RECLAMATION

Managing Water in the West

Big Sandy Enlargement Project Draft Environmental Assessment

PRO-EA-16-012

Upper Colorado Region
Provo Area Office
Provo, Utah

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

March 2019

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Chapter 1 Purpose of and Need for Proposed Action

1.1 Introduction

This Environmental Assessment (EA) was prepared to examine the potential environmental impacts of the Big Sandy Enlargement Project (Project) in Sweetwater and Sublette counties, Wyoming. The Project, originally proposed by the Wyoming Water Development Commission (WWDC), is sponsored by the Bureau of Reclamation. If the Project is approved, Reclamation would construct, modify, 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. 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 (Figure A-1). 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 constructed 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.

The 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.

Reclamation is evaluating the potential to increase the storage of Big Sandy Reservoir. Reclamation proposes to increase water storage by raising the spillway crest by 5 feet (Figure A-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, 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 Purpose of and Need for Proposed Action

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 additional storage would allow for more carryover water from wet years into future (drier) years so full water deliveries can be made later in the summer. 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.

The Federal Action being considered is whether or not Reclamation should enlarge Big Sandy Reservoir by modifying the Big Sandy spillway crest and outlet works, Big Sandy Dike, and the Big Sandy Feeder Canal.

1.3 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.

1.3.1 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.

1.3.2 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 will be conducted from March 12, 2019 to April 15, 2019. A second public meeting will be held on March 26, 2019, from 6-7:30 p.m. 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.

1.3.3 Wyoming Game and Fish Department (WGFD)

Reclamation contacted Wyoming Game and Fish Department (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.

1.3.4 U.S. Army Corps of Engineers (USACE)

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.

1.3.5 U.S. Fish and Wildlife Service (USFWS)

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 C).

1.3.6 Wyoming State Historic Preservation Office (SHPO)

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 H). A Memorandum of Agreement (MOA) will be 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 will be signed by Reclamation, SHPO, and interested parties.

1.3.7 Wyoming State Geological Survey (WSGS)

On September 12, 2017, Dr. Zachary Nelson requested information from WSGS and the University of Wyoming about potential paleontological resources in the Project area. The 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 Area of Potential Effect (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 3.3.4 for additional information.

1.3.8 Native American Consultation

Reclamation is conducting 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 consultation is being conducted in compliance 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.

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
Permits and Authorizations

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 construction.
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.
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.

1.5 Related Projects and Documents

1.5.1 Rock Springs Resource Management Plan (RMP) Revision

The Bureau of Land Management (BLM) Rock Springs Field Office has initiated a planning effort to revise the Green River RMP with an associated Environmental Impact Statement (EIS) and comprehensive travel and transportation management plan (CTTMP). The Rock Springs planning area includes 3.6 million acres of surface land and 3.5 million acres of mineral estate, administered by the BLM in portions of Lincoln, Sweetwater, Uinta, Sublette, and Fremont counties in southwestern Wyoming.

1.5.2 State of Wyoming Executive Order (EO) 2015-4, Greater Sage-Grouse Core Area Protection

Governor Matt Mead issued EO 2015-4, which states 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.

1.5.3 Colorado River Salinity Control Program Final EIS for Big Sandy River Unit Sublette and Sweetwater Counties, Wyoming

An EIS was prepared by the Natural Resource Conservation Service (NRCS; formerly the Soil Conservation Service) in 1987 to assess the impacts of a voluntary salinity control program in the Eden-Farson area, including areas above and below Big Sandy Reservoir.

1.5.4 Eden Valley Irrigation and Drainage District (EVIDD) Piping Projects

The EVIDD has piped several canals and laterals in the Eden Project, including the Eden Canal; E-5, E-6, E-7, E-8, E-13, M-1, and M-1B laterals. Piping laterals F-1, F-2, and F-5 are projects currently under environmental review.

1.5.5 Riley Ridge to Natrona Project

The BLM High Desert District prepared a Draft 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 (H_2S) 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 passes by the northeast corner of Big Sandy Reservoir, staying at least 1 mile from the proposed Big Sandy Reservoir Enlargement.

1.5.6 Big Sandy Federal No. 2-34

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 are located approximately 16.5 miles north of the city of Farson, Wyoming.

1.6 Scope of Analysis

The purpose of this EA is to determine whether or not Reclamation should implement the proposed dam modifications to increase storage and, therefore, develop a more secure and reliable water supply. That determination includes consideration of whether there would be significant impacts to the environment, which includes the human environment, as a result of the No Action or Proposed Action Alternatives. In order to implement the Proposed Action, this EA must be completed and a FONSI issued. Analysis in the EA includes temporary impacts from construction activities and long-term impacts as a result of modifying the dam and appurtenant features.

Chapter 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, the reservoir would not be enlarged. It would continue to be operated at the existing storage capacity of 38,600 acre-feet.

2.3 Proposed Action

The Proposed Action is the preferred alternative. It consists of the following modifications.

2.3.1 A 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.

2.3.3 A 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) Cutoff Wall Through the Dike Embankment and Foundation

A CB seepage cutoff wall would be constructed 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 riprap is required or the 8:1 slope has 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 can 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.

This proposal replaces the Big Sandy Feeder Canal Headworks in its existing location and replaces the six drop structures in the canal. 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 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 same locations.

2.3.7 Construction Procedures

2.3.7.1 Construction Sequence

Construction would likely occur in the following sequence:

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

2.3.7.2 Clear and Grade

The areas needed for construction 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 Cutoff 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 cutoff wall spoils or fill from the new borrow pit.

2.3.7.6 Construct 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 Construct 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 Construct 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 2020. 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 construction of the spillway crest.

2.3.7.10 Construct 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 Construction

All construction 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 construction. Other disturbed areas would be planted and restored with native vegetation.

2.3.7.12 Construction Materials Requirements

Table 2-1 lists major construction 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 Major Construction Material Requirements
For the Proposed Action

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 construction of the Project 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 Construction Timeline

The current proposed timeline for the project would have construction begin in 2020. It is anticipated construction 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 did not meet the purpose of or need for the Project.

2.4.1 Construct a Seepage Berm Downstream of the Dike

A weighted seepage berm would be constructed 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 reconstruction of 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 wall through the dike). This alternative, while viable, did not reduce the annualized failure probability as well as the CB cutoff 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 cutoff 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.

2.5 Minimization Measures Incorporated into the Proposed Action

The minimization measures, along with other measures listed under each resource in Chapter 3 and Chapter 4 have been incorporated into the Proposed Action to lessen the potential adverse effects.

- All land surface disturbances would be confined to areas previously disturbed, ditch right-of-way, existing roads, agricultural farmland, and small staging areas adjacent to the Project area, to the extent possible.

- Stockpiling of materials would be limited to those areas approved and cleared in advance.

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

- The Contractor would be responsible during construction for safety measures, noise control, dust control, and air, and water pollution.

Chapter 3 Affected Environment and Environmental Consequences

3.1 Introduction

This chapter describes the environment that could be affected by the Proposed Action. These impacts are discussed under the following resource issues: geology and soils resources; visual resources; cultural resources; paleontological resources; Wilderness, and Wild and Scenic Rivers; hydrology; water quality; system operations; health, safety, air quality, and noise; floodplains; prime and unique farmlands; wetlands and riparian resources; wildlife resources; threatened, endangered, and sensitive species; recreation; socioeconomics; access and transportation; water rights; grazing; Indian Trust Assets (ITAs); and environmental justice. The present condition or characteristics of each resource are discussed first, followed by a discussion of the predicted impacts caused by the Proposed Action. The environmental effects are summarized in Section 3.5.

3.2 Resources Considered and Eliminated from Further 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
Resources Eliminated From Analysis

Resource	Rationale for Elimination from Further Analysis
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.

3.3 Affected Environment and Environmental Consequences

This chapter describes the affected environment (baseline conditions) and environmental consequences (impacts as a result of the Proposed Action) on the quality of the human environment that could be impacted by construction and operation of the Proposed Action, as described in Chapter 2.

3.3.1 Geology and Soils Resources

The geology at Big Sandy Dam and Reservoir consists of the Laney Shale Member of the Tertiary Green River Formation. Bedrock comprising the dam and dike foundations are horizontally bedded (dipping 1 degree NE). The Laney Shale Member consists of sandstone, siltstone and shale with occasional thin, platy layers of limestone. The unit also consists of interbedded claystone and reworked tuff zones. The depositional environment transitions from lakebeds to shoreline to meandering streams. The Laney Shale Member is mostly fine to medium grained, poorly to moderately cemented, soft to moderately hard, slightly porous, friable sandstone below elevation 6,735 feet. Generally the Laney Shale Member is poorly cemented, slightly fissile, thinly bedded, friable siltstone that predominates above elevation 6,735 feet.

Soils form a thin veneer over the weak bedrock materials described above, and potentially range in thickness from roughly 1 to 4-feet-thick over the bedrock. The soils consist of Silty and Sandy Clays, Clayey Sand, and Silty Sand with varying amounts of fine to medium gravel. Soils covering the bedrock material encompass the reservoir area.

3.3.1.1 No Action

Under the No Action, the Project would not be built. There would have no effect on geology and soils.

3.3.1.2 Proposed Action

Temporary surface soil impacts during construction would be expected. Airborne particulate matter (dust) is anticipated while mining and processing neighboring surface soils for construction borrow materials. Potential soil erosion impacts after grubbing due to water and wind erosion are possible during construction. Construction erosion and sediment controls would serve to minimize these impacts.

3.3.2 Visual Resources

The visual resource of the area would be of a natural wildland setting with very little development and dirt access roads from the highway to the reservoir.

Most of the visual aspect of the reservoir consists of sagebrush with a few pockets of medium to large vegetation. Scarred beaches from wave action are is also visible throughout times of the year.

3.3.2.1 No Action
The No Action would have no effect on visual resources.

3.3.2.2 Proposed Action
Visual resources would be minimally impacted due to the Proposed Action. Inundation by the expanded reservoir would be seasonal and temporary in nature and 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 vegetation. In the event that the cottonwoods (*Populus spp*.) along the eastern and western border of the reservoir are partially inundated for too long, the visual environment may change temporarily because the larger vegetation may die. However, the vegetation is likely to be replaced with similar habitat at the edges of the higher water level.

3.3.3 Cultural Resources
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. Historic properties are defined 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 this proposed action includes the area that could be physically affected by any of the proposed project alternatives (the maximum limit of disturbance). The indirect APE includes changes in the visual setting of historic properties due to the project. This is often assessed through a view shed analysis.

A Class I literature review, a Class III cultural resource inventory, a shovel-testing program for subsurface deposits, and a visual analysis for affected sites were completed by Reclamation archaeologist, Dr. Zachary Nelson. 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. Many of the

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 due to wave action. Prehistoric peoples were attracted to the basin due to the presence of water, fish, and game; but also due to 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 4 miles south of the reservoir via the Oregon-California-Mormon Pioneer-Pony Express trail 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. Due to 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 brought water to the Eden-Farson irrigation network, but it did not have water reserves for drought years. Consequently, Reclamation was empowered by Congress to "reclaim" the land for agricultural purposes. 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 turned over to the EVIDD to manage.

Against this background of prehistoric and historic use, the proposed project would periodically inundate areas that were not previously inundated and aging infrastructure of the Eden Project would be updated. The Class I and Class III inventories identified the prehistoric and historic sites in Table 3-2.

Historic and Prehistoric Sites From the Cultural Report

ID	Description	Evaluation	Project Effect
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	Long-term erosion
48SU6	Open Camp (=48SU5327)	Not Eligible	Long-term erosion
48SU7	Open Camp	Not Eligible	None

ID	Description	Evaluation	Project Effect
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 due to the presence of intact subterranean features which can potentially provide important information about the past. Because the project may cause additional erosion along the side of the site, Reclamation proposes to monitor these sites for 10 years at the end of the irrigation season to see if the sites are being damaged. In addition, Reclamation will monitor other nearby sites including 48SU5, 48SU6, 48SU7 and 48SU7670 for a period of 10 years. As no features are known to exist along the reservoir side of the sites, the monitoring would be precautionary. Site 48SU2 may be impacted by erosion caused by the higher water level, accordingly, Reclamation will develop and implement a treatment plan for this site.

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, in that 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 inlet, and drop structures, and the north section of the canal would continue to deteriorate due to disuse, which might be exasperated by the increased water in the reservoir. Consequently, Reclamation determines that there would be an overall adverse effect to the canal. Adverse effects to the Eden Canal are already included in a mitigation document that Reclamation is implementing.

The reconfiguration of the Big Sandy spillway, involving a 5 foot raise, is a noticeable change in the visual aspects of the historic dam. Consequently, Reclamation determines that there is an adverse effect to Site 48SU7646/48SW19744 due to the project's implementation.

The project may have indirect effects on eligible historic linear sites by impacting the sites' integrity of setting through the introduction of modern elements. In order to assess this aspect of the project, individual linear sites were analyzed for possible disruption. 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 1 mile and more from the closest mapped location of the sites. Because the proposed effect is to add water to the reservoir, the difference in view is slight. This holds true for even the closest site, Site 48SW1841. Reclamation finds that the project would have no adverse effect on the Site 48SW1841 and no effect on Site 48SU1408 (New Fork Wagon Road), 48SU3508 (Historic Automobile Road), 48SW827 (Emigrant Trail), and the "Abandoned Rock Springs – Pinedale Highway".

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 H). An MOA will be developed to detail the steps to mitigate the adverse effect to Big Sandy Dam (Site 48SU7646/48SW19744) and 48SU2. The MOA will be signed by Reclamation, SHPO, and interested parties. Those findings will be included in the Final Environmental Assessment document.

3.3.3.1 No Action

Under the No Action Alternative, there would be no adverse effects to cultural resources. Existing conditions would continue.

3.3.3.2 Proposed Action

The proposed action would cause an alteration to the characteristics of the eligible sites and would, therefore, have an effect on the historic property according to 36 CFR 800.16(i). Pursuant to 36 CFR 800.5, the criteria of adverse effect were applied to the eligible sites. An adverse effect is defined as an effect that could diminish the integrity of a historic property's location, design, setting, materials, workmanship, feeling, or association. The proposed action would diminish the integrity of the Big Sandy Dam, the Eden Canal, Site 48SU2, and would have an adverse effect to the historic properties.

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.

Pursuant to 36 CFR 800.6(c), an MOA will be developed to resolve the adverse effects to the Big Sandy Dam. Tribes and other interested parties will be invited asked to participate in the creation of the MOA.

3.3.4 Paleontological Resources

The APE is located within the Green River Formation which is a sedimentary geologic unit known to have a very high potential for paleontological material. Consequently, 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. 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.

3.3.4.1 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 construction activities at the dike or Dam, and there would be no inundation of new areas. Existing conditions would continue.

3.3.4.2 Proposed Action

Under the Proposed Action Alternative, there would be ground disturbing activities which have low potential to disturb subsurface fossil material. No mitigation measures were recommended by Paleo Solutions, Inc. for the non-significant localities. In addition, no mitigation measures were recommended for the significant fossil locality for the following reasons: (1) The locality is sufficiently distant from the APE, including the proposed borrow area where ground disturbing activities may occur, (2) fossils at the locality have been collected, and (3) the collected fossils have been sent to the Utah Field House Museum of Natural History to be curated with Reclamation's other collections. Therefore, unless fossils are discovered as a result of ground disturbing activities, the Proposed Action would have no effect on paleontological resources.

3.3.5 Hydrology

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 1989 to 2010 averaged 4800 acre-feet of spill per year. Outside of spring runoff, releases to the river are not typically made as there is no minimum flow requirement.

3.3.5.1 No Action

The No Action Alternative would have no effect on hydrology. The conditions in the basin above, and the river downstream of Big Sandy Reservoir would remain as they are.

3.3.5.2 Proposed Action

Under the Proposed Action Alternative, the basin and hydrology upstream of the reservoir would remain in its essentially unaltered, natural condition. The Proposed Action has the potential to have a minor impact on the already-controlled hydrology immediately downstream of the reservoir. If dam and reservoir operations are altered as planned—to provide additional carryover water from wet to dry years and provide additional irrigation water to extend the irrigation season—the Big Sandy River downstream of the reservoir would see fewer spring-time spillway flows as a result of the reservoir capturing more of the spring runoff and more summer-time irrigation return flows as a result of increased irrigation deliveries. It is anticipated that under the Proposed Action damaging flood flows downstream of the reservoir would be mitigated somewhat due to the increased storage capacity. Spills from the reservoir are likely to decrease in frequency from 10 in every 22 years to roughly 3 in every 20 years and from an annual average volume of 4800 acre-feet to roughly 2000 acre-feet. Summer-time return flows to the river would increase in relation to the volume of additional water used for irrigation.

3.3.6 Water Quality

A model-based analysis was performed to assess the potential effects of the Proposed Action on water quality. The analysis compared water quality before and after enlargement of the reservoir. Given that the data availability does not reach the level required by a detailed model, a simpler model approach was more appropriate.

The model assumed the following:

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) is 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 is 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.

3.3.6.1 No Action

The No Action would have no effect on water quality. The Reservoir would not be enlarged, nor would any ground disturbance occur under the No Action alternative.

3.3.6.2 Proposed Action

Model Results

Water Balance

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

	Precipitation (AF)		Inflow (AF)		ET (AF)		Outflow (AF)	
Year	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 were due to the increase in the surface area of the reservoir after enlargement. Inflow from the river should not be affected and outflow was assumed to be constant.

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 3-4.

Table 3-4
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-enlargement TSS concentrations are higher than predicted post-enlargement TSS concentrations. In short, the enlargement would improve TSS water quality. On average, the in-reservoir TSS concentrations were predicted to be reduced by approximately 25 percent after the enlargement.

The adjusted TDS concentration ratio, R, was calculated for the same years (see Table 3-5).

Table 3-5
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-enlargement TDS concentrations were predicted to be higher than the post-enlargement 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 the enlargement.

Water Quality Protection during Construction Activities

During construction, impacts to water quality would be mitigated by following the environmental commitments in Section 4.1, items 3 and 4.

Based on the model-based analysis and the environmental commitments, the Proposed Action would have minor, temporary adverse effects on water quality. However, enlarging the reservoir would have a net benefit, reducing the TDS and TSS concentrations in the Reservoir by a predicted 24.8 percent and 8.5 percent, respectively.

3.3.7 System Operations

Big Sandy Dam and Reservoir, as part of the Eden Project, provides reliable irrigation during the dry seasons for the Eden Valley Irrigation and Drainage District.

The 38,600 acre-feet live capacity reservoir collects inflows from the roughly 400 square-mile drainage basin upstream of the dam. Inflows to the reservoir are primarily a result of spring snowmelt runoff that typically occurs from late April to late July. Snowmelt runoff inflows in excess of the reservoir capacity are bypassed to Eden Reservoir (13,164 acre-feet live capacity) by means of the Big Sandy Feeder Canal or spilled to the Big Sandy River below Big Sandy Dam. The volume of spill varies from year to year based on reservoir carryover storage from previous years and the volume of snowmelt runoff. 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.

Irrigation water deliveries are typically made from Big Sandy Reservoir from May to September. The Means Canal, with a capacity of 600 cfs, conveys water from Big Sandy Reservoir to the Westside Lateral, which serves lands on the west side of the Big Sandy River, and to the Eden Canal, which serves lands east of the River. Little Sandy Diversion Dam diverts water into the Little Sandy Canal which also supplies water to the Eden Canal. Water is diverted from Big Sandy Reservoir to the Eden Reservoir and from the Little Sandy Canal into the Eden Reservoir. Water is drawn from Eden Reservoir to serve the Eden Canal and Farson Lateral.

3.3.7.1 No Action

The No Action Alternative would have no effect on system operations.

3.3.7.2 Proposed Action

The Proposed Action Alternative has the potential to have a minor impact on the system operations. If dam and reservoir operations are altered as planned—to provide additional carryover water from wet to dry years and provide additional irrigation water to extend the irrigation season—the Big Sandy River downstream of the reservoir would see fewer spring-time spillway flows as a result of the reservoir capturing more of the spring runoff and more summer-time irrigation return flows as a result of increased irrigation deliveries. 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 percent lower than the historic mean. The water delivery systems could see higher flows and/or a longer duration of use should more irrigation water be delivered as a result of enlarging the reservoir. The additional capacity of the reservoir under the Proposed Action would provide improved carryover conditions resulting in a more reliable water supply during dry years. The modifications to the Big Sandy Feeder Canal and headworks under the Proposed Action would result in greater flexibility and efficiency in delivering and storing excess water from the Big Sandy River in Eden Reservoir.

3.3.8 Health, Safety, Air Quality, and Noise

The Project area is located in Sweetwater and Sublette counties, Wyoming in a rural, primarily agricultural setting. There are no known public health concerns in

the Project area. Safety concerns in the area are generally related to traffic along Wyoming State Highway 28 which is located in the Project area. Safety concerns include those related to vehicles traveling along the highway. Public safety resources in the general vicinity of the Project area include the Eden Farson Fire Control District Training Unit which is located on US Highway 191, approximately 11 miles south of the Project area. Current air quality in the Project area is good, typical of rural and agricultural areas. The ambient noise within the Project area includes a combination of natural sounds (wind, bird and insect calls) and mechanical sounds (cars, trucks, tractors, etc.). In general, noise levels are consistent with rural communities, likely averaging from 42 to 65 decibels based on their proximity to the state highway that runs through the Project area.

3.3.8.1 No Action

Existing public health, air quality and noise conditions in the Project area would be maintained. Therefore, the No Action Alternative would have no effect on public health, air quality or noise.

3.3.8.2 Proposed Action

The Proposed Action would have no impacts on public health and safety in the Project area. Emergency dispatch service including the local fire, police and ranger stations would not be impacted by the Proposed Action. Any temporary road or access closure would be coordinated with local law enforcement and emergency services. In addition, a Traffic Control Plan, including appropriate signage restricting access to the construction area, would be developed in coordination with Sublette and Sweetwater County officials. The Proposed Action is anticipated to have short-term noise and air quality impacts during active construction. Noise levels would be elevated during construction, but no new noise would be generated from the Proposed Action after construction. Air quality impacts from land disturbance activities such as excavation and compaction of soils along the Project alignment would be short term. Noise and air quality impacts would be mitigated through the implementation of the Best Management Practices (BMPs) throughout construction. The BMPs would include a dust mitigation plan and proper maintenance of construction equipment.

Reclamation, or a designated contractor, would develop and implement a Spill Prevention Containment and Countermeasures Plan (SPCCP) prior to the onset of construction. The SPCCP would include measures to be implemented onsite that would keep construction and hazardous materials out of waterways and drainages. The SPCCP would include provisions for daily checks for leaks; hand-removal of external oil, grease, and mud; and the use of spill containment booms for refueling. In addition, construction equipment refueling and regular maintenance would be restricted to designated staging areas located away from streams and sensitive habitats.

Reclamation expects that adherence to BMPs that dictate the use, containment, and cleanup of contaminants would minimize the risk of introducing such

products to the waterway because the prevention and contingency measures would require frequent equipment checks to prevent leaks, would keep stockpiled materials away from the water, and would require that absorbent booms are kept on-site to prevent petroleum products from entering the river in the event of a spill or leak.

3.3.9 Floodplains

Executive Order 11988: Floodplain Management (EO 11988) (May 24, 1977) established federal policy for each agency to take action to reduce the risk of flood loss. Executive Order 11988 defines a floodplain as lowland and relatively flat areas adjoining inland and coastal waters including flood prone areas of offshore islands, including at a minimum, that area subject to a one percent or greater chance of flooding in any given year. Encroachment onto floodplains can reduce the flood-carrying capacity of the floodplain and extend the flooding hazard beyond the encroachment area.

According to the Flood Insurance Rate Map, the majority of the Project area is located in Flood Zone A. Flood Zone A corresponds to areas that are subject to inundation by the one percent annual chance-flood or 100-year flood event.

3.3.9.1 No Action

Under the No Action Alternative, the Project would not be built and the existing conditions of the Project area would be maintained. There would be no impact to the floodplain or the potential for flooding.

3.3.9.2 Proposed Action

The majority of the Proposed Action would take place inside of the active floodplain. The removal and replacement of the Big Sandy Feeder Canal drop structures would take place outside of the active floodplain. The proposed work on the existing spillway crest, toe drain, outlet works, and dike embankment would allow an additional 12,900 acre-feet of water, when available, to be stored in the reservoir. This storage capacity increase has the potential to expand the 100-year floodplain within the Project area.

3.3.10 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 due to 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. Based on conversations with the USACE (Personal Comm – Tom Johnson), sample locations that relied primarily on aerial imagery as the hydrologic indicator were determined to not meet the hydrology standards. 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*).

3.3.10.1 No Action

The No Action would have no negative effect on wetlands and riparian vegetation. Hydrologic flow patterns in Big Sandy River and annual reservoir storage fluctuations would continue.

3.3.10.2 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 and 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.

The USACE has determined that maintenance activities that do not result in expansion of the Big Sandy Dam embankment 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 as defined in Section 404(f)(B) and codified in regulations at 33 CFR 323.4(a)(2). Fill below the OWHM at the spillway and canal headworks would be covered under a permit from the USACE.

3.3.11 Wildlife Resources

Wildlife resources within the general area of the Project include mammals, birds, reptiles and amphibians, and fish.

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.

Birds

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*).

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 3-6). 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 3-7). Cutthroat trout were last stocked in 2004.

Table 3-6
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 3-7
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

3.3.11.1 No Action

The No Action would have no negative effects on wildlife. Free water and habitat conditions would remain the same.

3.3.11.2 Proposed Action

General Effects

Under the Proposed Action there would be no long-term detrimental effects to wildlife. However, in the short term, especially during and immediately after construction, animals would have to find unfamiliar habitat wherein they are more susceptible to exposure to the elements and predation. Construction activity would cause 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 may affect nesting habitat, and thermal cover for a variety of species. However, this is expected to be low impact due to the gradual habitat transition that would occur due to enlargement of the reservoir. Vegetation along the perimeter of the reservoir may increase with the enlargement of the reservoir. During construction, water availability is unlikely to change from typical conditions below the dam and on the north side of the reservoir.

Big Game

Approximately 266 of the 500 acres that would be inundated would be considered upland habitat, primarily dominated by big sagebrush. Depending on length and depth of the inundation, this habitat designated as crucial for elk and pronghorn may be lost (see Section 3.3.12.2.4 for full discussion of upland habitat lost). The amount lost due to reservoir enlargement would be negligible compared to the thousands of acres of contiguous habitat available to elk and pronghorn in the area.

Raptors

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.

The Geographic Information System (GIS) analysis indicated that the golden eagle nests were greater than 0.5 miles away from the nearest construction, 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).

Based on GIS analysis and using the same raptor guidelines cited above, construction on the dam would occur within the distance buffer for great horned owls (0.125 miles) and the seasonal buffer (December 1 to September 30). However, the intent of construction activities on the dam would not be to harm, harass, or kill any raptors potentially occupying the nest during construction.

Based on the Solicitor's opinion from the U.S. Department of Interior (USDOI 2017) and guidance from USFWS (USFWS 2018b), this would not be considered "take" under the Migratory Bird Treaty Act of 1918. Therefore, there would be minimal impacts to raptors in the Project area.

Fish

Construction effects on fishes in the reservoir would be minimal. The construction component 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 is about 4,000 acre-feet, leaving a sufficient amount of water for fish to over-winter. Implementing the Proposed Action would have no measurable effect on the fishery.

3.3.12 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 USFWS'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, (Appendix B) but was still included in this analysis. The WGFD'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.

3.3.12.1 No Action

The No Action would have no effect on Threatened, Endangered, and Sensitive Species.

3.3.12.2 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.

3.3.12.2.1 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 (Endangered Species Act 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.

3.3.12.2.2 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.

3.3.12.2.3 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.

3.3.12.2.4 Four Fish

Four federally Endangered fish species may occur as downstream residents of the Colorado River System: Colorado pikeminnow (*Ptychocheilus lucius*), bonytail (*Gila elegans*), humpback chub (*Gila cypha*), and razorback sucker (*Xyrauchen texanus*) (USFWS 2004). The Colorado pikeminnow, bonytail, and humpback chub are all members of the minnow family. The razorback sucker is a member of the sucker family. All four of these fish species share similar habitat requirements and historically occupied the same river systems. Declines in populations of these species are mainly attributed to the impacts of water development (e.g. dams and reservoirs) on natural temperature and flow regimes, creation of migration barriers, habitat fragmentation, the introduction of competitive and predatory non-native fishes, and the loss of inundated bottom lands and backwater areas (Minckley and Deacon 1991, USFWS 1993). No Critical Habitat for these species has been designated in Wyoming (Upper Colorado River Endangered Fish Recovery Program 1999). However, the potential for project-related reductions in water quantity to tributaries to the Colorado River warrant their inclusion in this analysis.

Habitat of the bonytail is primarily limited to narrow, deep, canyon-bound rivers with swift currents and whitewater areas (Valdez and Clemmer 1982; Archer et al. 1985; Upper Colorado River Endangered Fish Recovery Program 1999). With no known reproducing populations in the wild today, the bonytail is thought to be

the rarest of the endangered fishes in the Colorado River System. The bonytail historically inhabited portions of the upper and lower Colorado River basins. Today in the upper Colorado River Basin, only small, disjunct populations of bonytail are thought to exist in the Yampa River in Dinosaur National Monument, in the Green River at Desolation and Gray canyons, in the Colorado River at the Colorado/Utah border, and in Cataract Canyon (USFWS 2005).

The Colorado pikeminnow is the largest member of the minnow family and occurs in swift, warm waters of the Colorado River basins. The species was once abundant in the mainstem of the Colorado River and most of its major tributaries throughout Wyoming, Colorado, Utah, New Mexico, Arizona, Nevada, California, and Mexico. It was known to occur historically in the Green River of Wyoming at least as far north as the City of Green River. In 1990, one adult was collected from the Little Snake River in Carbon County, Wyoming (Baxter and Stone 1995).

Habitat of the humpback chub is also limited to narrow, deep, canyon-bound rivers with swift currents and whitewater areas (Valdez and Clemmer 1982, Archer et al. 1985, USFWS 2005). The humpback chub was historically found throughout the Colorado River System and its tributaries, which are used for spawning (Valdez et al. 2000). It is estimated that the humpback chub currently occupies 68 percent of its original distribution in five independent populations that are thought to be stable (Valdez et al. 2000).

The razorback sucker is an omnivorous bottom-feeder and is one of the largest fishes in the sucker family. Habitat use of adult razorback sucker varies depending on season and location. This species was once widespread throughout most of the Colorado River Basin from Wyoming to Mexico. Today in the Colorado River Basin, populations of razorback suckers are only found in the upper Green River in Utah, the lower Yampa River in Colorado, and occasionally in the Colorado River near Grand Junction (USFWS 2005). Suitable habitat for these four fish species exists downstream of the project area in the Green River and its main tributaries.

The Upper Colorado River Endangered Fish Recovery Program is a partnership working to recover the endangered fish of the Upper Colorado River Basin (USFWS 2005). 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 acre-feet (AF) in the Upper Colorado River Basin are considered to jeopardize the species. Based on the analysis in section 3.3.6, approximately 955 AF would be lost to evaporation. See Table 3-3 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. Applying this efficiency to the average annual yield of 2,936 AF, 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 annual depletion (see Table 3-8).

Table 3-8
Estimated Water Depletions

Type	Amount (AF)
Evaporation	955
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 C).

3.3.12.2.5 Greater Sage Grouse

The proposed Big Sandy Reservoir enlargement would raise the existing normal high water mark from 6,757.5 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*). Additional acres would be permanently (about 37 acres) or temporarily (up to 265 acres) disturbed during construction. 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. Governor Mead then issued Greater Sage-Grouse Executive Order (EO) 2011-5, which states 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 very 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. 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 7 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 (see Chapter 7 References) indicates that dominant 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. The 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 construction activities, particularly along the Big Sandy Feeder Canal. Although work would occur using areas that were previously disturbed, noise from construction 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 E).

3.3.12.2.6 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 it occurs and breeds 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.

Table 3-9
Full Impact Summary of Species

Group	Name	Potential	Determination of Effects
Mammals	Gray wolf (*Canis lupus*)	Not suitable habitat; unlikely to occur in the Project area.	No Effect
	Mule deer (*Odocoileus hemionus*)	Occupied habitat.	No Effect
	Pronghorn (*Antilocapra americana*)	Occupied habitat.	Minor Effect
	Rocky Mountain elk (*Cervus canadensis nelsoni*)	Suitable habitat.	Minor Effect
Birds	Yellow-billed Cuckoo (*Coccyzus americanus*)	Not suitable habitat; unlikely to occur in the Project area.	No Effect
	Greater Sage-grouse (*Centrocercus urophasianus*)	Occupied habitat.	Minor Effect
	Burrowing Owl (*Athene cunicularia*)	Not suitable habitat; unlikely to occur in the Project area.	No Effect
Reptiles and Amphibians	Western Rattlesnake (*Crotalus viridis*)	Not suitable habitat; unlikely to occur during the construction period.	No Effect
	Western Chorus Frog (*Pseudacris triseriata*)	Not suitable habitat; unlikely to occur during the construction period.	No Effect
	Tiger Salamander (*Ambystoma tigrinum*)	Not suitable habitat; unlikely to occur during the construction period.	No Effect

Group	Name	Potential	Determination of Effects
Fish	Brown trout (*Salmo trutta*)	Minimal disturbance near construction on the Dam.	Minor Effect
	Cutthroat trout (*Oncorhynchus clarkii*)	Minimal disturbance near construction on the Dam.	Minor Effect
	Catfish (*Ictalurus punctatus*)	Minimal disturbance near construction on the Dam.	Minor Effect
	Burbot (*Lota lota*)	Minimal disturbance near construction on the Dam.	Minor Effect
	Bonytail chub (*Gila elegans*)	Water depletions >0.1 acre-feet.	Adverse Effect
	Colorado pikeminnow (*Ptychocheilus Lucius*)	Water depletions >0.1 acre-feet.	Adverse Effect
	Humpback chub (*Gila cypha*)	Water depletions >0.1 acre-feet.	Adverse Effect
	Razorback sucker (*Xyrauchen texanus*)	Water depletions >0.1 acre-feet.	Adverse Effect
Plants	Ute ladies'-tresses (*Spiranthes diluvialis*)	No known populations occur within 100 miles of the Project area.	No Effect

3.3.13 Recreation

The recreation around Big Sandy Reservoir consists of multiple campsites with picnic tables and fire pits along the edge of the reservoir with a few restroom facilities nearby. On the west side of the reservoir there is a boat ramp with a vault toilet, a camping loop area with an artesian well, vault restroom, a shade shelter, and multiple tables and fire pits. On the south side of the reservoir there are dispersed campsites with fire pits. On the south east corner of the reservoir there are multiple campsites with tables, fire pits, and a vault restroom. Below the dam there is a camping area with a shade shelter and a restroom.

3.3.13.1 No Action

The No Action alternative would have no effect on recreation.

3.3.13.2 Proposed Action

The Proposed Action would have some impact on recreation facilities, as well as access to the reservoir for recreation. The boat ramp would need to be replaced to match the reservoir levels. Two vault toilets by the reservoir would be

approximately 45 and 90 feet from the water with the reservoir at full capacity. While these two vault toilets would not necessarily need to be moved, both would be replaced at higher elevation, pending funding availability. Moving or replacing the third vault toilet near the boat ramp would be unnecessary. The campsites along the southeast corner of the reservoir would need to be replaced and moved to higher ground, due to wave action eroding away the bank. Tables and fire pits southwest of the main camping area near the boat ramp would need to be replaced and moved as well. The outlet of the artesian well would need to be extended to higher ground and irrigation lines reattached. The shade structure and existing vault restroom below the dam should not be impacted. During the construction period, access to the recreation area on the east side of the reservoir would be restricted, which would reduce the number of visitors to the area. After construction, there may be a larger amount of visitors due to the larger reservoir and updated amenities that would exist.

3.3.14 Socioeconomics

The project area covers two counties: Sublette and Sweetwater. The majority of this section is divided by county. However, "County Region" in the following figures and tables combines statistics from Sublette and Sweetwater Counties.

Table 3-10

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.

Figure 3-1

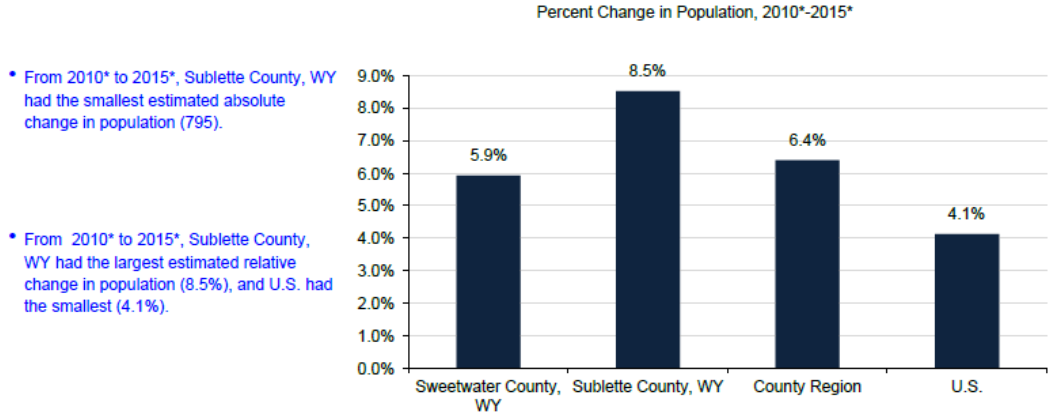
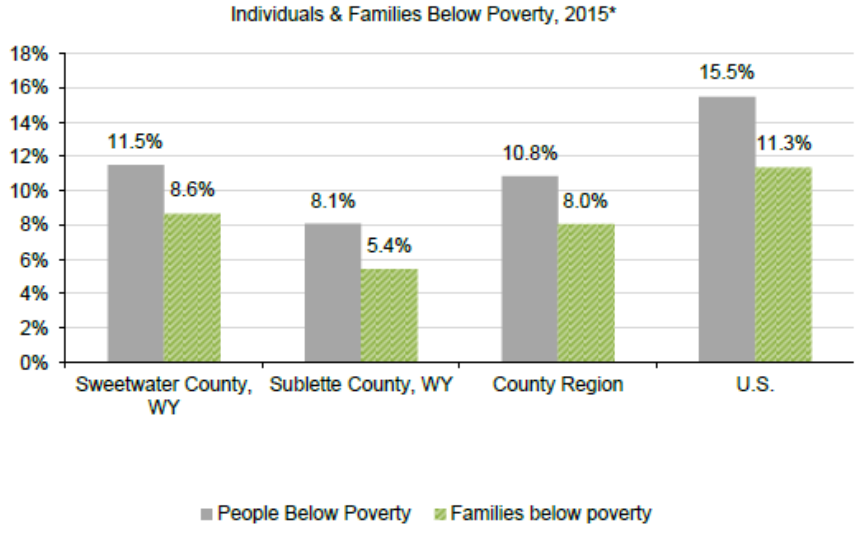


Figure 3-2

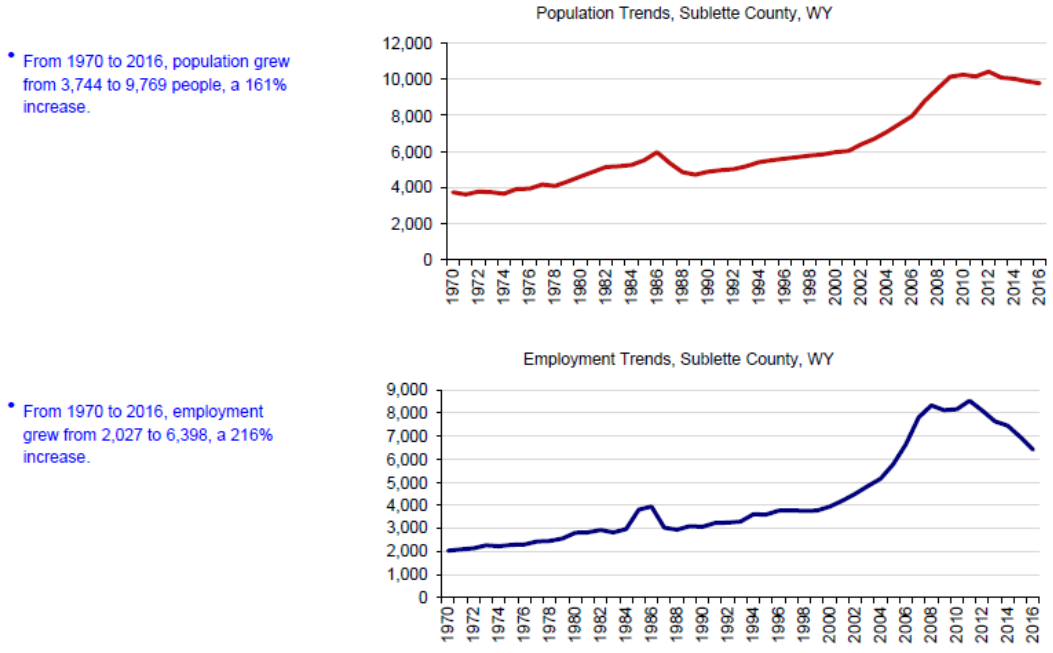


Sublette County

The estimated population of Sublette County in 2015 was 10,117 individuals, which is an increase of 8.5 percent from 9,322 people in 2010 (Figure 3-1) (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 95.5 percent of people in Sublette County obtained a high school degree or higher (U.S. Census Bureau 2015).

Figure 3-3

Population and Employment Trends, Sublette County, WY



Approximately 90.5 percent of people in Sweetwater County and 95.5 percent of people in Sublette County obtained a high school degree or higher (U.S. Census Bureau 2015).

Table 3-11
Employment by Industry in Sublette County, WY

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%

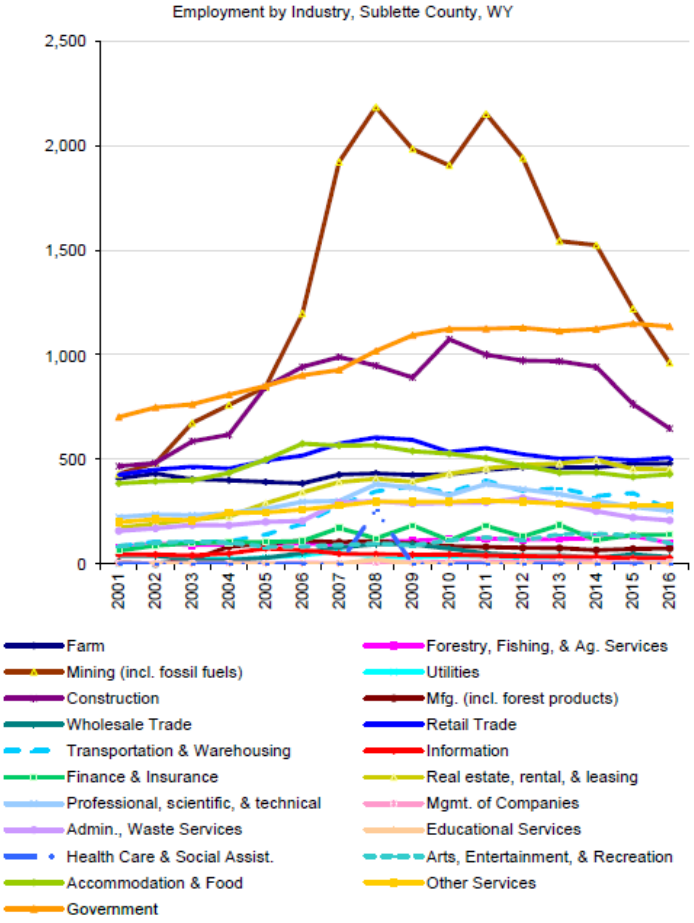
All employment data are reported by *place of work*. Estimates for data that were not disclosed are indicated with tildes (~).

Data Sources: U.S. Department of Commerce. 2017. Bureau of Economic Analysis, Regional Economic Accounts, Washington, D.C. Table CA25N.

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) (see Table 3-11).

Figure 3-4
Employment by Industry in Sublette County, WY

- In 2016 the three industry sectors with the largest number of jobs were government (1,135 jobs), construction (647 jobs), and farm (480 jobs).
- From 2001 to 2016, the three industry sectors that added the most new jobs were mining (including fossil fuels) (530 new jobs), real estate and rental and leasing (279 new jobs), and transportation and warehousing (176 new jobs).



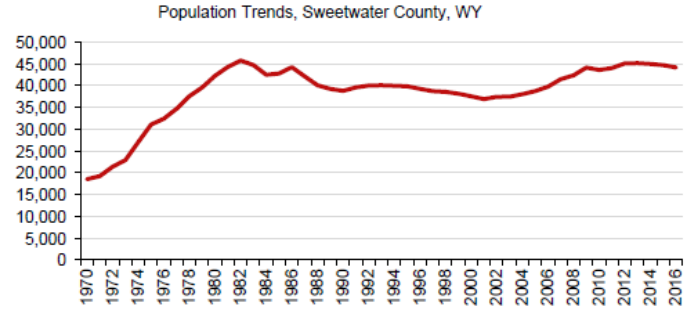
Data Sources: U.S. Department of Commerce. 2017. Bureau of Economic Analysis, Regional Economic Accounts, Washington, D.C. Table CA25N.

Sweetwater County

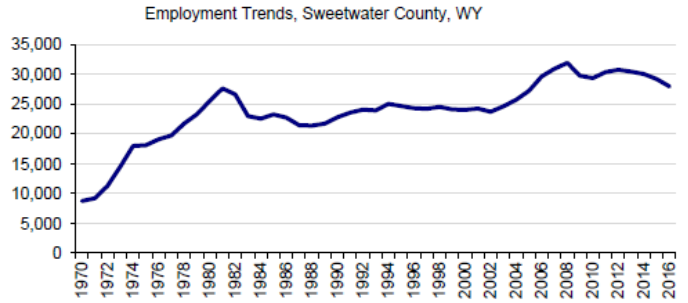
The estimated population of Sweetwater County in 2015 was 44,772 individuals, which is an increase of 5.9 percent from 42,266 people in 2010 (Figure 3-1) (U.S. Department of Commerce 2016). Median household income in 2014 was $69,022 with per capita income estimated to be $30,568, and 8.6 percent of individuals in poverty. The civilian labor force accounts for 72.6 percent of all individuals in Sweetwater County. Approximately 90.5 percent of people in Sweetwater County obtained a high school degree or higher (U.S. Census Bureau 2015).

Figure 3-5
Population and Employment Trends, Sweetwater County, WY

- From 1970 to 2016, population grew from 18,536 to 44,165 people, a 138% increase.



- From 1970 to 2016, employment grew from 8,699 to 27,917, a 221% increase.



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 (U.S. Department of Commerce 2016).

Table 3-12
Employment by Industry in Sweetwater County, WY

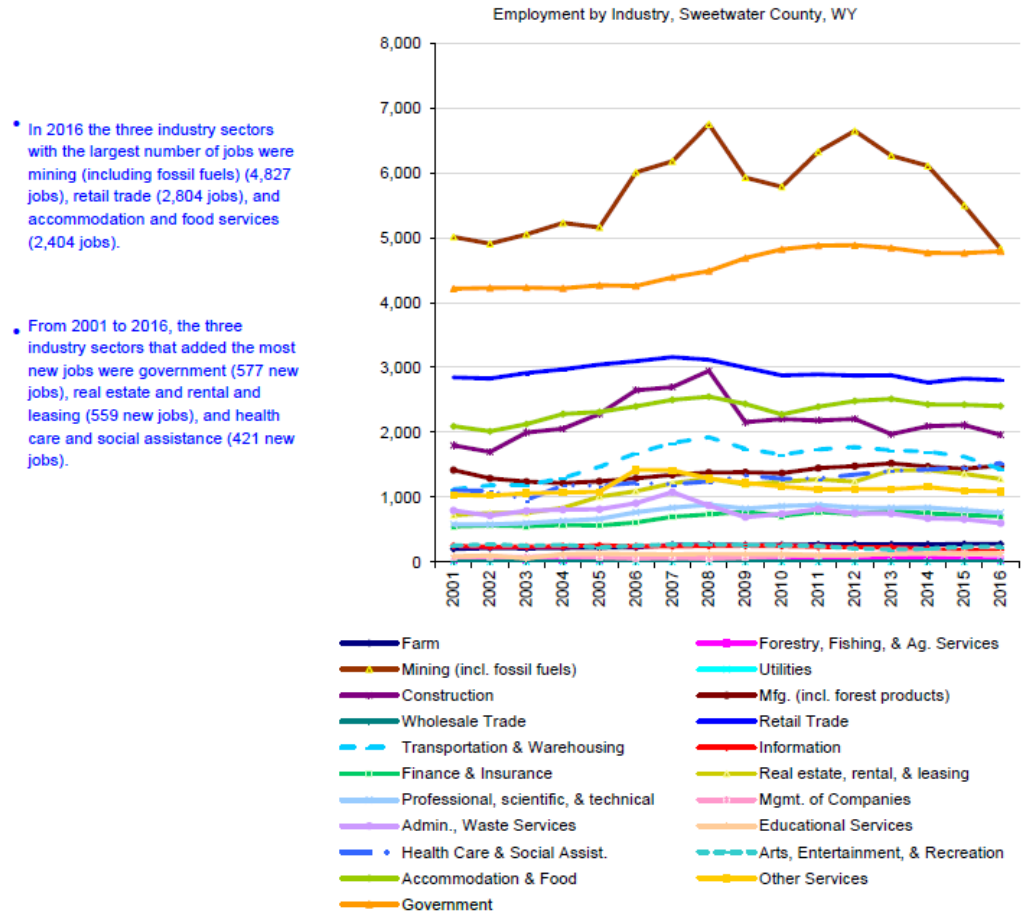
Employment by Industry, 2001-2016

	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 (~).

Data Sources: U.S. Department of Commerce. 2017. Bureau of Economic Analysis, Regional Economic Accounts, Washington, D.C. Table CA25N.

Figure 3-6
Employment by Industry in Sweetwater County, WY



Data Sources: U.S. Department of Commerce. 2017. Bureau of Economic Analysis, Regional Economic Accounts, Washington, D.C. Table CA25N.

3.3.14.1 No Action

Under the No Action there would be no adverse effects to socioeconomics.

3.3.14.2 Proposed Action

Short-Term Economic Effects

Under the Proposed Action short and long-term impacts are anticipated to occur in the local area. 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. This action would bring an influx of construction activity and would provide opportunities for the community to meet the demands of the individuals engaged in the construction activities.

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. 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.

There are limited sources for a broad range of construction 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 vacancies on construction crews that could be filled by local individuals, but this socio-economic analysis does not mandate the use of local resources.

Long-Term Economic Effects

A comprehensive economic analysis for the Big Sandy Enlargement is contained in Big Sandy Reservoir Enlargement Level II, Phase I Study Final Report (Study) prepared by WENK Associates for the Wyoming Water Development Commission in 2017.

Here is a summary of its findings relevant to this discussion: Due to additional water being available for primarily late season irrigation of currently irrigated lands, the Study anticipates an average increase in hay production of 1,516 tons of alfalfa and 915 tons of "other" hay. Based on average area crop prices from 2010 - 2014, additional annual revenues from increased agricultural production would equal approximately $364,716 per year. Estimated costs to harvest the additional hay were approximately $81,293.

With a reservoir enlargement providing an increased average surface area of 499 acres, an increase of 4,990 additional activity days are anticipated on the reservoir which, if multiplied by a daily value averaging $65.18 per day (fishing and boating/water skiing), would equate to an annual recreation benefit estimate of $325,248 annually.

The present value of the direct irrigation benefits was calculated to be $6.10 million, the present value of the indirect irrigation benefits was calculated to be $9.94 million, and the present value of the recreation benefits was calculated to be $7.0 million (all present value calculations assume a discount rate of 4 percent and a 50-year project life). With a total estimated benefit of enlarging Big Sandy Reservoir equaling $23.04 million and an estimated construction cost of $8.4 million, the project benefit/cost ratio is approximately 2.74.

3.3.15 Access and Transportation

The Project is located within Sweetwater and Sublette counties and can be accessed from Highway 191 by using County Road 28 which crosses directly over the dam and dike. The impact area of influence for transportation includes roads that would be used during construction, operation and maintenance of the Proposed Action and the No Action alternatives. The impact area of influence for utilities includes any utilities that would be moved, replaced or experience service interruptions under the Proposed Action or No Action Alternative.

During construction, it is estimated that up to about fifteen construction vehicles per day would travel to the site depending on the features being worked on at the time. Within the site, continuous operation of heavy equipment is anticipated on a daily basis. The majority of the vehicle trips from off-site would be for transporting construction materials including concrete, cement-bentonite, excavation and backfill materials. The contractor would be transporting heavy construction equipment at the beginning and end of the Project. Upon completion of construction, vehicle trips are expected to be reduced to no more than three per day for Operation and Maintenance (O&M) purposes during irrigation season.

3.3.15.1 No Action

The No Action would have no impact on access, and transportation.

3.3.15.2 Proposed Action

The Proposed Action would have short-term effects during construction but no long-term effects on access and transportation. Public access to Big Sandy Dam and Dike would be restricted in the interest of public safety. A Traffic Control Plan will be developed in coordination with Sublette and Sweetwater county authorities. Signage would be required at the appropriate locations notifying the public that access to the Dam and Dike would be prohibited during construction. Once construction is complete, the area would be reopened for public use.

3.3.16 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 AF 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 AF.

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.

3.3.16.1 No Action

Under the No Action, the Project would not be built. This would have no effect on water rights.

3.3.16.2 Proposed Action

This proposed action would increase the storage capacity of Big Sandy Reservoir to 52,600 AF which is 12,900 AF above the allowable storage of 39,700 AF 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 neighboring non-project users from potential impairment from the additional storage in Big Sandy Reservoir may cause. If any interference between senior water rights 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.

3.3.17 Grazing

Cattle and sheep grazing is common throughout the rangelands of the western U.S. There is currently one livestock operator in the project area. At this time, the livestock operator mainly grazes sheep on two 40-acre quarter sections of private land on the northeast side of the reservoir (Peter Arambel, pers. comm. 2018) (Figure A-6). In 1950, Reclamation obtained a perpetual easement 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."

3.3.17.1 No Action

Under the No Action alternative, there would be no impact to current grazing operations.

3.3.17.2 Proposed Action

Implementing the Proposed Action has the potential to negatively impact grazing operations. The following analysis quantifies the negative impact 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 A-6). 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 30, 2018, to determine what soils occurred in the 22.2 acres. Table 3-13 shows the soil name and corresponding map unit symbol, and acres. The Natural Resources Conservation Service'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 feet.

Table 3-13 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. 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 3-13

Calculating 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 3-13, 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 3-13, 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 3-13, 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. Based on this analysis, there could be a minor overall effect to grazing operations if the Proposed Action were implemented.

3.3.18 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 nonsignificant, 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. Should ITA concerns be identified by tribes during the tribal consultation process, Reclamation will address their concerns.

3.3.18.1 No Action
The No Action Alternative would have no impact on ITAs.

3.3.18.2 Proposed Action
Because there are no ITAs within the project vicinity, implementation of the Action Alternative would have no effect on ITAs.

3.3.19 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 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 3-14.

Table 3-14

Population by Race

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 3-15).

Table 3-15

Poverty by Race and Ethnicity

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 3.3.18, there are no ITAs in the Project vicinity nor Indian reservations. Based on Table 3-15, approximately 0.5 percent of the county region was comprised of individuals identifying as American Indian alone. However, information regarding which tribe the individual identified with was not available.

3.3.19.1 No Action

Under the No Action Alternative, the Project would not be implemented. This would have no effect on minority and low-income populations, nor Indian tribes.

3.3.19.2 Proposed Action

The proposed Project would not disproportionately (unequally) affect any low-income or minority communities within the Project area. Project funding would not target or disproportionately affect disadvantaged races, ethnicities, or communities of lower economic status. Inconveniences during construction would be experienced equally by those accessing Big Sandy Reservoir, and the Reservoir is not known to be utilized disproportionately by the above-described groups. Additionally, implementation of the Proposed Action would not involve population relocation, health hazards, hazardous waste, property takings, or negative impacts to the local economy. For the reasons described, the Proposed

Action would have no adverse human health or environmental effects on minority and low-income populations, nor Indian tribes.

3.4 Cumulative Effects

In addition to Project-specific impacts, Reclamation analyzed the potential for significant cumulative impacts to resources affected by the Project and by other past, present, and reasonably foreseeable activities within the watershed. According to the Council on Environmental Quality's regulations for implementing NEPA (50 CFR §1508.7), a "cumulative impact" is an impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. It 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.

Cumulative effects for this Project may include maintenance and repair work on the spillway, canal headworks, and canal drop structures, all of which are on previously disturbed areas. Grazing and agricultural practices would be expected to continue as they have for decades, with no cumulative impact from this Project. Any impacts from this work would be temporary in nature with no long-term impacts. Based on resource specialists' review of the Proposed Action, Reclamation has determined that this action would not have a significant adverse cumulative effect on any resources.

3.5 Summary of Environmental Effects

Table 3-16 summarizes environmental effects under the No Action and the Proposed Action Alternatives.

Table 3-16

Summary of Environmental Effects

Project Resource	**No Action**	**Proposed Action**
Geology and Soils Resources	No Effect	No Effect
Visual Resources	No Effect	No Effect
Cultural Resources	No Effect	Adverse Effects
Paleontological Resources	No Effect	No Effect
Wilderness and Wild and Scenic Rivers	No Effect	No Effect
Hydrology	No Effect	No Effect
Water Quality	No Effect	No Effect
System Operations	No Effect	No Effect
Health, Safety, Air Quality, and Noise	No Effect	No Effect
Prime and Unique Farmlands	No Effect	No Effect
Floodplains	No Effect	No Adverse Effect
Wetlands and Riparian Resources	No Effect	No Adverse Effect
Wildlife Resources	No Effect	No Effect
Threatened, Endangered, and Sensitive Species	No Effect	Adverse Effect
Recreation	No Effect	Minor Effect
Socioeconomics	No Effect	No Effect
Access and Transportation	No Effect	No Long-term Effect
Water Rights	No Effect	No Effect
Indian Trust Assets	No Effect	No Effect
Environmental Justice	No Effect	No Effect
Cumulative Effects	No Effect	No Effect

Chapter 4 Environmental Commitments

Environmental Commitments, along with Minimization Measures in Section 2.5 have been developed to lessen the potential adverse effects of the Proposed Action.

4.1 Environmental Commitments

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 construction area, additional environmental analyses may be necessary.

2. **Standard Reclamation Best Management Practices (BMPs)** – BMPS's will be applied during construction activities, to minimize environmental effects and will be implemented by construction forces, or included in construction specifications. Such practices or specifications include sections in the EA on Geology and erosion control, visual resources, 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 construction 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. Construction materials, 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 construction.

3. **Wyoming Pollution Discharge Elimination System Permit (WPDESP)** - WPDESP will be required from the State of Wyoming

before any discharges of water, if such water is to be discharged as a point source into a regulated water body. Appropriate measures will be taken to ensure that construction related sediments will not enter the stream either during or after construction. 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 construction and prevent erosion and sedimentation in "Wyoming Surface Waters".

5. **Fugitive Dust Control Permit** - The Division of Air Quality regulates fugitive dust from construction 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 construction activity. The BMP's will be followed to mitigate for temporary impact on air quality due to construction 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** - In the case that any cultural resources, either on the surface or subsurface, are discovered during construction, Reclamation's Provo Area Office archaeologist shall be notified and construction 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. 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, with respect to Federal lands. The Wyoming SHPO and interested Native American Tribal representatives will be promptly notified. Consultation 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 by the proponent during ground disturbing actions, construction must be suspended until a qualified paleontologist can be contacted to assess the find.

8. **Wildlife Resources** –

a. Bald and Golden Eagles – In the case that bald and/or golden eagles are observed within the project area and vicinity, Reclamation's Provo Area Office wildlife biologist shall be notified and construction 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 prohibits anyone, without a permit issued by the Secretary of the Interior, from "taking" eagles, including their parts, nests, or eggs. The Act defines "take" as 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 Migratory Bird Treaty Act (MBTA) was issued on December 22, 2017 by the US Department of the Interior (DOI) under Secretarial Order 3345. Furthermore, the USFWS issued guidance through an M-Opinion. That guidance states 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. control of 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** - Construction sites will be closed to public access. Temporary fencing, along with signs, will be installed to prevent public access.

11. **Previously Disturbed Areas** - Construction and staging activities will be confined to previously disturbed areas where possible, for such activities as work, staging, and storage, waste areas and vehicle and equipment parking areas. Vegetation disturbance will be minimized as much as possible.

12. **Disturbed Areas** - All disturbed areas resulting from the Project will be smoothed, shaped, contoured, and rehabilitated to as near the pre-Project construction condition as practicable. After completion of the construction 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 construction, as funding is available.

Chapter 5 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.

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Chapter 6 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
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

Chapter 7 References

Amlin, N. 2000. Influences of Drought and Flood Stresses on Riparian Cottonwoods and Willows. Masters of Science Thesis, University of Lethbridge. Lethbridge, Alberta.

Anderson, M. D. 2008. Carex rostrata, C. utriculata. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2012, June 15].

Archer, D. L., L. R. Kaeding, B. D. Burdick, and C. W. McAda. 1985. A Study of the Endangered Fishes of the Upper Colorado River, Final Report. Cooperative agreement 14-16-0006-82-959. Grand Junction, Colorado: U.S. Department of the Interior, Fish and Wildlife Service.

Baxter, G. T., and M. D. Stone. 1995. Fishes of Wyoming. Cheyenne, WY: Wyoming Game and Fish Department. 290 pp.

BLM. 2018. Allotment Master Report WY13006 Reservoir.

Brink, V.C. 1954. Survival of plants under flood in the Lower Frazer River valley, British Columbia. Ecology 35: 94-95.

California Native Plant Society (CNPS). No date. Native perennial grasses, sedges, and rushes for Nevada and Placer County landscapes. Redbud Chapter.

Connelly, J.W., M. A. Schroeder, A.R. Sands and C.E. Braun. 2000. Guidelines to manage sage grouse populations and their habitats. Wildlife Society Bulletin 28:967-985.

Dionigi, C.P., I.A. Mendelssohn, and V.I. Sullivan. 1985. Effects of soil waterlogging on the energy status and distribution of Salix nigra and S. exigua (Salicaceae) in the Atchafalaya River basin of Louisiana. American Journal of Botany 72:109-119.

Environmental Laboratory. 1987. Corps of Engineers Wetlands Delineation Manual. Technical Report Y-87-1. Department of the Army, Waterways Experiment Station, Corps of Engineers, Vicksburg, Mississippi.

Hillman, C.N. and T.W. Clark. 1980. Mustela nigripes. In Mammalian Species No. 126. The American Society of Mammalogists. 3 pp.

Hoag, J.C., D. Tilley, D. Ogle, and L. St. John. 2011. Description, propogation, and establishment of wetland – riparian grass and grass-like species in the Intermountain West. TN Plant Materials No. 38. U.S. Department of Agriculture Natural Resources Conservation Service. Boise, Idaho – Salt Lake City, Utah.

Israelsen, K. R. 2009. Herbicide, Salinity, and Flooding Tolerance of Foxtail Barley (Hordeum jubatum L.) and Desirable Pasture Grasses. Utah State University. All Graduate Theses and Dissertations. Paper 519. http://digitalcommons.usu.edu/etd/519

Jeglum, J.K. 1971. Plant indicators of pH and water level in peatlands at Candle Lake, Saskatchewan. Canadian Journal of Botany 49: 1661-1676.

Kuzovkina, Y.A., M. Knee, and M.F. Ouigley. Cadmium and copper uptake and translocation in five willow (Salix L.) species. International Journal of Phytoremediation 63:269-287.

Meena, Jack. 1993. A Water Management Model for the Green River. M.S. Thesis, University of Wyoming, Laramie, WY.

Minckley, W. L. and J. E. Deacon. 1991. Battle Against Extinction: Native Fish Management in the American West. University of Arizona Press.

National Oceanic and Atmospheric Administration's National Weather Service, State Precipitation Summary Web Site. [online] accessed February 17, 2017, Big Sandy River (WY) above Big Sandy Reservoir (BSRW4): https://water.weather.gov/afws/stprecipsummary.php?state=WY

Natural Resources Conservation Service. Acres of Prime Farmland, 1997. Accessed 23 December 2016, at https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_012232.pdf

Rains, M.C., J.F. Mount, and E.W. Larsen. 2004. Simulated changes in shallow groundwater and vegetation distributions under different reservoir operations scenarios. Ecological Applications 14: 192-207.

River Partners. 2008. Effects of Long Duration Flooding on Riparian Plant Species in Restoration Plantings. San Joaquin River National Wildlife Refuge, Stanislaus County, California. L. Singleton, S. Small, and T. Griggs. Modesto, California. Prepared for U.S. Fish and Wildlife Service.

Romin, L.A. and J.A. Muck. 2002. Utah Field Office Guidelines for Raptor Protection from Human and Land Use Disturbances. U.S. Fish and Wildlife Service, Utah Field Office, Salt Lake City, Utah.

St. John, L., D. G. Ogle, D. Darris, S. Parr. 2011 Plant Guide for Tufted Hairgrass (Deschampsia caespitosa). USDA-Natural Resources Conservation Service, Aberdeen, Idaho Plant Materials Center. 83210-0296.

Thomann, R.V. and Mueller, J.A. (1987) Principles of Surface Water Quality Modeling and Control. Harper-Collins, New York.

Tilley, D., Ogle, D., and L. St. John. 2011. Plant guide for water sedge (Carex aquatilis). USDA- Natural Resources Conservation Service, Idaho Plant Materials Center. Aberdeen, Idaho.

Upper Colorado River Endangered Fish Recovery Program. 1999. Online at: http://www.coloradoriverrecovery.org/

U.S. Army Corps of Engineers. 2010. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region (Version 2.0), ed. J.S. Wakeley, R. W. Lichvar, and C.V. Noble. ERDC/EL TR-10-1. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

U.S. Army Corps of Engineers. 2016. Letter from Thomas Johnson dated May, 18, 2016.

U.S. Census Bureau. 2015. Website accessed 4 April 2017 at https://factfinder.census.gov/bkmk/table/1.0/en/ACS/15_5YR/S1501/0500000US56037

U.S. Census Bureau. 2015. Website accessed 4 April 2017 at https://factfinder.census.gov/bkmk/table/1.0/en/ACS/15_5YR/DP03/0500000US56037

U.S. Department of Agriculture Natural Resource Conservation Service (USDA NRCS). 2000. Plant Guide: Coyote Willow (Salix exigua). Prepared by M. Stevens, G. Fenchel, C. Hoag, USDA NRCS, Plant Materials Centers, Los Lunas, NM and Aberdeen, Idaho.

U.S. Department of Agriculture Natural Resource Conservation Service (USDA NRCS). 2004. Plant Guide: Kentucky Bluegrass (Poa pratensis). Prepared by S. Wennerberg, USDA NRCS, National Plant Data Center, Baton Rouge, Louisiana.

U.S. Department of Agriculture Natural Resource Conservation Service (USDA NRCS). 2005a. Plant Guide: Nebraska Sedge (Carex nabascensis). Prepared by D. G. Ogle, USDA NRCS, Idaho State Office, Boise, Idaho.

U.S. Department of Agriculture Natural Resource Conservation Service (USDA NRCS). 2005b. Plant Guide: Creeping Spikerush (Eleocharis palustris). Prepared by D. G. Ogle, USDA NRCS, Idaho State Office, Boise, Idaho.

U.S. Department of Agriculture Natural Resource Conservation Service (USDA NRCS). 2005c. Plant Guide: Baltic Rush (Juncus balticus). Prepared by M. Stevens and C. Hoag, USDA NRCS, Plant Material Center, Aberdeen, Idaho.

U.S. Department of Commerce. 2016. Census Bureau, American Community Survey Office, Washington, D.C., as reported in Headwaters Economics' Economic Profile System (headwaterseconomics.org/eps).

U.S. Department of Commerce. 2016. Census Bureau, American Community Survey Office, Washington, D.C.; U.S. Department of Commerce. 2000. Census Bureau, Systems Support Division, Washington, D.C., as reported in Headwaters Economics' Economic Profile System (headwaterseconomics.org/eps).

U.S. Department of Interior, Bureau of Reclamation, Water Operations – Big Sandy Reservoir Web Site, Accessed April 17, 2017, https://www.usbr.gov/rsvrWater/rsv40Day.html?siteid=936&reservoirtype=Reservoir

U.S. Department of Interior. 2017. M-37050, The Migratory Bird Treaty Act Does Not Prohibit Incidental Take.

U.S. EPA, Corvallis Environmental Research Laboratory. 1977. Report on Big Sandy Reservoir, Sublette and Sweetwater Counties, Wyoming, EPA Region VIII (Working Paper No. 881).

USFWS. 1993. "Colorado River Endangered Fishes Critical Habitat." Draft biological support document. Salt Lake City, UT: U.S. Department of the Interior, Fish and Wildlife Service.

USFWS. 2004. Threatened, Endangered, and Proposed Species of Carbon County, Wyoming. Cheyenne, WY: U.S. Department of the Interior, Fish and Wildlife Service.

USFWS. 2005. Final Programmatic Biological Opinion, Management Plan for Endangered Fishes in the Yampa River Basin. United States Department of the Interior, Fish and Wildlife Service, Mountain/Prairie Region (Denver, CO). Online at: http://www.coloradoriverrecovery.org/documents-publications/section-7- consultation/yampaPBO/FinalYPBO.pdf.

USFWS. 2018a. Wyoming ES – Species – EABA. Online at: https://www.fws.gov/wyominges/Species/Raptors.php.

USFWS. 2018b. Guidance on the recent M-Opinion affecting the Migratory Bird Treaty Act. Washington, D.C.: U.S. Department of Interior, Fish and Wildlife Service.

USGS. 2017. National Water Census – Data Portal. Accessed February 1, 2018 at https://cida.usgs.gov/nwc/#!waterbudget/huc/14040104

U.S. Geological Survey, Surface-Water Daily Data for Wyoming, Web Site, Accessed February 17, 2017, 09213500: https://nwis.waterdata.usgs.gov/wy/nwis/qwdata/?site_no=09213500 and 09213700: https://waterdata.usgs.gov/nwis/dv?referred_module=sw&site_no=09213700

Valdez, R. A. and G. H. Clemmer. 1982. "Life history and prospects for recovery of the humpback and bonytail chub." In Fishes of the Upper Colorado River System: Present and Future (Miller, W. H., H. M. Tyus, and C. A. Carlson, eds). Bethesda, MD: Western Division, American Fisheries Society, 109–119.

Valdez, R. A., R. J. Ryel, S. W. Carothers, and D. A. House. 2000. "Recovery goals for the humpback chub (Gila cypha) of the Colorado River Basin: A supplement to the humpback chub recovery plan." Washington, DC: U.S. Fish and Wildlife Service.

Western EcoSystems Technology (WEST), Inc., 2016. Aquatic Resources Inventory Report, Big Sandy Reservoir Expansion Project Sublette and Sweetwater Counties, Wyoming.

Western EcoSystems Technology (WEST), Inc. 2017. Analysis of Big Sandy enlargement on greater sage-grouse.

Wyoming Climate Atlas by Jan Curtis and Kate Grimes Web Site. 2004. Accessed April 17, 2017, http://www.wrds.uwyo.edu/sco/climateatlas/precipitation.html#41

Chapter 8 Appendices