 -5, since these are the executive orders the Density Disturbance Calculation Tool analysis used to determine impacts to sage-grouse.	Change made.
2	Angi Bruce	WGFD	We perceive no potentially significant negative effects from the project, nor do we anticipate significant fishery benefits with the enlargement of the Big Sandy Reservoir.	Thank you for your comment.
3	Dave Vlcek	Sublette County Historic Preservation Commission	First the Purpose an Need section does not establish need for the project. Purpose, yes, but need, no. Increased water storage is not a need, but a desire. In the past EA, USBR stated that the Eden Valley Irrigators didn't need additional water. The State of Wyoming legislature has voted not to approve of "water banking". Thus the "need" of this project is highly questionable. Regardless, a large surplus of water will be created if the project is constructed. P. 51 of the new EA says that the Wy State Engineer's Office must permit this excess water. Who can apply for the water? Why? What would be the result upon prior users? To "firm up water supply" is a nonprofessional statement not supported by the EA analysis, based upon past use, needs, projected allocations or potential alternative directions water use may take.	USBR did not state there was no need for the additional water and the assertion comes with no citation to the EA. The purpose and need statement has been updated to better explain the need for the project (irrigation demand). "Water banking" is not the intent of the project. USBR will apply to the Wyoming State Engineer's Office for a current day storage right for the additional irrigation water. The additional stored water would be available to EVIDD. The impact to prior users is described in the EA under the water rights section 3.3.16.
4	Dave Vlcek	Sublette County Historic Preservation Commission	Tribal Consultation is alluded to, but no specific detail is provided. Which Tribes? How Often? Any proposed field visits? Phone conversations? Face to Face meetings? Status? The EA is incomplete in this regard.	Thank you for your comment. Reclamation updated section 6.8 to reflect the following information. Reclamation sent letters to the following tribes on September 24, 2018: Apache Tribe of Oklahoma, Arapaho Tribe of the Wind River Reservation, Wyoming, Cheyenne and Arapaho Tribes, Oklahoma, Comanche Nation, Oklahoma, Crow Tribe of Montana, Fort Belknap Indian Community of the Fort Belknap Reservation of Montana, Shoshone Tribe of the Wind River Reservation, Shoshone-Bannock Tribes of the Fort Hall Reservation of Idaho, and Ute Indian Tribe (Uintah & Ouray Reservation). The Apache Tribe of Oklahoma responded on October 9, 2019 with a determination of no adverse effect. No other tribes responded at that time. Follow up emails and phone calls were made to tribes that generally are interested in activities in the Big Sandy Area. These include the Arapaho Tribe of the Wind River Reservation, Wyoming, Shoshone Tribe of the Wind River Reservation, and Ute Indian Tribe (Uintah & Ouray Reservation). Emails and phone calls were made on the same days: February 21, and March 1. There was no response via email. Messages were left on the phones, but no response was received.
5	Dave Vlcek	Sublette County Historic Preservation Commission	Re Visual Resources: I request a site specific repl,y from the Oregon California Trails Association concerning their specific comments upon this project and potential effects to the National Historic Trails system, due to this project.	Reclamation called and emailed Fern Linton of the Oregon-California Trails Association on December 20, 2018, January 20, 2019, and March 27, 2019. Fern downloaded the cultural report on March 28, 2019.
6	Dave Vlcek	Sublette County Historic Preservation Commission	Re Archaeological Resources and their National Register status: SU2, SU3, SU4, SU5, SU6 and SU7: The National Register status remains in question. Yes WySHPO has "signed off" on Dr. Nelson's report, but many questions still remain. A planned Spring , 2019 field visit by local, experienced archaeologists and Dr. Nelson is a critical and imperative necessity prior to writing off all these resources as nonsignificant. The 10 year monitoring plan needs to be specified. When will monitoring occur? How often? By whom? Availability? What of results? And what is the status of the agreed upon Geoarchaeological Sensitivity Modeling? Has Mr. Eckerle been contacted, per Mary Hopkins, Wy SHPO's suggestion? How will this model be applied to the project? When? How?	Per the MOA stipulations, additional archaeological investigation will be included in a Historic Properties Treatment Plan, which is still undeveloped. The plan will include monitoring and geophysical modelling stipulations. It will be in place and reviewed by SHPO prior to ground disturbing activities.
7	Dave Vlcek	Sublette County Historic Preservation Commission	The EA does not recognize past impacts to cultural resources created by illegal arifact collecing, nor does there appear to be any attempt to curtail this in the future.	Illegal collecting is, by definition, against the law. Should anyone be caught illegally collecting or disturbing archaeological sites, then federal regulations apply.
8	Dave Vlcek	Sublette County Historic Preservation Commission	I note the recreation section of the EA is weak, lacking in past use data, or projected increased use.	Visitation usage is not tracked. Because of the location of Big Sandy Reservoir it is not a "destination location". Visitation is not expected to increase substantially.

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9	Dave Vlcek	Sublette County Historic Preservation Commission	EA at 3.4, Cumulative Effects ignores any mention to archaeological resources, despite the fact that NRHP-Eligible sites are in the direct Area of Effect of this project. Yet Table 3-16 lists Adverse Effects to cultural resources. It is hard for me to justify a FONSI with all of these unanswered questions, proposed field work pending.	Cumulative effects to cultural resources were analyzed in section 4.3.2. Reclamation, SHPO, and other interested parties developed a memorandum of agreement to mitigate effects to cultural resources. As part of the mitigation plan, a Historic Properties Treatment Plan will be developed and implemented prior to ground-disturbing activities.
10	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	1. (10) of DSC's 40-acre parcels. Although the Bureau of Reclamation claims an easement to inundate those lands, any right it had under those easements to inundate the land above the high- water line has been abandoned by nonuse and is subject to termination pursuant to Wyoming law.	The Warranty Deed specifically says "Also *perpetual* easements to submerge, seep, flow, silt, flood or otherwise affect with water from whatever source…". To the best of our knowledge, there is no state law that dictates abandoning perpetual easements based on non-use.
11	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	2. With respect to the Arambel's lands below the reservoir, both DSC and MLC own lands that will be adversely affected by raising the reservoir elevation. Specifically, raising the reservoir will raise the water table in the area, causing groundwater to percolate up through DSC's and MLC's soil. During the public meeting in Farson in March, Bureau of Reclamation officials admitted the bedrock they plan to tie the wall into is not gneiss, but sandstone – a permeable stone. Groundwater percolation will not only make the lands too muddy to use for ingress and livestock grazing, it is also anticipated to cause the lands to become alkaline/saline and kill the vegetation currently growing on the land that is used for livestock grazing at various times of the year. The history of the Big Sandy Reservoir amply demonstrates the Arambel's concerns. Specifically, there is a spring on the Arambel's property below the reservoir that flows water year round, which then runs into the Big Sandy River. This spring did not exist until after the Big Sandy Reservoir was built. There are other springs and pools of water adjacent to and below the reservoir and dike that hold water year-round, which percolates up through the ground below the reservoir. One such pool contains water that animals will not drink. It would be unwise for the Bureau to ignore these pools and springs and not test them to determine why animals will not drink them before they compound the problem by raising the reservoir elevation by five (5) feet. Second, aerial photography clearly identifies the presence of white rings and other white soils around drainages and elsewhere indicating alkaline/saline soils between the Big Sandy Reservoir and Eden Reservoir. See several years of aerial photography available through the Sweetwater County Assessor's Office at https://maps.greenwoodmap.com/sweetwater/. Those wetlands and the resulting alkaline/saline rings did not exist prior to the two (2) reservoirs being built and the construction of the feeder canal. Some of the land that does not show up as white is also high in salinity, but salt grasses have started growing there, which are unpalatable to livestock, thus masking the white soils. One of the Bureau's purposes in raising the reservoir elevation is to provide greater opportunities to divert water through the feeder canal to Eden Reservoir. The operation of the feeder canal has resulted in groundwater percolation to cause reservoirs to form on MLC's lands and increased alkali/salinity of soils is present on MLC's and the adjacent lands. This is obvious from looking at the various years of aerial photography at the link above, from 2006 to 2017. By increasing the amount of water stored in Big Sandy Reservoir and diverted through the feeder canal, it will increase the amount of groundwater percolation from the canal onto MLC's lands. The soil composition underlying the Arambel's land is such that groundwater percolation has brought, and will continue at a greater rate to bring, alkali and salts to the surface of the land, killing the vegetation and causing more unpalatable salt grasses to grow where the salinity has been raised. It is not unreasonable to expect the same types of consequences that were caused by the previous building of the reservoir and feeder canal will flow from the enlarged reservoir at an accelerated pace. This will have an adverse effect on the Arambel's livestock operations.	As described in section 3.2.3.4 and Appendix E, best available data show that there would be no change to a minimal increase in groundwater at the private lands between Eden and Big Sandy Reservoirs. Therefore, there would be no or negligible increases in salinity on the private land, regardless of anything at Fontenelle Reservoir.

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11 Cont.	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	There is a spring on the Arambel's property below Eden Reservoir that contains highly saline water. This spring did not exist on the property before the Eden Reservoir was built. This saline spring is a perfect example of what will occur if the Big Sandy Reservoir is enlarged and it supports and justifies their concerns. However, the Bureau has done nothing to try to understand these concerns or perform any testing related to the issue. Further, even though more storage capacity and water in the Big Sandy Reservoir will increase the amount of water in Eden Reservoir via releases through the feeder canal, the Bureau has done nothing to evaluate the effect of holding more water in Eden Reservoir. Further, there is a spring in the Means Canal, located in the NESW of Section 6, in Township 26 North, Range 105 West. The spring runs from a gap in the shale that was cut by the canal and it runs water most of the year, until winter when the water freezes. If the reservoir is raised by 5 feet, the groundwater percolation is likely to increase. The spring is large enough that it can be seen on the aerial photography on the Assessor's website for the year 2015. This amply demonstrates that groundwater percolates from the Big Sandy Reservoir to the adjacent lands, but it has not been evaluated or even acknowledged by the Bureau. Therefore, the Bureau cannot claim to have taken a hard look at the groundwater percolation issues. Further, the construction of Fontenelle Reservoir is a perfect example of what will happen if the Bureau raises the elevation of Big Sandy Reservoir. See the link below to aerial photography showing white soils where the lands were damaged by alkali/salt after Fontenelle was constructed. https://www.google.com/maps/d/embed?mid=1f3AK3oMKgEf94cFL2FH5G4FrHak&moduleurl=http%3A%2F%2Fmaps.google.com%2Fhelp%2Fmaps%2Flocal_search%2Fmapplet.html&ma pclient=google&hl=en&ie=UTF8&oe=UTF8&t=h&msa=0&ll=42.108187345181584%2C-109.71851834619497&spn=0.127396%2C0.171661&z=10&output=embed The lands below Fontenelle Reservoir – another Bureau project – were damaged as a result of groundwater percolation on adjacent lands resulting from the Bureau's construction of that reservoir. As a direct result of the Bureau's poor siting and planning in constructing Fontenelle Reservoir, the lands below Fontenelle Reservoir are now useless as farm ground. It appears the Bureau is about to repeat prior mistakes. The two (2) reservoirs – Big Sandy Reservoir and Fontenelle Reservoir – are located in Wyoming's high desert between the Wyoming range and Wind River range, in the same river system and about 35 miles apart, and share similarities in soil composition. Thus, the Arambels are concerned that raising the elevation of the Big Sandy Reservoir and the water table is likely to lead to similar results.	As described in section 3.2.3.4 and Appendix E, best available data show that there would be no change to a minimal increase in groundwater at the private lands between Eden and Big Sandy Reservoirs. Therefore, there would be no or negligible increases in salinity on the private land, regardless of anything at Fontenelle Reservoir.

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11 Cont.	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	DSC and MLC wish to have an expert visit the property and test the soils, water and substrata to verify their concerns. However, the Big Sandy Reservoir area has experienced a wetter than usual spring and two (2) major snowstorms, which made it impossible for their experts to access the property, much less see the terrain. Further, the Bureau has chosen to release its draft EA and hold the comment period at the busiest time in the Arambel's livestock operation and at a time when it is most difficult to for them and their experts to access the land for testing due to weather and ground saturation issues. Mr. Arambel and this office have made repeated efforts to reach the Bureau by phone and email to discuss the issues through the fall and winter of 2018. However, we were largely ignored or dismissed with a brief, non-informative email putting off any discussion by merely stating that the EA was not yet complete. Mr. Arambel was only recently been invited to meet with the Bureau by phone; however, that meeting was unproductive. Had the Bureau told us they were going to ignore our comments regarding salinity and increased groundwater percolation in the fall, we could have had the lands tested then. However, they waited to put the draft EA out for comment at a time when it was not possible to get an expert to the lands in question. DSC and MLC has requested an extension of time to allow their expert to inspect and test the soils, water, and substrata and submit his findings. To date, DSC and MLC have not yet received a decision on the request from the Bureau. When the snows melt and the lands dry out enough to allow access by vehicle, DSC and MLC believe their expert will confirm that raising the reservoir by five (5) feet will cause groundwater percolation on the Arambel's property and an increase in alkalinity/salinity. This should be no surprise in light of the fact the Arambel's properties are sandwiched between Big Sandy Reservoir to the north and west, Eden Reservoir to the south and east, and the feeder canal to the north and west. Similar events have already occurred on the Arambel's and other lands between the two (2) reservoirs. Therefore, the water table is already elevated. However, raising the elevation of Big Sandy Reservoir, the larger of the two reservoirs, by an additional five (5) feet, will raise the water table even higher. The Bureau appears to ignore that an extra 5 feet of water in Big Sandy Reservoir will lead to increased water in the feeder canal and increased water in the Eden Reservoir – thus raising the water table from three (3) sides of the Arambel's property. Further, with respect to the lands located below the reservoir, the Bureau does not claim any sort of easement to affect those lands. Further, the Bureau of Reclamation has made no effort to obtain an easement from DSC or MLC.	These comments were submitted in early spring 2019, and although there was ample opportunity to perform such testing, Peter Arambel indicated no such testing had been conducted as of November 2019 site visit with Reclamation staff (Jared Baxter and Tom Davidowicz). As described in the subsection to section 3.2.4.3 and Appendix E, best available data show there would be no change to a minimal increase in groundwater at the private lands between Eden and Big Sandy Reservoirs. Reclamation does not claim an easement on Arambel's lands below the reservoir and is not authorized to obtain additional easements for the proposed Project.
12	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	3. The Arambel's livestock operations, which include livestock owned by MLC and Pretty Water, LLC, will be adversely affected. Specifically, the deeded land they use for stock water above the reservoir will become inundated, thus creating mud and quicksand. Further, it will kill forage used by the Arambel's livestock operation. The EA and attached Appendices incorrectly states the Arambel's do not use land above the reservoir for grazing. There may be times when the lands are not used if the risk of getting livestock stuck in quicksand is a concern. However, at other times, their lands and the adjacent BLM lands most certainly are used in the Arambel's livestock operations. If the reservoir is enlarged, the quicksand issue must be addressed so the Arambel's livestock have access to stock water without risking the lives of their livestock. This can and should be accomplished by drilling groundwater wells and installing stock tanks as an alternative source of stock water away from the reservoir bank.	The grazing section of the EA (section 3.8) has been updated to reflect the best available data, which show that the lands outside of the river channel are used for grazing operations but would not be inundated. Therefore, there would be no impact to grazing operations. Reclamation has no obligation to provide water to the livestock operator's livestock, regardless of whether the proposed project is implemented or not. Finally, quicksand is the result of more than just inundation. Other environmental factors contribute to creating the conditions necessary for quicksand, which would occur regardless of the proposed project or not. Therefore, the proposed project represents no significant change from the status quo. The EA correctly cites Reclamation's personal communication with Peter Arambel who indicated that the Arambel's use land above the reservoir seasonally for grazing.

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13	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	4. In addition to livestock, wildlife in the area will be adversely affected. The Arambel's land above the reservoir is home to a unique 300-head herd of desert elk. The elk certainly winter in the area, but often stay in the area year-round. The Bureau incorrectly asserts the wildlife affected by the enlargement of the reservoir will simply move to adjacent land. This comment demonstrates a detachment from this area and poor understanding of the challenges to survival that the desert elk and other wildlife and livestock face in Wyoming's high desert, where the winters are severe, the wind is significantly greater than most places, and the only significant trees or other cover for thirty (30) miles in any direction are on the Arambel's private land. Elk choose the Arambel's land, particularly during winter, because it provides the only running water for many miles, protects them from the wind, and provides cover from view of people and predators such as wolves. These elk only started frequenting the Arambel's property after reintroduced wolves entered the forested areas thirty (30) miles to the east of the Big Sandy Reservoir. These elk were chased out of the mountains by the wolves and they have chosen to reside there ever since. The elk cannot move west because there is no protection from wind in the Sublette Flats and there are less reliable sources of drinking water. The elk cannot live on the lands east of the Arambel property because the lands are higher in profile, thus visible to people and predators, and not protected from the wind. Indeed, there are vast amounts of public land adjacent to the Arambel's property that will not be inundated by the proposed enlargement. This desert elk herd only exists because DSC is able to restrict public access to its deeded land, thus preventing poaching, hunting, or otherwise disturbance of the elk. Further, moose now frequent the Arambel's property above the reservoir, where a healthy stand of willows has developed over time. By inundating the land, it will kill the willows and destroy the habitat needed to support moose.	The best available data show that the winter home range of elk in Wyoming is much larger (between 100 and 350 km2, Benkobi et al. The Prairie Naturalist 37(3): September 2005; Anderson et al., Landscape Ecology (2005) 20:257–271) than Arambel's property near Big Sandy Reservoir. Thus, to state that elk only occur on small parcels (relative to an elk's home range) of private land (and when no big game hunt is occurring, negating any hunting concerns) is false. As demonstrated in the wetlands/vegetation sections, seasonal inundation would not affect plant survival, only plant community composition. Therefore, there would be no effect to willows, which are one of the main components in the diet of moose, again indicating that the Project would not measureably affect moose or other species reliant on willow vegetation.
14	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	5. In the Bureau's response to comments, it states the grass on Arambel's land is unpalatable to livestock. The Bureau's assertion is inaccurate. DSC and MLC asserts the forage is palatable to the herds of cattle, sheep, and goats that graze these lands and the plant survey the Bureau used is inaccurate.	This is not true and comes with no citation to the EA. Nowhere in the draft EA does it state forage is unpalatable to livestock.
15	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	6. The Bureau minimizes concerns that wetlands will be lost by the enlargement. The Bureau insists much of the vegetation below the high-water line will not be killed because the water will only remain at that level for a short period of time. While the Bureau's estimate may be correct some years, it will only take one instance when the water level remains at high-water line for a longer period to kill everything below high-water line. The Bureau's assertion is not only incorrect, it flies in the face of the experience in Wyoming at every reservoir around the State. In short, wherever there is a high-water line on a reservoir in Wyoming, there is a bathtub ring around the reservoir where the vegetation has been killed by the inundation of those lands. Further, even if vegetation grows back in some of those areas, it will not be the types of vegetation that are desirable for wetlands or grazing. Therefore, the Bureau's current plan to enlarge the reservoir would not meet the federal government's requirement of "no net loss" to wetlands. Therefore, the proposed enlargement cannot go forward unless the Bureau presents a plan that does not lead to the loss of wetlands.	This is not true based on the existing plant communities identified through a wetland delineation approved by the USACE and the scientific literature cited in the EA (see chapter 7, References). There is no reason to believe a single instance of extended inundation would result in a net loss of wetlands.
16	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	7. One of the most glaring deficiencies in the EA is the assessment of whether it will impact the four (4) fish species. Although a Biological Opinion from the U.S. Fish and Wildlife Service is attached, the Biological Opinion contradicts itself. After the Biological Opinion takes several pages explaining how a loss of water supply in the Green River system will adversely impact the four (4) fish species, it then concludes in the last pages that the opposite is true. The inconsistencies and the contradictions between the analysis and the conclusion cannot be harmonized. Either the analysis of the effect on fish is wrong and there is no adverse impact or the analysis is correct and the four (4) fish species will be adversely affected. In short, these federal agencies cannot have it both ways. It is precisely this type of doublespeak that undermines public confidence in government.	The Biological Opinion provided by the USFWS is not inconsistent. Mitigation was provided through Reclamation's participation in the UCRIP as stated in the BO. In addition, terms and conditions were also requested by USFWS that would need to be implemented by Reclamation.
17	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	8. The Arambels dispute the Bureau's assertion that wave action will not kill vegetation on the east side of the reservoir. This assertion is grossly incorrect. Wave action will clearly kill vegetation on the east side of the reservoir. The Big Sandy Reservoir is located in a high-wind area of the State. In fact, the winds are so high and so consistent, that Big Sandy Reservoir is a destination for wind surfing. Wind surfers can rely on significant wind, with no trees or topography to block the wind. As a result, the wave action on the east side of the reservoir is highly significant and the Bureau cannot ignore this undeniable fact. Evidence of the high winds in this area exists in the form of sand dunes east of the reservoir.	The area surrounding the eastern edge of the reservoir is currently used heavily by DSC and MLC's livestock because the forage there is among the most palatable in the area. This is due to the seasonal reservoir levels that provide water for plant communities. Reclamation maintains the position, based on the best available data, that some vegetation may be replaced by different communities based on inundation data.
18	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	9. During the late summer and fall of 2018, Big Sandy Reservoir experienced a toxic algae bloom. The Arambels were advised to not allow their livestock to drink from the reservoir and were forced to move livestock from the reservoir to other lands. This toxic algae bloom lasted from August to November because of the unseasonably warm fall. The EA contains no analysis of the effects of the proposed enlargement upon the toxic algae bloom problem. The Arambels assert the toxic algae bloom problem will be exacerbated by raising the reservoir. Toxic algae blooms occur where there is stagnant water for an extended period of time. By increasing the amount of water impounded behind the reservoir and inundating new lands that will only be covered by a few feet of water, it will exacerbate the algae bloom problem.	Harmful algal blooms would not increase in frequency or duration. In fact, the opposite would be true due to increased depth of water. Therefore, this claim was not analyzed in the EA.

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19	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	10. The Bureau's analysis of effects on sage grouse within the sage grouse core area involves creative math. The Arambels renew their previous comments related to this issue as none of the Arambel's concerns related to this issue were addressed in the revised EA.	No creative math was involved. Reclamation used GIS and CAD to identify construction areas. Reclamation then used those construction areas and construction timing to follow Wyoming state law by using the sage grouse DDCT, which outlines the general methodology on their website: https://ddct.wygisc.org/Data/Sites/24/files/DDCT_Procedures.pdf. Reclamation received a letter from WGFD confirming conformance with the Wyoming executive orders regarding sage grouse.
20	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	11. In Paragraph 3.3.17 of the EA, the Bureau incorrectly states the Arambels graze sheep on two 40-acre parcels of private land. However, DSC owns ten 40-acre parcels of land that are grazed by cattle, sheep, and goats. The EA appears to minimize the amount of grazing taking place in the area. There may be only one (1) family that grazes the private, State, and Federal grazing permit lands around the reservoir, but this family owns numerous livestock companies and runs a large grazing operation. Their livestock migration route must have forage and drinking water available at the time the livestock need to move through the country. Any break in the grazing pattern disrupts the entire grazing system. However, even more importantly, the Big Sandy Reservoir area is at the center of their livestock operations. This is where they birth their livestock in the spring and early summer, where they stage the livestock summer migration east and north to their summer high-county grazing allotments, where they ship livestock from in the fall, and it is where they stage their migration south to the Colorado line during the winter grazing months. Therefore, any actions that adversely affect their operation effect how they birth livestock in the spring, stage livestock for summer grazing, ship livestock in the fall, and stage for the winter migration south.	In section 3.8, the EA cites a personal communication from Peter Arambel, president of the DSC and MLC. It was received via email on January 15, 2018. In that email he states "We utilize all of the acres except the river channel. We are able to graze the riparian areas once the ground has frozen in the fall. Consequently, using google earth you will be able to see the existing river channel. Only the channel is not grazed." Reclamation has refined its stated assumptions of the grazing section. The area not in the river channel to the northwest of the reservoir would be inundated. Therefore it should not be included in the grazing analysis in the EA as forage/AUMs lost. The EA has been updated to reflect that change.
21	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	12. The Bureau's response to comment no. 17 in the Appendices is incorrect for all of the reasons set forth above. Further, there will be significant impacts to the human environment because the proposed reservoir enlargement will increase the salinity in the soil through groundwater percolation on soils below the reservoir, between the Big Sandy Reservoir and the Eden Reservoir. With respect to the Bureau's response to comment no. 18 in the Appendices, the Bureau has not followed the Cooperative Status Rules for Sublette County Commissioners and Sweetwater County Commissioners.	Reclamation's EA showed no significant impacts, including the section regarding groundwater and its effect on salinity (section 3.2.4.3 in the EA). Neither Sublette or Sweetwater County, entities which maintain authority over the issue, commented on or objected to cooperative status on the EA.
22	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	13. In the Bureau's response to comment no. 19 in the Appendices, the Bureau expresses the opinion that there would be very little to no effect on grazing from the project. Such a conclusion is unsupported for the various reasons set forth above, including, but not limited to, the loss of grazing vegetation, the creation of quicksand, the inundation of DSC's fences, the increase in salinity on its lands due to groundwater percolation, and the creation of sand dunes on the east side of the reservoir caused by wave action denuding the land and depositing silt and sand.	Based on the best available data and the analysis in section 3.8 of the EA, Reclamation asserts there would be a minimal effect on grazing.
23	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	14. With respect to the Bureau's response to comment no. 20 in the Appendices, DSC and MLC assert the 2010 bathymetric survey completed in 2010 is no longer accurate in light of the significant flooding and siltation that occurred during 2016. The flooding that occurred in 2016 was the single largest flooding event since 1983 and increased sedimentation in the reservoir. Therefore, all the Bureau's assumptions based on this outdated survey are inaccurate.	Reclamation reasserts the validity of the 2010 bathymetric survey. Significant flooding has occurred in many years (e.g., 1983) since construction of the dam was completed and the bathymetry survey showed no major difference in reservoir volume at the spillway elevation. Therefore, major siltation due to flooding is not an issue.

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24	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	15. With respect to the Bureau's response to comment no. 22 in the Appendices, the response contains numerous inaccuracies. First, no land trade has yet occurred. Second, as stated above, the existing wetlands would not survive the enlargement and the area below the high-water line, particularly on the east side of the reservoir, would be denuded by wave action. Further, it will only take one (1) instance of high-water levels remaining longer than the Bureau's model suggests for the vegetation to be killed. Third, the Bureau is incorrect in its assertion that DSC, MLC and the Arambel's other companies do not use the land adjacent to the river for grazing, lambing, or calving. In fact, the area north of Big Sandy Reservoir is their historic lambing and calving grounds. The reason for this is because the sheep make a 200-mile swing from the Colorado border up through BLM and Rock Springs Grazing Association lands to the area around Big Sandy Reservoir to calve and lamb so the livestock are close the Wind River Mountains and can be moved into the Forest Service grazing allotments during the summer, which is around July 10th most years. DSC, MLC, and the Arambel's other grazing operations must utilize an area for calving and lambing that has a readily available stock water site and good vegetation. Fourth, simply because the Arambel cannot predict precisely quicksand will be present and how many livestock will be killed by quicksand, does not make the concern any less real. The Arambels have lost hundreds of head of livestock to quicksand in the past. Fifth, although the Bureau insists it will complete a cement-bentonite wall on the dike that goes down to the bedrock, this will not prevent groundwater percolation on the lands on DSC and MLC's lands below the reservoir because the bedrock is porous. The Bureau admitted the bedrock is sandstone during the Farson public meeting in March. Sixth, the Bureau's description of the artesian well location is inaccurate. Finally, the fences are currently in the reservoir basin – its assertion as to fences is incorrect.	First, Reclamation acknowledges no land trade had occurred and never stated that it had. Second, an analysis was completed by a qualified biologist based on scientific literature to determine whether vegetation would be lost (section 3.4 of the EA). The biologist concluded there would be no net loss of vegetation due to inundation. Third, Reclamation has refined its assumptions of the grazing section (section 3.8 of the EA). None of the area not in the river channel to the northwest of the reservoir would be inundated and therefore would not be included in the grazing analyis as forage/AUMs lost. The EA has been updated to reflect that change. Fourth, additional surface acres of inundation does not necessarily equate to increased acreage of quicksand. Many environmental factors contribute to development of quicksand, most of which will occur regardless of whether the spillway is raised. Fifth, section 3.2.4.3 and Appendix E added to the EA demonstrates the effectiveness of the cement-bentonite wall despite bedrock being sandstone. Sixth, no other well locations are known and commentors have provided no locational information to verify and analyze the statement. Finally, the personal communication from Peter Arambel via email on January 15, 2018 specifically called out the fence in Section 7 R 105 T 26. This is outside the reservoir basin between Eden and Big Sandy Reservoirs.
25	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	16. With respect to the Bureau's response to comment no. 23, the Bureau's hydrologic model is inaccurate. It makes assumptions as to how long water will be retained at high-water level. Although it may be accurate in average years, it will only take one (1) instance of high-water levels for an extended period of time to kill the vegetation. Further, the Wyoming wind and the resulting wave action on the east side of the reservoir will assure the vegetation is killed and the wetlands are lost.	The inundation analysis completed in the Level II feasibility study (Wenck 2017) provides reasonable estimates for duration of inundations. It is expected that actual inundation durations would not greatly differ from the maximum length of inundation of 211 days and average inundation of 53 days stated in the study (as stated in section 3.6.1.7 of the EA).
26	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	17. With respect to the Bureau's response to comment no. 24, the Bureau needs to consult again with the Wyoming Game & Fish regarding critical winter habitat for antelope, deer, elk, and sage grouse. Highly-stressed herds of antelope have been in the area all winter, as has the Arambel's resident desert elk herd. Further, the density disturbance calculation tool uses creative math in its selection of numbers to calculate the percentage of disturbance. The Arambels reiterate and restate their comments submitted over 1½ years ago by reference, which the Bureau have largely ignored or minimized.	Reclamation has consulted with WGFD who provided comments on both draft EAs. Reclamation addressed initial comments and effects to crucial habitat in the second draft EA (see section 3.5 on wildlife resources, and section 3.6.1.7 on sage grouse). WGFD provided no additonal comments regarding the named species.
27	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	18. With respect to the Bureau's response to comment no. 25, the Bureau acknowledges water is ponding in low areas south of the dike, thus acknowledging that groundwater has percolated from this reservoir on to lands below the reservoir. Such groundwater percolation is likely to continue, given the porosity of the bedrock, and the increased pressure of additional water five (5) feet above the current high water line.	An additional 5 feet of head equates to only 2.3 additional PSI. Reclamation also added a section to the EA (section 3.2.4.3 and Appendix E) describing the effects on groundwater with the addition of the cement-bentonite wall.
28	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	19. With respect to the Bureau's response to comment no. 27 of the Appendices, fencing around disturbed areas is absolutely necessary to ensure vegetation has a chance to take hold and is not damaged by wildlife, including but not limited to, elk, moose, antelope, deer, wild horses, as well as livestock. The BLM requires oil and gas companies to fence around disturbed sites during revegetation while vegetation is allowed to take hold – why would the Bureau require anything less? Given the poor soil and the arid climate, it is reasonably likely revegetation will not take hold unless done properly and protected. Similar failures in this regard are amply demonstrated by the areas disturbed by EVIDD's pipeline project below the reservoir, which have still not been successfully revegetated a few years after the pipeline was constructed.	As stated in Environmental Commitment 8c in the EA, Reclamation will work with appropriate agencies to reestablish native vegetation suitable for sage grouse and other wildlife.
29	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	20. The Bureau needs to make plans to preserve endangered or threatened fish species at the time the reservoir is drained down for construction. There is nothing in the EA to address this issue.	There are no endangered or threatened fish species that would be affected by the drawdown.
30	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	21. With respect to the Bureau's response to comment no. 33 in the Appendices, DSC and MLC question why the air pollution from machinery and dust produced by the project has not been analyzed and quantified.	These impacts will be addressed and mitigated through environmental commitments (chapter 5 in the EA).

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31	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	22. With respect to the Bureau's response to comment no. 34, DSC questions where the alternative habitat for displaced wildlife is located. As stated previously, given the severe winter winds, cold weather, and need for cover from humans and predators, wildlife have chosen DSC's deeded land. The vast majority of adjacent land does not meet the needs of wintering wildlife.	The vast majority of land adjacent to Big Sandy Reservoir is also high elevation sagebrush-steppe (section 3.6.1.7). Again, WGFD, who manages wildlife in Wyoming, provided no additional comments on wildlife.
32	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	23. With respect to the Bureau's response to comment no. 47, the Bureau's assertion is false for the reasons stated previously.	See section 3.2.4.3 and Appendix E in the EA regarding groundwater and salinity.
33	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	24. With respect to the Bureau's response to comment no. 48, the Bureau's assertion that the reservoir will not cause the Arambel's land to become higher in salinity as a result of groundwater percolation is false for the reasons stated previously. Further, the Bureau is fully aware of the affected Arambel properties. Although Sublette County may not have provided the legal descriptions to the Bureau, the Arambels provided the legal descriptions for the lands that will be affected by groundwater percolation and an increase in salinity.	Reclamation is aware of the Arambel's properties near Big Sandy Reservoir. See section 3.2.4.3 and Appendix E in the EA regarding groundwater and salinity.
34	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	25. With respect to the Bureau's response to comment no. 54, DSC and MLC agree with Mr. Vlcek's comments. The Bureau's response fails to adequately address the issues raised by Mr. Vlcek. Further, there is no Highway 189 in the area. The Bureau fails to address dust control and how existing improvements such as fire pits, benches, and outhouses can possibly be moved to "previously disturbed areas."	Reclamation stated 189 but should have said 191. There are plenty of nearby areas that are previously disturbed as can be viewed by aerial imagery. Dust control is a standard industry practice that would be addressed through specifications to the contractor.
35	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	26. With respect to the Bureau's response to comment no. 60, there are areas devoid of vegetation that have been denuded by wave action. These areas are above the water line for long periods of time during the year after the water recedes, but no vegetation has grown back in these areas because of siltation and wave action. Therefore, the Bureau's response is inaccurate.	As stated in section 3.8, the area surrounding the eastern edge of the reservoir is currently used heavily by DSC and MLC's livestock because the forage there is among the most palatable in the area. This is due to the seasonal reservoir levels that provide water for plant communities. Reclamation maintains the position that, based on best available data, some vegetation may be replaced by different communities based on inundation data.
36	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	27. The Bureau's response to comment no. 67 is incorrect. The Big Sandy River, below the reservoir, has a continuous flow of water year-round. It is not a dry riverbed, nor is it dry or nearly dry for most of the year.	Section 3.2 of the EA has been updated to reflect this.
37	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	28. Further, there is no discussion in the EA related to the following important issues, which must be part of any analysis of the proposed project. The areas not addressed include: a. dust control during construction; b. pre-project water quality data; c. pre-project oil sampling including the Arambel's property below the reservoir and all other wetlands below the dam; d. pre-project fish survey on the river below the dam; e. a biological survey of the river below the dam; f. a discussion of and mapping of the springs and seeps below the reservoir; and g. the effects on the springs and seeps below the reservoir from the construction of the project as well as the post-construction operation of the reservoir.	NEPA does not require an analysis of every issue at hand in an EA, only the issues with potential significant impacts to the environmental (40 CFR 1500.1b). A-Managed through environmental commitments or standard industry practices B-Water quality pre and post was completed based on the best available data (see EA section 3.3) C-There is no reason to expect that Increasing the reservoir elevation would affect subsurface oil D-Reclamation consulted with WGFD to determine species present in the area (see section 3.5) E-Biologists visited the reservoir area as described in the EA (see section 3.5) F-Any springs/seeps fed by the reservoir are subject to reservoir operations G-See response to F above
38	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	29. At the public meeting in Farson in March, the Arambels pointed out that there is an old oxbow of the Big Sandy River full of sediment in Township 27 North, Range 106 West, Section 28, NESW, NWSW and SWSW. The sediment in the old oxbow will be washed into the reservoir if it is enlarged as proposed. The Bureau has failed to consider this in the draft EA.	The center of the oxbow is 5 ft higher than the proposed spillway elevation of 6762.5 ft. It is unlikely it would be washed into the reservoir, especially as the water would not be deep in this area.

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39	Peter Arambel	Dunton Sheep Company & Midland Live Stock Company	30. The Colorado River Compact Commission, the compact States, and the federal agencies have spent years and millions of dollars in an effort to reduce salinity in the Colorado River system. Why would the Bureau approve a project that will increase salinity in the Colorado River basin?	As described in section 3.2.4.3 and Appendix E, there would be no change to a minimal increase in groundwater at the private lands between Eden and Big Sandy Reservoirs, resulting in no or negligible increases in salinity on the private land.
40	Gary Wockner	Save the Colorado	First, the DEA completely fails to identify or analyze the streamflow reduction in the Big Sandy River, downstream of the dam, due to the proposed reservoir enlargement. The "hydrology" section of the DEA (Section 3.3.5) is ridiculously facile and non-technical. The section completely fails to: • Identify the amount, in acre feet or cubic feet per second, of additional water diverted from the Big Sandy River below the proposed expanded dam. • Analyze the impacts of the additional water diversion on the hydrology of the river below the dam. Then, absurdly, in Section 3.7 (page 40), in the "Summary of Environmental Effects" table, the DEA says there is "No Effect" on the hydrology of the Proposed Action. Of course, there has to be an effect on the hydrology of the river, because the reservoir is proposed to be expanded precisely to take more water out of the river. In fact, the DEA identifies that the reservoir is proposed to be expanded – Section 1.2, the "Purpose and Need", states exactly that: "The current storage capacity is 38,600 acre-feet. A 5 foot raise of the spillway crest would allow a total storage capacity of 52,300 acre-feet or an increase of 13,700 acre-feet." And then says, "The additional water stored in the reservoir is needed to firm up the water supply for lands irrigated in the Farson/Eden area through the Eden Project." The streamflow reduction must be identified, and then the environmental impacts of that reduction must be analyzed on the downstream: • Wetlands • Water Quality • Fishery • Aquatic Life • Other Wildlife Resources.	Thank you for your comments. It is true that the Colorado River system is a highly utilized system and potential changes to the system, large or small, warrant thorough investigation to quantify their likely impacts. To more thoroughly evaluate and document the impacts that the proposed Big Sandy enlargement would likely have on reservoir operations and the hydrology of the Big Sandy, Green, and Colorado Rivers downstream of Big Sandy Dam, a model was created and documented in some detail in the Hydrology section of the Final EA and in Appendix A of the Final EA. Here is a brief summary of some of the findings added to the EA. The model routed the historic daily inflows for 30 years (1990–2019) through the proposed enlarged Big Sandy Reservoir prioritizing annual irrigation releases, estimated to be 54,918 acre-feet (2.26 acre-feet per acre, 17,010 acres, 30% conveyance loss) per year (or matching historic releases when higher than 54,918 acre-feet). Comparing the results of the enlarged reservoir model to historic 1990–2019 conditions: • Irrigation releases would likely increase by an average of approximately 2,430 acre-feet per year (over the 30-year model run, releases increased by a total 73,047 acre-feet, or 4.8%, from 1,536,664 acre-feet historically to 1,609,711 acre-feet in the model, or an average annual increase of 2,430 acre-feet). • Big Sandy spillway discharges would likely decrease by an average of approximately 2,910 acre-feet per year (over the 30 years modeled, spillway discharge decreased by 87,285 acre-feet, or 45%, from 193,917 acre-feet historically to 106,632 acre-feet in the model, or an average annual decrease of 2,910 acre-feet). Over the 9 years of Big Sandy streamflow data that overlap with the model (1990–1998), the model indicated an approximately 7% decrease in total flow volume (from 261,750 historic to 242,180 modeled acre-feet). Over the 30 years from 1990 to 2019, the model indicates that the Big Sandy enlargement would likely decrease Green River total streamflow at Green River, Wyoming, by less than one-third of one percent (0.3%) and Green River peak flows by less than one percent.

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41	Gary Wockner	Save the Colorado	Second, because the DEA completely fails to identify or analyze the reductions in streamflow in the river, and the total acre-feet reduced, the DEA completely fails to identify and analyze any cumulative impacts that may occur on the flow in the Green River downstream and the Colorado River further downstream. As the Bureau of Reclamation is well aware, the entire Colorado River system – including its tributaries in Wyoming which includes the Big Sandy River – is extremely stressed with threats of shortages, compact calls, and other types of "contingency plans" to address the likely and looming water shortages. The Bureau itself has spent considerable resources studying the "water supply and demand" problem on the Colorado River. The amount of new water diverted from the proposed expansion of Big Sandy Reservoir must be identified, and then the cumulative impact of that new diversion must by analyzed in the face of the threats to water supply in the Colorado River basin. Further, climate change scientists predict that the amount of water in the Colorado River system is going to decrease even further due to the impacts of climate change. Any new diversion of water from the entire system must analyze its cumulative impact coupled with climate change reductions.	Thank you for your comments. It is true that the Colorado River system is a highly utilized system and potential changes to the system, large or small, warrant thorough investigation to quantify their likely impacts. To more thoroughly evaluate and document the impacts that the proposed Big Sandy enlargement would likely have on reservoir operations and the hydrology of the Big Sandy, Green, and Colorado Rivers downstream of Big Sandy Dam, a model was created and documented in some detail in the Hydrology section of the Final EA and in Appendix A of the Final EA. Here is a brief summary of some of the findings added to the EA. The model routed the historic daily inflows for 30 years (1990–2019) through the proposed enlarged Big Sandy Reservoir prioritizing annual irrigation releases, estimated to be 54,918 acre-feet (2.26 acre-feet per acre, 17,010 acres, 30% conveyance loss) per year (or matching historic releases when higher than 54,918 acre-feet). Comparing the results of the enlarged reservoir model to historic 1990–2019 conditions: • Irrigation releases would likely increase by an average of approximately 2,430 acre-feet per year (over the 30-year model run, releases increased by a total 73,047 acre-feet, or 4.8%, from 1,536,664 acre-feet historically to 1,609,711 acre-feet in the model, or an average annual increase of 2,430 acre-feet). • Big Sandy spillway discharges would likely decrease by an average of approximately 2,910 acre-feet per year (over the 30 years modeled, spillway discharge decreased by 87,285 acre-feet, or 45%, from 193,917 acre-feet historically to 106,632 acre-feet in the model, or an average annual decrease of 2,910 acre-feet). Over the 9 years of Big Sandy streamflow data that overlap with the model (1990–1998), the model indicated an approximately 7% decrease in total flow volume (from 261,750 historic to 242,180 modeled acre-feet). Over the 30 years from 1990 to 2019, the model indicates that the Big Sandy enlargement would likely decrease Green River total streamflow at Green River, Wyoming, by less than one-third of one percent (0.3%) and Green River peak flows by less than one percent.
42	Gary Wockner	Save the Colorado	In closing, the DEA for the expansion of Big Sandy Reservoir is deficient. In order to comply with the National Environmental Policy Act, the Final Environmental Assessment must correct these deficiencies by identifying and analyzing all impacts. In addition, if the impacts are not adequately analyzed in the EA, the Clean Water Act may also be violated when the Bureau chooses the Least Environmentally Damaging Alternative.	The analysis in the EA complies with CEQ's (40 CFR 1500-1508) and DOI's (43 CFR 46) NEPA regulations. NEPA does not require an agency to select the environmentally preferable alternative, only that a Record of Decision following an Environmental Impact Statement identify which alternative is environmentally preferable (40 CFR 1502.2(b), 43 CFR 46.450).
43	Wally Johnson	Sweetwater County Board of County	General Comment: Sweetwater County strongly supports the Big Sandy Enlargement Project and recognizes its importance as a water supply insurance policy provided by storing water during wet years for irrigation support during dry years.	Thank you for your comment.
44	Wally Johnson	Sweetwater County Board of County	Permits and Authorizations: Sweetwater County appreciates the BOR including permitting requirements of Sweetwater County in Table 1-1 Perm its and Authorizations.	Thank you for your comment.
45	Wally Johnson	Sweetwater County Board of County	Wildlife: Sweetwater County encourages the BOR to carefully coordinate wildlife concerns with the Wyoming Game and Fish Department. Some concerns that may need special attention include Wyoming Species of Greatest Conservation Need, Sage Grouse and riparian and non-riparian habitat areas potentially altered by the project.	Thank you for your comment.
46	Wally Johnson	Sweetwater County Board of County Commissioners	Recreation: Sweetwater County appreciates the actions to preserve or enhance recreational facilities affected by raising the reservoir level 5 feet. As we discussed during the meeting in Farson, the Big Sandy Reservoir and its related recreational facilities that provide important opportunities for Sweetwater and Sublette Counties and all of southwest Wyoming. To the extent feasible, Sweetwater County encourages the BOR to upgrade the recreational facilities as part of this project. We have listed some of our ideas for improvement in the attached letter to the BOR dated June 15, 2018. The county understands that all recreational facilities have associated maintenance costs, and Sweetwater County encourages the BOR to work together with the BLM to potentially create a joint maintenance agreement that could help share the costs of maintenance.	Thank you for your comment. Reclamation would replace certain facilities/amenities if the Project is implemented. However, upgrades to said facilities is not authorized for the Project. Reclamation encourages ddditional discussions between Sweetwater County and Reclamation recreation staff regarding other avenues for upgrading and/or improving recreational opportunities at Big Sandy Reservoir.

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47	Wally Johnson	Sweetwater County Board of County Commissioners	Socio-economics: Sweetwater County recognizes that this project will help secure the productivity and economy of the farming and ranching operations within the Eden Valley especially during periods of drought. In addition, the county recognizes that the planned improvement of reservoir recreational facilities will enhance the growing recreational economy of the region.	Thank you for your comment.
48	Wally Johnson	Sweetwater County Board of	Transportation: Since the construction of the project may impact several Sweetwater County roads, the county encourages the BOR to closely coordinate all construction related transportation with Gene Legerski, Sweetwater County Public Works Director (307) 872-3921.	Thank you for your comment.
49	Wally Johnson	Sweetwater County Board of County Commissioners	Cultural and Historic Resources: Sweetwater County has participated in the BOR Section 106 review of the Big Sandy enlargement project and has approved a draft of the final cultural and historic resource plan. The county encourages the BOR to work closely with both the Sweetwater County Museum and the Eden Valley Improvement District regarding the production and maintenance of historical displays and materials resulting from this project.	Thank you for your comment.