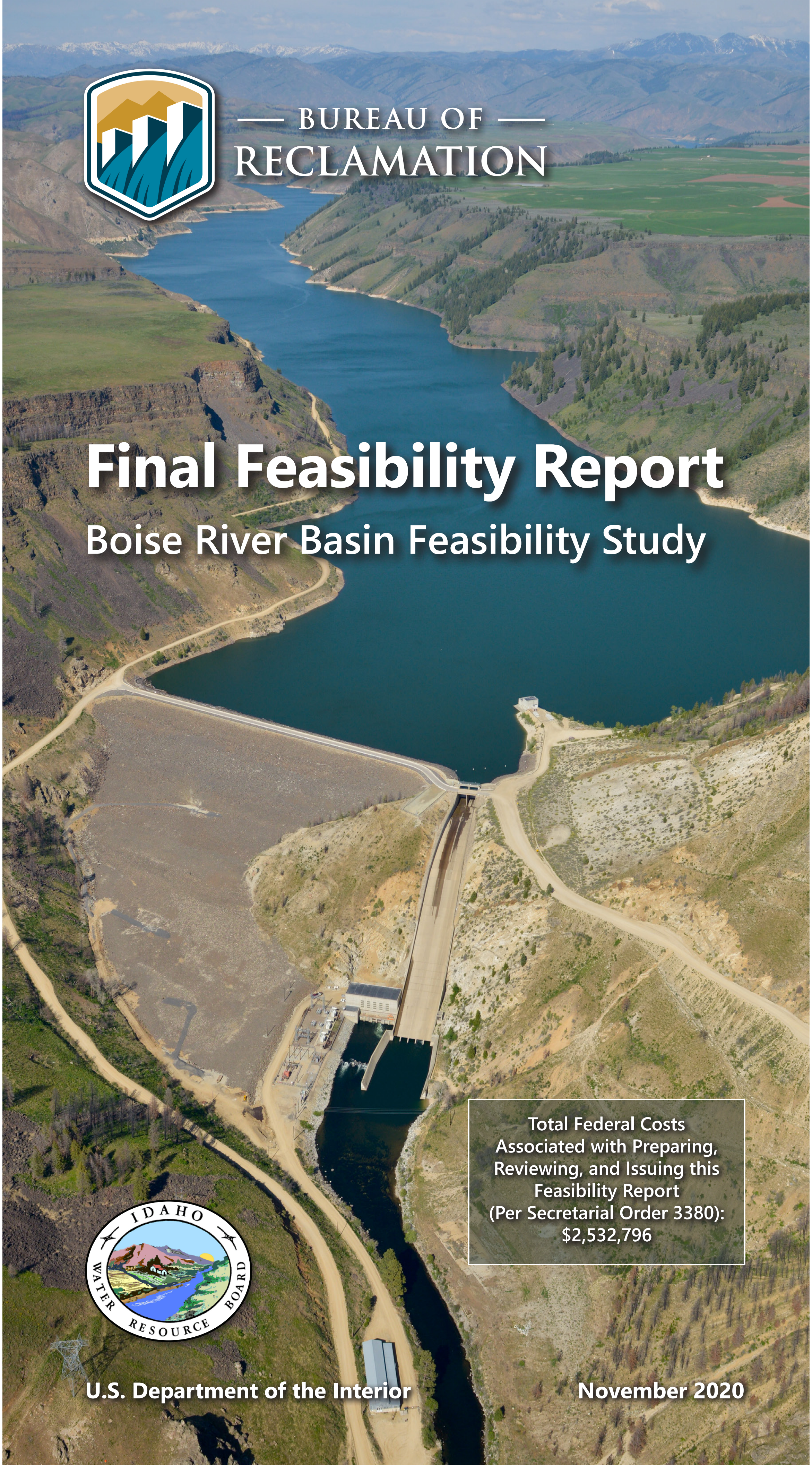

BUREAU OF RECLAMATION

Final Feasibility Report

Boise River Basin Feasibility Study

Total Federal Costs Associated with Preparing, Reviewing, and Issuing this Feasibility Report (Per Secretarial Order 3380): $2,532,796

IDAHO WATER RESOURCE BOARD

U.S. Department of the Interior

November 2020

Mission Statements

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

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

Final Feasibility Report

Boise River Basin Feasibility Study
Interior Region 9: Columbia-Pacific Northwest

Prepared for Reclamation by Sundance-EA Partners II, LLC, led for this task by Jacobs Engineering Group Inc. under Contract Number 140R1019D0001

Cover photos: Main photo, Anderson Ranch Dam and Reservoir (courtesy Bureau of Reclamation); top right photo, Pine Campground (courtesy U.S. Forest Service); fourth down, Bull trout (courtesy Joel Sartore/National Geographic Creative); all others courtesy Bureau of Reclamation.

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Executive Summary

The Boise River Basin Feasibility Study (Study) evaluates increasing storage opportunity within the Boise River basin to meet existing and future water supply demands within the basin, primarily through the expansion of Anderson Ranch Reservoir in Elmore County, Idaho. This Feasibility Report, created for the Study, presents plans to accomplish the Study objectives and makes recommendations for further action.

The Study is being conducted by the U.S. Department of the Interior (DOI), Bureau of Reclamation (Reclamation), Columbia-Pacific Northwest Region, in partnership with the Idaho Water Resource Board (IWRB). The IWRB is a Governor-appointed board, responsible for the formulation and implementation of a state water plan, the financing of water projects, and the operation of programs that support the sustainable management of Idaho's water resources.

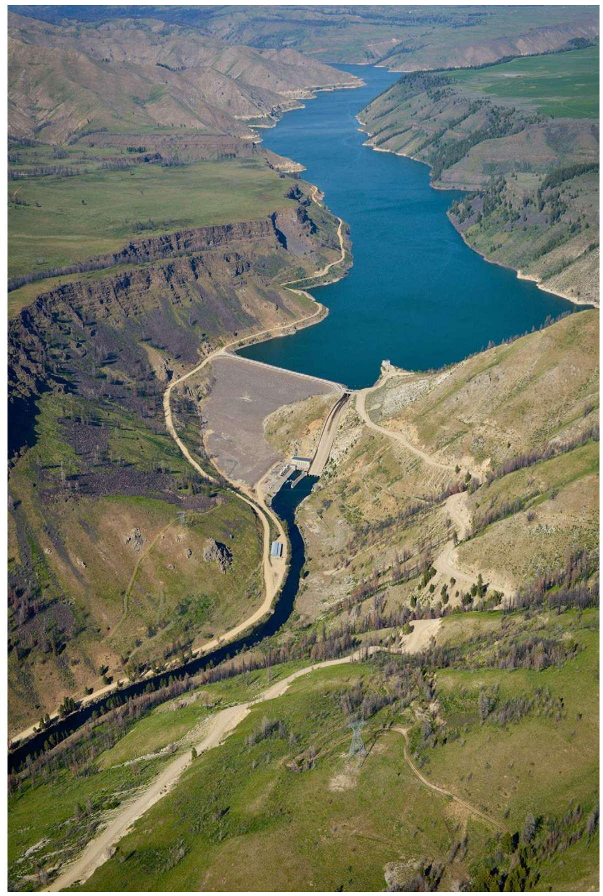


Photo by Kirsten Strough
Anderson Ranch Dam and Reservoir

A feasibility study involves the systematic planning, engineering, environmental, economic, and social analyses of plans for Federal water and energy projects consistent with the *Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies* (PR&G) (CEQ 2015), and an allocation of costs and payment responsibilities by the Federal and non-Federal entities. The completed feasibility study culminates in a feasibility report to form the basis for Reclamation's recommendation to the Secretary of the Interior regarding implementation of a recommended plan. A separate but accompanying Environmental Impact Statement (EIS) is being completed for the Study.

Background

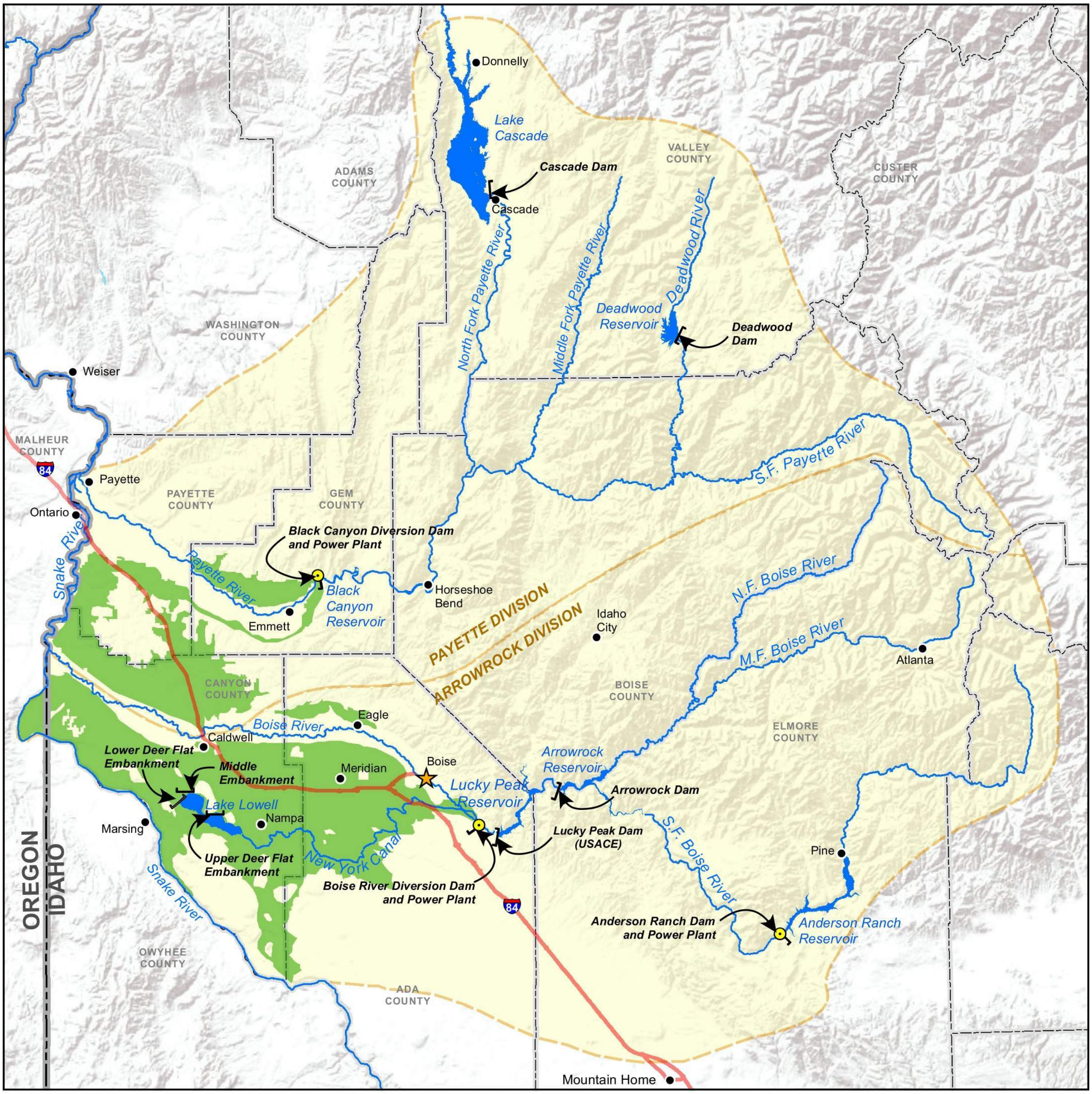
The Boise Project consists of two divisions: Arrowrock and Payette. The Arrowrock Division is within the Boise River basin and is designated as Water District 63 by the State of Idaho. The Payette Division is in the Payette River basin and is administered as Water District 65. This Study evaluates increasing storage opportunity within the Boise River basin only (the Arrowrock Division of the Boise Project) (Figure ES-1).

The Arrowrock Division provides irrigation water supply to irrigable acres situated between the Boise and Snake Rivers. Water for the Arrowrock Division is stored in Anderson Ranch Reservoir on the South Fork Boise River; in Arrowrock Reservoir on the Boise River; and in Lake Lowell, an offstream reservoir in a natural depression impounded by three low dams. Anderson Ranch Dam is 42 miles upstream of Arrowrock Dam. Boise Diversion Dam, 16 miles downstream of Arrowrock and 7 miles southeast of the city of Boise, diverts water into the New York Canal, which delivers water to Arrowrock Division lands (Figure ES-1). Three reservoirs (Anderson Ranch Reservoir, Arrowrock Reservoir, and Lucky Peak Reservoir), with a total active capacity of nearly 1 million acre-feet, furnish irrigation water to about 280,000 acres in the Boise River basin or Water District 63. Lucky Peak Dam and Reservoir is owned and operated by the U.S. Army Corps of Engineers (USACE). Reclamation and USACE operate the three storage dams in a coordinated manner for their authorized purposes. Individual facility authorizations include the following:

- Anderson Ranch Reservoir: Irrigation water supply, power, and flood control; with dead storage space providing for silt control, fish conservation, and recreation
- Arrowrock Reservoir: Irrigation water supply
- Lucky Peak Reservoir: Irrigation water supply, flood control, and recreation

The Boise Project area is characterized by wide valleys and a semiarid climate with warm, dry summers and cold winters. The upper elevations are forested and mountainous. Precipitation at the lower elevations averages about 10 inches annually and falls mainly in the winter as a mixture of rain and snow. Precipitation at the higher elevations averages up to 40 inches per year, with most falling as snow during the winter.

Consumptive use within the Boise Project is primarily for agriculture. Irrigation development was well underway before storage was developed under Federal authorities. Lands newly developed as part of the Federal project receive a full water supply from the project. Some lands, with the oldest water rights and sufficient water supply, remain under private irrigation. Those privately developed lands with an insufficient water supply generally became part of the Boise Project to obtain supplemental irrigation water supply.



Legend

- Reclamation Power Plant
- Reclamation Dam/Diversion (unless otherwise noted)
- Capital City
- City
- Reclamation Reservoirs
- Areas Benefited by Project
- Project and Division Boundary
- County Boundary
- State Boundary

Notes:
1. This map is provided as-is and may contain representations of property boundaries. It is intended for general references only. None of the parties involved in preparing this map or data contained herein warrant or represent information to be complete and accurate and cannot be held responsible for errors or omissions.
2. Date: 4/6/2020 MSFO GIS Dept.

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Figure ES-1. Boise Project
Boise Project - Arrowrock Division
Boise River Basin Feasibility Study

Purpose and Scope

The primary purpose of this Feasibility Report is to describe the formulation and evaluation of alternatives and to address identified water resources problems and opportunities developed during the Study. This includes developing water supplies and improving the reliability of water delivered from the Boise River basin. The scope of this report includes the following topics:

- A description of existing and future water resources and related problems and needs in the Study area warranting Federal consideration and the identification of planning objectives to address these problems and needs
- A summary of the plan formulation process, including planning constraints, principles, and criteria used to help guide the Study
- An evaluation of a Proposed Plan
- Recommendations for a preferred plan for implementation
- Conclusions and recommendations for future action

Study Area

Anderson Ranch Dam and Reservoir

Anderson Ranch Dam is a zoned earthfill embankment structure, with structural and hydraulic heights of 456 feet and 330 feet, respectively. The dam impounds Anderson Ranch Reservoir, which stores water for irrigation water supply, power, and flood control. The reservoir also provides for silt control, fish and wildlife, and recreation. At full pool, the reservoir surface area is 4,772 acres, with a length of about 17 miles and a shoreline of approximately 50 miles. The total storage volume in Anderson Ranch Reservoir is 474,942 acre-feet, including the following:

- 413,074 acre-feet of active storage
- 36,956 acre-feet of inactive space (powerhead space)
- 24,912 acre-feet of dead pool

The spillway at Anderson Ranch Dam has a discharge capacity of 20,000 cubic feet per second (cfs), and the combined discharge capacity of the outlet works is 10,000 cfs. Currently, Reclamation uses two of the three 8.5-foot-diameter power penstocks as a part of the hydroelectric system to generate power. The third penstock was installed for the future expansion of power generation. Each of the two active penstocks supplies water to a turbine that drives a 20,000-kilowatt (kW) generator for a maximum combined generating capacity of 40,000 kW. The combined discharge capacity of the turbines is approximately 1,600 cfs (Reclamation 2019a).

South Fork Boise River and Boise River Watershed

The Boise River, located in southwestern Idaho, is a tributary to the Snake River. The headwaters of the three forks of the Boise River originate in the Sawtooth Range of the Rocky Mountains. The contributing watershed to Anderson Ranch Dam is 980 square miles, with elevations ranging from 4196 feet at Anderson Ranch Dam to a 10337-foot peak in Camas County.

From its headwaters, the South Fork Boise River flows southwest to Anderson Ranch Reservoir. Downstream of Anderson Ranch Dam, the South Fork Boise River flows approximately 29 miles until reaching the backwater of Arrowrock Reservoir, where it joins with two other forks and becomes the Boise River. Downstream of Arrowrock Dam, the Boise River enters the backwater of Lucky Peak Reservoir before flowing through Lucky Peak Dam and downstream through Boise and other communities in the Treasure Valley (Garden City, Eagle, Star, Nampa, Middleton, Caldwell, Notus, and Parma). The river is diverted for agriculture at several locations, including Boise Diversion Dam for the New York Canal, which terminates at Lake Lowell; and Eckert Diversion Dam for the Ridenbaugh Canal, near Barber Park in Boise.

Through the urban corridor, the river is lined with levees and riprap, and the Boise River Greenbelt extends downstream of Lucky Peak Dam for 25 miles, providing recreation access to the river (such as summer float tubing). Farther downstream through agricultural areas, the river's floodplain is wider as it flows west across the Snake River Plain before its confluence with the Snake River at the Idaho-Oregon border near Parma, Idaho.

Climate, Hydrology, and Water Management

Climate in the Study area is typical of the Intermountain West, with precipitation occurring as snow in the winter and convective thunderstorms in the summer. Extreme precipitation statistics also generally follow the monthly precipitation pattern, with the wettest extreme precipitation days occurring in December and January. However, some very wet days are caused by convective thunderstorms during the otherwise dry months of August and September. The mean annual precipitation is 19.8 inches, and average annual snowfall is 55 inches. Temperatures at Anderson Ranch Dam range from lows of 19 degrees Fahrenheit (°F) in January (monthly average low) to 91°F in July (monthly average high).

Natural flows in the Boise River are characterized by low flows from late summer (August) through the late winter (February) and increasing flows starting in March, with peaks occurring from April through June. The highest recorded natural flow on the South Fork Boise River of 10,900 cfs to Anderson Ranch Reservoir (USGS gage 13186000 SF Boise River Near Featherville, Idaho) occurred in May 2017, and typical spring peaks range from 2,000 to 8,000 cfs. Low flows are typically around 220 cfs.

Flow in the Boise River is regulated by the three Federal storage reservoirs. Arrowrock and Anderson Ranch dams are operated by Reclamation, and Lucky Peak Dam is operated by

USACE. Together, these dams and the reservoirs on the Boise River system are operated jointly to fulfill irrigation, hydropower, and flood control requirements.

The total active capacity of the three-reservoir system is 949,700 acre-feet. Because Anderson Ranch Dam is at the highest elevation of the three reservoirs, it provides the most flexibility in operations. The timing and volume of discharge at Anderson Ranch Dam depend on multiple factors, including the following:

- Previous year carryover
- Environmental conditions
- Maintenance activities
- Irrigation

Flows in the South Fork Boise River are managed for multiple objectives, including downstream fisheries and flood risk management (FRM). From fall to early spring, a minimum flow of 300 cfs is maintained. FRM operations drive releases in the spring and early summer. In summer, releases typically range from 600 to 1,600 cfs, which is the powerplant's capacity. Summer flows satisfy downstream irrigation demands, maintain Arrowrock Reservoir above its minimum pool 37,912-acre-foot volume (elevation 3100 feet), and maintain volumes in the three reservoirs for the next water year. After irrigation demand and other operational considerations are met, the 600-cfs minimum flow target is typically maintained until fall, but flows can drop below the target in dry water years.

Land Management and Use

The management of natural flows during spring snowmelt and runoff periods and subsequent delivery of stored water to water users in the late summer have been vital to the growth of the Treasure Valley. In some parts of Ada County and most of Canyon County, irrigation (sprinkler and flood) supports a wide range of crops, including the following (University of Idaho 2019):

- Corn (sweet and field)
- Sugar beets
- Potatoes
- Grain (wheat and barley)
- Alfalfa (hay and seed)
- Beans

Land around Anderson Ranch Reservoir is primarily owned by the Federal government and managed by the U.S. Forest Service (USFS) and Reclamation. Other public land is administered by the U.S. Bureau of Land Management (BLM) and the State of Idaho. Public and private lands are used for livestock grazing, agriculture, timber, utilities, and residential and commercial development. Residential and commercial development focuses around the unincorporated communities of Pine and Featherville, upstream of the reservoir. These areas include many seasonal use homes and cabins. Most private farms and ranches in the area are near Prairie, downstream of the dam and north of the river.

Recreation Resources

Because Anderson Ranch Dam and Reservoir is centrally located within a 2-hour drive of Treasure Valley, Mountain Home, and Magic Valley, recreation is common for day trips and for extended outings. Public land is used heavily by residents and nonresidents for recreation, including the following:

- Boating; fishing; camping; hiking; and off-road, all-terrain vehicle use in the summer
- Fishing and big game and upland game hunting in the fall
- Fishing, cross-country skiing, and snowmobiling in the winter

Access to Anderson Ranch Dam and Reservoir and the surrounding area is provided by a network of paved and unpaved rural roads managed by Glenns Ferry or Mountain Home highway districts or the USFS. Roads are referred to as either Highway District (HD) roads under HD jurisdiction or National Forest System (NFS) roads under USFS jurisdiction.

Eight developed campgrounds and five boat ramps surround the reservoir, all managed by the USFS. Nester's Private Campground is privately owned and operated, and the Fall Creek Resort and Marina is authorized by the USFS through a Special Use Permit. During low water, reservoir shorelines are popular for dispersed recreation including the following:

- Picnicking
- Tent and recreational vehicle camping
- Fishing
- Paddle sports
- Mooring for motorized watercraft
- Off-road, all-terrain vehicles

The South Fork Boise River downstream of Anderson Ranch Dam, renowned as a blue-ribbon trout fishery for its naturally reproducing (no hatchery input) native trout, provides resident and non-resident anglers with fishing opportunities from rafts and river boats during the spring and summer flows and wading access during fall and winter flows. Twelve dispersed camping areas and five float-boat launches are scattered along the approximately 11-mile river reach accessible by road. The downstream 18-mile canyon section (inaccessible by road) is popular for anglers and whitewater rafters with more than 10 Class II and Class III rapids.

Numerous developed and undeveloped river access points are accessible both upstream and downstream of the reservoir; and multiple trailheads, adjacent to roads around the reservoir, provide access to trails up into the surrounding hills and mountains. During big game and upland game hunting seasons in the fall, road pullouts and campgrounds around the reservoir are used as hunting base camps. Throughout winter, the area is a popular destination for snowmobiling and cross-country skiing, with more than 380 miles of marked and groomed snowmobile trails in the Trinity Mountains north of Anderson Ranch Reservoir.

Water Resources

Treasure Valley surface water and aquifer systems are complex and have significant and dynamic hydrological interconnections. Natural stream flows, stored surface water, and groundwater are used and reused in multiple locations across the valley for irrigation and domestic, commercial, municipal, and industrial (DCMI) water.

Nearly 80% of the annual Boise River surface water flow occurs as snowpack runoff from March to July. The average natural flow volume in the Boise River, based on records from 1929 through 2010, is about 1.9 million acre-feet annually, as measured and calculated at Lucky Peak Dam. This volume represents the sum of unregulated tributary flows. The average annual basin outflow, as measured at the Parma gage (1972 through 2010) and including seasonal runoff and discharge or return flows from the aquifer, is 1.1 million acre-feet. Carryover water, or stored water that is available at the end of an irrigation season, varies from year to year and is highly dependent on snowpack levels and irrigation demand for that season (IWRB 2012a).

Irrigation water conveyance through the Treasure Valley consists of a complex network of waterways that cross the landscape to supply agricultural lands. The hydrology and landscape of the Treasure Valley are drastically different today than they were in the late 1800s, when the area was first settled by farmers and ranchers. Ephemeral creeks have been modified to perennial drains to serve as both delivery and drainage mechanisms for irrigation water. The construction of diversions, canals, laterals, ditches, sloughs, and drains has contributed to the presence of persistent shallow groundwater aquifers. Through many decades of operation, the constructed irrigation and drainage infrastructure in the area has established a balance between surface and groundwater that functions to serve water users. The shallow groundwater aquifers of the Treasure Valley are directly connected with the Boise River (Stevens Historical Research Associates [undated] as cited in IDEQ 2015).

Currently, during the irrigation season, natural surface water inflow to the Boise River above Lucky Peak Dam is insufficient to meet irrigation demand between Lucky Peak Dam and Middleton. Therefore, irrigators rely on stored water in the three reservoirs (Anderson Ranch, Arrowrock, and Lucky Peak) to supplement natural flows and meet irrigation demands. Along the Boise River from Middleton to the confluence with the Snake River near Parma, groundwater seepage and return flow from irrigation drains supplement natural flows and help satisfy irrigation demands (Stevens Historical Research Associates [undated] as cited in IDEQ 2015).

The groundwater aquifer is the primary source of water for DCMI users in the Treasure Valley, accounting for approximately 95% of the valley’s drinking water (IWRB 2012a). The existing DCMI water demand is estimated as follows in Ada, Canyon, and Elmore counties (SPF 2016):

- Ada and Canyon counties (combined): 79,500 acre-feet in 2010 and 110,200 acre-feet in 2015
- Elmore County: 5,440 acre-feet in 2010 and 4,870 acre-feet in 2015

Biological Resources

The Study area landscape is defined by lower montane ridges and mountain stream valleys. Mid- to high-elevation habitats are composed of shrubs and forest communities of Douglas fir and subalpine fir with scattered lodgepole pine and quaking aspen; low- to mid-elevation habitats are composed of coniferous evergreen and mixed coniferous-deciduous forest types; and sagebrush steppe and grassland communities dominate lower-elevation, non-forested areas adjacent to Anderson Ranch Reservoir, as well as the South Fork Boise River downstream of the dam. The western side of the reservoir is primarily steep and south-facing, with little to no vegetation established along the shoreline. Vegetation below the existing highwater line of the reservoir consists primarily of weedy annuals, because fluctuating water levels and steep slopes inhibit the establishment of permanent riparian habitat along the shoreline.

Riparian areas are well-developed along the South Fork Boise River (upstream and downstream of the dam); its tributaries; and the reservoir shoreline, where more gradual slopes are present, primarily on the eastern side of the reservoir. Wetlands in the Study area include palustrine, riverine, and lacustrine systems. Generally, these wetlands are located as follows:

- Lacustrine wetlands are present around the reservoir perimeter.
- Riverine wetlands are located where streams and rivers discharge into the reservoir (including the South Fork Boise River upstream and downstream of the dam).
- Palustrine wetlands are adjacent to water bodies and in small depressional areas subject to ponding.

The diversity of aquatic habitat within the Study area supports aquatic macroinvertebrates and native and introduced fish. Anderson Ranch Reservoir is well-known as a kokanee salmon fishery. Native fish (including bull trout, redband trout, and mountain whitefish) and non-native fish (including yellow perch and smallmouth bass) are present in the area. The South Fork Boise River supports strong populations of wild rainbow trout and mountain whitefish. Migratory bull trout are present at very low densities, as are native nongame fish, including largescale sucker, bridgelip sucker, northern pikeminnow, and sculpin.

Invasive plant species and noxious weeds are present in the Study area, especially in disturbed sites and near high recreation use areas. Water bodies in the Study area provide suitable conditions for invasive species, including the following aquatic species already documented in some Idaho waters: parasites that cause whirling disease, New Zealand mudsnail, Asian clam, American bullfrog, oriental weather loach, and multiple crayfish species. Other invasive species not yet documented in Idaho, with potential to occur in the Study area include quagga mussel and zebra mussel. The presence of aquatic invasive species has not yet been documented in the Study area, but they may exist.

The range of vegetation types in the Study area provide a diversity of wildlife habitats, including wintering and nesting habitat for bald eagles and peregrine falcon. Many of the lower-elevation grasslands and shrublands are important winter range for elk and mule deer, and these areas provide foraging habitat for mountain quail, sage grouse, and introduced turkey and chukar. Mid-elevation forests provide habitat for Franklin grouse and ruffed grouse, as well as habitat for several sensitive species including northern goshawk, flammulated owl, and white-headed woodpecker. Higher-elevation forests and ridges provide nesting and foraging habitat for many migratory birds and summer range for mammals such as elk, black bear, mountain lion, and mountain goat. Anderson Ranch Reservoir projects habitat for resident and migratory waterfowl, including merganser, common loon, and Clark’s grebe.

Five Threatened and Endangered (T&E) species (one bird, two mammals, one tree, and one fish) identified by U.S. Fish and Wildlife Service (USFWS) are known or expected to occur in Elmore County. They include the following:

- Three Federally listed species (yellow-billed cuckoo, Canada lynx, and bull trout)
- One species proposed for listing (North American wolverine)
- One candidate species (whitebark pine)

Critical habitat for bull trout occurs in the Study area. Additionally, interior redband trout is an Idaho species of concern and a BLM and USFS sensitive species, and westslope cutthroat trout is listed as a State of Idaho and Federal species of concern by both BLM and USFS and has been proposed for Federal *Endangered Species Act* (ESA) (Public Law [PL] 93-205) listing in some areas of its range. Westslope cutthroat trout have been documented in the South Fork Boise River.

Water and Related Resources Problems, Needs, and Opportunities

Planning for current and future water needs in the Boise River basin is essential for a secure long-term water supply. The IWRB, with support from the Office of the Governor, State Legislature, and local water users, continues to support and pursue increased water storage within the Boise River basin to provide long-term water supply reliability and flexibility, so that water can be provided where and when it is needed. Population growth, climate variability, environmental compliance requirements, and increased concern regarding flood risks have led to increased interest in storage projects to enhance long-term water supply reliability and flood risk reduction as water management tools.

The water resource problems, needs, and opportunities were identified for the Study based on the following:

- Study authority and guidance
- Information from prior studies, projects, and programs
- Existing and likely future water resource conditions
- Input to the Study process through public outreach

Planning objectives were then developed based on identified problems, needs and opportunities, and Study authorities.

Problems Identified

The following sections summarize major water resources problems in the Study area.

Water Demand

Significant growth has occurred and is anticipated to continue in the Treasure Valley and surrounding areas. The Treasure Valley population increased by 22% from 2010 to 2019 (USCB 2019), and projections indicate a further increase in the Treasure Valley population by 2065, from approximately 711,000 (current population) to 1.57 million people (SPF 2016). Coinciding with population growth, extensive land use changes are occurring throughout the valley. Row-crop agriculture and pastoral lands are transitioning to residential and urban environments. These changes have increased the demand for DCMI water. A study prepared for the IWRB and the Idaho Department of Water Resources concluded that projected annual water demand for DCMI uses is anticipated to increase to between 219,000 and 298,000 acre-feet per year by 2065. This represents a DCMI water demand increase ranging from 109,000 to 188,000 acre-feet per year (SPF 2016). These estimates include a 20% reduction in usage by conservation measures. As a result, future demand for water supply from the Boise River system (including Anderson Ranch, Arrowrock, and Lucky Peak reservoirs) is expected to increase.

Climate Variability

In addition to a rapidly increasing demand on water resources for consumptive use, climate variability may exacerbate the problem. Management of the Boise River system is highly dependent on water storage in the snowpack of the surrounding mountains. The River Management Joint Operating Committee (RMJOC) II Climate Change Study (2018), or RMJOC-II Climate Change Study, notes overall trends of increased fall and winter streamflow, earlier and higher spring peak runoff, and earlier streamflow recession. The 2018 study also suggests the potential for increased rain-on-snow events during the winter and spring, as well as annual runoff peaks shifting several weeks earlier compared to historical conditions. The existing infrastructure and fixed storage capacity may not be adequate to manage these projected changes in precipitation patterns (that is, current storage capacity may be insufficient to capture water in ‘wet’ years to offset ‘dry’ years). Furthermore, the early streamflow recession in summer and fall may result in greater dependency on storage water, resulting in less reservoir carryover and an increase in groundwater pumping.

Environmental Flows

Current Boise River system operations consider environmental requirements from three active ESA consultations:

1. Bull trout (USFWS 2005)
2. Bull trout critical habitat (USFWS 2014)
3. Salmon augmentation flows (NOAA 2008)

Within the Boise River system, the Incidental Take Statements associated with the three ESA consultations provide protective coverage through ESA to continue operations and include 10 Terms and Conditions (T&Cs) and 14 Conservation Recommendations. From these requirements, 10 operational targets and 9 physical and biological habitat features are monitored. Furthermore, annual coordination with the USFWS and the National Marine Fisheries Service (NMFS) for within season operations, as well as annual monitoring and a summary report of annual operating and monitoring, are also required.

Prioritizing environmental compliance requires a holistic approach to balance the requirements. This is achieved by using detailed within season forecasting and prior season foresight to reach operational targets each season. Anderson Ranch Reservoir is managed as part of the Boise River system water operations: balancing environmental compliance across the system sometimes means a compromise between individual environmental targets and targets across seasons. Additional water in Anderson Ranch Reservoir, the highest reservoir in the Boise River system, could allow more consistency in meeting environmental targets both within and across seasons. Consistency in meeting existing environmental targets could help Reclamation identify additional flexibility in operations that, when leveraged with existing water deliveries, could provide added fish and wildlife benefits. Benefits to ESA-listed species with volumes of additional water could be realized across each environmental metric, ultimately increasing the ecological wellness of the aquatic system. For example, an increase in flows that improves rearing habitat for juvenile fishes in the South Fork Boise River could help to sustain populations of natural reproducing native fishes, in addition to benefiting bull trout because of the direct association to the prey base. In some years, the migratory population of bull trout in the Boise River system downstream of Anderson Ranch Reservoir has less than 100 adults that migrate to spawning areas; an abundant and diverse prey base ultimately can mean more eggs, better spawning survival, and increased recruitment of young fish to the population.

Needs

The combination of population growth and climate projections is expected to create challenges in meeting existing water contract obligations and increased water supply demand in the Treasure Valley. With these challenges, there is a need to identify, investigate, recommend, and implement a plan for increased storage within the Boise River basin.

Opportunities

Omnibus Public Land Management Act of 2009 (PL 111-11), Section 4007 of the *Water Infrastructure Improvements for the Nation Act* (WIIN Act) (PL 114-322), and the State of Idaho's State Water Plan, 2008 House Joint Memorial 8, 2019 House Joint Memorial 4, and 2019 Idaho House Bill Number 285, provide the opportunity for Reclamation, in partnership with the IWRB, to further investigate increased storage in the Boise River system and potentially construct a storage project. New storage would provide the ability to capture additional water to help meet evolving demands and would provide added flexibility regarding the timing and location of delivery. Because the locations of future development and associated DCMI water demands are uncertain, and because these locations may correspond to areas with limited or restricted groundwater supplies, the flexibility provided by additional surface water storage to meet these future demands is significant.

In years when sufficient water is available to meet environmental commitments and considerations, Reclamation could use water identified for environmental purposes to coordinate with local, State, and Federal entities to provide environmental flows for interim fish and wildlife uses (such as maintenance flows, habitat enhancement and restoration projects, and flushing flows). Following the direction provided by Section 4007 of the WIIN Act to provide a Federal benefit, Reclamation has recognized the opportunity to reserve a portion of the proposed space for environmental flows and intends to reserve 10% of the space for these uses.

Planning Objectives

Primary and secondary planning objectives were developed for this Study based on water and related resource problems, needs, opportunities, and Study authorities. Primary planning objectives are those which specific alternatives are formulated to address. Secondary planning objectives are one or more of actions, operations, or features that should be considered in the plan formulation process, but only to the extent possible through the pursuit of the primary planning objectives.

Primary Planning Objectives

The primary planning objectives are as follows:

- Increase storage capacity in the Boise River basin to help meet existing and future demand.
- Enhance fish and wildlife environment within the Boise River basin or downstream.

Secondary Planning Objective

The secondary planning objective is as follows:

- Reduce flood risks within the Boise River basin.

Plan Formulation

The PR&G, developed by the Council on Environmental Quality (CEQ 2015), provided the approach for formulation of alternative plans. The Study is also consistent with the *Department of Interior 707 DM 1 Handbook and the Reclamation Manual* (DOI 2015); and *Water and Related Resources Feasibility Studies, Reclamation Manual, Directives and Standards, CMP-09-02* (Reclamation 2019b).

Planning Process

This Feasibility Report is the final planning report in the feasibility study process. This Study builds on and uses the results and findings of previous planning documents. The iterative planning process uniquely took place across, and included, multiple planning studies conducted by Reclamation and USACE under varying study authorities. Each planning study was conducted in partnership with the IWRB. While each earlier planning study was performed under a unique agency-specific authority, studies were conducted with similar water resource problems and planning objectives, planning constraints, and planning considerations for the alternative analyses and comparisons. Results from these studies have been incorporated into this Study's plan formulation.

As Figure ES-2 shows, the planning and evaluation process started in 2006 with Reclamation's *Final Boise/Payette Water Storage Assessment Report* (2006 Assessment) (Reclamation 2006), which screened more than 200 potential storage sites in the Boise and Payette River basins, ultimately focusing on nine areas of opportunity. Two subsequent studies led by USACE further evaluated locations identified in Reclamation's 2006 Assessment:

1. *Lower Boise River Interim Feasibility Study, Idaho, Water Storage Screening Analysis* (USACE 2010)
2. *Lower Boise River Interim Feasibility Study, Idaho, Preliminary Evaluation of Arrowrock Site* (USACE 2011)

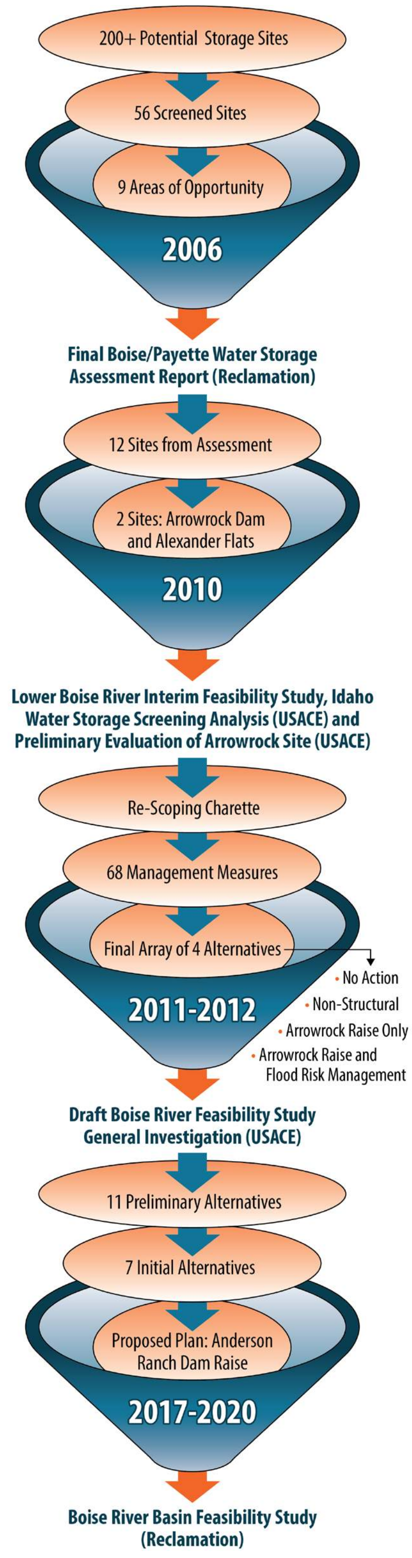

Figure ES-2. Iterative Planning Process

These findings were summarized in USACE's Draft Boise River General Investigation (Boise GI unpublished).

In 2017, Reclamation, in collaboration with the IWRB, initiated this Study, which utilized past study efforts from both Reclamation and USACE as a basis for development of a preliminary list of 11 alternatives. These alternatives were refined to seven initial alternatives, and then to one Proposed Plan (Figure ES-2).

Planning Directives, Objectives, Constraints, and Considerations

Reclamation's formulation of alternative plans followed the PR&G (CEQ 2015), which is the current guidance for formulation of Federal water resources projects. The PR&G requires identification of planning directives, objectives, and constraints to guide feasibility studies. The directives, objectives, constraints, and other considerations associated with this Study are summarized in this report.

Planning Directives

Following the 2006 Assessment (Reclamation 2006), two Federal directives (the first in 2009) and five State directives (the first in 2008) demonstrated the Federal and State commitments to this Study:

- Omnibus Public Land Management Act of 2009 (PL 111-11)
- Section 4007 of the WIIN Act (PL 114-322)
- House Joint Memorial Number 8 (Idaho Legislature 2008)
- House Bill 428 and 644 (Idaho Legislature 2008)
- House Bill 479 (Idaho Legislature 2014)
- House Joint Memorial Number 4 (Idaho Legislature 2019)
- House Bill 285 (Idaho Legislature 2019)

Specifically, Section 4007 of the WIIN Act authorized the Secretary of the Interior to complete the following:

- Enter an agreement with the State of Idaho.
- Commit to a cost share of up to 50% of the total cost of the Federally owned storage project in return for at least a proportionate share of Federal benefits.
- Determine project feasibility.
- Secure the non-Federal funding commitment.

Under the WIIN Act, projects can only receive funding if enacted appropriations legislation designates funding to them by name, after the Secretary of the Interior recommends specific projects and transmits such recommendation to Congress. The Secretary of the Interior must determine whether a proposed storage project is feasible on or before January 1, 2021, in accordance with Reclamation laws and must secure agreement(s) for providing upfront funding to pay the non-Federal share of the capital costs, or post-authorization costs, of the project.

With House Bill 285, the 2019 Idaho Legislature appropriated $20,000,000 for reclamation, upstream storage, offstream storage, aquifer recharge, reservoir site acquisition and protection, water supply, water quality, recreation, and water resource studies, including feasibility studies for qualifying projects. The IWRB has the authority to determine which water projects are undertaken pursuant to the bill.

Planning Objectives

As defined in the PR&G (CEQ 2015), the Federal Objective is set forth in the *Water Resources Development Act* of 2007 (PL 110-114). This Act requires Federal water resources investments to reflect national priorities, encourage economic development, and protect the environment as follows:

> *"1) Seeking to maximize sustainable economic development; 2) Seeking to avoid the unwise use of floodplains and flood-prone areas and minimizing adverse impacts and vulnerabilities in any case in which a floodplain or floodplains area must be used; and 3) Protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems."*

Specific to this Study, as described in the previous section, Reclamation and the IWRB developed three planning objectives:

1. Increased water storage capacity (primary)
2. Fish and wildlife environment enhancement (primary)
3. Flood risk reduction (secondary)

Planning Constraints and Considerations

Specific to this Study, Reclamation identified the following four primary planning constraints:

1. Comply with Federal laws, regulations, and policies.
2. Be consistent with Idaho water law and water rights.
3. Do not impact authorized Boise Project purposes and existing contracts/agreements.
4. Do not violate dam safety standards.

For this Study, Reclamation also included other planning considerations during the formulation, evaluation, and comparison of initial plans and detailed alternative plans. The considerations relate to economic justification, environmental compliance, and technical standards (as well as local policies, practices, and conditions). Examples of these other planning considerations include the following:

- Ability to implement (technical, legal, etc.)
- Costs of implementation (construction, operations and maintenance [O&M], mitigation, etc.)
- Potential impacts on the environment (*National Environmental Policy Act* [NEPA] [PL 91-190], ESA, *National Historic Preservation Act* [PL 102-575], *Clean Water Act* [CWA] [PL 92-500], etc.)

Basis for the Initial Alternatives

Three independent, but interrelated, studies evaluated initial alternatives in the Study area. Each had planning objectives, constraints, and considerations similar to those of this Study. Table ES-1 lists the three studies and the focus or outcome of each study.

Table ES-1. Studies that Evaluated Initial Alternatives

Study	Summary	Coordination, Consultation, and Public Involvement
Final Boise/Payette Water Storage Assessment Report (Reclamation 2006)	Assessment focused exclusively on water storage possibilities as a component of an overall effort to address water supply and water management issues in the Boise Project.	A broad-based working group of local water users and Federal, State, and local partners; irrigation interests; flood control districts; and environmental groups participated in meetings and provided comments.
Draft Boise River General Investigation Study (Boise GI unpublished)	This interim feasibility study focused on water storage as one potential measure to provide additional water supply and flood risk reduction. USACE and IWRB conducted four public information meetings to present the preliminary results of the Water Storage Screening Analysis. More than 150 agencies, organizations, and individuals submitted comments that were incorporated.	USACE and IWRB conducted four public information meetings to present the preliminary results of the Water Storage Screening Analysis. More than 150 agencies, organizations, and individuals submitted comments which were incorporated. Following a planning charette and project rescoping, USACE published an NOI to prepare an EIS for the Boise GI. A 70-foot raise of Arrowrock Dam was proposed for feasibility and environmental analysis. However, the Federal interest could not be justified, as project costs exceeded benefits, and the project was terminated.
USACE and Reclamation Joint Reformulation (2016)	USACE and Reclamation worked together to identify viable alternatives to provide additional water storage capacity – particularly potential smaller, cost-effective raises to the existing dams on the Boise River (Anderson Ranch, Arrowrock, and Lucky Peak).	Reclamation conducted an interested party meeting about raising Anderson Ranch Dam, but not enough funding was identified to meet the 50% non-Federal cost share requirement. Reclamation subsequently met with stakeholders to present initial hydrology and climate change modeling results. The IWRB requested that Reclamation and USACE explore potential solutions to increase storage systemwide. Reclamation presented a proposal to explore smaller-scale dam raises at Anderson Ranch, Arrowrock, and Lucky Peak dams, and the IWRB committed to the proposal.

Notes:
Boise GI = Boise River General Investigation Study
NOI = Notice of Intent

Initial Alternatives of this Feasibility Study

As part of this Study, Reclamation conducted an initial technical review of available information and completed site visits to Anderson Ranch, Arrowrock, and Lucky Peak dams in 2018. The results of these technical reviews concluded that an increase in reservoir storage at Arrowrock and Lucky Peak dams is likely to be significantly more difficult than raising Anderson Ranch Dam due to the physical and regulatory complexities associated with the facilities; and that increasing reservoir storage at Arrowrock and Lucky Peak dams would provide less storage potential.

Preliminary analyses conducted by Reclamation and USACE determined that raising Anderson Ranch Dam by 6 feet would increase storage by approximately 29,000 acre-feet; raising Arrowrock Dam by 10 feet would increase storage by approximately 20,000 acre-feet; and raising Lucky Peak Dam by 4 feet would increase storage by approximately 10,000 acre-feet. Along with a proposed raise of Anderson Ranch Dam, Reclamation evaluated a wide range of non-structural alternatives. From the final list of 15, 4 were advanced for further evaluation:

1. Dredging Anderson Ranch Reservoir
2. Canal lining
3. Automating canal systems
4. Managed recharge of groundwater

Based on screening of preliminary alternatives, as well as the 2019 non-structural analysis, Reclamation determined the following to be initial alternatives of this Study (Tables ES-2 and ES-3).

Table ES-2. Initial Structural Alternatives Identified in the Boise River Basin Feasibility Study

Initial Alternative	Approximate Additional Water Storage Capacity (acre-feet)
6-foot Raise at Anderson Ranch Dam	29,000
10-foot Raise at Arrowrock Dam	20,000
4-foot Raise at Lucky Peak Dam	10,000

Table ES-3. Initial Non-structural Alternatives Identified in the Boise River Basin Feasibility Study

Initial Alternative	Approximate Additional Water Storage Capacity (acre-feet)
Dredging Anderson Ranch Reservoir	25,000
Canal Lining	Unknown[a]
Automating Canal Systems	Unknown[b]
Managed Recharge of Groundwater	Unknown[c]

Initial Alternative	Approximate Additional Water Storage Capacity (acre-feet)
No Action	0

[a] During the Study, an alternative to line portions of the New York and Mora Canals (both Federal facilities) was briefly considered but eliminated after determining it would not meet the primary planning objectives.

[b] Following additional analysis specific to the Boise River basin, it was concluded that, while 33 of the 50 diversion sites are unautomated, the 17 diversion sites that are automated account for the majority of the diverted flow. Automating the remaining 33 of 50 sites would result in minimal potential water savings; therefore, canal automation was screened from further analysis.

[c] At this time, it is not yet understood who (both putting water into the aquifer and pulling out of the aquifer), what (infrastructure required to pull water out, transport it, and recharge it), where (both injection/infiltration and well sites), when (when and where water would be available once in the aquifer), or how (implementation - capital/long-term O&M investment, groundwater administration, etc.) the State's managed aquifer recharge study could be implemented in lieu of a storage project. The State and other independent entities will continue to explore options to use managed aquifer recharge as a water management tool in the future.

Selection of Proposed Plan for Feasibility-level Evaluation

Reclamation concluded that the feasibility of raises to all three dams could not be evaluated before January 1, 2021. Subsequently, Reclamation recommended to the IWRB that focusing Study efforts on a raise of Anderson Ranch Dam would be most appropriate. The IWRB agreed, signing a board resolution in July 2018, authorizing Reclamation to focus Study analysis on a raise of Anderson Ranch Dam with the intent to determine project feasibility in accordance with conditions of Section 4007 of the WIIN Act.

Given the significant engineering challenges and implementation risks associated with increasing reservoir storage at Arrowrock and Lucky Peak dams; resource constraints associated with evaluating alternatives at the feasibility level; and time constraints associated with the Secretary of the Interior making a finding of feasibility in accordance with Section 4007 of the WIIN Act, Reclamation and the IWRB, as evidenced by their July 2018 resolution, determined to carry forward a 6-foot raise at Anderson Ranch Dam as the structural alternative to be analyzed at the feasibility level.

Following extensive efforts in 2019 to identify and evaluate non-structural alternatives per the PR&G (including input from external stakeholders), Reclamation and the IWRB screened out all non-structural alternatives identified. The feasibility-level alternative to be evaluated is the Anderson Ranch 6-foot Dam raise. This alternative, herein referred to as the Proposed Plan, would raise Anderson Ranch Dam 6 feet from the present top-of-pool elevation and would provide 29,000 acre-feet of additional water storage capacity in the Boise River basin.

Without Plan (No Additional Federal Action)

For all Federal feasibility studies of potential water resources projects, future conditions Without Plan represents a projection of reasonably foreseeable future conditions that could occur if no action alternatives are implemented (that is, the future without the proposed project). Future conditions Without Plan represents the existing infrastructure and facilities in the Study area and the existing water supply conditions in the Treasure Valley area. In a study prepared for the IWRB, Treasure Valley projected annual water demand for DCMI uses is anticipated to increase to between 219,000 and 298,000 acre-feet per year by 2065. This represents a DCMI water demand increase ranging from 109,000 to 188,000 acre-feet per year (SPF 2016).

Extensive land use changes are occurring and are likely to continue throughout the Treasure Valley. Most visibly, row-crop agriculture and pastoral lands are transitioning to residential and urban environments. Some portion of increased population growth in the Treasure Valley would occur on lands currently used for irrigated agriculture. Therefore, water that would have been needed for irrigation of these lands may, instead, be used to serve urban demands, such as residential and commercial irrigation. However, this would only partially offset the change in agricultural to urban water demand because growth would also occur on non-irrigated agricultural lands.

In addition to a rapidly increasing demand on water resources for consumptive use, climate change is likely to stress existing water resources. Management of the Boise River system is highly dependent upon water stored in the form of snowpack in the watershed. Future climate variability will impact the timing and volume of flows entering Anderson Ranch Reservoir, and these changes are expected to affect how Reclamation operates its two reservoirs in the three-reservoir system (Anderson Ranch, Arrowrock, and Lucky Peak). The existing infrastructure and fixed storage capacity of the current Boise River system may not be adequate to manage these projected changes to current surface water resources (that is, current storage capacity may be insufficient to capture water in ‘wet’ years to offset ‘dry’ years).

Proposed Plan (Anderson Ranch 6-foot Dam Raise)

The Proposed Plan would raise Anderson Ranch Dam by 6 feet. This increase in the dam height would increase the active reservoir water surface (RWS) elevation from 4196 feet to 4202 feet, and the additional dam height would increase the storage volume of Anderson Ranch Reservoir by approximately 29,000 acre-feet, as shown on Figure ES-3. This new reservoir space would allow Reclamation to store precipitation when available during wet years for supplemental supply and to hold over for use during dry years.

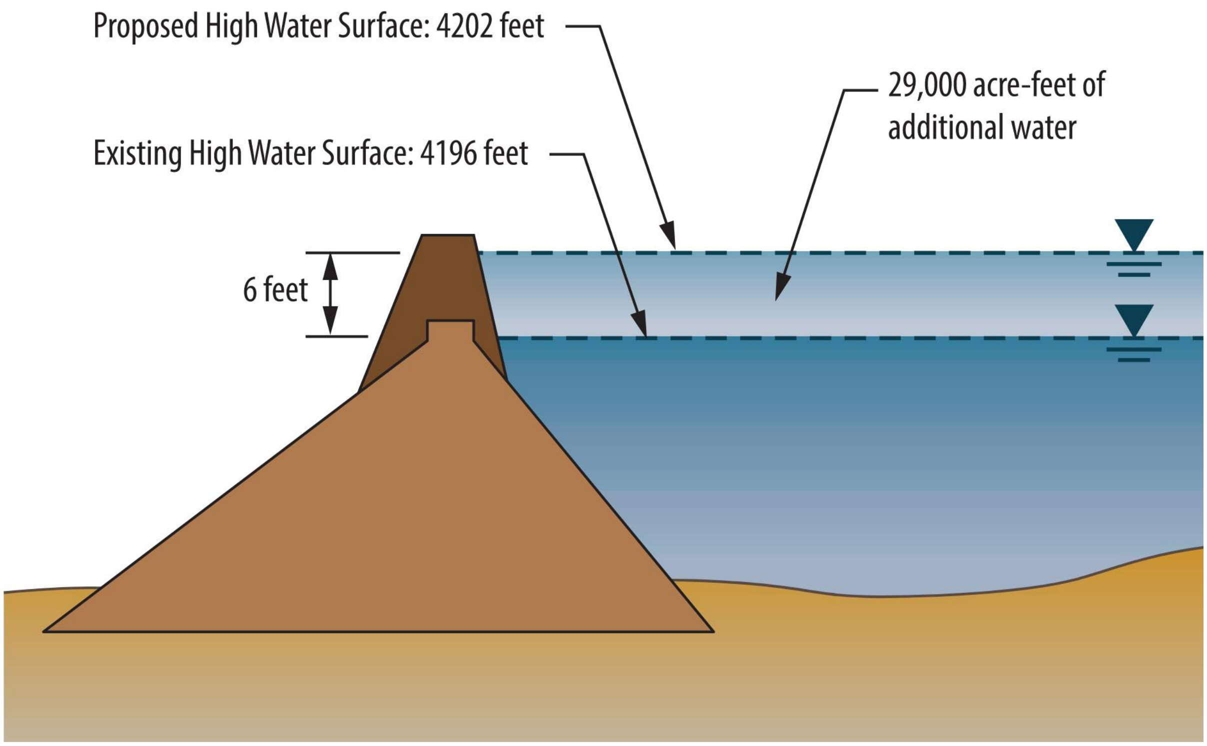

Figure ES-3. Proposed 6-foot Anderson Ranch Dam Raise

In addition to the dam raise, the Proposed Plan includes changes to the spillway and outlet works at the dam as well as adjacent approach roads. Beyond the dam and immediate vicinity, the Proposed Plan would include multiple modification, rehabilitation, or replacement projects around the perimeter, or rim, of the reservoir to existing infrastructure and facilities including roads, bridges, culverts, boat ramps, campgrounds, and the Pine Airstrip. The construction of the Proposed Plan would require road closures and detours and associated improvements to the detour routes. Additional design information and details regarding construction considerations, schedule, and cost estimates for the dam raise prepared by Reclamation's Technical Service Center are provided in Appendix B – Engineering Summary Report.

Major components of the Proposed Plan include the following:

- Expansion of Anderson Ranch Reservoir by 29,000 acre-feet by raising Anderson Ranch Dam 6 feet
- Dam crest raise to elevation 4212 feet using compacted zoned fill and compacted soil cement on the downstream face; construction of a reinforced concrete parapet wall along the upstream crest
- Replacement of the spillway ogee crest structure, bridge, center pier, spillway floor slabs and chute walls, and approach structure; removal, refurbishment, and reinstallation of existing spillway radial gates

- Realignment of approximately 2,200 feet of the right abutment approach road at a maximum grade of 12%
- Establishment of a detour route along HD-131, which includes snow removal, moderate road improvements along alignment, and approximately 3,000 feet of new alignment construction
- Riprap road embankment or shoreline stabilization, or both, to prevent erosion and protect existing road infrastructure at 12 locations around the perimeter of the reservoir, varying in length from 100 to 800 feet
- Removal of existing retaining walls and reinstallation with a higher top-of-wall elevation to withstand the increased water surface elevation at three locations along HD-61 (between Curlew Creek and Lime Creek); the total length of existing wall to be replaced with a mechanically stabilized earth (MSE) wall is 400 feet
- Construction of a new MSE wall at one additional location along HD-120 (near Castle Creek) to protect the existing road from an increased water surface elevation; the total length of the new MSE wall is 125 feet
- A grade raise of approximately 1 foot of a length of road along HD-128 (south of the Pine Airstrip) to properly impound the increased top of active water surface elevation of the reservoir; the road length that needs to be raised is approximately 800 feet long and consists of two 12-foot lanes with 2-foot shoulders
- Relocation of a rural airport with one turf runway at a different orientation and similar dimensions, keeping it out of the future water line after the proposed dam raise; this project would be primarily an earthwork project, with a near net zero cut and fill balance
- A 1-foot raise of the Pine Bridge over the South Fork Boise River may be needed to prevent any encroachment of the existing freeboard space; this would require the temporary removal of the superstructure, the installation of additional piles, the reconstruction of taller abutments to withstand additional loads, and the reuse of the existing superstructure; a design standard variance could be pursued and, if granted, would negate the need for this project
- Reparation of the abutment slopes at the Lime Creek Bridge to the original slopes and the installation of Class 5 riprap
- Retrofitting of the Deer Creek culvert at HD-61 and the Fall Creek culvert at HD-113 with channel regrading, as well as construction of instream structures to increase the pool depths and provide grade control, and installation of baffles in the existing culvert to facilitate fish passage
- Removal and relocation or removal only of up to 24 power poles and associated overhead power distribution line, two transformers, and approximately 200 feet of underground powerline in conduit

- Relocation of USFS recreation facilities, including campgrounds and campsites, day use areas, picnic tables, fire rings, boat dock and ramp infrastructure, access roads, and a drinking water well

Plan Evaluation

The PR&G (CEQ 2015) requires Federal agencies investing in water resources strive to maximize public benefits, which encompass environmental, economic, and social goals. Benefits can be monetary or non-monetary and may be quantified or unquantified benefits. This information allows stakeholders and decision-makers to review a range of alternative solutions, with varying degrees of benefits or impacts, or both. The plan evaluation used the ecosystem services framework to evaluate the Proposed Plan.

Ecosystem Services Framework

An overarching objective of this evaluation is an accounting of the costs and benefits associated with the Proposed Plan, and how associated ecosystem services are impacted relative to the Without Plan condition. This approach is identified as the ecosystem services framework approach in the PR&G (CEQ 2015) as a requirement (DOI 2015) but also may not apply to all analyses (CEQ 2014). The decision to use the ecosystem services framework to evaluate the Proposed Plan is based on the purposes and non-market economic valuation approaches applied in the public benefits analysis. Functioning ecosystems provide a range of services that are essential to support economic activity and improve environmental conditions. Ecosystems directly and indirectly support human wants and needs that contribute toward social welfare. These contributions reflect economic benefits. Some are essential for human survival (such as food), while others support services that contribute toward human enjoyment (such as recreation). Economic benefits can also result from the passive use value that people derive from the protection, enhancement, and preservation of natural resources (such as national parks and habitat for T&E species) for the use and enjoyment of others, including future generations. Ecosystem services contribute toward the full range of economic benefits that people obtain from nature (Millennium Ecosystem Assessment 2003; Smith et al. 2011). The essential problem is tracing through the ecosystem processes to identify how they ultimately benefit humans and then quantifying the magnitude of these environmental benefits. It is not appropriate to value both the indirect benefit (for example, flood protection) and the direct benefits that result from flood protection (such as avoided damages). To avoid double-counting, where possible, the goal is to identify the direct benefits and passive use benefits.

The ecosystem services concept provides a common framework to support decision-making. Four general kinds of ecosystem services are considered:

1. **Provisioning services** refer to the food, fuel, fiber, and clean water that ecosystems provide. Provisioning services are the products obtained from ecosystems, and water is one of the most valuable ecosystem services. Human modification of ecosystems (such as

reservoir creation) has significantly impacted natural river systems by making water available to people for a variety of uses but also reducing river flows downstream of dams and increasing open water evaporation. Water also provides a service in the form of renewable energy through hydropower by making the energy more available to people.

2. **Regulating services** refer to specific ecosystem processes that indirectly support economic benefits for which people are willing to pay. Regulating services are obtained from the impact of an ecosystem on naturally occurring processes, which influence climate, plant reproduction, and water flows. On the global scale, ecosystems play an important role in climates by emitting or sequestering greenhouse gases, or both. At a local scale, existing land use patterns and development trends have had an effect in the Study area, and these trends affect temperature and precipitation. The effect of change on the timing and magnitude of runoff, flooding, and aquifer recharge is highly dependent on the ecosystem.
3. **Cultural services** refer to the benefits ecosystems confer that do not directly relate to our physical health or material well-being. Cultural services are non-material benefits that people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences. Examples include recreation, aesthetic, spiritual, existence, and option "values."
4. **Habitat and Supporting services** refer to services necessary for the support and maintenance of all other ecosystem services. They differ from provisioning, regulating, and cultural services in that their impacts on people are often indirect or occur over a very long time, whereas changes in the other categories have relatively direct and short-term impacts on people. Even so, they are critical building blocks of functioning systems.

Whereas provisioning, regulating, and cultural services are largely experiential, habitat and supporting services primarily generate passive use (or "non-use" values), which depend simply on the continued survival of the ecosystem and its attributes. Estimating the value of provisioning services is relatively straightforward, because market data typically can be used. However, estimating the value of regulating, cultural, habitat, or supporting services is relatively challenging for two reasons. First, ecosystem process models are needed to trace through the ecosystem and identify the outcomes that satisfy human wants and needs. Second, the quantification of the resultant economic benefits typically involves non-market valuation methods, including willingness to pay studies applying techniques specific to the service in question. As a result, these methods may not be used in all PR&G analyses. Economic benefits, therefore, depend upon both the ecological landscape (which defines how the level and quality of ecosystem services respond to a change) and the human landscape (which determines the economic value that the public derives from the direct human uses and passive uses that result from those changes).

DOI bureaus and offices apply ecosystem services analyses and conduct research on ecosystem services in cooperation with other partners on local, regional, and national scales. Reclamation considers ecosystem services when evaluating the benefits and costs of water projects. The differences in services provided by the Proposed Plan, relative to the Without Plan condition, are the basis for comparing public benefits. Figure ES-4 illustrates the ecosystem services, by type, that are supported by the Proposed Plan.

Figure ES-4. Ecosystem Services Supported by the Proposed Plan

Table ES-4 summarizes the types of ecosystem services and ultimate benefits to humans that were considered in evaluating the Proposed Plan. This table lists three types of benefits: environmental, economic, and social. The environmental and social benefit identifiers indicate whether the outcome contributes positively or negatively to an environmental or other social goal. The economic benefit relates to the public's willingness to pay for the outcome and is preferably expressed in dollars. Where that is not feasible, the outcome is described qualitatively in terms of how it contributes toward the environmental or social goals of the public.

Table ES-4. Summary of Ecosystem Services Framework for Evaluation of the Proposed Plan

Ecosystem Services	Project Example	Environmental Public Benefits	Economic Public Benefits	Social Public Benefits	Monetized	Related or Additional Services
Provisioning Services	Water Supply	Unknown	Increase	Increase	Economic benefit of DCMI and irrigation water supply	Food (increase), Water Regulation (unknown), Erosion (decrease), Water Quality (increase)
Regulating Services	Natural Hazard Regulation (Flood Control)	Marginal decrease	Unknown	Marginal increase	Not monetized	Water Regulation (unknown)
Provisioning Services	Hydropower	Increase	Increase	Unknown	Hydropower revenue generation	Climate Regulation (unknown)
Cultural Services	Recreation	Decrease	Increase	Increase	Economic benefit of improvement to motorized boating	Aesthetic Values (unknown)
Habitat and Supporting Services	Fish and Wildlife	Increase	Increase	Increase	Fish and wildlife water supply	Soil Formation (unknown), Fish Habitat (increase)

Notes:

Increase is defined generally by an increase in production of the service (e.g., for provisioning services, an increase in food production).

Decrease is defined generally by a decrease in production of the service (e.g., for cultural services, a decrease in shade at established campgrounds due to tree removal).

Unknown is defined generally as the change is either small or not evaluated, and the direction (whether positive or negative) is unclear.

Public Benefits and Costs

The evaluation of public benefits and costs is an important aspect of the plan evaluation. This section presents the results of the analysis of the Proposed Plan public benefits, which involves evaluating the environmental, economic, and social goals of public benefits. The monetized and quantified economic benefits of the Proposed Plan are detailed in Appendix C – Economic Benefits. The costs are detailed in Appendix D – Cost Allocation. Together, the information from these two appendices provides the overall benefit-cost ratios in Section 5.3.3. Table ES-5 provides the present value economic benefits by project purpose.

Table ES-5. Present Value Economic Benefits by Project Purpose

Purpose	Economic Valuation Approach and Methodology	Present Value Economic Benefits (in 2025 U.S. Dollars)
DCMI	Willingness to pay: Shortage Cost Function ($748 per acre-feet)	$129,399,000
Irrigation	Willingness to pay: Schmidt et al. 2009 ($105 per acre-feet)	$18,164,000
Fish and Wildlife	Avoided Cost: Market Appraisal (DOI 2011) ($70 per acre-feet)	$2,691,000
Hydropower	Market Price: Revenue Generation ($37 per megawatt-hour)	$3,799,000
Recreation	Benefit-Transfer: Average of Upper and Lower Bound Estimates (increase of $5.06 per person per day)	$5,524,000
	Total Present Value Economic Benefits	$159,577,000
	Annualized Total Benefit	**$4,700,000**

Note: Total present value benefit is adjusted to annual equivalent values, depicted in the table as annualized total benefit, over the period of analysis by use of the 2020 Federal discount rate as described in the PR&G Agency Specific Procedures (ASP) (707 DM 1 Handbook) (DOI 2015).

Table ES-6 shows the total construction costs, interest during construction, and resulting present value total cost of the Proposed Plan, as detailed in Appendix D – Cost Allocation.

Table ES-6. Interest during Construction and Total Present Value

Cost Category	Cost (in 2025 U.S. Dollars)
Total Construction Cost	$83,300,000
Interest during Construction	$8,370,000
Present Value Total Cost	$91,670,000
Total Annualized Costs	**$2,700,000**

Note: Total present value costs are adjusted to annual equivalent values, depicted in the table as total annualized costs over the period of analysis using the 2020 Federal discount rate, as described in the PR&G ASP (707 DM 1 Handbook) (DOI 2015).

PR&G Guiding Principles

The following Principles constitute the overarching concepts the Federal government seeks to promote through Federal investments in water resources now and into the foreseeable future. The PR&G Guiding Principles are presented in no order and their organization denotes no hierarchy or rank (CEQ 2014).

- **Healthy and Resilient Ecosystems** not only enhance the essential services and processes performed by the natural environment, but also contribute to the economic vitality of the Nation. In order to protect ecosystems, the Proposed Plan seeks first to avoid or minimize any adverse environmental impact. When damage to the environment is unavoidable, mitigation for adverse effects is provided for in the Proposed Plan through mitigation measures.
- **Sustainable Economic Development** was evaluated quantitatively in the Draft Environmental Impact Statement (DEIS) (Reclamation 2020a). The evaluation was completed for both short-term socioeconomic changes following construction of the Proposed Plan and long-term changes assumed to occur during the operational phase of the Proposed Plan. The results of this analysis indicate that the construction activities associated with the Proposed Plan are expected to create employment opportunities within and outside the analysis area, and an overall increased level of income and total industry output.
- **Floodplains** are critical components of watersheds and connect land and water ecosystems by supporting high levels of biodiversity and productivity. Floodplains that have not been adversely affected can sustain their natural functions and increase the resilience of communities. For this reason, Federal investments in water resources should avoid the unwise use of floodplains and flood-prone areas and minimize adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used. The Proposed Plan would preserve the natural and beneficial values served by the floodplains.
- **Public Safety** was assessed in the determination of existing and future conditions and, ultimately, in the decision-making process. The Proposed Plan avoids, reduces, and mitigates risks to the extent practicable and include measures to manage and communicate residual risks. As discussed in Appendix B, the Proposed Plan has been developed in order to remain risk neutral with respect to current dam safety facility risk.
- **Environmental Justice** involves identification of potentially affected minority, low-income, and other disadvantaged communities; and engaging them in a meaningful way throughout the Study. There would be no disproportionate impacts on minority and low-income populations as a result of the Proposed Plan.
- **Watershed Approach** to analysis and decision-making facilitates evaluation of a more complete range of potential solutions and is more likely to identify the best means to achieve multiple goals over the entire watershed. Existing conditions in the watershed

informed the planning process and plan formulation and resulted in the Proposed Plan as a solution for the problems and needs of the watershed. Furthermore, planning objectives for the Study were formulated specifically to meet multiple objectives.

Table ES-7 illustrates that the planning, formulation, and evaluation of the Proposed Plan is aligned with the PR&G Guiding Principles.

Table ES-7. Summary of PR&G Guiding Principles

Guiding Principles	Proposed Plan
Healthy and Resilient Ecosystems	Yes
Sustainable Economic Development	Yes
Floodplains	Yes
Public Safety	Yes
Environmental Justice	Yes
Watershed Approach	Yes

Evaluation Criteria

The PR&G (CEQ 2015) includes four criteria to formulate and evaluate alternative plans: completeness, effectiveness, efficiency, and acceptability. Each is defined as follows:

1. **Completeness** is a determination of whether a plan includes all elements necessary to realize planned effects, and the degree to which intended benefits of the plan depend on the actions of others.
2. **Effectiveness** is the extent to which an alternative alleviates problems and achieves objectives.
3. **Efficiency** is the measure of how efficiently an alternative alleviates identified problems while realizing specific objectives consistent with protecting the Nation’s environment.
4. **Acceptability** is the workability and viability of a plan concerning its potential acceptance by other Federal agencies, Idaho State and local governments, and public interest groups and individuals.

The Proposed Plan is identified as the Recommended Plan. The Proposed Plan would achieve a net increase in public benefits while protecting the environment. Table ES-8 summarizes the findings of the plan evaluation following the requirements of the PR&G. Based on the plan evaluation, the Proposed Plan provides a net public benefit of $2,000,000 annually. The resulting benefit-cost ratio is 1.74. This evaluation followed the PR&G recommended ecosystem services framework and consideration of the environmental, economic, and social goals of public benefits. The Guiding Principles of the PR&G are each achieved with the Proposed Plan. The plan formulation criteria have considered the plan complete, highly effective, efficient, and highly acceptable.

Table ES-8. Summary of Plan Evaluation

Item	Proposed Plan
Total Annual Economic Benefits to the Public	$4,700,000
Total Annual Costs	$2,700,000
Net Annual Economic Benefits to the Public	**$2,000,000**
Proposed Plan Benefit-Cost Ratio	**1.74**
PR&G Guiding Principles	All Guiding Principles Achieved
Plan Formulation Criteria	Rating
• Completeness	Complete
• Effectiveness	Highly Effective
• Efficiency	Efficient
• Acceptability	Highly Acceptable

Note: Total present value benefits and costs are adjusted to annual equivalent values, depicted in the table as total annual economic benefits to the public and total annual costs, over the period of analysis by use of the 2020 Federal discount rate as described in the PR&G ASP (707 DM 1 Handbook) (DOI 2015).

Implementation of the Recommended Plan

As required by the PR&G (CEQ 2015), the plan that maximizes net public benefits is typically selected for recommendation to the Secretary of the Interior for consideration and approval (DOI 2015). A plan recommending Federal action is to be the plan that best addresses the targeted water resources problems and needs while considering public benefits relative to costs.

The Proposed Plan is the Recommended Plan based upon the evaluation and comparisons described in Chapter 5. The Proposed Plan has a net annual public benefit of $2.0 million; a benefit-cost ratio of greater than 1.0; and a high overall ranking for completeness, effectiveness, efficiency, and acceptability. The Proposed Plan provides water supply benefits to DCMI, irrigation, fish and wildlife, hydropower, and recreation.

The combination of population growth and climate projections is expected to create challenges in meeting existing water contract obligations and increased water supply demand in the Treasure Valley and is the main driver for this Study. This Study assesses increased storage potential in the Boise River watershed behind Reclamation's Anderson Ranch Dam to meet this water supply need. In addition to the DCMI and irrigation purposes of the Proposed Plan, other purposes (such as water supply for fish and wildlife, hydropower, and recreation) add to the overall benefit of the Proposed Plan. By evaluating these purposes through the ecosystem services framework, the net public benefits of the Proposed Plan demonstrate the need for the project and the compelling return to this Federal investment.

Feasibility of Recommended Plan

The Recommended Plan is projected to be technically feasible, constructible, and operable and maintainable. Designs and cost estimates for the Proposed Plan have been developed to a feasibility level as verified through the Design, Estimating, and Construction Review process. The Recommended Plan will be considered environmentally feasible upon the signing of a Record of Decision (ROD) and after permits and approvals have been secured for construction. The DEIS (Reclamation 2020a) evaluates environmental effects and identifies mitigation measures. The Recommended Plan maximizes public benefits and is projected to be economically feasible, generating annual net benefits of $2.0 million annually. The non-Federal cost share partners are required to provide upfront funding for the non-Federal cost assignments per the requirements of Section 4007 of the WIIN Act. On April 2, 2019, the Idaho State Legislature transmitted to Reclamation the House Joint Memorial Number 4 adopted by the House of Representatives and the State Senate to support the non-Federal cost share requirements and financial feasibility.

Coordination, Consultation, and Outreach

Throughout the Study, Reclamation engaged the public, stakeholders, Tribes, Federal and State agencies, and other interested parties. If the project is authorized by Congress, Reclamation will continue coordination, consultation, and outreach during implementation. Specifically, Reclamation conducted formal scoping and consultation with permitting agencies, as well as informal public engagement and meetings, stakeholder outreach, environmental review, and agency coordination activities for three initial alternatives (Table ES-9).

Table ES-9. Coordination, Consultation, and Outreach

Party	Summary
Public Outreach	Reclamation and the IWRB led a site visit for congressional staff and key stakeholders to discuss preliminary findings of an initial technical review of USACE‘s Lucky Peak Dam and Reclamation’s Arrowrock and Anderson Ranch dams. Reclamation and the IWRB hosted an Open House for 70 participants to describe the feasibility study.
State Collaboration	Reclamation and the State held a State-agency coordination meeting to allow for early coordination with potential State-agency stakeholders.

Party	Summary
Federal Consultation and Coordination	Agency consultation and involvement was ongoing throughout the Study, both informally and formally. Reclamation formally requested that the USFS, USFWS, BLM, and USACE participate as cooperating agencies. The USFS response confirmed they would participate as a cooperating agency due to their jurisdictional responsibility over land within the Study area. USACE confirmed their participation as a cooperating agency related to their involvement through the 404-permitting process. Reclamation, the USFS, and USACE participated in regular meetings and coordinated review sessions. Reclamation has consulted with BPA as the Federal power marketing administration for Anderson Ranch Dam. As discussed in Section 6.3.4.5, construction costs allocated to hydropower will be included in existing agreements with the BPA for repayment in accordance with Federal Reclamation law.
Tribal Government to Government Consultation	During the scoping period and development of the DEIS (Reclamation 2020a), Reclamation contacted two Federally recognized Tribes with connections to the Study area: (1) the Shoshone-Bannock Tribes of the Fort Hall Reservation, and (2) the Shoshone-Paiute Tribes of Duck Valley Reservation.

Note:

BPA = Bonneville Power Administration

Environmental Review

Reclamation is the lead agency pursuant to NEPA. Reclamation published an NOI in the Federal Register on August 9, 2019, to advise interested agencies and the public that an EIS would be prepared. In addition to the NOI, informational materials were publicly distributed to inform stakeholders about the Study and solicit input. Materials included press releases, newspaper notices, Reclamation news releases, website postings, and general notification flyers.

The 30-day scoping comment period extended from August 9, 2019, through September 9, 2019. The public was invited to submit written comments on the scope, content, and format of the environmental document by mail, fax, or email to Reclamation. Three formal scoping meetings were held to gather input and comments before the development of the EIS. The meetings were held in Pine, Boise, and Mountain Home, Idaho, on August 27, 28 and 29, 2019, respectively. Approximately 175 people attended the three meetings.

A *Scoping Summary Report* was prepared by Reclamation following the scoping period, and a Public Comment Summary will be prepared by Reclamation following the public comment period. Each report outlines the process and outcome of the public meetings and other activities; outlines scoping requirements; lists all documents and products generated for project outreach; summarizes comments made during the scoping process; describes issues anticipated to be addressed in the Final Environmental Impact Statement (FEIS); and provides copies of all written comments, summaries of the scoping meetings, and other project-related print materials used to inform interested parties about the project alternatives.

The DEIS (Reclamation 2020a) was released for public review in July 2020 and, in accordance with NEPA requirements, was available for public and agency review and comment for a 45-day period following the publishing of the Notice of Availability of the EIS by the U.S. Environmental Protection Agency (EPA). A virtual public meeting will be held during the public comment period. An FEIS will be prepared by Reclamation for public release in February 2021.

Recommendations

The overall recommendation of this Feasibility Report is that the Secretary of the Interior, acting through Reclamation, participate in funding and implementing the Proposed Plan, including the environmental commitments and mitigation measures identified in the planned FEIS. Section 4007 of the WIIN Act provides authority for the Secretary of the Interior to complete the following:

1. Participate in surface water storage projects that are constructed, operated, and maintained pursuant to Reclamation laws
2. Enter into an agreement with non-Federal partner(s) on behalf of the United States for planning, permitting, design, and construction costs

The Secretary of the Interior can participate in a Federally owned storage project up to "an amount equal to not more than 50% of the total cost of the Federally owned storage project." Section 4007 of the WIIN Act requires that at least a proportional share of the project benefits must be Federal benefits, including water supplies dedicated to specific purposes such as environmental enhancement and wildlife refuges. Section 4007 of the WIIN Act contains a set of requirements that must be met before funding.

This Feasibility Report documents partial confirmation of these requirements, and remaining requirements are expected to be confirmed through action by the State of Idaho, as the local sponsor (refer to Chapter 6). Pursuant to fulfilling the final requirements of Section 4007 of the WIIN Act, the following is recommended:

- Approve the Recommended Plan, as outlined in this report, and submit the following determinations to Congress, in accordance with Section 4007(c)(2)(D) of the WIIN Act:
    - The project is technically, environmentally, economically, and financially feasible.
    - Sufficient non-Federal funding is available to complete the project.
    - The project sponsors are financially solvent.
    - In return for the Federal investment, a proportionate share of the project benefits are Federal benefits.

- Request that Congress funds the Federal share of construction.
  - Request that Congress authorize Reclamation to increase the construction cost if necessary to allow for escalation from assumed price levels to the notice to proceed for each contract or work package, based upon Reclamation's Construction Cost Trends publication or similar source.
- Authorize the Commissioner of the Bureau of Reclamation to enter into a cost-sharing agreement for the construction of the Recommended Plan.

The Recommended Plan includes the following purposes: DCMI, irrigation, fish and wildlife, hydropower, and recreation. These will be the authorized purposes for the storage associated with the raised portion of Anderson Ranch Dam upon determination of feasibility by the Secretary of the Interior, transmittal of recommendation for funding to Congress, and Congress' acceptance of those authorized purposes through legislation designating the project by name.

Acronyms and Abbreviations

Acronym or Abbreviation	Meaning
°F	degree Fahrenheit
2006 Assessment	*Final Boise/Payette Water Storage Assessment Report*, July 2006
707 DM 1 Handbook	*Agency Specific Procedures For Implementing the Council on Environmental Quality's Principles, Requirements and Guidelines for Water and Land Related Resources Implementation Studies*
AJE	Alternative Joint Expenditures
amsl	above mean sea level
ASP	Agency Specific Procedures
B.P.	before present
BA	Biological Assessment
BFE	Base Flood Elevation
BiOp	Biological Opinion
BLM	U.S. Bureau of Land Management
Boise GI	Boise River General Investigation Study
BPA	Bonneville Power Administration
CAMP	Treasure Valley Comprehensive Aquifer Management Plan
CCE	Cat Creek Energy LLC
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulation
cfs	cubic foot per second
CMP	Comprehensive
Contractor	Sundance-EA Partners II, LLC
CWA	*Clean Water Act*
DCMI	domestic, commercial, municipal, and industrial
DEC	design, estimate, and construction
DEIS	Draft Environmental Impact Statement
DM	Departmental Manual

Acronym or Abbreviation	Meaning
DOI	U.S. Department of the Interior
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	*Endangered Species Act*
FAC	Project Planning and Facility Operations, Maintenance, and Rehabilitation
FEIS	Final Environmental Impact Statement
FR	Federal Register
FRM	flood risk management
GIS	geographic information system
HD	Highway District
Idaho Power	Idaho Power Company
IDC	interest during construction
IDEQ	Idaho Department of Environmental Quality
IDFG	Idaho Department of Fish and Game
IDWR	Idaho Department of Water Resources
IG	Interagency Guidelines
ITD	Idaho Transportation Department
ITS	Incidental Take Statement
IWRB	Idaho Water Resource Board
Jacobs	Jacobs Engineering Group Inc.
kW	kilowatt
LiDAR	light detection and ranging
MSE	mechanically stabilized earth
MWh	megawatt-hour
NCC	non-contract cost
NEPA	*National Environmental Policy Act*
NFS	National Forest System
NMFS	National Marine Fisheries Service
NOI	Notice of Intent

Acronym or Abbreviation	Meaning
O&M	operations and maintenance
OM&R	operations, management, and replacement
P&G	*Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*
P&R	*Principles and Requirements for Federal Investments in Water Resources*
PL	Public Law
PL 57-161	*Reclamation Act of 1902*
PL 89-72	*Federal Water Project Recreation Act of 1965*
PL 90-542	*Wild and Scenic Rivers Act of 1968*, as amended
PL 91-190	*National Environmental Policy Act*
PL 92-500	*Clean Water Act*
PL 93-205	*Endangered Species Act*
PL 101-601	*Native American Graves Protection and Repatriation Act*
PL 102-575	*National Historic Preservation Act of 1966 as amended through 1992*
PL 106-53	*Water Resources Development Act of 1999*
PL 108-447	*Snake River Water Rights Act of 2004*
PL 110-114	*Water Resources Development Act of 2007*
PL 111-11	*Omnibus Public Land Management Act of 2009*
PL 114-322	*Water Infrastructure Improvements for the Nation Act*
PL 115-141	*Consolidated Appropriations Act of 2018*
PL 115-244	*Energy and Water, Legislative Branch, and Military Construction and Veterans Affairs Appropriations Act, 2019*
PR&G	*Principles, Requirements and Guidelines for Water and Land Related Resources Implementation Studies*
QCI	Quadrant Consulting, Inc.
Recharge Study	Treasure Valley Managed Recharge Feasibility Study
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
Rim Analysis	Boise River Storage Feasibility Study – Land, Structure, and Real Estate Survey/Analysis

Acronym or Abbreviation	Meaning
RMJOC	River Management Joint Operating Committee
ROD	Record of Decision
RPM	reasonable and prudent measure
RWS	reservoir water surface
SMART	specific, measurable, attainable, risk-informed, and timely
SPF	SPF Water Engineering, LLC
State Water Plan	Idaho State Water Plan
Study	Boise River Basin Feasibility Study
T&Cs	Terms and Conditions
T&E	Threatened and Endangered
Treasure Valley DCMI Report	*Treasure Valley DCMI Water-Demand Projections (2015-2016)*
TSC	Technical Service Center
U.S.	United States
USACE	U.S. Army Corps of Engineers
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USFS	U.S. Department of Agriculture, Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WEDA	Western Dredging Association
WIIN Act	*Water Infrastructure Improvements for the Nation Act*
WOTUS	waters of the United States

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Chapter 1 Introduction

The Boise River Basin Feasibility Study (Study) evaluates increasing storage opportunity within the Boise River basin to meet existing and future water supply demands within the basin, primarily through the expansion of Anderson Ranch Reservoir in Elmore County, Idaho. This Feasibility Report, created for the Study, presents plans to accomplish the Study objectives and makes recommendations for further action.

The Study is being conducted by the U.S. Department of the Interior (DOI), Bureau of Reclamation (Reclamation), Columbia-Pacific Northwest Region, in partnership with the Idaho Water Resource Board (IWRB). The IWRB is a Governor-appointed board, responsible for the formulation and implementation of a state water plan, the financing of water projects, and the operation of programs that support the sustainable management of Idaho's water resources.

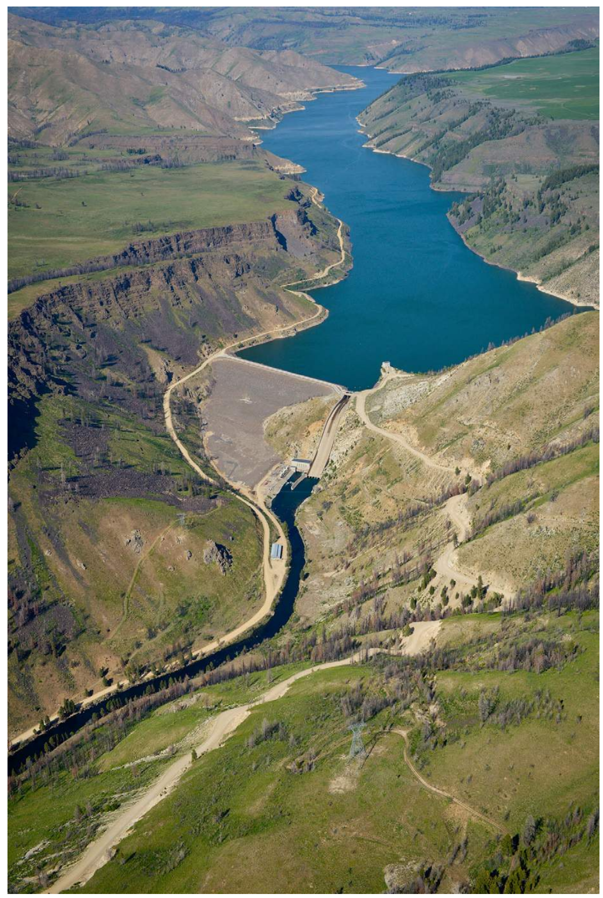


Photo by Kirsten Strough
Anderson Ranch Dam and Reservoir

A feasibility study involves the systematic planning, engineering, environmental, economic, and social analyses of plans for Federal water and energy projects consistent with the *Principles, Requirements and Guidelines for Water and Land Related Resources Implementation Studies* (PR&G) (CEQ 2015), and an allocation of costs and payment responsibilities by the Federal and non-Federal entities. The completed feasibility study culminates in a feasibility report to form the basis for Reclamation's recommendation to the Secretary of the Interior regarding implementation of a recommended plan. A separate but accompanying Environmental Impact Statement (EIS) is being completed for the Study.

This chapter summarizes the purpose and scope for the Study; pertinent Federal, State, and local agency authorization and guidance; the project location and Study area; the Study background; related studies, projects, and programs; and report organization.

1.1 Background

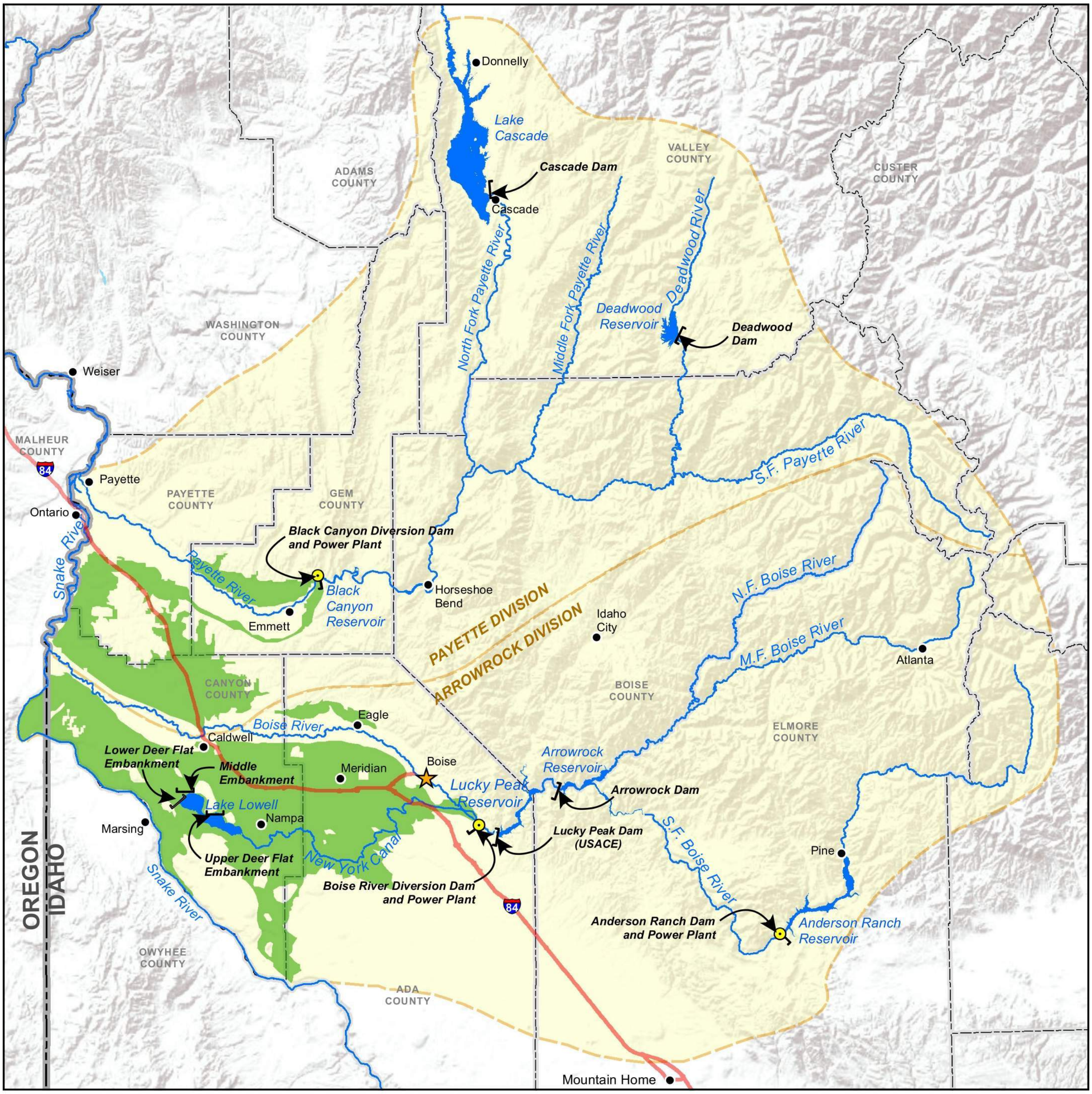
The Boise Project consists of two divisions: Arrowrock and Payette. The Arrowrock Division is within the Boise River basin and is designated as Water District 63 by the State of Idaho. The Payette Division is in the Payette River basin and is administered as Water District 65. This Study evaluates increasing storage opportunity within the Boise River basin only (the Arrowrock Division of the Boise Project) (Figure 1-1).

The Arrowrock Division provides irrigation water supply to irrigable acres situated between the Boise and Snake Rivers. Water for the Arrowrock Division is stored in Anderson Ranch Reservoir on the South Fork Boise River; in Arrowrock Reservoir on the Boise River; and in Lake Lowell, an offstream reservoir in a natural depression impounded by three low dams. Anderson Ranch Dam is 42 miles upstream of Arrowrock Dam. Boise Diversion Dam, 16 miles downstream of Arrowrock and 7 miles southeast of the city of Boise, diverts water into the New York Canal, which delivers water to Arrowrock Division lands (Figure 1-1). Three reservoirs (Anderson Ranch Reservoir, Arrowrock Reservoir, and Lucky Peak Reservoir), with a total active capacity of nearly 1 million acre-feet, furnish irrigation water to about 280,000 acres in the Boise River basin or Water District 63. Lucky Peak Dam and Reservoir is owned and operated by the U.S. Army Corps of Engineers (USACE). Reclamation and USACE operate the three storage dams in a coordinated manner for their authorized purposes. Individual facility authorizations include the following:

- Anderson Ranch Reservoir: Irrigation water supply, power, and flood control; with dead storage space providing for silt control, fish conservation, and recreation
- Arrowrock Reservoir: Irrigation water supply
- Lucky Peak Reservoir: Irrigation water supply, flood control, and recreation

The Boise Project area is characterized by wide valleys and a semiarid climate with warm, dry summers and cold winters. The upper elevations are forested and mountainous. Precipitation at the lower elevations averages about 10 inches annually and falls mainly in the winter as a mixture of rain and snow. Precipitation at the higher elevations averages up to 40 inches per year, with most falling as snow during the winter.

Consumptive use within the Boise Project is primarily for agriculture. Irrigation development was well underway before storage was developed under Federal authorities. Lands newly developed as part of the Federal project receive a full water supply from the project. Some lands with the oldest water rights and sufficient water supply remain under private irrigation. Those privately developed lands with an insufficient water supply generally became part of the Boise Project to obtain supplemental irrigation water supply.



Legend

- Reclamation Power Plant
- Reclamation Dam/Diversion (unless otherwise noted)
- Capital City
- City
- Reclamation Reservoirs
- Areas Benefited by Project
- Project and Division Boundary
- County Boundary
- State Boundary

Notes:
1. This map is provided as-is and may contain representations of property boundaries. It is intended for general references only. None of the parties involved in preparing this map or data contained herein warrant or represent information to be complete and accurate and cannot be held responsible for errors or omissions.
2. Date: 4/6/2020 MSFO GIS Dept.

N

0 5 10 15 20 25
Miles

Figure 1-1. Boise Project
Boise Project - Arrowrock Division
Boise River Basin Feasibility Study

1.2 Purpose and Scope

The primary purpose of this Feasibility Report is to describe the formulation and evaluation of alternatives and to address identified water resources problems and opportunities developed during the Study. This includes developing water supplies and improving the reliability of water delivered from the Boise River basin. The scope of this report includes the following topics:

- A description of existing and future water resources and related problems and needs in the Study area warranting Federal consideration and the identification of planning objectives to address these problems and needs
- A summary of the plan formulation process, including planning constraints, principles, and criteria used to help guide the Study
- An evaluation of a Proposed Plan
- Recommendations for a preferred plan for implementation
- Conclusions and recommendations for future action

1.2.1 Study Overview and Status

This Study is a continuation of several years of previous efforts to achieve the objective of additional water storage in the Boise River basin.

Early efforts began with the *Final Boise/Payette Water Storage Assessment Report* (2006 Assessment) (Reclamation 2006). The 2006 Assessment was conducted by Reclamation at the request of local water users. Prolonged drought conditions during that period, in combination with urban growth, motivated local water users to request that Reclamation evaluate additional water storage opportunities in these two basins. The assessment included a literature report summarizing available information regarding potential water storage opportunities within the Boise and Payette River basins. Both basins had been well studied since the 1940s in more than 200 documents published regarding local water supplies. The remainder of the 2006 Assessment focused on new or enhanced storage capabilities, including new on-stream and offstream reservoir storage facilities, and retrofits to existing reservoir facilities.

In 2010, the IWRB partnered with USACE as the non-Federal cost share partner on the Boise River General Investigation Study (Boise GI unpublished) to determine feasibility of undertaking flood control in the Boise River basin. The USACE authorization was further expanded to include ecosystem restoration and water supply as project purposes to be identified. In 2010, the *Lower Boise River Interim Feasibility Study, Water Storage Screening Analysis* (USACE 2010) provided technical information regarding water storage potential of the areas of opportunities identified in the 2006 Assessment. A secondary screening compared the sites based on future water demand, flood risk reduction, hydropower potential, cost index, social effects, and environmental effects and presented these in the *Lower Boise River Interim Feasibility Study, Preliminary Evaluation of Arrowrock Site* (USACE 2011).

In 2012, USACE implemented specific, measurable, attainable, risk-informed, and timely (SMART) planning guidelines (USACE 2013) that led to a rescope of the Boise GI. The refined scope objectives were intended to reduce flood risk, reduce life safety risks associated with flooding, and increase water storage in the Boise River basin. Following multiple planning and screening efforts, a 70-foot raise of Arrowrock Dam was carried forward for feasibility and environmental analysis. However, after hydrological and economic modeling, USACE determined that the Federal interest could not be justified, as project costs exceeded benefits (USACE 2016). The project was formally terminated on January 24, 2017.

Parallel to the Boise GI, the IWRB commissioned the *Treasure Valley DCMI Water-Demand Projections (2015-2016)* (Treasure Valley DCMI Report) to inform the USACE feasibility study. The study concluded that a significant amount of new water supply may be needed to meet domestic, commercial, municipal, and industrial (DCMI) demands of the growing Treasure Valley population over a 50-year planning horizon.

Through the terminated Boise GI efforts and the Treasure Valley DCMI Report, the IWRB established a need for additional water supply in the Treasure Valley and resolved to investigate surface water storage to help meet future water needs in the Treasure Valley in accordance with the Idaho State Water Plan (State Water Plan). At the request of the IWRB, USACE and Reclamation leveraged resources and identified potential smaller raises to the existing dams on the Boise River (Anderson Ranch, Arrowrock, and Lucky Peak dams) that may be cost-effective and provide additional water storage capacity.

Using information from the Boise GI, Reclamation completed the *Anderson Ranch Dam Raise Preliminary Hydrologic Evaluation Technical Memorandum* (Reclamation 2016) and the broader *Boise Feasibility Study Preliminary Hydrologic Evaluation Technical Memorandum* (Reclamation 2017) to study the potential storage benefit associated with a 6-foot raise of Anderson Ranch Dam, a 10-foot raise of Arrowrock Dam, and a 4-foot raise of Lucky Peak Dam.

In October 2017, under *Omnibus Public Land Management Act of 2009* (Public Law [PL] 111-11), a formal Memorandum of Understanding was entered into between Reclamation and the IWRB for the Study to explore potential storage increases at one or more of Lucky Peak Reservoir, Arrowrock Reservoir, or Anderson Ranch Reservoir. The Memorandum of Understanding also identified Reclamation pursuing approval under Section 4007 of the *Water Infrastructure Improvements for the Nation Act* (WIIN Act) (PL 114-322); this approval was to be another option to authorize and fund both investigation and construction of affordable water storage infrastructure projects that support water supply, hydropower, flood control, and fish and wildlife in the Treasure Valley.

In March 2018, the Study was named to receive WIIN Act authority and funding in the *Consolidated Appropriations Act, 2018* (PL 115-141). Under Section 4007 of the WIIN Act, projects determined to be feasible before January 1, 2021, are eligible to receive construction authority and Federal funding proportionate to Federal benefit. Following WIIN Act authority and funding, the project schedule was fast-tracked, and a cost share Memorandum of Agreement was executed between Reclamation and the IWRB to study raises to the existing dams on the Boise River to provide additional water storage capacity.

In July 2018, following initial technical review and engineering field work and surveys conducted by Reclamation's Technical Service Center (TSC), Reclamation recommended focusing Study efforts on a raise of Anderson Ranch Dam due to the physical and regulatory complexities associated with raises of Lucky Peak and Arrowrock Dams. The IWRB agreed, signing a board resolution in July 2018, authorizing Reclamation to focus Study analysis on a 6-foot raise of Anderson Ranch Dam.

Reclamation completed feasibility-level designs of the Anderson Ranch Dam raise and required projects necessary around the reservoir perimeter, or rim, as a result of the raise in July and October 2019, respectively. Reclamation plans to complete the Study in November 2020 and to submit it to the Secretary of the Interior for feasibility determination.

Reclamation initiated formal environmental compliance activities with the issuance of a Notice of Intent (NOI) in the Federal Register (FR) announcing Reclamation's development of an EIS on August 9, 2019. Public scoping meetings were held on August 26 to 28, 2019. Reclamation released a Draft Environmental Impact Statement (DEIS) in July 2020 and plans to release a Final Environmental Impact Statement (FEIS) in February 2021. The Record of Decision (ROD) will follow in May 2021.

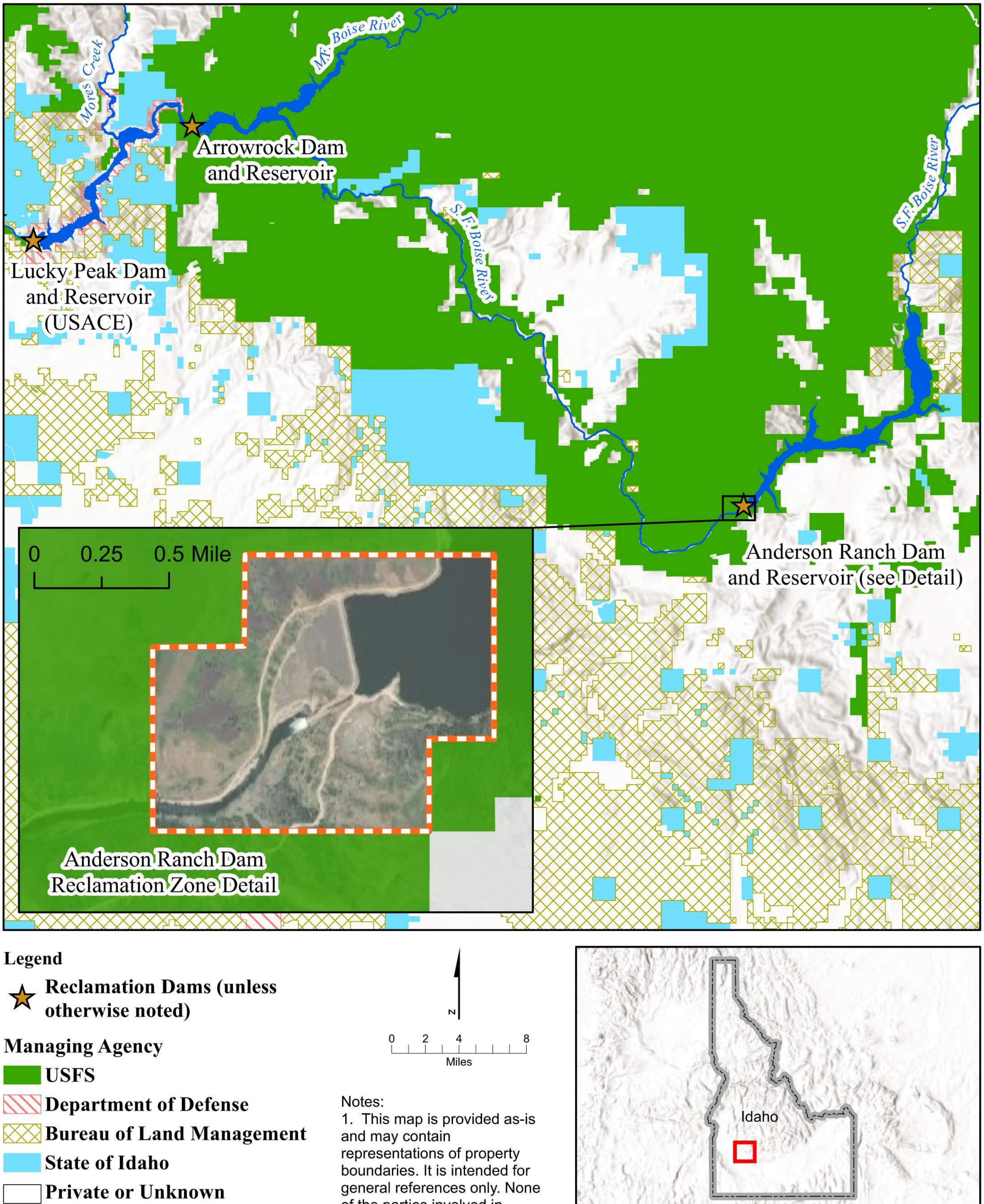
1.2.2 Project Location and Study Area

Anderson Ranch Reservoir is on the South Fork Boise River in Elmore County, Idaho. The reservoir is in the mountainous region east of Boise, Idaho. The largely recreational town of Pine, Idaho, is at the northern tip of the reservoir.

The Boise River rises in three separate forks to the east and northeast of Boise and is formed by the confluence of the North Fork Boise River and Middle Fork Boise River, about 20 miles east of Boise and upstream of Arrowrock Reservoir. The South Fork Boise River joins the mainstem at the southern arm of Arrowrock Reservoir. All three forks of the Boise River flow generally west and southwest toward the Treasure Valley. Mores Creek and its major tributary, Grimes Creek, flow generally south, draining in an area to the west of the three forks of the Boise River. Mores Creek joins the Boise River mainstem about 10 miles east of Boise. The Boise River continues west through Boise and past Caldwell to join the Snake River. The Boise River drains about 3,970 square miles, including parts of Ada, Boise, Camas, Canyon, and Elmore counties (Figure 1-1).

The Study area includes Anderson Ranch Reservoir watershed and associated facilities, the South Fork Boise River, and Water District 63 service area.

The Anderson Ranch Reservoir area is surrounded largely by Federal lands. These Federal lands are managed by Reclamation and the U.S. Department of Agriculture (USDA), Forest Service (USFS) under a Master Interagency Agreement (Master Agreement). The Master Agreement, dated April 6, 1987, covers Reclamation-authorized projects within or adjacent to National Forest System (NFS) Lands. Through the Master Agreement, the USFS has management and administration jurisdiction of Federal lands, except for the Reclamation Zone, which is the area that Reclamation designates as necessary for the operation of the Project (Figure 1-2).



Notes:
1. This map is provided as-is and may contain representations of property boundaries. It is intended for general references only. None of the parties involved in preparing this map or data contained herein warrant or represent information to be complete and accurate and cannot be held responsible for errors or omissions.

Figure 1-2. Land Management Boise Project - Arrowrock Division
Boise River Basin Feasibility Study

1.3 Study Authorization and Guidance

Reclamation is the lead Federal agency conducting the Study. The IWRB is the cost share partner and lead agency for the State of Idaho. The following subsections describe Federal and State of Idaho authorization and legislation relevant to this project.

1.3.1 Federal Authorities

The Secretary of the Interior is authorized to undertake feasibility studies on projects that address water shortages within the Snake, Boise, and Payette River systems through the *Omnibus Public Land Management Act of 2009* (PL 111-11, Section 9001), which was enacted in March 2009:

> *"The Secretary of the Interior, acting through the Bureau of Reclamation, may conduct feasibility studies on projects that address water shortages within the Snake, Boise, and Payette River systems in the State of Idaho, and are considered appropriate for further study by the Bureau of Reclamation Boise Payette water storage assessment report issued during 2006."*

The Study was developed consistent with the requirements provided in Section 4007 of the WIIN Act for "…Federally owned storage projects that the Secretary of the Interior determines to be feasible before January 1, 2021." Enacted in December 2016, the WIIN Act is a legislative measure to provide water relief in western states, as well as to increase recreation and conservation and improve the management of water and other natural resources.

According to the WIIN Act, Title III, Subtitle J, Section 4007, Subsection (a)(1):

> *"The term ''Federally owned storage project'' means any project involving a surface water storage facility in a Reclamation State—*
>
> *(A) to which the United States holds title; and*
>
> *(B) that was authorized to be constructed, operated, and maintained pursuant to the reclamation laws."*

Further guidance is provided in the WIIN Act, Section 4007(b):

> *"(1) Agreements.—On the request of any State, any department, agency, or subdivision of a State, or any public agency organized pursuant to State law, the Secretary of the Interior may negotiate and enter into an agreement on behalf of the United States for the design, study, and construction or expansion of any Federally owned storage project in accordance with this section.*
>
> *(2) Federal Cost Share.—Subject to the requirements of this subsection, the Secretary of the Interior may participate in a Federally owned storage project in an amount equal to not more than 50 percent of the total cost of the Federally owned storage project.*

> *(3) Commencement.—The construction of a Federally owned storage project that is the subject of an agreement under this subsection shall not commence until the Secretary of the Interior—*
>
> > *(A) determines that the proposed Federally owned storage project is feasible in accordance with the reclamation laws;*
> >
> > *(B) secures an agreement providing upfront funding as is necessary to pay the non-Federal share of the capital costs; and*
> >
> > *(C) determines that, in return for the Federal cost share investment in the Federally owned storage project, at least a proportionate share of the project benefits are Federal benefits, including water supplies dedicated to specific purposes such as environmental enhancement and wildlife refuges."*

Section 4007(b) allows the Secretary of the Interior to participate in surface water storage projects that are constructed, operated, and maintained pursuant to Reclamation laws. The Secretary of the Interior can participate up to "an amount equal to not more than 50 percent of the total cost." Section 4007 of the WIIN Act requires that at least a proportional share of the project benefits must be Federal benefits, including water supplies dedicated to specific purposes, such as environmental enhancement and wildlife refuges. As described, Section 4007(b) further requires a request from any department, agency, or subdivision of a State, or any public agency organized pursuant to State law for the Secretary of the Interior to participate in the design, study, and construction or expansion of the Federally owned storage project.

Under Section 4007 of the WIIN Act, the Secretary of the Interior may then authorize the construction of the Federally owned storage project if the Secretary of the Interior concurs the project is feasible and provides a Federal benefit; an agreement providing upfront non-Federal funding is available to complete the project; and the non-Federal storage project sponsors are financially solvent.

Under WIIN Act, Section 4007(b), subject to compliance with State water rights laws, the Secretary of the Interior may enter into agreements with each party involved with the Federally owned storage project for use of the storage capacity of the project. For individual projects to receive funding, enacted appropriations legislation must name the project. In addition, as described in Section 4007(h)(2), before enacting the legislation, the Secretary of the Interior must transmit to Congress a recommendations letter with the projects to be funded.

The Study received WIIN Act funding on March 23, 2018, through PL 115-141, Title II:

> *"That in accordance with Section 4007 of Public Law 114–322 and as recommended by the Secretary in a letter dated February 23, 2018, funding provided for such purpose in fiscal year 2017 shall be made available to the Shasta Dam and Reservoir Enlargement Project, the North-of-Delta Offstream Storage Investigation/Sites Reservoir Storage Project, the Upper San Joaquin River Basin Storage Investigation, the Friant-Kern Canal Subsidence Challenges Project, the Boise River Basin Feasibility Study, the Yakima River Basin Water*

Enhancement Project—Cle Elum Pool Raise, and the Upper Yakima System Storage Feasibility Study."

1.3.2 State Authorities

The IWRB is charged with the development of the Idaho State Water Plan (State Water Plan). The plan includes the Statewide water policy plan and associated component basin and water body plans, which cover specific geographic areas of the State.

Article XV, Section 7 of the Idaho Constitution provides the authority for the preparation of a state water plan. This constitutional amendment was adopted in November 1964 following a Statewide referendum and states the following:

> *"There shall be constituted a Water Resource Agency, composed as the Legislature may now or hereafter prescribe, which shall have power to formulate and implement a state water plan for optimum development of water resources in the public interest; to construct and operate water projects; to issue bonds, without state obligation, to be repaid from revenues of projects; to generate and wholesale hydroelectric power at the site of production; to appropriate public waters as trustee for Agency projects; to acquire, transfer and encumber title to real property for water projects and to have control and administrative authority over state land required for water projects; all under such laws as may be prescribed by the Legislature."*

Article XV, Section 3 of the Idaho Constitution provides for the appropriation and allocation of water. Section 3 provides the following:

> *"The right to divert and appropriate the unappropriated waters of any natural stream to beneficial uses, shall never be denied, except that the state may regulate and limit the use thereof for power purposes. Priority of appropriation shall give the better right as between those using the water; but when the waters of any natural stream are not sufficient for the service of all those desiring the use of the same, those using the water for domestic purposes shall (subject to such limitations as may be prescribed by law) have the preference over those claiming for any other purpose; and those using the water for agricultural purposes shall have preference over those using the same for manufacturing purposes. And in any organized mining district those using the water for mining purposes or milling purposes connected with mining have preference over those using the same for manufacturing or agriculture purposes. But the usage by such subsequent appropriators shall be subject to such provisions of law regulating the taking of private property for public and private use, as referred to in Section 14 of article I of this Constitution."*

Article XV, Section 7 of the Idaho Constitution provided for the creation of a "Water Resource Agency" but did not establish the agency. In 1965, the 38th Legislature established the IWRB, and directed the following (as amended):

> *"The board shall, subject to legislative approval, progressively formulate, adopt and implement a comprehensive state water plan for conservation, development, management and optimum use of all unappropriated water resources and waterways of this state in the public interest… In adopting a comprehensive state water plan the board shall be guided by these criteria:*
>
> > *(a) Existing rights, established duties, and the relative priorities of water established in article XV, Section 3, of the constitution of the state of Idaho, shall be protected and preserved;*
> >
> > *(b) Optimum economic development in the interest of and for the benefit of the state as a whole shall be achieved by integration and coordination of the use of water and the augmentation of existing supplies and by protection of designated waterways for all beneficial purposes;*
> >
> > *(c) Adequate and safe water supplies for human consumption and maximum supplies for other beneficial uses shall be preserved and protected;*
> >
> > *(d) Subject to prior existing water rights for the beneficial uses now or hereafter prescribed by law, minimum stream flow for aquatic life, recreation and aesthetics and the minimization of pollution and the protection and preservation of waterways in the manner hereafter provided shall be fostered and encouraged and consideration shall be given to the development and protection of water recreation facilities;*
> >
> > *(e) Watershed conservation practices consistent with sound engineering and economic principles shall be encouraged."*

House Joint Memorial Number 8, passed and approved by the 2008 Idaho Legislature, encouraged the IWRB, in coordination with other public and private entities, to initiate and complete the study of additional water storage projects in the State of Idaho.

House Bills 428 and 644, passed and approved by the 2008 Idaho Legislature, directed the IWRB to conduct a Statewide comprehensive aquifer planning and managing effort, including evaluation of additional surface water storage and provided funding to carry out the effort.

House Bill 479, passed and approved by the 2014 Idaho Legislature, appropriated $1.5 million to complete the Boise GI. Through a resolution dated October 24, 2017, the IWRB committed remaining unspent appropriations from the terminated Boise GI, along with additional appropriations, to Reclamation's *Boise River Basin Feasibility Study* as the non-Federal cost share partner for the Study. In coordination with Reclamation, the IWRB signed a board resolution dated July 27, 2018, refining the scope of the Study to focus on a raise of Anderson Ranch Dam.

House Joint Memorial No, 4, passed and approved by the 2019 Idaho Legislature, supports the construction of new water infrastructure in Idaho—particularly, the raising of Anderson Ranch Dam—and urges the congressional delegation for the State of Idaho to take any further actions necessary as follows: (1) to confirm the feasibility study and *National Environmental Policy Act* (NEPA) (PL 91-190) analysis for the Anderson Ranch Dam raise are completed within the proposed timeframe; and (2) as determined in the feasibility study, to advance the project through additional congressional action to authorize construction and provide further WIIN Act funds.

House Bill 285, passed and approved by the 2019 Idaho Legislature, appropriated $20,000,000 for reclamation, upstream storage, offstream storage, aquifer recharge, reservoir site acquisition and protection, water supply, water quality, recreation, and water resource studies, including feasibility studies for qualifying projects. The IWRB has the authority to determine which water projects are undertaken pursuant to the bill.

1.4 Related Studies, Projects, and Programs

This section summarizes studies, projects, and programs of various Federal, State, and local agencies or working groups that are directly or indirectly relevant to the Study.

1.4.1 Activities of Federal Agencies

The following subsections provide detailed information about Federal projects and plans relevant to the Study.

1.4.1.1 U.S. Army Corps of Engineers

Lower Boise River and Tributaries, Idaho Reconnaissance Study, May 1995

The purpose of the reconnaissance study was to review various water resource problems, needs, and opportunities in the lower Boise River basin, and determine whether the planning process should proceed into the feasibility phase. The study area encompassed the Boise Valley from Lucky Peak Dam downstream to the mouth of the Boise River, and the Mores Creek subbasin that flows into the Lucky Peak Reservoir. The study focused primarily on problem areas along the main river channel and side drainages northeast of Boise.

Initial efforts in the study focused on identifying overall water resource and related problems and needs of the basin. The problems and needs were then screened further to those areas within the purview of USACE authority. Problem areas addressed in more detail in the report include flood control, environmental restoration, and water supply; the report presents potential solutions to the problems.

The report concludes with a recommendation that the reconnaissance study be placed in an “inactive” status until sponsorship for the follow-on feasibility study can be developed. Continued coordination is to be accomplished under other available authorities until such time as an appropriate sponsorship can be developed.

Expedited Reconnaissance Study, Section 905(b) (WRDA 86), 2001

This reconnaissance study, authorized under the *Water Resources Development Act* of 1999 [PL 106-53], was to determine whether there was Federal interest in undertaking feasibility studies for flood control on the Boise River near Boise, Idaho, and to review other water resource problems and needs within the lower Boise River basin for potential feasibility studies.

The study identified problems related to flood control (specifically, reduced flood control related to rapid urban growth within historical flood plains), noting the current 1% annual chance flow for the Boise River at Glenwood Bridge is 16,600 cubic feet per second (cfs); however, due to urban growth and encroachment, local minor flooding can be realized when flows exceed 4,500 cfs at Glenwood Bridge. A second problem was identified in recreational access along the Boise River, noting the expressed interest of the water delivery organization in improving methodologies for diverting water and allowing for the safe passage of recreationalists. A third problem was identified regarding the configuration and use of the floodplain as a result of the construction of the upstream reservoirs, specifically urban development encroaching on the floodplain reducing natural qualities and riparian habitat along the river. The study developed eight alternative plans to address the problems identified. The alternatives evaluation identified potential interested project sponsors for each alternative.

In conclusion, the study recognized the local efforts as positive toward developing a comprehensive plan for the Boise River, and recommended the USACE Walla Walla District continue to work with potential sponsors to address flooding and environmental restoration concerns on local levels while working toward a more comprehensive plan, which could be done through existing programs and interim feasibility studies.

Boise River General Investigation Study (Boise GI), 2010 to 2017

USACE was authorized to conduct a General Investigation of the lower Boise River to review various water resource problems, needs, and opportunities. General Investigation studies are typically conducted in two phases: reconnaissance and feasibility. The purpose of the reconnaissance phase is to determine whether water resource problems warrant Federal participation and whether planning efforts should move forward to the more detailed feasibility phase. The purpose of the feasibility phase is to investigate and recommend solutions to water resource problems. USACE completed reconnaissance studies in 1995 (*Lower Boise River and Tributaries, Idaho*) and 2001 (*Expedited Reconnaissance Study, Section 905[b] [WRDA 86], Boise River, Idaho*), both of which documented Federal support for pursuit of a feasibility study. Considerable interest was shown in the areas of flood damage reduction, aquatic and riparian habitat restoration, water quality and supply, and recreation safety.

In May 2009, USACE and the IWRB entered into an agreement to initiate the first, or interim, phase of a two-phased feasibility study. The first (interim) phase of the feasibility study was aimed at providing technical information regarding surface water storage potential in the basin, with a focus on water storage upstream of Lucky Peak Dam and reducing flood risk in the lower

Boise River downstream of Lucky Peak Dam. Specifically, the interim feasibility study would complete the following:

1. Evaluate and document existing conditions on the Boise River.
2. Evaluate public safety issues related to flooding.
3. Analyze surface water storage opportunities in the basin.
4. Develop a path forward to complete the feasibility study.

Lower Boise River Interim Feasibility Study, Water Storage Screening Analysis, 2010

The surface water storage evaluation used information contained in Reclamation's *Final Boise/Payette Water Storage Assessment Report,* completed in July 2006. The study identified 12 sites worthy of further investigation. In early 2010, USACE reviewed existing information to narrow the 12 sites down to a short list of the most promising options, which would undergo a more in-depth evaluation during the Interim Feasibility phase and throughout the Feasibility Study.

This *Water Storage Screening Analysis* (USACE 2010) document describes the screening criteria and process used to rank the 12 storage sites; it then details the results of the analysis. The scope of the screening analysis involved using available information that allowed comparison of differences between proposed water storage sites and concepts for the purpose of narrowing the list to a few sites for more detailed analysis.

USACE conducted a two-step screening evaluation. The first step involved narrowing the list of 12 sites to the 6 sites that best met future water supply needs and reduced flood risk downstream of Lucky Peak Dam. The second step compared and scored the remaining 6 sites for performance using six criteria:

1. Future water demand
2. Flood risk reduction
3. Hydropower potential
4. A relative cost index
5. Social effects
6. Environmental effects

The three top-ranked water storage and flood risk reduction sites were as follows:

1. Replacement of Arrowrock Dam
2. Construction of a new dam at the Alexander Flats site
3. Construction of a new dam at the Twin Springs site

Lower Boise River Interim Feasibility Study, Preliminary Evaluation of Arrowrock Site, 2011

Following the conclusion of the *Lower Boise River Interim Feasibility Study, Water Storage Screening Analysis* (Water Storage Screening Analysis), the IWRB directed USACE to conduct additional analysis of the Arrowrock site. The Arrowrock concept considered in the Water Storage Screening Analysis assumed a new 368-foot, roller-compacted concrete dam would be constructed immediately downstream of the existing Arrowrock Dam, increasing storage approximately 300,000 acre-feet.

The purpose of the *Lower Boise River Interim Feasibility Study, Preliminary Evaluation of Arrowrock Site* was to examine the proposed Arrowrock site to identify the most appropriate surface water storage concept for the site (that is, raise the existing structure or construct a new facility downstream); to determine whether there were major engineering or geological constraints that would make a dam raise or a new downstream dam at the Arrowrock site technically unfeasible or cost-prohibitive; and to identify issues for future study. The analysis relied on existing data and field reconnaissance. Existing data analysis efforts included researching historical documents related to Arrowrock Dam, and reviewing existing geological records, maps, and construction documents. A field reconnaissance was conducted downstream of Arrowrock Dam in July 2011. Information was gathered on rock types, fracture orientation and spacing, topographical information, potential axes alignments, and other related site conditions. Geological maps and documents were reviewed before and during the field investigation. Dam types were researched to identify design criteria for selecting a site and dam type for a potential new downstream dam. Raising the existing Arrowrock Dam was also evaluated.

Based on existing information and resources available during the analysis, the report concluded both concepts (that is, constructing a new dam immediately downstream of the existing Arrowrock Dam or raising the existing dam) were technically feasible. The existing information did not identify geological or engineering constraints that would discount either option in favor of the other. The report recommended that, if only one concept were pursued, raising Arrowrock Dam was recommended for further study. The existing structure would reduce the quantity of new construction material required, which should provide significant cost advantages.

Lower Boise River Interim Feasibility Study, 2014 to 2017

Following conclusions from the *Water Storage Screening Analysis* and *Preliminary Evaluation of Arrowrock Site*, the IWRB and USACE partnered on a feasibility study to evaluate raising Arrowrock Dam to provide flood risk reduction and meet current and future water supply needs in the lower Boise River watershed.

On April 24, 2014, USACE published an NOI in the FR announcing its intent to prepare an EIS for the Boise GI. The feasibility study would evaluate alternatives to reduce flood risk and meet current and future water supply needs in the lower Boise River watershed. To the extent feasible, the study would also seek to provide ancillary ecosystem restoration benefits, minimize impacts on species listed under the Federal *Endangered Species Act* (ESA) (PL 93-205) (16 USC 1531 et seq.), including bull trout, and minimize socioeconomic effects.

Following preliminary design and economic analysis, it was determined in 2016 that a large raise of Arrowrock Dam was cost-prohibitive and generated a cost-benefit ratio that was too low for USACE to proceed with the project. For a study alternative to be recommended for implementation, it must have a benefit-to-cost ratio of 1.0 or higher. The alternatives that were analyzed resulted in a 0.7 benefit-to-cost ratio and did not meet the economic criteria to be recommended.

1.4.1.2 Department of the Interior – Bureau of Reclamation

Boise and Payette River Basins: Literature Report for Potential Water Storage Opportunities, November 2005 (Reclamation 2005a)

This literature report was prepared to document available information regarding potential water storage opportunities within the Boise River and Payette River basins in southeastern Idaho and is an appendix to the *Final Boise/Payette Water Storage Assessment Report*. Both basins have been well studied since the 1940s, and more than 200 documents have been published regarding local water supplies. The literature review assembled 53 documents that dated back to 1938, produced by a wide range of entities and organizations. Available literature on potential water storage sites was reviewed and summarized within the report.

Final Boise/Payette Water Storage Assessment Report, July 2006

Prolonged drought conditions during that period, in combination with urban growth, motivated local water users' request that Reclamation conduct an assessment as a first step in the process of evaluating additional water storage opportunities in the Boise and Payette River basins. The assessment was a preliminary survey of problems and needs that used existing information to explore conceptual solutions to water resources issues in specific areas. The assessment focused primarily on new or enhanced storage capabilities, including new on-stream and offstream reservoir storage facilities, and retrofits of existing reservoir facilities.

The assessment screened the initial 200-plus sites identified in the *Literature Report for Potential Water Storage Opportunities* (Reclamation 2005a) to 56 potential sites. The results of the screening and ranking process indicated that viable potential water storage sites tend to cluster in discrete reaches and subbasins. To be more useful in future studies, these clusters were identified as "areas of opportunity," which are pockets in each basin where excess natural water supplies may be available for storage and where, at an assessment-level analysis, there were apparently fewer potential socioeconomic and environmental effects relative to other areas within each basin. The following four "areas of opportunity" were identified within the Boise River basin:

- **Lower South Fork Boise River.** Indian Creek-Mayfield and Krall Mountain were identified as potential offstream storage sites within reach of the river. Either facility would require a diversion pipeline and tunnel.
- **North Fork and Middle Fork Boise River.** Barber Flats, Alexander Flats, Twin Springs, and Rabbit Creek were identified as sites within the catchment area where two major forks join, which is strategic for providing flood control. Multiple configurations of on-stream and offstream diversions may be possible.
- **Raising Lucky Peak or Arrowrock Dams.** This would involve the retrofit of existing facilities, raising the dam height.
- **Raising Anderson Ranch Dam.** This would involve the retrofit of existing facilities, raising the dam height.

Anderson Ranch Dam Raise Preliminary Hydrologic Evaluation Technical Memorandum, April 2016

This technical memorandum evaluated the potential storage benefit associated with a 6-foot raise of Anderson Ranch Dam. The evaluation was conducted using the Boise Planning Model to estimate frequency of fill of the expanded storage space given historical hydrology and future 2080s climate change flows. The results of the evaluation suggest the following:

- The probability of filling the expanded storage space is roughly equivalent to the probability of filling the existing storage space under both hydrology scenarios.
- Larger and earlier runoff peaks in the 2080s Median scenario increase the probability of fill in both storage scenarios (current "baseline" conditions and proposed 6-foot dam raise conditions).

The technical memorandum evaluates the results of the analysis in terms of the percent of years that a particular storage volume is equaled or exceeded over the 28-year simulation period. In conclusion, the new storage space would fill completely in 46% of years (13 out of 28 years) given historical hydrological conditions and in 68% of years (19 out of 28 years) given future 2080s Median Climate Change hydrological conditions. Results also suggested that the increased operational flexibility provided by the expanded space would increase the probability of filling the older, or current, system space.

Boise Feasibility Study Preliminary Hydrologic Evaluation Technical Memorandum, February 2017

This technical memorandum evaluated the potential storage benefit associated with a 6-foot raise of Anderson Ranch Dam, a 10-foot raise of Arrowrock Dam, and a 4-foot raise of Lucky Peak Dam. Such increases in dam height correspond to an estimated 29,000 acre-feet of additional storage in Anderson Ranch Reservoir; 20,000 acre-feet of additional storage in Arrowrock Reservoir; and 10,000 acre-feet of additional storage in Lucky Peak Reservoir. These storage increases were evaluated under two different storage scenarios:

1. Increases at all three reservoirs (59,000 acre-feet or a 6% increase in system storage capacity)
2. Increases at only Anderson Ranch Reservoir and Arrowrock Reservoir (49,000 acre-feet or a 5% increase in system storage capacity)

The evaluation was conducted using the Boise Planning Model to estimate the fill frequency of the expanded storage space given historical hydrology and future 2080s climate change flows. The results of the study suggested the following: (1) the probability of filling the expanded storage space is roughly equivalent to the probability of filling the existing storage space under both hydrology scenarios, and (2) larger runoff peaks in the 2080s Median scenario increase the probability of fill.

The technical memorandum evaluates the results of this analysis in terms of the percent of years that a particular storage volume is equaled or exceeded over the 28-year simulation period under historical hydrology and future 2080s Median hydrology. Comparable to the 2016 Preliminary Hydrologic Evaluation Technical Memorandum focused solely on a 6-foot raise of Anderson Ranch Dam, this evaluation concluded that the system would fill completely in 43% to 46% of years (12 to 13 out of 28 years) given historical hydrologic conditions and in 64% of years (18 out of 28 years) given future 2080s Median Climate Change hydrologic conditions. Likewise, results also suggested that the increased operational flexibility provided by the expanded space in the Boise River system would increase the volume of fill in drier years, as a result of the reservoirs not needing to draft as deeply to provide space for flood control. The analysis assumed no change in current flood control rule curves going into the future. This evaluation formed the basis of further analysis for the Study, as detailed in Appendix A – Water Operations Technical Memorandum.

Boise River Storage Feasibility Study – Land, Structure, and Real Estate Survey/Analysis, April through June 2019 (Jacobs 2019)

In support of Reclamation's evaluation, CH2M HILL, Inc. (now Jacobs Engineering Group Inc. [Jacobs]) completed the *Boise River Storage Feasibility Study – Land, Structure, and Real Estate Survey/Analysis*, or Rim Analysis (Jacobs 2019). The Rim Analysis involved using government-provided aerial imagery and topographical light detection and ranging (LiDAR) data, as well as other available geographic information system (GIS) data (that is, data related to property boundaries, easements, utility locations, septic systems, and other infrastructure) to evaluate and review potential impacts resulting from incremental increases in water surface elevations at Anderson Ranch, Arrowrock, and Lucky Peak reservoirs. Areas of potential impact at Anderson Ranch Reservoir (due to the proposed increase in reservoir pool elevation) were identified in the Rim Analysis and include the following: roads, the Pine Airstrip, bridges, culverts, power utility infrastructure, recreational facilities, groundwater wells, and septic systems. Each of these areas of potential impact around the reservoir rim were considered.

Feasibility Design Report – Anderson Ranch Dam 6-foot Reservoir Raise Technical Memorandum, May 2019 (Reclamation 2019a)

The purpose of this technical memorandum was to document the feasibility-level design alternatives, relevant analyses, cost estimates, construction schedule, and considerations for final design of the proposed 6-foot reservoir raise of Anderson Ranch Dam. The scope of the TSC's design alternatives were limited to Anderson Ranch Dam, appurtenant structures, and approach roads in the immediate vicinity of the dam that would be impacted by a raise of the dam crest.

This technical memorandum provides information sufficient for supporting the Study, and the design efforts are summarized in Appendix B – Engineering Summary Report. The feasibility-level design efforts have been qualitatively evaluated to be risk neutral at this stage in the design process.

Engineering Design and Cost Estimates – Anderson Ranch Reservoir Rim Technical Memorandum, November 2019

Sundance-EA Partners II, LLC (Contractor) engaged two subconsultants, Jacobs and Quadrant Consulting, Inc. (QCI), to prepare feasibility-level designs, cost estimates, and a construction schedule for projects around the perimeter, or rim, of Anderson Ranch Reservoir that would need modification, rehabilitation, or replacement as a result of the proposed enlargement of Anderson Ranch Dam and Reservoir.

This technical memorandum documents the engineering evaluations, analyses, and development of design criteria that went into the feasibility-level designs, cost estimates, and construction schedule for rim projects that would be needed as a result of the proposed increase to the top of active water surface elevation from elevation 4196 to 4202 (6 feet). The design efforts are summarized in Appendix B.

1.4.1.3 Department of the Interior – Fish and Wildlife Service

The U.S. Fish and Wildlife Service (USFWS) is required under ESA to assess factors affecting listed resident species, identify recovery criteria, identify actions necessary to achieve these goals, and estimate the cost and time required to carry out the actions.

In November 2004, Reclamation consulted with the USFWS on the effects of operations and maintenance (O&M) of the Reclamation projects in the upper Snake River basin (above Brownlee Reservoir) under Section 7 of the ESA. The consultation with the USFWS addressed impacts on bull trout and other resident ESA-listed species in the project areas but did not explicitly address impacts on bull trout critical habitat because none was designated in the affected area at that time.

In March 2005, Reclamation received a Biological Opinion (BiOp) from USFWS concluding the O&M of the upper Snake River projects were not likely to jeopardize the continued existence of bull trout or other species analyzed in the consultation (USFWS 2005). The 2005 BiOp contained an Incidental Take Statement (ITS) with associated reasonable and prudent measures (RPMs) and Terms and Conditions (T&Cs) aimed at reducing incidental take at Federal facilities in the Boise, Payette, and Malheur River systems. The 2005 BiOp and ITS did not address effects to bull trout in the Powder River, because bull trout were not known to occupy the Powder River at that time. T&Cs of the ITSs issued with the 2005 BiOp are included as part of environmental compliance consultations related to this Study.

In October 2010, the USFWS designated revised critical habitat for bull trout in portions of the Boise, Payette, Malheur, and Powder rivers, and the mainstems of the Snake and Columbia rivers, all of which are hydrologically influenced in varying degrees by operation of Reclamation's upper Snake River projects (75 FR 63898). In 2011, two bull trout were documented in Phillips Reservoir, in the Powder River basin. The designation of critical habitat and the discovery of bull trout in the Powder River triggered the need for Reclamation to initiate consultation (50 Code of Federal Regulation [CFR] Section 402.16).

On December 30, 2013, Reclamation initiated a formal consultation by submitting a Biological Assessment (BA) to USFWS, assessing the effects of the upper Snake River projects on bull trout critical habitat, and the effects of Baker Project operations on bull trout and critical habitat in the Powder River. The USFWS issued a final BiOp on June 27, 2014 (USFWS 2014). The 2013 Assessment and the 2014 BiOp are companion documents to the 2004 Assessment and 2005 BiOp, which are incorporated by reference.

1.4.1.4 Department of Commerce – National Marine Fisheries Service

The National Marine Fisheries Service (NMFS) is required under ESA to assess factors affecting listed salmonid species, identify recovery criteria, identify actions necessary to achieve these goals, and estimate the cost and time required to carry out the actions.

In November 2004, Reclamation consulted with NMFS on the effects of O&M of the Reclamation projects in the Snake River basin above Brownlee Reservoir under Section 7 of the ESA.

In May 2008, Reclamation received a BiOp (2008 BiOp) from NMFS refining the proposed action from the 2004 Assessment to include the provisions of salmon flow augmentation for salmon consistent with the terms of the 2004 Nez Perce Water Rights Settlement adjudication. T&Cs of the ITSs issued with the 2008 BiOp are included as part of environmental compliance consultations related to this Study.

1.4.1.5 U.S. Environmental Protection Agency and U.S. Army Corps of Engineers

The Federal *Clean Water Act* (CWA) (PL 92-500) is administered jointly by U.S. Environmental Protection Agency (EPA) and USACE. Section 404 of the CWA establishes a program to regulate the discharge of dredged or fill material into waters of the United States (WOTUS), including wetlands. Activities in WOTUS regulated under this program include the following: fill for development, water resource projects (such as dams and levees), infrastructure development (such as highways and airports), and mining projects. Section 404 requires a permit before dredged or fill material may be discharged into WOTUS. Specifically, Section 404(c) authorizes EPA to veto a USACE decision to issue a permit if a proposed action would have an unacceptable effect on municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas. The EPA also develops standards and criteria for water quality and issues permits for discharges pursuant to the CWA under Sections 401 and 402.

1.4.1.6 Water Infrastructure Improvements for the Nation Act

As mentioned, the WIIN Act is Federal legislation signed into law in 2016 to address the needs of the Nation’s harbors, locks, dams, flood protection, and other water resources infrastructure critical to economic growth, health, and competitiveness. Among other things, Section 4007 of the WIIN Act authorizes appropriations for Federal funding for the final design and construction of water storage projects.

1.4.2 Activities of the State of Idaho

The following subsections provide detailed information about the State of Idaho’s projects and plans relevant to this Study.

1.4.2.1 Idaho State Water Plan, November 2012

In 1988, the Idaho Legislature passed legislation amending State water planning requirements and providing for the development of a state water plan. The plan was to be developed in stages by developing comprehensive plans for each river basin, drainage area, river reach, groundwater aquifer, or other geographic consideration in the State. The resources described in each plan include navigation, energy conservation, recreational opportunities, flood control, timber, livestock watering, natural or cultural features, power development, fish and wildlife, irrigation, water supply, mining, scenic values, DCMI uses, other aspects of environmental quality, and economic development. Each plan also describes the various existing and planned uses of these resources and discusses goals, objectives, and recommendations for improving, developing, or conserving water and waterways concerning these resources.

The *Comprehensive State Water Plan – South Fork Boise River Basin*, which includes Anderson Ranch Dam, was adopted in June 1990 and readopted in January 1996. The *Comprehensive State Water Plan – Upper Boise River Basin*, which includes the Boise River and reservoirs upstream of Lucky Peak Dam, the North and Middle Forks of the Boise, and Mores Creek drainage, was adopted in December 1992.

The State Water Plan was adopted by the IWRB to guide the development, management, and use of the State's water and related resources. The wise use and management of the State's water are critical to the State's economy and the welfare of its citizens. The State Water Plan strives to ensure that through cooperation, conservation, and good management, future conflicts will be minimized, and the optimum use of the State's water resources will benefit the citizens of Idaho. The State Water Plan is subject to change to be responsive to new opportunities and needs.

On November 28, 2012, the IWRB adopted a revised State Water Plan which was the result of extensive public involvement and reflects the changing landscape of water in Idaho. It updated many policies from previous plans and added policies related to new water management issues. The objectives of the revised State Water Plan are formulated for the conservation, development, management, and optimum use of all unappropriated water resources and waterways of Idaho in the public interest. These objectives include water management, public interest, environmental quality, and public safety.

1.4.2.2 Comprehensive Aquifer Management Planning, 2008 to 2018

The 2008 Legislature approved legislation establishing the Statewide Comprehensive Aquifer Planning and Management Program (Idaho Code Section 42-1779) and the Aquifer Planning and Management Fund (Idaho Code Section 42-1780). This legislation authorized characterization and planning efforts for ten different basins from 2008 through 2018.

The Comprehensive Aquifer Planning and Management Program was designed to provide IWRB and Idaho Department of Water Resources (IDWR) with the necessary information to develop plans for managing groundwater and surface water resources into the future. The first phase of the program had a technical component to characterize the surface water and groundwater resources of each basin. The second phase of the program had a planning component to integrate the technical knowledge with an assessment of current and projected future water uses and constraints.

At the culmination of the program, the intent was to develop long-range plans for conjunctively managing the water resources of each basin by integrating hydrological realities with social needs. These water management plans were designed to address water supply and demand issues over a 50-year planning horizon, and to investigate strategies that will lead to sustainable water supplies and optimum use of the water resources.

Proposed Treasure Valley Comprehensive Aquifer Management Plan, 2012 (Not Adopted)

On March 26, 2010, the IWRB appointed the Treasure Valley Comprehensive Aquifer Management Plan (CAMP) Advisory Committee, which was composed of representatives from water providers, local governments, utilities, business interests, and conservation groups. Between April 2010 and June 2011, the committee held regular meetings and, through those meetings, developed the proposed CAMP.

The CAMP provided a framework for the long-range management of the aquifer. It described the overarching goals and actions that could be implemented to accomplish the stated goals for residents and the State of Idaho and to promote productive regional cooperation to benefit the area over a 50-year planning horizon. The planning area for the CAMP covers Ada and Canyon counties and portions of Elmore, Boise, Gem, and Payette counties.

The Treasure Valley aquifer system is a valuable and significant resource to the region and the State of Idaho. The aquifer is a key part of the regional water resources that make the area attractive for economic growth and an appealing place to live and work. At the direction of the IWRB and Idaho Legislature, the CAMP was founded on recommendations developed collaboratively by the CAMP Advisory Committee. The CAMP was designed to be a component of the State Water Plan. The IWRB recognized that the long-term management of the water resources of the Treasure Valley must be acceptable to the local community and consider the social and economic interests of the residents and public interest. The long-range plan must also be consistent with the legal constraints and laws of Idaho.

The CAMP Advisory Committee identified several challenges facing the region over the 50-year planning horizon:

- Predicted future demand cannot be met solely by readily available groundwater supplies in some areas.
- Uncertainty for meeting existing and future needs utilizing the existing water supply infrastructure will increase as annual precipitation variability increases.
- Natural flow in the summer and fall is predicted to be reduced.
- Currently, there is no Treasure Valley drought plan.
- Water infrastructure may not be able to meet existing and future needs.
- Interconnected sources must be managed.
- It may be challenging to meet water needs and uses associated with future development patterns in a manner that minimizes conflict.
- Quality of life must be maintained.

- Environmental needs must be met.
- Water supply needs must be met.
- There is a lack of an organizational structure for groundwater users to collectively plan for, and respond to, future challenges.
- Advanced technical capabilities are needed to meet increasingly complex water management challenges.
- Existing water management tools that appear to be under-used could help provide solutions to meet water needs in the future.

Guided by the CAMP goals and vision, the CAMP Advisory Committee identified several recommended actions for addressing the challenges discussed in this plan. These actions include the following:

- Enhance water data collection, analysis, and planning.
- Investigate and support additional storage and supply.
- Reduce demand through water conservation, considering the benefits of incidental recharge.
- Preserve and protect water delivery infrastructure.
- Use tools associated with the State *Municipal Water Rights Act* of 1996.
- Encourage the use of water marketing to address the conversion of water use throughout the valley.

Section 3 of the proposed CAMP specifically mentioned the need to investigate additional storage or other sources of water supply, because it may be needed in the future to offset the increased variability of water supply and additional water demand. Because of the extended lead time required for initiating storage and water supply projects, the study of these projects should be continual. This will make sure the information is available when decisions need to be made. The following actions should be part of the evaluation of future supply options:

- Continue the study of the feasibility of potential surface water storage projects in a manner that comprehensively addresses supply options and avoids conflict.
- Investigate the feasibility of utilizing managed recharge for meeting future water demands.
- Support the exchange of the Reclamation's salmon flow augmentation space in Lucky Peak (excluding stream flow maintenance) with replacement water supply consistent with the Nez Perce term sheet.
- Evaluate augmentation of existing cloud seeding programs as an option for increasing water supply.

Ultimately, the IWRB accepted the Water Resource Planning Committee's recommendation to not submit it to the Legislature in 2013. At this time, the proposed CAMP has been put on hold.

1.4.2.3 Treasure Valley DCMI Water Demand Projections, 2016

In 2016, the IWRB contracted with SPF Water Engineering, LLC (SPF) to complete the Treasure Valley DCMI Report. The scope of the Treasure Valley DCMI Report included estimating current DCMI water use and projecting the amount of additional water needed to supply DCMI water demand by the year 2065. The Treasure Valley DCMI Report was commissioned to help support USACE's *Lower Boise River Feasibility Study*.

The analysis concluded that the net DCMI water demand could increase from 110,000 acre-feet per year in 2015 to between 219,000 and 298,000 acre-feet per year by the year 2065. This is a DCMI water demand increase ranging from 109,000 to 188,000 acre-feet per year. It was also projected that the Treasure Valley population is expected to increase from approximately 624,500 people in 2015 to approximately 1.57 million people by the year 2065.

1.4.2.4 Treasure Valley Groundwater-Flow Model, 2016 to 2021

In 2016, the U.S. Geological Survey (USGS), in partnership with the IDWR, embarked on a 5-year project to construct a numerical groundwater flow model of the Treasure Valley and surrounding area. Resource managers will use the model for water supply planning and management. As part of the model construction, the hydrogeological understanding of the aquifer system will be updated with information collected during the last two decades and new data collected for the study. Funding for the project is being provided by the USGS and by the IWRB through a special appropriation from the Idaho Legislature for Statewide aquifer stabilization and sustainability studies. The Treasure Valley Groundwater-Flow Model is currently under development and is scheduled for completion in 2021.

1.4.2.5 Treasure Valley Managed Aquifer Recharge Feasibility Study, 2020

The IWRB is responsible for formulating and implementing the State Water Plan for the optimum development of the water resources in the public interest. The IWRB has been directed by the Idaho Legislature to identify and implement projects to stabilize and enhance groundwater supplies throughout Idaho. As such, the IWRB commissioned the Treasure Valley Managed Recharge Feasibility Study (Recharge Study) to develop a better understanding of the feasibility of managed recharge as a long-term water management tool in the Treasure Valley. The Recharge Study is considered a preliminary analysis and does not meet Federal feasibility-level standards. To meet Federal feasibility-level standards, additional definition about the end user, recharge site locations, and corresponding infrastructure requirements would be required. Water supply availability, physical feasibility of managed recharge, and infrastructure requirements were evaluated through the Recharge Study. The Recharge Study found that there are opportunities to develop managed aquifer recharge programs in the Treasure Valley. It identified locations, amount of potential water supply sources, and potentially favorable recharge areas; and evaluated the costs of numerous water delivery scenarios.

The water availability analysis investigated the volume, timing, and location of water available for recharge and reached the following conclusions:

- Water is available in all basins evaluated, but availability varies yearly and by location.
- Water is seasonally limited above Middleton and Letha and is continually available below Middleton and Letha.
- The Boise River basin has the least availability.
- The Payette River basin has the greatest volume of available natural flow.
- The Snake River basin has the greatest volume of flood control releases and continually available reach gains below Murphy.

1.4.3 Activities of Regional and Local Entities and Agencies

This section describes ongoing local water management projects and plans relevant to the Study.

1.4.3.1 South Fork Boise River Diversion Project

The Elmore County Board of Commissioners secured a 10,000-acre-foot water right (Water Right Number 63-34348) with a March 3, 2017, priority date with the intent of pumping water out of Anderson Ranch Reservoir into Little Camas Reservoir. From Little Camas Reservoir, this water would be diverted through the existing Mountain Home Irrigation District canal to the divide between the South Fork Boise River drainage and Long Tom Creek drainage, to subsequently be used to support groundwater recharge lower in the Long Tom Creek drainage basin. The pipeline and pump station would be located on Federal land and would cross a small section of Reclamation property. To date, no finalized design has been presented.

1.4.3.2 Cat Creek Energy LLC

Cat Creek Energy LLC (CCE) has preliminarily proposed an energy and water storage renewable power station to be constructed on land to the south, and elevated above, Anderson Ranch Reservoir on Cat Creek. A 20,000-acre-foot water permit (Water Permit Number 34403) was secured for hydropower use with a priority date of May 16, 2017. CCE secured a second 30,000-acre-foot water permit (Water Right Number 63-34652) for consumptive use (irrigation, DCMI, and mitigation) with an April 26, 2019, priority date. CCE has communicated its intent to pursue a third water right permit for an additional 50,000 acre-feet for consumptive use. Preliminary proposals state the proposed project would generate up to 720 megawatts of power with 9,996 cfs of pumping capability and would tie into the Mountain Home power transmission corridor and interconnect to both 230- and 500-kilovolt transmission systems. CCE reports the constructed reservoir would fill via surface water approximately 10 out of 20 years. The developer has indicated that 80,000 acre-feet (the secured 30,000 acre-feet and the not-yet-pursued 50,000 acre-feet) would be available for beneficial use by Water District 63 spaceholders to be distributed through the existing reservoir system.

The project proponent intends to obtain a license from the Federal Energy Regulatory Commission and a Lease of Power Privilege from Reclamation to create the pumped hydroelectric energy storage project. If the project proposal is implemented and the third water permit secured, there would be a 100,000-acre-foot reservoir created near the mouth of Cat Creek, above Anderson Ranch Reservoir, to be filled by pumping water from Anderson Ranch Reservoir. This project proposal encompasses surrounding areas and would include wind and solar energy. To date, no finalized design has been presented.

1.5 Organization of Feasibility Report

This report contains nine chapters that define and evaluate the plan proposed for a reservoir expansion, as follows:

- **Chapter 1, Introduction** provides background information about the Study, the purpose and scope of the Study, Study authorization, and related studies, projects, and programs.
- **Chapter 2, Water Resources and Related Conditions** describes identified problems and opportunities within the Study area, within the context of existing and anticipated future water resources conditions.
- **Chapter 3, Plan Formulation** describes the detailed formulation process.
- **Chapter 4, Plan Description** presents the Without Plan and Proposed Plan formulated for the Study.
- **Chapter 5, Plan Evaluation** presents an evaluation of the Proposed Plan formulated for the Study against the Without Plan conditions.
- **Chapter 6, Recommended Plan, Implementation Requirements, and Uncertainty** identifies the recommended plan and provides details about its implementation, including environmental, economic, and financial feasibility, and sources of uncertainty.
- **Chapter 7, Coordination, Consultation, and Public Involvement** summarizes the public involvement and engagement, stakeholder outreach, environmental review, and agency coordination activities undertaken by Reclamation.
- **Chapter 8, Findings, Conclusions, and Recommendations** presents Study findings, conclusions, and recommendations for further action.
- **Chapter 9, References** provides a list of sources consulted in preparation of this report.

Appendices to the Feasibility Report are as follows:

- **Appendix A** – Water Operations Technical Memorandum
- **Appendix B** – Engineering Summary Report
- **Appendix C** – Economic Benefits Analysis
- **Appendix D** – Cost Allocation Analysis

Environmental documentation is being completed in the form of an EIS, bound separately from this Feasibility Report.

Chapter 2 Water Resources and Related Conditions

This chapter addresses an essential step in the planning process—identifying and assessing existing and likely future conditions—to establish an understanding and basis for comparing the potential effects of alternative plans. This step includes describing water resources problems, needs, and opportunities to be addressed; developing planning objectives; and inventorying, forecasting, and analyzing the existing and likely future conditions in the Study area. Identified problems, needs, and opportunities serve as the basis for the planning objectives of the Study, which guide the formulation of alternative plans. The plan formulation process for Federal water resources studies and projects is described in PR&G (CEQ 2015) and further described in Chapter 3, Plan Formulation.

2.1 Water and Related Resources Problems, Needs, and Opportunities

Planning for current and future water needs in the Boise River basin is essential for a secure long-term water supply. The IWRB, with support from the Office of the Governor, State Legislature, and local water users, continues to support and pursue increased water storage within the Boise River basin to provide long-term water supply reliability and flexibility, so that water can be provided where and when it is needed. Population growth, climate variability, environmental compliance requirements, and increased concern regarding flood risks have led to increased interest in storage projects to enhance long-term water supply reliability and flood risk reduction as water management tools.

The water resource problems, needs, and opportunities were identified for the Study based on the following:

- Study authority and guidance
- Information from prior studies, projects, and programs
- Existing and likely future water resource conditions
- Input to the Study process through public outreach

Planning objectives were then developed based on identified problems, needs, and opportunities, and Study authorities.

2.1.1 Problems Identified

The following sections summarize major water resources problems in the Study area.

2.1.1.1 Water Demand

Significant growth has occurred, and is anticipated to continue, in the Treasure Valley and surrounding areas. The Treasure Valley population increased by 22% from 2010 to

2019 (USCB 2019), and projections indicate a further increase in the Treasure Valley population by 2065, from approximately 711,000 (current population) to 1.57 million people (SPF 2016). Coinciding with population growth, extensive land use changes are occurring throughout the valley. Row-crop agriculture and pastoral lands are transitioning to residential and urban environments. These changes have increased the demand for DCMI water. A study prepared for the IWRB and the IDWR concluded that projected annual water demand for DCMI uses is anticipated to increase to between 219,000 and 298,000 acre-feet per year by 2065. This represents a DCMI water demand increase ranging from 109,000 to 188,000 acre-feet per year (SPF 2016). These estimates include a 20% reduction in usage by conservation measures. As a result, future demand for water supply from the Boise River system (including Anderson Ranch, Arrowrock, and Lucky Peak reservoirs) is expected to increase.

2.1.1.2 Climate Variability

In addition to a rapidly increasing demand on water resources for consumptive use, climate variability may exacerbate the problem. Management of the Boise River system is highly dependent on water storage in the snowpack of the surrounding mountains. The River Management Joint Operating Committee (RMJOC) II Climate Change Study (2018), or RMJOC-II Climate Change Study, notes overall trends of increased fall and winter streamflow, earlier and higher spring peak runoff, and earlier streamflow recession. The 2018 study also suggests the potential for increased rain-on-snow events during the winter and spring, as well as annual runoff peaks shifting several weeks earlier compared to historical conditions. The existing infrastructure and fixed storage capacity may not be adequate to manage these projected changes in precipitation patterns (that is, current storage capacity may be insufficient to capture water in 'wet' years to offset 'dry' years). Furthermore, the early streamflow recession in summer and fall may result in greater dependency on storage water, resulting in less reservoir carryover and an increase in groundwater pumping.

2.1.1.3 Environmental Flows

Current Boise River system operations consider environmental requirements from three active ESA consultations as follows:

1. Bull trout (USFWS 2005)
2. Bull trout critical habitat (USFWS 2014)
3. Salmon augmentation flows (NOAA 2008)

Within the Boise River system, the ITS associated with the three ESA consultations provide protective coverage through ESA to continue operations and include 10 T&Cs and 14 Conservation Recommendations. From these requirements, 10 operational targets and 9 physical and biological habitat features are monitored. Furthermore, annual coordination with the USFWS and the NMFS for within season operations, as well as annual monitoring and a summary report of annual operating and monitoring, are also required.

Prioritizing environmental compliance requires a holistic approach to balance the requirements. This is achieved by using detailed within season forecasting and prior season foresight to reach operational targets each season. Anderson Ranch Reservoir is managed as part of the Boise River system water operations; balancing environmental compliance across the system sometimes means a compromise between individual environmental targets and targets across seasons. Additional water in Anderson Ranch Reservoir, the highest reservoir in the Boise River system, could allow more consistency in meeting environmental targets both within and across seasons. Consistency in meeting existing environmental targets could help Reclamation identify additional flexibility in operations that, when leveraged with existing water deliveries, could provide added fish and wildlife benefits. Benefits to ESA-listed species with volumes of additional water could be realized across each environmental metric, ultimately increasing the ecological wellness of the aquatic system. For example, an increase in flows that improves rearing habitat for juvenile fishes in the South Fork Boise River could help to sustain populations of natural reproducing native fishes, in addition to benefiting bull trout because of the direct association to the prey base. In some years, the migratory population of bull trout in the Boise River system downstream of Anderson Ranch Reservoir has less than 100 adults that migrate to spawning areas; an abundant and diverse prey base ultimately can mean more eggs, better spawning survival, and increased recruitment of young fish to the population.

2.1.2 Needs

The combination of population growth and climate projections is expected to create challenges in meeting existing water contract obligations and increased water supply demand in the Treasure Valley. With these challenges, there is a need to identify, investigate, recommend, and implement a plan for increased storage within the Boise River basin.

2.1.3 Opportunities

PL 111-11, Section 4007 of the WIIN Act, and the State of Idaho's State Water Plan, 2008 House Joint Memorial 8, 2019 House Joint Memorial 4, and 2019 Idaho House Bill Number 285, provide the opportunity for Reclamation, in partnership with the IWRB, to further investigate increased storage in the Boise River system and potentially construct a storage project. New storage would provide the ability to capture additional water to help meet evolving demands and would provide added flexibility regarding the timing and location of delivery. Because the locations of future development and associated DCMI water demands are uncertain, and because these locations may correspond to areas with limited or restricted groundwater supplies, the flexibility provided by additional surface water storage to meet these future demands is significant.

In years when sufficient water is available to meet environmental commitments and considerations, Reclamation could use water identified for environmental purposes to coordinate with local, State, and Federal entities to provide environmental flows for interim fish and wildlife uses (such as maintenance flows, habitat enhancement and restoration projects, and flushing flows). Following the direction provided by Section 4007 of the

WIIN Act to provide a Federal benefit, Reclamation has recognized the opportunity to reserve a portion of the proposed space for environmental flows and intends to reserve 10% of the space for these uses.

2.2 Planning Objectives

Primary and secondary planning objectives were developed for this Study based on water and related resource problems, needs, opportunities, and Study authorities. Primary planning objectives are those which specific alternatives are formulated to address. Secondary planning objectives are one or more of actions, operations, or features that should be considered in the plan formulation process, but only to the extent possible through the pursuit of the primary planning objectives.

2.2.1 Primary Planning Objectives

The primary planning objectives are as follows:

- Increase storage capacity in the Boise River basin to help meet existing and future demand.
- Enhance fish and wildlife environment within the Boise River basin or downstream.

2.2.2 Secondary Planning Objective

The secondary planning objective is as follows:

- Reduce flood risk within the Boise River basin.

2.3 Existing and Likely Future Resource Conditions in the Study Area

One critical step in a water resources evaluation is characterizing the existing resource conditions in the Study area and how these conditions may change in the future. The characterization provides a basis to compare alternative plans and remain in compliance with the PR&G (CEQ 2015), NEPA, and Reclamation policy guidance, including Reclamation Directives and Standards.

2.3.1 Existing Conditions Summary

The following sections summarize existing conditions of resources within the Study area. Additional information on these resources can be found in Chapter 3, Plan Formulation, and the DEIS; specifically, the respective specialist reports in Appendix B of the EIS (Reclamation 2020a).

2.3.1.1 Physical Infrastructure

Existing infrastructure in the Study area includes Anderson Ranch Dam and Reservoir and associated water management and hydroelectric facilities, as well as nearby transportation and utilities, as described herein.

Anderson Ranch Dam and Reservoir

Anderson Ranch Dam is a zoned earthfill embankment structure, with structural and hydraulic heights of 456 feet and 330 feet, respectively. Table 2-1 summarizes the characteristics of Anderson Ranch Dam.

Table 2-1. Existing Anderson Ranch Dam Characteristics

Characteristic (unit of measurement)	Units
Impounded Reservoir Storage (acre-feet)	474,900
Maximum RWS Elevation (feet amsl)	4196.0
Dam Crest Elevation (feet amsl)	4210.0
Maximum Dam Height Above Downstream Toe (feet)	456
Dam Crest Length (feet)	1,350

Notes:

amsl = above mean sea level

RWS = reservoir water surface

The dam impounds Anderson Ranch Reservoir, which stores water for irrigation water supply, power, and flood control. The reservoir also provides for silt control, fish and wildlife, and recreation. At full pool, the reservoir surface area is 4,772 acres, with a length of about 17 miles and a shoreline of approximately 50 miles. The reservoir shape is defined by three major tributary arms, each more than 1 mile long:

1. Little Camas Creek
2. Fall Creek
3. Lime Creek

The total storage volume in Anderson Ranch Reservoir is 474,942 acre-feet, including the following:

- 413,074 acre-feet of active storage
- 36,956 acre-feet of inactive space (powerhead space)
- 24,912 acre-feet of dead pool

The spillway at Anderson Ranch Dam has a discharge capacity of 20,000 cfs, and the combined discharge capacity of the outlet works is 10,000 cfs. Currently, Reclamation uses two of the three 8.5-foot-diameter power penstocks as a part of the hydroelectric system to generate power. The third penstock was installed for the future expansion of power generation. Each of the two active penstocks supplies water to a turbine that drives a 20,000 kilowatt (kW) generator for a maximum combined generating capacity of 40,000 kW.

The combined discharge capacity of the turbines is approximately 1,600 cfs (Reclamation 2019a).

Transportation and Utilities

Transportation and utilities near Anderson Ranch Dam and Reservoir provide services typical to similar rural settings in southern and central Idaho.

Transportation

Access to Anderson Ranch Dam and Reservoir and the surrounding area is provided by a network of paved and unpaved rural roads managed by Glenns Ferry or Mountain Home highway districts or USFS. Roads are referred to as either Highway District (HD) roads under HD jurisdiction or NFS roads under USFS jurisdiction. Four primary roads provide vehicle access around the reservoir:

1. HD-61 extends north from its intersection with U.S. 20, follows the northeastern shore of the reservoir, and crosses Pine Bridge to the communities of Pine and Featherville.
2. HD-128 provides access from Pine south to Sloans Gulch. The road is inaccessible past the Pine Airstrip during winter months.
3. HD-120 from Fall Creek Campground to Anderson Ranch Dam provides access to the northwestern shore.
4. HD-134 extends north from its junction with U.S. 20 to Anderson Ranch Dam, providing the most direct access to the dam and alternate access to the northwestern reservoir shore. Combined with HD-121, HD-134 is also the route used by buses to transport children to public schools in Mountain Home, and to haul hay, cattle, and farm equipment between Prairie and Mountain Home.

Extending downstream of the reservoir, HD-121 provides access from Anderson Ranch Dam south along the northern bank of the South Fork Boise River to the community of Prairie.

The 2014 Elmore County Comprehensive Plan (Elmore County 2014) describes the highway and related transportation services as providing adequate services throughout the county to meet the current needs for moving people and goods, except for those roads in mountainous communities.

Three bridges provide channel crossings:

1. Located on HD-61, the Lime Creek Bridge is a 154-foot long, prestressed concrete bridge maintained year-round by Glenns Ferry HD.
2. Located on HD-61, the Pine Bridge over the South Fork Boise River, replaced in October 2018, is a 183-foot-long, steel girder and concrete bridge. Pine Bridge is maintained year-round by Glenns Ferry HD and Mountain Home HD.
3. The Spillway Bridge, over Anderson Ranch Dam crest on HD-134, is 65 feet long.

Located on the western shore of Anderson Ranch Reservoir, the Pine Airstrip (Federal Aviation Administration identifier 1U9) is operated by the Idaho Transportation Department

(ITD) Division of Aeronautics under a Special Use Permit by the USFS. The turf airstrip, with a visual approach to each end, is approximately 2,300 feet long and 125 feet wide, and is suitable for small airplanes. Aircraft operations average 20 takeoffs and landings per week (for a 12-month period ending June 30, 2017) consisting of 98% transient general aviation and 2% military. More operations occur in the summer with the increased recreational activity. The airstrip is not maintained in winter (AirNav 2020).

Utilities

CenturyLink owns a buried fiberoptic cable that crosses Anderson Ranch Dam at the dam road and at nearby manholes and other connection points, and wireless service is available in some higher-elevation (above the river canyon) areas. Areas north of the project area and remote recreational areas have inconsistent or no cellular service.

Idaho Power Company (Idaho Power) operates overhead and underground power lines, power poles, and transformers in the project area, including a four-cable transmission line spanning the reservoir.

2.3.1.2 Physical Environment

This section describes elements of the physical environment within the Study area.

Watershed Characteristics

The Boise River, located in southwestern Idaho, is a tributary to the Snake River. The headwaters of the three forks of the Boise River originate in the Sawtooth Range of the Rocky Mountains. The contributing watershed to Anderson Ranch Dam is 980 square miles, with elevations ranging from 4196 feet at Anderson Ranch Dam to 10337 feet at an unnamed peak about 1 mile south of Bromaghin Peak, on the Blaine-Camas county line. From its headwaters in Camas County, the South Fork Boise River flows southwest to Anderson Ranch Reservoir.

Downstream of Anderson Ranch Reservoir, the South Fork Boise River flows northwest toward the southern arm of Arrowrock Reservoir. The North Fork Boise River and Middle Fork Boise River flow southwest from headwaters in Boise and Elmore counties to form the Boise River, which flows southwest into Arrowrock Reservoir.

Downstream of Arrowrock Reservoir, the Boise River enters Lucky Peak Reservoir and is joined from the north by Mores Creek before flowing through Lucky Peak Dam and downstream through Boise and other communities in the Treasure Valley (Garden City, Eagle, Star, Nampa, Middleton, Caldwell, Notus, and Parma). The river is diverted for irrigation at several locations, including Boise Diversion Dam for the New York Canal, which terminates at Lake Lowell; and Eckert Diversion Dam for the Ridenbaugh Canal, near Barber Park in Boise.

Through the urban corridor, the river is lined with levees and riprap, and the Boise River Greenbelt extends downstream of Lucky Peak Dam for 25 miles, providing recreation access to the river (such as summer float tubing). Farther downstream through agricultural areas, the river's floodplain is wider as it flows west across the Snake River Plain before its confluence with the Snake River at the Idaho-Oregon border near Parma, Idaho.

Climate, Hydrology, and Water Management

Climate in the Study area is typical of the Intermountain West, with precipitation occurring as snow in the winter and convective thunderstorms in the summer. The mean annual precipitation at Anderson Ranch Dam between 1942 and 1997 is 19.8 inches, with a range of 12.8 inches (1949) to 35.5 inches (1970). The driest recorded months are July, August, and September, which each receive less than 1 inch per month on average. Average annual snowfall at Anderson Ranch Dam is 55 inches, and more than half of this falls in December and January. Temperatures at Anderson Ranch Dam range from lows of 19 degrees Fahrenheit (°F) in January (monthly average low) to 91°F in July (monthly average high).

Natural flows in the Boise River are characterized by low flows from late summer (August) through the late winter (February) and increasing flows starting in March, with peaks occurring from April through June. The highest recorded natural flow on the South Fork Boise River of 10,900 cfs to Anderson Ranch Reservoir (USGS gage 13186000 SF Boise River Near Featherville, Idaho) occurred in May 2017, with typical spring peaks ranging from 2,000 to 8,000 cfs. Low flows are typically around 220 cfs (USGS 13186000 SF Boise River Near Featherville, Idaho).

Flow in the Boise River is regulated by the three Federal storage reservoirs. Arrowrock and Anderson Ranch dams are operated by Reclamation, and Lucky Peak Dam is operated by USACE. Together, these dams and the reservoirs on the Boise River system are operated jointly to fulfill irrigation, hydropower, and flood control requirements. The management of natural flows during spring snowmelt and runoff periods and subsequent delivery of stored water to water users in the late summer has been vital to the growth of the Treasure Valley.

The total active capacity of the three-reservoir system is 949,700 acre-feet. Because Anderson Ranch Dam is at the highest elevation of the three reservoirs, it provides the most flexibility in operations. The timing and volume of discharge at Anderson Ranch Dam depend on multiple factors, including the following:

- Previous year carryover
- Environmental conditions
- Maintenance activities
- Irrigation

Based on Reclamation data, Anderson Ranch Reservoir reached full pool (4196.0 feet) during 12 of the last 20 years (60%) and was maintained at full capacity for 16 days on average in each of those 12 years.

Throughout the water year, flows in the South Fork Boise River are managed for multiple objectives, including downstream fisheries, by maintaining minimum targets informed by consultation with Idaho Fish and Game and public input, as well as flood risk management

(FRM) objectives developed and coordinated by Reclamation and USACE (Reclamation 1997).

Typically, South Fork Boise River flows are managed as follows:

- September 16 to March 31 (fall to early spring): 300 cfs minimum flow target. Once set in the fall, Anderson Ranch Reservoir maintains a relatively constant elevation through the winter, with some filling in wet years and some drafting in dry years.
- April 1 to September 15 (early spring to fall): 600 cfs minimum flow target. However, Anderson Ranch Dam discharge is often much higher in early spring through early summer period due to FRM operations. In summer, releases from Anderson Ranch Dam typically range from 600 to 1,600 cfs (that is, the power plant capacity). Summer flows satisfy downstream irrigation demands, maintain Arrowrock Reservoir above its minimum pool 37,912-acre-foot volume (elevation 3100 feet), and maintain volumes in the three reservoirs for the next water year. After irrigation demand and other operational considerations are met, the 600-cfs minimum flow target is typically maintained until fall (September 16), but flows can drop below the target in dry water years.

Topography, Geology, and Soils

Surface geology is primarily volcanic basalts south of the South Fork Boise River, and Idaho batholith granitics to the north. The river area includes a sequence of volcanic, metavolcanic, metamorphic, and metasedimentary features that exhibit the geological turmoil and constant change the area has experienced over the past 850 million years. Anderson Ranch Dam and Reservoir are in a narrow, steep-sided valley cut through several hundred feet of igneous extrusive and intrusive rock. The Anderson Ranch and Fall Creek basalts form rimrock above Anderson Ranch Reservoir and overlie the granitic bedrock of the Idaho Batholith, which forms the canyon walls (Howard et al. 1982). The weathering of these igneous rocks is responsible for the steep slopes around the reservoir and South Fork Boise River.

Within the last decade, several mass failures have occurred in the South Fork Boise River watershed, leading to permanent road and campground closures. In 2013, wildfires followed by thunderstorms led to five debris flows in the area between Anderson Ranch Dam and the Danskin Boat Launch downstream (Phillips 2013). Landslide-prone slopes are also common around the reservoir and are present near Anderson Ranch Dam and along HD-120 from the dam to Fall Creek. One previous landslide is along the road to Fall Creek (HD-120); it appears to have stabilized, and vegetation is developing on the slide surface (Bennett 2018). Landslide-prone slopes also exist along HD-61 north of Lime Creek Bridge.

Geomorphology, Sedimentation, and Erosion

Episodic mass failures and chronic sediment supply from natural and human-caused forces, including fire, grazing, timber harvest, and road use and maintenance, contribute sediment to the South Fork Boise River. Since initially providing storage in December 1945, Anderson Ranch Reservoir has accumulated sediment conveyed by the South Fork Boise River and other reservoir tributaries, depositing in coarse alluvial fans near the upper end of the reservoir and forming a braided channel. Reclamation's Sedimentation Study (Reclamation 1998) estimated that 18,236 acre-feet of sediment had accumulated in Anderson Ranch Reservoir from 1945 to 1998, corresponding to an estimated average annual rate of 346.7 acre-feet of reservoir capacity lost to sediment accumulation.

Shoreline erosion is present around the perimeter of the reservoir and is exacerbated by roads, including along HD-120, which is built into the steep-sided canyon walls and follows along the reservoir shore. Shoreline erosion occurs primarily during early summer from waves caused by wind and boat wakes when reservoir levels are high.

Floodplains

Based on the Federal Emergency Management Agency Digital Flood Insurance Rate Maps for Elmore County, Idaho (Flood Insurance Rate Map panels 1602120325B and 1602120425B; June 19, 2019), the 1% annual chance regulatory floodplain in the Study area is predominately Zone A, which means no Base Flood Elevations (BFEs) have been determined. A Zone AE floodplain, where BFEs have been determined, exists upstream of Pine Bridge. Some wetland and riparian habitats are scattered around the reservoir perimeter where gradual slopes are present, but fluctuating water levels mostly limit vegetation in these areas to weedy annuals.

Groundwater Resources

The Study area is not within any IDWR-defined groundwater management areas. In the watershed, groundwater occurs in two general hydrogeological units: unconsolidated aquifers of permeable alluvial deposits near the ground surface; and fractured bedrock aquifers, exposed at the surface or overlain by alluvial deposits. Groundwater flow in the unconfined alluvial aquifer generally mimics local topography, with groundwater flow ultimately reaching tributary stream channels.

Based on available data for the Study area, no groundwater quality problems are known, and groundwater quality is considered suitable for domestic consumption. The Idaho Department of Environmental Quality (IDEQ) Source Water Assessment and Protection website lists four public wells in the Study area: Pine Resort Well Number 1, Deer Creek Lodge Well Number 1, USFS Curlew Creek Campground Well Number 1, and Fall Creek Resort Well Number 1.

Municipal or centralized wastewater services are not present in the Study area. Wastewater from homes and businesses is treated through onsite septic systems on individual property parcels. Public vault toilets maintained by the USFS are located at six recreational facilities near the reservoir.

Water Quality

Water quality standards and designated beneficial uses for Anderson Ranch Reservoir, its tributaries, and the South Fork Boise River between Anderson Ranch Reservoir and Arrowrock Dam are identified in the Idaho Water Quality Standards (Idaho Administrative Code 58.01.02), and the status of attaining water quality standards and supporting designated beneficial uses are reported in Idaho's 2016 Integrated Report biannual report (IDEQ 2018). Anderson Ranch Reservoir exceeds cold water biota standards during summer months. As a result, from a State regulatory perspective, the reservoir does not fully support cold water aquatic life or salmonid spawning, despite the presence of several cold-water aquatic species. It also does not fully support secondary contact recreation beneficial use due to water quality impairment from mercury. Tributaries to Anderson Ranch Reservoir either fully support designated beneficial use criteria or have not yet been assessed, except for Lime Creek. Lime Creek does not support cold water aquatic life and salmonid spawning beneficial uses because of water quality impairment from temperature (IDEQ 2018).

Between Anderson Ranch Dam and Arrowrock Reservoir, the South Fork Boise River is fully supporting cold water aquatic life, salmonid spawning, and primary contact recreation beneficial uses. However, it has not yet been assessed for aesthetic, agricultural water supply, domestic water supply, industrial water supply, or wildlife habitat beneficial uses (IDEQ 2018).

Reclamation developed the Anderson Ranch Reservoir Water Quality Model to characterize baseline water quality conditions in Anderson Ranch Reservoir and in the South Fork Boise River below Anderson Ranch Dam. This model is described in Appendix A.

Aesthetics

The diversity of visual experiences at Anderson Ranch Reservoir and the surrounding area is influenced by the natural geology and topography as well as human-made features. Surface geology is primarily volcanic basalts south of the South Fork Boise River and Idaho batholith granitics to the north. The river area includes a sequence of volcanic, metavolcanic, metamorphic, and metasedimentary features that exhibit the geological turmoil and constant change the area has experienced over the past 850 million years. The area is of exceptional educational and scientific value because of its rare physical (geologic) features (USFS 2010). The landscape is characterized by gentle to steep slopes that are weakly to strongly dissected by streams. Mid- and upper elevations are dominated by shrubs and forest communities of Douglas fir and subalpine fir, with pockets of lodgepole pine and aspen. Drier areas are abundant around the reservoir, and the camping areas are vegetated with native and cultivated plants.

Around Anderson Ranch Reservoir, seasonal variations in the natural setting include fluctuating water levels and vegetation color that is intensely green during the wetter seasons and light brown in the drier seasons. Fluctuating reservoir levels have created a calcium carbonate 'bathtub ring' on rock formations, visible when lake elevations fall below full pool.

Downstream of Anderson Ranch Dam, the scenic resources include the steep-walled basalt canyon with talus slopes, rock formations, canyon enclosures, and isolation. The South Fork Boise River offers large volume and flow, rapids and cascades, meandering waterways, and clear water. Occasional alluvial benches and ponderosa pine on the gentler slopes create a diverse setting.

Infrastructure on the natural landscape includes Anderson Ranch Dam, boat ramps, roads, campgrounds, and electrical transmission facilities. There is a variety of commercial, agricultural, and residential uses on or near the reservoir. Special use authorizations include a designated utility corridor containing Idaho Power distribution lines, operations along HD-134, and utility corridors to private inholdings.

Noise

Anderson Ranch Reservoir is in a sparsely populated area used for boating, camping, fishing, and hunting. Existing sources of noise include traffic on local roads and recreational uses of the reservoir, including motorboating and jet skis. Sensitive noise areas include a few parcels of private land with houses or cabins, campgrounds, dispersed recreation areas, and the unincorporated communities of Pine and Featherville, located along the South Fork Boise River, 11 miles and 20 miles upstream of Anderson Ranch Dam, respectively.

Hazardous Materials

Hazardous materials in the Study area are generally associated with past land uses, and hazardous materials may also be present in surface soils along roads as a result of accidental releases. The following locations likely contain hazardous materials:

- The original town site of Pine, an historical mining camp located on the South Fork Boise River in the late 19th and early 20th centuries, is now inundated by Anderson Ranch Reservoir. The Idaho Geological Survey maintains records of mine claims made in Idaho (IGS 2019). Near the reservoir, 12 historical mine sites and claims are documented, including one near the Pine Airstrip (Gertrude #1 to #4).
- Two solid waste disposal sites are identified in IDEQ records:
  - Pine Landfill (IDEQ ID: 2011BAZ5142, Solid Waste ID SW320011, Reference Site ID 4739): This site is about 1 mile southeast of Pine, upslope and to the east of the North Pine-Featherville Road by about 0.5 mile (IDEQ 2019a). This landfill is closed and no longer used.
  - Pine Transfer Station, located off North Pine-Featherville Road in the town of Pine: Citizens of Pine deposit their waste here in steel waste containers. The containers are picked up by Elmore County and taken to approved county landfill locations (Elmore County 2018).
- Six underground storage tank sites are identified in IDEQ records. The underground storage tanks at five of the sites are documented as permanently out of use and removed from the ground through the IDEQ closure process (IDEQ 2019b). The sixth such tank, a 3,000-gallon storage tank at Fall Creek Resort and Marina, was used as recently as 2016 to store gasoline for boats and recreational vehicles. This tank is listed as “temporarily out of use” in IDEQ records (IDEQ 2019c). The tank is located adjacent to the road and was in use as recently as 2018. However, the marina no longer provides gasoline for boats or recreational vehicles.

- Several underground structures and transformers owned by Idaho Power are located near Fall Creek. Electrical transformers and other electrical equipment manufactured before 1979 may contain polychlorinated biphenyls. Wooden utility poles may also be treated with preservatives that contain heavy metals or chemicals.

2.3.1.3 Land Management and Use

Land around Anderson Ranch Reservoir is primarily owned by the Federal government and managed by the USFS and Reclamation under a Master Interagency Agreement signed in 1987. Through the agreement, USFS has management and administration jurisdiction of Federal lands, except for land managed by Reclamation (known as the Reclamation Zone) for the operations of Anderson Ranch Dam and other Reclamation purposes. Other public land is administered by the U.S. Bureau of Land Management (BLM) and State of Idaho. Reclamation administers four easements around the reservoir for agricultural and grazing activities. USFS manages four grazing allotments on Boise National Forest on or near the reservoir: three for cattle and one for sheep (USFS 2019). USGS maintains a stream gaging station just downstream of Anderson Ranch Dam on the South Fork Boise River.

Extensive tracts of private land are also located throughout the area. Primary land uses include livestock grazing, agriculture, timber, utilities, and residential and commercial development. Residential and commercial development is focused around the unincorporated communities of Pine and Featherville, upstream of the reservoir. These areas include many seasonal use homes and cabins. Most private farms and ranches in the area are near Prairie, downstream of the dam and north of the river. Annually, farmers and ranchers near Prairie collectively haul approximately 4,000 head of cattle, over 300 loads of hay (at more than 20 tons per load), and numerous pieces of farming equipment on HD-121 and across Anderson Ranch Dam on HD-134 (C. Davidson 2019). In addition, cattle are trailed across the dam up to eight times per year between July and October, to move them between grazing allotments on opposite sides of the river (C. Davidson 2019).

As Section 2.3.1.4 describes, public land in the Study area is used heavily by residents and nonresidents for recreation, including boating, fishing, camping, hiking and off-road, all-terrain vehicle use in the summer; fishing and big game and upland game hunting in the fall; and fishing, cross-country skiing, and snowmobiling in the winter.

Collectively in Ada, Camas, Canyon, and Elmore counties, based on data collected in 2012 and 2017 by the National Agricultural Statistics Service Census of Agriculture, overall acreage in agricultural production decreased from 2012 to 2017, but the overall value of agricultural production increased. In 2017, Canyon County had the greatest value of production, and Elmore County had the largest acreage. The management of natural flows during spring snowmelt and runoff periods and subsequent delivery of stored water to water users in the late summer has been vital to the growth of the Treasure Valley. In some parts of Ada County and most of Canyon County, irrigation (sprinkler and flood) supports a wide range of crops including the following (University of Idaho 2019):

- Corn (sweet and field)

- Sugar beets
- Potatoes
- Grain (wheat and barley)
- Alfalfa (hay and seed)
- Beans

2.3.1.4 Recreation Resources

Because Anderson Ranch Reservoir is centrally located within a 2-hour drive of Treasure Valley, Mountain Home, and Magic Valley, recreation is common for day trips, as well as extended outings. Anderson Ranch Reservoir, the South Fork Boise River upstream and downstream of the reservoir, and surrounding public lands provide numerous recreation opportunities year-round, including fishing, sightseeing, wildlife viewing, swimming, hunting, hiking, biking, and motorized and nonmotorized boating.

Anderson Ranch Reservoir is used for fishing, pleasure boating, standup paddle boarding, and water skiing. During the summer, at least four businesses rent motorboats and other water sports equipment. Eight developed campgrounds and five boat ramps surround the reservoir, all managed by USFS. Nester's Private Campground is privately owned and operated, and the Fall Creek Resort and Marina is authorized by the USFS through a Special Use Permit. During low water, especially around Curlew Campground and upstream toward the Pine Bridge, shorelines are popular for dispersed recreation including picnicking, tent and recreational vehicle camping, fishing, paddle sports, mooring for motorized watercraft, and off-road, all-terrain vehicles.

The South Fork Boise River downstream of Anderson Ranch Dam, renowned as a blue-ribbon trout fishery for its naturally reproducing (no hatchery input) native trout, provides resident and non-resident anglers with fishing opportunities from rafts and river boats during the spring and summer flows and wading access during fall and winter flows. Along the approximately 11-mile river reach from the Tailwaters boat launch (a short distance downstream of Anderson Ranch Dam) to the Danskin launch, 12 dispersed camping areas and 5 float-boat launches are scattered. The canyon section, approximately 18 river miles from Danskin launch to Neal Bridge takeout just above the backwater from Arrowrock Reservoir, is popular for anglers and whitewater rafters, with more than 10 Class II and Class III rapids. Four dispersed camping areas are used in this reach, which is not accessible by road.

Numerous developed and undeveloped river access points are accessible both upstream and downstream of the reservoir; multiple trailheads, adjacent to roads around the reservoir, provide access to trails up into the surrounding hills and mountains. During big game and upland game hunting seasons in the fall, road pullouts and campgrounds around the reservoir are used as hunting base camps. Throughout winter, the area is a popular destination for snowmobiling and cross-country skiing, with more than 380 miles of marked and groomed snowmobile trails in the Trinity Mountains north of Anderson Ranch Reservoir.

2.3.1.5 Water Resources

Water Supply

Treasure Valley surface water and aquifer systems are complex and have significant and dynamic hydrological interconnections. Natural stream flows, stored surface water, and groundwater are used and reused in multiple locations across the valley for irrigation and DCMI water.

Nearly 80% of the annual Boise River surface water flow occurs as snowpack runoff from March to July. The average natural flow volume in the Boise River, based on records from 1929 through 2010, is about 1.9 million acre-feet annually, as measured and calculated at Lucky Peak Dam. This volume represents the sum of unregulated tributary flows. The average annual basin outflow, as measured at the Parma gage (1972 through 2010) and including seasonal runoff and discharge or return flows from the aquifer, is 1.1 million acre-feet. Carryover water, or stored water that is available at the end of an irrigation season, varies from year to year and is highly dependent on snowpack levels and irrigation demand for that season (IWRB 2012a).

Water Demands

Irrigation water conveyance through the Treasure Valley consists of a complex network of waterways that cross the landscape to supply agricultural lands. The hydrology and landscape of the Treasure Valley are drastically different today than they were in the late 1800s, when the area was first settled by farmers and ranchers. Ephemeral creeks have been modified to perennial drains to serve as both delivery and drainage mechanisms for irrigation water. The construction of diversions, canals, laterals, ditches, sloughs, and drains has contributed to the presence of persistent shallow groundwater aquifers. Through many decades of operation, the constructed irrigation and drainage infrastructure in the area has established a balance between surface and groundwater that functions to serve water users. The shallow groundwater aquifers of the Treasure Valley are directly connected with the Boise River (Stevens Historical Research Associates [undated] as cited in IDEQ 2015).

Currently, during the irrigation season, natural surface water inflow to the Boise River above Lucky Peak Dam is insufficient to meet irrigation demand between Lucky Peak Dam and Middleton. Therefore, irrigators rely on stored water in the three reservoirs (Anderson Ranch, Arrowrock, and Lucky Peak) to supplement natural flows and meet irrigation demands. Along the Boise River from Middleton to the confluence with the Snake River near Parma, groundwater seepage and return flow from irrigation drains supplement natural flows and help satisfy irrigation demands (Stevens Historical Research Associates [undated] as cited in IDEQ 2015).

The groundwater aquifer is the primary source of water for DCMI users in the Treasure Valley, accounting for approximately 95% of the valley’s drinking water (IWRB 2012a). The existing DCMI water demand is estimated as follows in Ada, Canyon, and Elmore counties (SPF 2016):

- Ada and Canyon counties (combined): 79,500 acre-feet in 2010 and 110,200 acre-feet in 2015
- Elmore County: 5,440 acre-feet in 2010 and 4,870 acre-feet in 2015

Water Rights

Water rights in Idaho are defined through Idaho water law pursuant to the laws, regulations, and orders in the regulatory framework. In Idaho, both surface water and groundwater are managed through the doctrine of prior appropriation. In the Boise River, competing water right demands include irrigation, flood control, minimum flow targets, ecological flow releases, and ecological storage constraints. Anderson Ranch Reservoir provides the storage and delivery of water to meet priority downstream water right appropriations. Potential irrigation space holders include existing Reclamation contractors and the IWRB, which can contract water to existing Water District 63 water users or offer water through the Idaho water supply bank's Water District 63 rental pool, or both.

Wild and Scenic Rivers (Federal)

The national *Wild and Scenic Rivers Act of 1968*, as amended (PL 90-542; 16 USC 1271 – 1287), established the National Wild and Scenic Rivers System, which identifies rivers of the Nation that possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values. This act preserves the free-flowing condition of rivers that are designated and protects their local environments.

The USFS has classified the reach of the South Fork Boise River from Anderson Ranch Dam to Mennecke Creek (downstream of Danskin Bridge) as eligible for recreation status under PL 90-542 for its outstanding recreational, geological, and heritage values. The USFS has also classified the next two reaches downstream, specifically Mennecke Creek to Trail Creek and Trail Creek to Crank Creek (downstream of Neal Bridge) as scenic (outstanding recreation and geological values) and wild (outstanding scenic, recreation, and geological values), respectively.

Protected Rivers (State)

As a component of the Comprehensive State Water Plan process, the IWRB designates some river segments with outstanding fish and wildlife, recreational, aesthetic, or geological value as a State-Protected River. If the IWRB decides the values of preserving an outstanding waterway in its existing condition outweigh the values of continued development, it can, subject to legislative approval, designate that waterway either a Natural River or Recreational River to protect existing resources and use. Within the Study area, the South Fork Boise River (from Anderson Ranch Dam downstream to Black Canyon Creek) and Lime Creek (from the North and Middle Forks confluence in the Sawtooth National Forest to its mouth on the east side of Anderson Ranch Reservoir) are designated as protected by the State, under recreational and natural classifications, respectively.

2.3.1.6 Biological Resources

Biological resources in the Study area are described in this section and result from a variety of climatic and vegetative associations within and adjacent to the Study area.

Vegetation and Wetlands

The Study area landscape is defined by lower montane ridges and mountain stream valleys. Forests are composed of coniferous evergreen and mixed coniferous-deciduous forest types. Mid- to high-elevation habitats are composed of shrubs and forest communities of Douglas fir and subalpine fir with scattered lodgepole pine and quaking aspen. Low- to mid-elevation forests are dominated by Douglas fir, ponderosa pine, and quaking aspen; these forests have common understory species such as woods rose, snowberry, antelope bitterbrush, bluebunch wheatgrass, needle-and-thread grass, Idaho fescue, arrowleaf balsamroot, western yarrow, and lupine. These forest types are present primarily on the eastern reservoir shoreline, on side drainages, on north- and east-facing slopes in the surrounding foothills, and in the northern end of the reservoir near the community of Pine. Sagebrush steppe and grassland communities dominate lower-elevation, non-forested areas adjacent to the reservoir and the South Fork Boise River downstream of the dam.

The western side of the reservoir is primarily steep and south-facing, with little to no vegetation established along the shoreline. Vegetation below the existing highwater line of the reservoir (elevation 4196 feet) consists primarily of weedy annuals; fluctuating water levels and steep slopes inhibit establishment of permanent riparian habitat along shoreline.

Riparian areas are well-developed along the South Fork Boise River (upstream and downstream of the dam), its tributaries, and the reservoir shoreline where more gradual slopes are present, primarily on the eastern side of the reservoir. Riparian species in the Study area include black cottonwood, quaking aspen, willows, red osier dogwood, alder, mountain maple, chokecherry, water birch, black hawthorn, mock orange, thimbleberry, mannagrass, blue wildrye, wooly sedge, field horsetail, and common spikerush.

Wetlands in the Study area include palustrine, riverine, and lacustrine systems. Generally, lacustrine wetlands are present around the reservoir perimeter, riverine wetlands are located where streams and rivers discharge into the reservoir (including the South Fork Boise River upstream and downstream of the dam), and palustrine wetlands are adjacent to water bodies and in small depressional areas subject to ponding. Seasonally flooded wetlands typically are vegetated with hardy riparian plant species such as sedges, rushes, spike rush, cattail, and bulrush.

Invasive species and noxious weeds are present, especially in disturbed sites and near high recreation use areas including roads, trails, river corridors, campgrounds, and the Pine Airstrip. Elmore County is home to 29 State-designated noxious weeds including two species of aquatic noxious plant species, and suitable habitat exists within the Study area for all 29 weed species. Nine noxious weed species are known to occur within the Study area (Hampton 2019). Leafy spurge is the highest priority for control by USFS. Exotics such as Russian olive are also present in the lower reaches of the river.

Fish and Aquatic Species

The diversity of aquatic habitat within the Study area supports aquatic macroinvertebrates and native and introduced fish. The habitats include deep reservoir habitat that provides cold water refugia for native species during most times of the year; shallow shoreline habitat that promotes increased primary productivity and supports a diversity of native and non-native fishes (IDFG 2019a); and complex riverine habitats in the South Fork Boise River and its tributaries. The Idaho Department of Fish and Game (IDFG) exclusively manages the fishery, including stocking and regulations, in a manner that favors the presence of individual species (Idaho State Statute 33).

Anderson Ranch Reservoir is well-known as a kokanee salmon fishery. Native fish (including bull trout, redband trout, and mountain whitefish) and non-native fish (including yellow perch and smallmouth bass) live in the reservoir (IDFG 2019b). South Fork Boise River, downstream of Anderson Ranch Dam, is a nationally renowned trout fishery and was the first river section in the IDFG Southwest Region to be managed under “trophy trout” regulations. This fishery remains a prime wild trout fishery and is supported by populations of wild rainbow trout and mountain whitefish. Migratory bull trout are present at very low densities, as are native nongame fish including largescale sucker, bridgelip sucker, northern pikeminnow, and sculpin.

Water bodies in the Study area provide suitable conditions for invasive species, including the following aquatic species already documented in some Idaho waters: parasites that cause whirling disease, New Zealand mudsnail, Asian clam, American bullfrog, oriental weather loach, and multiple crayfish species. Other invasive species not yet documented in Idaho, with potential to occur in the Study area, include quagga mussel and zebra mussel. The presence of aquatic invasive species has not yet been documented in the Study area, but they may exist.

Wildlife

The range of vegetation types in the Study area provide a diversity of wildlife habitats, including wintering and nesting habitat for bald eagles and peregrine falcon. Many of the lower-elevation grasslands and shrublands are important winter range for elk and mule deer, and these areas provide foraging habitat for mountain quail, sage grouse, and introduced turkey and chukar. Mid-elevation forests provide habitat for Franklin grouse and ruffed grouse, as well as habitat for several sensitive species including northern goshawk, flammulated owl, and white-headed woodpecker. Higher-elevation forests and ridges provide nesting and foraging habitat for many migratory birds and summer range for mammals such as elk, black bear, mountain lion, and mountain goat. Anderson Ranch Reservoir provides habitat for resident and migratory waterfowl, including merganser, common loon, and Clark’s grebe.

Special Status Species

Five Threatened and Endangered (T&E) species (one bird, two mammals, one tree, and one fish) identified by the USFWS are known or expected to occur in Elmore County. They include three Federally listed species (yellow-billed cuckoo, Canada lynx, and bull trout), one species proposed for listing (North American wolverine), and one candidate species (whitebark pine). Critical habitat for bull trout occurs in the Study area.

Additionally, interior redband trout is an Idaho species of concern and a BLM and USFS sensitive species (Western Native Trout Status Report 2018). They have at least three life history strategies (lake dwelling [adfluvial], stream dwelling, and resident) that allow them to occur in Anderson Ranch Reservoir, Arrowrock Reservoir, and the South Fork Boise River (Western Native Trout Status Report 2018). Also, westslope cutthroat trout is listed as a State of Idaho and Federal species of concern by both BLM and USFS and has been proposed for ESA listing in some areas of its range (USFS 2016). They are known to have occurred in the Boise National Forest and have been documented in recent surveys (IDFG 2019b, 2019c) in South Fork Boise River.

2.3.1.7 Socioeconomic Resources

Throughout the four-county region (Ada, Camas, Canyon, and Elmore counties), from 2010 to 2017, the populations of Ada and Canyon counties each grew about 1%, consistent with overall growth rate for the State of Idaho. However, over this same period, the populations of Camas and Elmore counties declined by about 3% and 0.4%, respectively (Reclamation 2020a).

From 2000 to 2010 and from 2010 to 2017, total housing units increased in Ada, Canyon, and Elmore counties, but total housing units declined slightly between 2010 and 2017 in Camas County. In 2000, 2010, and 2017 for the four-county region, housing vacancy rates were higher than the Federal housing shortage threshold of 5%, but they were lower than the State average vacancy rate. Camas County had the fewest houses and the most vacancies (Reclamation 2020a).

In the four-county region, real per capita personal income (in 2018 dollars) declined between 2000 and 2010, in contrast to the State and Nation, which experienced a small increase. The lower rates from 2000 to 2010 are most likely due to the combined effects of the early 2000 recession and the Great Recession (Reclamation 2020a).

Real earnings (in 2018 dollars) by industry grew at a faster rate after 2010, primarily driven by earnings growth in the construction; manufacturing; finance, insurance, and real estate; and services sectors. In the four-county region, these four sectors accounted for almost 60% of the total industry earnings in each of the three years (2001, 2010, 2017). Notably, mining, quarrying, and oil and gas extraction in the four counties increased almost seven-fold from 2001 to 2010 and then retracted to less than the 2001 earnings by 2017 (Reclamation 2020a).

The civilian labor force (composed of civilian employment and civilian unemployment) increased in the four-county region from 2000 to 2010 and again from 2010 to 2017, except in Elmore County, where it declined slightly between 2010 and 2017. For the four-county region, the average unemployment rate in the civilian labor force increased from 3.8% in

2000 to 9.2% in 2010 before declining again to 3.1% in 2017. From 2000 to 2017, the trend in unemployment rate for the four-county region was generally similar to the State’s trend and generally less than the national average (Reclamation 2020a).

Average annual employment by industry across the four-county region is concentrated in the services, retail trade, and government sectors, which together account for about two-thirds of all jobs. In 2001, an estimated 313,189 people were employed in the four-county region. Between 2001 and 2017, annual employment increased by approximately 110,310 jobs (35%), and from 2010 to 2017 average annual growth rate was more than twice the 2000 to 2010 rate, increasing from 1.3% to 2.7% (Reclamation 2020a).

2.3.1.8 Cultural Resources

Evidence of Native American occupation in southwestern Idaho dates as early as 14,500 years before present (B.P.). Archaeologists have defined three prehistoric cultural periods in southwest Idaho. These are the Paleo-Indian period (14,500 to 7,000 B.P.), the Archaic period (7,000 to 300 B.P.), and the Protohistoric period (300 B.P. to European contact). The Danskin Rockshelter (10EL01), located downstream of Anderson Ranch Dam, indicates a prolonged seasonal use through the Early, Middle, and Late Archaic periods (7,000 to 250 B.P.).

Shoshone and Bannock peoples and Northern Paiute groups occupied the Boise and Payette River basins at the time of European movement into the area that is now Idaho. Early explorers reported that the Boise River and vicinity was an important seasonal meeting and trading location for non-resident groups from the Columbia River, northern Idaho, the Oregon deserts, and Wyoming. The subsistence strategy observed by the early 1800s included exploitation of plant, animal, and raw material resources obtained by traveling seasonally. Multiple family groups spent winters in small villages along the lower and middle areas of the Payette and Boise rivers.

Nine cultural resource sites had been documented in or immediately adjacent to the Study area before this current work (Table 2-2). Site types include a historical camp site, a historical government camp, a historical building, a stage road route, a relocated town, a historical relocated cemetery, a recently replaced bridge, and a dam and powerplant and associated features. In addition, six cultural resources were identified and documented in the Study area as part of the cultural resource investigations for this project, including the Pine Airstrip, Fall Creek Resort and Marina, the Old Lester Road, and three county roads (Table 2-2). No archaeological resources have been documented in the Study area.

Table 2-2. Cultural Resources Documented in the Study Area

Site Number	Site Type	Site Description	National Register Evaluation
10EL745	Pine Cemetery	Historical cemetery	Undetermined
10EL826	Unknown	None given on site form	Undetermined

Site Number	Site Type	Site Description	National Register Evaluation
10EL2485	Historical Camp Site	Root cellar, stone walls, 1940s food cans, lantern parts, box springs, and steel drums	Undetermined
39-339	Town of Pine	Buildings and old mine shaft	Undetermined
39-930	South Boise Stage Road	Road	Eligible (1/6/14)
39-8319	Historical Building	Log building	Undetermined
39-18218	Pine Road Bridge	Bridge (replaced in 2018)	Ineligible (2/17/11)
39-18222	Reclamation Village	Location of the old government camp in use during construction of Anderson Ranch Dam	Ineligible (3/6/15)
39-1202	Anderson Ranch Dam and Powerplant	Earthen dam, associated features, and powerplant facility	Eligible (1/5/99)
BS-2520	Pine Airstrip	Back country dirt airstrip	Ineligible (1/16/20)
BS-2521	Fall Creek Resort and Marina	Complex of buildings for lodging and recreation	Ineligible (1/16/20)
BS-2539	HD-131	Also called Cow Creek Road	Determined ineligible
BS-2545	HD-113	Also called Lake Creek Road	Determined ineligible
BS-(to be determined)	HD-61	Also called Pine-Featherville Road	Determined eligible
MSF-19-07	Old Lester Road	Abandoned road bed that once connected a group of buildings called Lester (near the mouth of Lester Creek) to the “main” road above the river valley	Ineligible (1/16/20)

2.3.1.9 Tribal Interests

The Shoshone-Bannock Tribes of the Fort Hall Reservation and the Shoshone-Paiute Tribes of Duck Valley Reservation are two Federally recognized Tribes with connections to the Study area. Based on information in Reclamation’s geospatial database, “Native American lands” (reservation and trust land) are not located within the Study area for either tribe. Also, Reclamation did not identify any Indian Trust Assets in the project area.

The Idaho Supreme Court has affirmed the Shoshone-Bannock Tribes’ Tribal members’ right to take fish off-reservation pursuant to the Fort Bridger Treaty. The court also recognized "that treaty Indians have subsistence and cultural interests in hunting and fishing…" and "The Fort Bridger Treaty … contains a unified hunting and fishing right, which…is unequivocal" (Idaho Supreme Court 1972). The treaty did not grant a hunting, fishing, or gathering right; it reserved a right the Shoshone-Bannock Tribes have always exercised.

The Shoshone-Paiute Tribes of the Duck Valley Reservation, located on the Idaho/Nevada border, do not have off-reservation rights outside their Executive Order Reservation. The Shoshone-Paiute Tribes may have cultural and religious interests in the area of Anderson Ranch Reservoir. These interests of the tribe may be protected under the historical preservation laws and the *Native American Graves Protection and Repatriation Act* (PL 101-601).

2.3.1.10 Environmental Justice

Environmental justice considerations include disproportionately high and adverse human health and environmental impacts on minority and low-income populations. Minority population includes both racial minority and ethnic (for example, Hispanic origin) minority populations. Native American populations are included in the racial minority count. The population in Elmore County is about 13% minority and about 13% low-income (Reclamation 2020a). Related to the end user populations in Ada and Canyon counties, the proportions of minority are about 8% and about 6%, respectively, and the proportions of low-income population are 11% and 16%, respectively. Though Elmore County's minority population percentage is slightly higher than the corresponding percentages for the State (9% minority), the proportion is less than the threshold for determining the presence of an environmental justice population on the basis of race and ethnicity. Similarly, while proportions of low-income populations in both Elmore and Canyon counties are higher than those of the State (12%), the difference is not significant enough to establish the presence of an environmental justice population on the basis of income.

2.3.1.11 Safety

The remote, rugged, rural, mountainous area poses challenges for safety, which are compounded by limited services. The volume of emergency response requests peaks in summer due to increased recreation. Mountain Home, approximately 28 miles from the dam via paved and unpaved roads, is the closest community with a full suite of emergency services (including fire, ambulance, and law enforcement). Daylight- and weather-permitting, a medivac helicopter service available from Boise can land remotely or at Prairie or the Pine landing areas. Other emergency response capabilities are provided by Elmore County and the unincorporated communities of Pine, Featherville, and Prairie by a mix of salaried, on-call, and volunteer staff. Water rescue response is deployed from the nearest boat launch to the incident. Some services are limited in winter due to lack of infrastructure. Smith Prairie (the broader Prairie community area) has an ambulance; however, without a storage building, winter response is unavailable. Mountain Home, Smith Prairie, Pine, and Featherville have extraction teams for on- and off-road accidents. USFS provides support for forest fires, and BLM provides support for brush fires.

2.3.2 Summary of Likely Future Conditions

Understanding the future timing and magnitude of the availability and allocation of water resources is central to this Study. Future conditions are inferred from historical data and trends; current conditions; and tools such as population, socioeconomic, climate, and hydrological models. This information—and the associated assumptions—helps characterize how current problems, needs, and opportunities are likely to change in the future, specifically for this Study in the absence of a project. The future without-project condition is synonymous with the NEPA-required No Action Alternative.

The Treasure Valley (Ada County and Canyon County) population is estimated to have increased 22% from 2010 to 2019 (USCB 2019), and population projections indicate significant continued growth. Coinciding with population growth, extensive land use changes are occurring throughout the Treasure Valley. Most visibly, row-crop agriculture and pastoral lands are transitioning to residential and urban environments. Together, these population and associated land use changes continue to increase the demand for DCMI water.

Recognizing the need to better understand future water demand, the IWRB funded the Treasure Valley DCMI Report (SPF 2016). The primary conclusion of the Treasure Valley DCMI Report was that DCMI demand could increase as much as 109,000 to 188,000 additional acre-feet per year by 2065. Other conclusions from that study emphasize the importance of understanding and evaluating future water supply sources (SPF 2016):

- The combined population of Ada and Canyon counties is expected to increase from approximately 624,500 people in 2015 to approximately 1.6 million people by the year 2065.
- Substantial water demand reductions are possible through conservation, and more detailed conservation planning may be necessary to achieve higher conservation goals. The study's projections incorporate a 20% reduction in indoor use and a 10% reduction in outdoor use.
- Options for supplying the increased net DCMI demand could include Boise River diversions (increased surface water storage, use of flood flows for aquifer storage and recovery strategy, or direct diversions), additional development of Treasure Valley groundwater, new diversions from the Snake River, or the reuse of treated municipal effluent.
- Surface water from existing irrigation could become more available for indoor DCMI uses in the future. However, this would likely require market incentives to cover the costs of delivery system improvements and operations and changes in existing Boise River basin storage contracts.

The primary assumptions associated with future DCMI water demand in the Study area include the following:

- Rate of population growth

- Rate of land conversion from agriculture to urban
- Effectiveness of water conservation measures (residential and agricultural)
- Climate variability

Future climate variability will impact the timing and volume of flows entering Anderson Ranch Reservoir, and these changes are expected to affect how Reclamation operates its two reservoirs in the three-reservoir system (Anderson Ranch, Arrowrock, and Lucky Peak). Future climate variability is expected to increase, including higher temperatures, a greater range between dry and wet years, and more frequent extreme climate events (hot, wet, or dry). Results from climate models comparing baseline (1980 to 2009) to future (2050 to 2079) suggest that annual average temperature could increase by as much as 9°F and long-term monthly mean temperature could increase by as much as 12°F (in March). Winter and spring seasons have the highest increase in average temperature (Reclamation 2020a).

Projected changes in annual precipitation for the future climate models vary widely. Annual watershed precipitation could increase as much as 37%. The changes in precipitation are more apparent as long-term monthly precipitation averages. Winter and spring precipitation could increase by as much as 0.9 inch (30%) in March to 1.8 inches (40%) in January; late summer precipitation increases substantially, by as much as 2.4 inches (265%) in August and 0.8 inch (68%) in September. Projected changes in overall amount of snowpack show a substantial reduction. March, April, and May are projected to have the greatest reduction in snow water equivalent. For example, in April, the maximum modeled reduction in snow water equivalent is 8 inches (67% decrease); in May, the reduction is 5.5 inches (90% decrease) (Reclamation 2020a).

Future changes in climate variability and trends are expected to affect unregulated inflows to the South Fork Boise River at Anderson Ranch Dam. Future average annual simulated stream flow is projected to increase by as much as 47%. The largest change in stream flow is observed as a shift in the timing of the hydrograph. Spring runoff is projected to occur earlier, with the peak of the hydrograph shifting by as much as 1 month earlier. Wintertime runoff is also projected to increase due to higher temperatures, more precipitation falling as rain than snow, and earlier snowmelt. Consequently, less water is projected to store in snowpack. This shift, together with the increase in evapotranspiration due to elevated temperature, would lead to less summer runoff, especially in June and July. The largest changes in monthly streamflow are projected to occur in spring. For example, January to April runoff increases by as much as 100% to 400%. Projected future summer flow decreases are the largest in June (38% decrease), but late summer runoff is projected to increase by as much as 25% in August due to the increase in summer precipitation (Reclamation 2020a).

Recreational resources in the Study area would continue to be heavily used by local and Treasure Valley residents, as well as regional visitors. The impacts of recreational vehicles and all-terrain vehicles for dispersed camping and recreation near the South Fork Boise River and around Anderson Ranch Reservoir are expected to lead to continued infestations of invasive plants and noxious weeds, as well as loss of riparian habitat. Roads throughout the Study area could require additional maintenance because of increased recreational traffic.

Together, these recreation-caused impacts could reduce habitat for native fish and wildlife species and lead to fish and wildlife population reductions in the Study area (Reclamation 2020a).

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Chapter 3 Plan Formulation

This chapter details the plan formulation process for the Study, including a description of the planning objectives, constraints, and considerations; the formulation of initial plans; and development of the Proposed Plan.

3.1 Governance

In 2015, the Council on Environmental Quality (CEQ) released the PR&G, the culmination of an interagency effort to update the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G; U.S. Water Resources Council 1983). The PR&G govern how Federal agencies evaluate proposed water resource developments and include the following components:

- The *Principles and Requirements for Federal Investments in Water Resources* (P&R) outline the overarching concepts that the Federal government seeks to achieve through policy implementations and requirements for inputs into analysis of Federal investment alternatives (CEQ 2013).
- The Interagency Guidelines (IG) provide guidance for determining the applicability of the P&R for affected Federal agencies, including DOI, U.S. Department of Agriculture (USDA), U.S. Department of Commerce, EPA, USACE, Federal Emergency Management Agency, and Tennessee Valley Authority (CEQ 2014).
- Agency Specific Procedures (ASP) are used for identifying which programs and activities are subject to the PR&G. DOI's *Agency Specific Procedures For Implementing the Council on Environmental Quality's Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies (707 DM 1 Handbook)* is its ASP (DOI 2015).

The P&R, IG, and ASP are not regulations but are statements of policy, intended to articulate expectations for the internal management of the Federal government. The P&R and IG do not impose any legally binding requirements on Federal agencies.

The Study is consistent with DOI's 707 DM 1 Handbook (DOI 2015), which is also consistent with *Water and Related Resources Feasibility Studies, Reclamation Manual, Directives and Standards, CMP 09-02* (Reclamation 2019b).

3.2 Planning Process

The planning process for Federal water resources studies is identified in the PR&G and generally consists of four deliberative and iterative steps:

1. Identify water resources problems, needs, and opportunities; and develop planning objectives, constraints, and criteria.

2. Inventory and forecast conditions likely to occur in the Study area.
3. Formulate, evaluate, and compare alternative plans.
4. Select a plan for recommendation to decision-makers for implementation or no action.

This Feasibility Report is the final planning report in the feasibility study process and builds on the results and findings of the previous planning documents. This Study uses the results from the iterative planning process that uniquely took place across, and included, multiple planning studies conducted by Reclamation and USACE under varying study authorities. Each planning study was conducted in partnership with the IWRB. While each earlier planning study was performed under unique agency-specific authority, studies were conducted with similar water resource problems and planning objectives, planning constraints, and planning considerations for the alternative analyses and comparisons. Results from these studies have been incorporated into this Study's plan formulation approach (Figure 3-1) and are described in this chapter.

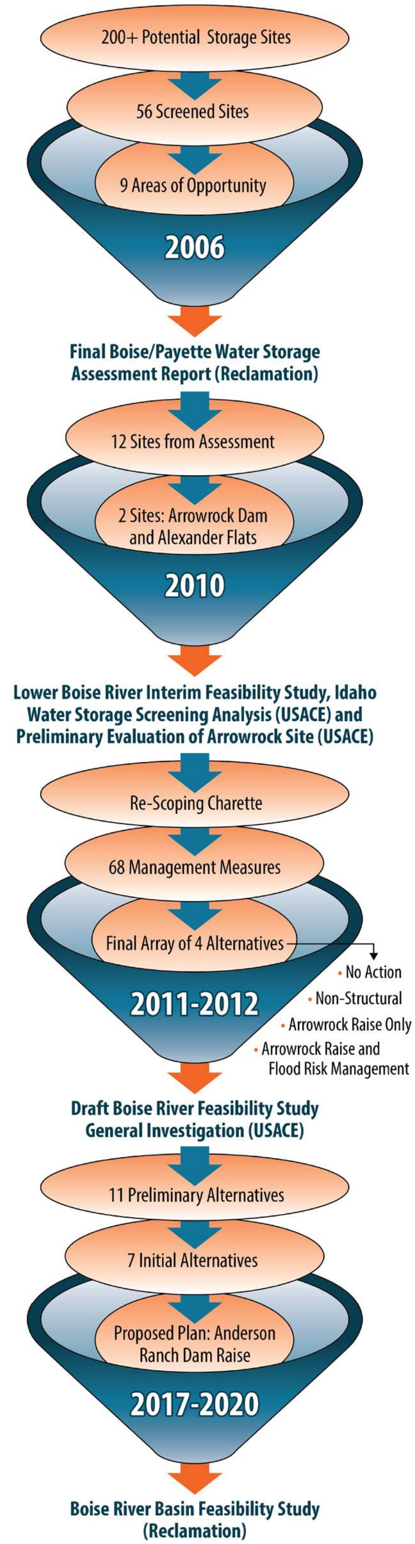


Figure 3-1. Iterative Planning Process

3.3 Planning Directives, Objectives, Constraints, and Considerations

This section discusses the planning objectives, constraints, and other considerations specific to the Study.

3.3.1 Planning Directives

The PR&G (CEQ 2015) provides fundamental guidance for the formulation of Federal water resources projects. It also requires that planning studies identify basic planning constrains and that other considerations specific to a feasibility study be developed and identified. Planning constraints help guide a feasibility study. Some are more rigid than others, but all are influential in guiding the plan formulation process. Several key constraints identified for this Study are discussed in the following subsections.

3.3.1.1 Federal Directive

Omnibus Public Land Management Act of 2009 (Public Law 111-11)

The Secretary of the Interior was authorized to undertake feasibility studies on projects that address water shortages within the Snake, Boise, and Payette River systems in March 2009 through PL 111-11, Section 9001, which terminated 10 years after date of enactment (March 30, 2009):

> *"The Secretary of the Interior, acting through the Bureau of Reclamation, may conduct feasibility studies on projects that address water shortages within the Snake, Boise, and Payette River systems in the State of Idaho, and are considered appropriate for further study by the Bureau of Reclamation Boise Payette water storage assessment report issued during 2006."*

Federal study authorization was reaffirmed and extended in September 2018 through the *Energy and Water, Legislative Branch, and Military Construction and Veterans Affairs Appropriations Act, 2019* (115 HR 5895, Section 204, PL 115-244) to March 30, 2029:

> *"The Omnibus Public Land Management Act of 2009 (Public Law 111–11; 123 Stat. 1295) is amended by striking ''10'' and inserting ''20''."*

Water Infrastructure Improvements for the Nation Act (Public Law 114-322)

The Secretary of the Interior was further authorized to undertake explicitly the Boise River Basin Feasibility Study in April 2018 through PL 115-141:

> *"That in accordance with section 4007 of Public Law 114–322 and as recommended by the Secretary in a letter dated February 23, 2018, funding provided for such purpose in fiscal year 2017 shall be made available to the Shasta Dam and Reservoir Enlargement Project, the North-of-Delta Offstream Storage Investigation/Sites Reservoir Storage Project, the Upper San Joaquin River Basin Storage Investigation, the Friant-Kern Canal Subsidence Challenges Project, the Boise River Basin Feasibility Study, the Yakima River Basin Water Enhancement Project—Cle Elum Pool Raise, and the Upper Yakima System Storage Feasibility Study."*

Under Section 4007(b) of the WIIN Act, the Secretary of the Interior received the authority for the following:

> *"(1) AGREEMENTS.—On the request of any State, any department, agency, or subdivision of a State, or any public agency organized pursuant to State law, the Secretary of the Interior may negotiate and enter into an agreement on behalf of the United States for the design, study, and construction or expansion of any federally owned storage project in accordance with this section.*
>
> *(2) FEDERAL COST SHARE.—Subject to the requirements of this subsection, the Secretary of the Interior may participate in a federally*

owned storage project in an amount equal to not more than 50 percent of the total cost of the federally owned storage project.

(3) *COMMENCEMENT.—The construction of a Federally owned storage project that is the subject of an agreement under this subsection shall not commence until the Secretary of the Interior—*

(A) *determines that the proposed Federally owned storage project is feasible in accordance with the reclamation laws;*

(B) *secures an agreement providing upfront funding as is necessary to pay the non-Federal share of the capital costs; and*

(C) *determines that, in return for the Federal cost share investment in the Federally owned storage project, at least a proportionate share of the project benefits are Federal benefits, including water supplies dedicated to specific purposes such as environmental enhancement and wildlife refuges."*

Under the WIIN Act, projects can receive funding only if enacted appropriations legislation designates funding to them by name, after the Secretary of the Interior recommends specific projects and transmits such recommendation to Congress. The Secretary of the Interior must determine whether a proposed storage project is feasible on or before January 1, 2021, in accordance with Reclamation laws, and secure agreement(s) for providing upfront funding to pay the non-Federal share of the capital costs, or post-authorization costs, of the project.

3.3.1.2 State Directive

House Joint Memorial Number 8

House Joint Memorial Number 8, passed and approved by the 2008 Idaho Legislature, encouraged the IWRB, in coordination with other public and private entities, to initiate and complete the study of additional water storage projects in the State of Idaho.

House Bill 428 and 644

House Bills 428 and 644, passed and approved by the 2008 Idaho Legislature, directed the IWRB to conduct a Statewide comprehensive aquifer planning and managing effort, including the evaluation of additional surface water storage and provided funding to carry out the effort.

House Bill 479

House Bill 479, passed and approved by the 2014 Idaho Legislature, appropriated $1.5 million to complete USACE's Boise GI. Through October 24, 2017 (the IWRB Resolution), the IWRB committed remaining unspent appropriations from the terminated Boise GI, along with additional appropriations, to Reclamation's Boise River Basin Feasibility Study as the non-Federal cost share partner for the Study.

House Joint Memorial Number 4

House Joint Memorial Number 4, passed and approved by the 2019 Idaho Legislature, supports the construction of new water infrastructure in Idaho; particularly the raising of Anderson Ranch Dam, and urges the congressional delegation for the State of Idaho to take any further actions necessary to complete the following:

1. Confirm that the feasibility study and NEPA analysis for the Anderson Ranch Dam raise are completed within the proposed timeframe
2. As determined in the feasibility study, advance the project through additional congressional action to authorize construction and provide further WIIN Act funds

House Bill 285

House Bill 285, passed and approved by the 2019 Idaho Legislature, appropriated $20,000,000 for reclamation, upstream storage, offstream storage, aquifer recharge, reservoir site acquisition and protection, water supply, water quality, recreation, and water resource studies, including feasibility studies for qualifying projects. The IWRB has the authority to determine which water projects are undertaken pursuant to the bill.

3.3.2 Planning Objectives

3.3.2.1 Federal Objective

The Federal Objective is defined in the P&R (CEQ 2013) as follows:

> *"The Federal Objective, as set forth in the Water Resources Development Act of 2007, specifies that Federal water resource investments shall reflect national priorities, encourage economic development and protect the environment by:*
>
> *(1) Seeking to maximize sustainable economic development;*
>
> *(2) Seeking to avoid the unwise use of floodplains and flood-prone areas and minimizing adverse impacts and vulnerabilities in any case in which a floodplain or floodplains area must be used; and*
>
> *(3) Protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems."*

Considering the many complex water management challenges and competing demands for limited Federal resources, Federal agencies investing in water resources should strive to maximize public benefits, particularly compared to costs. Public benefits encompass environmental, economic, and social goals, including monetary and non-monetary benefits, and allow for the inclusion of quantified and unquantified benefits. Stakeholders and decision-makers expect the formulation and evaluation of a diverse range of alternative solutions, which may produce varying degrees of benefits or impacts, or both. As a result, the tradeoff among potential solutions need to be assessed and properly communicated during the decision-making process.

In 2014, the CEQ completed an interagency effort to update the 1983 P&G. This effort led to the development of the PR&G, and various agency-specific guidelines for their application. The approach to quantifying and monetizing benefits in the PR&G and the P&G is *not* significantly different (DOI 2015). For the Study, the approach to evaluating public benefits is consistent with the PR&G.

3.3.2.2 Boise River Basin Feasibility Study Planning Objectives

The Study planning objectives were developed based on identified water resources problems, needs, and opportunities in the Study area, and specific direction in the Study authorization, and are consistent with the PR&G and Reclamation Policies, Directives and Standards, and guidance.

Primary Objectives

Primary objectives are those which alternatives are formulated to specifically address:

- Increase storage capacity in the Boise River basin to help meet existing and future demand.
- Enhance fish and wildlife environment within the Boise River basin or downstream.

Secondary Objective

Secondary planning objectives are actions, operations, features, or a combination thereof, that should be considered in the plan formulation process, but only to the extent possible through pursuit of the primary planning objective:

- Reduce flood risk within the Boise River basin.

3.3.3 Planning Constraints

The PR&G (CEQ 2015) provides fundamental guidance for the formulation of Federal water resources projects. It also requires that planning studies identify basic planning constrains and that other considerations specific to the feasibility study be developed and identified. Planning constraints help guide a feasibility study. Some are more rigid than others, but all are influential in guiding the plan formulation process. Several key constraints identified for this Study are as follows:

- Comply with Federal laws, regulations, and policies.
- Be consistent with Idaho water law and water rights.
- Do not impact authorized Boise Project purposes and existing contracts and agreements.
- Do not violate dam safety standards.

3.3.4 Other Planning Considerations

In addition to the planning constraints, a series of other planning considerations helps guide plan formulation, not only in formulating the initial plans, but also in determining which alternatives best address the planning objectives. Planning considerations relate to economic justification, environmental compliance, and technical standards as well as considerations driven by local policies, practices, and conditions. Examples of these other planning considerations, used in the feasibility study for formulating, evaluating, and comparing initial plans, and later, detailed alternative plans, include the following:

- Ability to implement (technical, legal, etc.)
- Costs of implementation (construction, O&M, mitigation, etc.)
- Potential impacts on the environment (NEPA, ESA, *National Historic Preservation Act* [PL 102-575], CWA, etc.)

3.4 Evaluation Criteria

The Federal planning process described in the PR&G includes four criteria for consideration in formulation and evaluating alternative plans: completeness, effectiveness, efficiency, and acceptability (CEQ 2015).

1. **Completeness** is a determination of whether a plan includes all elements necessary to realize planned effects, and the degree that intended benefits of the plan depend on the actions of others.
2. **Effectiveness** is the extent to which an alternative alleviates problems and achieves objectives.
3. **Efficiency** is the measure of how efficiently an alternative alleviates identified problems while realizing specific objectives consistent with protecting the Nation's environment.
4. **Acceptability** is the workability and viability of a plan concerning its potential acceptance by other Federal agencies, State and local governments, and public interest groups and individuals.

3.5 Basis for Initial Alternatives

The primary function of an alternative must be to alleviate unsatisfactory conditions or satisfy a need that exists or will exist in the future without the programs or projects under consideration. Alternative plan formulations should focus on solutions that are practicable, feasible, and meet the planning objectives. Alternatives are to be formulated in a systematic manner. A range of potential plans should be initially investigated; as those plans are refined, some should be eliminated.

This section describes in more detail the purpose, focus, and outcome of the various assessments and studies (Figure 3-1) that led to the Study. It is through these iterative assessments and studies that over 200 initial storage sites were formulated, initially investigated, and screened; ultimately, this process resulted in the development of seven alternatives that were evaluated as part of this Study. Although very similar, the planning objectives, constraints, and considerations for these initial alternatives are not identical to those of this Study.

3.5.1 2006 Final Boise/Payette Water Storage Assessment Report

Reclamation completed the 2006 Assessment, for which authority was provided under the *Reclamation Act of 1902* (PL 57-161) 32 Statute 388, and those Acts amendatory thereof and supplementary thereto. PL 57-161 and supplementary Acts authorize Reclamation to manage and coordinate the Idaho Investigation program that develops innovative water management tools and partnerships to meet the growing demand for water in the American West. The 2006 Assessment provided a preliminary survey of problems and needs that used existing information to explore conceptual solutions to water resources issues in specific areas. The 2006 Assessment also helped determine the Federal role and desirability of potential partner(s) to proceed to the next planning phase.

The 2006 Assessment focused exclusively on water storage possibilities as a component of an overall effort to address water supply and water management issues in the Boise Project. Demand-side actions (such as conservation and reuse), while certainly an important consideration in any comprehensive solution, were beyond the scope of the study effort. This Reclamation-led Assessment developed conceptual storage needs, compiling a list of over 200 previously identified potential storage sites. Based on a 50-year period of analysis, this list was screened based on the following:

- **Hydrology and Refill Capacity.** A preliminary yield potential of the site (that is, the percentage of years it would refill under long-term average hydrological conditions) helped to determine whether a site could reliably refill.
- **Special Designations.** Sites located on reaches with special designations, such as Wild and Scenic Rivers, may be more difficult to develop.
- **Endangered Species and Bull Trout Habitat.** Sites located with reaches that support critical bull trout life stages (such as spawning) may be more difficult to develop.
- **Minimum Storage Volume.** Given the large uncertainty with estimated water supply storage needs, a minimum of 50,000 acre-feet of storage was required of all potential new storage sites (noting that existing retrofitting opportunities were not screened against this criterion).

Based on this screening, the initial list of 200 potential new storage sites was narrowed to a list of 56 potential sites. These were then ranked based on the following criteria:

- **Refined Hydrologic Analysis.** Reclamation's MODSIM model was used to determine the overall quantities of water available for new storage in each basin, given current operating limitations (for example, water contracts, water rights, existing regulatory or administrative minimum flows, and other relevant aspects and realities of current operations).
- **Socioeconomic and Environmental Constraints Analysis.** Potential reservoir sites were compared in terms of their relative potential impact on socioeconomic and environmental factors such as infrastructure, recreation, and biological resources.

- **Needs Analysis.** The results of hydrological and constraints analyses were reviewed critically to confirm final potential candidate sites could meet a full range of defined needs and achieving a wide range of benefits.

The results of the screening and ranking process indicated that viable potential water storage sites tended to cluster in discrete reaches and subbasins. Thus, the 2006 Assessment recognized nine "areas of opportunity" for new storage sites: four in the Boise River basin and five in the Payette River basin (Figure 3-2).

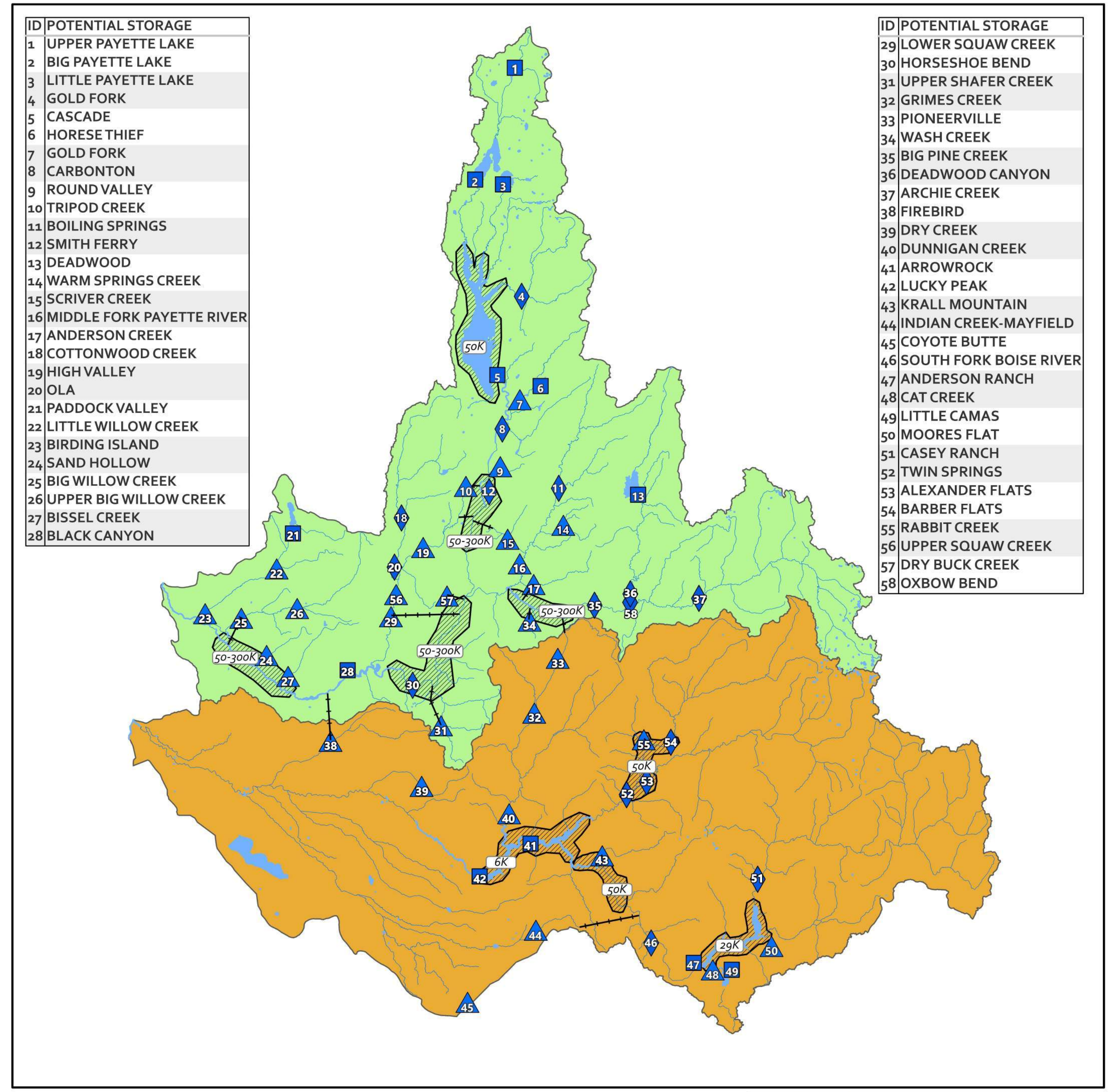
3.5.1.1 Boise River Basin Areas of Opportunities

- **Lower South Fork Boise River.** Indian Creek-Mayfield and Krall Mountain were identified as potential offstream storage sites within reach of the river. Either facility would require a diversion pipeline and tunnel.
- **North Fork and Middle Fork Boise River.** Barber Flats, Alexander Flats, Twin Springs, and Rabbit Creek were identified as sites within the catchment area where two major forks join, which is strategic for providing flood control. Multiple configurations of on-stream and offstream diversions may be possible.
- **Raising Lucky Peak or Arrowrock Dams.** This would involve the retrofit of existing facilities, raising the dam height.
- **Raising Anderson Ranch Dam.** This would involve the retrofit of existing facilities, raising the dam height.

3.5.1.2 Payette River Basin Areas of Opportunities

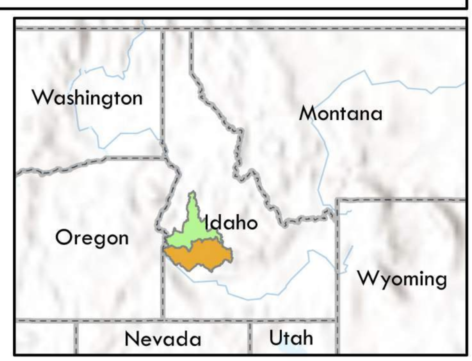
- **Lower South Fork Payette.** Wash Creek and Anderson Creek were identified as potential offstream storage sites. Grimes Creek and Dunnigan Creek were identified as potential offstream storage sites via a transbasin transfer to the Boise River basin. Any facility would require a diversion pipeline and tunnel.
- **Lower North Fork Payette.** Tripod Creek, Schriver Creek, Upper Squaw Creek, and Lower Squaw Creek were identified as potential offstream storage sites. Facilities would require a diversion pipeline and tunnel.
- **Mainstem Payette.** Dry Buck Creek, Lower Squaw Creek, and Upper Shafer Creek were identified as potential offstream storage sites. Facilities would require a diversion pipeline and tunnel.
- **Lower Payette.** Big Willow Creek, Bissel Creek, and Sand Hollow Creek were identified as potential offstream storage sites near the mouth of the Payette River. These may require only a gravity pipeline.
- **Dredging Cascade Reservoir.** Approximately 50,000 acre-feet of sediment in Cascade Reservoir would be dredged to create more active capacity.

The assessment notably did not prioritize or rank these areas of opportunities. A comparison of technical attributes of each area of opportunity is shown in Tables 3-1 and 3-2.



ID	POTENTIAL STORAGE
1	UPPER PAYETTE LAKE
2	BIG PAYETTE LAKE
3	LITTLE PAYETTE LAKE
4	GOLD FORK
5	CASCADE
6	HORESE THIEF
7	GOLD FORK
8	CARBONTON
9	ROUND VALLEY
10	TRIPOD CREEK
11	BOILING SPRINGS
12	SMITH FERRY
13	DEADWOOD
14	WARM SPRINGS CREEK
15	SCRIVER CREEK
16	MIDDLE FORK PAYETTE RIVER
17	ANDERSON CREEK
18	COTTONWOOD CREEK
19	HIGH VALLEY
20	OLA
21	PADDOCK VALLEY
22	LITTLE WILLOW CREEK
23	BIRDING ISLAND
24	SAND HOLLOW
25	BIG WILLOW CREEK
26	UPPER BIG WILLOW CREEK
27	BISSEL CREEK
28	BLACK CANYON

ID	POTENTIAL STORAGE
29	LOWER SQUAW CREEK
30	HORSESHOE BEND
31	UPPER SHAFER CREEK
32	GRIMES CREEK
33	PIONEERVILLE
34	WASH CREEK
35	BIG PINE CREEK
36	DEADWOOD CANYON
37	ARCHIE CREEK
38	FIREBIRD
39	DRY CREEK
40	DUNNIGAN CREEK
41	ARROWROCK
42	LUCKY PEAK
43	KRALL MOUNTAIN
44	INDIAN CREEK-MAYFIELD
45	COYOTE BUTTE
46	SOUTH FORK BOISE RIVER
47	ANDERSON RANCH
48	CAT CREEK
49	LITTLE CAMAS
50	MOORES FLAT
51	CASEY RANCH
52	TWIN SPRINGS
53	ALEXANDER FLATS
54	BARBER FLATS
55	RABBIT CREEK
56	UPPER SQUAW CREEK
57	DRY BUCK CREEK
58	OXBOW BEND



Notes:
1. This map is provided as-is and may contain representations of property boundaries. It is intended for general reference only. None of the parties involved in preparing this map or data contained herein warrant or represent information to be complete and accurate and cannot be held responsible for errors or omissions.

Figure 3-2. Areas of Opportunity
Boise Project - Arrowrock Division
Boise River Basin Feasibility Study

BUREAU OF RECLAMATION

Table 3-1. 2006 Assessment "Areas of Opportunity" in the Boise River Basin

Area	Maximum Storage Potential (acre-feet)[a]	Feasible Uses	Estimated Field Costs (U.S. dollars)[b]	Opportunities and Challenges
Lower South Fork Boise River	50,000 to 60,000	DCMI, irrigation, and flow augmentation	$410,000,000 to $600,000,000	State-designated Natural River within area; important bull trout wintering habitat; storage sites would provide day use flat-water recreation opportunity tradeoff with free-flowing fishery recreation and habitat; and new facility would need to be operated with existing reservoirs
North Fork and Middle Fork Boise River	50,000	DCMI, flood control, and flow augmentation	$150,000,000 to $380,000,000	Offstream facilities are closer to potential diversion points; flexible combination of on-stream and offstream storage potential; storage sites would provide day use flat-water recreation opportunity tradeoff with free-flowing fishery recreation and habitat; and new facility would need to be operated with exiting reservoirs
Raising Lucky Peak or Arrowrock Dam	6,000	DCMI, irrigation, flood control, and flow augmentation	Not available[c]	State-designated Natural River within area; bull trout habitat; retrofitting might allow for an easier permitting process; and infrastructure is in place to manage increased flat-water recreational benefits
Raising Anderson Ranch Dam	29,000	DCMI, irrigation, flood control, and flow augmentation	$16,000,000 to $26,000,000[d]	State-designated Natural River within area; bull trout habitat; retrofitting might allow for an easier permitting process; and infrastructure is in place to manage increased flat-water recreational benefits

[a] Volume represents the available water that could be used to meet future demands reliably 90% of the time.

[b] Assessment cost estimates reflect only field (direct) construction costs compiled using past and current reservoir development costs and interpolated for site conditions. All costs indexed to 2010 dollars.

[c] Costs associated with raising Lucky Peak or Arrowrock dam were not included in Reclamation's analysis (Reclamation 2005b).

[d] Costs associated with raising Anderson Ranch Dam were estimated field costs included in Reclamation's analysis (Reclamation 2005b).

Table 3-2. 2006 Assessment "Areas of Opportunity" in the Payette River Basin

Area	Maximum Storage Potential (acre-feet)[a]	Feasible Uses	Estimated Field Costs (U.S. dollars)[b]	Opportunities and Challenges
Lower South Fork Payette	150,000 to 225,000	DCMI, irrigation, flow augmentation, and limited flood control	$170,000,000 to $1,290,000,000	Diversion would need to occur from within a State-designated Recreational River reach; upper reach of the area coincident with a Federally proposed Wild and Scenic designation; flexible combination of offstream storage; potential for recreation; and larger storage volumes may reduce instream flows in area
Lower North Fork Payette	300,000	DCMI, irrigation, flow augmentation, and limited flood control	$170,000,000 to $1,200,000,000	Diversion would need to occur from within a State-designated Recreational River reach; lower reach of the area coincident with a Federally proposed Wild and Scenic designation; flexible offstream storage; potential for recreation; and Squaw Creek drainage gravity-driver conveyance pipeline much shorter than that required with South Fork Payette area of opportunity
Mainstem Payette	300,000	DCMI, irrigation, flow augmentation, and flood control	$170,000,000 to $1,200,000,000	Diversion could occur from a State-designated Recreational River reach; potential for recreation; conveyance pipeline from this reach of the Mainstem Payette is much longer than required for the Lower North Fork Payette area of opportunity; and operational impact on Black Canyon
Lower Payette	300,000 to 400,000	Flow augmentation and flood control	$140,000,000 to $450,000,000	No State- or Federal-designated reaches within this area to preclude diversion and storage; potential for recreation; and operational impact on Black Canyon
Dredging Cascade Reservoir	Unknown	DCMI, irrigation, flood control, and flow augmentation	Unknown	No impact to reservoir footprint; no State- or Federal-designated reaches impacted; retrofitting might allow for an easier permitting process; infrastructure is in place to manage increased flat-water recreational benefits; and potential aquatic impacts

[a] Volume represents the available water that could be used to meet future demands reliably 90% of the time.

[b] Assessment cost estimates reflect only field (direct) construction costs compiled using past and current reservoir development costs and interpolated for site conditions. All costs indexed to 2010 dollars.

3.5.2 2016 Draft Boise River General Investigation (USACE)

With a focus on water storage as one potential measure for addressing flood risk reduction and water supply planning objectives and leveraging its flood risk reduction-focused authority, USACE developed a two-phased approach to a feasibility study. The larger, first phase of its feasibility study required evaluation of structural and non-structural alternatives to address identified water resource problems. The second phase of the feasibility study focused on alternatives other than surface water storage and evaluated whether a combination of strategies was appropriate to resolve water resource problems in the Boise River drainage.

USACE developed the two-phased feasibility study approach to assist the IWRB with the CAMP, a planning effort initiated by IWRB to address future water supply and demand issues in the lower Boise River basin over a 50-year planning horizon. The CAMP process included a series of technical studies to characterize surface and groundwater resources. The surface water storage assessment conducted during the interim feasibility study was one of the technical studies associated with the CAMP. Surface water storage was one of many strategies to meet future water demand that the IWRB was considering during the CAMP.

Under Section 414 of PL 106-53, Congress authorized the Secretary of Defense to determine the feasibility of undertaking flood control on the Boise River. Subsequently, Section 4038 of the *Water Resources Development Act of 2007* (PL 110-114) expanded this authorization to include ecosystem restoration and water supply as project purposes to be studied. Given the IWRB's interest in new storage, the IWRB acted as the local study sponsor and partnered with USACE to conduct a study that commenced in 2010. Alternatives for the Boise GI were formulated for water supply and FRM purposes.

In 2010, USACE and the IWRB completed an analysis (*Lower Boise River Interim Feasibility Study, Idaho, Water Storage Screening Analysis* (USACE 2010), providing technical information regarding water storage potential, based on 12 sites within the 9 areas of opportunity identified in Reclamation's 2006 Assessment. These areas of opportunity were screened for the ability of a site to provide additional water supply and reduce flood risk. Based on this screening, the 12 individual sites were narrowed to 6 sites and 7 concepts (2 options for Lucky Peak Dam). Anderson Ranch Dam was determined not to provide the necessary FRM and was not considered further by USACE.

A secondary level of screening compared the sites based on future water demand, flood risk reduction, hydropower potential, cost index, social effects, and environmental effects. Results indicated the best large surface water storage site was a new dam at Arrowrock Dam, while the best small surface water storage site was a new dam at the Alexander Flats site. Further analysis of the Arrowrock site was performed to compare a raise of the existing dam against construction of a new dam immediately downstream (*Lower Boise River Interim Feasibility Study, Preliminary Evaluation of Arrowrock Site* [USACE 2011]). The report recommended further study of a raise of Arrowrock Dam if only one concept was pursued.

In 2012, USACE and the IWRB conducted a planning charette and rescoped the project to bring it into alignment with USACE's required SMART planning guidelines. This included identifying and developing 68 management measures (features or activities that can be implemented at a specific geographic site and are designed to meet one or more study objectives) based on a broader range of sources than Reclamation's 2006 Assessment. All potential storage sites identified in the Boise GI were identified in the 2006 Assessment. The management measures for further consideration in Reclamation's Boise River Basin Feasibility Study were an Arrowrock Dam raise, modification to Lucky Peak for dam raise, canal lining, and managed aquifer recharge.

A list of planning objectives, constraints, and secondary screening criteria was developed by USACE:

Planning Objectives:

1. Reduce flood risk along the Boise River downstream of Lucky Peak Dam.
2. Reduce life safety risk associated with flooding in the lower Boise River watershed.
3. In conjunction with FRM, increase available water supply to 80,000 acre-feet to meet current and future water demands in the lower Boise River basin.

Planning Constraints:

1. Comply with Federal laws, regulations, and policy.
2. Verify alternatives are consistent with Idaho water law and water rights.
3. Do not impact the ability of irrigation districts and canal companies to divert water from the Boise River or its tributaries in a manner consistent with their water rights.
4. Do not impact current water service and repayment storage contracts associated with the Federal reservoirs.
5. Do not impact the ability to maintain the administrative minimum water release target of 240 cfs for fish and instream maintenance.
6. Do not impact Reclamation's ability to deliver flow augmentation water consistent with the 2004 Nez Perce Water Rights Settlement (*Snake River Water Rights Act of 2004* [PL 108-447]).
7. Do not impact incidental aquifer recharge in the Treasure Valley.
8. Do not create new fish passage barriers that impact bull trout or other species listed under the ESA.
9. Do not violate safety standards of the existing reservoir system.

Secondary Screening Criteria:

1. The ability of USACE or the Non-Federal Sponsor, or both, to implement the project
2. Increases in Boise River system storage capacity
3. Minimization of potential construction costs, mitigation costs, and future O&M costs

As a result of screening efforts through 2015, USACE further narrowed the list of management measures to carry forward. The remaining management measures were then grouped by their ability to maximize benefits, minimize environmental impacts, maximize cost-effectiveness, or minimize cost, or a combination thereof.

These focused alternatives were further screened against the following criteria to develop a final array of alternatives:

- **Completeness:** Certainty regarding the ability of the alternative to achieve projected benefits
- **Effectiveness:** The extent to which the alternative meets identified opportunities
- **Efficiency:** Cost-effectiveness of alternatives, as measured by the benefit-to-cost ratio
- **Acceptability:** Compliance with all laws and regulations, as well as the extent to which the plan is supported by local interest
- **National Economic Development:** The extent which alternative plans maximize net economic benefits
- **Environmental Quality:** The extent to which alternatives would avoid, mitigate, or minimize potential environmental effects
- **Safety:** The extent to which the plan would provide a reduction in overall life safety risk within the project area
- **Total Project Costs:** The extent to which each alternative minimizes total project costs
- **Benefits:** The extent to which the plan would maximize project benefits

The final array of alternatives selected in the Boise GI for feasibility-level analysis are presented in Table 3-3.

Table 3-3. Final Array of Alternatives Identified in the Boise GI

Alternative	Name	Focus
A	Arrowrock Dam raise with additional downstream FRM	Flood risk reduction and water supply
B	Non-structural	Flood risk reduction
C	Arrowrock Dam raise only	Flood risk reduction and water supply
D	No Action	Not applicable; no Federal action would be implemented

Despite rescoping the project, the results of the alternatives formulation indicated that a raise of Arrowrock Dam appeared to be one of the most promising alternatives to meet flood risk reduction and water supply needs. USACE proceeded with completing extensive hydrological and economic modeling on the final array of alternatives, considering four scales of raises at Arrowrock, ranging from 30 feet to 70 feet.

The results of the detailed analysis, however, made clear that none of the alternatives reviewed for the Boise GI produced enough benefits for flood risk to justify construction project costs. It was determined that a Federal interest could not be justified: subsequently, the IWRB terminated the Boise GI with USACE in late 2016.

3.5.3 2016 USACE and Reclamation Joint Reformulation

While the Boise GI was terminated, the need for additional water supply and significant flood risk reduction in the Treasure Valley still existed. The IWRB was interested in continuing to investigate and requested that USACE and Reclamation work together to identify viable alternatives to provide additional water storage capacity—particularly, potential smaller, cost-effective raises to the existing dams on the Boise River (Anderson Ranch, Arrowrock, and Lucky Peak). Under PL 111-11, Reclamation was authorized to conduct feasibility studies addressing water shortages within the Snake, Boise, and Payette River systems.

From May to July 2016, USACE and Reclamation formulated a list of preliminary alternatives with the potential to achieve the planning objectives of the Boise GI. The preliminary alternatives developed were based on the two agencies' authorities, the areas of opportunity identified in Reclamation's 2006 Assessment, and USACE's Boise GI. These preliminary alternatives, as well as their associated water storage capacity, are described in Table 3-4.

Table 3-4. Preliminary Alternatives Formulated for Boise River Basin Feasibility Study

Site	New Construction or Retrofit	Water Storage Capacity
Barber Flats Dam raise, 330 feet	New construction	190,000 acre-feet
Barber Flats Dam raise, 220 feet	New construction	80,000 acre-feet
Alexander Flats Dam raise, 300 feet	New construction	90,000 acre-feet
Arrowrock Dam raise, 10 feet	Retrofit of existing	20,000 acre-feet
Arrowrock Dam raise, greater than 10 feet	Retrofit of existing	Greater than 20,000 acre-feet
Lucky Peak Pool raise, 4 feet	Retrofit of existing	10,000 acre-feet
Garden City Levee	New construction	Unknown
New York Canal Bypass to Snake River	New construction	2,700 cfs
Anderson Ranch Dam raise, 6 feet	Retrofit of existing	29,000 acre-feet
Anderson Ranch Dam raise, greater than 6 feet	Retrofit of existing	Greater than 29,000 acre-feet
Diversion from South Fork Boise River to Elmore County	New construction	50,000 acre-feet

At this point, Reclamation and USACE determined that Reclamation would continue the analysis as the lead agency, due to Reclamation's water supply focus.

In October 2017, the IWRB issued a resolution to partner with Reclamation on the Study, leveraging information generated in the previous studies, to continue to explore increased storage projects within the Boise River basin on a smaller project scale to address water supply needs and reduce flood risk in the Treasure Valley.

Reclamation screened these preliminary alternatives based on their ability to meet the planning objectives presented in Section 3.3.2 and consistency with the Study authorities and Idaho State Water Law, and rated them for cost and implementation risks (including environmental concerns, cultural and historical resource concerns, and engineering challenges) (Table 3-5).

3.5.4 2019 Non-structural Analysis

The PR&G (CEQ 2015) require that should non-structural approaches effectively address a problem, they must be fully considered and carried forward, and given full and equal consideration in the decision-making process. The 2006 Assessment was a preliminary survey of problems and needs that used existing information to explore conceptual solutions to water resources focused on new or enhanced on-stream and offstream storage capabilities. It did not explore non-structural solutions. The Boise GI evaluated various non-structural measures, carrying forward a non-structural alternative to its final array; however, it did not complete a full analysis due to its early termination.

As part of the Study, Reclamation developed and screened the 15 non-structural alternatives (Table 3-6) based on whether the alternatives would align with Study authorities, be consistent with Idaho State Water Law, and meet the planning objectives presented in Section 3.3.2. Following further analysis, 4 of the 15 non-structural alternatives were carried forward for further analysis:

1. Automating Canal Systems
2. Canal Lining
3. Managed Recharge of Groundwater/Aquifer Storage and Recovery
4. Dredging of Anderson Ranch Reservoir

These non-structural alternatives are discussed further in Section 3.8.

Table 3-5. Preliminary Alternatives Identified for Consideration in the Boise River Basin Feasibility Study

Preliminary Alternative	Within Current Idaho Water Law	Consistent with Authorities	Planning Objective: Potential Increase in Water Storage	Cost[a]	Implementation Risk[b]	Notes	Carry Forward
Barber Flats Dam raise, 330 feet	Yes	Yes	Yes	High	High	Significant inundation	No
Barber Flats Dam raise, 220 feet	Yes	Yes	Yes	High	High	Significant inundation	No
Alexander Flats Dam raise, 300 feet	Yes	Yes	Yes	High	High	Potential negative impacts on fish passage for bull trout	No
Arrowrock Dam raise, 10 feet	Yes	Yes	Yes	Medium	Medium	Minimal modifications to the road required, impacts on historical dam tender house	Yes
Arrowrock Dam raise, greater than 10 feet	Yes	Yes	Yes	High	High	Presents significant engineering and cost challenges, as modifications to the road would have to be made	No
Lucky Peak Pool raise, 4 feet	Yes	Yes	Yes	Low	High	Could be done through implementation of a bladder dam	Yes
Garden City Levee	Yes	No	No	Low	High	Reclamation currently does not have feasibility study authority for this alternative	No
New York Canal Bypass to Snake River	Yes	No	Yes	High	High	Reclamation currently does not have feasibility study authority for this alternative	No

Preliminary Alternative	Within Current Idaho Water Law	Consistent with Authorities	Planning Objective: Potential Increase in Water Storage	Cost[a]	Implementation Risk[b]	Notes	Carry Forward
Anderson Ranch Dam raise, 6 feet	Yes	Yes	Yes	Medium	Low	Preliminary modeling demonstrates favorable probability of refill; minor spillway modifications	Yes
Anderson Ranch Dam raise, greater than 6 feet	Yes	Yes	Yes	Medium to High	Medium	Significant spillway modifications; cost dependent on height of raise greater than 6 feet	No
Diversion from South Fork Boise River to Elmore County	Yes	No	Yes	Unknown	High	Lack of appraisal-level information regarding this alternative; Reclamation has no authority to pursue	No

[a] Costs were rated according to the following scale: $0-50M: Low, $50-500M: Medium, $500M+: High. Based on USACE estimates, developed using parametric data (unit prices; cubic yard, linear feet, etc.) from similar construction activities (Anderson Ranch Dam raise conceptual cost estimates developed by Reclamation)

[b] Implementation Risks were developed through internal discussions with Study team and Reclamation management.

Table 3-6. Preliminary Non-structural Alternatives for Boise River Basin Feasibility Study

Non-structural Alternative	Consistent with Authorities	Within Current Idaho Water Law	Measurable Water Volume(s) or Flow Rate(s)	Violates No Planning Constraints	Meets Planning Objective: Potential Increase in Water Storage[a]	Carry Forward
Public Education Programs	No	Yes	Low	Yes	Yes	No
Incentive Programs for Demand Reduction	No	Yes	Medium	Yes	Yes	No
Regulatory Programs	No	No	High	Maybe	Yes	No
Canal Lining – Federal Facilities	No	Yes	High	Maybe	Yes	Yes
Canal Lining – Non-Federal Facilities	No	Yes	High	Maybe	Yes	No
Automating Canal Systems	Yes	Yes	Medium	Maybe	Yes	Yes
Conversion from Flood to Sprinkler/Drip Irrigation	No	Yes	Medium	Maybe	Yes	No
Wastewater Reuse	No	Yes	High	Yes	Yes	No
Managed Recharge of Groundwater/Aquifer Storage and Recovery	Yes	Yes	Medium	Maybe	Yes	Yes
Cloud Seeding for Snowpack Enhancement	No	Yes	Low	Yes	Yes	No
Operational Changes to Flood Control Rule Curves	Yes	Yes	High	No	Yes	No
Reallocation (Willing Buyer, Willing Seller)	No	Yes	High	Yes	Yes	No
Reappropriation (Legal Mandates)	No	Yes	High	Yes	Yes	No

Non-structural Alternative	Consistent with Authorities	Within Current Idaho Water Law	Measurable Water Volume(s) or Flow Rate(s)	Violates No Planning Constraints	Meets Planning Objective: Potential Increase in Water Storage[a]	Carry Forward
Reservoir Dredging	Yes	No	High	Yes	Yes	Yes
Watershed-scale Best Management Practices to Decrease Sedimentation Load to Anderson Ranch Dam	No	Yes	Low	Yes	Yes	No

[a] Non-structural Analysis rated each alternative on its potential to increase water storage and was summarized in this table for clarification to indicate all non-structural alternatives analyzed would provide additional water storage, meeting the planning objective of the Study.

3.6 Initial Alternatives

Preliminary analyses conducted by Reclamation and USACE determined raising Anderson Ranch Dam by 6 feet would increase storage by approximately 29,000 acre-feet; raising Arrowrock Dam by 10 feet would increase storage by approximately 20,000 acre-feet; and raising Lucky Peak Dam by 4 feet would increase storage by approximately 10,000 acre-feet. Based on screening of preliminary alternatives, as well as the 2019 non-structural analysis, Reclamation determined the following to be initial alternatives of the Study (Tables 3-7 and 3-8).

Table 3-7. Initial Structural Alternatives Identified in the Boise River Basin Feasibility Study

Initial Alternative	Approximate Additional Water Storage Capacity (acre-feet)
6-foot Anderson Ranch Dam raise	29,000
10-foot Arrowrock Dam raise	20,000
4-foot Lucky Peak Dam raise	10,000

Table 3-8. Initial Non-structural Alternatives Identified in the Boise River Basin Feasibility Study

Initial Alternative	Approximate Additional Water Storage Capacity (acre-feet)
Dredging	25,000
Canal Lining	Unknown[a]
Automating Canal Systems	Unknown[b]
Managed Recharge of Groundwater	Unknown[c]
No Action	0

[a] During the Study, an alternative to line portions of the New York and Mora Canals (both Federal facilities) was briefly considered but eliminated after determining it would not meet the primary planning objectives.

[b] Following additional analysis specific to the Boise River basin, it was concluded that, while 33 of the 50 diversion sites are unautomated, the 17 diversion sites that are automated account for the majority of the diverted flow. Automating the remaining 33 of 50 sites would result in minimal potential water savings; therefore, canal automation was screened from further analysis.

[c] At this time, it is not yet understood who (both putting water into the aquifer and pulling out of the aquifer), what (infrastructure required to pull water out, transport it, and recharge it), where (both injection/infiltration and well sites), when (when and where water would be available once in the aquifer), or how (implementation - capital/long-term O&M investment, groundwater administration, etc.) the State's managed aquifer recharge study could be implemented in lieu of a storage project. The State and other independent entities will continue to explore options to use managed aquifer recharge as a water management tool in the future.

3.7 Structural Alternative Analysis

As part of the Study, Reclamation conducted an initial technical review of available information and competed site visits of Anderson Ranch, Arrowrock, and Lucky Peak dams in 2018. The results of these technical reviews concluded an increase in reservoir storage at Arrowrock and Lucky Peak dams is likely to be significantly more difficult than a raise of Anderson Ranch Dam due to the physical and procedural complexities associated with the facilities.

3.7.1 Lucky Peak 4-foot Dam Raise

The proposed 4-foot raise to Lucky Peak is limited to a modification of the spillway structure and does not include a raise to the dam crest. Raising the RWS elevation without raising the dam crest and saddle dike would result in either a reduction of the flood storage capacity for Lucky Peak or a reduction in freeboard. Both alternatives increase the overall risk of the facility. Additionally, Lucky Peak has not yet gone through a formal quantitative risk analysis. The first Period Assessment (a facility review similar in scope to Reclamation's Domestic Safety Evaluation of Existing Dams Comprehensive Review) is scheduled in 2020, and Reclamation's TSC estimated the duration of feasibility-level design to be 25 months. Thus, achieving potential feasibility determination under Section 4007 of the WIIN Act by January 1, 2021, is not possible.

While USACE and Reclamation have similar methods for estimating risk, this has the potential to lead to disagreements in the portrayal or interpretation of risk between the two agencies as the project moves forward into feasibility designs. It is possible that USACE would be unwilling to accept the additional risks associated with the reservoir raise without other significant modifications to the embankment dam structure.

For these reasons, a dam raise at Lucky Peak Dam was removed from further consideration as part of this Study.

3.7.2 Arrowrock 10-foot Dam Raise

A 10-foot raise at Arrowrock Dam presented several significant engineering challenges and implementation risks. The geometry of the arch dam and bedrock abutments needed to raise the dam and resolve stresses from such a raise would require the construction of large concrete thrust blocks at the abutments to act as standalone gravity sections while also maintaining arching action. It would be challenging to facilitate discharge through the existing spillway chutes while also constructing said thrust blocks for the dam raise.

Additionally, there was a concern that the raising of the dam along the footprint of the existing dam could possibly be achieved by raising the chimney section of the dam vertically; however, there may be difficulty in performing a suitable design for vertical post-tensioned anchors, for which the dam was not originally designed. Should the chimney raise be deemed unsuitable, raising the dam 10 feet may require that additional concrete overlay be placed along the downstream slope of the dam. The additional concrete along the downstream face would need to be determined through three-dimensional finite element modeling, as well as analysis to confirm any increase in stresses did not cause an incremental risk of dam failure.

Further complicating this alternative are potential impacts on the historical dam tender's home and the power plant (added to the National Register of Historical Places in 1976). A raise at this location appeared to present a much greater challenge than raises at Anderson Ranch Dam or Lucky Peak Dam.

For these reasons, a dam raise at Arrowrock Dam was removed from further consideration as part of this Study.

3.7.3 2018 IWRB Resolution to Narrow Study to Anderson Ranch Dam Raise

Reclamation concluded that evaluation of the feasibility of raises to all three dams would not be complete before January 1, 2021, and subsequently recommended to the IWRB that focusing Study efforts at this time on a raise of Anderson Ranch Dam would be most appropriate. The IWRB agreed, signing a board resolution in July 2018, authorizing Reclamation to focus Study analysis on a raise of Anderson Ranch Dam with the intent to determine project feasibility in accordance with conditions of Section 4007 of the WIIN Act.

Following the 2018 IWRB Resolution, Reclamation considered developing a 3-foot dam raise alternative. Engineering analysis concluded a raise of more than 1 foot would require structural modification of the spillway—a considerable component of project construction costs that varied little with height. A 6-foot dam raise would provide much more water at a significantly lower unit cost than a 3-foot dam raise. Therefore, the 3-foot dam raise structural alternative was not further evaluated in this Study.

The PR&G (CEQ 2015), DOI's 707 DM 1 Handbook (DOI 2015), and *Water and Related Resources Feasibility Studies, Reclamation Manual, Directives and Standards, CMP 09-02(H)(3)(b),* (Reclamation 2019b) state the following:

> *"Each alternative plan formulated for the PR&G analysis should be included in the NEPA document, or if there are any differences in the array of alternatives between the PR&G analysis and NEPA document, those differences should be explained and justified."*

To ensure Reclamation evaluated a reasonable range of alternatives for the NEPA compliance process, the DEIS associated with this Study includes a 3-foot dam raise of Anderson Ranch Dam as an alternative. The analysis of this alternative in the DEIS includes information developed for the Study. Appendix A includes the hydrologic analysis for the 3-foot and 6-foot dam raise alternatives.

3.8 Non-structural Alternative Analysis

Typically, non-structural alternatives alter the use of existing infrastructure or human activities to reduce or avoid impacts on existing hydrological, geomorphic, and ecological processes. Following the initial alternative identification and screening effort described herein, further analyses were conducted applying the planning considerations.

3.8.1 Reservoir Dredging

Since initial storage in December 1945, Anderson Ranch Reservoir has accumulated sediment conveyed by the South Fork Boise River and other reservoir tributaries. Depositional patterns typically form an alluvial fan (in plain view) and wedge shape (in profile view), with coarser (larger) material depositing at the upstream end (closest to the river/tributary and reservoir confluence) and finer (smaller) material depositing farther downstream within the reservoir. Reservoir dredging would consist of using a mechanical or hydraulic dredge, or both, to remove sediment (silt, sand, and gravel) from the reservoir bed, convey the sediment, and store the sediment in repositories.

Mechanical dredges work by mechanically excavating sediment from the bottom surface through use of a bucket. A mechanical dredge usually consists of the following (USACE 2008):

- A bucket equipped with a cutting and grabbing edge
- A crane or other means of lowering, manipulating, and retrieving the bucket
- A means of transporting (usually a barge) the dredged material from the dredging site to a sediment handling or disposal facility
- Depending on site conditions, the potential operations of mechanical dredging equipment on shore; however, most dredges are set up on a barge (floating platform)

Hydraulic dredging involves using suction to lift a mixture of sediment and water (known as a slurry) from the bottom of the surface and then transferring the mixture through a pipeline to another location. A hydraulic dredge usually consists of a dredge head and a hydraulic pump. Because the sediment must be fluidized and pumped, large volumes of water are mixed and transported with the sediment, resulting in the recovery of a slurry that is typically composed of from 10 to 15% (by weight) solids but that may contain as little as 1 to 2% solids (USACE 2008).

3.8.1.1 Initial Analysis

Dredging increases storage volume by removing deposited sediment from the reservoir. Reclamation's 1998 Sedimentation Study estimated 18,236 acre-feet of sediment had accumulated in Anderson Ranch Reservoir since initial filling in 1945, corresponding to an estimated average annual rate of 346.7 acre-feet of reservoir capacity lost to sediment accumulation. Extrapolating this same annual rate to 2019 and assuming a constant rate of deposition (which may be a conservative [low] estimate, given recent fires and mass wasting in the watershed) would suggest as much as 7,000 acre-feet of additional storage has been lost to deposition, bringing the total volume of sediment deposited in the reservoir since 1945 to approximately 25,000 acre-feet. Removing all 25,000 acre-feet would add back a water storage volume roughly similar to the 29,000-acre-feet volume associated with the proposed dam raise action.

Dredging and the associated dewatering, handling and hauling, and disposal of the sediment is expensive and causes many impacts on aquatic and terrestrial ecosystems. In addition, dredge spoils may contain contaminants (such as mercury, arsenic, lead, and copper) from historical mining practices, and dredging requires repositories in perpetuity. Depending on the methods used, dredging may limit water storage operations during dredging activity.

Using estimated costs and rates available online and preliminary internal estimates prepared for other regional projects (such as the Lower Basin Coeur d'Alene River cleanup), the assumptions provided in Table 3-9 were used to develop rough order of magnitude cost and production estimates for dredging Anderson Ranch Reservoir.

Table 3-9. Order of Magnitude Cost and Production Estimate for Dredging

Item	Quantity
Current volume of sediment in Anderson Ranch Reservoir	25,000 acre-feet (40,000,000 cubic yards)
Volume of sediment deposited annually in the reservoir	347 acre-feet (560,000 cubic yards)
Dredge cost range [a]	$100 to $265 per cubic yard
Dredge production rate [b, c]	1,000 cubic yards per day = 365,000 cubic yards per year

[a] Cost range based on current estimates for regional project, considered to be more representative than comparable values shown in Table 3-10.

[b] Production rates are calculated at 100 cubic yards per hour. Based on an average efficiency factor of 85% for a mechanical dredge, a 12-hour dredge day would produce approximately 1,000 cubic yards within 10 hours of uptime.

[c] The Engineering Performance Standards for Dredging (EPA 2003) reports that mechanical dredging rates range from 82 cubic yards per hour for large "production" dredges to 27 cubic yards per hour for small "alternative" dredges. Under the right site conditions, the production rate for hydraulic dredging is significantly greater than mechanical dredging. The production rate for hydraulic dredging varies based on the required pumping head and the capacity of the pumps used. A web-based search for production rates of hydraulic dredges suggests typical production rates of 1,000 cubic yards per day (comparable to large production mechanical dredges), with upper limits of 10,000 cubic yards per day, if all site conditions are conducive. These conditions are not expected at Anderson Ranch Reservoir given the anticipated sediment size and composition.

Table 3-10 summarizes unit costs for key components of U.S. environmental dredging projects, adapted from the *Western Dredging Association (WEDA) Journal of Dredging* (WEDA 2016).

Table 3-10. Summary of Unit Costs for Key Components of U.S. Environmental Dredging Projects

Item	Average Cost (U.S. dollars)	Minimum Cost (U.S. dollars)	Maximum Cost (U.S. dollars)
Dry Excavation ($ per cubic meter)	$92 ($70 per cubic yard)	$13 ($10 per cubic yard)	$177 ($135 per cubic yard)
Mechanical Dredging ($ per cubic meter)	$99 ($75 per cubic yard)	$20 ($15 per cubic yard)	$283 ($215 per cubic yard)
Hydraulic Dredging ($ per cubic meter)	$79 ($60 per cubic yard)	$20 ($15 per cubic yard)	$256 ($195 per cubic yard)
Water Treatment ($ per liter)	$0.17 ($0.045 per gallon)	$0.0132 ($0.0035 per gallon)	$0.624 ($0.165 per gallon)
Landfill Disposal ($ per cubic meter)	$105 ($80 per cubic yard)	$6.6 ($5 per cubic yard)	$289 ($220 per cubic yard)
Special Disposal ($ per cubic meter)	$263 ($200 per cubic yard)	$13 ($10 per cubic yard)	$631 ($480 per cubic yard)

Based on these values, the anticipated cost to remove 25,000 acre-feet of existing sediment is $4 billion to $11 billion, and the duration would be more than a century (if using a single dredge). A single repository storing 25,000 acre-feet of sediment would require more than

1 square mile to almost 4 square miles of (flat) surface area, a location that may be challenging to identify in the basin. Figure 3-3 shows the footprints for three different repositories sizes relative to the footprint of the Ada County Landfill.

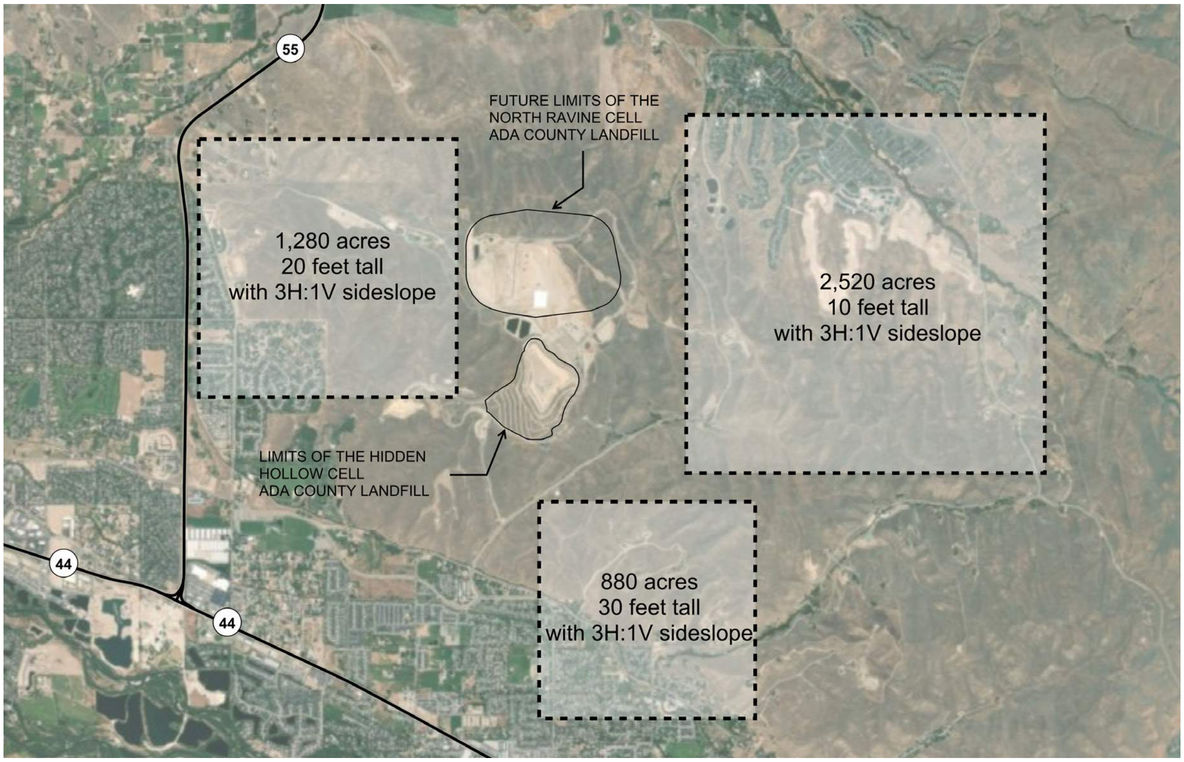


Figure 3-3. Comparison of To-scale Footprints for Three Different Repositories Relative to the Footprint of the Ada County Landfill

For context, to create 29,000 acre-feet of storage in 3 years (the anticipated new storage volume and duration of dam raise construction), 44 dredges would be required. Following those 3 years (for construction of the dam raise with the proposed action or operation of 44 dredges with the non-structural action), 1.5 dredges would need to operate continuously for the remaining life of the reservoir to offset the annual rate of sediment supply.

Additionally, the following factors could increase the estimated costs and reduce production rates:

- Sediment may be contaminated and may require special handling and storage requirements (for example, repositories).
- Sufficient locations for repositories may not be available due to proximity to the reservoir, volume requirements, land ownership, and environmental considerations.

3.8.1.2 Conclusion

While reservoir dredging aligns with Reclamation’s planning objectives and constraints, it presents potentially insurmountable challenges from the associated environmental impacts including handling and disposing of potentially contaminated sediment, as well as siting and construction of repositories. Also, with a cost estimate in the billions of dollars, this alternative was determined cost-prohibitive and eliminated as a viable non-structural alternative for further analysis.

3.8.2 Canal Lining

During the Study, an alternative to line portions of the New York and Mora Canals (both Federal facilities) was briefly considered but eliminated, after a cursory evaluation showed that it would not meet the primary planning objectives. The New York Canal distributes water for the Boise Project Board of Control. It diverts water from the Boise River at Boise Diversion Dam and delivers it at approximately 2,300 cfs during the peak of the irrigation season. Since its construction, the canal has seeped water into the shallow aquifer. Each year, this seeped water returns to the Boise River and provides water supply to diverters in the lower reaches of the Boise River.

The cursory evaluation considered reducing seepage from the New York and Mora Canals that would be accomplished by lining sections of the canals with a concrete cover liner system that has been estimated to be 95% effective at seepage reduction (Reclamation Canal-Lining Demonstration Project [Swihart and Haynes 2002]). By reducing seepage by about 8%, it was assumed that approximately 50,000 acre-feet of water could be left in reservoir storage and allocated for new uses. However, reducing seepage would also reduce the amount of return flow to the lower reaches of the Boise River. Downstream diverters would then either call on their storage more frequently or it was assumed they would rent water to make up their shortfall. The cursory evaluation concluded this alternative would result in a net zero benefit of providing additional water supply in the Boise River basin and was screened from further analysis.

3.8.3 Automating Canal Systems

The primary purpose of canal system automation is to upgrade canal operation to reduce operational requirements or improve water use efficiency, or both. Canal operation is enhanced by installing a practical and modern control system at headworks and check structures within the delivery system to improve water transfer efficiency. Local automatic control or supervisory control, or both, can provide the following advantages compared to conventional operation:

- Rapid transfer of water (small or large quantities) with frequent changes
- Achievement of flexibility in operations when simultaneous information on the entire delivery system is known
- Possibility of adjustments in canal flow to accommodate variances in canal turnout diversions on a daily or an hourly basis
- Immediate response to sudden and unannounced variances in canal diversion or storm runoff flooding into the canal

An automated canal system can respond to abrupt and unscheduled changes in turnout diversion and immediately initiate corrective action. This action reduces the necessity for excess flow and minimizes the occurrences of delivery shortages (King, et al. 1991).

3.8.3.1 Preliminary Analysis

Automation benefits include improved service to the water user, improved efficiency of water transfer, reduced operating costs, and reduced diversion of excess water into wasteways. Additionally, more efficient transfer of water could result in economic benefits if the delivery system can reduce return flows, carriage water, and overbank losses. A reduction in O&M costs, including personnel, associated with the installation of a control system represents a primary economic benefit.

Automation creates a need for technical expertise to maintain computer software and electronic equipment. Technical skills are required to repair problems and perform maintenance. Also, operations vary between different canal systems depending on the type of inlet and outlet facilities, flow capacity, and combination of service demands. Before a cost-benefit analysis related to the implementation of a controls system can be accomplished, the operational requirements and specific needs related to automation of the distribution system must be identified (Reclamation 1991). Understanding the cost/benefit analysis requires an assessment of the current operating efficiency of the delivery system to estimate potential efficiency gains resulting from increased control.

3.8.3.2 Secondary Analysis

Following the initial analysis, it was determined that canal automation met the planning objectives and did not violate the planning constraints or considerations. A second level of analysis was completed, which evaluated canal automation specific to the Boise River basin in an attempt to quantify potential water savings.

Secondary analysis efforts identified existing diversion sites and associated diversion rates using information provided from the IDWR public records and the IDWR Water District 63 Watermaster. In total, 50 lower Boise River diversion sites were identified with a total maximum diversion rate of 5,556 cfs. Once all diversion sites were identified, existing automated sites (Table 3-11) were categorically compared to the sites that remained to be automated (Table 3-12) according to the maximum diversion rates of each, as shown in Table 3-13.

Table 3-11. Automated Lower Boise River Diversion Sites

Diversion Site	Maximum Diversion Rate (cfs)	Percent of Total Maximum Diversion Rate (%)
New York	2,800	50.3996
Ridenbaugh	412	7.4159
Phyllis	400	7.1999
Sebree	323.6	5.8248
Riverside	260	4.6800
Farmers Union	200	3.6000

Diversion Site	Maximum Diversion Rate (cfs)	Percent of Total Maximum Diversion Rate (%)
Settlers	185	3.3300
Middleton	140	2.5200
Canyon County	68	1.2240
New Dry Creek	54	0.9720
Little Pioneer	23	0.4140
Boise City	21	0.3780
Thurman Mill	20	0.3600
Ballentyne	15	0.2700
Hart Davis	11	0.1980
Grahman Gilbert	3.4	0.0612
Thomas Aiken	3.4	0.0612
Total - Automated Diversion Sites	**4,939.4**	**88.9085**

Table 3-12. Non-automated Lower Boise River Diversion Sites

Diversion Site	Maximum Diversion Rate (cfs)	Percent of Total Maximum Diversion Rate (%)
Eureka #2	120	2.1600
McConnell Island	58	1.0440
Boise Valley	50	0.9000
Caldwell Lowline	40	0.7200
Caldwell Highline	40	0.7200
Lower Center Point	38	0.6840
Island Highline	34	0.6120
Eureka #1	25	0.4500
Mammon Pump	25	0.4500
Andrews	18	0.3240
Campbell	16	0.2880
Upper Centerpoint #3825	16	0.2880

Diversion Site	Maximum Diversion Rate (cfs)	Percent of Total Maximum Diversion Rate (%)
Davis	15	0.2700
Parma	15	0.2700
Mace Catlin	12.5	0.2250
Rossi Mill	12	0.2160
Hass	12	0.2160
Baxter	11	0.1980
Bowman Swisher	10	0.1800
McManus Theater	8	0.1440
Warmsprings	7	0.1260
New Union	6	0.1080
Siebenburg	6	0.1080
Conway Hamming	5	0.0900
Peniterary	3.98	0.0716
Bubb	3	0.0540
Lemp	3	0.0540
Clayton Lat	3	0.0540
Seven Suckers	1.7	0.0306
Mace	1.5	0.0270
Barber Pump	0.25	0.0045
Atwell	0.25	0.0045
Butch Otter	0.02	0.0004
Total - Non-automated Diversion Sites	**616.2**	**11.0915**

Table 3-13. Lower Boise River Diversion Sites

Category	Maximum Diversion Rate (cfs)	Percent of Total Maximum Diversion Rate (%)
Subtotal - Automated Diversion Sites	4,939.4	88.9085
Subtotal - Non-automated Diversion Sites	616.2	11.0915

Category	Maximum Diversion Rate (cfs)	Percent of Total Maximum Diversion Rate (%)
Total - Diversion Sites	**5,555.6**	**100**

3.8.3.3 Conclusion

Following additional analysis specific to the Boise River basin, it was concluded that, while 33 of the 50 diversion sites are unautomated, the 17 diversion sites that are automated account for approximately 89% of the flows diverted through canal headgate systems. Automating the remaining 33 of 50 sites would only affect 11% of the flows. Given the minimal potential water savings, canal automation was screened from further analysis.

3.8.4 Managed Aquifer Recharge

Aquifers are subsurface rocks or sediments, often referred to as a porous medium, capable of storing and transmitting water. Water managers and users have successfully stored water in aquifers for decades, recharging the aquifer when water is available in surplus and pumping water from the aquifer when demand exceeds water availability from other sources.

Aquifer storage and recovery: The use of managed recharge to store surface water in a confined underground area could be an important element in meeting future water use needs. Policy 1I of the State Water Plan acknowledges the potential benefit of using managed recharge to store surface water in a confined underground area to meet future water use needs. It also states the following:

> *"….Further understanding of the economic, legal, ecological, and technical feasibility of using confined underground aquifers for water storage in Idaho is required for the purpose of policy development and planning and to avoid injury to existing water rights."*

Incidental aquifer recharge: The incidental recharge of aquifers occurring "as a result of water diversion and use that does not exceed the vested water right of water right holders is in the public interest." (Idaho Code Section 42-234(5)). Incidental recharge may be an important component of some aquifer water budgets.

Per the State Water Plan, managed aquifer recharge is recognized as an "appropriate means of enhancing ground and surface water supplies, providing mitigation for junior groundwater depletions, or to help maintain desirable aquifer levels." In Idaho, managed aquifer recharge is the deliberate application of surface water to suitable aquifers to improve groundwater levels in a localized area or in a regional aquifer, or to increase discharge from aquifers in direct hydraulic communication with rivers (that is, to improve return flows to a river by capturing or storing surplus surface water in an aquifer that discharges back to a river through springs or drains). To develop a recharge project or program, a number of factors must be considered:

- The geological characteristics of the proposed location must be suitable to receive recharge water.

- Surface water must be available for diversion under an authorized water right and may not injure other water right holders.
- The purpose of the proposed recharge should be clearly defined as it would influence where, when, and how managed recharge can be accomplished.
- Infrastructure must be developed to both deliver surface water to the recharge site(s) and to withdraw water from the aquifer for the intended use. This conveyance system must also be operated and maintained.
- A measurement and monitoring program must be implemented to monitor water delivery, groundwater levels, and water quality.

Geological Conditions Influence Recharge Site Location

Geological conditions must be evaluated to determine whether a location is conductive to recharge (through injection or infiltration). The aquifer system in the Treasure Valley is known for its complexity and includes shallow, intermediate, and deep aquifers. The depths and thickness of the aquifers vary spatially and are controlled by faulting, topography, and land use characteristics. The system includes confined and unconfined aquifers, and there is significant hydraulic communication between various aquifers within the region, as well as the Boise and Snake Rivers. The Treasure Valley Groundwater-Flow Model is currently under development and will provide information about the aquifer system geologic conditions and the Treasure Valley water budget (scheduled completion in 2021). The Treasure Valley Managed Aquifer Recharge Feasibility Study was completed in March 2020 and provided general information about areas that may or may not be feasible for recharge.

To identify and develop a specific recharge site or project, additional analyses of the hydrogeological conditions will be required. This includes an evaluation of the surface and subsurface geology, physical aquifer characteristics, land use, groundwater quality, and localized and regional aquifer impacts. Infiltration, groundwater flow rates, and retention times can vary significantly based upon location and associated geology. Water recharged in an unconfined aquifer will travel in different directions and may influence groundwater conditions in a larger regional rather than localized area, or it may return to the river through drains and springs. It will not necessarily be available for diversion by a specific end user in the location to which it is applied. In addition, recharge may not be appropriate in areas at risk for landslides, flooded basements, or limited retention time. Therefore, site investigation is important in order to verify recharge feasibility and benefits.

Water Supply, Purpose of Use, and Water Right and Legal Considerations

A source of water for recharge must be identified when developing a recharge site(s). The potential availability of unappropriated natural flow in the Boise River was evaluated in the Treasure Valley Managed Aquifer Recharge Feasibility Study. However, this publication does not incorporate the most recent proposed projects and water right applications (such as Cat Creek and IWRB’s permit application) and does not consider infrastructure and conveyance limitations associated with diverting water when water is available (that is, if water is available for diversion as a result of flood releases from Lucky Peak, existing canal systems may not have capacity to carry recharge water, requiring construction of independent recharge conveyance facilities).

A water right permit is required to authorize the diversion of water for recharge. This requires the identification of a point of diversion and place or location of use. Though the purpose of use may be defined as "recharge," technical analysis of the benefit realized from the recharge activity may also be required to obtain a water right. In addition, Idaho law does not currently recognize aquifer storage and recovery, though Policy 1I of the State Water Plan acknowledges the potential benefit of using managed recharge to store surface water in a confined underground area to meet future water use needs. It also states the following:

> *"….Further understanding of the economic, legal, ecological, and technical feasibility of using confined underground aquifers for water storage in Idaho is required for the purpose of policy development and planning and to avoid injury to existing water rights."*

Therefore, storing water in the aquifer to allow for new groundwater pumping or to avoid curtailment of an existing use resulting from conjunctive administration (curtailment of junior groundwater pumping impacting senior surface water rights) may require development of a plan to mitigate for the use (for example, recharge could be used to offset the impacts of groundwater pumping). A mitigation plan would require a technical analysis of the recharge site, conveyance system, and water supply availability to justify the proposal.

Finally, recharge by injection or water infiltration into the aquifer does not necessarily result in an availability of an equal quantity of water for pumping at a later time, particularly if the water is applied to an unconfined aquifer through which water travels outside the localized area of application (that is, 1 acre-foot of water recharged would not necessarily authorize diversion of 1 acre-foot of groundwater for later use). This creates challenges in identifying who (willingness to pay) would be the owner and investor of the capital and long-term O&M costs of implementing a recharge project. Similarly, it is difficult to identify who would benefit from the recharge.

Infrastructure

The infrastructure to conduct managed recharge includes structures to divert water from the river, transport the water to the recharge location, and a facility to conduct the recharge (such as injection well or infiltration basin). In addition, infrastructure would be required to recover or divert the recharged water for the intended use.

Recharge facilities also require development of a monitoring plan for approval by the IDEQ or the IDWR's Underground Injection Control Program. Monitoring plans generally include measurement and monitoring the water diverted from the river for recharge, ongoing measurements of groundwater levels, and monitoring the surface and groundwater quality. Infrastructure or operational expenses associated with the monitoring plan can include the installation of measuring devices (including dataloggers and telemetry) and monitoring wells, as well as water quality sampling. The party responsible for infrastructure development, ongoing O&M, and monitoring must be established as part of recharge project development.

Managed Aquifer Recharge versus New Surface Storage

Managed aquifer recharge differs significantly from new storage at Anderson Ranch Reservoir. Additional storage in the Anderson Ranch Reservoir provides a new source of water supply from a quantifiable space for delivery to a specific location when it is needed, and it generally uses existing infrastructure for conveyance of the water. The end user and purpose of use (need) can be largely defined and does not influence the technical analysis of the dam raise.

Water captured through managed recharge would not be stored in a confined space, but rather in aquifers throughout the Treasure Valley aquifer system with varied spatial and geological boundaries. Recharged water may influence groundwater conditions in a larger regional area or a localized area or may return to the river through drains and springs. These circumstances make it difficult to predict who the end users or beneficiaries would be and how long the recharged water would be available for diversion and delivery to an end user.

In addition, the infrastructure required to deliver water from the river, to develop the recharge site, and to divert from the aquifer for a beneficial use, cannot be defined until an end user, a location, and a specific use are identified. More geological and hydrological investigation would be required to identify feasible recharge sites and whether those sites would be appropriate to satisfy a specified need.

Conclusion

Without defining the need, end user, recharge site location, and corresponding infrastructure requirements, the development of a managed aquifer recharge alternative has significant implementation challenges at this time.

The State and other independent entities will continue to explore options to use managed aquifer recharge as a water management tool in the future. However, at this time, it is not yet understood who (both putting water into the aquifer and pulling out of the aquifer), what (infrastructure required to pull water out, transport it, and recharge it), where (both injection/infiltration and well sites), when (when and where water would be available once in the aquifer), or how (implementation - capital/long-term O&M investment, groundwater administration, etc.) a project or program could be implemented. These fundamental questions must be answered before a viable project or program alternative can be developed that is implementable by Reclamation; therefore, managed aquifer recharge was removed from further consideration.

3.9 Selection of Proposed Plan for Feasibility-level Evaluation

Significant engineering challenges and implementation risks are associated with increasing reservoir storage at Arrowrock and Lucky Peak dams; resource constraints are associated with evaluating alternatives at the feasibility level; and time constraints are associated with the Secretary of the Interior making a determination of feasibility in accordance with Section 4007 of the WIIN Act. Given these factors, Reclamation and the IWRB, as evidenced by its July 2018 resolution, determined to continue carry forward a 6-foot raise at Anderson Ranch Dam as the structural alternative to be analyzed at the feasibility level.

Following extensive efforts in 2019 to identify and evaluate non-structural alternatives, per the PR&G (including input from external stakeholders), Reclamation and the IWRB screened out all non-structural alternatives identified. The feasibility-level alternative to be evaluated is the Anderson Ranch 6-foot Dam raise. This alternative, herein referred to as the Proposed Plan, would raise Anderson Ranch Dam 6 feet from the present top-of-pool elevation and would provide 29,000 acre-feet of additional water storage capacity in the Boise River basin.

3.10 Project Planning Horizon

The planning horizon is 100 years, which is consistent with *Water and Related Resources Feasibility Studies, Reclamation Manual, Directives and Standards, CMP 09-02,* (Reclamation 2019b) and is consistent with the expected service life of large civil engineering projects.

Chapter 4 Plan Description

This chapter describes the Without Plan (No Action) and Proposed Plan (Anderson Ranch 6-foot Dam raise) evaluated in this Feasibility Report, which was formulated in consideration of the Study authorization and identified problems, needs, and opportunities, and to meet the planning objectives of this Study.

4.1 Without Plan (No Additional Federal Action)

For all Federal feasibility studies of potential water resources projects, a future condition Without Plan represents a projection of reasonably foreseeable future conditions that could occur if no action alternatives are implemented (that is, the future without the proposed project). Reclamation recommends several criteria for including proposed future actions within the Without Plan condition; proposed actions should be (1) authorized; (2) approved through completion of NEPA and ESA compliance processes; (3) funded; and (4) permitted. Future conditions Without Plan (or no action) is the basis for comparison with the Proposed Plan (potential action alternative), consistent with the PR&G and NEPA guidelines.

Future conditions Without Plan represents the existing infrastructure and facilities in the Study area and the existing water supply conditions in the Treasure Valley area. The Treasure Valley (Ada County and Canyon County) population is estimated to have increased 22% from 2010 to 2019 (USCB 2019), and population projections indicate significant continued growth. Coinciding with population growth, extensive land use changes are occurring throughout the Treasure Valley. Most visibly, row-crop agriculture and pastoral lands are transitioning to residential and urban environments. Together, these population and associated land use changes continue to increase the demand for DCMI water. In a study prepared for the IWRB (Treasure Valley DCMI Report), projected annual water demand for DCMI uses is anticipated to increase to between 219,000 and 298,000 acre-feet per year by 2065. This represents a DCMI water demand increase ranging from 109,000 to 188,000 acre-feet per year (SPF 2016). Other conclusions from the same study include the following:

- The combined population of Ada and Canyon counties is expected to increase from approximately 624,500 people in 2015 to approximately 1.6 million people by the year 2065.
- Substantial water demand reductions are possible through conservation, and more detailed conservation planning may be necessary to achieve higher conservation goals. The study's projections incorporate a 20% reduction in indoor use and a 10% reduction in outdoor use.
- Options for supplying the increased net DCMI water demand could include Boise River diversions (increased surface water storage, use of flood flows for aquifer storage and recovery strategy, or direct diversions), additional development of Treasure Valley

groundwater, new diversions from the Snake River, or reuse of treated municipal effluent.

- Surface water from existing irrigation could become more available for indoor DCMI uses in the future. However, this would likely require market incentives to cover the costs of delivery system improvements and operations and changes in existing Boise River basin storage contracts.

In addition to a rapidly increasing demand on water resources for consumptive use, climate change is likely to stress existing water resources. The management of the Boise River system is highly dependent on water stored in the form of snowpack in the watershed. Future climate variability will impact the timing and volume of flows entering Anderson Ranch Reservoir, and these changes are expected to affect how Reclamation operates two reservoirs in the three-reservoir system (Anderson Ranch, Arrowrock, and Lucky Peak). Future climate variability is expected to increase, with higher temperatures, a greater range between dry and wet years, and more frequent extreme climate events (hot, wet, or dry). The RMJOC-II Climate Change Study (RMJOC-II 2018) notes overall trends of increased fall and winter streamflow, earlier and higher spring peak runoff, and earlier streamflow recession. The study also suggests the potential for increased rain-on-snow events during the winter and spring and annual runoff peaks shifting to several weeks earlier compared to historical conditions. The existing infrastructure and fixed storage capacity may not be adequate to manage these projected changes in precipitation patterns (that is, current storage capacity may be insufficient to capture water in ‘wet’ years to offset ‘dry’ years). Furthermore, the early streamflow recession in summer and fall may result in greater dependency on storage water, resulting in less reservoir carryover and an increase in groundwater pumping.

Key assumptions regarding future conditions Without Plan include the following:

- Treasure Valley DCMI Report projections include water conservation assumptions regarding future water demand projections. The forecasts account for a future reduction in water use due to increased water conservation measures that could result from public education, incentives, regulatory measures, or other approaches (SPF 2016).

- Treasure Valley DCMI Report water demand projections also discuss the potential for “population capture” by adjacent counties (that is, people that work in Ada and Canyon counties but choose to live in adjacent counties such as Gem County or Elmore County), which could also impact results in the Treasure Valley DCMI Report (SPF 2016).

- The Boise River Reservoir operations would continue similar to existing conditions (per the current 1985 Water Control Manual for Boise River Reservoirs). Reclamation would continue to operate Anderson Ranch Dam under current standing operating procedures. Irrigation water delivery, power generation, and FRM protocols would continue under current conditions.

- Reclamation would not modify Anderson Ranch Dam to expand storage capacity and total storage capacity within Anderson Ranch Reservoir would remain at

474,900 acre-feet (active 413,100 acre-feet). The facilities around the reservoir would be unaffected.

- The range of reservoir operations would remain the same as those identified in the 2005 and 2014 ESA consultations with the USFWS for ongoing O&M in the Snake River basin above Brownlee Reservoir, documented in Reclamation's 2004 and 2013 BAs for those consultations. An ITS issued in the 2005 BiOp provides Reclamation with coverage for the effects of ongoing O&M of Anderson Ranch Dam and Reservoir to bull trout, a threatened fish species that occurs both in Anderson Ranch Reservoir and the South Fork Boise River above and below the dam. Critical habitat for bull trout was designated in 2010, and a 2014 BiOp considered the effects of ongoing O&M of Anderson Ranch Dam and Reservoir on designated critical habitat for the species. Under the Without Plan condition, Reclamation would continue to fulfill the T&Cs and RPMs identified by the USFWS in both the 2005 and 2014 BiOps.
- Management rights and responsibilities of the USFS in the area would continue as current, including managing public use of water surface, financing, installation, and maintenance of all signs in the reservoir area, administration of roads and recreation sites, debris and hazards removal, and Special Use Permits outside the reservoir footprint. The USFS would continue to be responsible for interagency cooperation with the USFWS and the IDFG. The existing 19.5-foot-wide single travel lane across the crest of the dam would remain as the connection to HD-120 and would continue to serve as the main access to the western side of the reservoir, the South Fork Boise River, and to areas north and east of the reservoir (including the town of Prairie and the Trinity Mountains). It would continue its designation allowing alternating one-way traffic, controlled by traffic lights at either end of the dam crest, with adequate width for farm and maintenance equipment, trucks, and other oversized vehicles.
- The existing Deer Creek culvert under Pine-Featherville Road (HD-61) is seasonally perched on the downstream end, making it a potential barrier for upstream passage of aquatic organisms when the full pool water surface elevation is less than 4194.8 feet. The Deer Creek subwatershed is a high-priority migration corridor for bull trout between Anderson Ranch Reservoir and headwater streams.
- The existing Fall Creek culvert under HD-113 is seasonally perched on the downstream end, making it a potential barrier for upstream passage of aquatic organisms when the full pool water surface elevation is less than 4190.5 feet. Rocky Mountain Research Station environmental DNA data show positive bull trout detections in Meadow Creek and upper Fall Creek (Young et al. 2019). In addition, a photo taken in 2003 that was provided to Reclamation via the USFWS, Idaho Fish and Wildlife Office, shows kokanee salmon schooled below the perched culvert at low water.
- Future conditions Without Plan assumes no new facilities or impacts associated with the CCE Pump/Storage Project or the Elmore County South Fork Boise River Diversion Project.

4.2 Proposed Plan (Anderson Ranch 6-foot Dam Raise)

The Proposed Plan proposes to raise Anderson Ranch Dam to increase top of active RWS by 6 feet from present elevation (4196 feet) to 4202 feet, and corresponding enlargement of Anderson Ranch Reservoir, allowing for the ability to capture and store approximately 29,000 acre-feet of additional water (Figure 4-1). This new reservoir space would allow Reclamation to store precipitation runoff when available during wet years and to hold over for use during dry years. Potential spaceholders include existing Reclamation contractors (entities that have contracted with Reclamation for storage space in Boise River system reservoirs) and the IWRB, which could, in turn, contract water to existing Water District 63 water users or may offer water through the Idaho water supply bank's Water District 63 rental pool, or both.

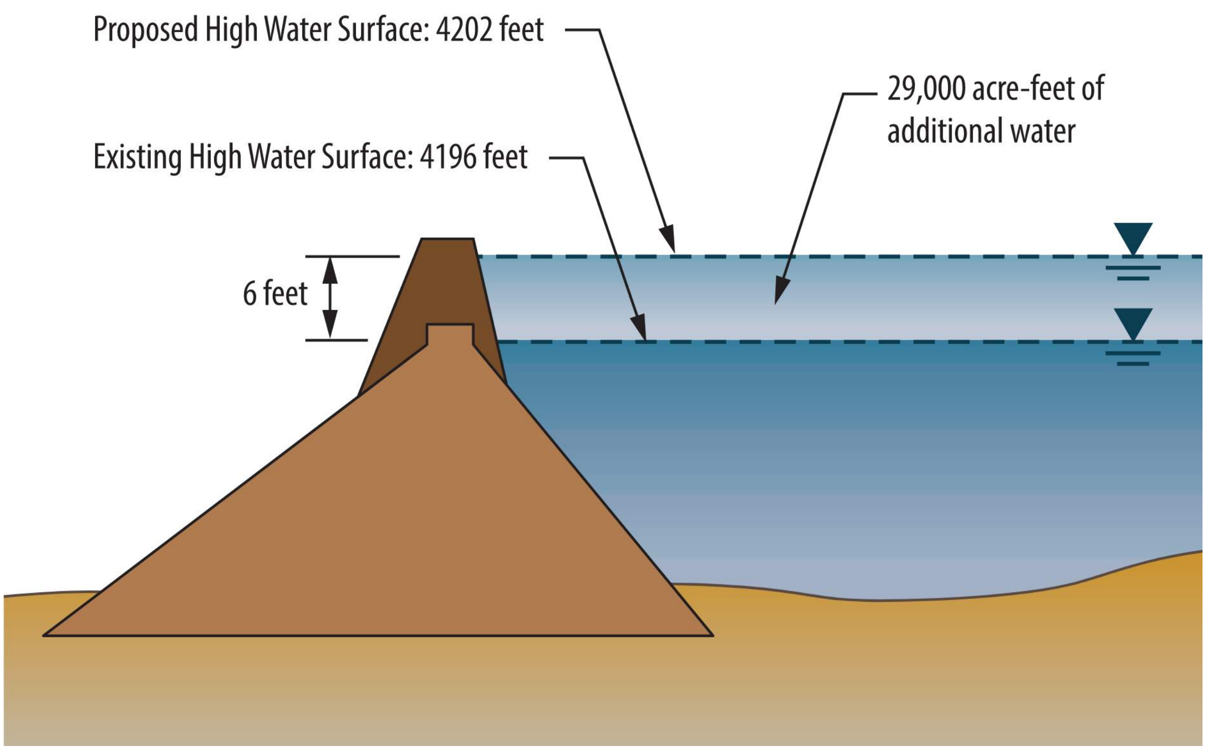


Figure 4-1. Proposed 6-foot Anderson Ranch Dam Raise

Potential changes in reservoir storage and stream flow associated with new storage space in Anderson Ranch Reservoir were evaluated using historical and climate change hydrology, and a range of possible release rates and timing for water accrued to the new storage space. Potential impacts during the construction phase of the Proposed Plan were also considered. Model results for the historical period suggest that system operations with an additional 29,000 acre-feet of storage in Anderson Ranch Reservoir results in conditions that fall within the historical operating range. Full details on water availability, refill probability, and modeling assumptions can be found in Appendix A.

Major features of the proposed action include those associated with raising the dam structure and corresponding projects around the perimeter, or rim, of Anderson Ranch Reservoir that need modification, rehabilitation, or replacement as a result of an increase in water surface elevation around the rim and adjacent reservoir areas. Additional design information and details regarding construction considerations, schedule, and cost estimates for the dam raise are provided in Appendix B. Major components of the Proposed Plan are described in this section.

4.2.1 Dam Raise

Reclamation's TSC proposed two overall methods for raising the reservoir 6 feet. The two methods are the most technically feasible and cost-effective measures to meet project objectives. Other raise alternatives were screened out early in the conceptualization process because they either did not satisfy fully, or well enough, all the design constraints or they were judged to cost significantly more than either of the two alternatives.

Based on the feasibility-level cost estimates, construction schedules, construction contract risks, dam safety risks and technical adequacy, the two methods (Soil Cement Downstream Raise and Mechanically Stabilized Earth [MSE] Wall Raise) are very comparable and viable modification options. Overall, the Soil Cement Downstream Raise is slightly more favorable and has less uncertainty with regards to dam safety risk. The TSC considers the Soil Cement Downstream Raise to be the preferred method of construction.

4.2.1.1 Soil Cement Downstream Raise

Design components of the dam raise modification include crest and abutment excavation, foundation treatment, zoned earthfill, parapet wall, and downstream soil cement slope. Materials for the downstream embankment raise would be placed above the existing embankment material. Materials would be produced from the excavation phase of work or borrowed from nearby sources. Other materials are proposed to be commercially sourced. Mountain Home (28 miles away) has a number of commercial borrow pits and concrete batching plants and is a likely candidate for supplying some of the zoned materials. At completion, the crest width would restore the ability to accommodate two-lane traffic and shoulder guard railing. The dam crest would be finished with road base and asphalt surfacing.

4.2.1.2 Mechanically Stabilized Earth Wall Raise

An MSE wall is a retaining structure composed of reinforced compacted soil that can stand nearly vertical. Lifts of soil are compacted over horizontally placed reinforcing elements (that is, geogrid, geotextile, steel straps, or welded wire mesh) so the soil is internally stable. The reinforced unit of soil may then act as a gravity retaining structure. The MSE wall is typically finished with precast concrete panels or modular block facing units. MSE walls have been used in highway applications for several decades with excellent reliability. They are most useful in highway-widening or bridge approach ramp applications where right-of-way is tight. MSE walls have been used to raise dam crests at Reclamation facilities as well, most notably Sherburne and Stampede Dams. Zoned earthfill for the dam raise would be placed along the abutment sections where sufficient crest right-of-way exists. At completion, the crest width would restore the ability to accommodate two-lane traffic and shoulder guard railing. The dam crest would be finished with road base and asphalt surfacing.

4.2.2 Spillway Modification

The intent of the spillway modification is to allow for additional fill to be placed against the spillway walls at the crest structure. To achieve this, the design team included removing and replacing some concrete portions of the spillway.

4.2.3 Outlet Works

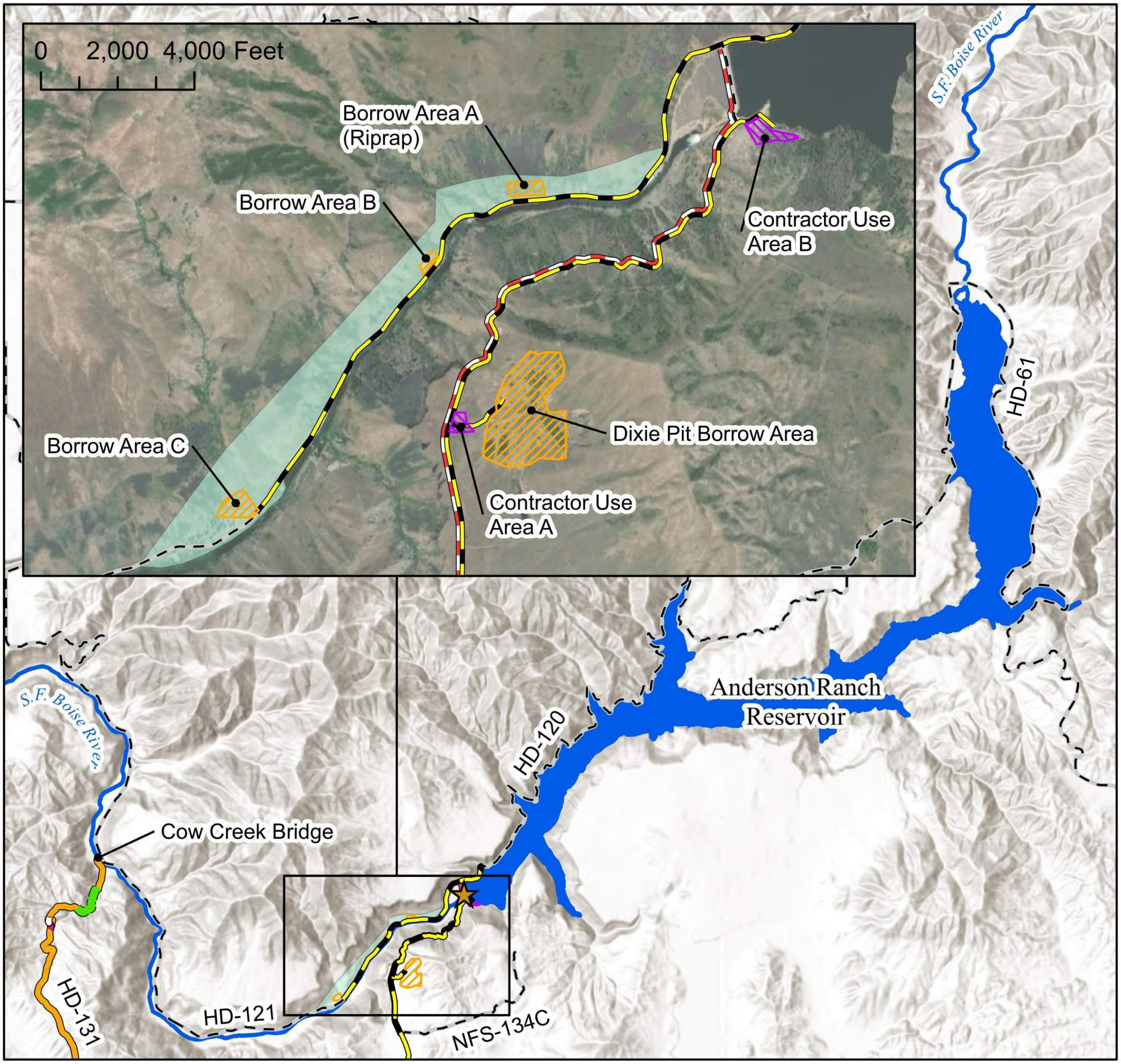
The existing outlet works at Anderson Ranch Dam would not require structural modification, except for the hoist house that controls the fixed wheel gate at the inlet. The most significant impact identified by the team to the hoist house is that some electrical boxes and wires would need to be relocated to prevent them from being submerged.

4.2.4 Borrow Areas and Contractor Use Areas

Field investigations and testing were performed to determine the soil index properties of the proposed borrow areas. The design team assumed that the following borrow sites are feasible based on field reconnaissance and geologic research (Figure 4-2):

- Dixie Pit Borrow Area located east of Anderson Ranch Dam on Anderson Ranch Dam Road; this site was a source of material for the original construction of Anderson Ranch Dam
- Toes of the South Fork Boise River tributaries (deposits along the northern side of HD-121 farther from the dam; depicted as Borrow Area A in Figure 4-2)
- Toe of the canyon slopes downstream of Anderson Ranch Dam (deposits along the northern side of HD-121 closer to the dam; depicted as Borrow Areas B and C in Figure 4-2)

There is a potential that borrow development operations may extend outside of these primary locations for numerous reasons including but not limited to State Historic Preservation Office restrictions, environmental impacts, insufficient or low quality borrow, and site access development. A potential impact zone along the northern bank of the South Fork Boise River extends from the downstream toe of the dam to 2.5 miles downstream for permitting clearance purposes, shown as Secondary Borrow Area on Figure 4-2.



Notes:
1. This map is provided as-is and may contain representations of property boundaries. It is intended for general references only. None of the parties involved in preparing this map or data contained herein warrant or represent information to be complete and accurate and cannot be held responsible for errors or omissions.

Figure 4-2. Borrow Areas and Contractor Use Areas
Boise Project - Arrowrock Division
Boise River Basin Feasibility Study

There is limited level and cleared space near the dam site; thus, suitable contractor space is likely limited. The design team proposed two sites that may be suitable for contractor use areas. The first contractor use area is located adjacent to the Dixie Pit and is proposed to be an appropriate location for office trailers, employee parking, borrow development, refueling and other staging activities (Contractor Use Area A on Figure 4-2). The second location is along the left abutment of the dam facility (Contractor Use Area B on Figure 4-2). This location was chosen for its moderate grades and relatively low density of vegetation. This staging area may be suitable for stockpiling, water tanks, reinforcing and formwork laydown areas, and other staging activities. Both locations are estimated to require clearing, grubbing, and some level of grading.

4.2.5 Haul Roads and Approach Roads

The proposed haul roads are identified based on estimated methods for delivery of fill material. The haul routes use existing roads HD-134, -120, and -121, as well as the Anderson Ranch Dam crest and spillway bridge (Figure 4-2). Access to the dam crest road is currently steep on both sides of the dam. HD-134, from the south, approaches the dam on the downstream side, descending a long steep slope. HD-121, on the downstream western side of the dam, climbs a short steep grade to the dam crest from the South Fork Boise River and then continues as HD-120 along the western side of the reservoir. The total length of haul routes (from borrow areas to the construction site) are approximately 4 miles one way (excluding the dam crest). A proposed turnaround is located at the boat ramp parking area approximately 0.5 mile upstream of the dam. It is estimated that grading work would be required to develop a haul route turnaround at the boat ramp parking area.

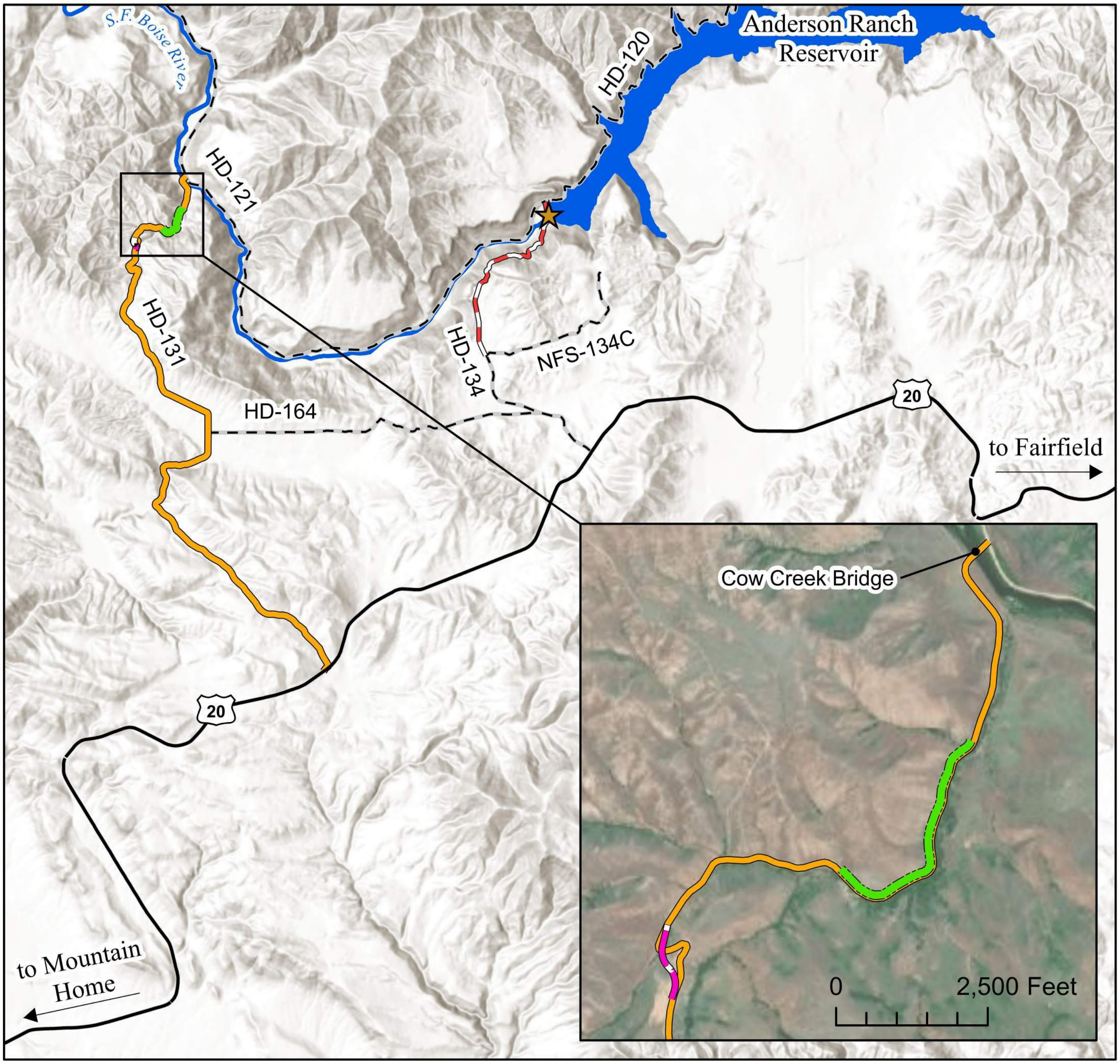
The approach roads are similar in design. As many retaining structures as possible were eliminated from each approach road design. Road design was restricted to 12% grade. The cross-section provides for two-lane traffic and protection for steep shoulders by using guardrails.

4.2.6 Cofferdam

The design team assumed that a cofferdam upstream of the spillway would be required to mitigate construction risk and to facilitate construction access across the spillway. The current feasibility-level design includes a cofferdam up to 20 feet high and a conservative reservoir restriction of 12 feet to 22 feet (RWS 4174), which will be further analyzed and refined during the final design.

4.2.7 HD-131 Detour

During construction activities, a detour route would be established along HD-131 (Figure 4-3). The majority of the detour route chosen is assumed to be acceptable for public access. Improvements would be made to the existing road to improve safety by reducing the number of sharp turns, widening specified sections, reducing the road grade, and removing some rocks (in the right-of-way) that currently block visibility. Winter maintenance would also be provided during the detour.



Legend

- Unpaved Road
- State Highway
- Road Closure
- Proposed Detour
- HD-131 Widened
- HD-131 Realignment
- Anderson Ranch Dam

N

0 1.5 3

Miles

Notes:

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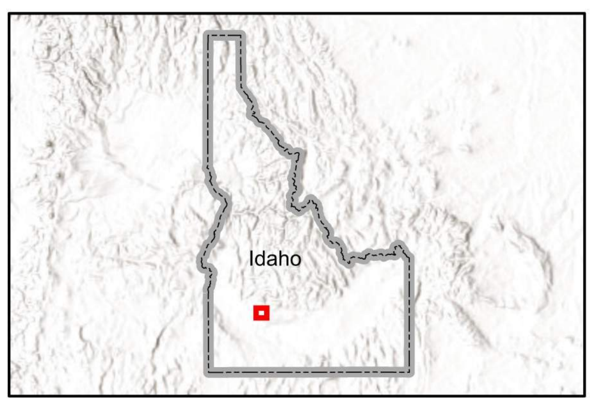


Figure 4-3. Road Closure and Detour Boise Project - Arrowrock Division
Boise River Basin Feasibility Study

4.2.8 Reservoir Rim Projects

Jacobs and QCI, as subconsultants to the Contractor, prepared feasibility-level designs, cost estimates, and schedules for projects around the perimeter, or rim, of Anderson Ranch Reservoir that would need modification, rehabilitation, or replacement as a result of an increase in water surface elevation. Detailed design information for the rim projects is provided in Appendix B – Engineering Summary Report.

In support of Reclamation's evaluation, CH2M HILL, Inc. (now Jacobs), completed the Rim Analysis (Jacobs 2019). The Rim Analysis involved using government-provided aerial imagery and topographical LiDAR data, as well as other available GIS data (that is, data related to property boundaries, easements, utility locations, septic systems, and other infrastructure) to evaluate and review potential impacts resulting from incremental increases in water surface elevations at Anderson Ranch, Arrowrock, and Lucky Peak reservoirs. Areas of potential impact at Anderson Ranch Reservoir (due to the proposed increase in reservoir pool elevation) were identified in the Rim Analysis and include the following: roads, the Pine Airstrip, bridges, culverts, power utility infrastructure, recreational facilities, groundwater wells, and septic systems. Each of these areas of potential impact around the reservoir rim were considered. An overview map of these projects is provided on Figure 4-4.

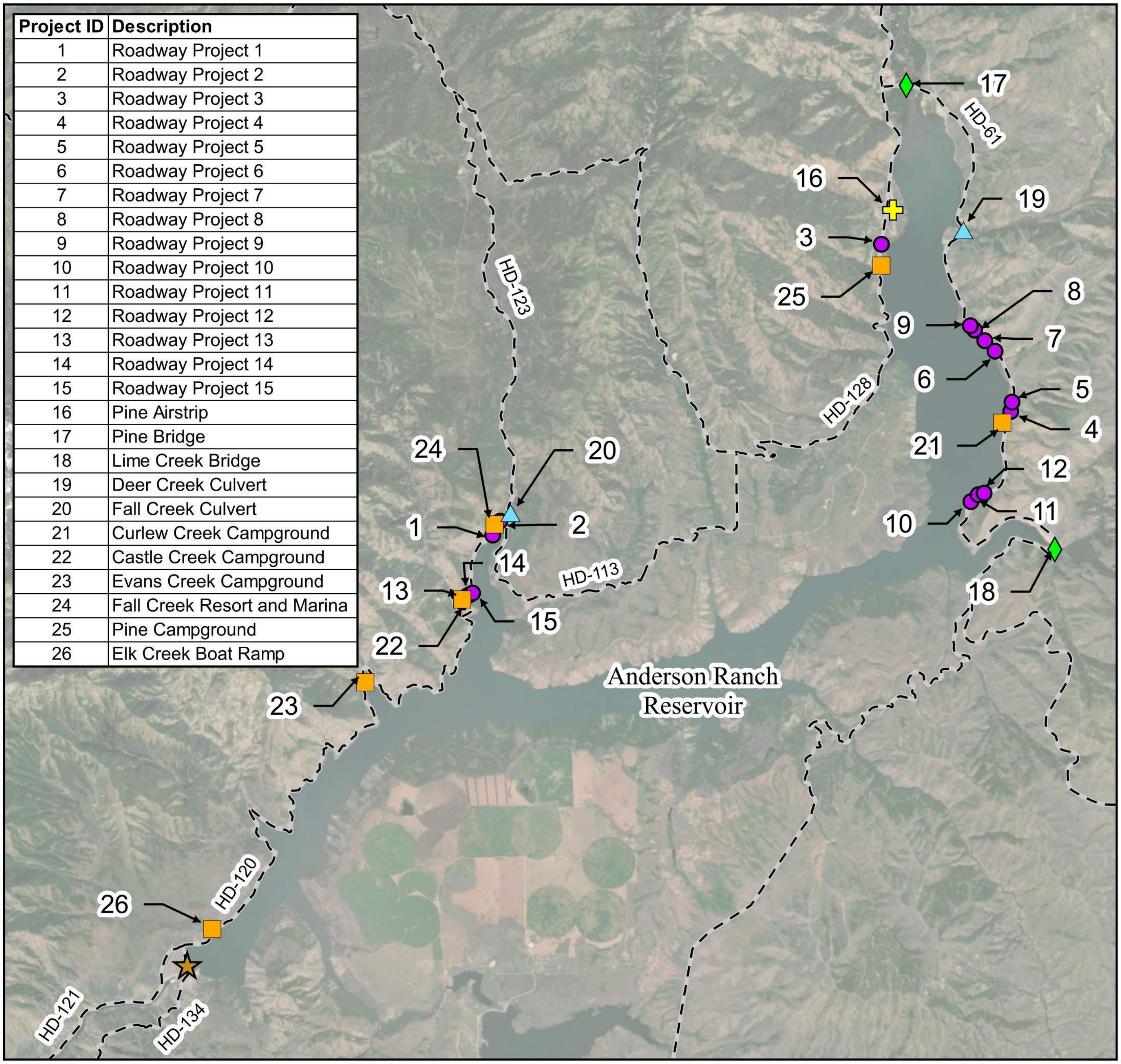
4.2.8.1 Roads

Three primary roads provide vehicle access around the rim of Anderson Ranch Reservoir (Figure 4-4):

1. HD-61 (Pine-Featherville Road) extends north from its intersection with U.S. Highway 20, crosses the Lime Creek Bridge, follows the northeastern shore of the reservoir, and crosses the Pine Bridge to the communities of Pine and Featherville. The road is maintained year-round by Glenns Ferry HD.
2. HD-128 (Lester Creek Road) provides access from Pine south to Sloan's Gulch and Lester Creek. The road is maintained by Mountain Home HD but is inaccessible past the Pine Airstrip area during winter months unless by snowmobile.
3. HD-120 (Anderson Dam Road) from Anderson Ranch Dam to Fall Creek provides access to the northwestern shore of the reservoir. The road is maintained year-round by Mountain Home HD.

In total, 12 locations around the perimeter of the reservoir, varying in length from 100 to 800 feet, require riprap road embankment or shoreline stabilization, or both, to prevent erosion and protect existing road infrastructure. Three locations along HD-61 (between Curlew Creek and Lime Creek) require the removal of existing retaining walls and their reinstallation with a higher top-of-wall elevation to withstand the increased water surface elevation. One additional location along HD-120 (near Castle Creek) requires a new MSE wall to protect the existing road from the increased water surface elevation.

Project ID	Description
1	Roadway Project 1
2	Roadway Project 2
3	Roadway Project 3
4	Roadway Project 4
5	Roadway Project 5
6	Roadway Project 6
7	Roadway Project 7
8	Roadway Project 8
9	Roadway Project 9
10	Roadway Project 10
11	Roadway Project 11
12	Roadway Project 12
13	Roadway Project 13
14	Roadway Project 14
15	Roadway Project 15
16	Pine Airstrip
17	Pine Bridge
18	Lime Creek Bridge
19	Deer Creek Culvert
20	Fall Creek Culvert
21	Curlew Creek Campground
22	Castle Creek Campground
23	Evans Creek Campground
24	Fall Creek Resort and Marina
25	Pine Campground
26	Elk Creek Boat Ramp

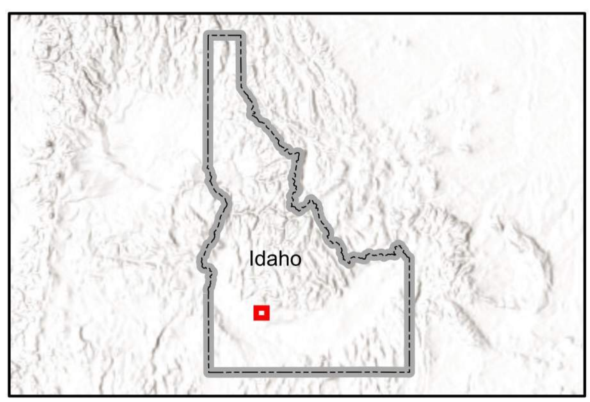


LEGEND

- Anderson Ranch Dam
- Aviation Project
- Bridge Project
- Culvert Project
- Recreation Project
- Roadway Project
- Road

N

0 1.5 Miles



Notes:
1. This map is provided as-is and may contain representations of property boundaries. It is intended for general references only. None of the parties involved in preparing this map or data contained herein warrant or represent information to be complete and accurate and cannot be held responsible for errors or omissions.

Figure 4-4. Reservoir Rim Projects
Boise Project - Arrowrock Division
Boise River Basin Feasibility Study

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Additionally, a length of road along HD-128 (south of the Pine Airstrip) would require a grade raise of approximately 1 foot to impound the increased top of active water surface elevation of the reservoir. The road length that needs to be raised is approximately 800 feet long and consists of two 12-foot lanes with 2-foot shoulders.

4.2.8.2 Pine Airstrip

The Pine Airstrip is owned and operated by the State of Idaho through the ITD Division of Aeronautics. It is located on land owned by Reclamation (2019b) and administered by the USFS. It is an airport with one turf runway having a visual approach to each end. The proposed increase in RWS elevation at Anderson Ranch Reservoir would inundate a portion of the southern end of the existing runway (approximately 50 to 70 feet in length) as well as the Runway Protection Zone at full pool.

Before completing the feasibility-level design, a meeting was held with ITD Aeronautics staff to discuss alternatives for runway relocation or realignment, or both. ITD's preferred alternative consists of realigning the runway such that the Runway Object Free Area is completely above the 4202-foot elevation contour. In coordination with the ITD, a feasibility-level design was developed for relocation of the existing runway with a different orientation and similar dimensions, keeping it out of the future water line after the proposed dam raise. The proposed relocation remains on the existing airport property and includes a shift of the runway, as well as a new orientation. This project would be primarily an earthwork project, with a near net zero cut and fill balance.

4.2.8.3 Hydraulic Evaluation of Pine Bridge and Nester's Private Campground

The Contractor performed a hydraulic analysis of the existing Pine Bridge over the South Fork Boise River relative to the proposed 6-foot increase in RWS elevation at Anderson Ranch Reservoir. Using updated bridge and hydraulic data, the hydraulic analysis was completed to evaluate the potential impacts on the bridge resulting from the backwater effect from Anderson Ranch Reservoir.

The Contractor then addressed the potential impact of increased reservoir elevation on Nester's Private Campground immediately upstream of the Pine Bridge. This campground is accessed via a narrow gravel road that spans multiple side channels of the river with small culvert and make-shift bridge structures. This hydraulic evaluation assessed potential impacts on the road, culverts, and bridges associated with the higher tailwater conditions.

Hydraulic model results indicate that, under the proposed high pool condition and considering maximum allowable surcharge (RWS of 4204.2 feet), the resulting freeboard at the Pine Bridge for a 50-year flood would be reduced to 1.5 feet. This does not meet the ITD minimum freeboard requirement of 2 feet, although the likelihood of a 50-year flood and high reservoir levels occurring simultaneously is very low.

Generally, one can expect the existing culverts in the Nester's Private Campground area to become partially submerged under high flow conditions in the South Fork Boise River. The campground is located in the natural floodplain and is not protected from naturally occurring floods. The results of this hydraulic analysis indicate that flooding impacts observed at Nester's Private Campground are the direct result of South Fork Boise River flows and not a result of backwater influence from the existing or the proposed reservoir elevations. This is also the case with the maximum reservoir surcharge condition considered, and increased RWS elevations do not measurably increase flood depths or inundation extents at Nester's Private Campground.

4.2.8.4 Bridges

The Lime Creek Bridge (ITD Bridge Key 19880) and the Pine Bridge over the South Fork Boise River (ITD Bridge Key 19886) were identified as the bridges that would be impacted by the proposed increase in RWS elevation at Anderson Ranch Reservoir. These structures were reviewed to identify necessary improvements to address the resulting impacts. Additionally, the Cow Creek Bridge (ITD Bridge Key 27855) was identified as a structure along the proposed HD-131 detour route for traffic during the construction of the dam improvements. This structure was analyzed to determine if it can support the anticipated detour traffic loads.

Pine Bridge (ITD Bridge Key 19886)

Located along HD-61 (Pine-Featherville Road), the Pine Bridge is a single-span, steel girder bridge that was constructed in 2018. This bridge carries traffic between Mountain Home and Pine, Idaho, over the South Fork Boise River. The Pine Bridge is jointly maintained by Glenns Ferry HD (to the east) and Mountain Home HD (to the west), and the underlying land is Federally owned. The original plans show the minimum clearance between the 50-year high water elevation and the low chord at 2.5 feet. The proposed increase in RWS elevation could reduce this provided freeboard below the 2-foot minimum required by ITD during a 50-year flood event if the reservoir level is high when a flood event occurs.

Reclamation acknowledges a low probability of these conditions occurring that would result in a reduction of freeboard and is pursuing a variance. If granted, the variance would negate the need for the proposed abutment modifications, including a modified design that would increase the superstructure elevation by 1 foot to satisfy the minimum ITD freeboard requirement. To raise the superstructure, the abutment beam seats would need to be elevated. This would require temporary removal of the superstructure, installation of additional piles, reconstruction of taller abutments to withstand additional loads, and replacement of the existing superstructure. Details are described in Appendix B – Engineering Summary Report.

Lime Creek Bridge (ITD Bridge Key 19880)

Located along HD-61 (Pine-Featherville Road), the Lime Creek Bridge is a three-span, prestressed concrete bridge that was constructed in 1984. This bridge carries traffic between Mountain Home and Pine, Idaho, over the intersecting waterways Lime Creek, Casey Creek, and the Anderson Ranch Reservoir. The Lime Creek Bridge is maintained by Glenns Ferry HD, and the underlying land is Federally owned. As reported in the 2018 ITD Inspection Report, current site conditions include critical scouring at the abutments and piers resulting from material being sloughed away over the life of the structure. The scour noted in the Inspection Report was verified during a Contractor site visit in September 2019.

Presently, the abutment slopes contain minimal material resembling the original installed riprap. Thus, before any increase in water elevation, the abutment slopes need repair and the installation of new riprap. In addition to these repairs, and in response to the anticipated increase in water elevation, the riprap should be extended beyond the limits specified in the original design. Additionally, the slope at the southeastern abutment, where Casey Creek joins Lime Creek, has experienced critical erosion, partially exposing the underside of the sloped wingwall and back of abutment. This slope would also need repair and the installation of riprap.

The freeboard currently provided at the bridge exceeds 10 feet and, with the anticipated increase in water elevation, would not decrease below the required 2-foot minimum. As such, the elevation of the low chord of the girders for this structure is not a concern. Additional lateral force applied on the piers under the anticipated increased water elevation is assumed under low velocity conditions with the reservoir being near full pool conditions. Regardless of the water velocity, the narrow width of the pier would keep the additional force negligible.

Cow Creek Bridge (ITD Bridge Key 27855)

In addition to the structures being impacted by the increased RWS elevation, the Cow Creek Bridge was analyzed to determine whether it can support the anticipated detour traffic loads during construction of the proposed dam improvements. Located along HD-131, the Cow Creek Bridge over the South Fork Boise River is a four-span, one-lane, reinforced concrete slab bridge that was constructed in 1959. This bridge has been identified along the proposed detour route for traffic during the construction of the dam improvements.

No design modifications for the Cow Creek Bridge are required. Based on the results of the load rating analysis (Appendix B), the Cow Creek Bridge can safely support the anticipated detour traffic loads during construction of the dam improvements.

4.2.8.5 Culverts

As part of initial land and infrastructure assessments related to this Study, culverts around Anderson Ranch Reservoir were evaluated. Details on these evaluations can be found in Appendix B. Information from field surveys and results of feasibility-level basin hydrology evaluations and culvert hydraulics analyses indicate that the existing culverts do not require modification or replacement as result of the proposed increased water surface elevation. However, culverts that are impacted during construction activities during road modifications would be replaced and are located on Federal land administered by the USFS. This includes replacement of a 30-inch-diameter culvert that would be impacted by the approximate 12-inch raise in Lester Creek Road (HD-128).

Additionally, in alignment with the Study planning objective to enhance fish and wildlife environment and Conservation Recommendation Number 8 of the 2005 Snake River Basin BiOp (USFWS 2005) to "...cooperate with others, including the Service, Tribes, States of

Idaho and Oregon, Forest Service, and others to take actions to improve or maintain high quality migratory corridors between Reclamation facilities and higher-elevation habitats and spawning areas," an opportunity was identified to improve aquatic organism passage to Deer and Fall creeks by modification of the existing culverts.

The existing Deer Creek culvert under Pine-Featherville Road (HD-61) is seasonally perched on the downstream end, making it a potential barrier for upstream passage of aquatic organisms when the full pool water surface elevation is less than 4194.8 feet. The Deer Creek subwatershed is a high-priority migration corridor for bull trout between Anderson Ranch Reservoir and headwater streams.

The existing Fall Creek culvert under HD-113 is seasonally perched on the downstream end, making it a potential barrier for upstream passage of aquatic organisms when the full pool water surface elevation is less than 4190.5 feet. USFS Rocky Mountain Research Station environmental DNA data show positive bull trout detections in Meadow Creek and upper Fall Creek. In addition, a 2003 photograph that was provided to Reclamation via the USFWS, Idaho Fish and Wildlife Office, shows kokanee salmon schooled below the perched culvert at low water.

To facilitate fish passage, each of these two existing culverts would be retrofitted with channel regrading; construction of instream structures to increase the pool depths and provide grade control; and installation of baffles in the existing culverts. Details are provided in Appendix B – Engineering Summary Report.

4.2.8.6 Utilities

Based on utility information from CenturyLink, buried fiberoptic cables would not be inundated by an increase in reservoir levels. At locations where road and bridge projects may impact utilities, no extended service interruptions are anticipated to telecommunications, and delays to traffic would be brief.

Several segments of power utility infrastructure owned by Idaho Power were identified during initial land and infrastructure assessments related to the Study. The Contractor coordinated directly with Idaho Power to determine the extent and magnitude of potential impacts on Idaho Power infrastructure from the proposed increased in RWS elevation. Idaho Power indicated that it holds a Special Use Permit for occupying and maintaining this infrastructure on lands administered by the USFS. Potential impacts are on an overhead powerline and an underground cable. Identified Idaho Power infrastructure that may need to be removed or relocated, or both, for reliability and maintenance purposes includes the following: utility poles, overhead power line, transformers, and underground powerline in conduit. Specific power pole locations would be addressed during a more definitive design phase. Based on Contractor correspondence with Idaho Power, no additional capital projects or upcoming work related to the existing power utility infrastructure near Anderson Ranch Reservoir are anticipated.

It was assumed that this work would be performed by Idaho Power, including any design work required for utility relocation. It was also assumed that no additional purchased easements would be required to execute the project, and that this work would be executed within the existing Special Use Permit, so an additional utility agreement would not be required.

4.2.8.7 Recreational Facilities

The proposed RWS elevation increase would directly impact the following recreational facilities:

- Curlew Creek Campground
- Castle Creek Campground
- Evans Creek Campground
- Pine Campground
- Elk Creek Boat Ramp
- Fall Creek Resort and Boat Ramp

These facilities are located on Federal land (Reclamation 2019e) and administered by the USFS under the Master Agreement. The Fall Creek Resort is authorized by the USFS through a Special Use Permit. Nester's Private Campground and Deer Creek Boat Ramp are not impacted by the RWS elevation increase.

Curlew Creek Boat Ramp and Campground

The Curlew Creek Campground includes nine existing campsites, eight of which would be impacted by the pool elevation rise. A day use picnic site would also be impacted. Two campsites would be abandoned and relocated onsite to areas outside of the new reservoir inundation extents. Fill material would be imported to raise the elevation of the other six campsites and one day use site. The imported fill material gradation would be designed to resist wave erosion from the reservoir pool. Existing picnic tables and fire rings would be removed, and new infrastructure would be installed at the new campsite locations. Approximately 60 trees greater than 6 inches in diameter would need to be removed to facilitate the improvements at the campground. The removed trees would be replaced with 60 2-inch caliper trees planted to provide shade at the modified sites.

The existing boat dock infrastructure would be reset to accommodate the new pool elevation, and two additional 16-foot dock sections would be required to maintain the current overall length of the dock. Signage at the existing boat dock would also need to be relocated. A new concrete dock access ramp would be installed at the top of the ramp.

The existing road loop at the boat ramp would be abandoned (approximately 2,000 square feet), and a new road would be constructed to align with the proposed extension of the boat dock.

The campground includes a drinking water well that would need to be relocated to maintain a minimum 50 feet of separation from surface water as required by IDEQ (2019d). This well would be abandoned per IDWR requirements and reconstructed onsite per IDEQ (2019d) and IDWR standards. The existing vault toilet is not expected to be impacted.

Earthwork quantities are estimated to include 4,900 cubic yards of imported fill and 1,200 cubic yards of imported gravel.

Castle Creek Campground

The two existing campsites at Castle Creek would both be impacted by the pool elevation increase. The campground would be abandoned, and the two campsites would be relocated to the Pine Campground. Existing picnic tables, fire rings, and other appurtenances would be removed.

No earthwork is required at the Castle Creek Campground site.

Evans Creek Boat Ramp and Campground

Of the eight existing campsites at Evans Creek, six would be impacted by the pool elevation increase. Imported fill material would be required to raise the elevation of the impacted campsites. The fill material gradation would be designed to resist wave erosion from the reservoir pool. Additionally, an existing seasonal stream channel passing through the campground would be retained. The adjacent campsites and imported fill material would be protected from erosion during runoff events with rock riprap, as necessary. Existing picnic tables, fire rings, and other campsite appurtenances would be removed, and new infrastructure would be installed at the new campsite locations. Approximately 25 trees greater than 6 inches in diameter would be removed to allow for placement of the fill material needed to increase the elevation of campsites. To mitigate for the loss of shade resulting from the tree removal, picnic shelters would be installed at each of the six new campsites. The removed trees would also be replaced with 25 2-inch caliper trees.

The existing vault toilet, access roads, and boat ramp are not expected to be impacted.

Earthwork quantities are estimated to be 5,200 cubic yards of imported fill, 900 cubic yards of imported gravel, and 220 cubic yards of rock riprap.

Pine Campground

All seven of the existing campsites at Pine Campground would be impacted by the pool elevation increase. One campsite would be relocated and would require limited site grading. Imported fill material would be required to raise the elevation of the other six campsite locations. The fill material gradation would be designed to resist wave erosion from the reservoir pool. Additionally, two new campsites would be created to replace the abandoned campsites at Castle Creek Campground. Existing picnic tables, fire rings, and other campsite appurtenances would be removed, and new infrastructure would be installed at the nine new campsite locations. Picnic shelters would also be installed at each of the new campsites.

The existing boat dock infrastructure would be adjusted to accommodate the new full pool elevation, and four additional 16-foot dock sections would be required to maintain the current in-water usable length. The boat ramp would also be extended, requiring placement of approximately 1,600 square feet of concrete. A new concrete dock access ramp would be installed at the top of the adjusted dock. The existing vault toilet is not expected to be impacted. Per the requirements set forth in USFS Handbook 2309.13, Chapter 10, the additional campground capacity due to the two new campsites relocated from the Castle Creek Campground requires the installation of a second vault toilet at the campground. The new vault toilet would be located to provide convenient facility access to the new campsites.

Earthwork quantities are estimated to be 100 cubic yards of cut, 3,600 cubic yards of onsite and imported fill, and 1,200 cubic yards of imported gravel.

Elk Creek Boat Ramp

The Elk Creek Boat Ramp would be extended to maintain ramp access at the increased full pool elevation. This would require the placement of approximately 16 cubic yards of concrete and the importation of fill material. The fill material gradation would be designed to resist wave erosion from the reservoir pool. The location of a number of existing boulders on the eastern side of the ramp would be adjusted to accommodate the ramp extension. The existing boat dock would be realigned to work with the new boat ramp extension, a new concrete dock access ramp would be installed, and an existing bollard would be removed and replaced at the top of the ramp. Additionally, three new 16-foot sections of boat dock would be required to maintain the in-water usable length of the dock. The existing vault toilet is not expected to be impacted.

Earthwork quantities are estimated to be 600 cubic yards of imported fill and 20 cubic yards of imported gravel.

Fall Creek Resort and Boat Ramp

Fall Creek Resort is located on Federal land managed by Reclamation and USFS under the Master Agreement. The Master Agreement, dated April 6, 1987, covers all Reclamation-authorized Projects within or adjacent to NFS Lands. The purpose of the Master Agreement is to establish procedures for planning, developing, operating, and maintaining water resource projects and related Reclamation programs located on or affecting lands and resources administered by the Forest Service, and for the Forest Service’s planning and implementation of activities on NFS lands within the total area of project influence.

As part of the Master Agreement, Regional Directors and Regional Foresters are delegated authority to execute local project supplemental agreements developed within the scope of the Master Agreement. Supplemental Agreement Number 7-07-10-L0841, dated June 9, 1987, transfers jurisdiction of Reclamation acquired and withdrawn lands around Anderson Ranch Reservoir to the USFS, including the issuance of Special Use Permits. The Fall Creek Resort and Marina is authorized by the USFS through a Special Use Permit issued and administered under its regulations.

Analysis of the proposed raise of Anderson Ranch Dam identifies an impact to the following improvements which are privately owned by the Fall Creek Resort and Marina permittee under Special Use Agreement: five existing campsites at the outlet of Fall Creek, three campsites at the Fall Creek Boat Ramp, and the Fall Creek Marina as a result of the increased water surface elevation.

Impacts of this proposed action to the permittee's improvements would be mitigated during project implementation, should the project be determined feasible and the Special Use Permit still be in effect. Any potential mitigation activities would be subject to future NEPA analysis as may be needed, would be consistent with the provisions of the Special Use Permit and USFS regulations, and may include options such as the following:

- Rebuild existing features to their existing condition
- Relocate existing features to a suitable location
- Compensation

The existing restroom near the impacted campsites at the Fall Creek Boat Ramp is not expected to be impacted. The Fall Creek Resort building across HD-120 from the reservoir also would not be impacted.

Fall Creek Boat Ramp

The Fall Creek Boat Ramp (located adjacent to the Fall Creek Resort and Marina) is also on Federal land managed by Reclamation and USFS under the Master Agreement. The boat ramp infrastructure is owned by the USFS and is operated and maintained consistent with the Master Agreement.

As the existing boat ramp is separate from the facilities that are privately owned by the Fall Creek Resort and Marina permittee, the boat ramp would be abandoned, and the existing concrete dock access ramp would be demolished. A proposed 250-foot-long concrete boat ramp would be installed and reoriented to better work with the higher reservoir pool elevation. Rock riprap would be placed along the ramp perimeter for scour protection. The existing floating dock would be removed from its current location and re-anchored to the new concrete ramp with four additional 16-foot sections. A new concrete dock access ramp and bollard would be installed.

Fill material would be placed to raise the elevation of the parking area around the boat ramp and the ramp approach. An information sign and lifejacket loaner station would be replaced at the new boat ramp location. The existing vault toilet at the boat ramp is not expected to be impacted.

Earthwork quantities are estimated to be 1,100 cubic yards of imported fill, 230 cubic yards of imported gravel, and 150 cubic yards of rock riprap.

4.2.9 Consistency of Proposed Plan with Other Studies, Projects, and Programs

The Proposed Plan presented in this Feasibility Report was evaluated for consistency with other existing and proposed studies, projects, and programs.

4.2.9.1 Federal Agencies

The Proposed Plan presented in this Feasibility Report is consistent with the following studies, projects, and programs of Federal agencies.

U.S. Department of the Interior Climate Change Policy

DOI's DM, 523 DM 1 (2012) establishes departmental policy and provides guidance to bureaus and offices for addressing climate change impacts upon the DOI's mission, programs, operations, and personnel. The policy establishes an Interior-wide approach for effectively and efficiently adapting to challenges posed by climate change, by using the best available science and tools to increase understanding of climate change and its impacts on water and other resources the DOI manages. This policy requires that each bureau and office of the DOI consider and analyze possible climate change impacts when undertaking long-range planning exercises, making major investment decisions, and developing adaptation strategies. The DOI also promotes coordination with interagency teams to undertake actions consistent with relevant national strategies and plans that address fish, wildlife, and freshwater resources, among other elements.

Climate change impacts water supplies, water demands, and other environmental conditions that affect Reclamation's ability to fulfill its mission. Reclamation's *Climate Change Adaptation* policy (CMP P16) establishes how Reclamation will address climate change impacts on its mission, facilities, operations and personnel, in accordance with 523 DM 1.

An evaluation of Reclamation system operations for the Proposed Plan and considering various future climate scenarios can be found in Appendix A. Climate change hydrology was analyzed to evaluate how the system might perform under a wide range of potential future hydrologic conditions. Analyzed climate change scenarios exhibit higher refill probabilities than the simulated historical dataset. This can be attributed to the year-round increase in stream flow in climate change conditions relative to the simulated historical conditions. Additional details and tables of refill probabilities for new storage in Anderson Ranch Reservoir can be found in Appendix A. The Proposed Plan presents an opportunity to capture the projected increased availability of surface water resulting from climate change hydrology, while existing infrastructure without the Proposed Plan may not be able to do so. Climate change could also impact demand for water and associated economic value because of an increase in average temperature and corresponding evapotranspiration, because of said temperature changes.

U.S. Department of the Interior – Bureau of Land Management

The Four Rivers Field Office Proposed Resource Management Plan and Final Environmental Impact Statement was released by the BLM (2020) on February 14, 2020. The plan reflected in the Proposed Resource Management Plan and FEIS is to manage public lands to promote economic development while conserving natural and cultural resources. Concerns about wildland fire, big game winter range, migration corridors, and connectivity would result in proactive management for natural and cultural resources while accommodating regional growth The Proposed Plan presented in this Feasibility Report is consistent with the BLM Resource Management Plan and FEIS.

U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration National Marine Fisheries Service

The *Fish and Wildlife Coordination Act of 1934*, as amended 1946, 1977 (16 USC 661-667e), requires Federal agencies to coordinate with USFWS and State wildlife agencies when planning new projects or modifying existing projects so that wildlife resources receive equal consideration and are coordinated with other project objectives and features.

Section 7 (a)(2) of the ESA requires Federal agencies to consult with USFWS and National Oceanic and Atmospheric Administration (NOAA) Fisheries when a Federal action may affect listed threatened or endangered species or their critical habitat. This is to verify that any action authorized, funded, or carried out by a Federal agency is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of its critical habitat.

Reclamation requested a species list from USFWS through the Information, Planning, and Consultation online tool, which is part of the Environmental Online Conservation System, to identify species with potential to occur in the Proposed Plan “action area” as defined in the ESA Consultation Handbook (USFWS and NMFS 1998). Reclamation has prepared a BA to address the impacts on three Federally listed species and two species proposed for listing under the jurisdiction of the USFWS, specifically: yellow-billed cuckoo, Canada lynx, bull trout, North American wolverine, and whitebark pine and their designated critical habitat within the action area. These are all of the species under the jurisdiction of USFWS identified through the Information, Planning, and Consultation tool request.

Reclamation will initiate formal consultation and will be submitting a BA analyzing the effects of construction from the Proposed Plan on Federally listed and candidate species to the USFWS. The USFWS will review the BA and prepare a BiOp for the proposed action. Depending upon USFWS determinations and associated requirements, if Reclamation proceeds with the Proposed Plan, it will be in compliance with T&Cs and RPMs outlined in the BiOp. Reclamation will consult with NOAA Fisheries because its proposed action could potentially affect flow conditions downstream of the Boise River system and, as a result, anadromous salmonids.

U.S. Army Corps of Engineers

Executive Order 11990, Protection of Wetlands and Section 404 of the CWA regulates the discharge of dredge and fill materials into WOTUS, including wetlands. USACE evaluates applications for Section 404 permits and requires mitigation for unavoidable impacts on the aquatic environment.

Wetlands were assessed by Reclamation staff within the varial zone at Anderson Ranch Reservoir. These efforts identified variable (upland/wetland) vegetation composition, topography and soil type within the assessment area. These findings support preliminary boundaries identified in the USFWS National Wetlands Inventory; however, a formal delineation of wetland/upland boundaries is being coordinated with USACE to determine extents and jurisdictional status of wetlands within the area.

In conjunction with the Section 404 permit, Reclamation would pursue Idaho State 401 certification. Idaho State 401 certifications are required for any permit or license issued by a Federal agency for an activity that may result in a discharge into WOTUS. This requirement allows the State of Idaho to have input into Federally approved projects that may affect its waters (rivers, streams, lakes, and wetlands) and to confirm the projects would comply with State water quality standards and any other water quality requirements of State law.

U.S. Forest Service

The *2010 Boise National Forest Amended Forest Plan* provides details about the management direction. Anderson Ranch Reservoir is located in the Lower South Fork Boise River Management Area. The overall forest-wide direction and specific direction for each management area are discussed separately. Direction is broken down into five categories, desired conditions, goals, objectives, standards, and guidelines. A brief summary of the desired condition relative to the following categories is provided in the following list:

- **Threatened, Endangered, Proposed and Candidate Species** – Habitats for T&E species are managed consistent with established and approved Recovery Plans. Management actions either contribute to, or do not prevent recovery or de-listing of these species.
- **Air Quality and Smoke Management** – People visiting the National Forest can experience clean air and spectacular vistas in a natural setting, while recognizing that those vistas may be affected periodically by smoke from management actions or wildfires.
- **Soil, Water, Riparian, and Aquatic Resources** – Management actions result in no long-term degradation of soil, water, riparian, and aquatic resources conditions.
- **Wildlife Resources** – The amount, distribution, and characteristics of source habitat are present at levels necessary to support persistence of native and desired non-native wildlife species within their respective ranges across the planning unit.
- **Vegetation** – Forested vegetation reflects a combination of successional development, disturbance regimes, and management activities.
- **Botanical Resources** – The amount, distribution, and characteristics of life-stage habitats are present to maintain or reach viable populations of native species.
- **Non-native Plants** – Noxious weed infestations are primarily restricted to locations along roads, trails, river corridors, and airstrips. Existing noxious weed populations are not expanding in size.

- **Fire Management** – Fire, both prescribed and wildland, is used as a tool to achieve and maintain vegetative conditions and desired fuel levels.
- **Timberland Resources** – Suited timberlands provide sustainable and predictable levels of forest products, both now and continuing in the future.
- **Rangeland Resources** – A sustainable level of forage, consistent with other resource management direction, is available for use through the Forest Service grazing permit system.
- **Mineral and Geology Resources** – Exploration, development, and production of mineral and energy resources are conducted in an environmentally sound manner.
- **Lands and Special Uses** – Forest management and public needs are met through land ownership adjustments, property boundary and landline location, and issuance of Special Use authorizations.
- **Facilities and Roads** – Needed facilities are developed to the standard adequate for their intended purpose. Reconstruction and remodeling of existing facilities, and construction of new facilities, occur as facilities wear out or need to change. Facilities are safe and efficient, and meet land and resource management objectives.
- **Recreation Resources** – People visiting the National Forest find opportunities for a wide spectrum of recreation experiences.
- **Scenic Environment** – The Forest provides a range of diverse landscapes. The scenic environment within the Forest ranges from landscapes displaying little or no evidence of management activities, to landscapes that have dominant visible evidence of management activities. Scenic quality is maintained or enhanced in areas of high scenic value and other highly used recreation areas.
- **Heritage Program** – People visiting the National Forest can find opportunities to explore, enjoy, and learn about cultural heritage.
- **Tribal Rights and Interests** – Tribes continue to have interest and reliance on ecosystems even as their cultures change, employing both traditional and contemporary ways of relating to their homelands and interest areas (lands where they traditionally ranged to sustain their way of life). Lands within the Forest help sustain American Indians’ way of life, cultural integrity, social cohesion, and economic well-being.
- **Wilderness, Recommended Wilderness, and Inventoried Roadless Areas** – People visiting wilderness within the National Forest can find outstanding opportunities for primitive and unconfined recreation, including exploration, solitude, risk, and challenge. The area is primarily affected by the forces of nature, with man’s imprint substantially unnoticeable.
- **Wild and Scenic Rivers** – River segments and their corridors that are eligible, suitable, or designated as Wild and Scenic Rivers are managed to retain their free-flowing status,

classification, and outstandingly remarkable values for scenery, wildlife, cultural, fish, geology, hydrology, and ecological/ botanical resources.

- **Research Natural Areas** – Research Natural Areas are areas where ecological processes generally prevail. They remain largely undisturbed by human uses or activities, and provide quality opportunities for non-manipulative scientific research, monitoring, observation, and study.
- **Social and Economic** – Sustainable and predictable levels of goods and services are provided for local communities. Firewood, post and poles, sawlogs, forage, developed and dispersed recreation, and other goods and services are made available to the public consistent with management direction. Local economic development goals are considered along with sustainable resource outputs when developing land management objectives.

The desired conditions, goals, objectives, standards, and guidelines are consistent with the Proposed Plan presented in this Feasibility Report.

4.2.9.2 State Agencies

The Proposed Plan presented in this Feasibility Report is consistent with the following studies, projects, and programs of State agencies.

Idaho Water Resource Board

The IWRB's State Water Plan and *Comprehensive State Water Plan: South Fork Boise River Sub-Basin Plan* were reviewed for consistency with the Proposed Plan presented in this Feasibility Report.

The State Water Plan identifies the IWRB's objectives with regards to water development, management, and conservation (IWRB 2012b). The stated objectives are as follows:

1. *"Water Management – Encourage the quantification of water supplies, water uses, and water demands for all water rights within the state. Encourage integrated, coordinated, and adaptable water resource management and the prudent stewardship of water resources.*
2. *Public Interest – Ensure that the needs and interests of the public are appropriately considered in decisions involving the water resources of the state.*
3. *Economic Development – Encourage and support economic development through the optimum use of water resources. Promote the integration and coordination of the use of water, the augmentation of existing supplies, and the protection of designated waterways for all beneficial purposes. Idaho Code Section 42-1734A(1)(b).*
4. *Environmental Quality – Maintain, and where possible enhance water quality and water-related habitats. Study and examine the quality of rivers, streams, lakes, and groundwater [Idaho Code Section 42-1734(15)] and ensure that due consideration is given to the needs of fish, wildlife, and recreation in managing the water resources of the*

state. Where appropriate, initiate state protection of waterways or water bodies with outstanding fish and wildlife, recreation, geologic, or aesthetic values.

5. *Public Safety – Encourage programs ensuring that life and property within the state are not threatened by the management or use of the state's water resources."*

The IWRB's *Comprehensive State Water Plan: South Fork Boise River Sub-Basin Plan* identifies IWRB's goals for the South Fork River basin (IWRB 1990). The plan relates the importance of managing NFS Lands and water resources within the South Fork Boise River basin in accordance with the State Water Plan in achieving "a quality of life" for the citizens of Idaho.

Goals related to NFS Lands are for providing management and maintenance of resources, specifically related to the following: recreation; wilderness; fish and wildlife; range lands; timber; water, soil, and air quality; minerals; human and community development; lands; facilities; protection of forests from disease, insects, and fire; and "achieving a high calculated present net value."

Goals related to water resources are for providing management and maintenance of resources in accordance with the State Water Plan, specifically related to recreation; fish and wildlife; irrigation; power development; energy conservation; flood control; water supply; timber; mining; domestic, municipal, and industrial water uses; natural and cultural features; scenic; livestock water; and environmental quality and economic development.

The Proposed Plan presented in this Feasibility Report is consistent with the objectives listed in these plans.

Idaho Department of Fish and Game

The *Fisheries Management Plan 2019-2024 – A Comprehensive Guide to Managing Idaho's Fisheries Resources* was adopted by the IDFG (2019a). Anderson Ranch Reservoir and the South Fork Boise River are located within the Boise River basin.

The seven objectives for the Boise River basin are provided in the following list:

1. *"Provide a diversity of fishing opportunities within the Boise River drainage.*
2. *Seek improved land and water management practices that significantly protect and enhance fish habitat.*
3. *Monitor effects of land management activities, fishery regulations, and other human activities on fish habitat and fish populations.*
4. *Seek changes to reservoir management and stream flows that benefit fish.*
5. *Maintain/Improve distribution and population status of Bull Trout.*
6. *Provide a diversity of alpine lake fishing opportunities.*
7. *Provide and maintain fishing and boating access sites throughout the drainage."*

These objectives are consistent with the Proposed Plan presented in this Feasibility Report.

4.2.9.3 Regional and Local Agencies/Entities

The Proposed Plan presented in this Feasibility Report is consistent with the following studies, projects, and programs of local agencies.

Ada, Camas, Canyon, and Elmore counties each have adopted comprehensive plans that include specific elements such as population and growth, economic development, agriculture, housing, and transportation (Ada County 2016, Camas County 2018, Canyon County 2020, Elmore County 2014). Each of the comprehensive plans includes county specific goals with respect to each element of the plan.

Additionally, the City of Boise has adopted the Boise River Resource Management and Master Plan, which was reviewed to identify potential inconsistencies with the Proposed Plan presented in this Feasibility Report. No inconsistencies were identified.

As described in Chapter 1, Reclamation has identified two potential future projects (South Fork Boise River Diversion Project and Cat Creek Energy) that could impact various elements of the Proposed Plan. The Proposed Plan presented in this Feasibility Report considers known project proposal information by Reclamation to date and is included in the NEPA analysis for the Anderson Ranch Dam raise.

Chapter 5 Plan Evaluation

This chapter outlines the evaluation of the Proposed Plan against the Without Plan condition according to certain evaluation criteria, as described in Chapter 3. This chapter also discusses assumptions and sensitivity associated with the evaluation.

In 2015, the CEQ released PR&G, the culmination of an interagency effort to update the P&G (U.S. Water Resources Council 1983). This evaluation is based on an application of the PR&G, which govern how Federal agencies evaluate proposed water resource developments and include the following components.

- The P&R outline the overarching concepts that the Federal government seeks to achieve through policy implementations and requirements for inputs into analysis of Federal investment alternatives (CEQ 2013).
- The IG provide guidance for determining the applicability of the P&R for affected Federal agencies, including DOI, USDA, U.S. Department of Commerce, EPA, USACE, Federal Emergency Management Agency, and Tennessee Valley Authority (CEQ 2014).
- ASP are used for identifying which programs and activities are subject to the PR&G. The DOI's 707 DM 1 Handbook provides its ASP (DOI 2015).

The P&R, IG, and ASP are not regulations but are statements of policy, intended to articulate expectations for the internal management of the Federal government. The P&R and IG do not impose any legally binding requirements on Federal agencies. This Study is consistent with the DOI's 707 DM 1 Handbook, which is also consistent with *Water and Related Resources Feasibility Studies*, *Reclamation Manual, Directives and Standards, CMP 09-02* (Reclamation 2019b).

PR&G includes two key concepts: (1) "Federal investment" and (2) "public benefit." Federal investment includes (CEQ 2014):

> *"…those [investments] that by purpose, either directly or indirectly, affect water quality or water quantity, including ecosystem restoration or land management activities"*

The total level of a given investment is determined on a present value basis over the life of the Federal investment. Public benefits include environmental, economic, and social goals, including monetary and non-monetary effects, and allow for both quantified and unquantified measures (CEQ 2013).

The goal of DOI's ASP is to ensure its bureaus and offices consistently apply a common framework for analyzing water resources projects, programs, activities, and related actions involving Federal investments in accordance with PL 110-114. PL 110-114 specifies that

Federal water resources investments shall reflect national priorities, encourage economic development, and protect the environment by doing the following:

1. *“Seeking to maximize sustainable economic development;*
2. *Seeking to avoid the unwise use of floodplains and flood-prone areas and minimizing adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used; and;*
3. *Protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems.”*

The department-level ASP recognizes that analysis undertaken in support of the PR&G depends on the availability of resources and can vary in scope and magnitude depending on the extent and effects of the action under consideration. Two levels of analysis are identified: (1) “standard” and (2) “scaled.” In general, the level of analysis should be commensurate with the significance of project investment and the potential environmental impacts. While there is not a clear distinction between the different levels of analysis, the two types of analysis can generally be distinguished in several ways, as follows:

- A standard analysis is described as a comprehensive analysis that seeks to evaluate all the relevant benefits and costs associated with the project or activity using original or secondary data. The types of economic analysis techniques used for a standard analysis would be those that are used to estimate willingness to pay in a benefit-cost analysis of programs and activities that have some effect on the environment.
- A scaled analysis is an analysis that is more limited in scope and would typically rely on benefits transfer methods (the use of results of previously completed studies to estimate benefits) and secondary data sources. A scaled analysis may be more appropriate for projects or activities with relatively low costs and low risks, pose minimal threats to human safety, or have minimal environmental effects. Similarly, if it appears that the magnitude of benefits or costs, or both, are such that refining benefit and cost estimates would not affect the outcome of the analysis, then a scaled analysis may be appropriate.

This analysis includes components that would be considered a scaled type of analysis, such as the estimation of ecosystem related benefits, and some that are more of a standard type of analysis, such as the methods used to estimate water supply benefits. This evaluation provides a mechanism for understanding and evaluating tradeoffs that must be made related to objectives, investments, and other social goals. It also provides a means to confirm whether the Proposed Plan is acceptable, effective, efficient, and complete, and contribute most favorably to national priorities.

5.1 Plan Evaluation Outline

The evaluation of the Proposed Plan is outlined in the PR&G and incorporated methods to evaluate three areas (CEQ 2014). The evaluation is to confirm that the Proposed Plan considers the three goals of public benefits; environmental, economic, and social goals. The three areas to evaluate the Proposed Plan are as follows:

1. Proposed Plan public benefits compared to costs
2. Performance of the Proposed Plan regarding the PR&G Guiding Principles
3. Consideration of the four plan formulation criteria: completeness, effectiveness, efficiency, and acceptability

Cost estimates developed for the Proposed Plan included in this report were based on price levels at the time of estimate preparation and were escalated to January 2025 dollars for purposes of the evaluation. Likewise, all monetized values of economic benefits were escalated to 2025 dollars using a 3% annual escalation rate.

5.2 Ecosystem Services Framework

An overarching objective of this evaluation is an accounting of the costs and benefits associated with the Proposed Plan, and how associated ecosystems are impacted relative to the Without Plan condition. This approach is identified as the ecosystem services framework approach in the PR&G (CEQ 2015) and as a requirement (ASP 2015) but also may not apply to all analyses (CEQ 2014). The decision to use the ecosystem services framework to evaluate the Proposed Plan is based on the purposes and non-market economic valuation approaches applied in the public benefits analysis. Functioning ecosystems provide a range of services that are essential to support economic activity and improve environmental conditions. Ecosystems directly and indirectly support human wants and needs that contribute toward social welfare. These contributions reflect economic benefits. Some are essential for human survival (such as food), while others support services that contribute toward human enjoyment (such as recreation). Economic benefits can also result from the passive use value that people derive from the protection, enhancement and preservation of natural resources (such as national parks, habitat for T&E species) for the use and enjoyment of others, including future generations. Ecosystem services contribute toward the full range of economic benefits that people obtain from nature (Millennium Ecosystem Assessment 2003; Smith et al. 2011). The essential problem is tracing through the ecosystem processes to identify how they ultimately benefit humans and then quantifying the magnitude of these economic benefits. It is not appropriate to value both the indirect benefit (for example, flood protection) and the direct benefits that result from flood protection (such as avoided damages). To avoid double-counting, where possible, the goal is to identify the direct human use benefits and passive use benefits.

The ecosystem services concept provides a common framework to support decision-making. Four general kinds of ecosystem services are considered:

1. **Provisioning services** refer to the food, fuel, fiber, and clean water that ecosystems provide. Provisioning services are the products obtained from ecosystems, and water is one of the most valuable ecosystem services. Human modification of ecosystems (such as reservoir creation) has significantly impacted natural river systems by making water available to people for a variety of uses but also reducing river flows downstream of dams and increasing open water evaporation. Water also provides a service in the form of renewable energy through hydropower by making the energy more available to people.
2. **Regulating services** refer to specific ecosystem processes that indirectly support economic benefits for which people are willing to pay. Regulating services are obtained from the impact of an ecosystem on naturally occurring processes, which influence climate, plant reproduction, and water flows. On the global scale, ecosystems play an important role in climates by emitting and sequestering greenhouse gases, or both. At a local scale, existing land use patterns and development trends have had an effect in the Study area, and these trends affect temperature and precipitation. The effect of change on the timing and magnitude of runoff, flooding, and aquifer recharge is highly dependent on the ecosystem.
3. **Cultural services** refer to the benefits ecosystems confer that do not directly relate to our physical health or material well-being. Cultural services are non-material benefits that people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences. Examples include recreation, aesthetic, spiritual, existence, and option “values.”
4. **Habitat and Supporting services** refer to services necessary for the support and maintenance of all other ecosystem services. They differ from provisioning, regulating, and cultural services in that their impacts on people are often indirect or occur over a very long time, whereas changes in the other categories have relatively direct and short-term impacts on people. Even so, they are critical building blocks of functioning systems.

Whereas provisioning, regulating, and cultural services are largely experiential, habitat and supporting services primarily generate passive use (or “non-use” values), which depend simply on the continued survival of the ecosystem and its attributes. Estimating the value of provisioning services is relatively straightforward because market data can typically be used. However, estimating the value of regulating, cultural, habitat, or supporting services, is relatively challenging for two reasons. First, ecosystem process models are needed to trace through the ecosystem and identify the outcomes that satisfy human wants and needs. Second, the quantification of the resultant economic benefits typically involves non-market valuation methods, including willingness to pay studies applying techniques specific to the service in question; and as a result, these methods may not be used in all PR&G analyses. Economic benefits, therefore, depend upon both the ecological landscape (which defines how the level and quality of ecosystem services respond to a change), and the human landscape (which determines the economic value that the public derives from the direct human uses and passive uses that result from those changes).

DOI bureaus and offices apply ecosystem services analyses and conduct research on ecosystem services in cooperation with other partners on local, regional, and national scales. Reclamation considers ecosystem services when evaluating the benefits and costs of water projects. The differences in services provided by the Proposed Plan, relative to the Without Plan condition, are the basis for comparing public benefits. Figure 5-1 illustrates the ecosystem services, by type, that are supported by the Proposed Plan.

Figure 5-1. Ecosystem Services Supported by the Proposed Plan

Table 5-1 summarizes the types of ecosystem services and ultimate benefits to humans that were considered in evaluating the Proposed Plan. This table lists three types of benefits: environmental, economic, and social. The environmental and social benefit identifiers indicate whether the outcome contributes positively or negatively to an environmental or other social goal. The economic benefit relates to the public's willingness to pay for the outcome and is preferably expressed in dollars. A brief description of the monetized benefits is provided in Table 5-1 and further details are described in Section 5.3. Where monetization is not feasible, the outcome is described qualitatively in terms of how it contributes toward the environmental or social goals of the public.

5.3 Public Benefits and Costs

The evaluation of public benefits and costs is an important aspect of the plan evaluation. This section presents the results of the analysis of the Proposed Plan public benefits, which involves an evaluation of the environmental, economic, and social goals of public benefits. The monetized and quantified economic benefits of the Proposed Plan are detailed in Appendix C – Economic Benefits. The costs are detailed in Appendix D – Cost Allocation. Together, the information from these two appendices provide the overall benefit-cost ratios in Section 5.3.3.

5.3.1 Public Costs

Feasibility-level cost estimates were developed for the Proposed Plan and are summarized in Appendix B. Additionally, ongoing annual operations, management, and replacement (OM&R) costs were estimated based on existing OM&R costs (Reclamation 2020b). Table 5-2 shows the total feasibility-level design construction cost estimates associated with implementation of the Proposed Plan. The costs shown also include those associated with the 6-foot dam crest raise and the corresponding projects around the perimeter, or rim, of Anderson Ranch Reservoir that need modification, rehabilitation, or replacement as a result of an increase in the water surface elevation. The total design and construction cost, including non-contract costs (NCCs), is estimated to be $83.3 million (in 2025 dollars), as detailed in Appendix B. The field cost estimates include the construction contract costs and construction contingencies. NCCs refer to the costs of work or services in support of the project, such as design costs, in accordance with *Cost Estimating, Reclamation Manual, Directives and Standards, FAC 09-01* (Reclamation 2019c).

Table 5-1. Summary of Ecosystem Services Framework for Evaluation of the Proposed Plan

Ecosystem Services	Project Example	Environmental Public Benefits	Economic Public Benefits	Social Public Benefits	Monetized	Related or Additional Services
Provisioning Services	Water Supply	Unknown	Increase	Increase	Economic benefit of DCMI and irrigation water supply	Food (increase), Water Regulation (unknown), Erosion (decrease), Water Quality (increase)
Regulating Services	Natural Hazard Regulation (Flood Control)	Marginal decrease	Unknown	Marginal increase	Not monetized	Water Regulation (unknown)
Provisioning Services	Hydropower	Increase	Increase	Unknown	Hydropower revenue generation	Climate Regulation (unknown)
Cultural Services	Recreation	Decrease	Increase	Increase	Economic benefit of improvement to motorized boating	Aesthetic Values (unknown)
Habitat and Supporting Services	Fish and Wildlife	Increase	Increase	Increase	Fish and wildlife water supply	Soil Formation (unknown), Fish Habitat (increase)

Notes:

Increase is defined generally by an increase in production of the service (e.g., for provisioning services, an increase in food production).

Decrease is defined generally by a decrease in production of the service (e.g., for cultural services, a decrease in shade at established campgrounds due to removal of trees).

Unknown is defined generally as the change is either small or not evaluated, and the direction (whether positive or negative) is unclear.

Table 5-2. Construction Cost Estimates for Proposed Plan

Component	Cost (in 2025 U.S. Dollars)
Field Costs – Dam Raise	$44,000,000
Field Costs – Rim Projects	$12,000,000
NCC – Dam Raise	$22,500,000
NCC – Rim Projects	$4,800,000
Total Construction Cost	**$83,300,000**

5.3.1.1 Interest during Construction

The Federal procedure for cost allocation includes calculating interest during construction (IDC). IDC represents the opportunity cost of capital incurred during the construction period and is included to confirm costs and benefits are evaluated on an equivalent time basis. IDC is calculated on total cost of construction, including field costs, NCCs, and post-authorization costs. Interest was calculated using the 2.75% fiscal year 2020 discount rate for Federal water-related planning projects (U.S. Treasury Department 2019). The inclusion of post-authorization costs in the IDC results in a 10-year period for IDC calculation. The use of a 10-year period for IDC calculation does not change the 5-year construction period for the Proposed Plan, nor does it impact the IDC calculated during the 5-year construction period. Table 5-3 shows the project's total construction costs, IDC, and resulting present value total cost.

Table 5-3. Interest during Construction and Total Present Value

Cost Category	Cost (in 2025 U.S. Dollars)
Total Construction Cost	$83,300,000
Interest during Construction	$8,370,000
Present Value Total Cost	$91,670,000
Total Annualized Costs	**$2,700,000**

Note: Total present value costs are adjusted to annual equivalent values, depicted in the table as total annualized costs, over the period of analysis by use of the 2020 Federal discount rate as described in the PR&G ASP (707 DM 1 Handbook) (DOI 2015).

5.3.2 Public Benefits

The public benefits of the Proposed Plan are evaluated in environmental, economic, or social terms, or a combination thereof. The ecosystem service framework identifies the expected changes in ecosystem services and how they ultimately benefit humans. Where reasonable, the resultant direct human use and passive use benefits are monetized for ease in comparing the economic benefits and costs to decide on economic efficiency. However, it is also informative to understand how the project contributes toward environmental and social goals, such that the environmental and social effects are described in qualitative terms.

5.3.2.1 Environmental

This section examines and describes the effects of the Proposed Plan on the environment. This includes favorable and unfavorable effects on various resources through the lens of the ecosystem services framework. These effects are evaluated in greater detail as a part of the NEPA environmental review and documentation process. A detailed discussion of possible effects of the Proposed Plan and proposed mitigation measures is included in the DEIS (Reclamation 2020a).

Provisioning Services

The Proposed Plan provides water supply that can be used for potential DCMI and irrigation water users; for creation of habitat for aquatic species with subsequent economic, recreational, and cultural benefits; and to support vegetation. The Proposed Plan also provides water supply that can be used to enable additional power generation above the Without Plan condition.

The water supply provided by the Proposed Plan is anticipated to have an insignificant environmental impact relative to DCMI and irrigation supply benefits. The Proposed Plan may indirectly provide some long-term water quality benefits. Reclamation developed the Anderson Ranch Reservoir Water Quality Model to characterize baseline water quality conditions in Anderson Ranch Reservoir and to evaluate how a 6-foot raise would affect water temperature in the South Fork Boise River below Anderson Ranch Dam (and a brief discussion of this model can be found in Appendix A). While there is potential that the proposed dam raise might contribute to colder water temperatures when water temperatures are typically the highest, this model and associated report have not been finalized at the time of this Study, so these benefits have not been quantified.

Adverse environmental effects associated with the water supply provided by the Proposed Plan include a potential decrease in shoreline stability and increase in invasive species. The decrease in shoreline stability (and associated increase in fine sediment supply) is caused by the increase in the pool elevation and exposure of near areas to wave action. However, this effect is assumed negligible compared to the volume of sediment transported into the reservoir by the South Fork Boise River and other reservoir tributaries. A greater adverse environmental effect is the increased area available to invasive species (weeds) at lower pool. The bare moist substrate and fluctuating water levels would provide more ground surface for weeds to establish. Lesser adverse environmental effects may include the following: upslope shifts in riparian and wetland vegetation at the reservoir fringe, relocations of species dependent on those habitats, and an increase in evapotranspiration from the larger reservoir surface area.

Additional services affected by water regulation are discussed in Regulating Services.

Regulating Services

The Proposed Plan creates additional reservoir surface area, increasing evapotranspiration rates which are already likely to increase due to higher temperatures associated with climate variability. Future climate variability will affect the timing and magnitude of unregulated inflows entering Anderson Ranch Reservoir and the Boise River system. Projected changes include a shift in precipitation patterns, with more precipitation falling as rain than snow. Projected streamflow changes are observed as a shift in the hydrograph, specifically a shift in the spring peak, projected to occur earlier in the year, and wintertime runoff projected to increase. Future climate variability may make the Proposed Plan more effective than it is in baseline climate conditions.

The future timing and magnitude of inflows indicate that the increased storage created by the Proposed Plan is a minor, indirect and long-term beneficial impact. The Proposed Plan creates 29,000 acre-feet of expanded storage capacity in the Boise River basin and allows for more flexibility in future operations. In years when water is available to fill any portion of the increased storage space from the Proposed Plan, Reclamation could utilize water identified for environmental purposes. Additional water supply provided by the Proposed Plan could allow more consistency in meeting environmental targets both within and across seasons. Consistency in meeting existing environmental targets could help Reclamation identify additional flexibility in operations that, when leveraged with existing water deliveries, could provide added fish and wildlife benefits. Benefits to populations of natural reproducing native fishes and ESA-listed species could be realized, ultimately increasing the ecological wellness of the aquatic system.

The Proposed Plan may indirectly provide some natural hazard regulation through flood risk reduction, with additional flexibility because of additional storage space. However, there are currently no plans to allocate space in the expanded reservoir to flood control or to modify current FRM operations. Furthermore, the increase in storage volume at Anderson Ranch Reservoir with the Proposed Plan would be relatively small (approximately 3% of the overall Boise River system). In addition to managed flood control, wetlands are particularly important for reducing flood impacts by moderating flows and allowing sediments to be deposited rather than be transported downstream. The Proposed Plan is expected to result in a long-term permanent loss of wetlands or shift in wetland type around Anderson Ranch Reservoir in response to the increased inundation. However, additional wetlands are also anticipated upgradient of the existing reservoir (Reclamation 2020a).

Vegetative cover also plays an important role in ecosystems. The Proposed Plan would likely result in long-term impacts on upland vegetation and riparian vegetation, with the predominant effect being a shift of vegetation based on the new hydrology within the area; however, impacts are not considered significant, because vegetative communities would re-establish along the new shoreline elevation. Upland communities that converted to riparian or wetland vegetation communities would provide ecological functions and habitat, though it would be different than those provided by the former upland vegetation community. Surrounding upland vegetation and habitat would continue to provide the functions formerly provided by areas that converted to riparian and wetland habitat. Impacts would be negligible and insignificant, as the adverse impacts are expected to be offset by the conversion of the upland areas into wetlands and riparian habitat. This converted upgradient vegetation would provide a more beneficial ecological function and habitat.

Vegetation also plays an important role in soil retention and the prevention of landslides. Shoreline erosion is present around the perimeter of Anderson Ranch Reservoir and is exacerbated by roads, including HD-120, which is built into the steep-sided canyon walls and follows the reservoir shore. Shoreline erosion occurs primarily during early summer from waves caused by wind and boat wakes when reservoir levels are high. Elements of the Proposed Plan include measures to prevent erosion and protect existing road embankments and shorelines in locations that were identified as a part of the feasibility-level design effort.

The implementation of the Proposed Plan is also likely to increase the amount of hydropower generated at the Anderson Ranch Dam hydropower facilities. The increased storage capacity behind Anderson Ranch Dam results in an increased likelihood of additional head being available for power generation and increased generation from additional water supply passing through the turbines.

Cultural Services

The Anderson Ranch Reservoir area is aesthetically pleasing, which enhances the recreation experience. Around Anderson Ranch Reservoir, seasonal variations in the natural setting include fluctuating water levels and vegetation color that is green during the wetter seasons and light brown in the drier seasons. Fluctuating reservoir levels have created a calcium carbonate ‘bathtub ring’ on rock formations, visible when lake elevations fall below full pool. Anderson Ranch Reservoir is used for fishing, pleasure boating, standup paddle boarding, and water skiing. During the summer, motorized boating is a popular recreational activity.

Downstream of Anderson Ranch Dam, the scenic resources include the steep-walled basalt canyon with talus slopes, rock formations, canyon enclosures, and isolation. The South Fork Boise River in this reach, renowned as a blue-ribbon trout fishery for its naturally reproducing (no hatchery input) native trout, provides resident and non-resident anglers with fishing opportunities from rafts and river boats during the spring and summer flows and wading access during fall and winter flows. Occasional alluvial benches and ponderosa pine on the gentler slopes create a diverse setting.

While short-term negative impacts on the aesthetic environment would be realized during construction of the Proposed Plan, the overall long-term characteristics would not be degraded, and visual differences would be minor. The visual environment would remain similar to its current state, offering rural and primitive mountainous vistas with seasonal fluctuating water levels.

The Proposed Plan is anticipated to provide an improvement to recreation in the long term. The changes to reservoir conditions and elements of the constructed facilities would primarily improve the recreational value to motorized boating visitors. The Proposed Plan may provide a change to recreation value to other recreation groups outside of motorized boating and to recreation downstream of the reservoir, but these changes are expected to be minor. The improvement to motorized boating recreation use value in the Proposed Plan is primarily from an increased surface area, the duration of inundation, and improved access.

The removal of numerous large trees, however, would be a direct adverse impact due to the loss of shade for several established campgrounds. The loss of shade is not considered significant because it is not permanent due to new trees being planted.

Habitat and Supporting Services

Table 5-4 summarizes the expected seasonal improvements to fish and wildlife habitat associated with releasing additional water from Anderson Ranch.

Table 5-4. Seasonal Environmental Benefits to Fish and Wildlife of the Proposed Plan

Seasonal Changes in Water Management	Benefits to Resident Fish Species
Additional summer releases	*Improve migration between foraging and thermal habitat.* Seasonal barriers at tributary deltas and varial zones, when present, limit fish movement. *Improve prey base.* Increased recruitment of prey base for summer spawning fishes and insect hatches improves feeding opportunities. *Contribute and maintain a complex aquatic environment.* Side channel and shoreline margins provide rearing habitat for juvenile fishes; allow large, woody debris to be maintained within the channel; and improve survival and recruitment of riparian tree species. *Maintain thermal refugia.* Summer water temperatures maintain the distribution and survival of cold water biota and minimize the spread of invasive aquatic organisms. *Maintain water quality refugia.* Summer water levels and flows help to maintain the distribution of cold water biota.
Additional fall releases	*Improve migration corridor between spawning and overwintering habitat.* Seasonal barriers at tributary deltas, when present, limit migration from tributaries to overwintering habitat in the reservoirs and South Fork Boise River, and increase predation during migration. *Improve prey base.* Increased recruitment of prey base for fall spawning fishes and insect hatches by maintaining access to seasonal habitat longer improves feeding opportunities. *Contribute to and maintain a complex aquatic environment.* A “flushing” flow can help to maintain connectivity to side channel habitat and to redistribute fine sediment across a watershed, acting to improve groundwater exchange.
Additional winter releases	*Improve migration corridor between foraging and overwintering habitats.* Habitat availability is currently reduced during seasonal low flow periods. *Improve prey base.* Increased recruitment of prey base by improved access to side channels and availability of deep-water habitat improves feeding opportunities. *Contribute and maintain a complex aquatic environment.* Diversity of habitat attributes within foraging and overwintering habitats improves survival of young fishes.

Over the long term, additional benefits to aquatic species may result from the Proposed Plan when additional water is stored in Anderson Ranch Reservoir. The proposed channel regrading and associated construction activities at the Fall Creek and Deer Creek culverts, both of which are currently perched when the reservoir is at lower pool elevations, would provide some benefit by providing fish passage. Although this additional access to forage habitat and other extended temporal access to tributaries entering Anderson Ranch Reservoir (as a result of higher pool elevations under certain conditions) is anticipated to benefit fish, these benefits are unlikely to measurably shift conditions from those Without Plan.

Increased area and duration of inundation with the Proposed Plan could cause mortality of large trees around the reservoir perimeter. While this would be offset in the short-term by planting smaller replacement trees, it could also eventually result in additional snags available for bird nesting. For example, special status species in the Study area that nest in tree cavities include the flammulated owl, Lewis' woodpecker, and white-headed woodpecker (National Audubon Society 2019).

The Proposed Plan would temporarily change conditions near T&E species' habitat (yellow-billed cuckoo and bull trout) but would not result in a "take" of listed T&E species to the extent that it would reduce existing populations, jeopardize the continued existence of that species, or adversely modify or destroy critical habitat.

5.3.2.2 Economic

The PR&G defines the objective of Federal investment to maximize public benefit, including contributions toward environmental, economic, and social goals. No hierarchical relationship exists among the three types of goals (environmental, economic, and social) and the goals are not mutually exclusive. The following sections present the economic benefits of the Proposed Plan. A detailed analysis of economic benefits is provided in Appendix C.

Domestic, Commercial, Municipal, and Industrial Water Supply

The Proposed Plan would provide water for potential DCMI users in the Treasure Valley study area. Future DCMI water demand in the study area is expected to exceed the available supply. As mentioned, the population of the Treasure Valley area has been estimated to increase to approximately 1.6 million people by 2065 (SPF 2016). The ability to meet future DCMI water demand is uncertain, and the DCMI water supply will likely experience shortages. The economic analysis (Appendix C) applied a simulated market price economic valuation method to estimate users' willingness to pay to avoid shortages in the DCMI water supply. This approach is considered the industry standard.

Irrigation

The Proposed Plan would provide water for potential irrigation use in the Treasure Valley study area. Agriculture in the Treasure Valley is diverse and important to the State economy. Each county in the Treasure Valley has high agricultural market value, and the region is a major contributor to Idaho's agricultural activity (USDA 2019). The value of irrigation water supply in the study area was estimated using two approaches: by estimating a change in net income and by simulating market prices (Appendix C). The net income approach applied the Reclamation Farm Budget Tool (Reclamation 2019f). The simulated market prices approach applied an irrigator's willingness to pay value for surface water, estimated by Schmidt, Stodick, and Taylor in *Modeling Spatial Water Allocation and Hydrologic Externalities in the Boise Valley* (Reclamation 2009). The latter approach was selected for this analysis, as it better represents the total economic value, or benefit, of the irrigation water supply of the Proposed Plan.

Fish and Wildlife

The Proposed Plan would provide water that could allow more consistency in meeting environmental targets both within and across seasons. Consistency in meeting existing environmental targets could help Reclamation identify additional flexibility in operations that, when leveraged with existing water deliveries, could provide added fish and wildlife benefits. These are discussed in Chapter 2. An avoided cost approach was used to quantify the benefit of the water supply for fish and wildlife use (Appendix C).

Hydropower

The Proposed Plan would likely increase the amount of hydropower generated at the Anderson Ranch Dam hydropower facilities. The Proposed Plan provides increased storage capacity behind the Anderson Ranch Dam, which increases the likelihood of additional head being available for power generation. It also increases the likelihood of increased generation from additional water passing through the turbines. The net increase in hydropower revenues generated by the Proposed Plan is estimated as shown in Appendix C.

Recreation

The Proposed Plan would provide a recreation benefit to motorized boating visitors from an increased reservoir surface area, an extended season of increased surface area, and improved reservoir access. The recreation benefits to motorized boating visitors were evaluated through an estimated change in dollar value per visitor day multiplied by the visitor use using a benefit-transfer approach (Appendix C). Changes in visitor days for other types of recreational activities were not estimated due to the limited historical visitor use data in the study area and the expectation that any changes due to the Proposed Plan are likely minor.

Summary of Monetized Project Benefits

Table 5-5 provides the economic valuation approach by purpose (that is, type of project benefit) and the present value economic benefits of the Proposed Plan in 2025 dollars, as set forth in Appendix C.

Table 5-5. Present Value Economic Benefits by Project Purpose

Purpose	Economic Valuation Approach and Methodology	Present Value Economic Benefits (in 2025 U.S. Dollars)
DCMI	Willingness to pay: Shortage Cost Function ($748 per acre-foot)	$129,399,000
Irrigation	Willingness to pay: Schmidt et al. 2009 ($105 per acre-foot)	$18,164,000
Fish and Wildlife	Avoided Cost: Market Appraisal (DOI 2011) ($70 per acre-foot)	$2,691,000
Hydropower	Market Price: Revenue Generation ($37 per megawatt-hour)	$3,799,000
Recreation	Benefit-Transfer: Average of Upper and Lower Bound Estimates (increase of $5.06 per person per day)	$5,524,000
	Total Present Value Economic Benefits	$159,577,000
	Annualized Total Benefit	**$4,700,000**

Note: Total present value benefit is adjusted to annual equivalent values, depicted in the table as annualized total benefit, over the period of analysis by use of the 2020 Federal discount rate as described in the PR&G ASP (707 DM 1 Handbook) (DOI 2015).

5.3.2.3 Social

This section describes how the benefits of the Proposed Plan contribute toward social goals. The provisioning services of water supply that have been quantified and monetized as economic benefits are central to understanding the contribution to the social goal of positive impacts on the study area. Two proposed uses of water supply are DCMI and irrigation. Agriculture in the Treasure Valley is diverse and important to the State economy. The region has a long agricultural history and the Treasure Valley region is a major contributor to Idaho’s agricultural activity (USDA 2019). The provision of water supply for irrigation in the Proposed Plan provides food for the region and nationally, from a community that would benefit socially from the additional water supply for irrigation, and continued prosperity of the agricultural heritage. The expected population growth and associated demand for water will require certainty in water supply, so the provision of water supply for DCMI uses will be beneficial to existing and new communities in the Treasure Valley. Additional contributions to the social goals are detailed in Table 5-6.

Table 5-6. Social Goals of Public Benefits by Ecosystem Service

Ecosystem Services	Project Example	Social Public Benefits	Related or Additional Services
Provisioning Services	Water Supply	Increase	Food (increase), Water Regulation (unknown), Erosion (decrease), Water Quality (increase)

Ecosystem Services	Project Example	Social Public Benefits	Related or Additional Services
Regulating Services	Natural Hazard Regulation (Flood Control)	Marginal increase	Water Regulation (unknown)
Provisioning Services	Hydropower	Unknown	Climate Regulation (unknown)
Cultural Services	Recreation	Increase	Aesthetic Values (unknown)
Habitat and Supporting Services	Fish and Wildlife	Increase	Soil Formation (unknown), Fish Habitat (increase)

Notes:

Increase is defined generally by an increase in production of the service (e.g., for provisioning services, an increase in food production).

Decrease is defined generally by a decrease in production of the service (e.g., for cultural services, a decrease in shade at established campgrounds due to removal of trees).

Unknown is defined generally as the change is either small or not evaluated, and the direction (whether positive or negative) is unclear.

Other ecosystem services provided by the Proposed Plan with a nexus to environmental goals also relate strongly with social goals. For example, the fish and wildlife habitat benefits are for species with cultural importance. Any benefit to the protection and enhancement of endangered anadromous fish species, including salmon and steelhead, enriches both Tribal and existence values held by communities in the study area and beyond. Other expected benefits of water quality and water supply have a related contribution to social goals from the strong connection that communities have with the environmental goals of the Proposed Plan.

Short-term effects to the social goals of public benefits may be negative during construction from drawdown. The Proposed Plan is expected to compensate existing users of the facility but other users of the reservoir (such as recreation) may temporarily experience a loss of opportunity.

5.3.3 Net Public Benefits

The Proposed Plan public benefits, quantified and unquantified, are comprised of environmental, economic, and social goals. The annual quantified and monetized economic benefits and Proposed Plan costs are shown in Table 5-7. In comparison with annual costs, the Proposed Plan generates $2,000,000 in net economic benefits to the public per year. The Proposed Plan benefit-cost ratio is 1.74.

Table 5-7. Summary of Proposed Plan Benefit-Cost Ratio

Benefit Category	Proposed Plan
Total Annual Economic Benefits to the Public	$4,700,000
Total Annual Costs	$2,700,000
Net Annual Economic Benefits to the Public	**$2,000,000**
Proposed Plan Benefit-Cost Ratio	**1.74**

Note: Total present value benefits and costs are adjusted to annual equivalent values, depicted in the table as total annual economic benefits to the public and total annual costs, over the period of analysis by use of the 2020 Federal discount rate as described in the PR&G ASP (707 DM 1 Handbook) (DOI 2015).

5.4 PR&G Guiding Principles

The following Principles constitute the overarching concepts the Federal government seeks to promote through Federal investments in water resources now and into the foreseeable future. The PR&G Guiding Principles are presented in no order and their organization denotes no hierarchy or rank (CEQ 2014).

5.4.1 Healthy and Resilient Ecosystems

Everyone depends completely on ecosystems and the services they provide, such as food, water, and aesthetic enjoyment. Federal investments in water resources should protect and restore the functions of ecosystems and mitigate any unavoidable damage to these natural systems. Ecosystems are dynamic complexes and provide important services to humans both directly and indirectly. Ecosystems also encompass vital intrinsic natural values, such as biodiversity. Healthy and resilient ecosystems not only enhance the essential services and processes performed by the natural environment, but also contribute to the economic vitality of the Nation.

Ecosystems are resilient when they are able to respond to and maintain their structure and function under external stresses, including climate change and invasive species. In order to protect ecosystems, the Proposed Plan seeks first to avoid or minimize any adverse environmental impact. When damage to the environment is unavoidable, mitigation for adverse effects is provided for in the Proposed Plan through mitigation measures. These mitigation measures are an integral part of the Proposed Plan and are described in detail in the DEIS (Reclamation 2020a).

5.4.2 Sustainable Economic Development

Federal investments in water resources should encourage sustainable economic development. Alternative solutions for resolving water resources problems should improve the economic well-being of the Nation for present and future generations through the sustainable use and management of water resources ensuring both water supply and water quality. Federal investments in sustainable economic development activities contribute to the Nation’s resiliency.

There is no standard set of metrics used for analyzing sustainable economic development (CEQ 2014). Rather, measures that are applicable to the nature of the investment, as well as the desired outcome, are used to verify sustainable economic development. For PR&G analyses, measures that are used to evaluate the performance of viable alternatives against the Guiding Principles include: economic measures, social measures, and environmental measures.

Changes in socioeconomic conditions were quantitatively evaluated in the DEIS (Reclamation 2020a). The evaluation was completed for both short-term socioeconomic changes following construction of the Proposed Plan and long-term changes assumed to occur during the operational phase of the Proposed Plan.

The potential impacts on population and housing were evaluated, along with the construction and operational expenditures and secondary (indirect and induced) impacts using a regional economic model of the analysis area. This model was also used to evaluate and quantify the secondary impacts associated with the quantifiable changes in recreational opportunities as well as those associated with changes in agricultural revenues. The results of this analysis can be found in the DEIS (Reclamation 2020a). In summary, the construction activities associated with the Proposed Plan are expected to create employment opportunities within and outside the analysis area, and an overall increased level of income and total industry output.

5.4.3 Floodplains

Floodplains are critical components of watersheds. They connect land and water ecosystems and support high levels of biodiversity and productivity. Floodplains that have not been adversely affected can sustain their natural functions and increase the resilience of communities. For this reason, Federal investments in water resources should avoid the unwise use of floodplains and flood-prone areas and minimize adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used.

The Proposed Plan would result in an increase of 146 inundated acres at Anderson Ranch Reservoir when at full pool. This would result in a long-term direct impact to the regulatory floodplain due to the increase in the surface water elevation of the reservoir, which would increase the regulatory floodplain area. However, the function of the floodplain would not change, and natural and beneficial values served by the floodplains would be preserved.

Immediately upstream of Anderson Ranch Reservoir is the privately owned Nester’s Campground. This campground is accessed via a narrow gravel road that spans multiple side channels of the river with small culvert and make-shift bridge structures. This area is within a Zone AE floodplain (BFEs determined with no floodway). As a part of the feasibility-level design efforts related to this Study, a hydraulic evaluation was completed to assess the potential for increased inundation associated with proposed higher tailwater conditions due to implementation of the Proposed Plan. The proposed increase in the RWS results in a backwater effect that affects the water surface at the Pine Bridge during flood flows if they occur at the same time as high RWS elevations (Appendix B). However, the hydraulic evaluation confirms the campground is not protected from naturally occurring floods.

Flooding impacts on Nester's Private Campground may be the result of South Fork Boise River flows and not a result of backwater influence from the existing or the proposed reservoir elevations. Results from the analysis indicate that increased RWS elevations would not measurably increase flood depths or inundation extents at Nester's Private Campground (Appendix B). Therefore, it can be reasonably assumed that the regulatory floodplain outside of the normal operating extents of the reservoir would be unaffected.

Overall, the frequency and duration of reservoir inundation would remain largely unchanged; the existing surface water elevation of the reservoir would increase, but the natural and beneficial values served by the regulatory floodplain would continue to function and the risk of flood on human safety, health, and welfare would be preserved (in compliance with Executive Order 11988).

5.4.4 Public Safety

Threats to public safety (including both loss of life and injury) from natural events should be assessed in the determination of existing and future conditions, and ultimately, in the decision-making process. The Proposed Plan must avoid, reduce, and mitigate risks to the extent practicable and include measures to manage and communicate residual risks. As discussed in Appendix B, the Proposed Plan has been developed in order to remain risk neutral with respect to current dam safety facility risk.

In the short term, the Proposed Plan would result in temporary public closures of Anderson Ranch Dam Road (HD-134) and sections of HD-131, HD-61, and all of NFS Road 134A; temporary road lane closures necessary for work on MSE walls and bridges; temporary impacts on the use of the Pine Airstrip; several temporary boat ramp closures; and brief loss of utility service due to relocations. The direct effect of implementation of the Proposed Plan is delayed response times during construction as a result of road travel delays or access closures, which would increase the time of local response to safety incidences. The temporary closure of the Pine Airstrip would preclude its use for fire response if a fire occurred.

The short-term interruption of emergency service vehicle access is not expected to result in more than a minor increase in emergency service response time or safety risk to motorists or other users of roads. Significant impacts on safety are not expected due to increased construction traffic. Under the Proposed Plan, increased emergency response times to Pine and Prairie could result in potentially significant impacts on safety without the proposed mitigation measures. These measures include staging emergency service resources locally during construction and associated road closures to reduce response times to Pine and areas north of the reservoir, specifically areas currently serviced from Mountain Home via HD-134 and HD-120. When construction is complete, safety response times would return to original condition. Also, after construction, a beneficial effect is that response times to the northern and western sides of the reservoir would be reduced because HD-134 over the dam would be two lanes.

5.4.5 Environmental Justice

Aquatic-related resources were identified as the primary resources in the Study area (Elmore County) and within the end user area (Ada and Canyon counties) that could be used by minority and low-income populations within these two areas. However, because no changes to access to this resource is expected, there would be no adverse impacts during the construction of the Proposed Plan. Thus, there would be no disproportionate impacts on minority and low-income populations. Furthermore, because the existing proportion of minority and low-income population in the Study area is less than the threshold for establishing the presence of an environmental justice population, there would be no impact to this population.

5.4.6 Watershed Approach

A watershed is land area that drains to a common waterbody. A watershed approach to analysis and decision-making facilitates the evaluation of a more complete range of potential solutions and is more likely to identify the best means to achieve multiple goals over the entire watershed. This approach enables the design of solutions that considers the benefits of water resources for a wide range of stakeholders within and around the watershed. It also promotes the evaluation of effects within a watershed and other interconnected systems to understand a full range of public benefits.

An important aspect of a watershed approach is the analysis of information regarding watershed conditions and needs. This information is detailed in part in Chapter 2, which contains discussion of existing water resources conditions and likely future conditions Without Plan. These existing conditions informed the planning process and plan formulation as detailed in Chapter 3 and resulted in the Proposed Plan as a solution for the problems and needs of the watershed. Furthermore, planning objectives for the Study were formulated specifically to meet multiple objectives, and subsequent analyses involved detailed modeling and forecasting of various watershed systems, such as: hydrology, climate variability, water operations With and Without Plan, and various other resource-specific analyses. In the context of water resources investment, watershed conditions and needs also include relevant economic and social characteristics of the watershed, which are discussed in Section 5.3.

5.4.7 Proposed Plan and PR&G Guiding Principles

Table 5-8 illustrates that the planning, formulation, and evaluation of the Proposed Plan is aligned with the PR&G Guiding Principles.

Table 5-8. Summary of PR&G Guiding Principles

Guiding Principles	Proposed Plan
Healthy and Resilient Ecosystems	Yes
Sustainable Economic Development	Yes
Floodplains	Yes

Guiding Principles	Proposed Plan
Public Safety	Yes
Environmental Justice	Yes
Watershed Approach	Yes

5.5 Proposed Plan Formulation Criteria

The PR&G include four criteria for evaluating alternatives: (1) completeness, (2) effectiveness, (3) efficiency, and (4) acceptability. This section details the extent that the Proposed Plan addresses elements of each criteria. The four project formulation criteria are specifically identified in the ASP (DOI 2015) and included in the glossary of the P&R (CEQ 2013).

5.5.1 Completeness

Completeness is a determination of whether a plan includes all the elements necessary to realize planned benefits and the degree to which the intended benefits might depend on the actions of others. The Proposed Plan is considered complete. Related to the planning objectives provided in Chapter 2, the Proposed Plan meets both the primary planning objectives and the secondary planning objective through a qualitative evaluation. While this achievement cannot be ranked among other alternatives, the Proposed Plan does not rely heavily on any other projects. While some of the public benefits have not been quantified or monetized (such as FRM), the discussion covers the comprehensive positive public benefits across all purposes of the Proposed Plan. The Proposed Plan's reliability in meeting the primary planning objective of increased storage capacity in the Boise River basin would not be reduced during dry years and may instead make the project more effective due to long-term climate variability projections.

5.5.2 Effectiveness

Effectiveness is the extent to which a final alternative would alleviate problems and achieve objectives. The Proposed Plan is considered highly effective. The provision of quantified, monetized economic benefits for multiple planning objectives demonstrates the effectiveness of the Proposed Plan in terms of achieving all planning objectives. While one secondary planning objective, flood management, has not been evaluated quantitatively in this Study, there is the option to evaluate it in the future. Much of the adverse public effects are temporary, because they are limited to the time during construction and relate to the drawdown of the reservoir. These adverse effects are alleviated by plans for mitigation. Furthermore, considering other water rights applicants as discussed in Section 6.5.3 and Appendix C, the project maintains feasibility under various water rights scenarios. For this reason, the Proposed Plan is considered high for effectiveness.

5.5.3 Efficiency

This evaluation criterion is a measure of how efficiently an alternative alleviates identified problems while realizing specified objectives. One approach to evaluating efficiency includes measuring dollar benefits per unit of cost. While this achievement cannot be ranked among other alternatives, the benefit-cost ratio is favorable. Therefore, the Proposed Plan is considered efficient. A second demonstration of the efficiency is net present value greater than zero. The Proposed Plan provides positive net public benefits overall, as well as for each purpose when evaluated independently. Previous studies, as described in Chapter 3, detail similar projects that have been evaluated but have not progressed as far as the Proposed Plan. This may be reflective of the ability of the Proposed Plan to realize the public benefits at the least cost compared to other similar projects evaluated by Reclamation or the State of Idaho. Section 5.6 summarizes costs, public benefits, and net benefits.

5.5.4 Acceptability

This is the workability and viability of a plan concerning its acceptance by other Federal agencies, State and local governments, and public interest groups and individuals. The acceptability of the Proposed Plan is considered highly acceptable, with support at both the Federal and State level. The viability and appropriateness of the Proposed Plan from the perspective of the Nation's general public is reflected in the inclusion of the Proposed Plan in the WIIN Act. Section 4007 of the WIIN Act was understood as a solution to the need for water infrastructure and water storage. The Proposed Plan, as identified as the Boise River Basin Feasibility Study, is a Section 4007 WIIN Act water storage project and was appropriated funding for this Study (CRS 2019). The State of Idaho, as the non-Federal cost share partner, has provided a consistent message in support of the Proposed Plan, as detailed in Section 6.3.4.

5.6 Summary of Plan Evaluation

The Proposed Plan is evaluated following the PR&G by including the previous sections on the achievements in public benefits and costs, the PR&G Guiding Principles, and the plan formulation criteria. The Proposed Plan was successful in each of these PR&G plan evaluations. Table 5-9 demonstrates the Proposed Plan achievements for each of the PR&G categories for plan evaluation. Most importantly, the Proposed Plan provides net public benefits. In addition, each of the PR&G Guiding Principles are met and the plan evaluation criteria had high rankings.

Table 5-9. Summary of Plan Evaluation

Item	Proposed Plan
Total Annual Economic Benefits to the Public	$4,700,000
Total Annual Costs	$2,700,000
Net Annual Economic Benefits to the Public	**$2,000,000**
Proposed Plan Benefit-Cost Ratio	**1.74**

Item	Proposed Plan
PR&G Guiding Principles	All Guiding Principles Achieved
Plan Formulation Criteria	Rating
• Completeness	Complete
• Effectiveness	Highly Effective
• Efficiency	Efficient
• Acceptability	Highly Acceptable

Note: Total present value benefits and costs are adjusted to annual equivalent values, depicted in the table as total annual economic benefits to the public and total annual costs, over the period of analysis by use of the 2020 Federal discount rate as described in the PR&G ASP (707 DM 1 Handbook) (DOI 2015).

5.7 Analysis Assumptions

Throughout Chapter 5, assumptions were made to evaluate the Proposed Plan and monetize public benefits. Section 6.5 discusses the risk and uncertainties of the Proposed Plan, while this section is limited to assumptions of the plan evaluation. The economic analysis assumes a Federal discount rate for Fiscal Year 2020 of 2.75%. This rate is a historically (over the last 40 years) low discount rate (U.S. Treasury 2020). Depending on prevailing economic conditions, the real discount may be higher or lower in the future. For the analysis, monetized values were escalated to 2025 dollars using a 3% annual escalation rate; consistent cost estimates prepared for the project and presented in Appendix B. This assumed escalation rate is the best estimate of the change expected but is an assumption of the analysis that could differ from the real rate of change that will occur over this time period.

It is assumed that the application of the ecosystem services framework facilitated the capture of the main ecosystem services that would be affected by the Proposed Plan and the aligning of each ecosystem service to one of the purposes of the Proposed Plan. This decision to limit the analysis was made on the assumption that the attention and focus on the main ecosystem services associated with a Proposed Plan purpose would include all those that had quantifiable and monetizable economic benefits to the public. Ecosystem services that did not contribute toward quantifiable economic benefits were nonetheless mentioned in the plan evaluation. This aligns with the lower anticipated magnitude of public benefit relative to those quantified and monetized. In addition, ecosystem services with a global nexus (for example, carbon dioxide emissions) were omitted due to the limited understanding of change from the Proposed Plan. The scale and scope of this application of the ecosystem services framework could be considered a scaled analysis. Overall, it was determined that the application of the ecosystem services framework was appropriate for the Proposed Plan and for an evaluation of Federal investment, an intention of the PR&G.

The monetization of public benefits relied on the best available data. Each economic valuation approach relied on existing data that were determined most representative to quantify the expected benefit. The analysis assumption on the future use of water supply provided by the Proposed Plan is an equal split between DCMI and irrigation. Appendix C describes the estimated public benefits under two other potential splits of the water supply. Additional analysis assumptions are provided in Appendix C and cover the multiple valuation approaches evaluated and the reason the selected valuation approach presented in this Study was chosen. The ecosystem services framework identified many other ecosystem services of the Proposed Plan that could not be quantified or monetized. The inclusion of these additional ecosystem services would likely increase the overall economic benefit of the Proposed Plan. Therefore, the economic benefits quantified are likely a conservative estimate of the overall economic benefits of the Proposed Plan.

Chapter 6 Recommended Plan, Implementation Requirements, and Uncertainty

This chapter identifies the Recommended Plan and describes the determination of feasibility, implementation requirements, and areas of risk and uncertainty.

6.1 Rationale for Plan Selection

As required by the PR&G, the plan that maximizes net public benefits is typically selected for recommendation to the Secretary of the Interior for consideration and approval (DOI 2015). The Secretary of the Interior may grant an exception, based on overriding considerations and merits of another plan. A plan recommending Federal action is to be the plan that best addresses the targeted water resources problems and needs while considering public benefits relative to costs.

The Secretary of the Interior will submit a recommendation to authorize the project to Congress with the Final Feasibility Report, the DEIS, and a summary of public comments and related modifications. Congress will consider the Secretary of the Interior's recommendations and use these documents, as well as any additional information they believe appropriate, to determine the public interest in the project and any specific project authorization language. Most activities pursued by the Federal government require assessing tradeoffs and, in many cases, the final decision requires judgment regarding the appropriate extent that monetized and nonmonetized benefits and impacts are factored into the decision.

The Proposed Plan is the Recommended Plan based upon the evaluation and comparisons described in Chapter 5. The Proposed Plan has a net annual public benefit of $2.0 million; a benefit-cost ratio of greater than 1.0; and a high overall ranking for completeness, effectiveness, efficiency, and acceptability. The Proposed Plan provides water supply benefits to DCMI, irrigation, fish and wildlife, hydropower, and recreation.

CEQ Regulations require identification of the environmentally preferable alternative (or alternatives) in the ROD (40 CFR 1505.2[b]). The environmentally preferable alternative may be different from the preferred alternative and refers to the alternative that would result in the fewest adverse effects on the human environment. Reclamation must consider, but is not obligated to select, the environmentally preferable alternative in its decision on the proposal (40 CFR 1505.2(a) and 43 CFR 46.450).

6.2 Recommended Plan

The following sections describe the major components, accomplishments, and public benefits of the Proposed Plan, which is the Recommended Plan.

6.2.1 Recommended Plan Major Components

Major components of the Recommended Plan, the Proposed Plan, include the following:

- Expansion of Anderson Ranch Reservoir by 29,000 acre-feet by raising Anderson Ranch Dam 6 feet
- Dam crest raise to elevation 4212 feet using compacted zoned fill and compacted soil cement on the downstream face; construction of a reinforced concrete parapet wall along the upstream crest
- Replacement of the spillway ogee crest structure, bridge, center pier, spillway floor slabs and chute walls and approach structure; removal, refurbishment, and reinstallation of existing spillway radial gates
- Realignment of approximately 2,200 feet of the right abutment approach road at a maximum grade of 12%
- Establishment of a detour route along HD-131, which includes snow removal, moderate road improvements along alignment, and approximately 3,000 feet of new alignment construction
- Riprap road embankment or shoreline stabilization, or both, to prevent erosion and protect existing road infrastructure at 12 locations around the perimeter of the reservoir, varying in length from 100 to 800 feet
- Removal of existing retaining walls and reinstallation with a higher top-of-wall elevation to withstand the increased water surface elevation at three locations along HD-61 (between Curlew Creek and Lime Creek); the total length of existing wall to be replaced with an MSE wall is 400 feet
- Construction of a new MSE wall at one additional location along HD-120 (near Castle Creek) to protect the existing road from an increased water surface elevation; the total length of the new MSE wall is 125 feet
- A grade raise of approximately 1 foot of a length of road along HD-128 (south of the Pine Airstrip) to properly impound the increased top of active water surface elevation of the reservoir; the road length that needs to be raised is approximately 800 feet long and consists of two 12-foot lanes with 2-foot shoulders
- Relocation of a rural airport with one turf runway at a different orientation and similar dimensions, keeping it out of the future water line after the proposed dam raise; this project would be primarily an earthwork project, with a near net zero cut and fill balance
- A 1-foot raise of the Pine Bridge over the South Fork Boise River may be needed to prevent any encroachment of the existing freeboard space; this would require the temporary removal of the superstructure, the installation of additional piles, the reconstruction of taller abutments to withstand additional loads, and the reuse of the existing superstructure; a design standard variance could be pursued and, if granted, would negate the need for this project

- Reparation of the abutment slopes at the Lime Creek Bridge to the original slopes and the installation of Class 5 riprap
- Retrofitting of the Deer Creek culvert at HD-61 and the Fall Creek culvert at HD-113 with channel regrading, as well as construction of instream structures to increase the pool depths and provide grade control, and installation of baffles in the existing culvert to facilitate fish passage
- Removal and relocation or removal only of up to 24 power poles and associated overhead power distribution line, two transformers, and approximately 200 feet of underground powerline in conduit
- Relocation of USFS recreation facilities, including campgrounds and campsites, day use areas, picnic tables, fire rings, boat dock and ramp infrastructure, access roads, and a drinking water well

6.2.2 Accomplishment of Objectives

As Chapter 2 discussed, primary and secondary planning objectives were developed for this Study. The primary objectives are considered essential to developing a viable project, and alternatives must meet all the primary objectives to advance in the evaluation process. The plan was developed to effectively and efficiently meet the primary objectives, and to the extent possible, consider the secondary planning objectives.

6.2.2.1 Primary Planning Objectives

Primary planning objectives were as follows:

- Increase storage capacity in the Boise River basin to help meet existing and future demand.
- Enhance fish and wildlife environment within the Boise River basin or downstream.

The Proposed Plan would increase the current storage capacity of Anderson Ranch Reservoir by approximately 29,000 acre-feet for a total active capacity of 442,074 acre-feet. Potential changes in reservoir storage and stream flow associated with new storage space in Anderson Ranch Reservoir were evaluated using historical and climate change hydrology, and a range of possible release rates and timing for water accrued to the new storage space. Potential impacts during the construction phase of the Proposed Plan were also considered. Model results for the historical period suggest that system operations with an additional 29,000 acre-feet of storage in Anderson Ranch Reservoir results in conditions that fall within the historical operating range.

Full details on water availability, refill probability, and modeling assumptions can be found in Appendix A. In summary, a planning model was used to analyze the amount of water available for potential new water rights at or near Anderson Ranch Reservoir. At the time of this study, multiple proposals for new water rights for diversion from and storage in Anderson Ranch Reservoir were being considered. In addition to the IWRB water right permit application, the two new potential water right permits represented are Elmore County's South Fork Boise River Diversion Project and Cat Creek Energy. Given the uncertainty regarding these proposals, a range of refill probabilities was analyzed to evaluate potential water availability for the Proposed Plan. Table 6-1 provides a summary of the water availability analysis contained in Appendix A.

Table 6-1. Refill Probability for 29,000 Acre-feet of New Storage in Anderson Ranch Reservoir for Different Diversion Configurations

Diversion Configuration (Priority Order)	Percent Probability of Complete Refill (29,000 acre-feet)
1. Elmore County's South Fork Boise River Diversion Project 2. Cat Creek Energy 3. Anderson Ranch Reservoir	38%
1. Elmore County's South Fork Boise River Diversion Project 2. Anderson Ranch Reservoir 3. Cat Creek Energy	56%
1. Anderson Ranch Reservoir Only	62%

The Diversion Configuration column of Table 6-1 shows the priority order for each refill probability, with entities listed in order from most senior to most junior water right priority. The evaluation of the Proposed Plan contained in this Feasibility Report considered the new potential storage space in Anderson Ranch Reservoir, along with two other proposed water rights for Elmore County and Cat Creek Energy (38% probability of refill). Evaluation of the first configuration listed in Table 6-1 is the most conservative estimate of water availability, and results in the lowest refill probability of the various configurations.

Additional storage (29,000 acre-feet) created by the Proposed Plan would provide more flexibility for management of flows and more certainty of future water supply for DCMI and irrigation water users. In years when water is available to fill any portion of the increased storage space from the Proposed Plan, Reclamation could use water identified for environmental purposes. Additional water supply provided by the Proposed Plan could allow more consistency in meeting environmental targets both within and across seasons. Consistency in meeting existing environmental targets could identify flexibility in operations that, when leveraged with existing water deliveries, could provide added fish and wildlife benefits. Benefits to ESA-listed species with any volume of additional water could be realized, ultimately increasing the ecological wellness of the aquatic system.

6.2.2.2 Secondary Planning Objective

The secondary planning objective is as follows:

- Reduce flood risk within the Boise River basin.

Additional storage (29,000 acre-feet) created by the Anderson Ranch Dam raise would create more capacity that could be used to help manage flood risk in the Boise River system. Conclusions from the *Boise Feasibility Study Preliminary Hydrologic Evaluation Technical Memorandum* (Reclamation 2017) indicate additional storage space may provide more flood control space. However, there are currently no plans to allocate space for flood control within the expanded reservoir or to modify current FRM operations, so flood control benefits have not been quantified for this Study.

6.2.3 Major Benefits

The following project purposes are the major benefits of the Recommended Plan (the Proposed Plan).

6.2.3.1 Domestic, Commercial, Municipal, and Industrial Water Supply

The Proposed Plan would provide water for potential DCMI users in the Treasure Valley study area. Future DCMI water demand in the study area is expected to exceed the available supply. As mentioned, the population of the Treasure Valley area has been estimated to increase to approximately 1.6 million people by 2065 (SPF 2016). The ability to meet future DCMI water demand is uncertain, and the DCMI water supply will likely experience shortages. The economic analysis (Appendix C) applied a standard approach of estimating users' willingness to pay to avoid shortages in the DCMI water supply. This approach simulates a simulated market price economic valuation.

6.2.3.2 Irrigation

The Proposed Plan would provide water for potential irrigation use in the Treasure Valley study area. Agriculture in the Treasure Valley is diverse and important to the State economy. Each county in the Treasure Valley has high agricultural market value, and the region is a major contributor to Idaho's agricultural activity (USDA 2019). The value of irrigation water supply in the study area was estimated using two approaches: (1) by estimating a change in net income, and (2) by simulating market prices (Appendix C). The net income approach applied the Reclamation Farm Budget Tool (Reclamation 2019f). The simulated market prices approach applied an irrigator's willingness to pay value for surface water, estimated by Schmidt, Stodick, and Taylor in *Modeling Spatial Water Allocation and Hydrologic Externalities in the Boise Valley* (Reclamation 2009).

6.2.3.3 Fish and Wildlife

The Proposed Plan would provide water that could allow more consistency in meeting environmental targets both within and across seasons. Consistency in meeting existing environmental targets could identify flexibility in operations that, when leveraged with existing water deliveries, could provide added fish and wildlife benefits. These are discussed in Chapter 2. An avoided cost approach was used to quantify the benefit of the water supply for fish and wildlife use (Appendix C).

6.2.3.4 Hydropower

The Proposed Plan would likely increase the amount of hydropower generated at the Anderson Ranch Dam hydropower facilities. The Proposed Plan provides increased storage capacity behind the Anderson Ranch Dam, which increases the likelihood of additional head being available for power generation. It also increases the likelihood of increased generation from additional water passing through the turbines. The net increase in hydropower revenues generated by the Proposed Plan is metric of the economic benefit (Appendix C).

6.2.3.5 Recreation

The Proposed Plan would provide a recreation benefit to motorized boating visitors from an increased reservoir surface area, an extended season of increased surface area, and improved reservoir access. The recreation benefits to motorized boating visitors were evaluated through a change in visitor use values (Appendix C). This benefit-transfer approach is based on the limited historical visitor use data on other types of recreation in the study area, as well as overall minor changes to the other recreation types.

6.2.3.6 Summary of Project Benefits

Table 6-2 provides the valuation approach by purpose and the present value economic benefits of the Proposed Plan in 2025 dollars, as provided in Appendix C.

Table 6-2. Present Value Economic Benefits by Project Purpose

Purpose	Economic Valuation Approach and Methodology	Present Value Economic Benefits (in 2025 U.S. Dollars)
DCMI	Willingness to pay: Shortage Cost Function ($748 per acre-foot)	$129,399,000
Irrigation	Willingness to pay: Schmidt et al. 2009 ($105 per acre-foot)	$18,164,000
Fish and Wildlife	Avoided Cost: Market Appraisal (DOI 2011) ($70 per acre-foot)	$2,691,000
Hydropower	Market Price: Revenue Generation ($37 per megawatt-hour)	$3,799,000
Recreation	Benefit-Transfer: Average of Upper and Lower Bound Estimates (increase of $5.06 per person per day)	$5,524,000
	Total Present Value Economic Benefits	$159,577,000
	Annualized Total Benefit	**$4,700,000**

Note: Total present value benefit is adjusted to annual equivalent values, depicted in the table as annualized total benefit, over the period of analysis by use of the 2020 Federal discount rate as described in the PR&G ASP (707 DM 1 Handbook) (DOI 2015).

6.3 Feasibility Evaluation

6.3.1 Technical Feasibility

The recommended plan is projected to be technically feasible and constructible, and it can be operated and maintained. Designs and cost estimates for the Proposed Plan have been developed (Appendix B) to a feasibility level according to *Reclamation Manual, Directives and Standards for Design Activities*, *FAC 03-03* (Reclamation 2015); *Cost Estimating*, *FAC 09-01*

(Reclamation 2019c); and *Construction Cost Estimates and Project Cost Estimates*, *FAC 09-02* (Reclamation 2019d). Appropriate contingencies for each feature have been applied to account for risk and uncertainty. No change in the determination of technical feasibility is anticipated.

Per *Reclamation Manual, Directives and Standards, FAC 10-01 (5)(A)(1)*, projects anticipated or estimated to have a total cost, at completion, greater than $10 million and are intended to meet a feasibility level of development, are required to undergo a design, estimate, and construction (DEC) review (Reclamation 2014).

The purpose of the DEC review process is to provide independent oversight that ensures products related to design, cost estimating, and construction are technically sound and provide a credible basis for decision-making by Reclamation leadership and other decision-makers. This includes an emphasis to ensure cost estimates for a project are appropriate for their intended purpose; potential fatal flaws in the designs, estimates, or schedules are identified; and major risk and uncertainties have been fully addressed in the estimates and schedules. These reviews are to be conducted with a broad corporate perspective in mind to identify one or more of the following: policy; legal; partner and stakeholder; or public issues, impacts, or ramifications of a corporate nature.

Following the completion of the feasibility-level design efforts, a DEC review of the Proposed Plan occurred from February 3 to 7, 2020. The DEC team consisted of Reclamation and non-Reclamation personnel, independent from the project team, with expertise in engineering, cost estimating, and construction management. As a result of the DEC review, recommendations from the review have been addressed in the cost estimates represented in this report and its appendices.

Although modified facilities would be constructed, and operational priorities could change under the Recommended Plan, the types of facilities and overall pattern of water diversion and storage operations would be similar to existing operations of the Boise Project; therefore, there is high confidence the project would be technically and operationally feasible. Additional OM&R costs are not anticipated under the Proposed Plan, as minimal changes are expected in maintenance requirements for existing project features.

6.3.2 Environmental Feasibility

A detailed discussion of possible effects of the Recommended Plan and proposed mitigation measures is included in the DEIS (Reclamation 2020a). The NEPA document provides details on methods, process, procedures, and assumptions used in evaluating environmental effects associated with the Recommended Plan. The impacts were organized by environmental resource or issue area. Significance criteria were used to define the level at which an impact would be considered significant, in accordance with NEPA. Each impact was categorized as follows, and impacts were also identified as beneficial, where appropriate:

- **Beneficial:** An impact that would cause a beneficial change to the environment, as measured by the applicable significance criterion

- **Negligible:** Effects that are unmeasurable, impractical to account for, of little or no consequence, importance, or significance; changes would not be detectable or measurable, or both; the resource or use would be essentially unchanged or unaltered
- **Minor:** Effects that are measurable and may have a slight effect, but are lesser in consequence, importance, and significance; change would be detectable, localized, or measurable, or a combination thereof, and would have a slight change or alteration to the resource or resource use
- **Moderate or Potentially Significant:** Effects that are measurable to a greater degree of accuracy, are important to account for, but may have a degree of uncertainty that limits the ability to make a definitive determination of magnitude or consequence, or both; changes would be clearly detectable, measurable, or have an appreciable effect on the resource or use, or a combination thereof; the resource or use would be notably changed or altered, and the effect is apparent
- **Major or Significant:** Effects that are measurable to a great degree of certainty, are important to account for, are of high intensity and magnitude, and are consequential; changes would be readily detectable, or have severe effect on the resource or use, or a combination thereof; the resource or use would be substantially altered over a large area or to a large degree; significant effects exceed significance criteria thresholds as described for the resource or use

Table 6-3 summarizes the potential environmental effects for resource categories.

Table 6-3. Summary of Environmental Impacts

Resource Area	Without Plan	Recommended Plan
Water Operations and Hydrology	Negligible	Minor
Geology and Soils	Negligible	Negligible
Water Resources	Negligible	Minor
Floodplains	Negligible	Negligible
Wetlands	Negligible	Minor
Vegetation	Negligible	Minor
Fisheries	Negligible	Beneficial
Wildlife	Negligible	Minor
T&E Species	Negligible	Beneficial
Aesthetics	Negligible	Negligible
Air Quality	Negligible	Negligible
Climate Variability	Potentially Significant	Potentially Significant
Noise	Negligible	Negligible

Resource Area	Without Plan	Recommended Plan
Land Use	Negligible	Negligible
Recreation	Negligible	Minor
Water Rights	Negligible	Beneficial, Significant
Transportation and Infrastructure	Negligible	Beneficial
Socioeconomics	Potentially Significant	Beneficial
Hazardous Materials	Negligible	Negligible
Safety	Negligible	Negligible
Cultural Resources	Negligible	Significant
Tribal Interests	Negligible	Minor
Environmental Justice	Negligible	Negligible

The beneficial effects associated with the Recommended Plan include the following:

- **Fisheries; T&E Species** – Additional storage capacity and flexibility to manage water operations for fish and wildlife and ecosystems. Beneficial effects may be realized as a result of an elevated pool in Anderson Ranch Reservoir, extended temporal connection with entering tributaries, and altered refill regime of waters into Arrowrock Reservoir (via South Fork Boise River). Beneficial effects for salmonids and other species are anticipated as a result of regrading and construction activities at Deer Creek and Fall Creek culverts.
- **Transportation and Infrastructure** – Road segment across Anderson Ranch Dam widened to two lanes following construction. This would create a long-term beneficial improvement to mobility and safety of general recreation use of the area.
- **Socioeconomics** – Additional water supplies could help to meet some of the projected shortages to DCMI users. Impacts on recreation are considered minor, and, for motorized boating recreation, they may be enhanced in the long term. Therefore, the socioeconomic impacts are likely to be beneficial and minor in the long term.

Several resource and issue areas would be affected by the Recommended Plan. However, some of the adverse effects would be temporary, construction-related effects that would be less than significant or would be reduced to minor levels through mitigation. Potential impacts on air quality, traffic, land use, biological resources, and water quality are generally are considered short-term and could be addressed through appropriate mitigation measures. Long-term adverse environmental effects associated with the Proposed Plan include a potential decrease in shoreline stability, potential increase in invasive species, and permanent loss to the historic features of Anderson Ranch Dam. The following significant and unavoidable impacts were identified for resource categories for the Recommended Plan presented herein:

- **Water Rights** – Estimated maximum volume shortfall of approximately 97,000 acre-feet per year will occur during construction (approximately 4 years under the Proposed Plan) and no reservoir space will be available to mitigate volume shortfalls affecting spaceholders' ability to use storage water.

- **Cultural Resources** – Multiple known cultural resources would be impacted by construction of the Proposed Plan, including a permanent loss to the historic features of Anderson Ranch Dam. For all cultural resources directly impacted by the project, Reclamation would implement mitigation measures and treatment plans.
- **Vegetation** – Short-term and potentially long-term loss of more than 85 trees around the rim of Anderson Ranch Reservoir is associated with developed recreation facility and campground reconstruction.
- **Wetlands** – Potential long-term loss of wetlands in areas of the rim projects and roadway projects may occur. Potential long-term loss of riparian areas including perennial and intermittent streams around the rim of Anderson Ranch Reservoir, areas of the rim projects, and roadway projects may occur.

Based on environmental resources studies to date, the Recommended Plan is projected to be environmentally feasible.

6.3.3 Economic Feasibility

The Recommended Plan is the Proposed Plan, and provides the greatest net public benefits, as discussed in Chapter 5. The Recommended Plan is projected to be economically feasible, generating net benefits of $2.0 million annually. Valuation methods and sensitivity analyses (presented in Appendix C and Section 5.7) demonstrate that, overall, the estimated economic benefits values and assumptions are reasonable and are consistent with values generated through different approaches.

The Proposed Plan's public benefits, quantified and unquantified, contribute to environmental, economic, and social goals as discussed in Section 5.3.2. The annual quantified and monetized economic benefits and Proposed Plan costs are shown in Table 6-4. In comparison with annual costs, the Proposed Plan generates $2,000,000 in net economic benefits per year. The Proposed Plan benefit-cost ratio is 1.74.

Table 6-4. Summary of Proposed Plan Benefit-Cost Ratio

Benefit Category	Proposed Plan
Total Annual Economic Benefits to the Public	$4,700,000
Total Annual Costs	$2,700,000
Net Annual Economic Benefits to the Public	**$2,000,000**
Proposed Plan Benefit-Cost Ratio	**1.74**

Note: Total present value benefits and costs are adjusted to annual equivalent values, depicted in the table as total annual economic benefits to the public and total annual costs, over the period of analysis by use of the 2020 Federal discount rate as described in the PR&G ASP (707 DM 1 Handbook) (DOI 2015).

6.3.4 Financial Feasibility

Section 4007 of the WIIN Act establishes that at the request of any State; any department, agency, or subdivision of a State; or any public agency organized pursuant to State law, the Secretary of the Interior may negotiate and enter into an agreement on behalf of the U.S. for the design, study, and construction or expansion of any Federally owned storage project. The agreement requires upfront funding by cost share partners for any non-Federal cost assignments. Section 4007 of the WIIN Act limits overall Federal cost share in a Federally owned storage project, such as Anderson Ranch Dam, to no more than 50% of total costs. In return for the Federal cost share investment in the Federally owned storage project, at least a proportionate share of the project benefits are Federal benefits. These required criteria are met and detailed in the initial cost assignments in Appendix D. Appendix D also details a change to existing Federal OM&R requirements, but it is not expected to be a consideration with WIIN Act funding, as the WIIN Act is not permitted for OM&R costs.

The non-Federal cost share partners are required to provide upfront funding for the non-Federal cost assignments per the requirements of Section 4007 of the WIIN Act. On April 2, 2019, the Idaho State Legislature transmitted to Reclamation the House Joint Memorial Number 4 adopted by the House of Representatives and the State Senate:

> *"NOW, THEREFORE, BE IT RESOLVED by the members of the First Regular Session of the Sixty-fifth Idaho Legislature, the House of Representatives and the Senate concurring therein, that we support the construction of new water infrastructure in Idaho and, in particular, the raising of the Anderson Ranch Dam.*
>
> *BE IT FURTHER RESOLVED that the Idaho Legislature urges the congressional delegation for the State of Idaho to take any further actions necessary to: (1) ensure that the feasibility study and NEPA analysis for the Anderson Ranch Dam raise are completed within the proposed timeframe; and (2) as determined in the feasibility study, advance the project through additional congressional action to authorize construction and provide further WIIN Act funds.*
>
> *BE IT FURTHER RESOLVED that the Idaho Legislature urges the IWRB, Corps, Reclamation, water users, and other stakeholders to consider other infrastructure projects to address future water needs, including but not limited to raising of Arrowrock, Lucky Peak, Minidoka, and Island Park dams."*

Through further Idaho State Legislature action, House Bill Number 285 was enacted in the House of Representatives by Appropriations Committee, further demonstrating financial commitment to the project:

> *"Be It Enacted by the Legislature of the State of Idaho:*
>
> *SECTION 1. There is hereby appropriated to the Department of Water Resources and the State Controller shall transfer $20,000,000 from the General Fund to the Water Management*

Account as soon as practicable for the period July 1, 2018 through June 30, 2019.

SECTION 2. That Section 42-1760, Idaho Code, be, and the same is hereby amended to read as follows:

42-1760. WATER MANAGEMENT ACCOUNT. (1) There is hereby created and established in the trust and agency fund the water management account. All moneys in the account are appropriated continuously to the [W]ater [R]esource [B]oard to be used and administered by it for the purposes specified in subsection (2) of this section, and shall not be subject to the provisions of the standard appropriations act of 1945 or Section 67-3516, Idaho Code. The state treasurer shall invest the idle moneys of the account, and the interest earned on such investments shall be retained by the account.

(2) The [B]oard may expend, loan or grant moneys from the water management account for new water projects or the rehabilitation of existing water projects limited to the following purposes: reclamation, upstream storage, offstream storage, aquifer recharge, reservoir site acquisition and protection, water supply, water quality, recreation, and water resource studies, including feasibility studies for qualifying projects. The [B]oard shall have the authority to determine which water projects are undertaken pursuant to this section."

It is anticipated that the remainder of the non-Federal cost share funds would be sought through further State appropriations or bond issuance. The State of Idaho, through the IWRB, may recover the upfront cost share through contractual space assignment agreements.

Section 4007 of the WIIN Act limits overall Federal cost share in a Federally owned storage project, such as Anderson Ranch Dam, to no more than 50% of total costs of the Federally owned storage project. The method that the State of Idaho, the non-Federal cost share partner, will use to raise the necessary funds is unknown at this time. As described in Section 6.3.4.5, the Federal government is assigned 11% of the construction costs.

6.3.4.1 Authorities for Federal Financial Participation

Federal financial participation in the Recommended Plan is authorized under the following:

- *Reclamation Project Act of 1939* (53 Statute 1187; 43 USC 485)
- *Federal Water Project Recreation Act of 1965* (PL 89-72)
- WIIN Act, Funding Section 4007 (PL 114-322, Section 4007), enacted in 2016

6.3.4.2 Cost Allocation Approach

The cost allocation of the proposed project among the multiple purposes uses the equitable approach of Alternative Joint Expenditures (AJEs). Two cost allocation methods are available to distribute the financial costs of multipurpose facilities equitably across all purposes. These methods are the AJE method and the Separable Costs – Remaining Benefits method. The two methods are similar in outcome and approach, only differing in the derivation of project costs specific to one single purpose. The AJE method relies on an estimate of the cost of a single-purpose alternative for each project purpose that provides a similar level of benefit.

As detailed in Appendix D, Reclamation does not anticipate additional OM&R costs with the Proposed Plan but recognizes that it would be difficult to quantify additional OM&R costs that would not already be incurred under existing conditions. Accordingly, the cost allocation assumed that no additional OM&R costs would be incurred under the Proposed Plan. However, if Reclamation later determined there are measurable incremental OM&R costs associated with the Proposed Plan, those costs would be assigned to the new storage space (as described in Appendix D) and further allocated among the Proposed Plan purposes.

Section 6.3.4.3 describes the procedure and derivation of the cost allocation. The present value total in the cost allocation only is comprised of the construction costs and the IDC, as Reclamation does not anticipate any additional OM&R costs with the Proposed Plan. Because there are no new or additional OM&R costs associated with the Proposed Plan, Section 6.3.3.4 provides the allocation of existing OM&R to the Proposed Plan separately. The estimated change to the annual OM&R cost paid by Reclamation under the Proposed Plan is also provided.

6.3.4.3 Cost Allocation

The AJE method removes the specific costs and allocates the remaining joint costs based on the justifiable expenditures. The full AJE calculation and resulting cost allocation involves the following nine steps, as shown in Table 6-5:

1. Present Value Costs: Total costs to be allocated, including both construction and IDC, as described in Appendix D
2. Present Value Benefits: Total economic benefits over the 100-year planning horizon discounted back to start of project, as described in Appendix D
3. Single-purpose Alternative: Present value cost of single-purpose alternative, as described in Appendix D
4. Justifiable Expenditure: The lesser of the present value benefits and the single-purpose alternative
5. Specific Costs: Components of the Proposed Plan included for specific purposes and excluded from the joint cost; specific costs are allocated to specific purposes, as described in Appendix D
6. Remaining Justifiable Expenditure: Justifiable expenditure, minus the specific costs

7. Percent Distribution for Remaining Joint Costs: The percent remaining justifiable expenditure for each purpose of the total remaining justifiable expenditures; the percent distribution informs the distribution of the remaining joint cost
8. Remaining Joint Cost: The present value costs, net specific costs divided among each purpose using the percent distribution
9. Total Allocation: The total allocation for each purpose that is the sum of specific costs and remaining joint cost; Item 9a shows the allocation of the construction costs, and item 9b shows the allocation of IDC

Table 6-5. Initial Cost Allocation

Item	Purpose: DCMI (in 2025 U.S. Dollars)	Purpose: Irrigation (in 2025 U.S. Dollars)	Purpose: Fish & Wildlife (in 2025 U.S. Dollars)	Purpose: Hydropower (in 2025 U.S. Dollars)	Purpose: Recreation (in 2025 U.S. Dollars)	Total (in 2025 U.S. Dollars)
1. Present Value Costs						$91,670,000
2. Present Value Benefits	$129,399,000	$18,164,000	$2,691,000	$3,799,000	$5,524,000	$159,577,000
3. Single-purpose Alternative	$80,652,000	$80,652,000	$2,691,000	$5,200,000		
4. Justifiable Expenditure	$80,652,000	$18,164,000	$2,691,000	$3,799,000	$5,524,000	$110,830,000
5. Specific Costs	$0	$0	$869,000	$0	$0	$869,000
6. Remaining Justifiable Expenditure	$80,652,000	$18,164,000	$1,822,000	$3,799,000	$5,524,000	$109,961,000
7. Percent Distribution for Remaining Joint Costs	73.3%	16.5%	1.7%	3.5%	5.0%	100%
8. Remaining Joint Cost	$66,557,000	$14,982,000	$1,544,000	$3,178,000	$4,540,000	$90,801,000
9. Total Allocation (9a plus 9b)	$66,557,000	$14,982,000	$2,413,000	$3,178,000	$4,540,000	$91,670,000
9a. Allocation of Construction Costs	$60,484,000	$13,615,000	$2,187,000	$2,888,000	$4,126,000	$83,300,000
9b. Allocation of IDC	$6,073,000	$1,367,000	$226,000	$290,000	$414,000	$8,370,000

6.3.4.4 Operations, Maintenance, and Replacement Cost Allocation

While no additional OM&R costs are expected to be associated with the Proposed Plan, there are ongoing annual OM&R costs associated with the existing operations of the facilities, some of which would need to be borne by participants of the Proposed Plan. OM&R costs include operator wages, energy costs, spare parts, supplies, and routine repair work, among other items. Average annual OM&R costs at Anderson Ranch Dam, for Fiscal Years 2014 through 2018, were $585,600 in 2025 dollars.

The Proposed Plan would be allocated 3.33% of the average annual OM&R cost at Anderson Ranch, based on the existing cost allocation method. The existing cost allocation method is the use-of-facilities method. Using this method, an average annual OM&R total of $19,520 (in 2025 dollars) would be allocated to the new storage space, as Table 6-6 shows. Appendix D specifies how this average annual OM&R total is allocated to each purpose of the Proposed Plan. Changes to the Federal assignment of existing or Proposed Plan OM&R costs will not form part of a WIIN Act funding agreement.

The allocation of the OM&R costs for the Proposed Plan follows the AJE method, by allocating based on benefits and using the same distributions estimated for construction costs and IDC. The Proposed Plan average annual OM&R costs of $19,520 are calculated as 3.33% of the existing total Anderson Ranch Dam OM&R costs (refer to Appendix D for details). Specifically, Item 7 (Percent Distribution for Remaining Joint Costs) in Table 6-5 determines the distribution of OM&R costs in Table 6-6.

Table 6-6. Allocation of Existing Operations, Maintenance, and Replacement Costs to Proposed Plan Purposes

Project Purpose	Assignment	Percent Allocation	Costs to be Allocated (in 2025 U.S. Dollars)
DCMI	Non-Federal	73.3%	$14,310
Irrigation	Non-Federal	16.5%	$3,220
Fish and Wildlife	Federal	1.7%	$330
Hydropower	Federal (reimbursable)	3.5%	$650
Recreation	Federal	5.0%	$980
Total Allocation		100%	**$19,520**

6.3.4.5 Construction Cost Assignment

The construction cost assignment of each Proposed Plan purpose is consistent with Federal authority and Section 4007 of the WIIN Act. The construction costs assigned to the Federal government (fish and wildlife; recreation) are existing, authorized, and nonreimbursable Federal purposes of Anderson Ranch Dam. These two purposes are recognized as Federal benefits that can be assigned a Federal cost share as described in Section 4007 of the WIIN Act. Two Proposed Plan purposes are assigned a non-Federal cost share (DCMI and irrigation water supply), and per Section 4007 of the WIIN Act, an agreement is required to provide upfront funding by non-Federal cost share partners. Of the construction costs of the Proposed Plan assigned to the Federal cost share, the construction costs assigned to the Federal government (fish and wildlife; recreation) are nonreimbursable, while the construction costs allocated to power are reimbursable and subject to repayment in accordance with Federal Reclamation law. The Federal cost share identified as a hydropower benefit will be allocated to the Bonneville Power Administration (BPA) as a reimbursable cost that will be included in long-term repayment through existing agreements. Table 6-7 shows the construction cost assignment and does not include IDC. Section 4007 of the WIIN Act requires that at least a proportional share of the project benefits must be Federal benefits. The Federal nonreimbursable benefits are greater than the associated construction costs assigned to the Federal government. The percentage of the construction costs assigned to the Federal government is 11%, which is less than the 50% Federal cost share limit for Federally owned storage projects as required by Section 4007 of the WIIN Act.

Table 6-7. Construction Cost Assignment

Purpose	Total Construction Cost (in 2025 U.S. Dollars)	Federal Cost Share (in 2025 U.S. Dollars)	Non-Federal Cost Share (in 2025 U.S. Dollars)
DCMI	$60,484,000	$0	$60,484,000
Irrigation	$13,615,000	$0	$13,615,000
Fish and Wildlife	$2,187,000	$2,187,000	$0
Hydropower	$2,888,000	$2,888,000	$0
Recreation	$4,126,000	$4,126,000	$0
Total	$83,300,000	$9,201,000	$74,099,000

6.3.4.6 Operations, Maintenance, and Replacement Cost Assignment

The existing OM&R costs for Anderson Ranch Dam are not anticipated to change with the Proposed Plan. However, the OM&R costs borne by existing participants would be reduced by 3.33% and allocated to the participants of the Proposed Plan. This reduction includes a 1.2% reduction in Federal assignment and a 2.13% reduction in non-Federal assignment, based on the existing cost allocation. However, there would also be a Federal OM&R cost assignment from the Proposed Plan. The net Federal OM&R costs are expected to decrease by 0.97%, because the 1.2% reduction in existing OM&R costs exceeds the 0.22% increase in the assigned OM&R costs as a participant of the Proposed Plan. Table 6-8 provides these calculations.

Table 6-8. Net Change in Federal Operations, Maintenance, and Replacement Cost Assignment

Item	Value (in 2025 U.S. Dollars)	Percentage
Average Annual Total Anderson Ranch OM&R costs	$585,600	100%
Existing Federal assignment of Anderson Ranch Dam OM&R costs	$213,160	36.4%
Existing Federal assignment (decreased) due to Proposed Plan	$206,150	35.2%
Change in existing Federal assignment due to Proposed Plan	-$7,010	-1.2%
Total Average Annual Anderson Ranch Dam OM&R costs in Proposed Plan	$19,520	3.33%
Federal assignment of Proposed Plan OM&R costs	$1,310	0.22%
Total Federal assignment – existing decreased and Proposed Plan	$207,460	35.43%
Net Change in Reclamation assignment of OM&R costs	-$5,700	-0.97%

Note:

Table 6-8 calculations measure the change to the existing nonreimbursable OM&R cost assignment to Federal purposes (recreation, fish and wildlife, and flood control). They do not include existing or Proposed Plan reimbursable OM&R cost assignments to Federal purposes (irrigation, hydropower).

6.4 Implementation Requirements

After this Feasibility Report is completed, several requirements will remain before the project can be implemented. These requirements are described in the following subsections.

6.4.1 Agreement on Upfront Cost Share with Non-Federal Partner

Consistent with Section 4007 of the WIIN Act, the Secretary of the Interior would need to negotiate and enter into an agreement with non-Federal partner(s) on behalf of the U.S. for planning, permitting, design, and construction costs. Section 4007 of the WIIN Act contains a set of requirements that must be met before funding. Of these requirements, this Feasibility Report confirms the following:

- The storage project is technically and financially feasible and provides a net Federal benefit in accordance with Reclamation laws.
- In return for the Federal cost share investment in the storage project, a proportional share of the project benefits are the Federal benefits, including water supplies dedicated to environmental enhancement for fish and wildlife.
- The Federal cost share is an amount equal to but not more than 50% of the total cost of the storage project.

The following Section 4007 requirements have been met by IWRB, as the local sponsor:

- The IWRB requested an agreement for the design, study, and construction or expansion of a Federally owned storage project. In October 2017, a Memorandum of Understanding was entered into by Reclamation and the IWRB for the design, study, and construction of increased storage in the Boise River basin. In March 2018, through a Memorandum of Agreement – Reimbursable Agreement, the IWRB committed the 50% non-Federal cost share for the Study.
- The IWRB, through House Joint Memorial Number 4 and House Bill Number 285, has made clear its commitment and support of the project and demonstrated its support of the financial feasibility of the project.

6.4.2 Project Authorization

If the project is recommended for Federal implementation by the Secretary of the Interior, it will be presented to Congress. Congress may: (1) approve the recommended plan, with or without further modification; (2) not approve the recommended plan; or (3) request additional information from the Secretary of the Interior.

6.4.3 Project Funding

The Recommended Plan is eligible to receive funding under Section 4007 of the WIIN Act as a Federally owned storage project and would be eligible for Federal funding up to 50% of total cost. The non-Federal cost share partner would be a public entity organized pursuant to Idaho law and would request an agreement with the U.S. for the permitting, design, and construction of the Recommended Plan. Funding could be provided for the project if enacted appropriations legislation designates funding to it by name, after the Secretary of the Interior recommends the specific project for funding and transmits such recommendation to the appropriate congressional committees.

6.4.4 Water Rights

The IWRB filed a water right permit application on June 7, 2019, for the potential additional storage (Water Right Number 63-34753). In order to divert and store water, a water right permit must be approved and issued by the IDWR.

6.4.5 Regulatory and Related Requirements for Environmental Compliance

Construction and operation of the authorized plan would be subject to the requirements of Federal, State, and local laws; policies; and environmental regulations. Reclamation would need to obtain various Federal, State, and local permits, and regulatory authorizations before project construction would begin. A list of potential permits and approvals is included in the DEIS (Reclamation 2020a). Reclamation would also have to make the determination that the proposed project partnerships would not injure Reclamation water rights.

6.4.6 Post-authorization Activities

If the Secretary of the Interior determines that the requirements of Section 4007 of the WIIN Act are met, and Congress authorizes construction and provides Federal funding, Reclamation would initiate and complete, in coordination with project partners and stakeholders, required post-authorization activities for the Recommended Plan. Reclamation plans to begin project construction, as defined in section 4011(f) of the WIIN Act, before December 16, 2021. Under section 4013, Subtitle J of the WIIN Act expires on that date for projects not already under construction. Key post-authorization activities include the following:

- Complete and submit the FEIS and ROD.
- Establish agreements with key project partners regarding planning, design, and construction activities.
- Enter into cost share agreement with non-Federal partner(s).
- Complete all Federal permitting.
- Complete additional surveys and geotechnical investigations for final designs.
- Complete investigation and design of all project facilities, including mitigation requirements.
- Refine hydropower analysis, which may result in minor change to Federal investment.
- Refine designs and cost estimates; update analyses of potential effects and economics (and related NEPA analyses and documentation, if necessary); prepare a final cost allocation; and prepare detailed plans, specifications, and bid packages.
- Acquire lands, easements, and rights-of-way.
- Secure water rights permit.
- Construct the new project facilities, including mitigation.
- Own and operate the completed facilities.

6.5 Risk and Uncertainty

Throughout the evaluation of the Proposed Plan, assumptions were made based on the best engineering and scientific judgment. Careful consideration was given to the approaches and evaluations for hydrology and system operations, feasibility-level design and cost estimates, and biological or environmental issues. While this is effective in predicting outcomes for future operations, costs, and benefits, many uncertainties associated with implementation of the Proposed Plan could affect the findings in this Feasibility Report. The assumptions underlying the economic evaluation approaches and the sensitivity of these assumptions to uncertainties are discussed below. In addition, the potential for changes to the underlying economic conditions and the effect that this could have on the individual values and thus the overall analysis, are also summarized in this section.

Key areas of uncertainty for this evaluation include uncertainties associated with climate variability and hydrology, water supply reliability, water demand projections, construction cost estimates, and dam safety.

6.5.1 Climate Variability and Hydrology

Potential future climate variability could result in hydrologic conditions that differ from those used to evaluate the With and Without Plan conditions. Climate variability presents challenges to water management, reservoir management, infrastructure construction, long-term infrastructure operations, and infrastructure maintenance. Historical trends and future climate projections show increasing temperatures, changes in seasonal precipitation patterns and runoff, and the resulting effects on the overall water cycle. An understanding of historical climate and future climate projections is important. Climate variability can exacerbate or alleviate environmental impacts on other resources, and climate variability can impact the overall construction and operation of a project.

An evaluation of Reclamation system operations for the existing conditions without the Proposed Plan and considering various future climate scenarios can be found in Appendix A. Climate change hydrology was analyzed to evaluate how the system might perform under a wide range of potential future hydrological conditions.

Each refill probability was simulated using the climate change scenarios described in Appendix A. These 30-year scenarios include the Livneh simulated historical (1980 through 2009) and two 2060s scenarios (2050 through 2079) capturing a range of future conditions. The full Livneh simulated historical dataset extends from 1950 through 2010. Similar to the historical results, evaluation of refill probability using the full historical period results in different refill probabilities compared to using the more recent 30-year period. Both climate change scenarios exhibit higher refill probabilities compared to the Livneh simulated historical dataset. This can be attributed to the year-round increase in stream flow in both 2060s climate change conditions relative to the Livneh simulated historical conditions. Tables of refill probabilities for new storage in Anderson Ranch Reservoir, as well as for the Elmore County and CCE diversions, are found in Appendix A. Future climate variability is not expected to make the project inoperable and may instead make the project more effective than in baseline climate conditions. Future climate timing and magnitude of inflows showed the potential for increased storage, as the Proposed Plan presents an opportunity to capture the projected increased availability of surface water resulting from climate change hydrology, while existing infrastructure without the Proposed Plan may not be able to do so. The increased availability of surface water from climate change would increase the value of the economic benefits associated with the Proposed Plan.

Climate change could also impact demand for water and associated economic value because of an increase in average temperature and corresponding evapotranspiration because of said temperature changes. Specific assumptions regarding climate change and impacts on demand for water are discussed in the Treasure Valley DCMI Report (SPF 2016).

6.5.2 Water Supply Reliability

The Proposed Plan would increase the current storage capacity of Anderson Ranch Reservoir by approximately 29,000 acre-feet for a total active capacity of 442,074 acre-feet. Potential changes in reservoir storage and stream flow associated with new storage space in Anderson Ranch Reservoir were evaluated using historical and climate change hydrology, and a range of possible release rates and timing for water accrued to the new storage space. Potential impacts during the construction phase of the Proposed Plan were also considered. Model results for the historical period suggest that system operations with an additional 29,000 acre-feet of storage in Anderson Ranch Reservoir result in conditions that fall within the historical operating range.

Appendix A provides full details about water availability, refill probability, and modeling assumptions. In summary, a planning model was used to analyze the amount of water available for potential new water rights at or near Anderson Ranch Reservoir. At the time of this Study, multiple proposals of new water rights for diversion from and storage in Anderson Ranch Reservoir were being considered. In addition to the IWRB water right permit application, the two new potential water right permits represented are Elmore County's South Fork Boise River Diversion Project and CCE. Given the uncertainty regarding these proposals, a range of refill probabilities was analyzed in Appendix A to evaluate the potential availability of water. Additional descriptions of these additional water rights can be found in Appendix A and in Chapter 1 of this Feasibility Report. Table 6-9 summarizes the water availability analysis from Appendix A.

Table 6-9. Probability of Complete Refill for the Proposed Plan for Different Diversion Configurations

Diversion Configuration (Priority Order)	Percent Probability of Complete Refill (29,000 acre-feet)
1. Elmore County's South Fork Boise River Diversion Project 2. Cat Creek Energy 3. Anderson Ranch Reservoir	38%
1. Elmore County's South Fork Boise River Diversion Project 2. Anderson Ranch Reservoir 3. Cat Creek Energy	56%
1. Anderson Ranch Reservoir Only	62%

The diversion configuration column depicts the priority order for each refill probability, with entities listed in order of most senior to most junior water right priority. This Feasibility Report considered the new potential storage space in Anderson Ranch Reservoir along with two other proposed water rights for Elmore County and Cat Creek Energy (38% probability of refill). It is possible that all the project elements associated with these water rights are not fully realized or undergo changes, which could increase the availability of water to the project if the Proposed Plan is implemented.

6.5.3 Water Demand Projections

The forecasts in the Treasure Valley DCMI Report (SPF 2016) accounted for a future reduction in water use due to increased water conservation measures that could potentially result from public education, incentives, regulatory measures, or other approaches. Levels of conservation realized in the future may vary from those that have been projected depending on conservation goals, planning, and implementation in the Treasure Valley. These projections also discuss the potential for "population capture" by adjacent counties (that is, people who work in Ada and Canyon counties but choose to live in adjacent counties such as Gem County or Elmore County), which could also impact the projection results. The Treasure Valley DCMI Report provides specific assumptions regarding population growth and future demand for DCMI water.

Population growth is a major factor in southwestern Idaho's future water use and management. The Treasure Valley (Ada County and Canyon County) population is estimated to have increased 22% from 2010 to 2019 (USCB 2019), and population projections indicate significant continued growth. Coinciding with population growth, extensive land use changes are occurring throughout the Treasure Valley. Most visibly, row-crop agriculture and pastoral lands are transitioning to residential and urban environments. Together, these population and associated land use changes continue to increase the demand for DCMI water. Water supplies for the larger population could come from the following places:

- Diversions from increased surface water storage
- Direct diversions from the Boise River or Snake River (or both)
- Additional development of groundwater
- A conversion of irrigation supplies, efficiency measures, reuse, or recycling, or some combination of these

Some portion of increased population growth in the Treasure Valley would occur on lands currently used for irrigated agriculture. Therefore, water that would have been needed for these lands for irrigation may instead be used to serve urban demands, such as residential and commercial irrigation. However, this would only partially offset the change in agricultural to urban water demand, since growth would also occur on non-irrigated agricultural lands.

6.5.4 Construction Cost Estimates

Cost estimates developed for the Proposed Plan included in this report were based on price levels at the time of estimate preparation and were escalated to January 2025 dollars (when construction is assumed to begin) for consistency and analysis (see Appendix B). A Federal planning horizon of 100 years was used. All cost estimates, even at a feasibility level, have inherent risks and uncertainties, which include the following:

- Labor costs
- Materials availability
- Competitive bidding environments
- Unidentified field conditions
- Financial or commodity market conditions, or both
- Changing regulatory environments

The feasibility-level cost estimate provided in this report (see Appendix B) is subject to change if the project advances to greater levels of design. Items potentially affecting the opinion of probable cost include the following:

- Modifications to the scope of the facility
- Unforeseen subsurface conditions
- Special phase requirements not considered or not determined at the feasibility study phase of the project
- Restrictive technical specification or excessive contract conditions
- Any specified item of equipment, material, or product that cannot be obtained from at least three vendors, or any other noncompetitive bid situations

6.5.5 Dam Safety

As described in Appendix B, construction of the Proposed Plan exposes the facility to higher risks while the spillway is out of service or the dam crest is being excavated, or both. The baseline probable maximum flood that is most significantly affected by the proposed modification is the overtopping of the dam during an extreme flood event. The ability to pass inflows from an extreme flood event are significantly reduced while the spillway is out of service, leading to an increased risk of the RWS rising and eventually overtopping the embankment dam. To begin a quantitative analysis of the dam-safety-related construction risks, the design team considered overtopping of the cofferdam to be as significant as a dam failure since the flows through the partially demolished and unlined spillway would result in catastrophic damage and would constitute a failed condition. Given these increased risks, the design team considered the need for reservoir restrictions during construction, cofferdams or a combination of both. To manage these risks, the design team assumed that the spillway construction and crest raise construction would take place in phases, with the spillway demolition and reconstruction taking place first. After the spillway is complete and operational, the cofferdam can be removed, and the crest raise construction can take place.

Chapter 7 Coordination, Consultation, and Public Involvement

The public, stakeholders, public agencies, and other interested parties have been engaged throughout the Study and will continue throughout subsequent implementation phases if a project is authorized by Congress. Since the initiation of the Study, Reclamation has conducted formal scoping and consultation with permitting agencies, as well as informal agency communications, interagency meetings, and public meetings. This chapter summarizes public involvement and engagement, stakeholder outreach, environmental review, and agency coordination activities undertaken by Reclamation.

7.1 Final Boise/Payette Water Storage Assessment Report (Reclamation 2006)

A broad-based stakeholder working group was convened to participate in the assessment effort. More than 60 invitations to participate were sent to a broad spectrum of local water users and interested parties including Federal, State, and local partners; irrigation interests; flood control districts; and environmental groups. Stakeholders participated in scheduled planning and review meetings and provided comments at each stage of the assessment.

7.2 Boise River General Investigation Study

USACE and the IWRB conducted four public information meetings during the June 29 through July 1, 2010, period to provide an overview of the Lower Boise River Feasibility Study and present the preliminary results of the Water Storage Screening Analysis. Written comments were requested on the June 2010 *Draft Water Storage Screening Analysis* document. A total of 154 agencies, organizations, and individuals submitted written comments during June and July 2010. Comments were received through July 31, 2010. Public comment was considered when finalizing the Water Storage Screening Analysis.

In 2012 during a planning charette, USACE and the IWRB rescoped the project to bring it into alignment with the USACE's SMART planning guidelines. The refined scope objectives looked to reduce flood risk, reduce life safety risk associated with flooding, and increase water storage in the Boise River basin. On April 24, 2014, USACE published an NOI in the FR announcing its intent to prepare an EIS for the Boise GI.

Following multiple planning and screening efforts, a 70-foot-raise of Arrowrock Dam was carried forward for feasibility and environmental analysis. However, after completion of hydrologic and economic modeling, USACE determined the Federal interest could not be justified as project costs exceeded benefits, and this information was presented to the IWRB in May 2016. The project was formally terminated on January 24, 2017.

7.3 Boise River Basin Feasibility Study

Reclamation pursued potential public interest in a raise at Anderson Ranch Dam. As authorized under PL 111-11, Reclamation could pursue a feasibility study, associated NEPA documentation, and initial design and engineering efforts with a non-Federal cost share partner willing to fund 50% of the study costs. Reclamation conducted an interested party meeting on April 30, 2015, to determine the level of interest of stakeholders in raising Anderson Ranch Dam. The meeting identified some interested funding partners but fell short of the full 50% non-Federal cost share commitment.

On May 10, 2016, Reclamation held an informational meeting with stakeholders to present the results of initial hydrology and climate change modeling, as well as an updated feasibility study schedule and budget. At this time, Reclamation had yet to identify funding partner(s) willing to commit the 50% non-Federal cost share required under PL 111-11. On September 27, 2016, Reclamation provided answers to the questions received during the informational meeting.

Following USACE's determination of an unfavorable benefit-cost ratio, the IWRB requested in May 2016 for Reclamation and USACE to explore potential solutions to increase storage systemwide. In November 2016, Reclamation presented to the IWRB an updated schedule and budget to explore smaller dam raises at Anderson Ranch, Arrowrock, and Lucky Peak dams using Reclamation's PL 111-11 authority to perform feasibility studies for increased surface water storage opportunities at these locations. On October 24, 2017, the IWRB passed a Resolution to Commit Funds and Provide Signatory Authority for the Boise River Basin Feasibility Study.

In July 2018, Reclamation concluded that the evaluation of the feasibility of raises to all three dams would not be complete before January 1, 2021, and subsequently recommended to the IWRB that focusing Study efforts on a raise of Anderson Ranch Dam would be most appropriate. The IWRB agreed, signing a board resolution in July 2018, authorizing Reclamation to focus Study analysis on a raise of the Anderson Ranch Dam with the intent to determine project feasibility in accordance with conditions of Section 4007 of the WIIN Act.

7.4 Public Involvement and Engagement and Stakeholder Outreach

On August 28, 2018, a site visit was conducted with the IWRB, congressional staff, and key stakeholders to discuss and present the preliminary findings of an initial technical review of USACE's Lucky Peak Dam and Reclamation's Arrowrock and Anderson Ranch dams.

On November 11, 2018, Reclamation and the IWRB hosted a Public Open House to share early information about the Study and increasing water storage capacity within the Boise River system, particularly at Anderson Ranch Dam. Subject matter experts were on hand during the Open House to answer questions from the public. In preparation for the Open

House, invitations were sent to approximately 200 stakeholders along with a supporting press release. It is estimated that approximately 70 participants attended the Public Open House.

On July 31, 2019, Reclamation and the State held a State-agency coordination meeting to allow for early coordination with potential State-agency stakeholders. Representatives from the IDEQ, Idaho Department of Lands, and the Idaho Attorney General's Office were in attendance.

7.5 Environmental Review

Reclamation is the lead agency pursuant to NEPA. Reclamation published an NOI in the FR on August 9, 2019, to advise interested agencies and the public that an EIS would be prepared. In addition to the NOI, numerous informational materials were publicly distributed to inform stakeholders about the Study and to solicit their input. These materials included press releases, newspaper notices, Reclamation news releases, website postings, and general notification flyers.

7.5.1 Draft and Final Environmental Impact Statement

A 30-day scoping comment period extended from August 9, 2019, through September 9, 2019. The public was invited to submit written comments on the scope, content, and format of the environmental document by mail, fax, or email to Reclamation. Three formal scoping meetings were held to gather input and comments before the development of the EIS. The meetings were held in Pine, Boise, and Mountain Home, Idaho, on August 27, 28, and 29, 2019, respectively. Approximately 175 people attended the three meetings.

The DEIS (Reclamation 2020a) was released for public review in July 2020, and in accordance with NEPA requirements, was available for public and agency review and comment for a 45-day period following the publishing of the Notice of Availability of the EIS by the EPA. A virtual public meeting was held on August 26, 2020, during the public comment period.

A Scoping Summary Report was prepared following the scoping period and a Public Comment Summary will be prepared following the public comment period. The reports outline the process and outcome of the public meetings and other activities; outlines scoping requirements; lists all documents and products generated for project outreach; summarizes comments made during the scoping process; describes issues anticipated to be addressed in the FEIS; and provides copies of all written comments, summaries of the scoping meetings, and other project-related print materials used to inform interested parties about the project alternatives. A FEIS will be prepared for public release in February 2021.

7.6 Tribal Government to Government Consultation

Reclamation contacted two Tribes during the scoping period and development of the DEIS (Reclamation 2020a):

- July 31, 2019: Reclamation sent a letter and informational package to the Shoshone-Bannock and Shoshone-Paiute Tribal councils. This package requested comments, included the dates and times for Public Open Houses and invited the Tribes to engage in a Government to Government Consultation or informational presentation concerning the project.
- September 13, 2019: The Shoshone-Bannock Tribes provided Reclamation with formal scoping comments.
- September 17, 2019: Reclamation Area Manager, Deputy Area Manager, and Native American Affairs Advisor met with three Shoshone-Paiute Tribal Council Members and two Tribal staff members.
- October 3, 2019: A staff-to-staff meeting took place between Reclamation and the Shoshone-Bannock Tribes at the Fort Hall Water Resources Building.

7.7 Agency Consultation and Coordination

Agency consultation and involvement occurred throughout the Study, both informally and formally.

Reclamation formally requested that the USFS, USFWS, BLM, and USACE participate as cooperating agencies. The USFS responded confirmed it would participate as a cooperating agency due to its jurisdictional responsibility over land within the project area. USACE confirmed its participation as a cooperating agency related to its involvement through the 404 permitting process.

Reclamation, the USFS, and USACE participated in regular meetings and coordinated review sessions.

Reclamation has consulted with BPA as the Federal power marketing administration for Anderson Ranch Dam. As discussed in Section 6.3.4.5, construction costs allocated to hydropower will be included in existing agreements with the BPA for repayment in accordance with Federal Reclamation law.

Chapter 8 Findings, Conclusions, and Recommendations

The Study being conducted by Reclamation includes an evaluation of the Proposed Plan consistent with the Federal PR&G (CEQ 2015). The PR&G evaluation includes the use of the ecosystem services framework to characterize the environmental, social, and environmental goals of public benefits. In coordination with this Study, an FEIS will be prepared consistent with NEPA. Following approval and publication of the Final Feasibility Report, the current project schedule assumes that an ROD will be signed in the spring of 2021, after the Secretary of Interior has found the project to be feasible and eligible for funding under Section 4007 of the WIIN Act and made a recommendation to Congress. The following section the major findings and conclusions of this Study.

8.1 Need for the Project

The combination of population growth and climate projections is expected to create challenges in meeting existing water contract obligations and increased water supply demand in the Treasure Valley and is the main driver for this Study. This Study assesses increased storage potential in the Boise River watershed behind Reclamation's Anderson Ranch Dam to meet this water supply need. In addition to the DCMI and irrigation purposes of the Proposed Plan, other purposes such as water supply for fish and wildlife, hydropower, and recreation add to the overall benefit of the Proposed Plan. By evaluating these purposes through the ecosystem services framework, the net public benefits of the Proposed Plan demonstrate the need for the project and the compelling return to this Federal investment.

8.2 Recommended Plan

The Proposed Plan is identified as the Recommended Plan. The Proposed Plan would achieve a net increase in Public Benefits while protecting the environment. Table 8-1 summarizes the findings of the plan evaluation following the requirements of the PR&G. Based on the plan evaluation, the Proposed Plan provides a net public benefit of $2,000,000 annually. The resulting benefit-cost ratio is 1.74. This evaluation followed the PR&G recommend ecosystem services framework and consideration of the environmental, economic, and social goals of public benefits. The Guiding Principles of the PR&G are each achieved with the Proposed Plan. The plan formulation criteria have considered the plan complete, highly effective, efficient, and highly acceptable.

Table 8-1. Summary of Plan Evaluation

Item	Proposed Plan
Total Annual Economic Benefits to the Public	$4,700,000
Total Annual Costs	$2,700,000
Net Annual Economic Benefits to the Public	**$2,000,000**
Proposed Plan Benefit-Cost Ratio	**1.74**
PR&G Guiding Principles	All Guiding Principles Achieved
Plan Formulation Criteria	Rating
• Completeness	Complete
• Effectiveness	Highly Effective
• Efficiency	Efficient
• Acceptability	Highly Acceptable

Note: Total present value benefits and costs are adjusted to annual equivalent values, depicted in the table as total annual economic benefits to the public and total annual costs, over the period of analysis by use of the 2020 Federal discount rate as described in the PR&G ASP (707 DM 1 Handbook) (DOI 2015).

8.3 Feasibility of Recommended Plan

The Recommended Plan is projected to be technically feasible, constructible, and can be operated and maintained. Designs and cost estimates for the Proposed Plan have been developed to a feasibility-level as verified through the DEC review process. The Recommended Plan will be considered environmentally feasible upon the signing of an ROD. The DEIS (Reclamation 2020a) evaluates environmental effects and identifies mitigation measures. The Recommended Plan maximizes public benefits and is projected to be economically feasible, generating annual net benefits of $2.0 million annually. The non-Federal cost share partners are required to provide upfront funding for the non-Federal cost assignments per the requirements of Section 4007 of the WIIN Act. On April 2, 2019, the Idaho State Legislature transmitted to Reclamation the House Joint Memorial Number 4 adopted by the House of Representatives and the State Senate to support the non-Federal cost share requirements and financial feasibility.

8.4 Environmental Compliance and Regulatory Requirements

The Boise River Basin Feasibility Study FEIS will satisfy NEPA by providing a thorough analysis of all issues related to the environment. The Council on Environmental Quality issued regulations and other guidance to Federal agencies regarding NEPA compliance (40 CFR 1500-1508). These requirements are binding to all Federal agencies. Reclamation has additional regulations that define the requirements for NEPA compliance and documentation under 43 CFR 46, DOI Implementation of NEPA, as well as policies outlined in the Reclamation Manual and NEPA Handbook.

Implementation of the Recommended Plan authorized by Congress would be subject to all applicable Federal laws, policies, and environmental regulations. All cooperating agencies, along with other Federal, State, Tribal, and local agencies with permitting or approval authority over any aspect of project implementation, are expected to use the information that will be contained in the FEIS to meet most, if not all, of their information needs, to make decisions, and to issue permits about the authorized project.

8.5 Recommendations

The overall recommendation of this Feasibility Report is that the Secretary of the Interior, acting through Reclamation, participate in funding and implementing the Proposed Plan, including the environmental commitments and mitigation measures that will be identified in the FEIS. The WIIN Act, Section 4007 provides authority for the Secretary of the Interior to complete the following:

1. Participate in surface water storage projects that are constructed, operated, and maintained pursuant to Reclamation laws
2. Enter into an agreement with non-Federal partner(s) on behalf of the United States for planning, permitting, design, and construction costs

The Secretary of the Interior can participate in a Federally owned storage project up to "an amount equal to not more than 50% of the total cost of the Federally owned storage project." Section 4007 of the WIIN Act requires that at least a proportional share of the project benefits must be Federal benefits, including water supplies dedicated to specific purposes such as environmental enhancement and wildlife refuges. Section 4007 of the WIIN Act contains a set of requirements that must be met before funding.

This Feasibility Report documents partial confirmation of these requirements, and remaining requirements are expected to be confirmed through action by the State of Idaho, as the local sponsor (refer to Chapter 6). Pursuant to fulfilling the final requirements of the WIIN Act, the following is recommended:

- Approve the Recommended Plan, as outlined in this report, and submit the following determinations to Congress, in accordance with Section 4007(c)(2)(D) of the WIIN Act:
  - The project is technically, environmentally, economically, and financially feasible.
  - Sufficient non-Federal funding is available to complete the project.
  - The project sponsors are financially solvent.
  - In return for the Federal investment, a proportionate share of the project benefits are Federal benefits.
- Request that Congress funds the Federal share of construction.
  - Request that Congress authorize Reclamation to increase the construction cost if necessary to allow for escalation from assumed price levels to the notice to proceed

for each contract or work package, based upon Reclamation's Construction Cost Trends publication or similar source.

- Authorize the Commissioner of Reclamation to enter into a cost-sharing agreement for the construction of the Recommended Plan.

The Recommended Plan includes the following purposes: DCMI, irrigation, fish and wildlife, hydropower, and recreation. These will be the authorized purposes for the storage associated with the raised portion of Anderson Ranch Dam upon determination of feasibility by the Secretary of the Interior, transmittal of recommendation for funding to Congress, and Congress' acceptance of those authorized purposes through legislation designating the project by name.

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Appendix A
Water Operations Technical Memorandum

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BUREAU OF RECLAMATION

Boise River Basin Feasibility Study Water Operations Technical Memorandum

Boise Project, Idaho
Columbia Pacific Northwest Region

U.S. Department of the Interior

July 2020

Mission Statements

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

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

Cover Photo: Anderson Ranch Dam, Boise Project, Idaho.

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Executive Summary

The Bureau of Reclamation (Reclamation) is evaluating the potential benefits and impacts of three storage alternatives in the Boise River System. To ensure that Reclamation evaluated a reasonable range of alternatives for the National Environmental Policy Act compliance process, the Environmental Impact Statement includes a 3-foot dam raise of Anderson Ranch Dam as an alternative; this alternative was not further evaluated as a structural alternative for the Feasibility Study. This approach is supported by Reclamation Manual, Directives and Standards CMP 09-02, *Water and Related Resources Feasibility Studies*.

The three storage alternatives evaluated are the No Action alternative, a 6-foot Raise of Anderson Ranch Dam (Preferred Alternative), and a 3-foot Raise of Anderson Ranch Dam. The 6-foot Raise would increase storage space in the reservoir by approximately 29,000 acre-feet and the 3-foot Raise would increase the storage space by approximately 14,400 acre-feet. Potential changes in reservoir storage and streamflow associated with new storage space in Anderson Ranch Reservoir were evaluated using historical and climate change hydrology and a range of possible release rates and timing for water accrued to the new storage space. Potential impacts during the construction phase of the proposed project were also considered.

Hydrologic Analysis with Historical Hydrology

Model results using historical inflow hydrology indicate that additional storage space in Anderson Ranch Reservoir has the potential to store additional water in the system but will not likely change system operations outside the historical operating range. Table ES-1 summarizes the key findings for the historical period for each of the reservoir and streamflow locations analyzed.

Table ES-1. Summary of key findings, by location, associated with modeling of the 6-foot Raise and the 3-foot Raise of Anderson Ranch Dam using historical hydrology.

Location	Key Findings	
	6-foot Raise	3-foot Raise
Anderson Ranch Reservoir	Year-round potential for increased storage and pool elevation in Anderson Ranch Reservoir up to 29,000 acre-feet.	Year-round potential for increased storage and pool elevation in Anderson Ranch Reservoir up to 14,400 acre-feet.
Arrowrock Reservoir	No change to the ability to meet minimum pool objectives as additional water is released from Anderson Ranch Reservoir to backfill Arrowrock Reservoir on an as-needed basis.	No change to the ability to meet minimum pool objectives as additional water is released from Anderson Ranch Reservoir to backfill Arrowrock Reservoir on an as-needed basis.

<table>
<tr><th rowspan="2">Location</th><th colspan="2">Key Findings</th></tr>
<tr><th>6-foot Raise</th><th>3-foot Raise</th></tr>
<tr><td>Lucky Peak Reservoir</td><td>No change to the ability to meet winter pool elevation objectives.</td><td>No change to the ability to meet winter pool elevation objectives.</td></tr>
<tr><td>South Fork Boise River below Anderson Ranch</td><td>a) No change to the ability of Anderson Ranch Dam to continue meeting downstream minimum streamflow objectives.
b) Potential for up to 9 days of increased flows below Anderson Ranch Dam in the late summer when releases from Anderson Ranch Reservoir are called upon to backfill Arrowrock Reservoir.
c) Summer releases from Anderson Ranch Reservoir will be made at the power plant capacity of approximately 1,600 cubic feet per second (cfs).
d) Potential for decreased water temperature during times of year when water temperatures are typically the highest.</td><td>a) No change to the ability of Anderson Ranch Dam to continue meeting downstream minimum streamflow objectives.
b) Potential for up to 4.5 days of increased flows below Anderson Ranch Dam in the late summer when releases from Anderson Ranch Reservoir are called upon to backfill Arrowrock Reservoir.
c) Summer releases from Anderson Ranch Reservoir will be made at the power plant capacity of approximately 1,600 cfs.
d) Water temperatures are similar to the baseline under this Alternative.</td></tr>
<tr><td>Boise River at Glenwood</td><td>Potential for increased summer flows depending on demand (rate, timing, and use location) for water accrued to the new storage space.</td><td>Potential for increased summer flows depending on demand (rate, timing and use location) for water accrued to the new storage space.</td></tr>
</table>

In order to better understand the sensitivity of the results to period selection, impacts were analyzed using two different historical periods: a full 50-year simulation period spanning 1958 through 2008, and the more recent 28-year subset spanning 1980 through 2008. Comparison of these two periods shows an increased proportion of years with low runoff volumes and earlier runoff recession (lower June and July runoff) in the 1980 through 2008 period compared to the 1958 through 2008 period. As a result of these differences, the system exhibits reduced carryover, less-frequent fill, and smaller flood releases in the later 1980 through 2008 period. There is also an increased number of years in the later period where storage accounts providing water for flow augmentation do not fill, resulting in decreased releases for flow augmentation in early summer. Differences between the 6-foot Raise and 3-foot Raise Alternatives (Alternatives) and No Action storage conditions are similar or slightly larger in magnitude in the longer analysis period. Both periods exhibit operations under the Alternatives falling within the historical operating range.

Climate Change Hydrology

The RMJOC-II Climate Change Study notes overall trends of increased fall and winter streamflow, earlier and higher spring peak runoff, and earlier streamflow recession. The study also suggests the potential for increased rain-on-snowpack events during the winter and spring and annual flow peaks shifting several weeks earlier compared to historical conditions. The climate change conditions simulated in this study demonstrated a stronger influence on operations compared to the proposed increase in storage at Anderson Ranch Reservoir. Both climate change scenarios showed wetter conditions (higher streamflow and storage content) during the winter and spring months compared to historical hydrology. Model results also suggest that that the storage benefit associated with the Alternatives may still be realized under future hydrologic conditions. However. it must be noted that these simulations utilize perfect forecasts[1] and current operational objectives. This study does not consider forecast uncertainty, nor how that uncertainty may change going into the future as warming conditions influence the proportion of precipitation that falls as rain rather than accumulating as snowpack.

Water Availability and Refill Probability

A summary of the water availability analysis is shown in Table ES-2. This analysis considered the new potential storage space in Anderson Ranch Reservoir along with two other proposed water rights for Elmore County and Cat Creek Energy (CCE).

Table ES-2. Probability of complete refill for the Alternatives and analysis time periods 1958-2008 (50-year) and 1980-2008 (28-year).

Scenario	6-foot Raise (29,000 acre-feet)	3-foot Raise (14,400 acre-feet)
Elmore County > CCE > Anderson Ranch	38%	42%
Anderson Ranch only	62%	64%

Construction Phase

Drawdown of Anderson Ranch Reservoir during the construction period for both Alternatives has the potential to result in reduced fill to reservoir storage accounts depending on runoff conditions. This analysis indicates the maximum volume of shortfall per year would equate to approximately 55,000 acre-feet per year for a 4,184 foot pool elevation restriction and a shortfall of approximately 97,000 acre-feet per year for a 4,174 foot pool elevation restriction.

[1] Defined in Section 3.6

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1 Project Overview

The Bureau of Reclamation (Reclamation) is evaluating the potential benefits and impacts of storage alternatives in the Boise River System. The analysis presented in this technical memorandum is being used to support the Feasibility Study (Study), associated Environmental Impact Statement (EIS), and Biological Assessment. To ensure that Reclamation evaluated a reasonable range of alternatives for the National Environmental Policy Act compliance process, the EIS includes a 3-foot dam raise of Anderson Ranch Dam as an alternative; this alternative was not further evaluated as a structural alternative for the Study. This approach is supported by Reclamation Manual, Directives and Standards CMP 09-02, *Water and Related Resources Feasibility Studies*. The three alternatives described in Table 1 are consistent with information in the EIS.

Table 1. Alternatives evaluated.

Alternative	Name	Description
A	No Action	The No Action alternative reflects current system configurations, operations, and demands. It is used as a comparative baseline for Alternatives B and C.
B	6-foot Raise of Anderson Ranch Dam (Preferred Alternative) (6-foot Raise)	The 6-foot Raise of Anderson Ranch Dam adds approximately 29,000 acre-feet of storage to the system.
C	3-foot Raise of Anderson Ranch Dam (3-foot Raise)	The 3-foot Raise of Anderson Ranch Dam adds approximately 14,400 acre-feet of storage to the system.

Table 2 shows the total and active capacities of the Boise Reservoir System under both No Action (Alternative A; assumed as current condition) and the proposed dam-raise conditions. The 6-foot Raise and the 3-foot Raise would equate to 6.4 percent and 3 percent increases, respectively, in the active capacity of Anderson Ranch Reservoir, and to 3 percent and 1 percent increases, respectively, in system active capacity.

Table 2. Storage capacities of the Boise Reservoir System for the baseline condition and proposed 6-foot Raise and 3-foot Raise Alternatives. "Total capacity" includes 36,956 acre-feet of inactive (powerhead) space in Anderson Ranch Reservoir, whereas "active capacity" does not.

Reservoir	Total Capacity (acre-feet)			Active Capacity (acre-feet)		
	Alternative A No Action - Current	Alternative B Proposed 6-foot Raise	Alternative C Proposed 3-foot Raise	Alternative A No Action - Current	Alternative B Proposed 6-foot Raise	Alternative C Proposed 3-foot Raise
Anderson Ranch	450,030	479,030	464,430	413,074	442,074	427,474
Arrowrock	272,224	272,224	272,224	272,224	272,224	272,224
Lucky Peak	264,371	264,371	264,371	264,371	264,371	264,371
System	986,625	1,015,625	1,001,025	949,669	978,669	961,069

This technical memorandum describes the assumptions and results of this study, which involved an analysis of changes in storage and streamflow associated with the new space under four different demand scenarios. This evaluation was conducted using the Boise subbasin of the Upper Snake RiverWare Model and historical and future hydrologic datasets developed as part of the RMJOC-II Climate Change Study (RMJOC-II 2018). Potential impacts to temperature regimes downstream of Anderson Ranch Reservoir were evaluated using the Anderson Ranch Reservoir CE-QUAL-W2 model.

2 Description of Models

2.1 Boise Planning Model

The Boise Planning Model is derived from the larger Upper Snake RiverWare Model. RiverWare® ver. 7.5 is a generalized river basin modeling tool that can be used to simulate detailed, site-specific river and reservoir operations. The Boise Planning Model and the Upper Snake RiverWare Model include logic to simulate competing water demands in the system while adhering to legal water right and physical constraints. A schematic of the Boise Planning Model is shown in Figure 1. Competing water demands include irrigation, Flood Risk Management (FRM), minimum-flow targets, ecological flow releases, and ecological storage constraints.

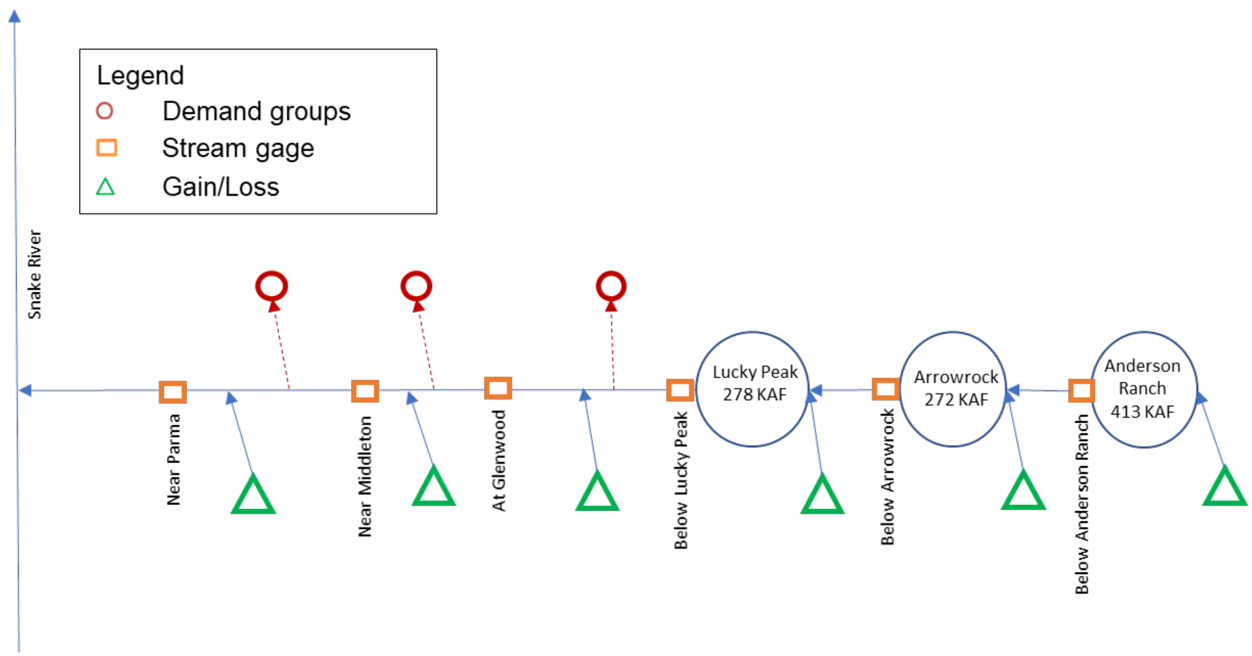


Figure 1. Boise Planning Model schematic; reservoir storage volumes reflect current active storage capacity.

Figure 2 through Figure 5 show baseline model (No Action model) simulated storage conditions, along with the observed historical storage in the Boise Reservoir System. Figure 6 and Figure 7 illustrate simulated and observed streamflow conditions below Anderson Ranch Dam and the Boise River at Glenwood Bridge locations. Differences between simulated and observed conditions can be attributed to updated operational objectives, the use of perfect foresight on future inflow volumes (vs. imperfect real-time forecasts), and the fact that actual, real-time operations may not adhere strictly to the objectives outlined in the model logic. An example of the model strictly adhering to FRM objectives that may have differed in actual operations can be seen in Figure 2 and Figure 3, where modeled storage volumes are lower than historical in the early 1980s prior to the 1985 Water Control Manual for Boise River Reservoirs.

Operational objectives have changed over the course of the simulation period. The current version of the model has been calibrated to simulate current operational objectives. These include, when possible:

1) Maintaining a minimum storage elevation in Arrowrock Reservoir of 3,100 feet (37,912 acre-feet)[2];

2) Keeping Lucky Peak Reservoir near full (approximately 264,000 acre-feet) from May 31st through September 1st for recreation;

[2] Real-time operations and the model use 50,000 acre-feet for this target to ensure the storage in the reservoir does not drop below the target.

3) Managing peak flows at Glenwood gage to be 6,500 cubic feet per second (cfs) (flood action flow) or less;

4) Reaching and maintaining the "elk pool"[3] (approximately 60,000 acre-feet) in Lucky Peak Reservoir from the end of the irrigation season through the middle of February;

5) Meeting minimum flow targets in the South Fork Boise River and at the Boise River at Glenwood Bridge location; and

6) Releasing a portion of stored water for flow augmentation (see Section 5 for a description of flow augmentation).

Flow augmentation deliveries are also simulated by the model. Flow augmentation water is defined as water released at targeted times and places to increase streamflows to benefit migrating salmon and steelhead. This water is partially delivered from stored water in the Boise System. More discussion about flow augmentation can be found in Section 4.

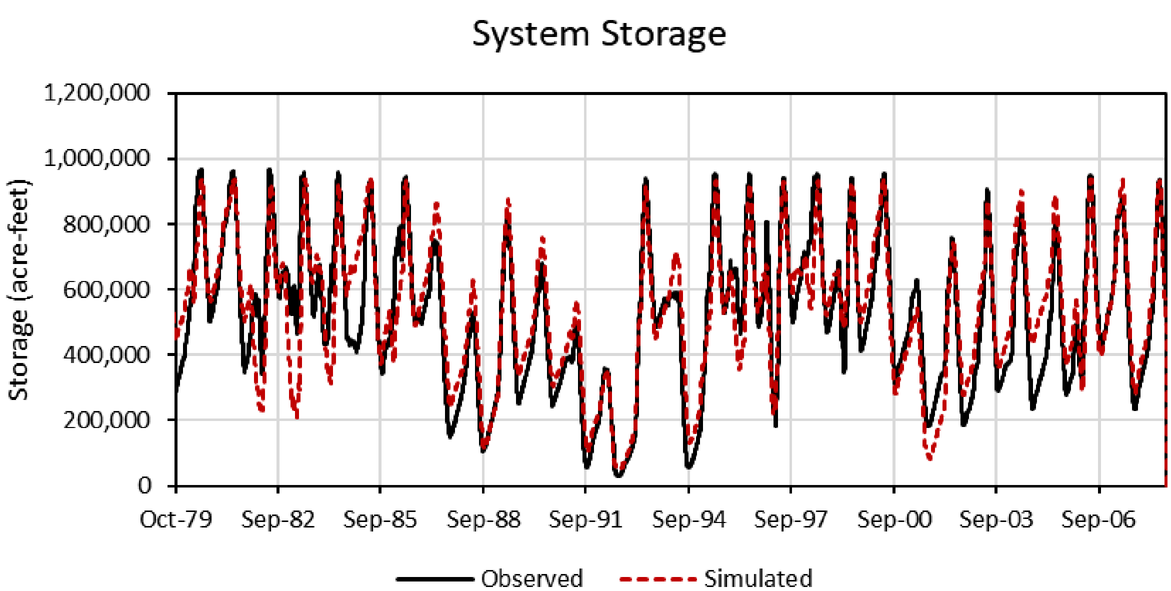


Figure 2. Simulated storage (red dashed line) and observed storage (black solid line) in the Boise Reservoir System for the 1980 through 2008 water years. Storage values depicted represent total system storage (excluding 36,956 acre-feet of inactive powerhead space in Anderson Ranch Reservoir).

[3] The term "elk pool" refers to a soft operational target of holding the water surface elevation of Lucky Peak at a level no higher than 2,960 feet (63,600 acre-feet content) during January and February each year to reduce potential elk mortality while crossing the Mores Creek arm of the reservoir. This soft operational target cannot always be met, particularly in late February when Arrowrock Reservoir approaches full and begins to pass inflow into Lucky Peak Reservoir, causing it to fill above the 2,960-foot level.

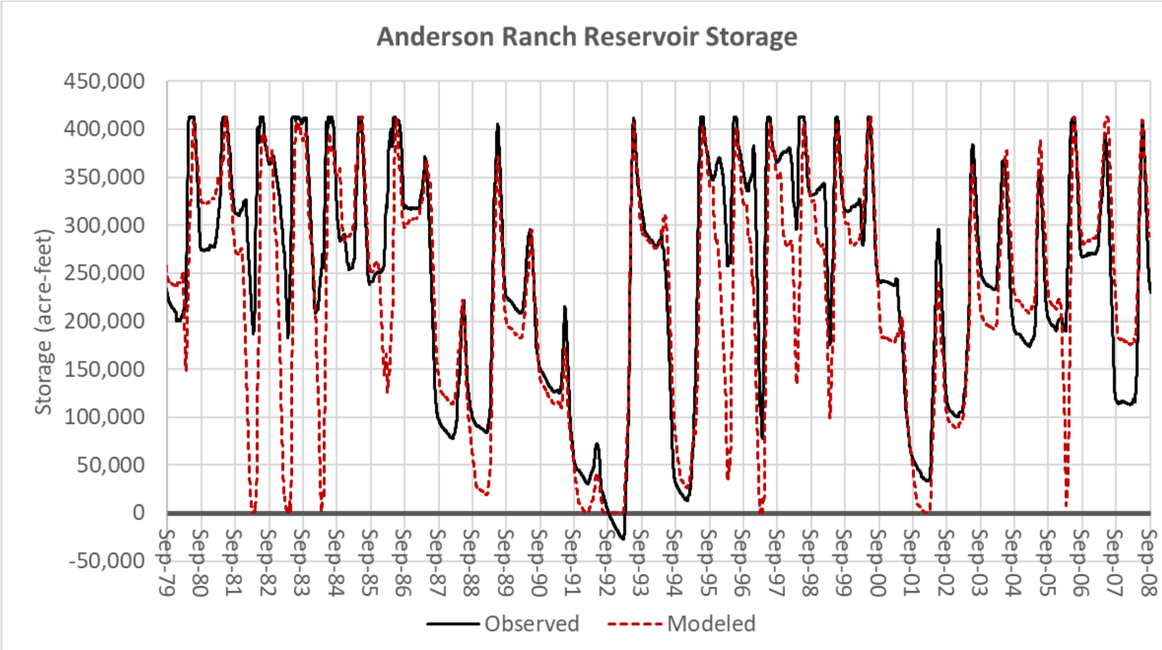


Figure 3. Simulated storage (red dashed line) and observed storage (black solid line) in Anderson Ranch Reservoir for the 1980 through 2008 water years. The 0 acre-feet storage line corresponds to the minimum storage target of maintaining 62,000 acre-feet of dead and inactive space in the reservoir, including 36,956 acre-feet of inactive powerhead space. Storage values going negative as in 1992 indicate that the reservoir was lowered into the powerhead space.

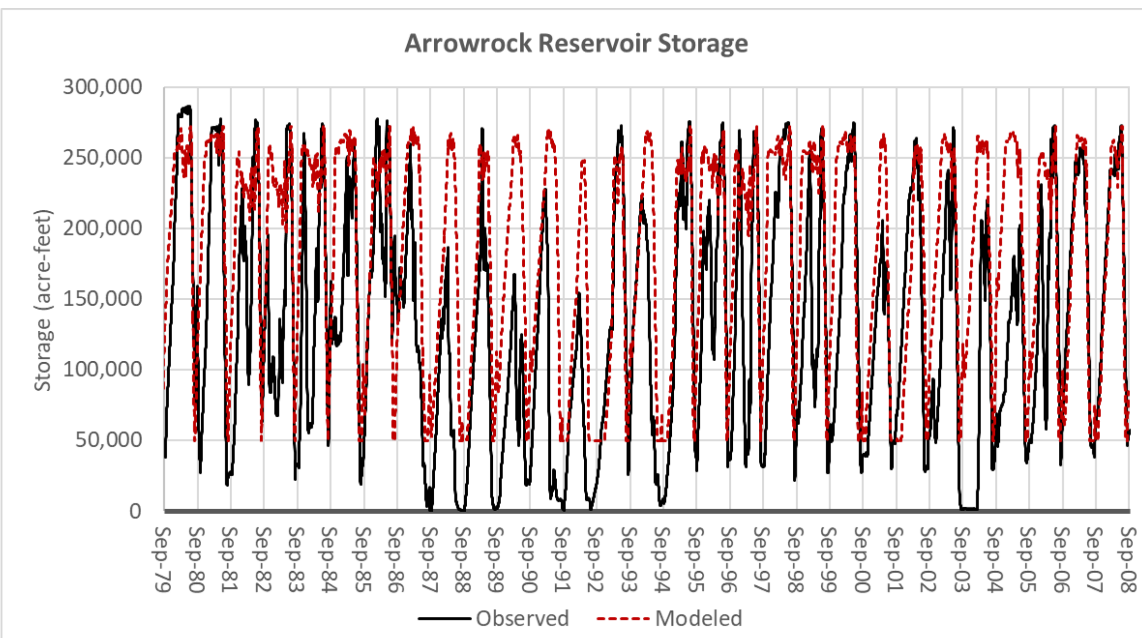


Figure 4. Simulated storage (red dashed line) and observed storage (black solid line) in Arrowrock Reservoir for the 1980 through 2008 water years.

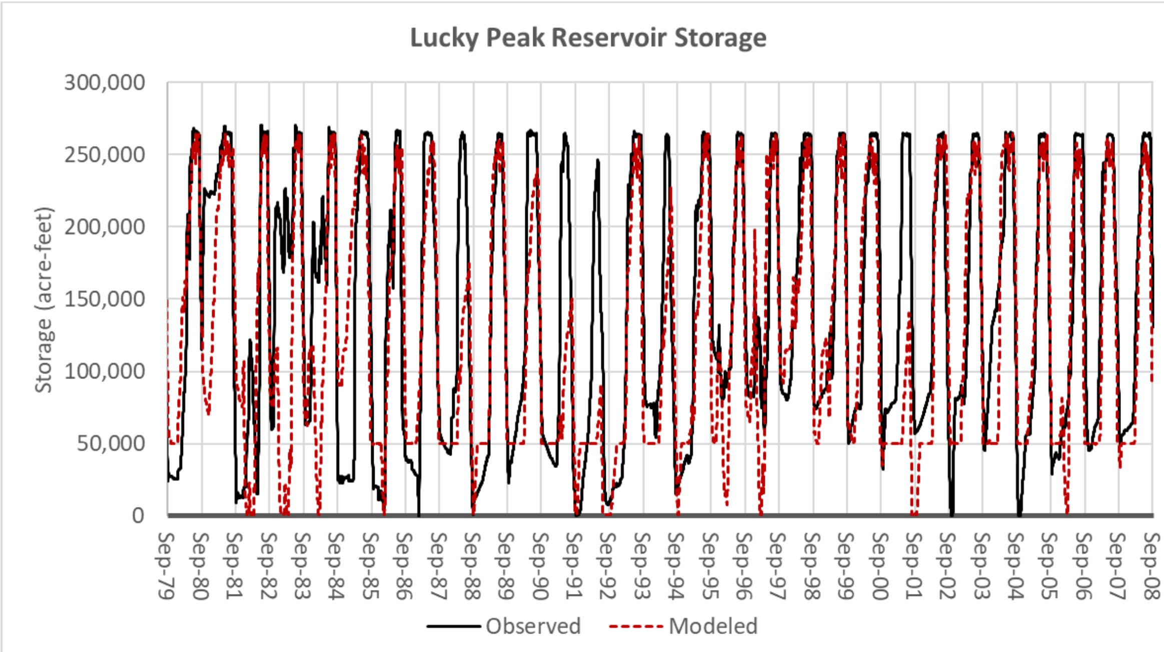


Figure 5. Simulated storage (red dashed line) and observed storage (black solid line) in Lucky Peak Reservoir for the 1980 through 2008 water years.

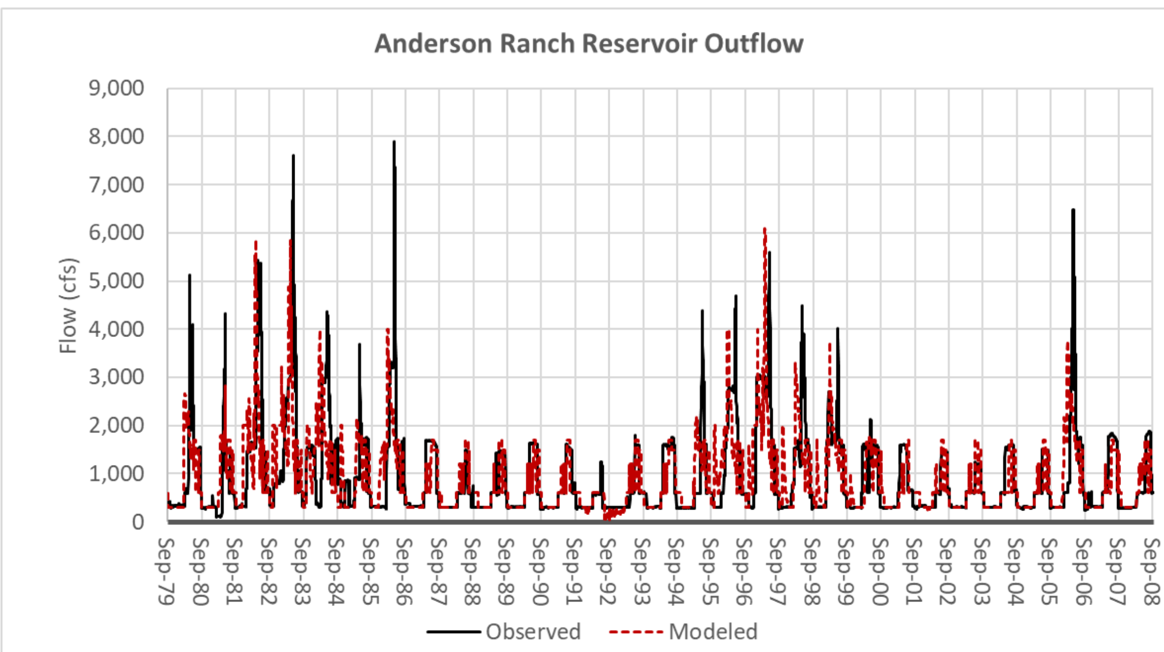


Figure 6. Simulated (red dashed line) and observed (black solid line) flow in the Boise River below Anderson Ranch Reservoir for the 1980 through 2008 water years.

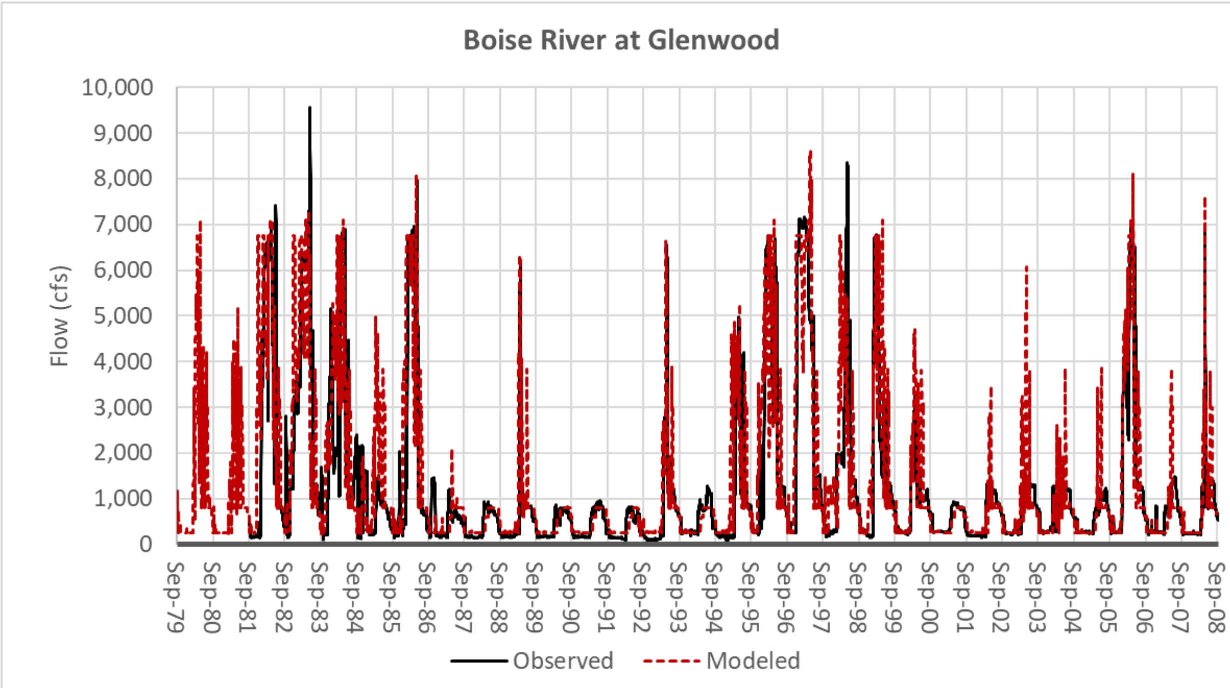


Figure 7. Simulated (red dashed line) and observed (black solid line) flow in the Boise River at Glenwood Bridge for the 1980 through 2008 water years.

2.2 Analysis Period

For this study, the model was run at a daily time-step over a 50-year period spanning October 1, 1958 through September 30, 2008. Preliminary water resource modeling conducted in 2017 used a previous version of the Boise Planning Model (Reclamation 2017) with a more limited simulation period (October 1, 1980 through September 30, 2008). Since this earlier work, Boise Planning Model improvements included extension of the simulation period further back in time to 1958. The longer period provides for a wider range of runoff and storage conditions and sequencing of year types (wet vs. dry). Figure 8 depicts comparisons of these two time periods in terms of January through July runoff volume exceedance for the Boise Reservoir System above Lucky Peak Dam and above Anderson Ranch Dam. As shown by these panels, the hydrologic regimes for the two periods have similar distribution of flows; however, the later period exhibits an increased occurrence of lower volume runoff years as indicated by the red line being below the black line over 50 percent of the time.

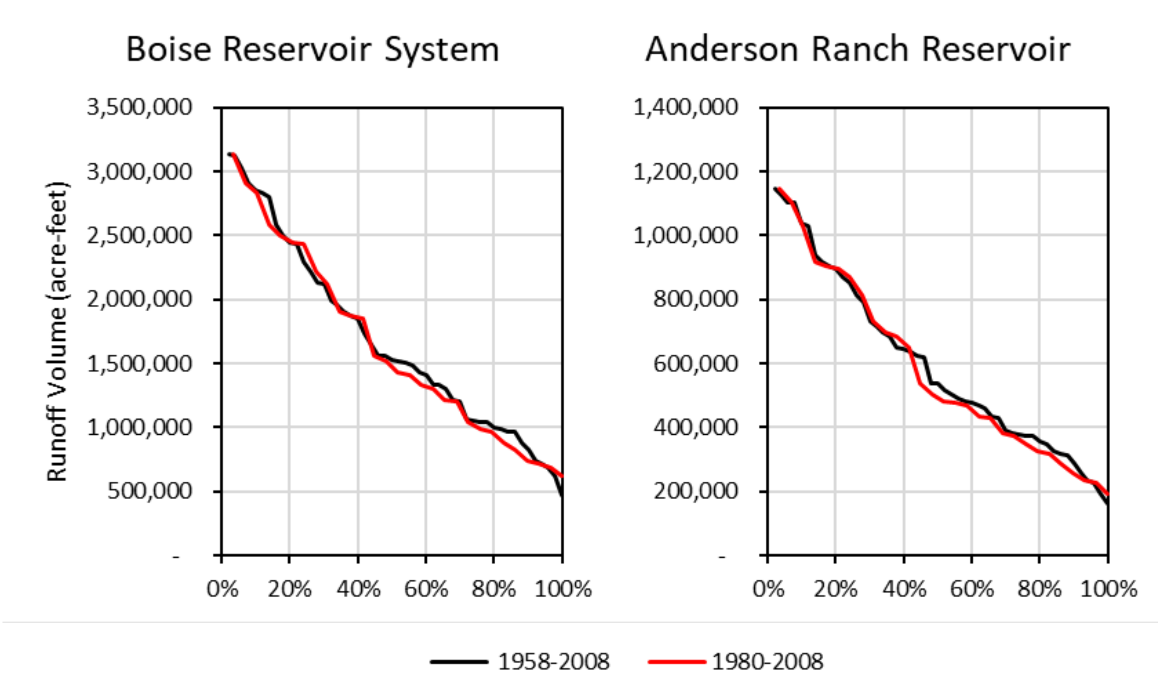
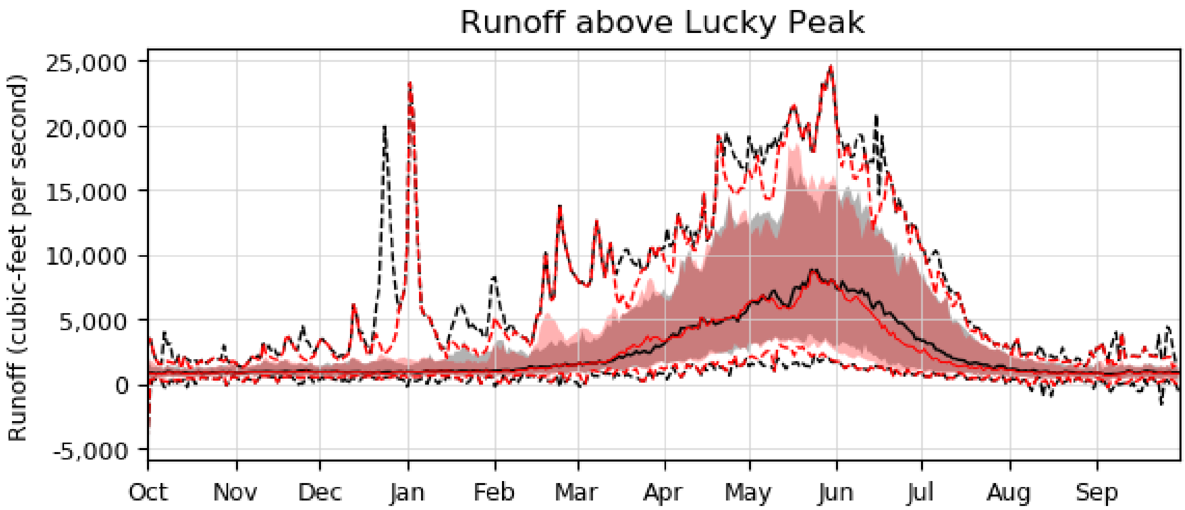


Figure 8. January through July runoff volume exceedance probabilities for the Boise Reservoir System above Lucky Peak Dam and above Anderson Ranch Reservoir. Black lines represent the 1958 through 2008 analysis period, while the red lines represent the shorter 1980 through 2008 period.

Figure 9 depicts the summary hydrographs for runoff above Lucky Peak Dam and above Anderson Ranch Dam. Both panels in this figure exhibit earlier runoff recession in June and July for the shorter analysis period as indicated by the red line falling below the black line in June and July, a critical period for refilling the reservoir system following winter FRM operations.



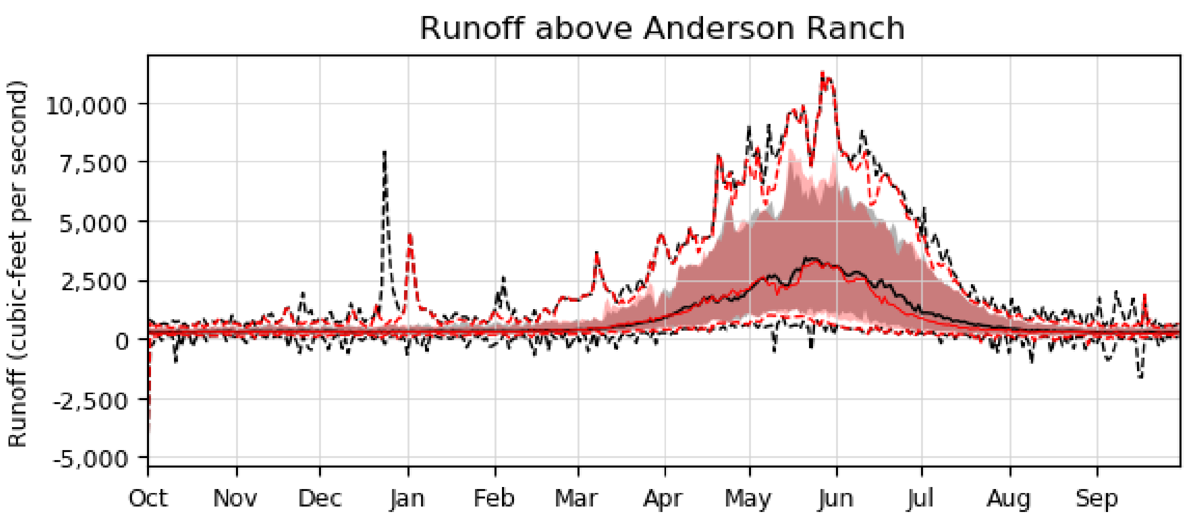


Figure 9. Summary hydrographs depicting the daily runoff conditions for the Boise Reservoir System above Lucky Peak Dam (top panel) and above Anderson Ranch Dam (bottom panel). The black lines and gray region represent the full 1958 through 2008 analysis period, while the red lines and shaded red region represent the shorter 1980 through 2008 analysis period. Solid lines represent the daily median runoff values, shaded regions are bound by the 10^{th}-percentile to 90^{th}-percentile values, and dashed lines represent the daily minimum and maximum values.

The combination of increased low-volume years and earlier streamflow recession in the shorter 1980 through 2008 period creates conditions where the reservoir system refills less frequently. This is shown in Figure 10 and Figure 11, where annual maximum storage volume is plotted relative to January through July runoff volume. Note that the 1980 through 2008 period is a subset of the 1958 through 2008 period; therefore, the black dots in these figures represent the 1958 through 1980 period, the red dots represent the 1980 through 2008 period, and the full 1958 through 2008 period is represented by the red and black dots combined. In the earlier part of the 1958 through 2008 period (black dots), the system consistently fills in years where runoff is greater than 1.0 million acre-feet (MAF), whereas in the later period (red dots), the system consistently fills in years where runoff is greater than 1.5 MAF. Below these thresholds, the system may still fill depending on carryover conditions. The 1958 through 2008 modeling period contains a larger proportion of years with system runoff greater than 1.5 MAF (52 percent of years) compared to the 1980 through 2008 period (45 percent of years), yet also features the driest year in the dataset (less than 500 thousand acre-feet (KAF) January through July runoff volume).

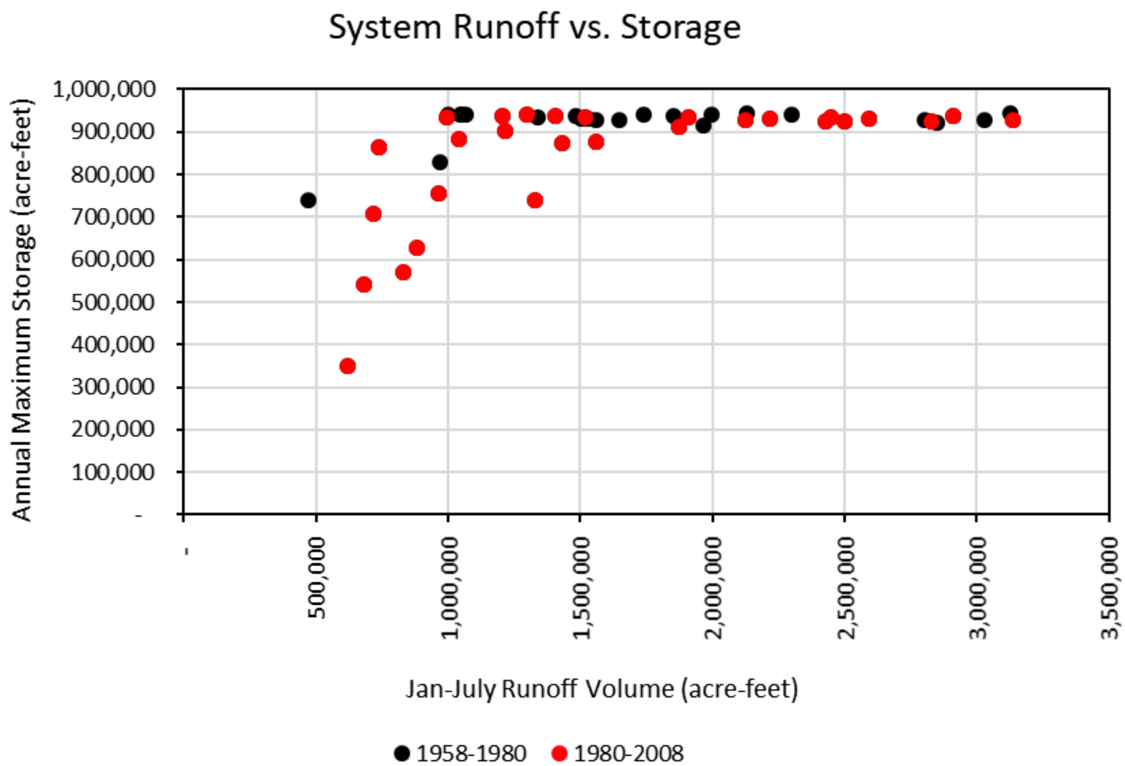


Figure 10. Annual maximum simulated Boise Reservoir System storage vs. January through July runoff volumes above Lucky Peak Dam. Black dots represent the 1958 through 1980 period and red dots represent the 1980 through 2008 period. The full 1958 through 2008 analysis period is therefore represented by the black and red dots combined.

Figure 11 is similar to Figure 10, but shows maximum storage and runoff for Anderson Ranch Reservoir only. As shown in Figure 11, Anderson Ranch Reservoir fills consistently at January through July runoff volumes greater than 350 KAF in the earlier part of the 1958 through 2008 period (black dots). This is in contrast to the later period (red dots), where the reservoir only fills consistently at runoff volumes greater than 600 KAF. In order to better understand how period selection influences model results, Section 3 summarizes key differences in reservoir operations results between the two analysis periods.

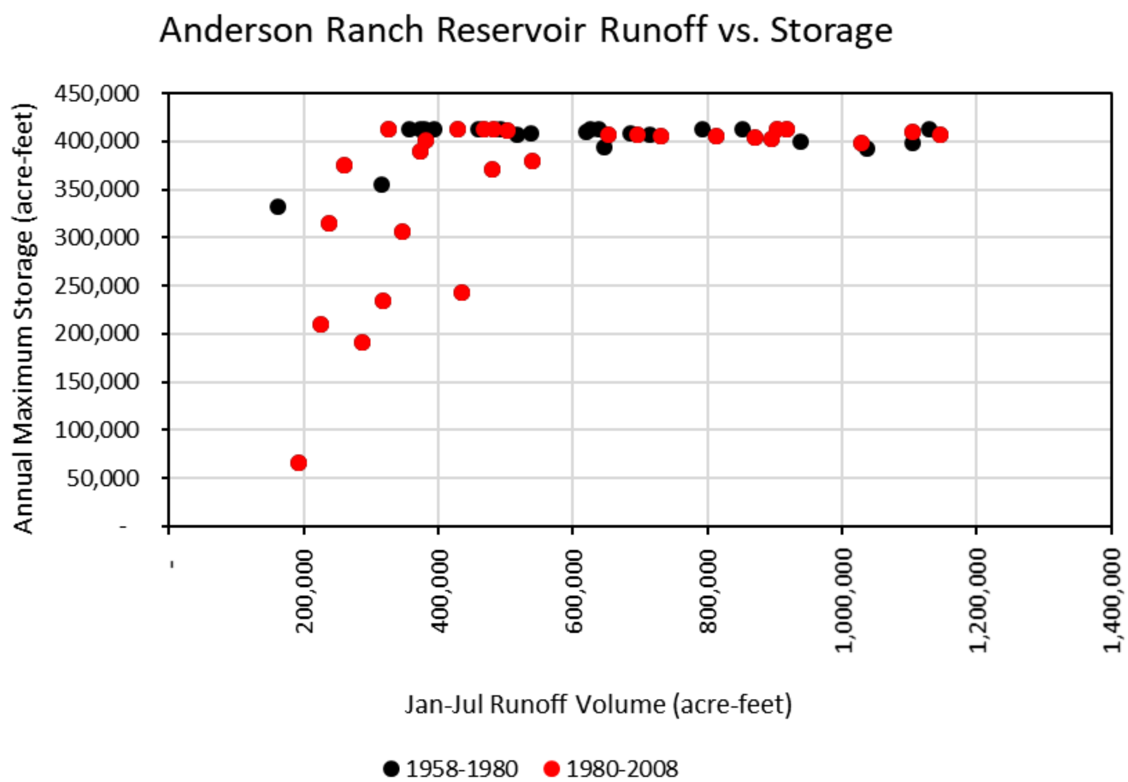


Figure 11. Annual maximum Anderson Ranch Reservoir storage vs. January through July runoff volumes above Anderson Ranch Dam. Black dots represent the 1958 through 1980 period and red dots represent the 1980 through 2008 period. The full 1958 through 2008 analysis period is therefore represented by the black and red dots combined.

The effect of the choice of period is most notable in the Water Availability Analysis (Section 5). Appendix A of this technical memorandum includes plots and discussion of how the analysis period effects the results of the Alternatives.

2.3 Anderson Ranch Reservoir Water Quality Model

The Anderson Ranch Reservoir Water Quality Model consists of a CE-QUAL-W2 (Cole and Wells 2018) model calibrated for the period spanning April 2016 through October 2017. The CE-QUAL-W2 (Version 4.1) model is a two-dimensional, laterally averaged hydrodynamic and water-quality model. Figure 12 illustrates the model segments and spatial extent.

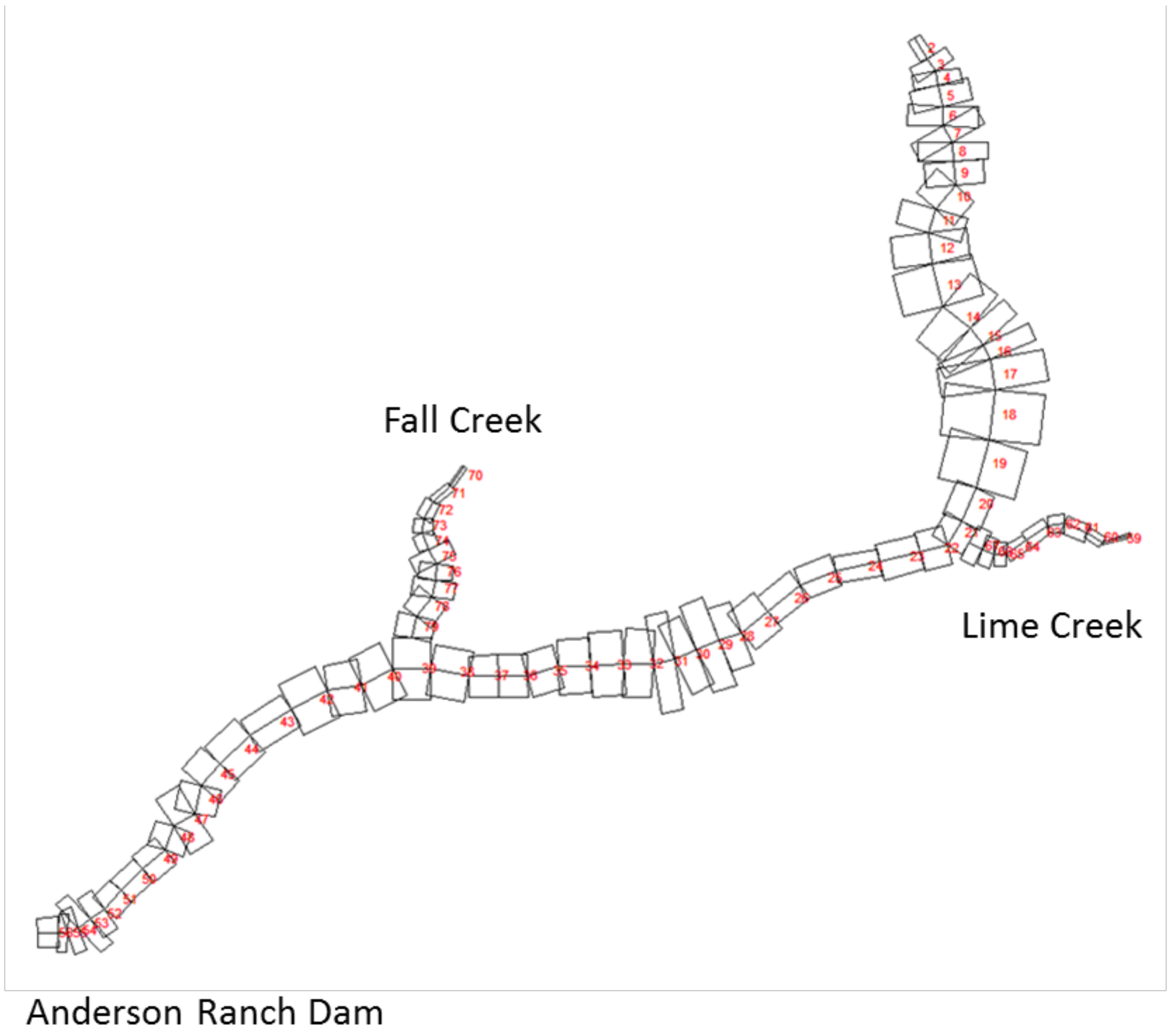


Figure 12. Anderson Ranch Reservoir water quality model segments. The main waterbody extends from the South Fork of the Boise River at Featherville, Idaho to Anderson Ranch Dam. Tributaries represented in the model include Lime Creek and Fall Creek.

Calibration of this preliminary model focused primarily on temperature regimes within the reservoir and in the reservoir outflow. The model has been utilized to confirm baseline water quality conditions in Anderson Ranch Reservoir and to better understand how a 6-foot raise might influence temperature regimes in the South Fork Boise River below Anderson Ranch Dam. Figure 13 illustrates the model simulated temperature (red dotted line) along with the historical observations (black solid line) for the calibration period spanning April 2016 through September 2017. As shown in the figure, the current calibration of the model tends to over-predict outflow temperatures during the warmest parts of the temperature regime and under-predict outflow temperatures during the cooler periods. For this study, these biases are considered in the interpretation of results.

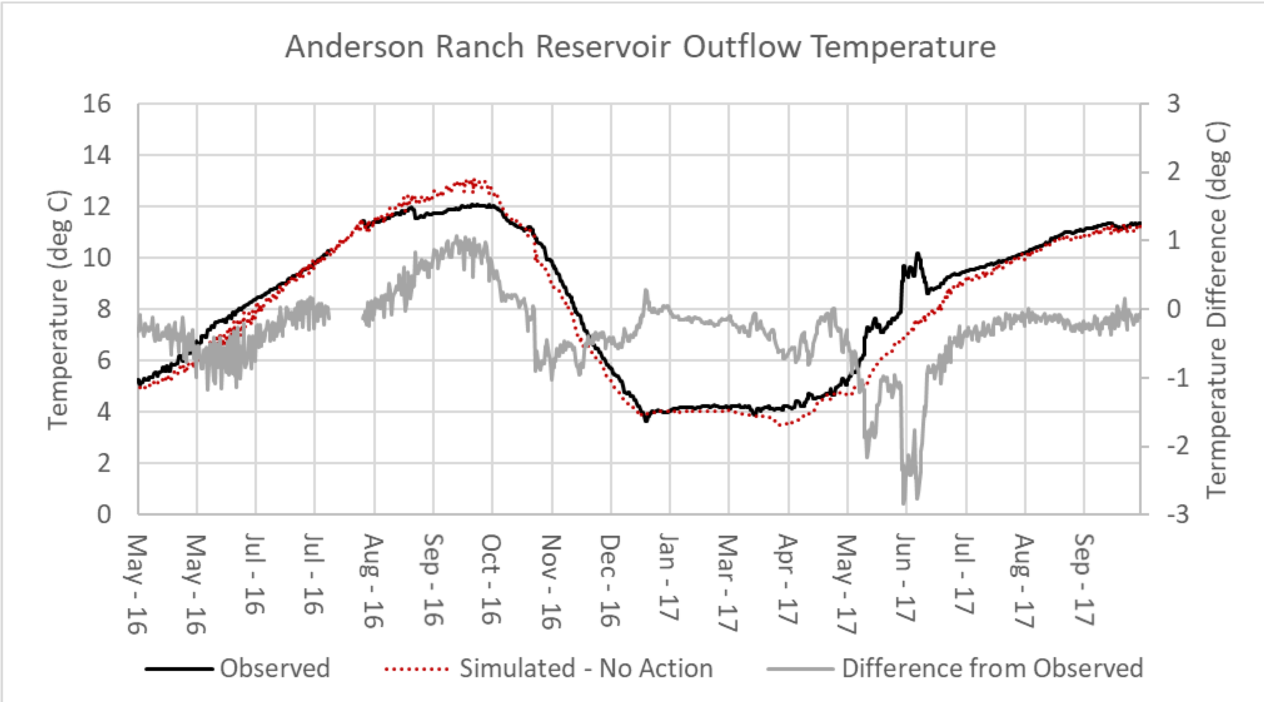


Figure 13. Simulated No Action (red dashed line) and observed (black solid line) outflow temperatures, along with the difference between the two (gray solid line), at Anderson Ranch Dam for the period spanning April 2016 through September 2017.

3 Boise System Operations Analysis

The Boise System Operations Analysis used the Boise Planning model, and the new storage was simulated by increasing the size of Anderson Ranch Reservoir for Alternative B (6-foot Raise) and Alternative C (3-foot Raise). FRM operations remained similar to historical, as the new storage space is not anticipated to be used for FRM. Irrigation delivery operations remained similar to historical with the exception of the additional storage releases from the new space. Any storage in the new space was routed downstream using one of four demand patterns (Table 3). Four patterns were simulated for this analysis because it is uncertain how the new storage water will be used, and there are possible different use patterns that could result in differences in carry-over storage or downstream flows. To evaluate the range of the impacts of the demand patterns for each storage scenario, the results are combined and summarized in the following plots.

Table 3. Demand pattern descriptions.

Number	Name	Description
1	No New Demand	The No New Demand pattern is based on the potential condition where the new space is used to satisfy existing surface water demands in cases where shortage might have otherwise occurred. In this scenario, water users above Glenwood have access to the accrued storage on an as-needed basis.
2	New Early-Season Demand	The New Early-Season Demand pattern is based on the potential condition where water accrued to the new space might be called upon early in the irrigation season. This is similar to the release of storage for flow augmentation (NOAA Fisheries 2008) in the spring and early summer. Use of accrued storage in this scenario is limited by flows at Glenwood[4], where flow augmentation releases occur only when flows at this location are less than 3,000 cfs. As a result of this limitation, water accrued to the new storage account may not be completely exhausted every year.
3	Irrigation Season Demand	The New Irrigation Season Demand pattern is based on the condition where water accrued to the new space is delivered during the irrigation season to users upstream of Glenwood. The water is released at a constant rate from the day the system is full (Day of Allocation) through October 15. Ten percent of the proposed space could be used to provide operational flexibility or for environmental purposes, which could include environmental flows.
4	New M&I Demand	The New M&I Demand pattern is based on the potential condition where water accrued to the new space is delivered for M&I purposes upstream of Glenwood. The water is released at a rate that changes depending on the time of year, similar to current M&I groundwater deliveries (SPF 2016; Table 13) from day the system is full (Day of Allocation) through March 15 of the following year. Ten percent of the proposed space could be used to provide operational flexibility or for environmental purposes, which could include environmental flows.

Plots presented in Section 3 below are shown to summarize the results for the two increased storage Alternatives (6-foot Raise and 3-foot Raise) as compared to No Action (baseline). The plots are shown as summary hydrographs of storage or flow with the daily 50th-percentile (solid lines) and the 10th-percentile to 90th-percentile range (shaded areas). The red solid region in this figure represents the full range of the daily median values associated with the four demand scenarios, while the shaded blue (6-foot Raise) or green (3-foot Raise) region captures the full range of the 10th- to 90th-percentiles. When the 10th percentile and 90th-percentile values of No Action and the Alternatives overlap, the shading becomes darker. When they don't overlap, only the lighter shading appears. The dashed black and blue or green lines represent the absolute maximum and minimum daily values in the Baseline Scenario and the Alternatives.

Although the modeling assumptions may not capture all of the complexities of real-time operations, the model output provides data that allow for the comparison of scenarios (No Action versus the Alternatives).

[4] Similar to real-time operations, the modeling scenarios assumed that if seasonal flow targets during the irrigation season were meet at Glenwood, this would also satisfy irrigation downstream of Glenwood.

3.1 System Storage

Figure 14 depicts the summary hydrograph of the system storage for Alternative B (6-foot Raise) as compared to Alternative A (No Action). The system storage in the 6-foot Raise is up to 29,000 acre-feet larger than No Action. The variation in storage is partly due to the different demand patterns that either use all of the water each year or results in some carryover. It is also partly due to the variability of water available to fill the new space. Generally, the system has more storage year-round due to some carryover of water in the new storage space except for the driest years where it is similar to No Action.

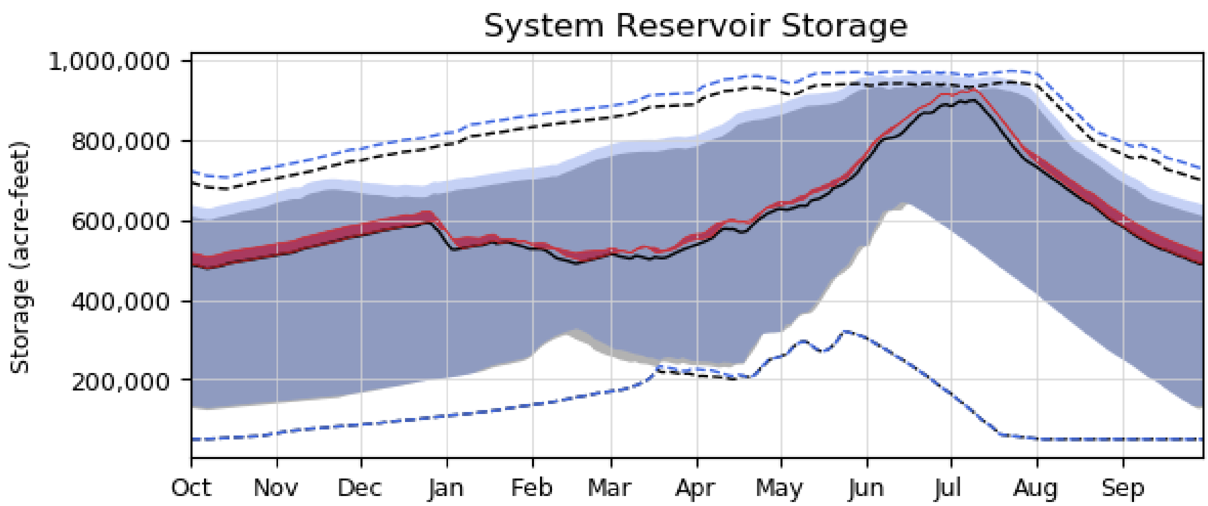


Figure 14. Boise Reservoir System summary storage hydrograph depicting the daily median storage content range for the 6-foot Raise (red region) and daily median for No Action (black line). The shaded blue region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed blue and black lines represent the daily minimum and maximum values. Storage values do not include 36,956 acre-feet of inactive powerhead space in Anderson Ranch Reservoir.

Figure 15 depicts the summary hydrograph of the system storage for Alternative C (3-foot Raise). This scenario behaves similarly to Alternative B, but the additional storage is only 14,400 acre-feet. As in Alternative B, the system has more storage except for the driest years.

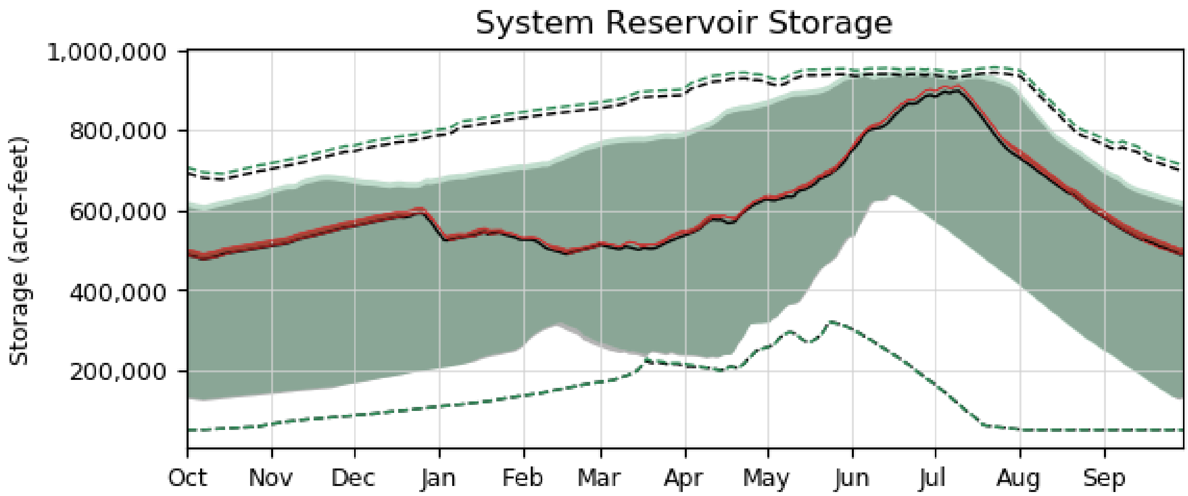


Figure 15. Boise Reservoir System summary storage hydrograph depicting the daily median storage content range for the 3-foot Raise Alternative (red region) and daily median for No Action (black line). The shaded green region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 3-foot Raise and No Action, respectively. Dashed green and black lines represent the daily minimum and maximum values. Storage values do not include 36,956 acre-feet of inactive powerhead space in Anderson Ranch Reservoir.

3.2 Anderson Ranch Reservoir

As shown by the summary hydrograph in Figure 16, Alternative B (6-foot Raise) would result in a year-round increase in daily storage contents at Anderson Ranch Reservoir compared to No Action by as much as 29,000 acre-feet. The system is operated in both Alternatives and No Action to make deliveries out of the lower two reservoirs (Lucky Peak and Arrowrock) while using storage from Anderson Ranch Reservoir to back fill as needed since it is on a tributary with less reliable water supply. In Alternatives B and C, this results in more water being held in Anderson Ranch Reservoir while the additional irrigation demand for the new storage is met with water from the lower system. This results in Anderson Ranch Reservoir having more storage in most years while Lucky Peak Reservoir and Arrowrock Reservoir generally have lower storage.

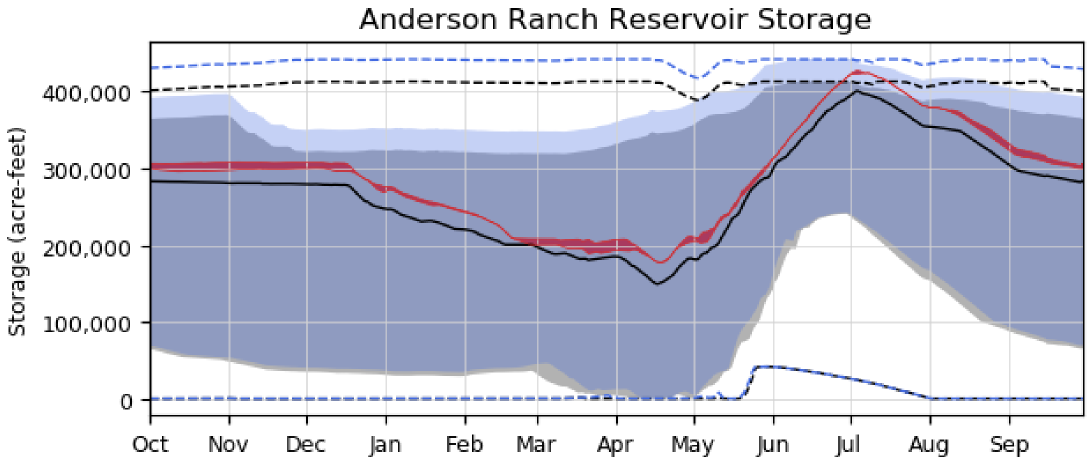


Figure 16. Anderson Ranch Reservoir summary storage hydrograph depicting the daily median storage content range 6-foot Raise Alternative (red region) and daily median for No Action (black line). The shaded blue region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed blue and black lines represent the daily minimum and maximum values. The 0 acre-feet storage line corresponds to the minimum storage target of maintaining 62,000 acre-feet of dead and inactive space in the reservoir including 36,956 acre-feet of inactive powerhead space.

Figure 17 shows the summary hydrograph for Alternative C (3-foot Raise) compared to No Action. As with the 6-foot Raise, storage is generally larger than No Action in Anderson Ranch Reservoir except for the driest years.

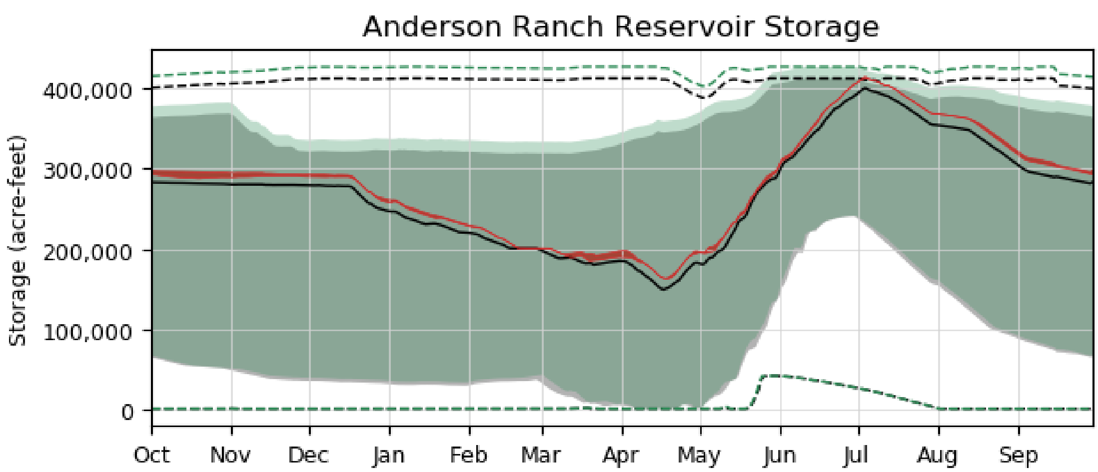


Figure 17. Anderson Ranch Reservoir summary storage hydrograph depicting the daily median storage content range for the 3-foot Raise Alternative (red region) and daily median for No Action (black line). The shaded green region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 3-foot Raise and No Action, respectively. Dashed green and black lines represent the daily minimum and maximum values. The 0 acre-feet storage line corresponds to the minimum storage target of maintaining 62,000 acre-feet of dead and inactive space in the reservoir including 36,956 acre-feet of inactive powerhead space.

When pool elevations are greater than 4,174 feet, releases over 11,700 cfs require use of the spillway at Anderson Ranch Dam. Given storage elevations and outflow conditions at Anderson Ranch Reservoir over the 1958 through 2008 analysis period, model results indicate no need for increased use of the spillway.

A stipulation of Reclamation's incidental take permit (USFWS 2005) is for a minimum volume threshold of 62,000 acre-feet in Anderson Ranch Reservoir to be maintained 93 percent of the years. This threshold volume represents the amount of water stored in the dead pool and inactive space, thus corresponding to the top of the inactive power head space and represented by zero-storage in Figure 16 and Figure 17. As shown in the figures, and like No Action, results from the Alternatives indicate the potential for storage contents to approach, but not fall below, this threshold. Median and 90^{th}-percentile daily storage conditions are well above this threshold for the Alternatives.

3.3 Arrowrock Reservoir

Arrowrock Reservoir and Lucky Peak Reservoir are currently operated such that their releases satisfy most of the downstream irrigation demands, with Anderson Ranch Reservoir providing releases to keep Arrowrock Reservoir above its minimum pool constraint. This would remain the case following one of the proposed dam raises at Anderson Ranch Reservoir.

Figure 18 illustrates the Arrowrock Reservoir storage summary hydrograph for No Action and Alternative B (6-foot Raise). The red solid region in this figure represents the full range of the possible daily median values associated with the 6-foot Raise, while the shaded-blue region captures the full range of the 10^{th}- to 90^{th}-percentiles. Due to the way the system operates (as described in Section 3.2), the additional demands are released from the lower system. The additional demands under the 6-foot Raise have the potential to result in reduced storage in Arrowrock Reservoir by the end of the irrigation season compared to No Action. Despite this reduction, Arrowrock Reservoir is shown to refill the additional space by early spring. The 10th- and 90^{th}-percentile storage conditions and the operating range are similar to No Action for the 6-foot Raise Alternative. Figure 19 shows the Arrowrock Reservoir summary pool elevation plot for the 3-foot Raise and for No Action.

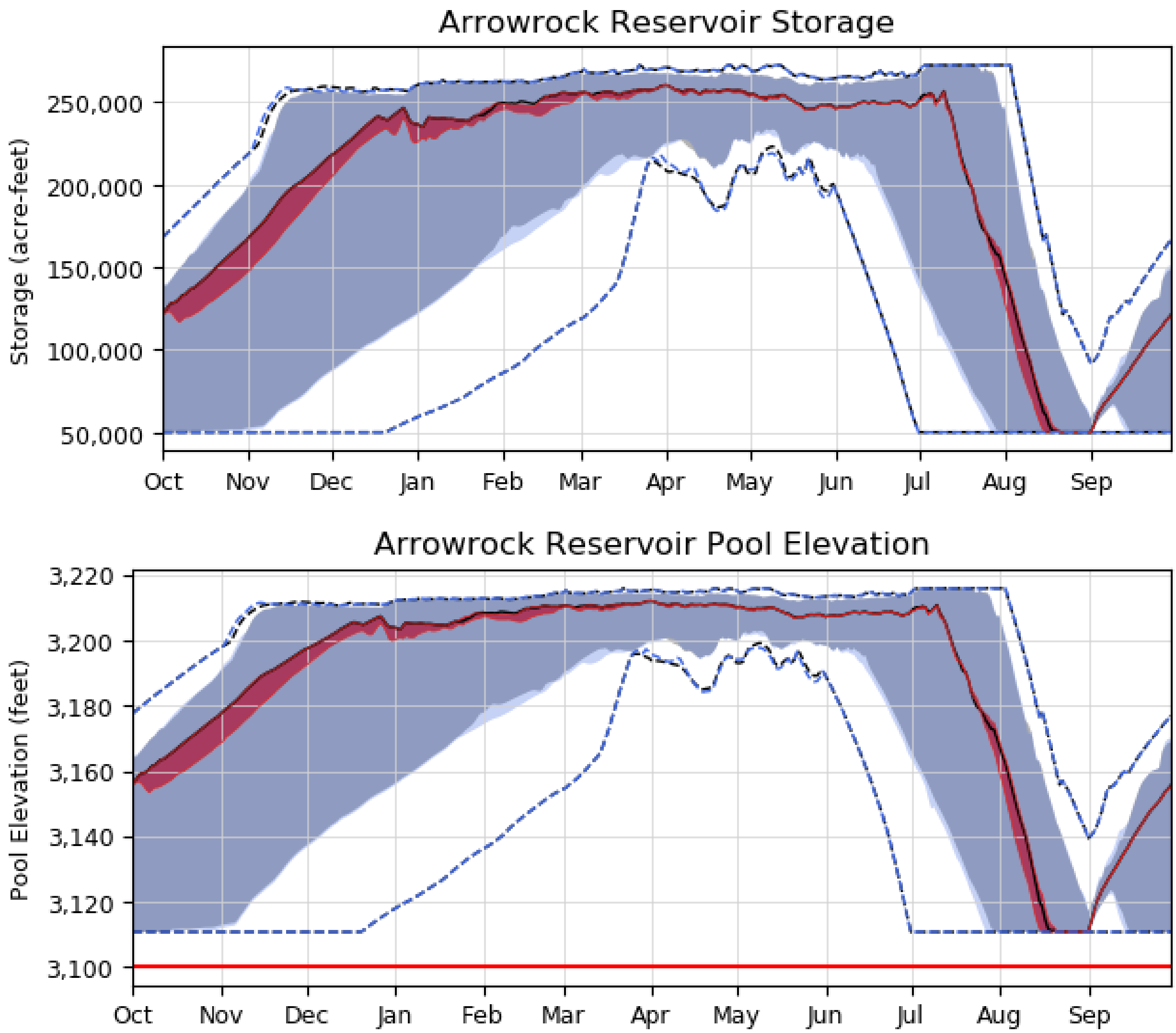


Figure 18. Arrowrock Reservoir summary pool elevation plot depicting the daily median pool elevation range for the 6-foot Raise (red region) and daily median for No Action (black line). The shaded blue region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed blue and black lines represent the daily minimum and maximum values. The red line represents the minimum pool elevation of 3,100 feet (37,912 acre-feet storage) threshold at which pool elevation conditions may adversely impact bull trout migration.

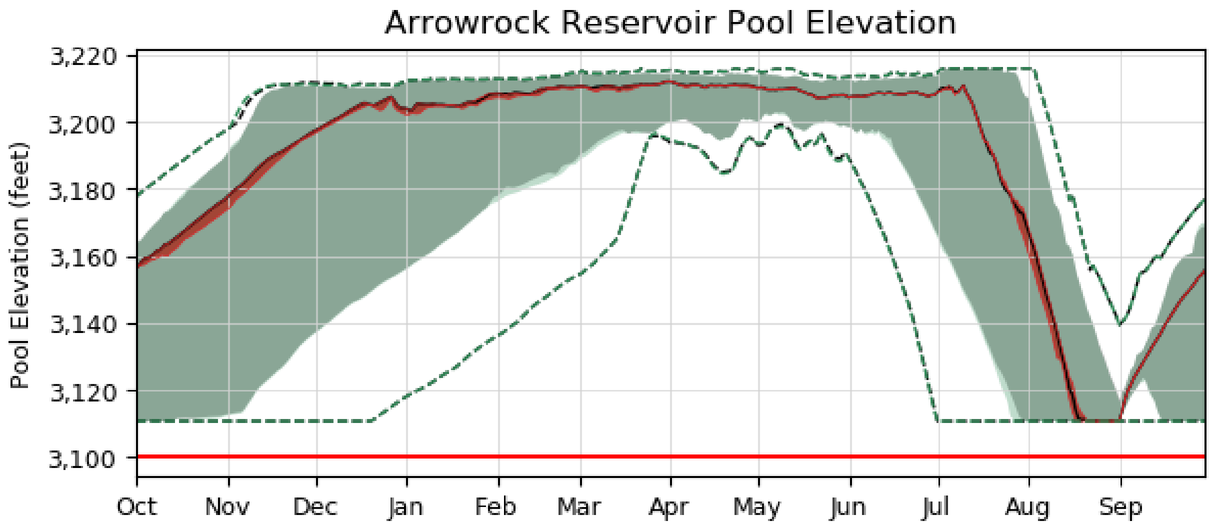


Figure 19. Arrowrock Reservoir summary pool elevation plot depicting the daily median pool elevation range for the 3-foot Raise (red region) and daily median for No Action (black line). The shaded green region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 3-foot Raise and No Action, respectively. Dashed green and black lines represent the daily minimum and maximum values. The red line represents the minimum pool elevation of 3,100 feet (37,912 acre-feet storage) threshold at which pool elevation conditions may adversely impact bull trout migration.

3.4 Lucky Peak Reservoir

Storage in Lucky Peak Reservoir associated with Alternative B (6-foot Raise) and Alternative C (3-foot Raise) changed relatively little from No Action, with the most notable changes (as seen in Figure 20 and Figure 21) occurring at the end of the irrigation season and the start of refill. The red solid region in these figures represents the full range of the daily median values associated with the raise Alternatives, while the shaded blue region captures the full range of the 10th- to 90th-percentiles. Increased demands under Alternatives B and C resulted in drafting Lucky Peak Reservoir down to the "elk pool" operational objective up to 5 days earlier when compared to No Action. From there, storage volumes are similar between No Action and the Alternatives through the winter until refill begins in February and March.

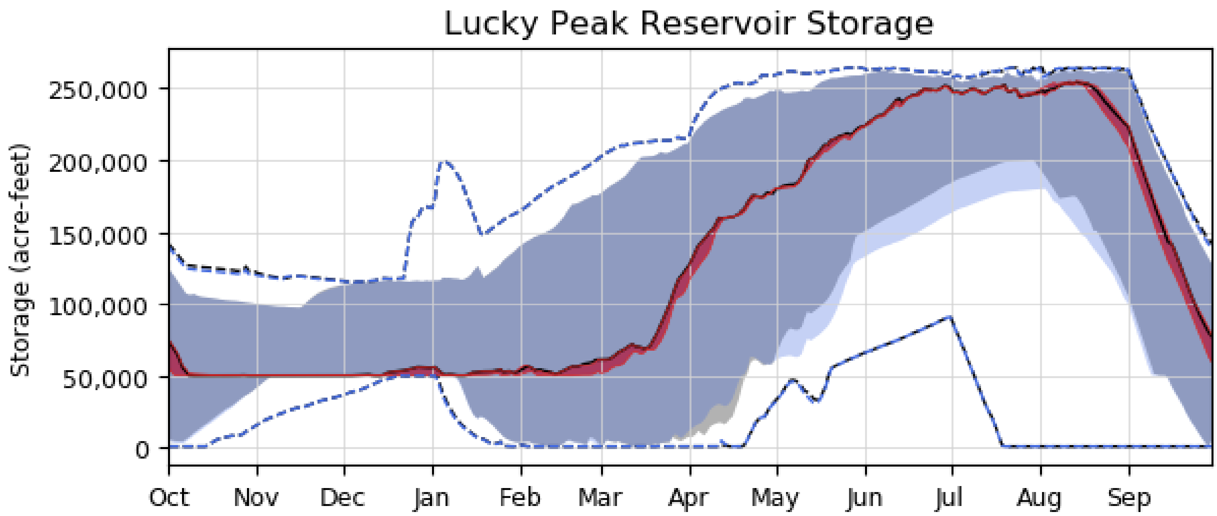


Figure 20. Lucky Peak Reservoir summary storage hydrograph depicting the daily median storage content range for the 6-foot Raise Alternative (red region) and daily median for No Action (black line). The shaded blue region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed blue and black lines represent the daily minimum and maximum values.

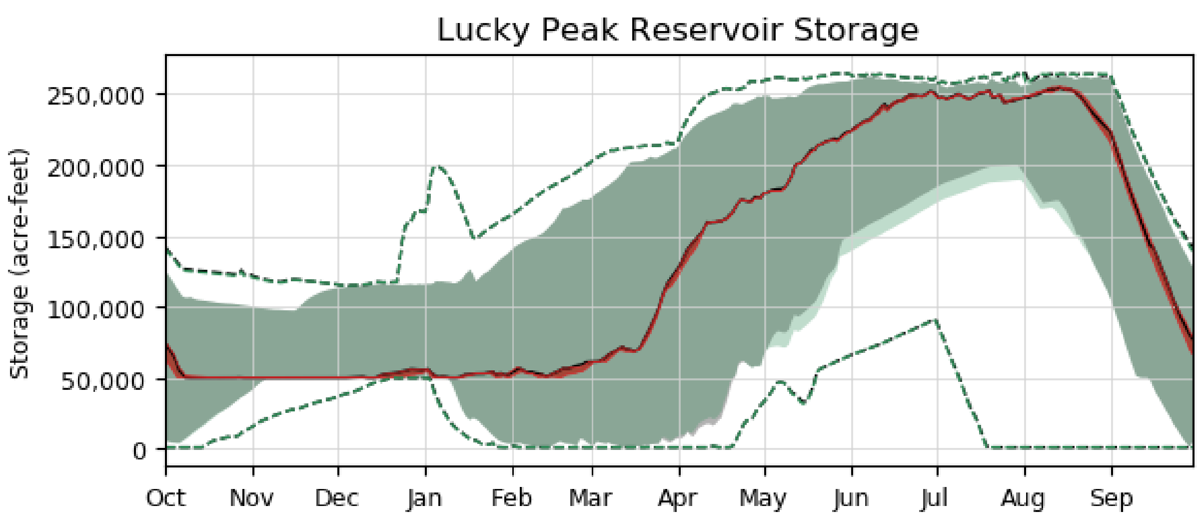


Figure 21. Lucky Peak Reservoir summary storage hydrograph depicting the daily median storage content range for the 3-foot Raise Alternative (red region) and daily median for No Action (black line). The shaded green region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 3-foot Raise and No Action, respectively. Dashed green and black lines represent the daily minimum and maximum values.

3.5 South Fork Boise River below Anderson Ranch Dam

Except under the most/least-frequent flow conditions, streamflow below Anderson Ranch Dam associated with Alternative B (6-foot Raise) and Alternative C (3-foot Raise) changed very little from the No Action condition. Figure 22 and Figure 23 illustrate the daily summary hydrograph for the 6-foot Raise and the 3-foot Raise Alternatives relative to No-Action. The largest differences between the Alternatives and No Action occurs in the early-spring in the maximum flow condition (where the model is balancing the system differently than may occur in real-time FRM operations) and in the late-spring in the maximum and 90th-percentile flow conditions (where the Alternatives result in an earlier recession as the new space refills). The median region in Figure 22 and Figure 23 show an increase in flow in mid-August with a slight difference in the timing of the increase between demand patterns. In the model, this increase in flow coincides with the point in time where releases from Anderson Ranch Dam are needed to keep Arrowrock Reservoir above a model target minimum content of 50,000 acre-feet (actual minimum pool is 3,100 feet or 37,912 acre-feet of storage). These releases are made at Anderson Ranch Dam powerplant capacity (approximately 1,600 cfs but can be as high as 1,800 cfs depending on forebay elevation/head). The daily streamflow exceedance plot in Figure 24 through Figure 29 illustrate similar findings with very little difference observed between the demand scenarios and the baseline condition.

In real-time operations, flows out of Anderson Ranch Reservoir to backfill Arrowrock Reservoir would likely begin earlier and result in a more constant flow through the end of the summer. The duration of these flows will depend upon on the required release volume. For example, a release of the full 6-foot Raise new-storage volume (29,000 acre-feet) would equate to 9.1 days of flow at 1,600 cfs and 4.5 days for the 3-foot Raise.

Minimum flow targets and ramping rates (the rate at which outflows can be increased or decreased) have been established for the South Fork Boise River below Anderson Ranch Dam for the purpose of maintaining fisheries habitat. These minimum flow targets are depicted by red lines in Figure 26, Figure 27, Figure 28, and Figure 29; 300 cfs from September 15 through March 31 and 600 cfs from April 1 through September 15. Modeling results indicate no changes to the potential of Anderson Ranch Dam outflows continuing to meet these minimum flow targets and ramping rates as compared to the No-Action.

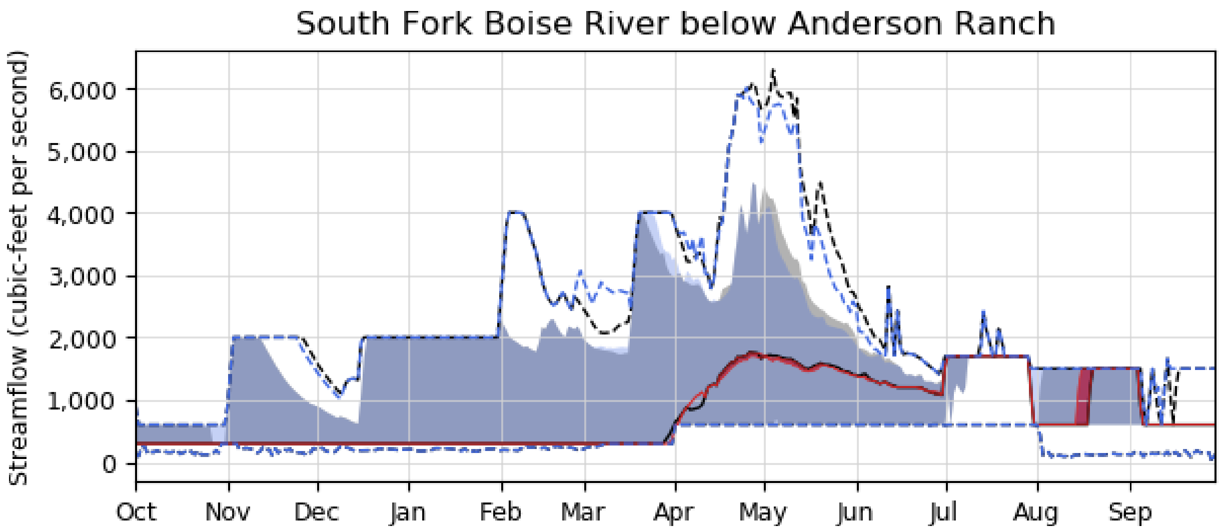


Figure 22. South Fork Boise River below Anderson Ranch Dam summary streamflow hydrograph depicting the daily median streamflow range for the 6-foot Raise (red region) and daily median for No Action (black line). The shaded blue region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed blue and black lines represent the daily minimum and maximum values.

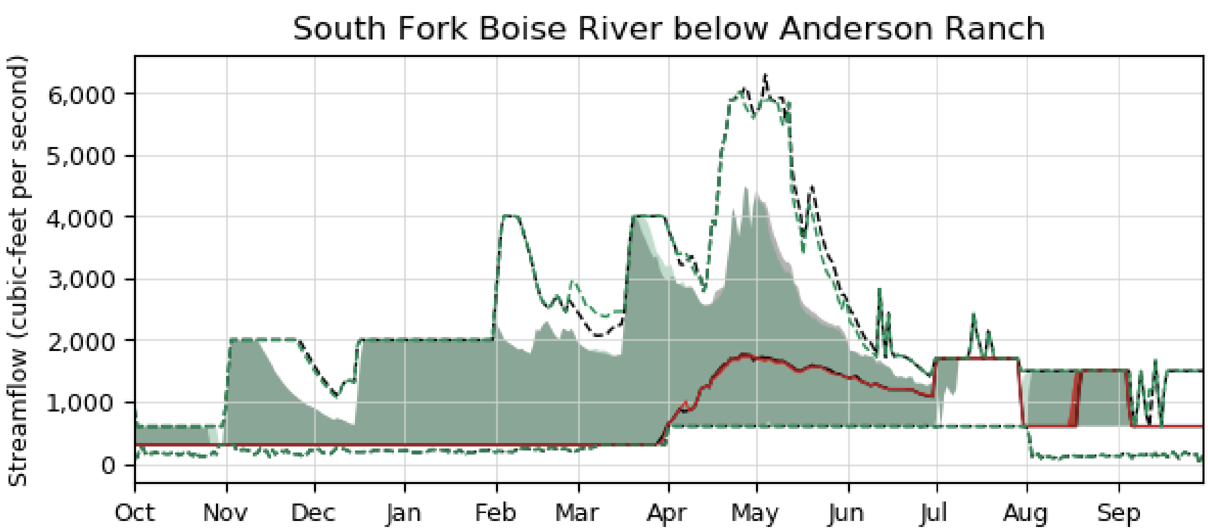


Figure 23. South Fork Boise River below Anderson Ranch Dam summary streamflow hydrograph depicting the daily median streamflow range for the 3-foot Raise (red region) and daily median for No Action (black line). The shaded green region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 3-foot Raise and No Action, respectively. Dashed green and black lines represent the daily minimum and maximum values.

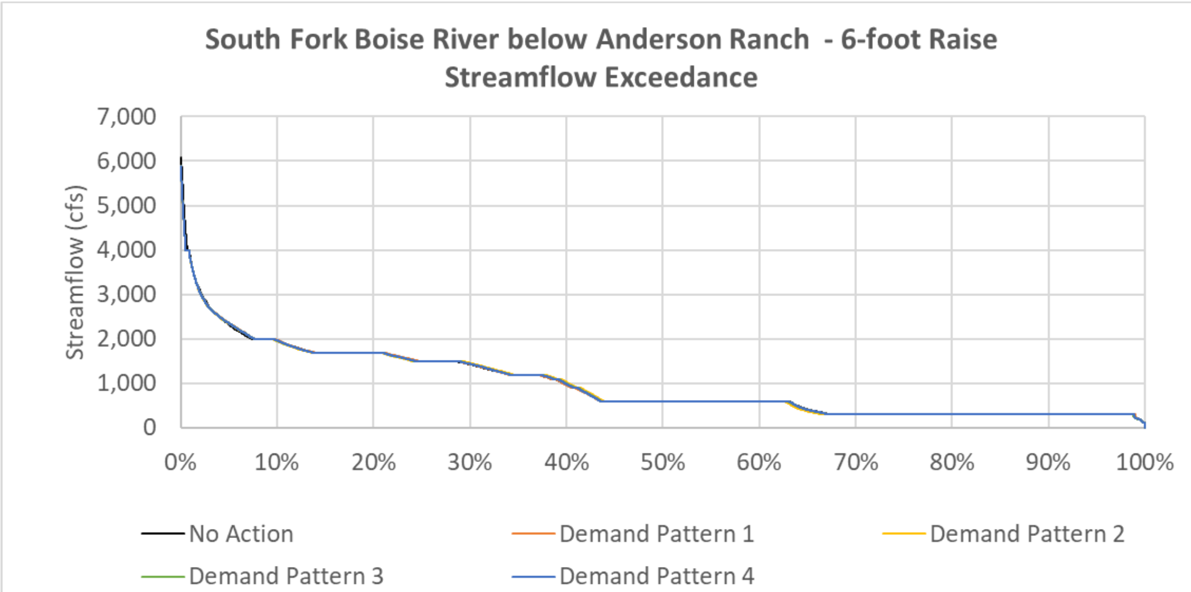


Figure 24. South Fork Boise River below Anderson Ranch Dam streamflow exceedance plot for the 6-foot Raise Alternative. The exceedance percentile represents the percent of days in the analysis period that streamflow was greater than or equal to a given streamflow amount.

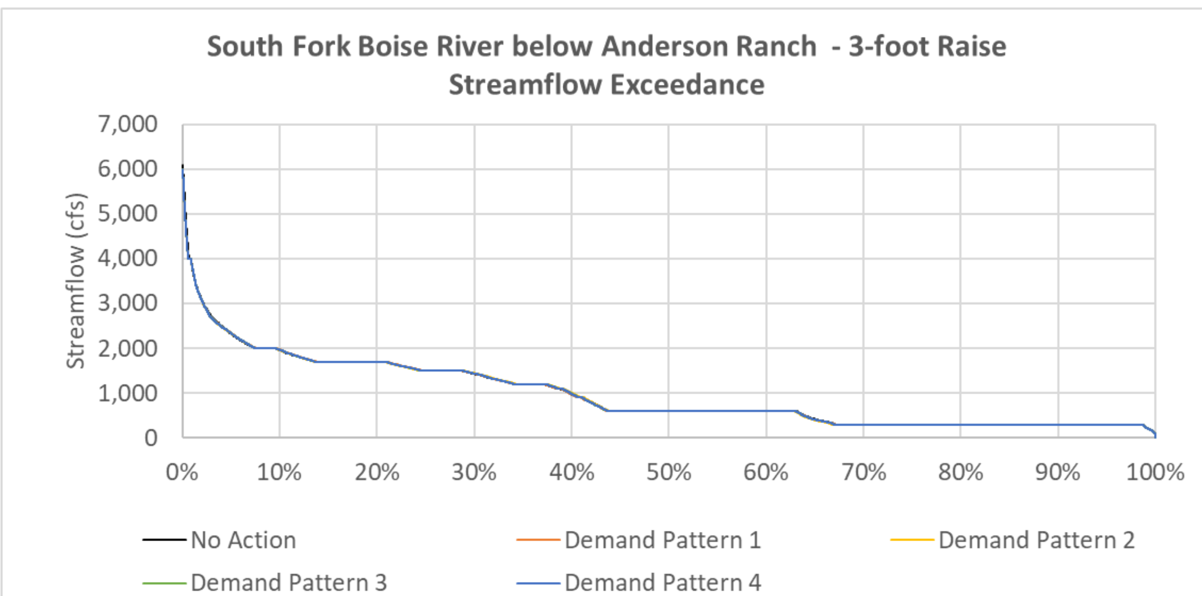


Figure 25. South Fork Boise River below Anderson Ranch Dam streamflow exceedance plot for the 3-foot Raise Alternative. The exceedance percentile represents the percent of days in the analysis period that streamflow was greater than or equal to a given streamflow amount.

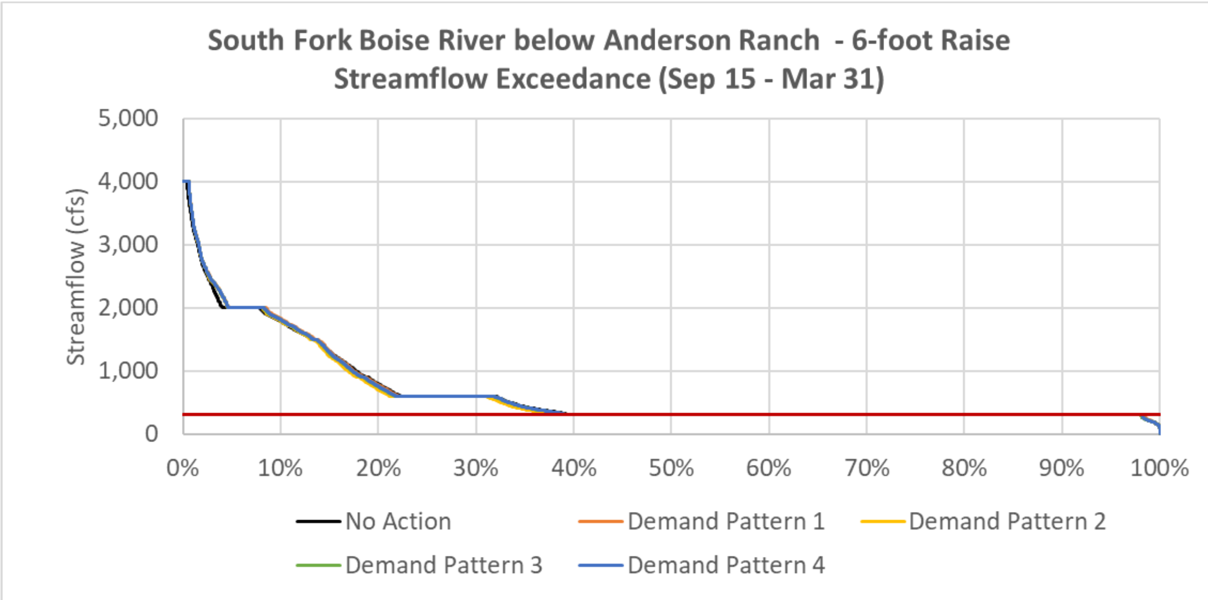


Figure 26. South Fork Boise River below Anderson Ranch Dam winter streamflow exceedance plot during the months of September 15 through March 31 for the 6-foot Raise Alternative. The exceedance percentile represents the percent of days in the analysis period that streamflow was greater than or equal to a given streamflow amount. Red line represents 300 cfs threshold.

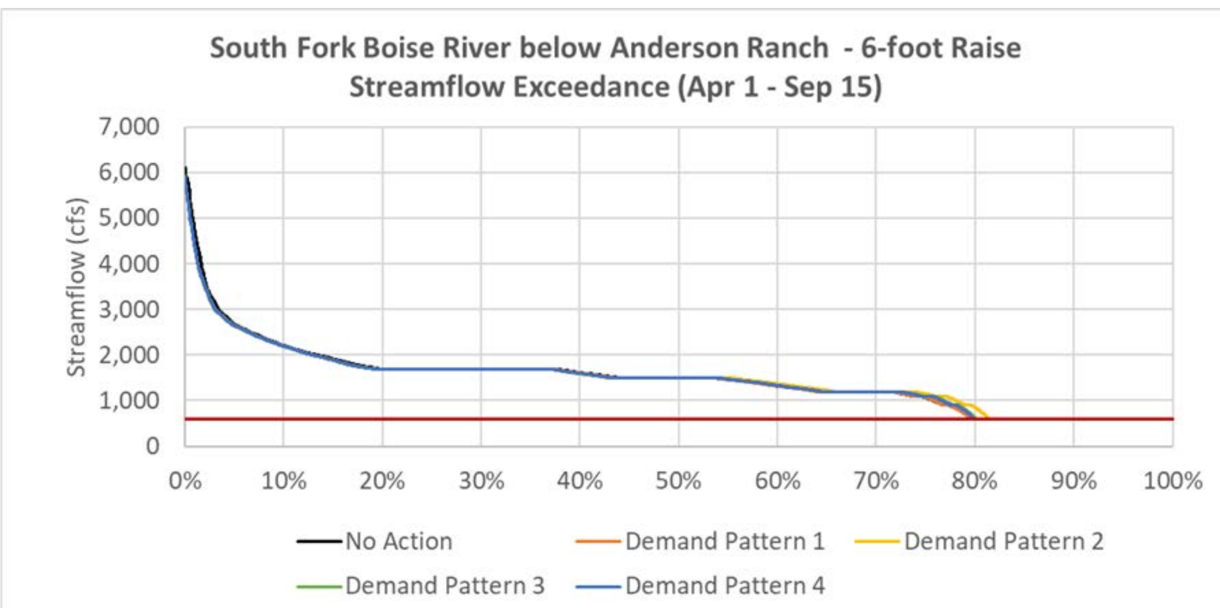


Figure 27. South Fork Boise River below Anderson Ranch Dam winter streamflow exceedance plot during the months of April 1 through Sept 15 for the 6-foot Raise Alternative. The exceedance percentile represents the percent of days in the analysis period that streamflow was greater than or equal to a given streamflow amount. Red line represents 600 cfs threshold.

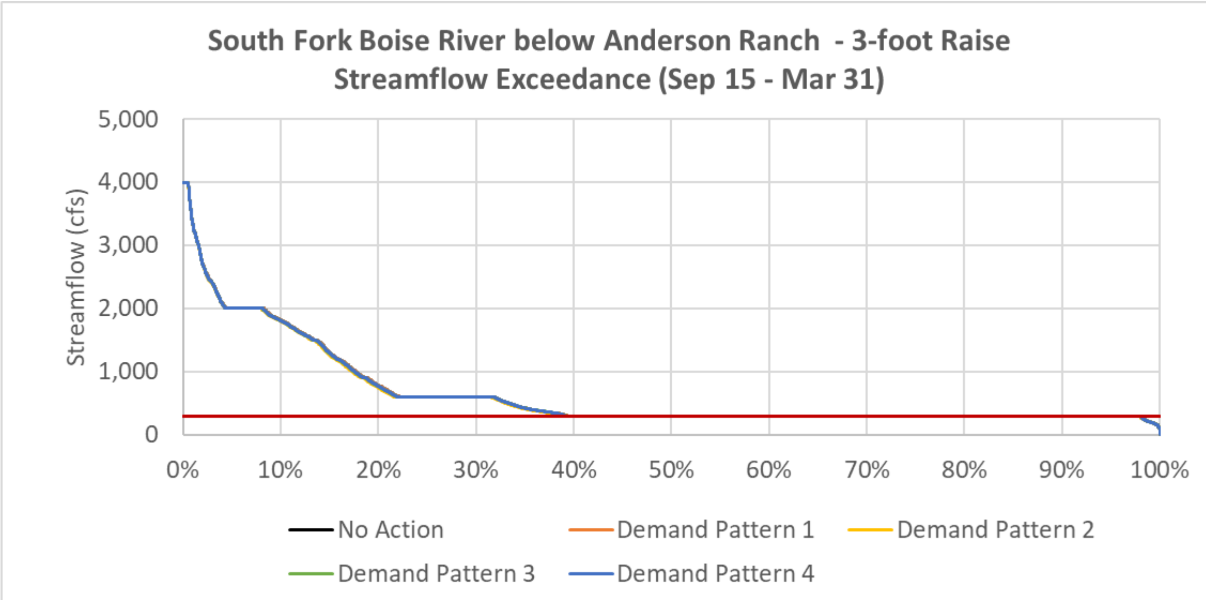


Figure 28. South Fork Boise River below Anderson Ranch Dam winter streamflow exceedance plot during the months of September 15 through March 31 for the 3-foot Raise Alternative. The exceedance percentile represents the percent of days in the analysis period that streamflow was greater than or equal to a given streamflow amount. Red line represents 300 cfs threshold.

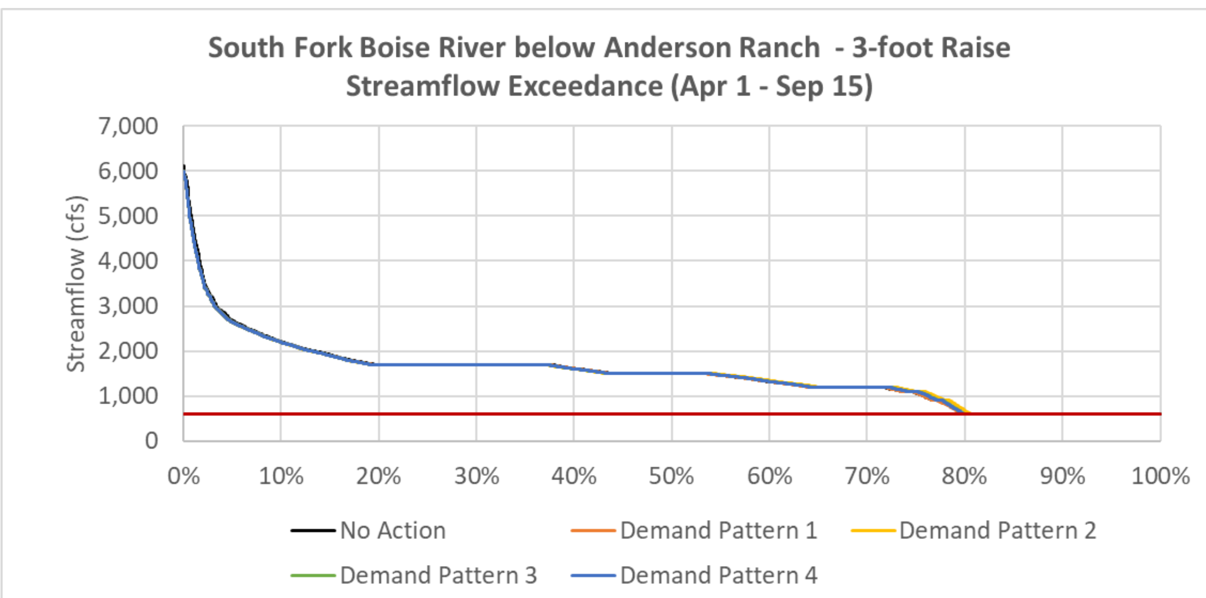


Figure 29. South Fork Boise River below Anderson Ranch Dam spring streamflow exceedance plot during the months of April 1 through September 15 for the 3-foot Raise Alternative. The exceedance percentile represents the percent of days in the analysis period that streamflow was greater than or equal to a given streamflow amount. Red line represents 600 cfs threshold.

Temperature regimes in the South Fork Boise River below Anderson Ranch Dam are important for supporting trout habitat. Based on operations modeling that suggested the potential for increased year-round storage in Anderson Ranch Reservoir, the Anderson Ranch Reservoir Water Quality Model was run assuming a 6-foot and a 3-foot increased pool depth across the entire 2016 and 2017 calibration period. All other model parameters and input data remained the same as the No Action condition. As illustrated in Figure 30, results for the 6-foot pool depth increase suggest some potential for decreased temperatures during the times of year when water temperatures are typically the highest. Results also show temperatures remaining between 2 degrees C and 15 degrees C (the suitable temperature range for trout) over the analysis period. Figure 31 shows the results for the 3-foot pool depth increase simulation. These results indicate temperatures similar to No Action.

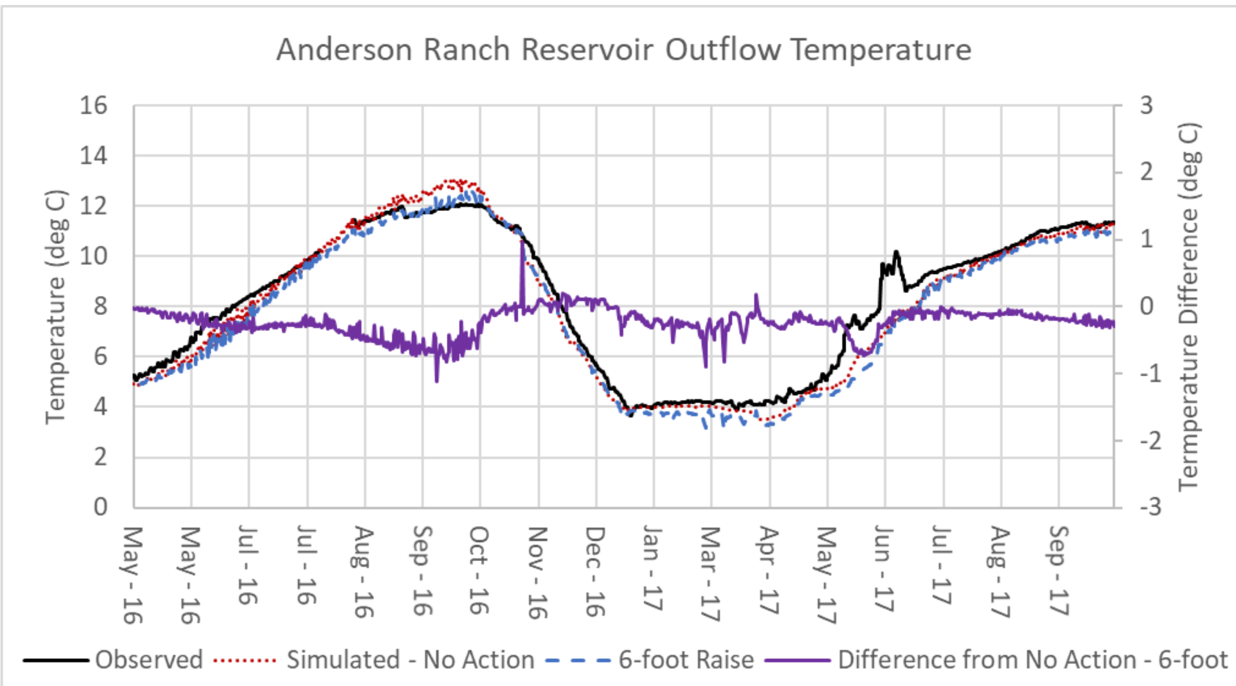


Figure 30. Simulated Anderson Ranch Dam outflow temperatures for the baseline condition and a theoretical sensitivity analysis scenario involving a year-round 6-foot deeper pool elevation. Temperature timeseries were generated using CE-QUAL-W2.

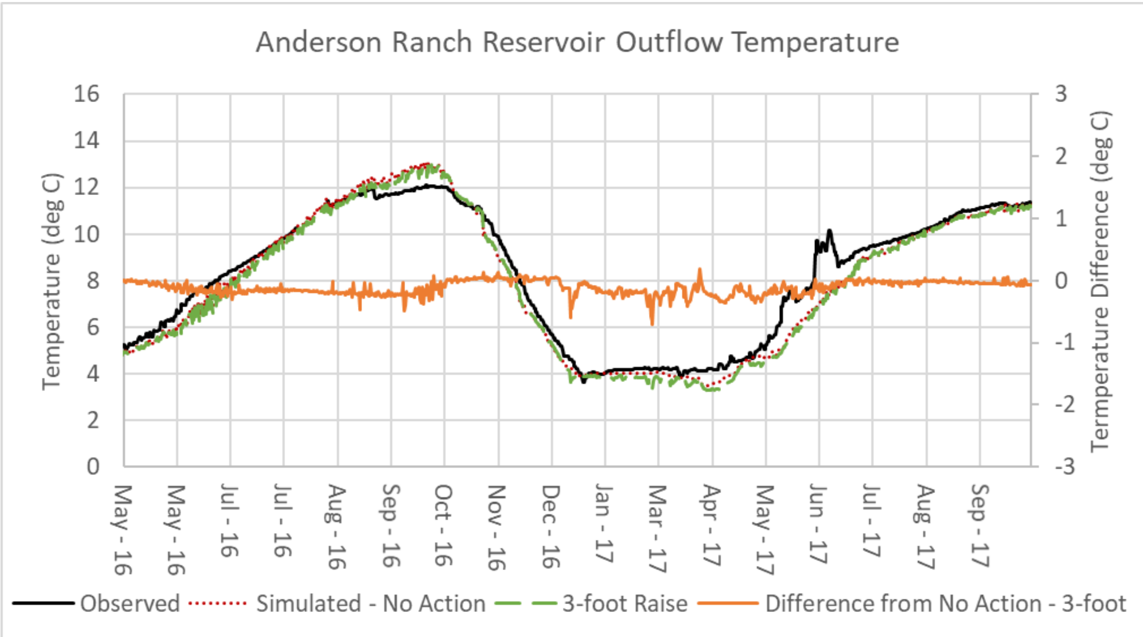


Figure 31. Simulated Anderson Ranch Dam outflow temperatures for the baseline condition and a theoretical sensitivity analysis scenario involving a year-round 3-foot deeper pool elevation. Temperature timeseries were generated using CE-QUAL-W2.

3.6 Boise River at Glenwood

The Boise System Reservoirs (Anderson, Arrowrock, and Lucky Peak) are collectively operated to provide FRM operations and limit flows when possible to 6,500 cfs or less at the Boise River at Glenwood Bridge location. During real-time operations, beginning on January 1st and generally continuing each month through July, the U.S. Army Corps of Engineers' Walla Walla District and Reclamation's Columbia Pacific Northwest Region water management groups generate and coordinate seasonal runoff volume forecasts for the Boise River basin. These forecasts are used to determine the system reservoir space requirements to meet downstream FRM objectives. Minimum streamflow objectives are met for all Alternatives at this location.

Unlike real-time operations, the Boise Planning Model utilizes a "perfect forecast" where the runoff volume is already known because it is the sum of inflows to the reservoirs, which is a model input. This can cause observed flows at Glenwood to increase or decrease more often than indicated by model results. This is important to keep in mind when interpreting the model results, as flows during the modeled period are mostly limited to 6,500 cfs while historical operations have resulted in higher flows in some years.

Figure 32 and Figure 33 illustrate the 10^{th}-, 50^{th}-, and 90^{th}-percentile streamflows in the Boise River at Glenwood for the 6-foot Raise and 3-foot Raise Alternatives, respectively. Figure 34 and Figure 35 depict the daily exceedance values for No Action and Alternative B (6-foot Raise) and Alternative C (3-foot Raise) with the four demand patterns. As shown in these figures, streamflow conditions at Glenwood are similar across all Alternatives and demand patterns. The most notable difference is seen in late July, where additional flow augmentation releases associated with Scenario 2 result in streamflow remaining around 3,000 cfs through the end of July.

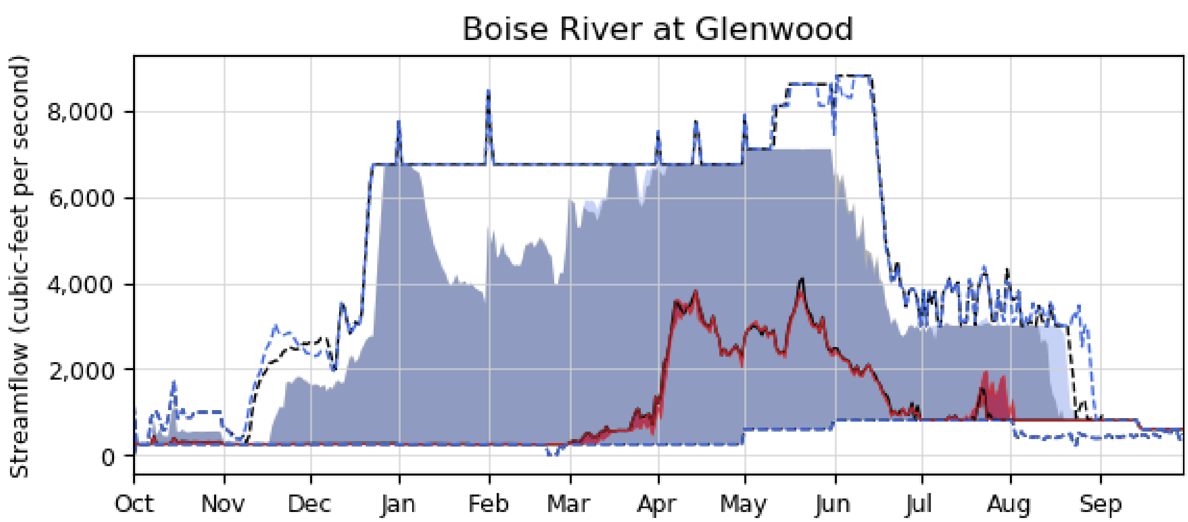


Figure 32. Boise River at Glenwood summary streamflow hydrograph depicting the daily median streamflow range for the 6-foot Raise (red region) and daily median for No Action (black line). The shaded blue region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed blue and black lines represent the daily minimum and maximum values.

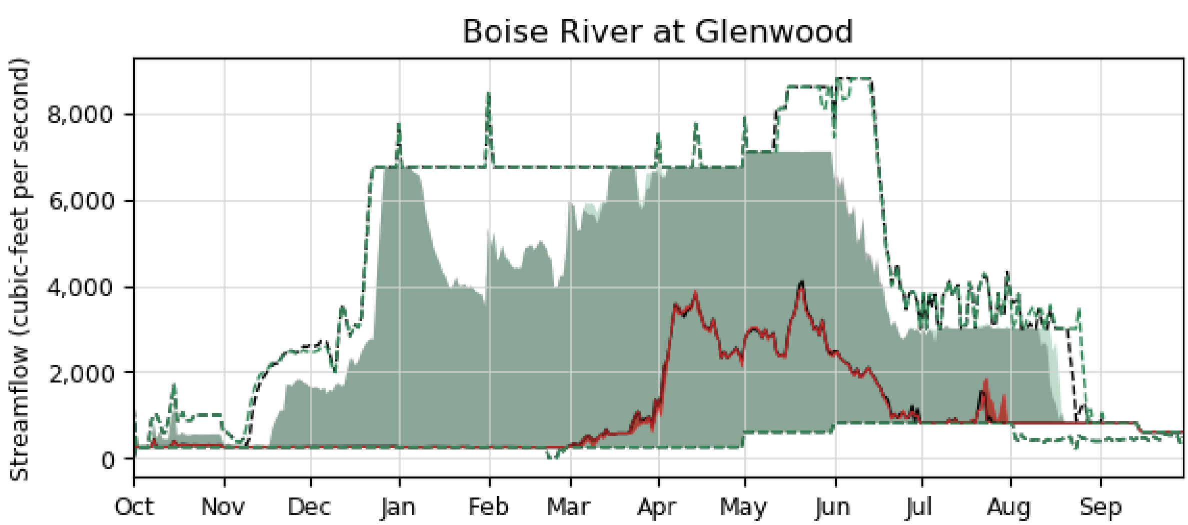


Figure 33. Boise River at Glenwood summary streamflow hydrograph depicting the daily median streamflow range for the 3-foot Raise (red region) and daily median for No Action (black line). The shaded green region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 3-foot Raise and No Action, respectively. Dashed green and black lines represent the daily minimum and maximum values.

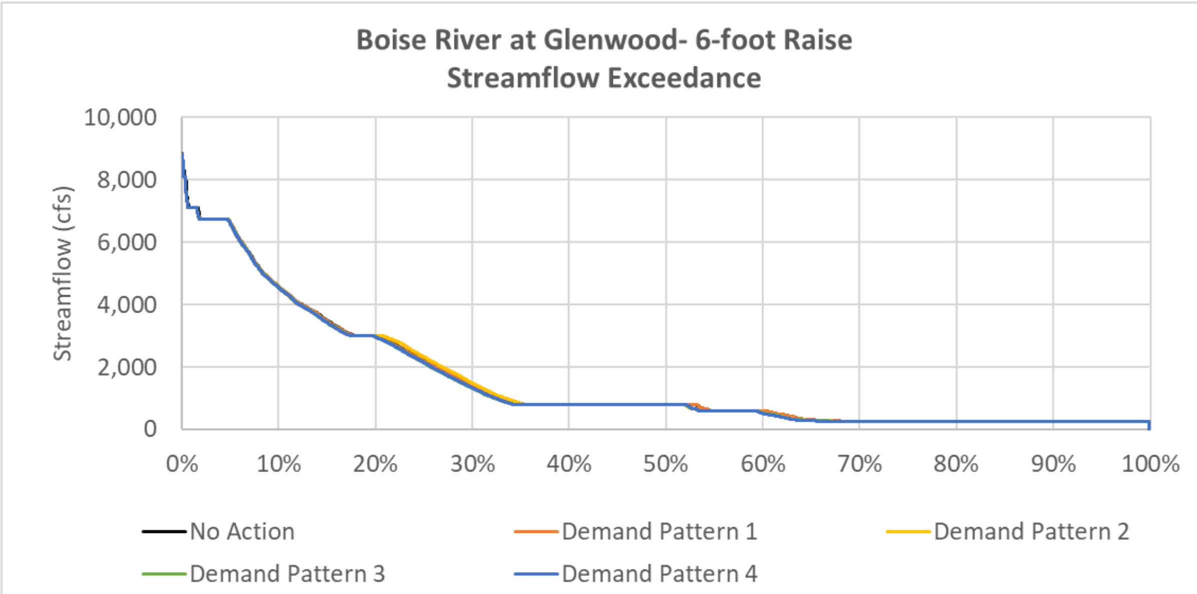


Figure 34. Boise River at Glenwood streamflow exceedance plot for the 6-foot Raise Alternative. The exceedance percentile represents the percent of days in the analysis period that streamflow was greater than or equal to a given streamflow amount.

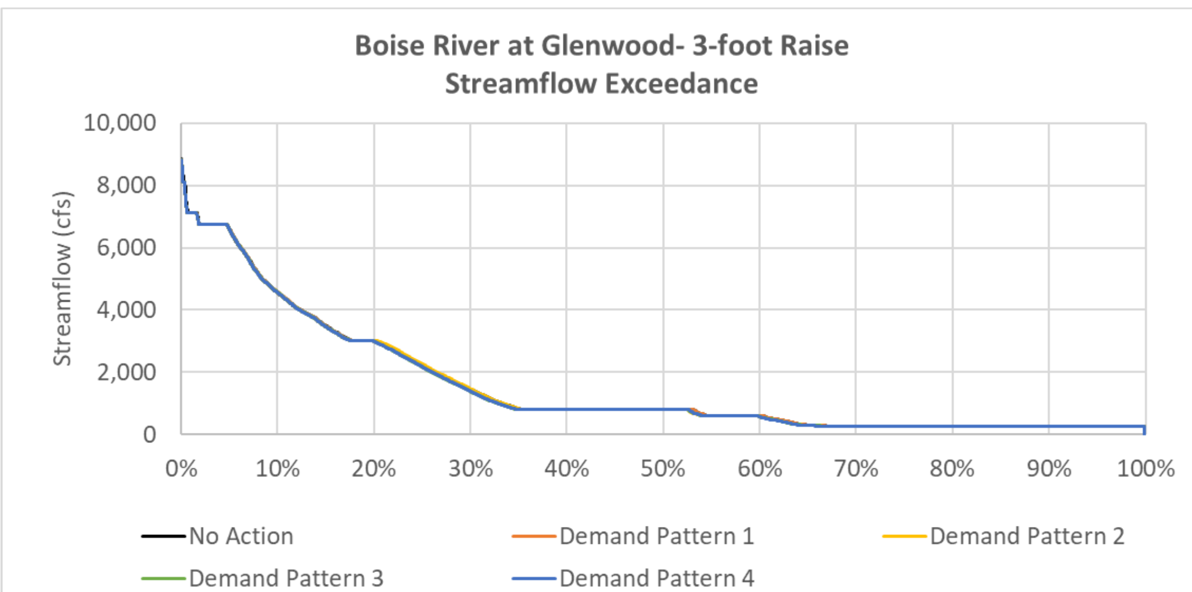


Figure 35. Boise River at Glenwood streamflow exceedance plot for the 3-foot Raise Alternative. The exceedance percentile represents the percent of days in the analysis period that streamflow was greater than or equal to a given streamflow amount.

3.7 Climate Change

Evaluation of the Alternatives at Anderson Ranch Dam included analysis of storage availability and streamflow impacts under a range of potential future conditions as characterized by the recent RMJOC-II Climate Change Study (RMJOC-II 2018). The RMJOC-II climate change stud developed a set of 160 natural streamflow projections using output from ten Global Climate Models, two downscaling techniques, two emission scenarios, and four versions of hydrologic models. See the RMJOC-II Climate Change Study documentation for more detail on the development of this dataset (RMJOC-II 2018).

The RMJOC-II Climate Change Study notes overall trends of increased fall and winter streamflow, earlier and higher spring peak runoff, and earlier streamflow recession. The study also suggests the potential for increased rain-on-snowpack events during the winter and spring and annual flow peaks shifting several weeks earlier compared to historical conditions.

3.7.1 2060s Streamflow Projections

A subset of the 160 RMJOC-II projections (consisting of Representative Concentration Pathways (RCP) 4.5 and RCP 8.5 projections) was selected using the objective subset selection method described in the current draft RMJOC-II Report Part 1, Section 8.2.2 (RMJOC-II 2018). This method was applied to the 2060s (2050 to 2079), using the Lucky Peak Reservoir and Anderson Ranch Reservoir locations, and used water year volume and winter/spring volume ratio as selection metrics. The resulting subset consisted of two future projections that, taken together, capture the 10^{th}- and 90^{th}-percentile future water year volumes and winter/spring volume ratios. These two metrics were identified as being important to water supply and Boise Reservoir System operations. These projections, labeled 2060s High and 2060s Low, are listed in Table 4. More information about the development of the projections can be found in Part I of the RMJOC-II Climate Change Study report (RMJOC-II 2018).

The RMJOC-II Climate Change Study streamflows were generated by running a calibrated VIC hydrologic model with forcing files associated with each climate change scenario as well as the Livneh baseline scenario. While RMJOC-II projections are transient projections spanning 1950 through 2099, this study considered discrete slices of the full record to represent the historical period (1958 through 2008) and the future 2060s period (2050 through 2079). The Livneh dataset, which served as the baseline forcing file in the VIC model calibration, provides an important reference point in interpreting changes associated with future climate change projections.

Figure 36 and Figure 37 depict comparisons of observed and simulated historical gains for each of the climate change projections for the historical period spanning 1980 through 2008. The Livneh projection and the CanESM2 projection show the closest agreement to historical observations in terms of flow magnitude and timing, while the historical CSIRO-Mk3-6-0 projection shows a lower and later runoff pattern and much higher summer flow compared to the other models. Despite the relatively poor historical fit of the CSIRO-Mk3-6-0 projection, this dataset was selected using the objective subset selection method described in the current draft RMJOC-II Report Part 1, Section 8.2.2 and serves to capture a wide range of runoff conditions.

Table 4. 2060s climate change scenarios selected to capture the 10th- and 90th-percentile changes in future water year volumes and winter/spring volume ratios.

Climate Scenario	Global Climate Model	Emissions Scenario	Downscaling Method	Hydrologic Model
2060s High	CanESM2	RCP 8.5	MACA	VIC
2060s Low	CSIRO-Mk3-6-0	RCP 4.5	BCSD	VIC

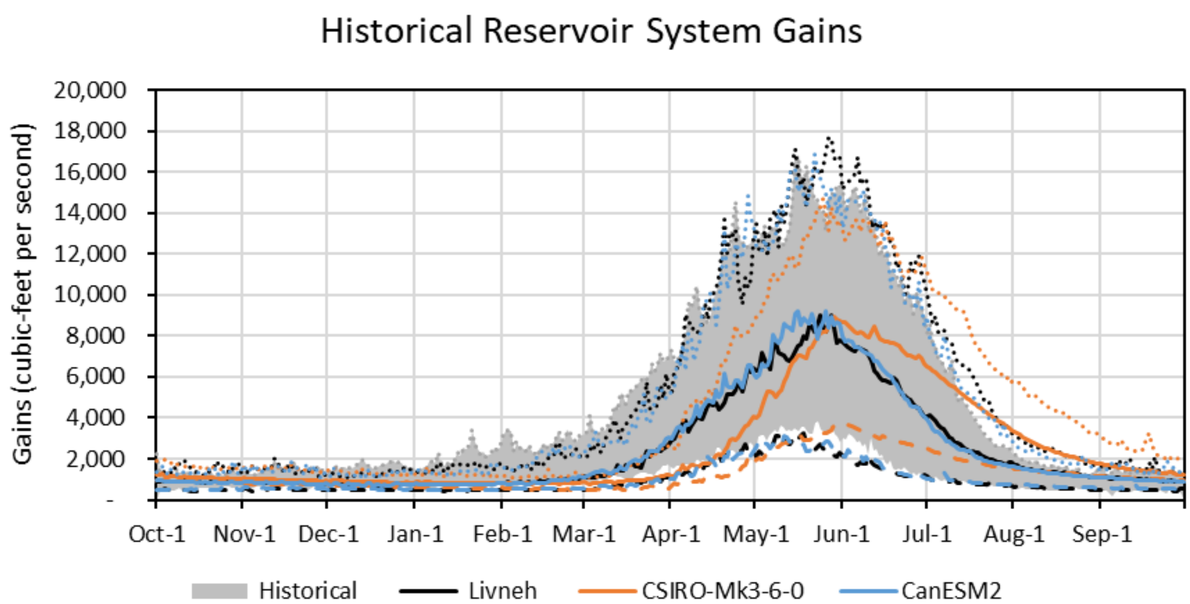


Figure 36. Comparison of observed and simulated gain (inflow) projections for the period spanning 1958 through 2008. The shaded area represents the 10th- to 90th-percentile daily observed gains during this period. The black set of lines represent the 10th-, 50th-, and 90th-percentile daily simulated gains associated with the historical Livneh dataset, while the orange and blue lines represent the simulated gains associated with the GCMs that were selected to represent the 2060s Low (CSIRO-Mk3-6-0) and 2060s High (CanESM2) climate change conditions.

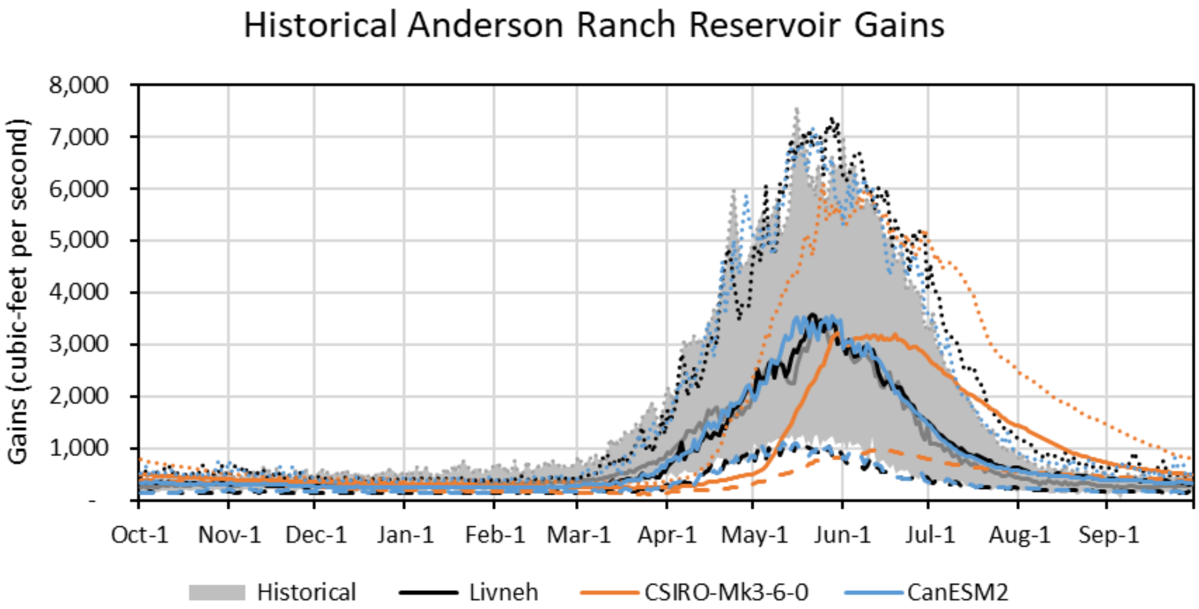


Figure 37. Comparison of observed and simulated gain (inflow) projections for the period spanning 1958 through 2008. The shaded area represents the 10th- to 90th-percentile daily observed gains during this period. The black set of lines represent the 10th-, 50th-, and 90th-percentile daily simulated gains associated with the historical Livneh dataset, while the orange and blue lines represent the simulated gains associated with the GCMs that were selected to represent the 2060s Low (CSIRO-Mk3-6-0) and 2060s High (CanESM2) climate change conditions.

Figure 38 and Figure 39 illustrate the future 2060s (2050 through 2079) projected gains associated with each climate change projection (CSIRO-Mk3-6-0 and CanESM2) relative to the observed historical period. As shown in these figures, the CSIRO-Mk3-6-0 projection exhibits similar median peak flow magnitude and timing to the historical period, but a much smaller 90th-percentile peak flow magnitude, longer peak runoff recession, and higher summer flows. The CanESM2 projection shows the most change from historical with large increases in runoff during the late-fall and winter months and peak runoff occurring approximately one month earlier.

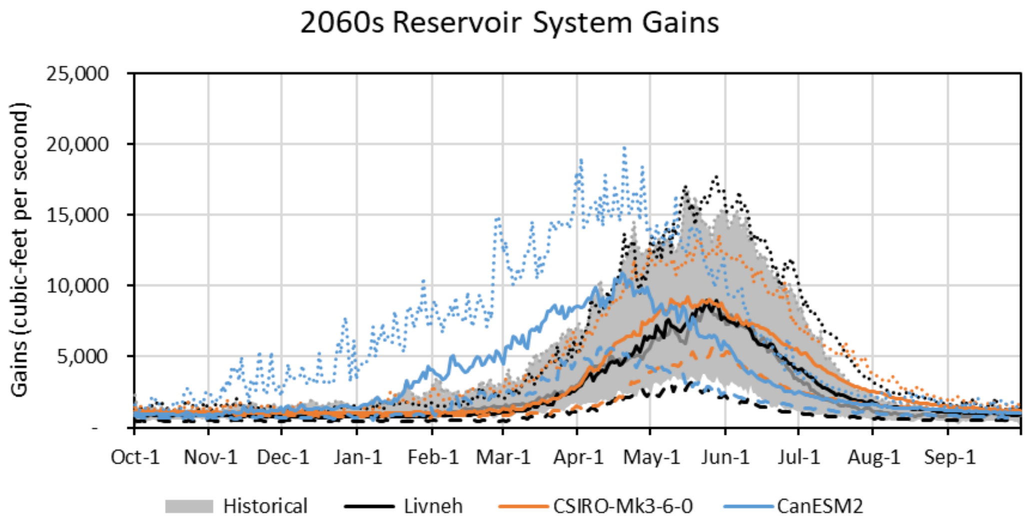


Figure 38. Comparison of historical observed gains and historical simulated gains (Livneh) to future simulated gain projections for the 2060s (CSIRO-Mk3-6-0 and CanESM2). The gray area and darker gray line represent, respectively, the 10th- through 90th-percentile and the 50th-percentile daily observed gains above Lucky Peak Dam over the historical 1958 through 2008 period. The black lines represent the simulated Livneh gains for the same historical period. The orange and blue lines represent the future (2050 through 2079) 10th-, 50th-, and 90th-percentile daily simulated gains for the 2060s Low (CSIRO-Mk3-6-0) and 2060s High (CanESM2) climate change conditions.

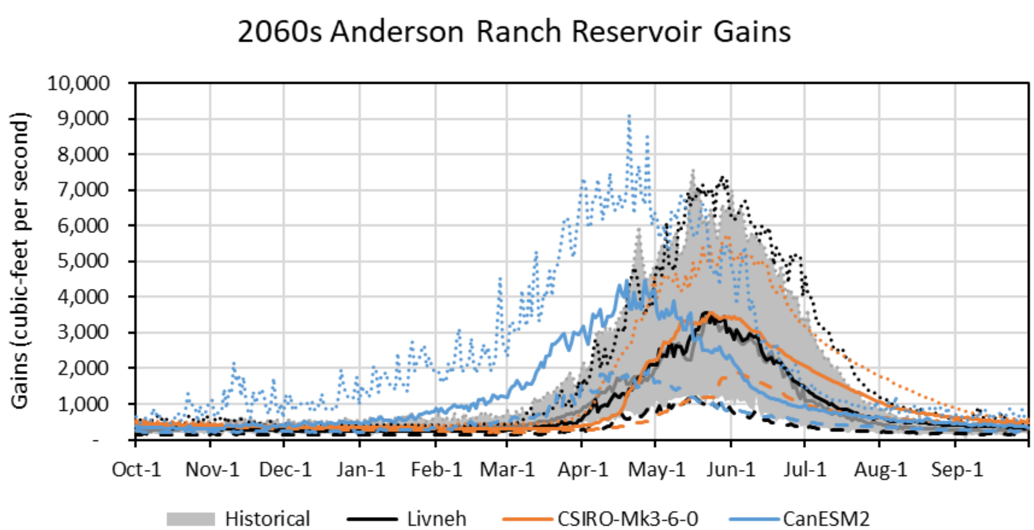


Figure 39. Comparison of historical observed gains and historical simulated gains (Livneh) to future simulated gain projections for the 2060s (CSIRO-Mk3-6-0 and CanESM2). The gray area and darker gray line represent, respectively, the 10th- through 90th-percentile and the 50th-percentile daily observed gains to Anderson Ranch Reservoir over the historical 1958 through 2008 period. The black lines represent the simulated Livneh gains for the same historical period. The orange and blue lines represent the future (2050 through 2079) 10th-, 50th-, and 90th-percentile daily simulated gains for the 2060s Low (CSIRO-Mk3-6-0) and 2060s High (CanESM2) climate change conditions.

3.7.2 2060s System Operations

Boise Reservoir System operations for No Action and for the two Alternatives were modeled under each climate scenario (simulated historical Livneh, 2060s Low, and 2060s High) for the purpose of evaluating how the system might perform under a wide range of potential future hydrologic conditions. The four demand patterns were modeled for each Alternative with each climate scenario and are summarized in the figures presented in this section. Figure 40 and Figure 41 illustrate the daily median and the daily 10th- to 90th-percentile range in system storage associated with the 6-foot Raise and 3-foot Raise Alternatives, respectively, and with No Action, for each hydrologic dataset. As shown by these figures, median daily storage volumes in the 2060s Low scenario exhibit conditions (magnitude and timing) similar to the Livneh modeled historical hydrology scenario (second panel), but with increased 10th- and 50th-percentile storage through the summer, fall and winter months. While the 2060s High scenario shows a similar maximum volume of fill for the 50th- and 90th-percentile, the timing of maximum fill occurs a month earlier. Compared to the Livneh scenario, this scenario also exhibits lower system carryover, similar winter storage, and earlier spring refill for these percentiles. Storage conditions for the 10th-percentile exhibit a year-round increase in the 2060s High scenario compared to the Livneh scenario. In the 2060s Low scenario, less-frequent high inflow volumes result in more years with smaller flood space requirements and therefore more years with smaller FRM drafts compared to historical period. In contrast, in the 2060s High scenario, much larger inflow volumes create conditions where the system is releasing as much water as possible to keep up with FRM objectives while also trying to keep flows downstream below flood stage.

Figure 42 and Figure 43 illustrate the daily median and the daily 10th- to 90th-percentile range in Anderson Ranch Reservoir storage associated with the 6-foot Raise and 3-foot Raise Alternatives, respectively, and with No Action, for each hydrologic dataset. Storage regimes between the dam raise scenarios are similar to one another with the dam raise scenarios exhibiting increased storage relative to the baseline condition in both climate change scenarios. As shown in this figure, the 2060s Low scenario exhibits year-round increase in median daily storage compared to the Livneh scenario, while the 2060s High scenario shows median storage conditions that are similar to Livneh during the summer and fall months and increased storage through the winter and spring. Increased summer gains in the 2060s Low scenario result in more frequent high carryover conditions compared to the historical period, while increased winter flows in the 2060s High scenario result in more years with high winter storage conditions.

Downstream of Anderson Ranch Dam, simulated streamflow in the South Fork of the Boise River shows an increase during the winter and spring under the 2060s High scenario compared to the Livneh scenario. The 2060s Low scenario also shows increased flows during the spring relative to the Livneh scenario, but no increase from mid-December through February. Both 2060s scenarios show increased median flows in the fall resulting from the model making FRM releases to meet winter flood space requirements. In the 2060s Low scenario, the fall FRM release is larger, corresponding to a larger October 1 carryover volume associated with increased summer gains under this hydrologic scenario. Streamflow differences between the 6-foot Raise and 3-foot Raise Alternatives are small and consist primarily of slight shifts in flow timing. These trends are exhibited in Figure 44 and Figure 45.

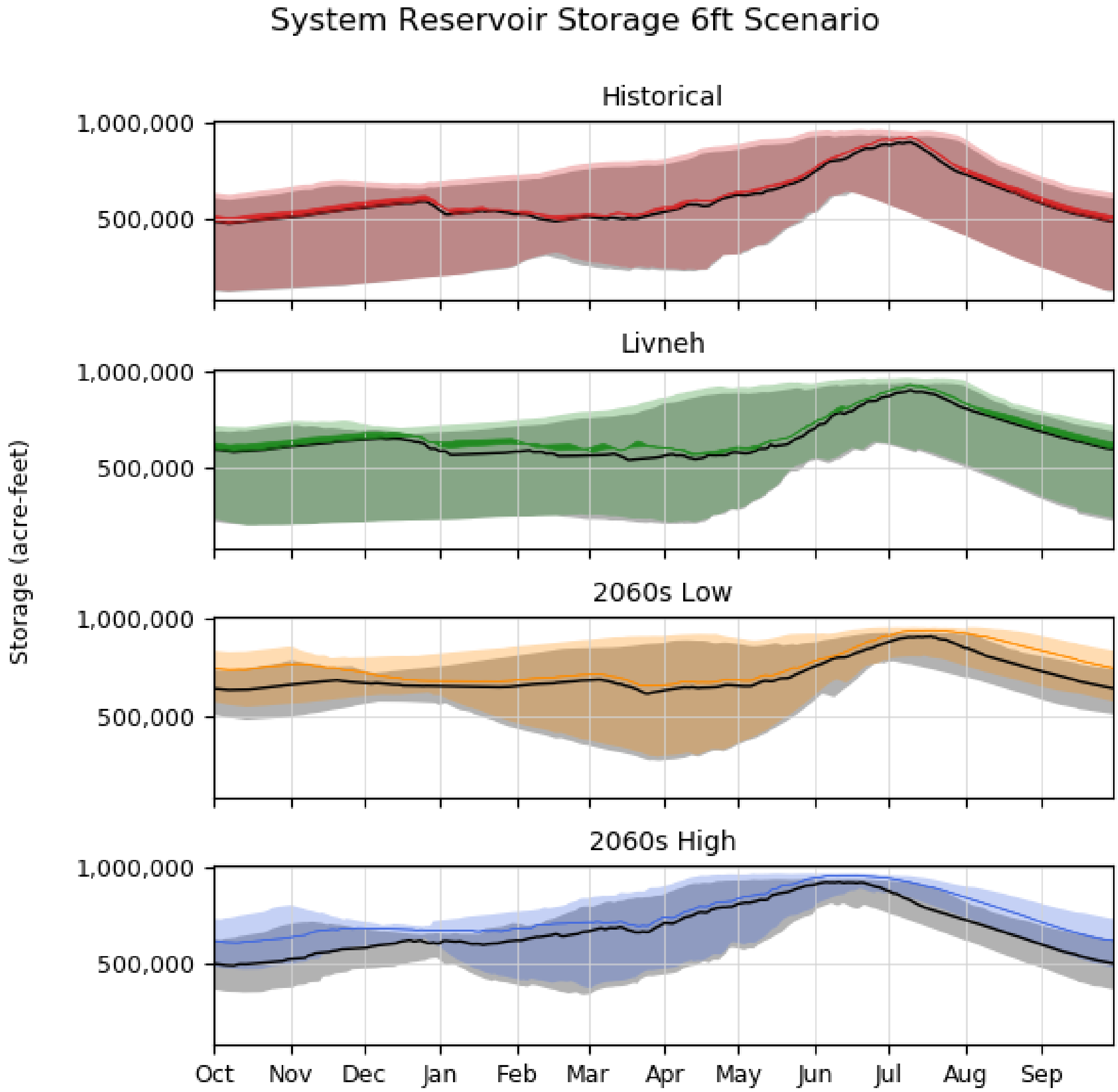


Figure 40. Boise Reservoir System historical and 2060s summary storage hydrographs depicting the daily median storage content range for the 6-foot Raise (narrow solid colored regions) and daily median for No Action (black lines). The shaded colored regions and the underlying shaded gray regions represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Each panel and color represent a different hydrologic condition. The top (red) panel represents the historical condition, the second (green) panel represents the Livneh historical hydrology, the third (orange) panel represents the 2060s Low climate change projection, and the fourth (blue) panel represents the 2060s High climate change projection. Storage values depicted represent total system storage, excluding 36,956 acre-feet of inactive powerhead space in Anderson Ranch Reservoir.

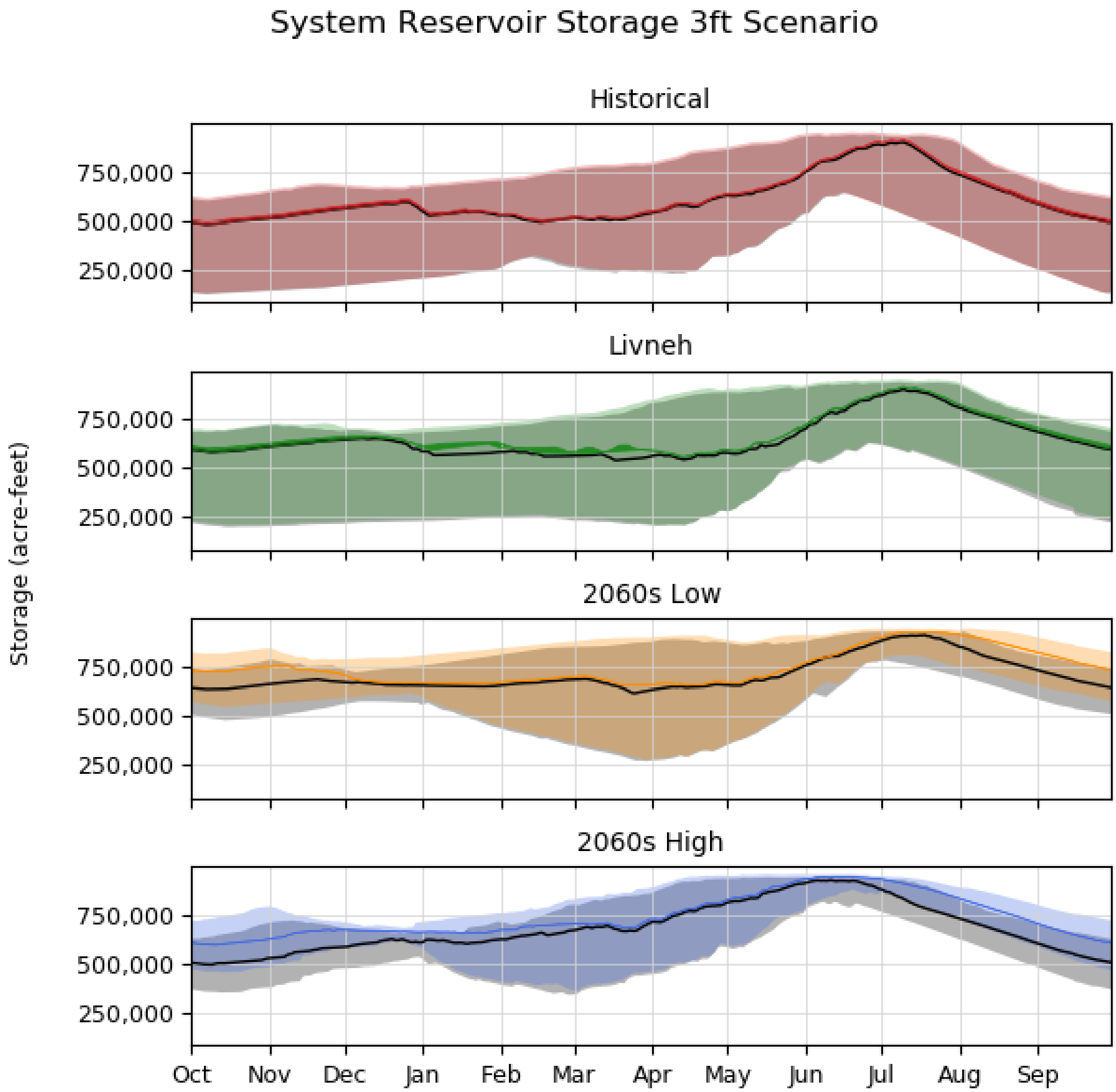


Figure 41. Boise Reservoir System historical and 2060s summary storage hydrographs depicting the daily median storage content range for the 3-foot Raise (narrow solid colored regions) and daily median for No Action (black lines). The shaded colored regions and the underlying shaded gray regions represent the 10th-percentile to 90th-percentile range captured by the 3-foot Raise and No Action, respectively. Each panel and color represent a different hydrologic condition. The top (red) panel represents the historical condition, the second (green) panel represents the Livneh historical hydrology, the third (orange) panel represents the 2060s Low climate change projection, and the fourth (blue) panel represents the 2060s High climate change projection. Storage values depicted represent total system storage, excluding 36,956 acre-feet of inactive powerhead space in Anderson Ranch Reservoir.

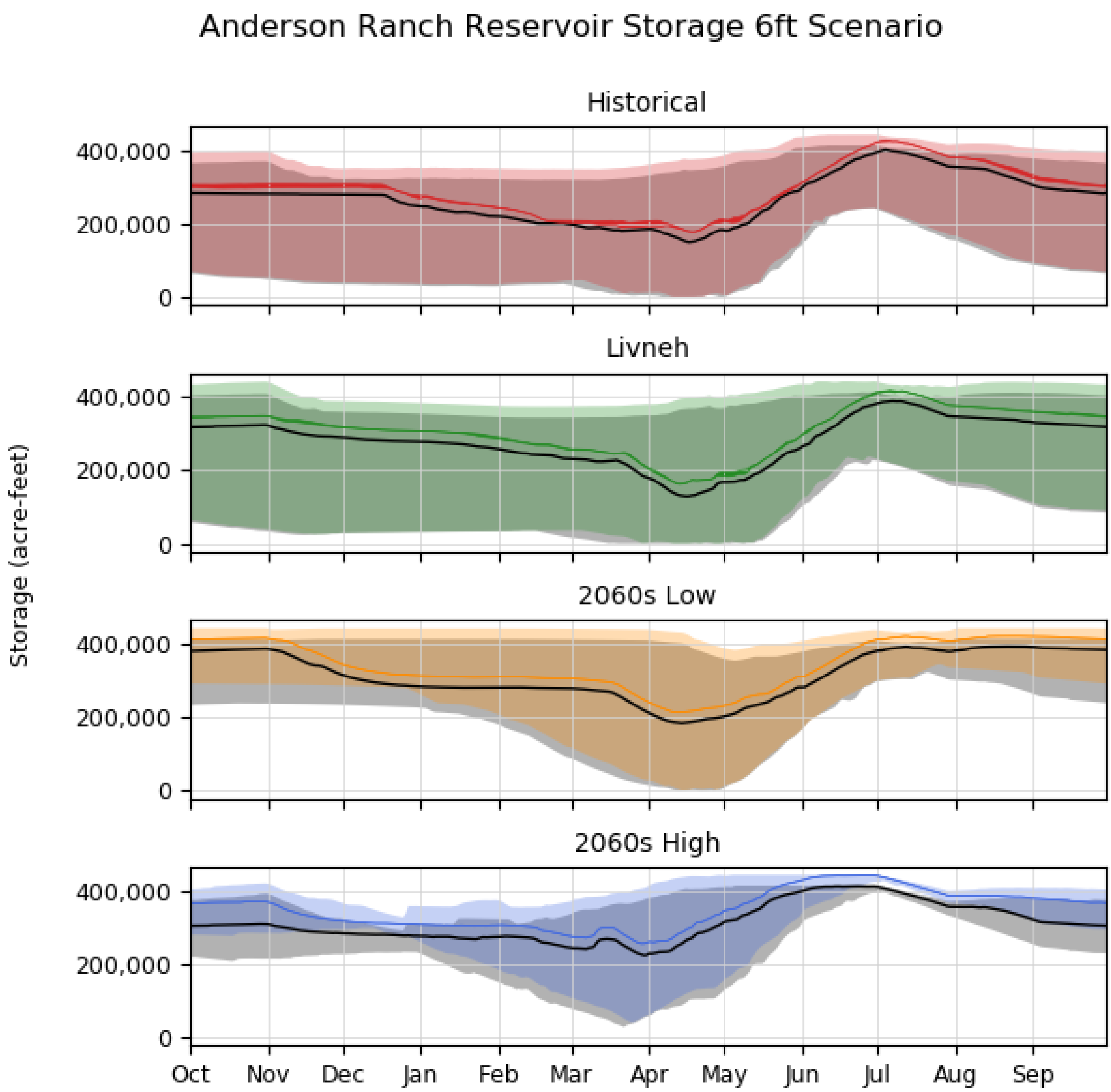


Figure 42. Anderson Ranch Reservoir historical and 2060s summary storage hydrographs depicting the daily median storage content range for the 6-foot Raise (narrow solid colored regions) and daily median for No Action (black lines). The shaded colored regions and the underlying shaded gray regions represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Each panel and color represent a different hydrologic condition. The top (red) panel represents the historical condition, the second (green) panel represents the Livneh historical hydrology, the third (orange) panel represents the 2060s Low climate change projection, and the fourth (blue) panel represents the 2060s High climate change projection. Storage values depicted do not include 36,956 acre-feet of inactive powerhead space in Anderson Ranch Reservoir.

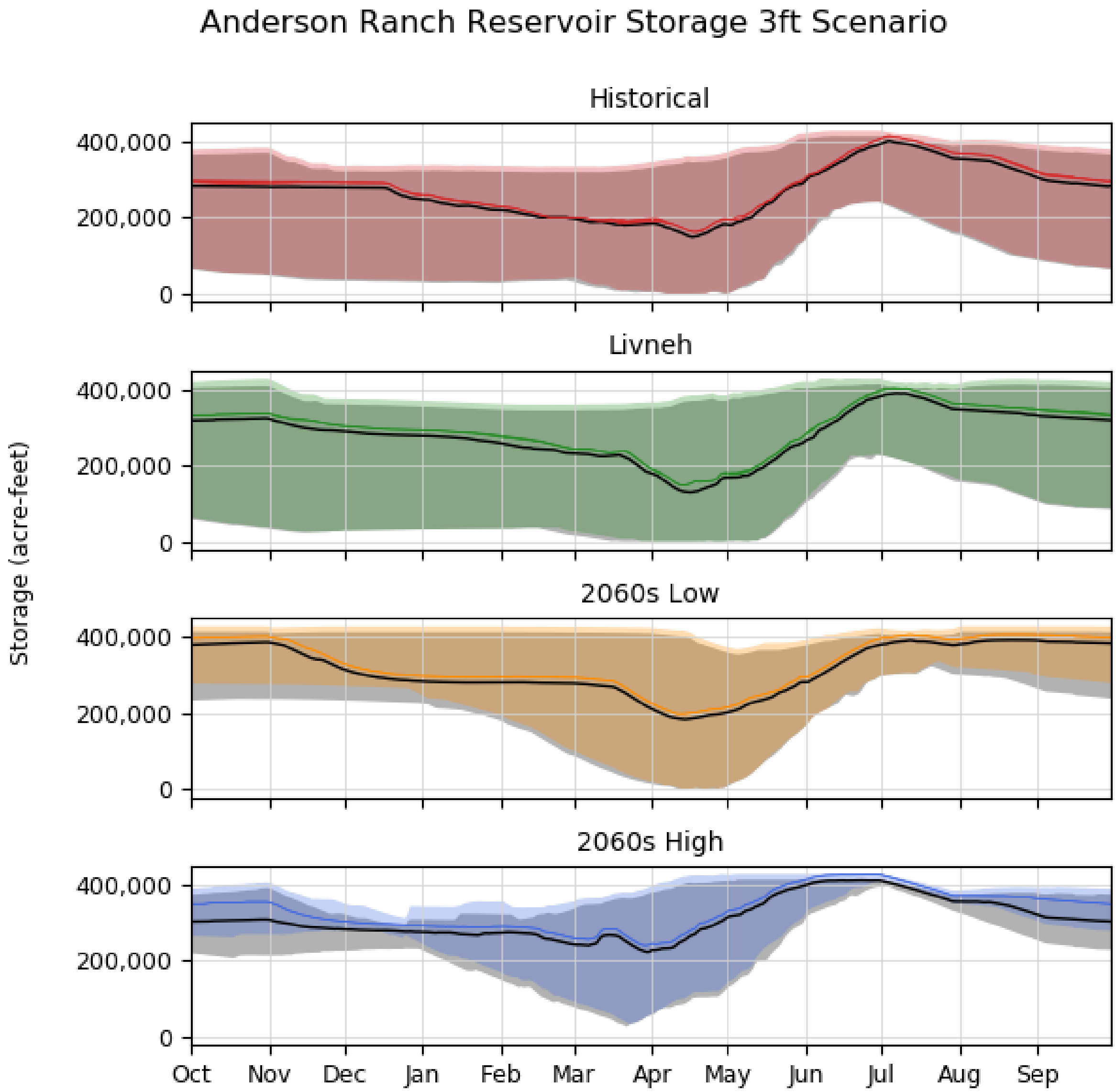


Figure 43. Anderson Ranch Reservoir historical and 2060s summary storage hydrographs depicting the daily median storage content range for the 3-foot Raise (narrow solid colored regions) and daily median for No Action (black lines). The shaded colored regions and the underlying shaded gray regions represent the 10th-percentile to 90th-percentile range captured by the 3-foot Raise and No Action, respectively. Each panel and color represent a different hydrologic condition. The top (red) panel represents the historical condition, the second (green) panel represents the Livneh historical hydrology, the third (orange) panel represents the 2060s Low climate change projection, and the fourth (blue) panel represents the 2060s High climate change projection. Storage values depicted do not include 36,956 acre-feet of inactive powerhead space in Anderson Ranch Reservoir.

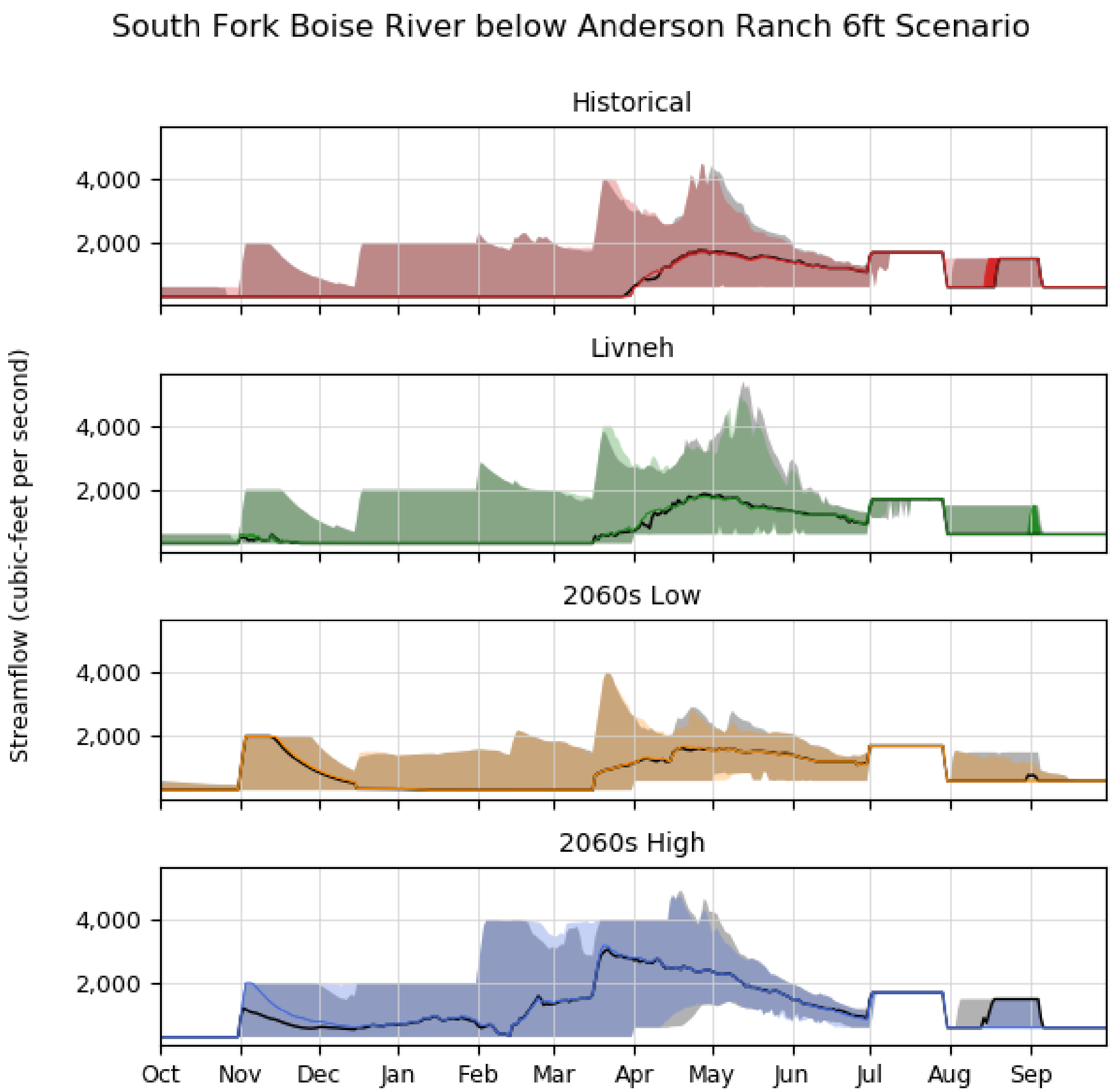


Figure 44. South Fork Boise River below Anderson Ranch historical and 2060s summary hydrographs depicting the daily median streamflow range for the 6-foot Raise (narrow solid colored regions) and daily median for No Action (black lines). The shaded colored regions and the underlying shaded gray regions represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Each panel and color represent a different hydrologic condition. The top (red) panel represents the historical condition, the second (green) panel represents the Livneh historical hydrology, the third (orange) panel represents the 2060s Low climate change projection, and the fourth (blue) panel represents the 2060s High climate change projection.

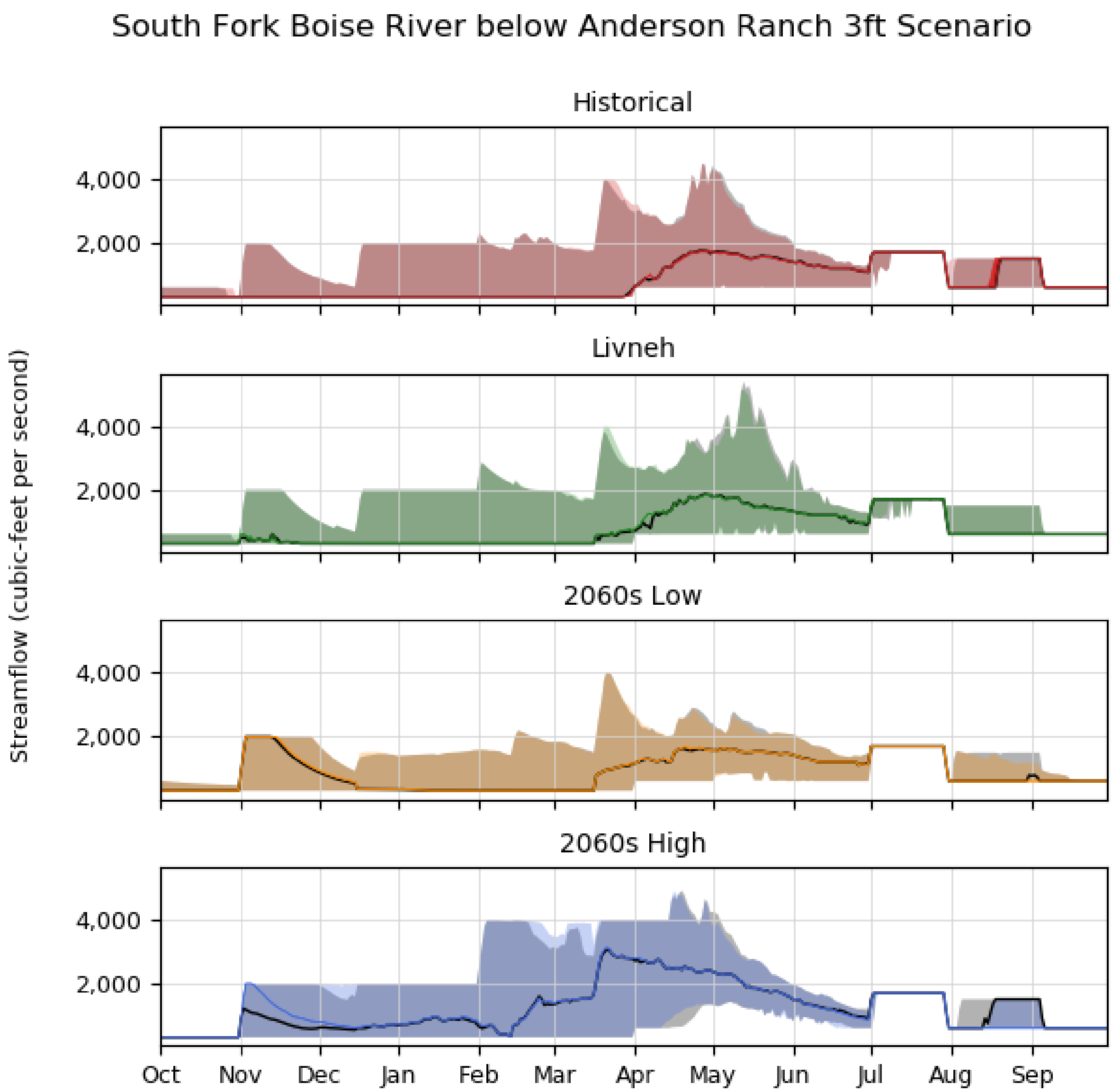


Figure 45. South Fork Boise River below Anderson Ranch historical and 2060s summary hydrographs depicting the daily median streamflow range for the 3-foot Raise (narrow solid colored regions) and daily median for No Action (black lines). The shaded colored regions and the underlying shaded gray regions represent the 10th-percentile to 90th-percentile range captured by the 3-foot Raise and No Action, respectively. Each panel and color represent a different hydrologic condition. The top (red) panel represents the historical condition, the second (green) panel represents the Livneh historical hydrology, the third (orange) panel represents the 2060s Low climate change projection, and the fourth (blue) panel represents the 2060s High climate change projection.

Arrowrock Reservoir and Lucky Peak Reservoir storage volumes are similar across all scenarios but show some key differences. In Arrowrock Reservoir, the most notable difference between the 2060s Low scenario and the Livneh scenario occurs in the 10th-percentile storage condition, where storage is consistently higher throughout the year in the 2060s Low scenario. The 2060s High scenario also shows higher 10th-percentile Arrowrock Reservoir storage conditions relative to the Livneh scenario, but a trend towards later refill and earlier recession compared to the 2060s Low and the Livneh scenarios. This change in timing is also seen in the daily median storage condition. As shown in Figure 46 and Figure 48 for the 6-foot Raise (Figure 47 and Figure 49 for the 3-foot Raise), the most notable changes in Lucky Peak Reservoir include lower carryover in 2060s High scenario, higher median storage through the winter months in the 2060s Low scenario, and earlier refill in the 2060s High scenario.

In Lucky Peak Reservoir, future hydrologic conditions shorten the period that the reservoir is able to maintain the 60,000-acre-foot storage content for the elk pool. In both future scenarios, storage content begins to increase in early winter, with maximum fill occurring several months earlier (April, instead of July) in the 2060s High scenario than in during the historical period. Timing of maximum fill in the 2060s Low scenario is similar to the historical condition.

In terms of differences between the Alternatives and No Action, the largest differences in median values are seen in Arrowrock Reservoir towards the end of the irrigation season where the solid colored regions show a wider range. The differences between the scenarios are less pronounced in Lucky Peak Reservoir, with the scenarios exhibiting a narrow range in median regimes under future hydrologic conditions.

Simulated streamflow in the Boise River at Glenwood show noticeable differences between hydrologic conditions (particularly through winter and spring months) and little to no difference between the Alternatives and the Baseline Scenario. As shown in Figure 50 and Figure 51, median winter streamflow is higher under both future hydrologic conditions. Daily median streamflow climbs steadily in the 2060s High condition from December through the winter until they reach a maximum of approximately 6,500 cfs in March. The 2060s Low condition results in elevated median streamflow during the winter months and spring runoff beginning a few weeks earlier than in the Livneh scenario.

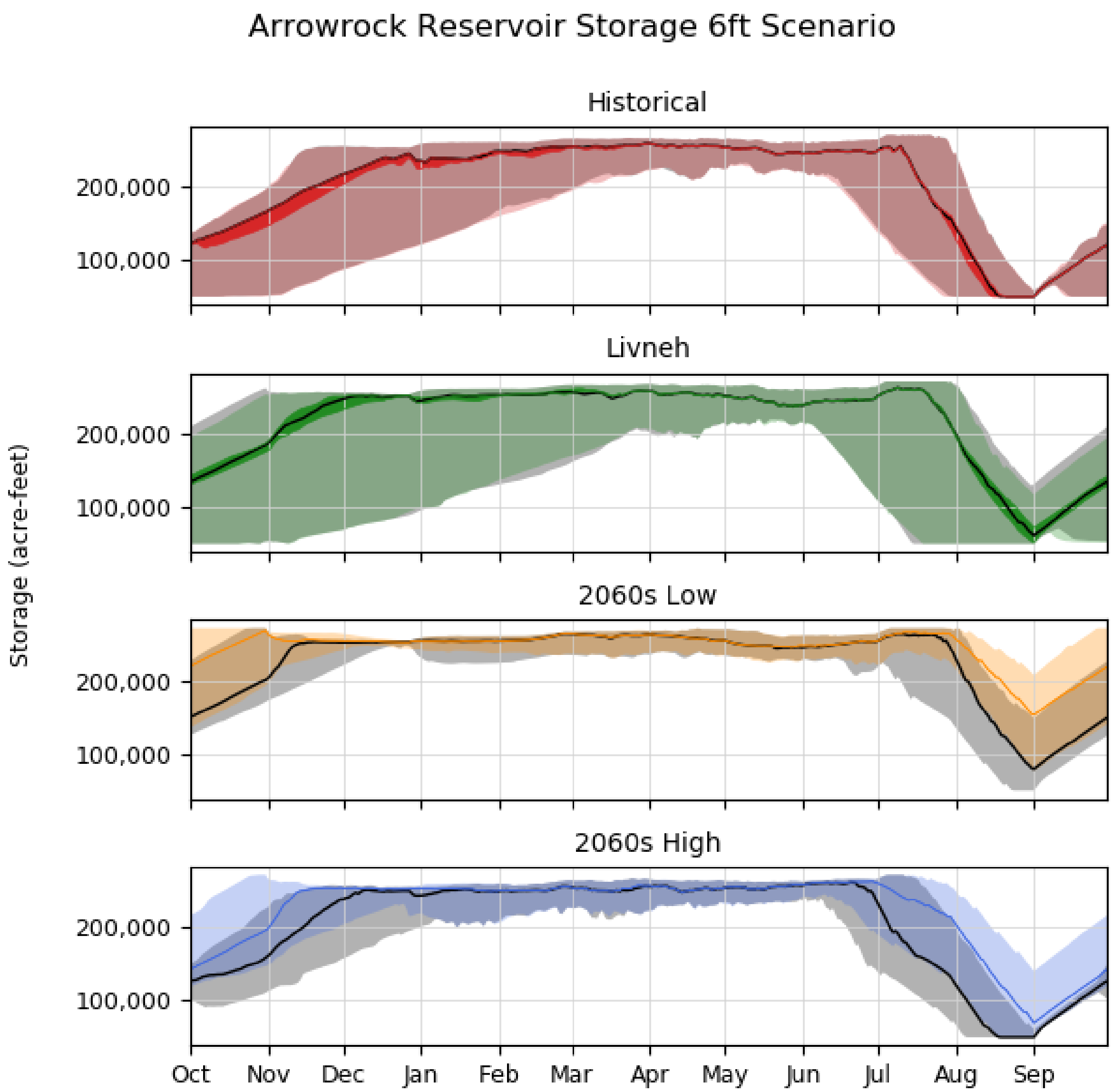


Figure 46. Arrowrock Reservoir historical and 2060s summary storage hydrographs depicting the daily median storage content range for the 6-foot Raise (narrow solid colored regions) and daily median for No Action (black lines). The shaded colored regions and the underlying shaded gray regions represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Each panel and color represent a different hydrologic condition. The top (red) panel represents the historical condition, the second (green) panel represents the Livneh historical hydrology, the third (orange) panel represents the 2060s Low climate change projection, and the fourth (blue) panel represents the 2060s High climate change projection.

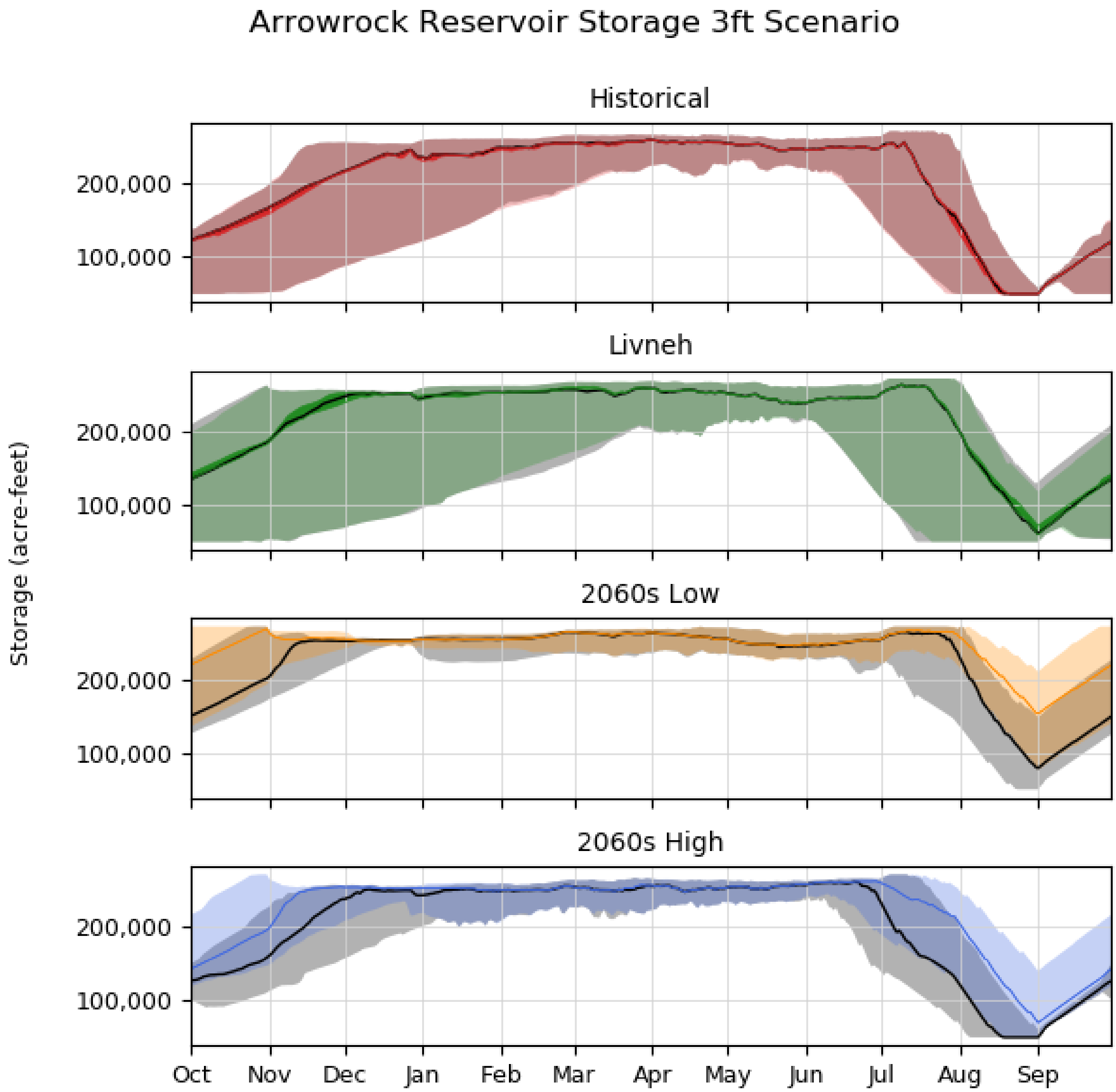


Figure 47. Arrowrock Reservoir historical and 2060s summary storage hydrographs depicting the daily median storage content range for the 3-foot Raise (narrow solid colored regions) and daily median for No Action (black lines). The shaded colored regions and the underlying shaded gray regions represent the 10th-percentile to 90th-percentile range captured by the 3-foot Raise and No Action, respectively. Each panel and color represent a different hydrologic condition. The top (red) panel represents the historical condition, the second (green) panel represents the Livneh historical hydrology, the third (orange) panel represents the 2060s Low climate change projection, and the fourth (blue) panel represents the 2060s High climate change projection.

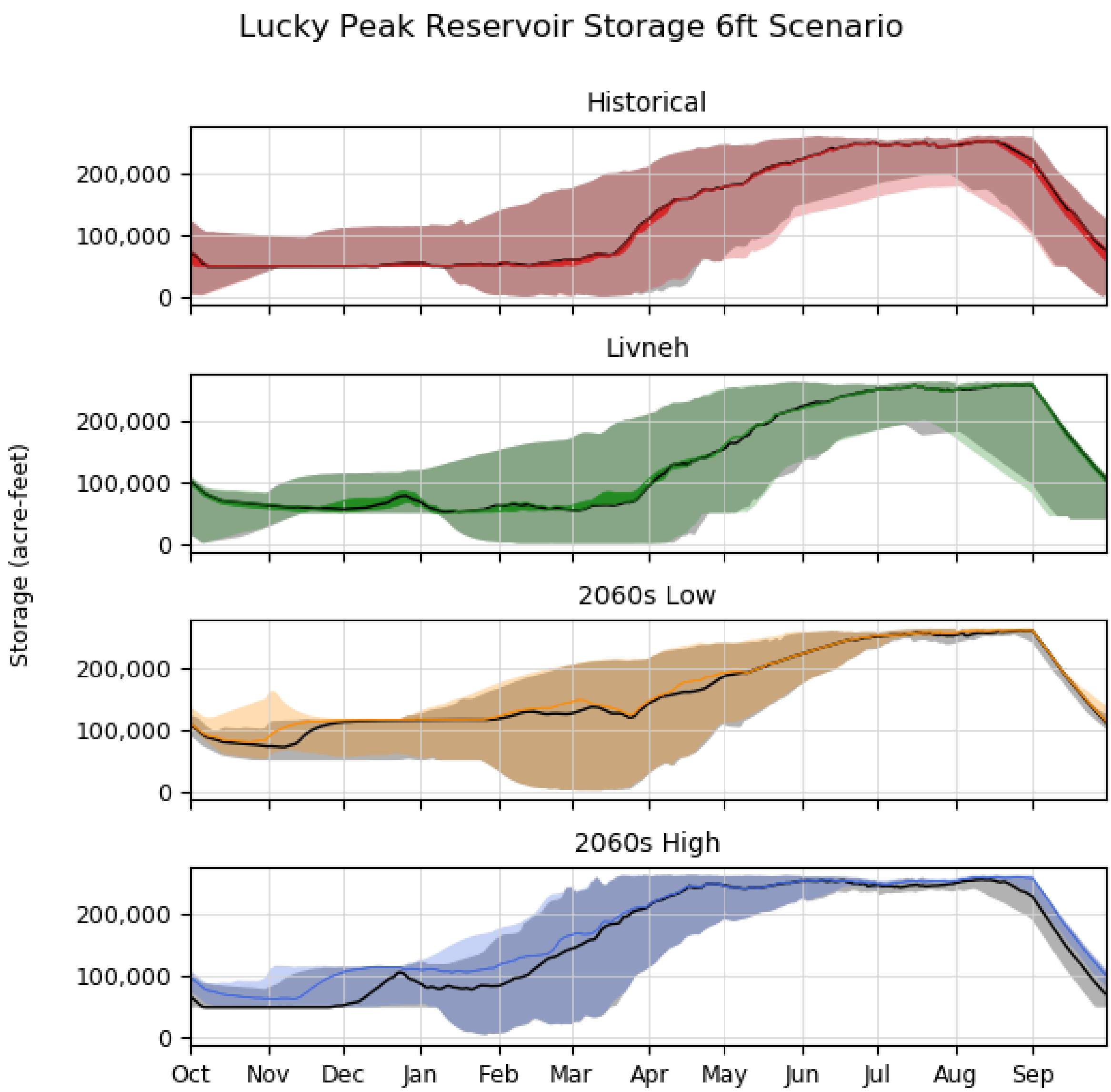


Figure 48. Lucky Peak Reservoir historical and 2060s summary storage hydrographs depicting the daily median storage content range for the 6-foot Raise (narrow solid colored regions) and daily median for No Action (black lines). The shaded colored regions and the underlying shaded gray regions represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Each panel and color represent a different hydrologic condition. The top (red) panel represents the historical condition, the second (green) panel represents the Livneh historical hydrology, the third (orange) panel represents the 2060s Low climate change projection, and the fourth (blue) panel represents the 2060s High climate change projection.

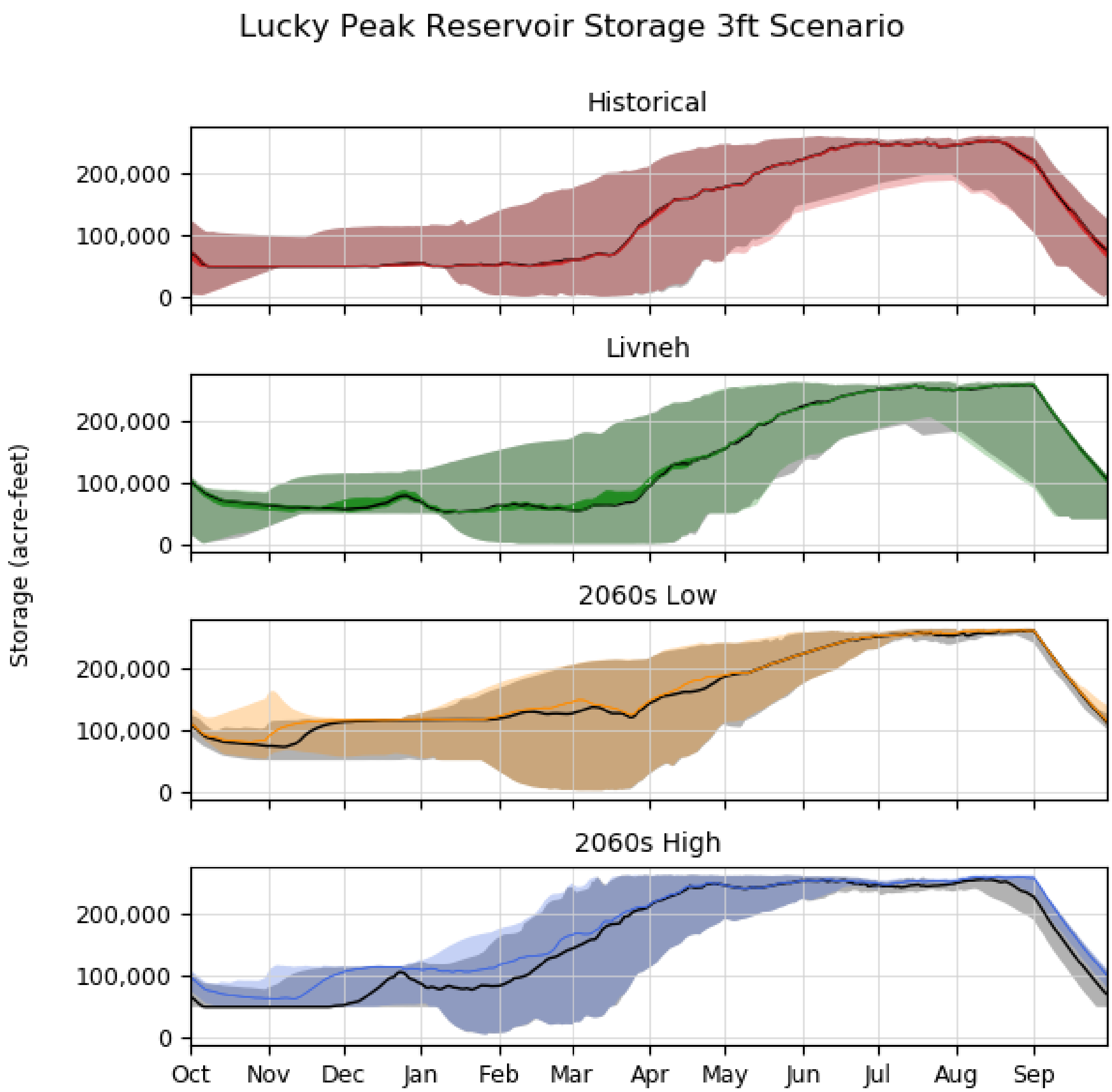


Figure 49. Lucky Peak Reservoir historical and 2060s summary storage hydrographs depicting the daily median storage content range for the 3-foot Raise (narrow solid colored regions) and daily median for No Action (black lines). The shaded colored regions and the underlying shaded gray regions represent the 10th-percentile to 90th-percentile range captured by the 3-foot Raise and No Action, respectively. Each panel and color represent a different hydrologic condition. The top (red) panel represents the historical condition, the second (green) panel represents the Livneh historical hydrology, the third (orange) panel represents the 2060s Low climate change projection, and the fourth (blue) panel represents the 2060s High climate change projection.

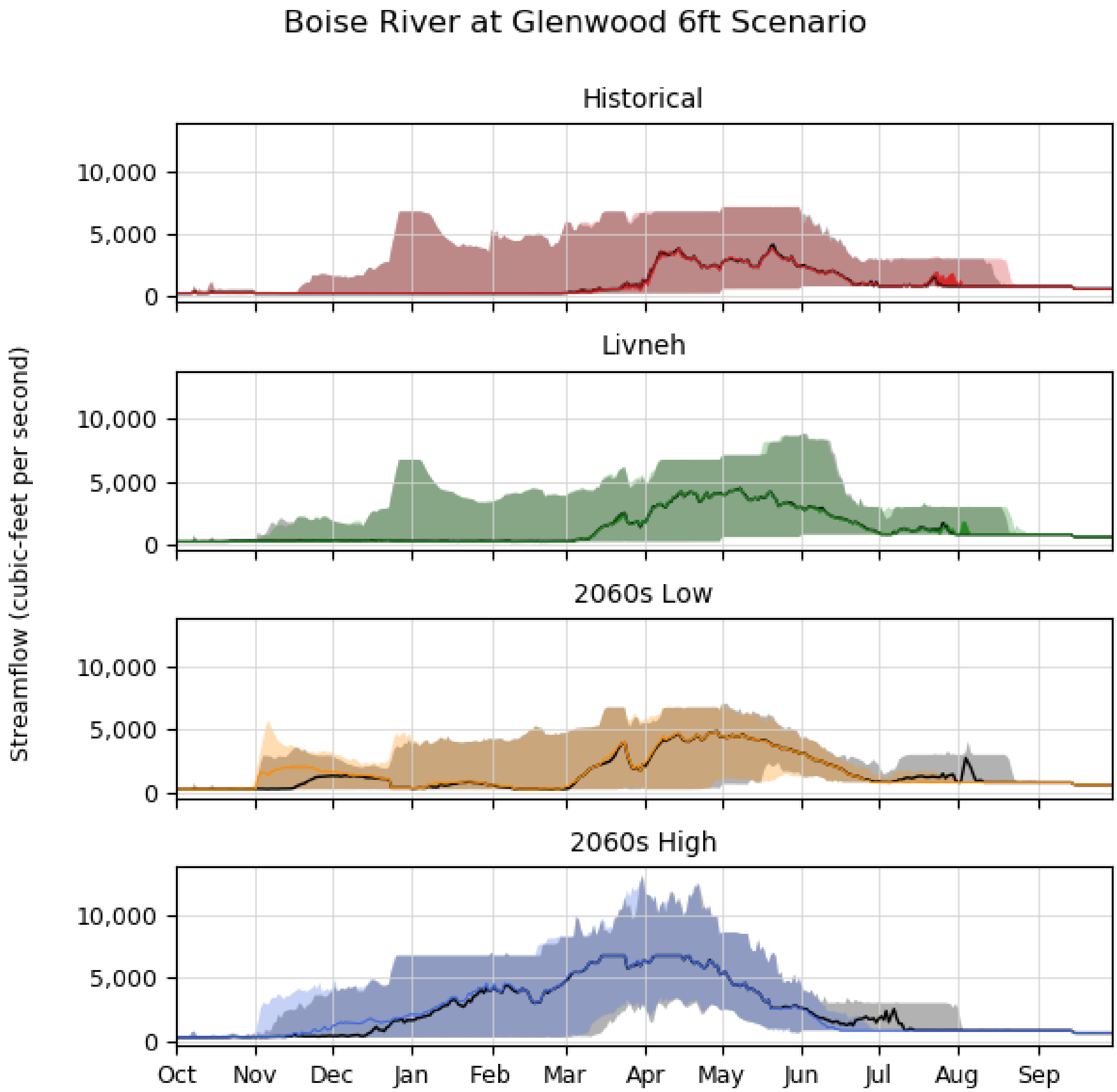


Figure 50. Boise River at Glenwood historical and 2060s summary hydrographs depicting the daily median streamflow range for the 6-foot Raise (narrow solid colored regions) and daily median for No Action (black lines). The shaded colored regions and the underlying shaded gray regions represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Each panel and color represent a different hydrologic condition. The top (red) panel represents the historical condition, the second (green) panel represents the Livneh historical hydrology, the third (orange) panel represents the 2060s Low climate change projection, and the fourth (blue) panel represents the 2060s High climate change projection.

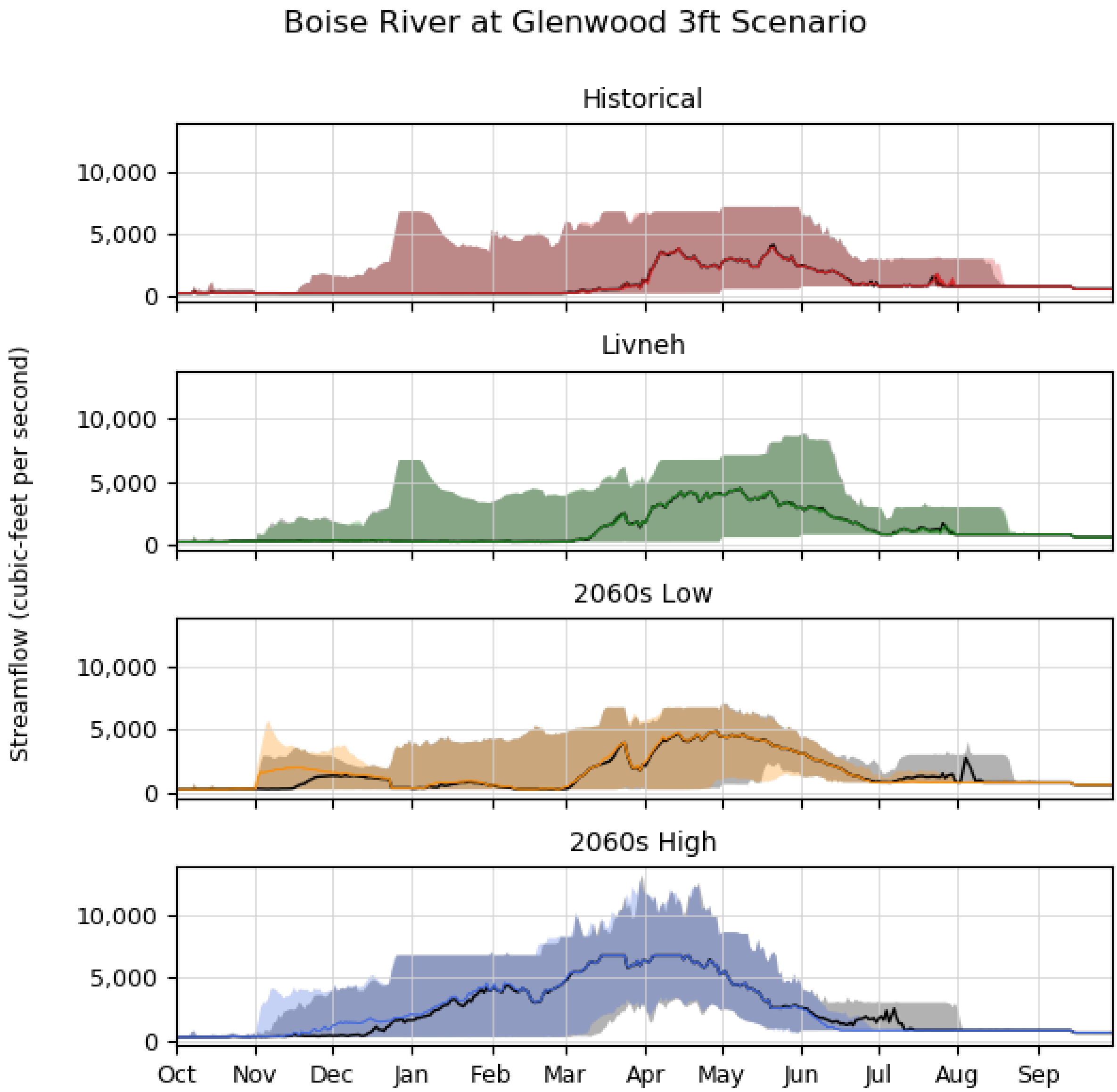


Figure 51. Boise River at Glenwood historical and 2060s summary hydrographs depicting the daily median streamflow range for the3-foot Raise (narrow solid colored regions) and daily median for No Action (black lines). The shaded colored regions and the underlying shaded gray regions represent the 10th-percentile to 90th-percentile range captured by the 3-foot Raise and No Action, respectively. Each panel and color represent a different hydrologic condition. The top (red) panel represents the historical condition, the second (green) panel represents the Livneh historical hydrology, the third (orange) panel represents the 2060s Low climate change projection, and the fourth (blue) panel represents the 2060s High climate change projection.

The climate change conditions simulated in this study demonstrated a stronger influence on operations compared to the proposed increase in storage at Anderson Ranch Reservoir. Both climate change scenarios showed a trend towards wetter conditions (higher streamflow and storage contents) during the winter and spring months compared to streamflow and storage conditions associated with the Livneh historical hydrology. That said, all hydrologic conditions showed the potential for increased storage under the Alternatives relative to the baseline condition. This suggests that the storage benefit associated with the dam raise may still be realized under future hydrologic conditions. Once again, it must be noted that these simulations utilize perfect forecasts and current operational objectives. This study does not consider forecast uncertainty, nor how that uncertainty may change going into the future as changing weather conditions influence the proportion of precipitation that falls as rain as opposed to accumulating as snowpack.

4 Potential Downstream Effects

On May 5, 2008, the National Oceanic and Atmospheric Administration (NOAA) Fisheries released a new biological opinion (2008 Upper Snake BiOp; NOAA Fisheries 2008) for the continued operations and maintenance of Reclamation projects in the Snake River Basin above Brownlee Reservoir. The Operations and Maintenance of the Boise River System is part of the larger Upper Snake River basin and covered by the Incidental Take Statement in the 2008 Upper Snake BiOp. As described in the proposed action in the 2008 NOAA BiOp, and as mandated by the 2004 Snake River Water Rights Act of 2004, Reclamation is required to provide water for downstream ecological needs, known as “Flow Augmentation Water.” Flow augmentation water is defined as water released at targeted times and places to increase streamflows to benefit migrating salmon and steelhead. The flow augmentation water is provided from multiple sources including: Reclamation’s uncontracted, powerhead reservoir space, annual storage rentals, acquired natural flow water rights, and leased natural flow water rights. The minimum volume target for flow augmentation is 427,000 acre-feet (though there may not be enough water to meet this target in dry years) and can be as much as 487,000 acre-feet from the entire Upper Snake River basin, depending on annual basin conditions. Reservoir space, including both uncontracted and contracted space, used to meet flow augmentation requirements would fill prior to any new reservoir space, including that created by a raise at Anderson Ranch Dam.

Separate from flow augmentation requirements as previously noted, through interagency coordination, Reclamation works with NOAA Fisheries and the Columbia River Technical Management Team (TMT) to coordinate Upper Snake flow augmentation releases. Upper Snake flow augmentation is intended to enhance flows in the lower Snake and Columbia rivers for federally protected out-migrating juvenile salmon and steelhead. Flow objectives and actual flows at Lower Granite Dam during the spring migration period are used to help determine flow augmentation release timing. The flow objectives at Lower Granite Dam vary between 85,000 cfs and 100,000 cfs (depending on water supply forecasts) during the spring (April 3 - June 20). It is important to note that Lower Granite Dam flow objectives are guidelines and often difficult to meet throughout the entire fish migration period, especially in dry years.

As part of this analysis, Reclamation assessed potential changes to flow at Lower Granite Dam on the Lower Snake River for Alternative B (6-foot Raise) and Alternative C (3-foot Raise). Figure 52 through Figure 55 show the monthly volume for each year from 1958 through 2008 at Lower Granite Dam for No Action and Alternatives B and C, respectively. In addition, the gray lines indicate the percent difference in flow which range from -1.3 percent to 0.7 percent for Alternative B and -0.4 percent to 0 percent for Alternative C for some years. Generally, there is a slight decrease in flows at Lower Granite as more water is being stored in the Boise System. However, there would be no change in the ability to anticipated flow augmentation volume from the No Action alternative due to the storage fill priority (see Section 5). Note that the largest percent change in flow was -1.3 percent in 1985 for Alternative B where there is a shift in timing in the delivery from June to July as the system filled earlier and released flow augmentation earlier.

Section 5 describes the total delivery of flow augmentation water out of the Boise System for the different Alternatives.

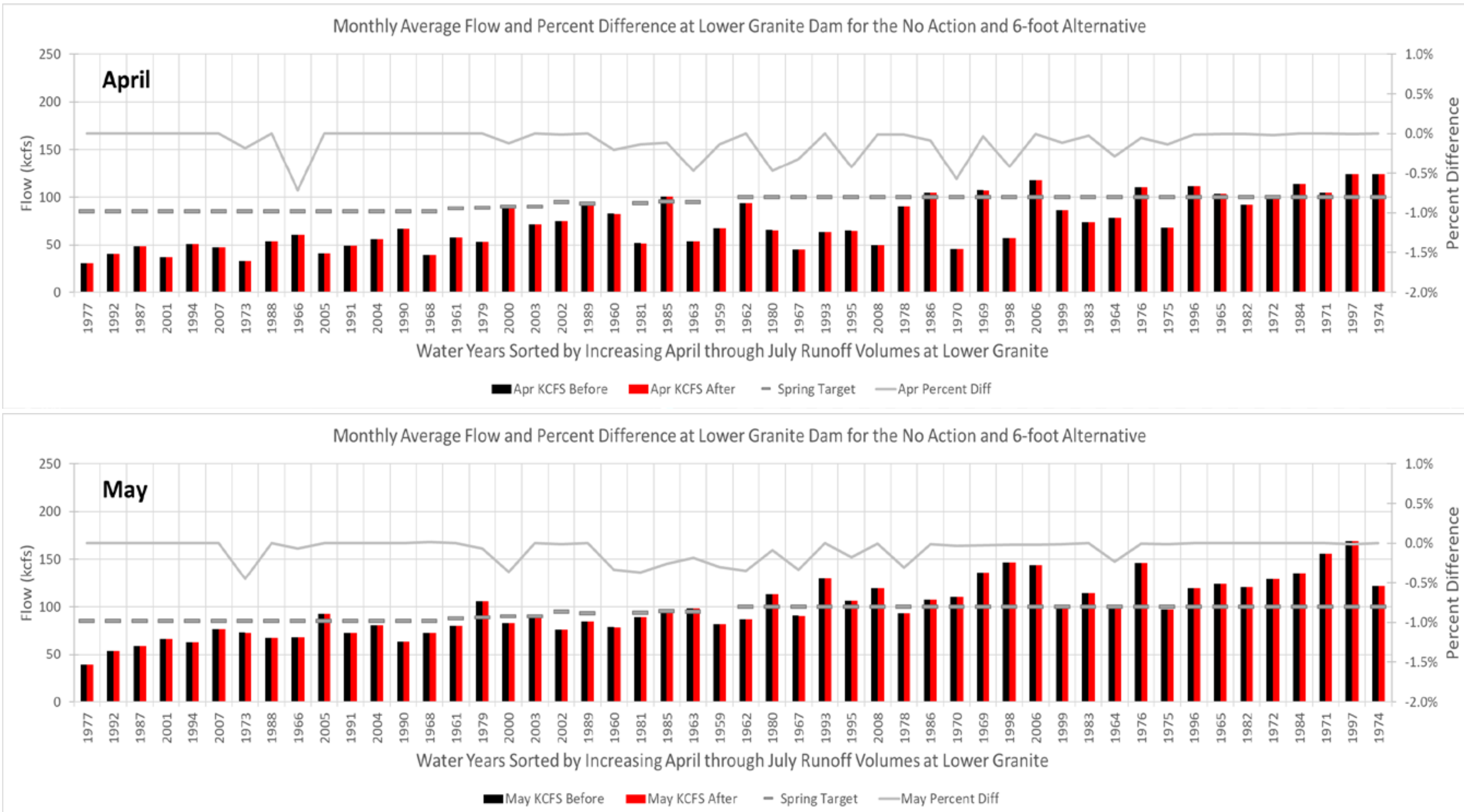


Figure 52. Flow at Lower Granite Dam for No Action (black bar), the 6-foot Raise Alternative (red bar), and the flow objective (gray dash) for April (top) and May (bottom). The percent change in flow is shown with the gray line.

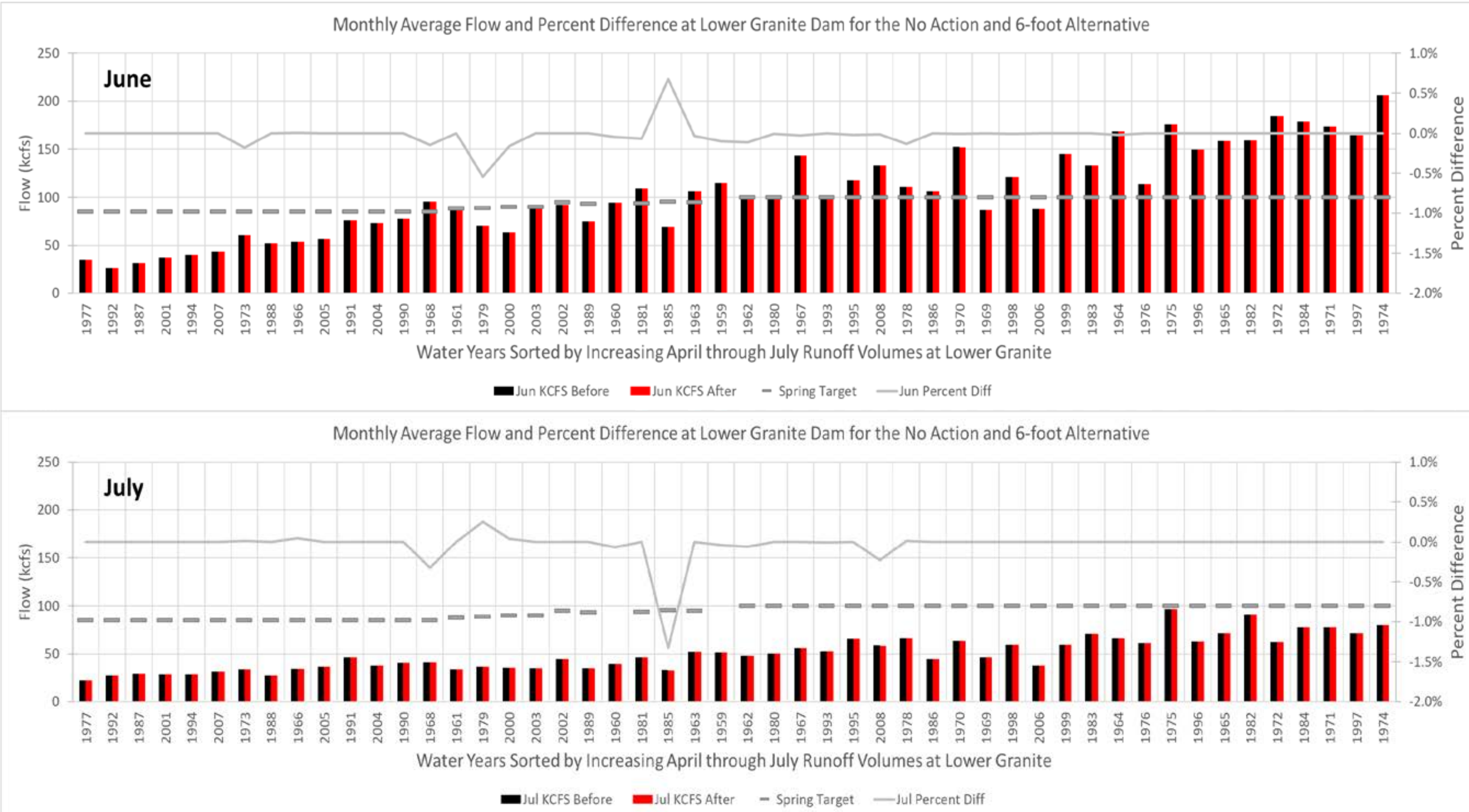


Figure 53. Flow at Lower Granite Dam for No Action (black bar), the 6-foot Raise Alternative (red bar), and the flow objective (gray dash) for June (top) and July (bottom). The percent change in flow is shown with the gray line.

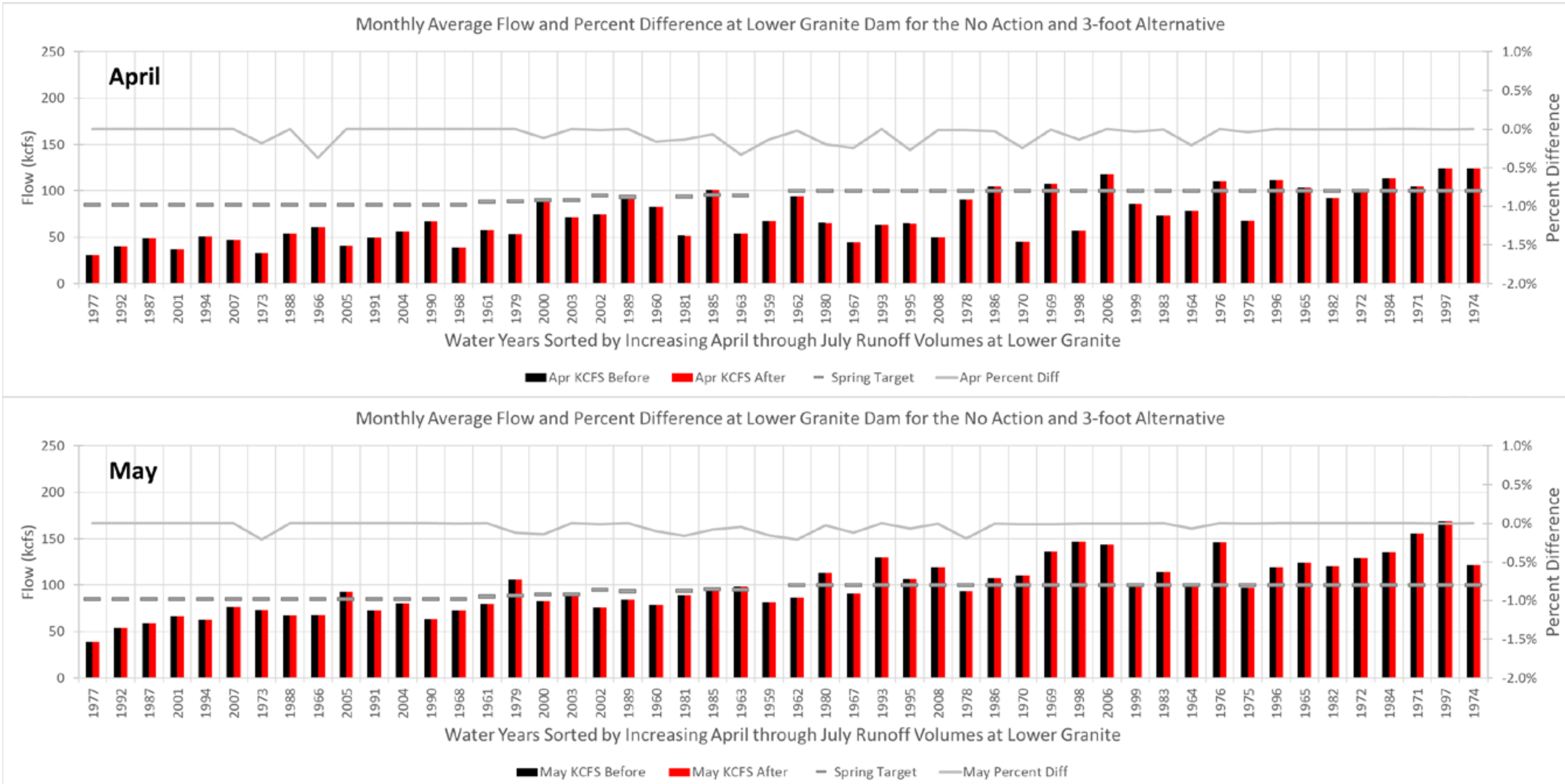


Figure 54. Flow at Lower Granite Dam for No Action (black bar), the 3-foot Raise Alternative (red bar), and the flow objective (gray dash) for April (top) and May (bottom). The percent change in flow is shown with the gray line.

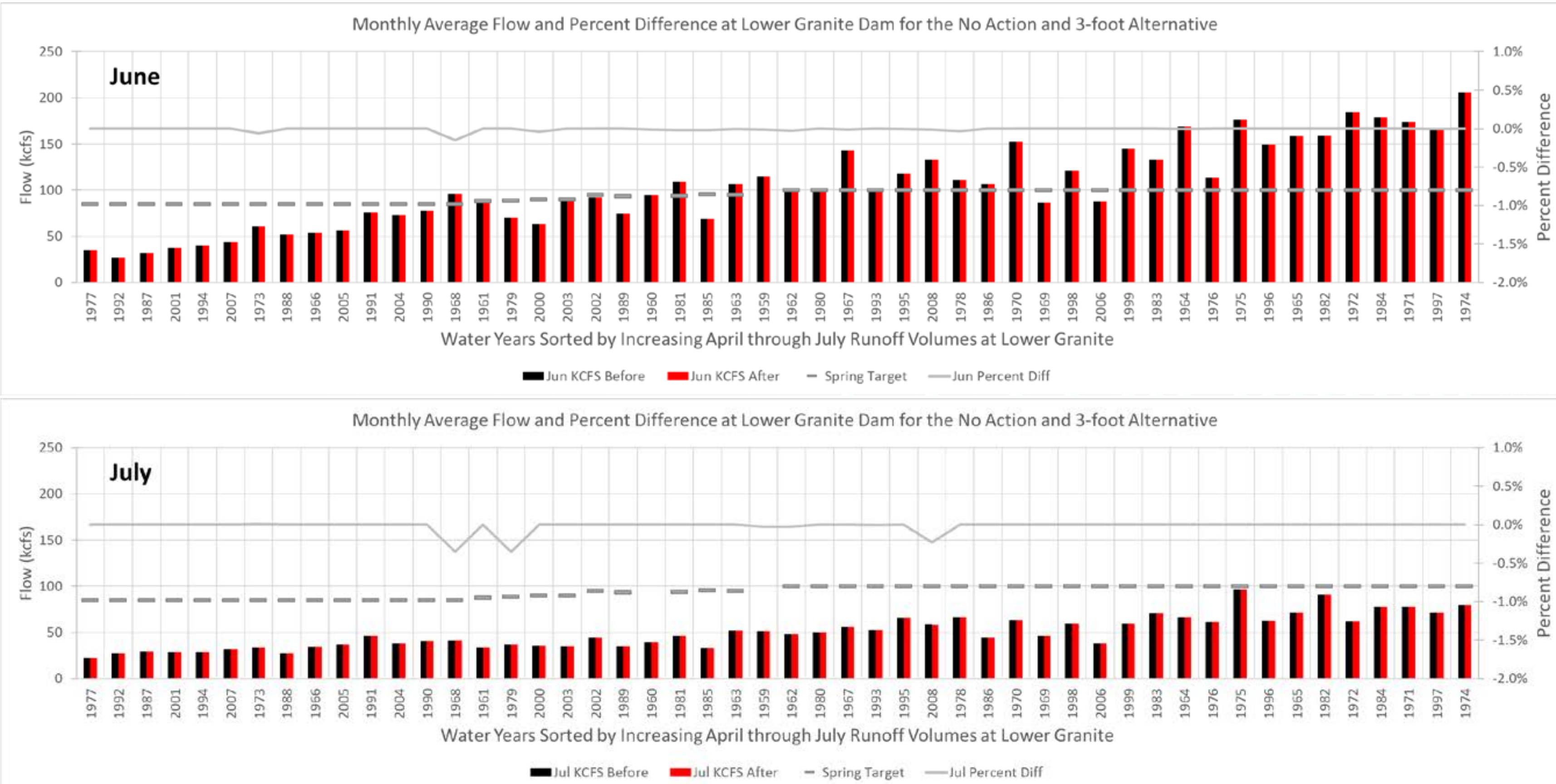


Figure 55. Flow at Lower Granite Dam for No Action (black bar), the 3-foot Raise Alternative (red bar), and the flow objective (gray dash) for June (top) and July (bottom). The percent change in flow is shown with the gray line.

5 Water Availability and Refill Probability

At the time of this study, multiple proposals of new water rights for diversion from – and storage in – Anderson Ranch Reservoir were being considered. Given the uncertainty around if and when these new proposals would be implemented, a range of scenarios was analyzed. The Director of the Idaho Department of Water Resources administers natural flow and storage water rights in priority using the water right accounting program. The sequential priority of water right administration is such that the space for water delivered in the previous water year for "flow augmentation" (water that is released out of basin to support ecosystems in the Columbia River) will accrue storage before any new junior storage or natural flow water rights established on the Boise River. Accordingly, those accounts, often previously known as "last to fill," are being modeled as filling before the new accounts or diversions, as this is anticipated how the system would operate in real time.

The analysis utilized a version of the Boise Planning Model to estimate the amount of water available to the potential new water rights at or near Anderson Ranch Reservoir. Both new storage and potential diversions were treated as diversions from Anderson Ranch Reservoir in the model versus in the System Operations model version that treated the new storage as space in the reservoir. Because of this, the timing of storage and use of the new Anderson Ranch Reservoir space could be different in real-time operations; however, the annual volume allocated to that space would be representative of what would be stored in real-time.

Table 5 lists the potential new water rights that were evaluated as part of this analysis along with their associated maximum diversion rate and annual volume limit. These three potential water rights were assumed to only be in priority when:

- There is a minimum of 800 cfs below Anderson Ranch Dam;
- There is a minimum of 240 cfs below New York Canal[5] June 16th through February 29th;
- There is a minimum of 1,100 cfs below New York Canal March 1st through May 31st; and
- The system is making releases for FRM.

[5] The New York Canal is the largest diversion from the Boise River. See Section 7 for more information.

Table 5. Potential new water rights considered in this analysis.

Entity	Diversion Rate Limit	Diversion Volume Limit
Anderson Ranch New Storage (#63-34753)	No limit	29,000 acre-feet
Elmore County (#63-34348)	200 cfs	10,000 acre-feet
	100 cfs	No limit
Cat Creek Energy (#63-34652)	3,000 cfs	30,000 acre-feet[6]

This modeling analysis assumed a flow augmentation target and space volume of 99,768 acre-feet of existing storage space (this does not include the new 6-foot or 3-foot storage space). This is comprised of 40,932 acre-feet of uncontracted space in Lucky Peak Reservoir, 21,880 acre-feet of rentals (representing the maximum volume of rentals provided from the Boise Reservoir System in 2017), and 36,956 acre-feet of Anderson powerhead space. Any physical accrual of storage above 849,901 acre-feet (representing the 949,669 -acre-foot maximum system capacity minus 99,768 acre-feet of last to fill space) was released for flow augmentation in each simulated year.

Considering the potential for analysis period selection to influence refill probability, the results of this analysis are presented for both the full 50-year simulation period and the shorter 28-year period used in the Preliminary Hydrologic Evaluation (Reclamation 2017).

Three different diversion configurations of the potential new accounts result in a total of six scenarios considered in this analysis. These scenarios include the following (with entities listed in the priority order in which they were modeled):

1. Anderson Ranch New Storage Six feet;
2. Elmore County > Anderson Ranch New Storage Six feet > Subordinated Cat Creek Energy;
3. Elmore County > Cat Creek Energy > Anderson Ranch New Storage Six feet;
4. Anderson Ranch New Storage Three feet;
5. Elmore County > Anderson Ranch New Storage Three feet > Subordinated Cat Creek Energy; and
6. Elmore County > Cat Creek Energy > Anderson Ranch New Storage Three feet.

[6] This is the consumptive use portion of this water right. When CCE makes its initial fill, it will divert up to 100,000 acre-feet at a rate of 9996 cfs. That is not considered in this modeling assessment.

5.1 Historical Results

Figure 56 and Figure 57 depict the exceedance curves of annual water availability for new storage in Anderson Ranch Reservoir for the October 1958 through September 2008 and the October 1980 through September 2008 analysis periods, respectively, for Alternative B (6-foot Raise). As shown in these figures, refill probability of 29,000 acre-feet of new storage ranges from 29 percent to 62 percent depending on scenario and analysis period. The highest refill probability was associated with the Anderson Ranch New Storage-only scenario for the 50-year period, while the lowest refill probability was associated with the scenario where Anderson Ranch fills last behind flow augmentation, Elmore County, and Cat Creek Energy (CCE) for the 28-year period.

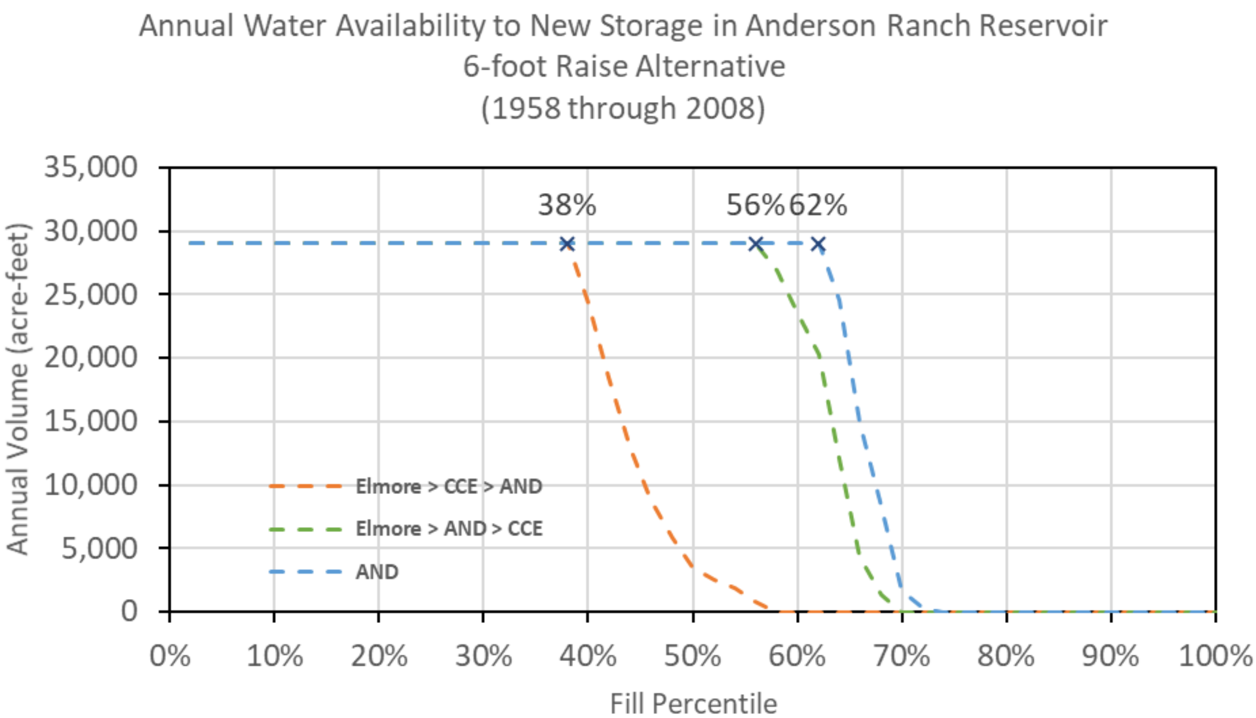


Figure 56. Refill probability for the 6-foot Raise Alternative (29,000 acre-feet of new storage in Anderson Ranch Reservoir) for the 50-year period spanning October 1958 through September 2008. The three scenarios shown represent varying orders of seniority for the Elmore County and Cat Creek Energy water right permits. The legend shows the priority order for each scenario, with entities listed in order from most senior to most junior.

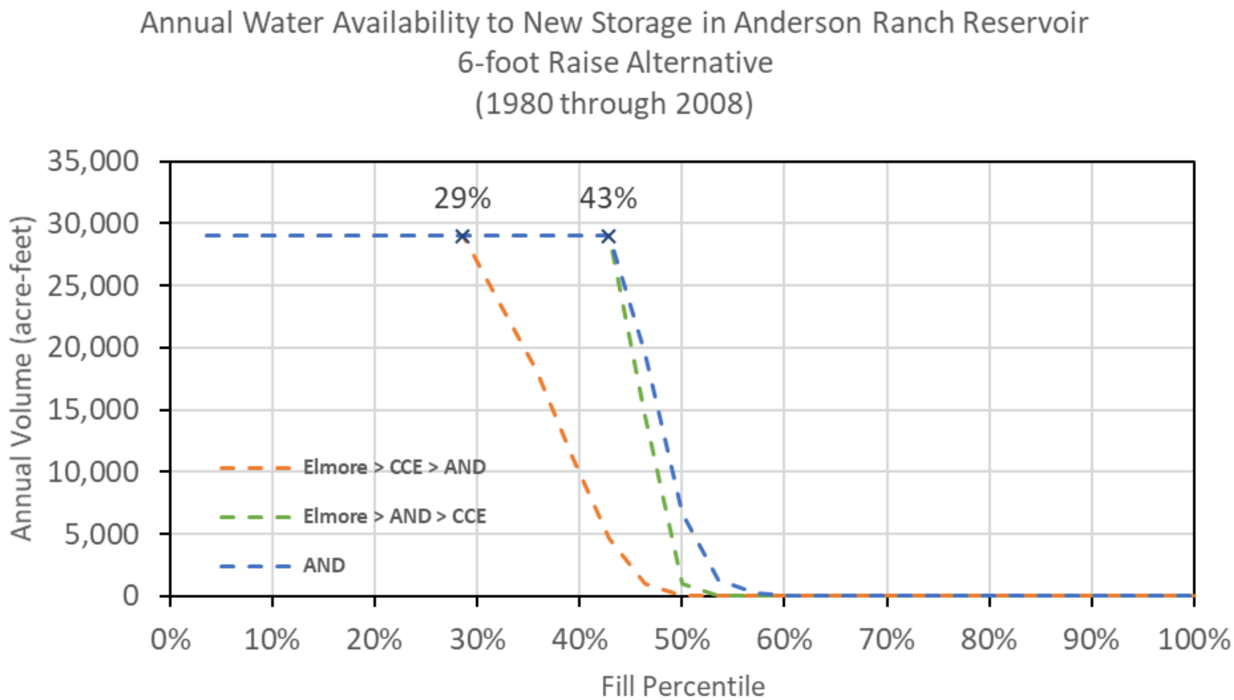


Figure 57. Refill probability for the 6-foot Raise Alternative (29,000 acre-feet of new storage in Anderson Ranch Reservoir) for the 28-year period spanning October 1980 through September 2008. The three scenarios shown represent varying orders of seniority for the Elmore County and Cat Creek Energy water right permits. The legend shows the priority order for each scenario, with entities listed in order from most senior to most junior.

Figure 58 and Figure 59 depict the exceedance curves of annual water availability for new storage in Anderson Ranch Reservoir for the October 1958 through September 2008 and the October 1980 through September 2008 analysis periods, respectively, for the 3-foot Raise Alternative. As shown in these figures, refill probability of 14,400 acre-feet of new storage ranges from 36 percent to 64 percent depending on scenario and analysis period. The 3-foot Raise scenarios have a generally higher refill probability because there is less space to fill. The highest refill probability was associated with the Anderson Ranch New Storage-only scenario for the 50-year period, while the lowest refill probability was associated with the scenario where Anderson Ranch fills last behind flow augmentation, Elmore County, and Cat Creek Energy for the 28-year period.

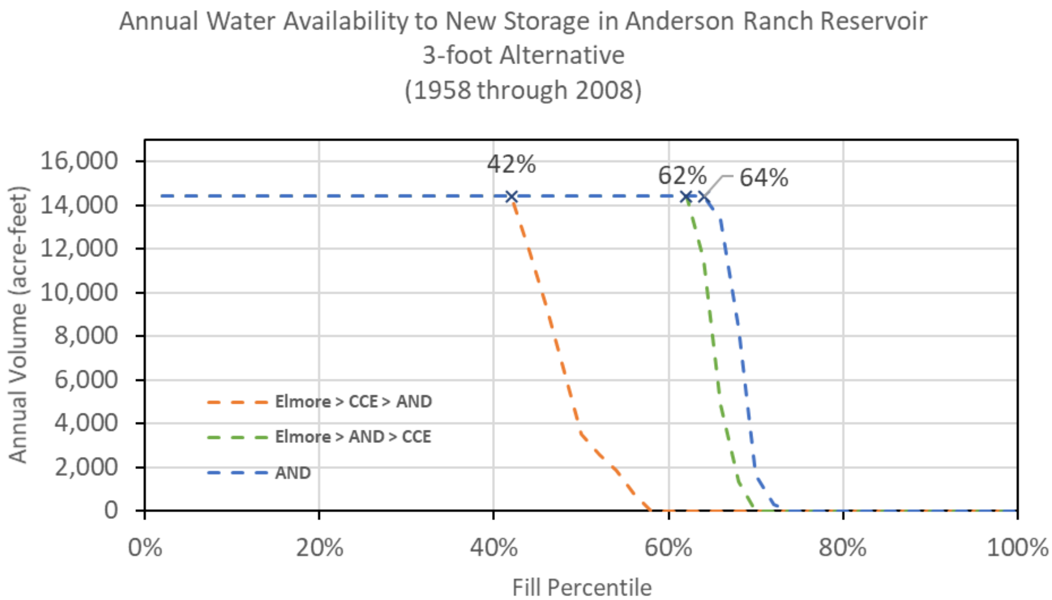


Figure 58. Refill probability for the 3-foot Raise Alternative (14,400 acre-feet of new storage in Anderson Ranch Reservoir) for the 50-year period spanning October 1958 through September 2008. The three scenarios shown represent varying orders of seniority for the Elmore County and Cat Creek Energy water right permits. The legend shows the priority order for each scenario, with entities listed in order from most senior to most junior.

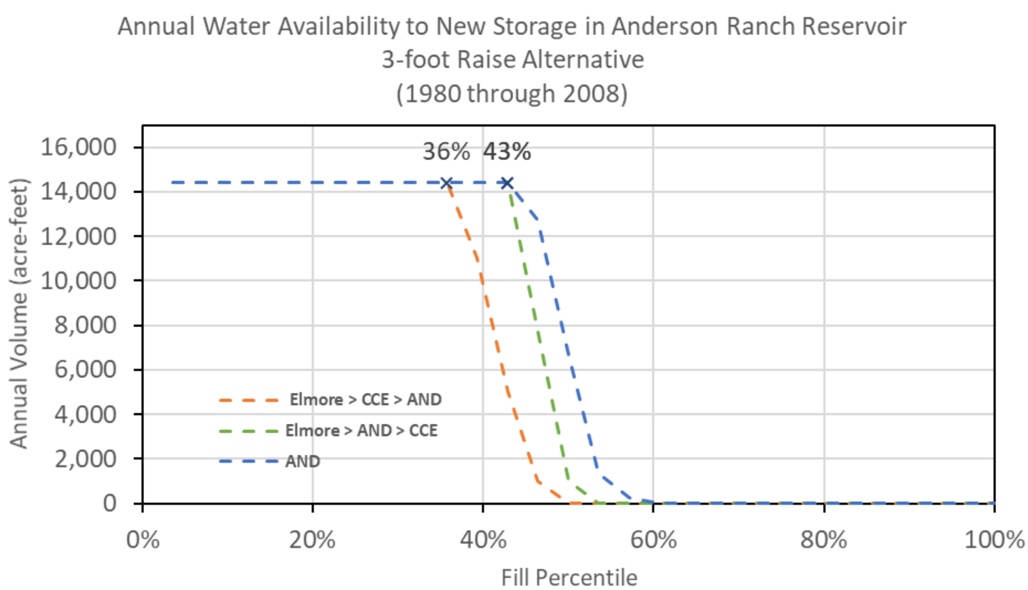


Figure 59. Refill probability for the 3-foot Raise Alternative (14,400 acre-feet of new storage in Anderson Ranch Reservoir) for the 28-year period spanning October 1980 through September 2008. The three scenarios shown represent varying orders of seniority for the Elmore County and Cat Creek Energy water right permits. The legend shows the priority order for each scenario, with entities listed in order from most senior to most junior.

Table 6 summarizes the estimated probability of completely filling 29,000 acre-feet of new storage in Anderson Ranch Reservoir for each of the scenarios and historical periods considered in this analysis. The top scenario, Elmore County > CCE > Anderson Ranch, is the most likely to occur given current water right applications based on publicly available information. The other two are shown for comparison purposes. The results for the 28-year period are similar to those reported by the 2017 Preliminary Hydrologic Evaluation which estimated the new storage would refill in 43 percent to 46 percent of years.

Table 6. Refill probability for the 6-foot Raise (29,000 acre-feet) and 3-foot Raise (14,400 acre-feet) Alternatives given two analysis periods and two new water right permits for Elmore County and Cat Creek Energy (CCE). The scenario column depicts the priority order for each scenario, with entities listed in order from most senior to most junior.

Scenario	6-foot Raise (29,000 acre-feet)		3-foot Raise (14,400 acre-feet)	
	50 Year	28 Year	50 Year	28 Year
Elmore County > CCE > Anderson Ranch	38%	29%	42%	36%
Elmore County > Anderson Ranch > CCE	56%	43%	62%	43%
Anderson Ranch Only	62%	43%	64%	43%

5.2 Climate Change

The water availability scenarios were run using the climate change scenarios described in Section 3.7. These 30-year scenarios include the Livneh Simulated Historical (1980 through 2009)[7] and two 2060s scenarios (2050 through 2079) capturing a range of future conditions. As shown in Table 7, both climate change scenarios exhibit higher refill probabilities compared to the Livneh Simulated Historical dataset. This can be attributed to the year-round increase in streamflow in both of the 2060s climate change conditions relative to the Livneh Simulated Historical conditions. Tables of refill probabilities for new storage in Anderson, as well as for the Elmore County and Cat Creek Energy diversions, are included in the Appendix.

[7] The full Livneh Simulated Historical dataset extends from 1950 through 2010. Similar to the historical results described in Section 4.1.1, evaluation of refill probability using the full period results in different refill probabilities compared to using the more recent 30-year period.

Table 7. Refill probability for the 6-foot Raise (29,000 acre-feet) and 3-foot Raise (14,400 acre-feet) Alternatives given two future climate change scenarios and two new water right permits for Elmore County and Cat Creek Energy (CCE). The simulated historical Livneh Baseline dataset is provided for reference. The scenario column depicts the priority order for each scenario, with entities listed in order from most senior to most junior.

Scenario	Livneh (1980-2009)		2060s Low		2060s High	
	6-foot Raise	3-foot Raise	6-foot Raise	3-foot Raise	6-foot Raise	3-foot Raise
Elmore County > CCE > Anderson Ranch	50%	56%	57%	63%	92%	92%
Elmore County > Anderson Ranch > CCE	56%	66%	78%	90%	92%	92%
Anderson Ranch Only	67%	73%	87%	92%	92%	95%

6 Construction Phase

Construction activities associated with the 6-foot Raise will necessitate drawdown of Anderson Ranch Reservoir and the installation of a coffer dam (Reclamation 2019). Two different pool elevation restrictions have been proposed (4,174 feet and 4,184 feet) based on findings of the flood routing study performed by the Denver Technical Services Center. These restrictions serve the purpose of protecting against flood overtopping failure modes to an acceptable level of risk as determined by Reclamation. The proposed construction schedule calls for Anderson Ranch Reservoir volume to be reduced to the restricted pool elevation at construction commencement for approximately 3.5 years.

6.1 Description of Operations

Depending on the hydrologic conditions, normal outflows for downstream water demand may be sufficient to reduce the pool elevation in Anderson Ranch Reservoir to below the designated restriction elevation (4,174 feet or 4,184 feet) by the end of August 2022. If this is not the case, summer releases will be adjusted accordingly to meet the restricted elevation requirement. For purposes of the EIS, a pool restriction of elevation 4,174 feet was analyzed due to this being the most restrictive with regards to possible impacts to streamflow, reservoir conditions, and FRM operations. Analyzing the lower restriction elevation of 4,174 feet also bounds lesser impacts that would be experienced from a higher restriction elevation of 4,184 feet (or higher). After installation of the coffer dam, operations for FRM and water supply will continue as normal under the restricted pool elevation, resulting in deeper drafts of Anderson Ranch Reservoir than would have occurred without the pool elevation restriction. Deeper drafts will be limited by the powerhead elevation of 4,036 feet. As pool elevations in Anderson Ranch Reservoir approach this lower limit, operations may need to be adjusted to maintain pool elevations above 4,036 feet while still meeting downstream targets including minimum flows in the South Fork Boise River and minimum pool elevation in Arrowrock Reservoir. The analysis on Boise System FRM operations during the pool restriction is summarized in the EIS.

6.2 Potential Storage Shortfall

Drawdown of Anderson Ranch Reservoir during the construction period for both Alternatives has the potential to result in reduced fill to reservoir storage accounts. The amount of shortfall will be dependent on runoff conditions. Only in the driest of years does Anderson Ranch pool elevation remain below the pool elevation limits associated with the construction operations. In other years, the volume of shortfall can be defined as the fill amount the reservoir could have achieved under normal operations, minus the amount of fill achieved under the pool restrictions.

This analysis focusses on the maximum potential shortfall, representing a condition where the reservoir could have filled completely but pool elevation restrictions limited the amount of fill. This analysis also assumes that the ability to fill downstream reservoirs would not be impacted by the restriction. Figure 60 illustrates the storage-elevation curve for Anderson Ranch Reservoir, as well as the storage volumes associated with a full pool (approximately 413,000 acre-feet) and two different restriction elevations (approximately 358,000 acre-feet for a 4,184 foot restriction and approximately 317,000 acre-feet for a 4,174 foot restriction). The maximum volume of shortfall per year under each restriction is then calculated as the full-pool volume minus the restricted-pool volume, resulting in a shortfall of approximately 55,000 acre-feet per year for a 4,184 foot restriction and a shortfall of approximately 97,000 acre-feet per year for a 4,174 foot restriction.

Assuming the shortfall volume would be shared proportionally among current Anderson Ranch spaceholders, the maximum shortfall volume for each spaceholder is calculated as the total shortfall volume multiplied by the percent of total space owned. Table 8 depicts the amount of space owned, the percent of space owned, and the shortfall volume per year under two different restriction elevations for each Anderson Ranch spaceholder.

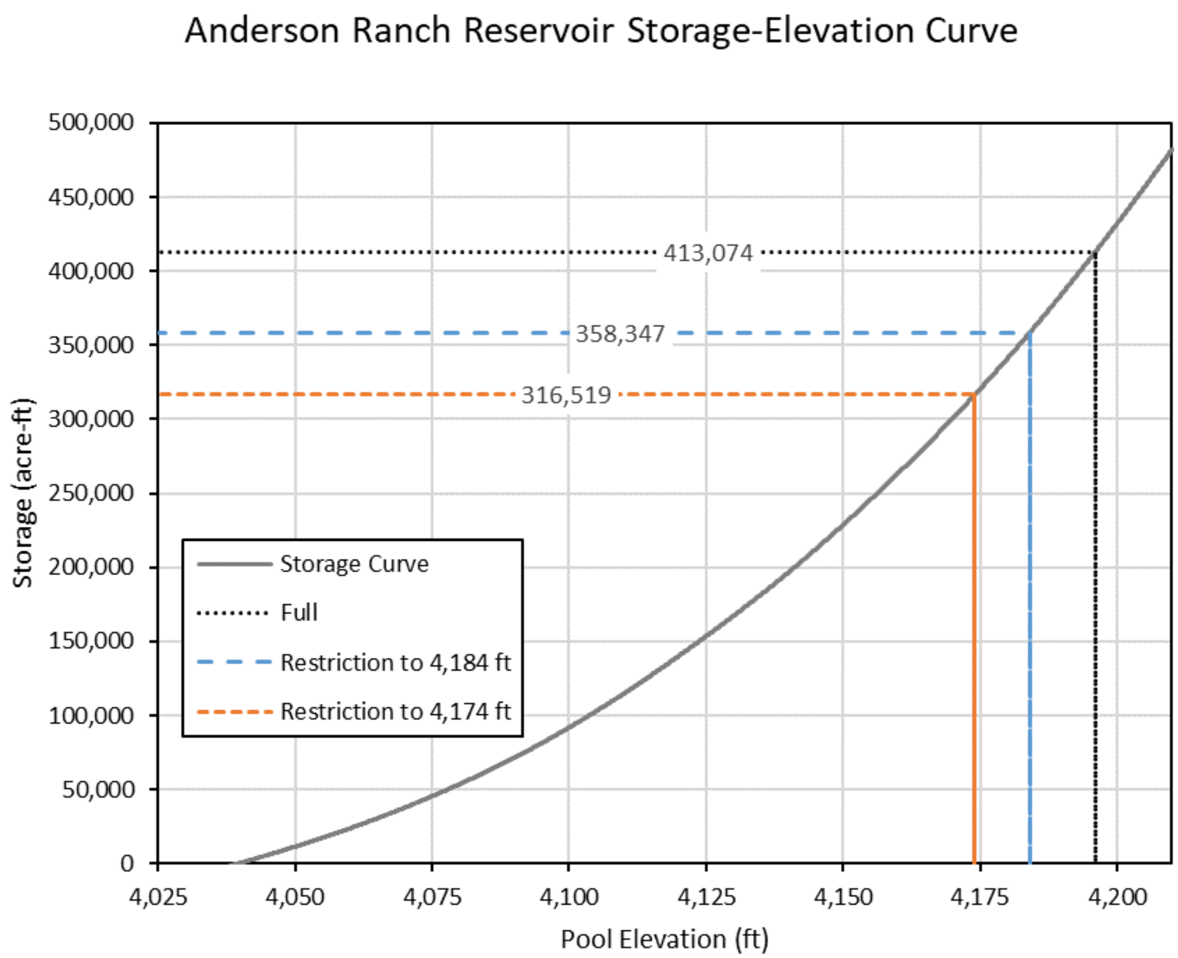


Figure 60. Storage/elevation curve for Anderson Ranch Reservoir with lines depicting storage at full pool (black dotted) and two different pool elevation restrictions associated with the proposed construction activities: 4,184 feet (blue dashed), and 4,174 feet (orange dashed).

Table 8. Anderson Ranch Reservoir spaceholders and the amount of space owned, percent of space owned (excluding power head), and the potential maximum shortfall volumes under two different pool elevation restrictions.

Spaceholder	Space Owned (acre-feet)	Percent of Total Space	Shortfall Volume for 4,184-foot Restriction (acre-feet/year)	Shortfall Volume for 4,174-foot Restriction (acre-feet/year)
Trinity Springs	800	0.19%	105.99	187.00
New York	351,554	85.11%	46,576.39	82,174.86
Surprise Valley/Micron	3,000	0.73%	397.46	701.24
Ridenbaugh	14,785	3.58%	1,958.82	34,55.96
Bubb	531	0.13%	70.35	124.12
Suez Water	1,000	0.24%	132.49	233.75
Settlers	5,675	1.37%	751.86	1,326.52
Farmers Union	5,593	1.35%	741.00	1,307.35
Boise Valley	939	0.23%	124.41	219.49
Capitol View	449	0.11%	59.49	104.95
New Dry Creek	1,266	0.31%	167.73	295.92
Ballentyne	367	0.09%	48.62	85.79
Phyllis	24,986	6.05%	3,310.32	5,840.41
Little Pioneer	2,123	0.51%	281.27	496.25
Uncontracted	6	0.00%	0.79	1.40
TOTAL	413,074	100%	54,727	96,555

7 Evaluation of Canal Lining

During the study, an alternative to line portions of the New York Canal and Mora Canal was briefly considered but eliminated after a cursory evaluation showed that it would not meet the planning objectives of providing additional water supply in the Boise River Basin. The New York Canal distributes water for the Boise Project Board of Control. It diverts water from the Boise River at Diversion Dam and delivers it at approximately 2,300 cfs during the peak of the irrigation season. Since its construction, water has seeped from the canal into the shallow aquifer. Each year, this seeped water returns to the Boise River and provides water supply to diverters in the lower reaches of the Boise River.

The cursory evaluation considered reducing seepage from the New York canal that would be accomplished by lining the canal. By reducing seepage by about 8 percent, it was assumed that

50,000 acre-feet of water could be left in reservoir storage and allocated for new uses. However, reducing seepage would also reduce the amount of return flow to the lower reaches of the Boise River. Downstream diverters would then either call on their storage more frequently or it was assumed they would rent water to make up their shortfall. The cursory evaluation concluded this alternative would result in a net zero benefit of providing additional water supply in the Boise River Basin.

8 Conclusions

This study evaluated the storage, streamflow, and temperature changes that may occur at key locations as a result of the proposed increased storage capacity at Anderson Ranch Reservoir for two Alternatives: a 6-foot Raise at Anderson Ranch Dam, and a 3-foot Raise at Anderson Ranch Dam. The primary conclusions of this study are listed below.

- Model results suggest no change to the ability of the Boise System to continue to meet the operating and ecological objectives in both Alternatives.
- Conditions under the Alternatives would not result in increased use of the spillway at Anderson Ranch Dam.
- There is potential for increased flows below Anderson Ranch Dam in the late summer when releases from Anderson Ranch Reservoir are called upon for irrigation demand and to backfill Arrowrock Reservoir. In these cases, it is presumed that releases will be made at the rate of power plant capacity, approximately 1,600 cfs. The duration of these flows depends on the new volume to be released. A release of the full 6-foot Raise volume (29,000 acre-feet) would equate to 9.1 days of flow at 1,600 cfs or 4.5 days for the 3-foot Raise volume (14,400 acre-feet).
- Results for the 6-foot Raise Alternative and 3-foot Raise Alternative showed a slight decrease in water temperatures during the times of year when water temperatures are typically the highest. Results show temperatures remaining between 2 degrees C and 15 degrees C (the suitable temperature range for fish) over the two-year water quality analysis period.
- Water availability analysis results indicate the 6-foot Raise Alternative account was able to fill completely in 38 percent of years in the 1958 through 2008 analysis period. For the 3-foot Raise Alternative, the account was able to fill completely in 42 percent of years in the 1958 through 2008 analysis period.
- 2060s climate change hydrologic conditions showed the potential for increased storage for the 6-foot Raise Alternative and 3-foot Raise Alternative compared to No-Action.

However, it must be noted that these simulations utilize perfect forecasts and current operational objectives. This study does not consider forecast uncertainty, nor how that uncertainty may change going into the future as warming conditions influence the proportion of precipitation that falls as rain rather than accumulating as snowpack.

- Drawdown of Anderson Ranch Reservoir during the construction phase of a dam-raise project has the potential to result in a shortfall of volume of 55,000 acre-feet per year of drawdown for a 4,184 foot restriction and a shortfall of volume of 97,000 acre-feet per year for a 4,174 foot restriction.

Literature Cited

Parenthetical Reference	Bibliographic Citation
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Appendix A

Analysis Period Sensitivity

The analysis period sensitivity is most notable in the Water Availability Analysis and is shown in Section 5. The information provided in this appendix is additional detail that may provide more context for each Alternative.

A.1 Reservoir Conditions

A comparison of results under two different analysis periods was conducted to better understand the sensitivity of the study results to period selection. As discussed in Section 2.2, increased occurrence of low runoff years, combined with earlier runoff recession, results in increased years with low refill in the 1980 through 2008 period when compared to the 1958 through 2008 period.

A.1.1 Alternative B – 6-foot Raise (Preferred)

Figure A-1 through Figure A-10 depict the daily 10^{th}-, 50^{th}-, and 90^{th}-percentile storage values for the 6-foot Raise Alternative, along with the daily minimum and maximum values. All figures exhibit a trend of lower carryover and lower storage volumes through the winter months in the shorter 1980 through 2008 period compared to the 1958 through 2008 period, but similar peak refill volumes. As in the longer 1958 through 2008 period, 1980 through 2008 operations under the scenarios fall within the historical range. Differences in system storage between this Alternative and No Action are similar in magnitude for both analysis periods. For storage at individual reservoirs, differences between this Alternative and No Action are larger in the longer 50-year period than in the shorter 28-year period.

As shown in Figure A-2, the 1980 through 2008 period shows lower median system carryover volume at the end of the irrigation season compared to the longer 1958 through 2008 period shown in Figure A-1, but the two periods show the system reaching similar median peak fill volumes by the end of June. Differences between the scenarios and the baseline condition are similar in magnitude in both periods.

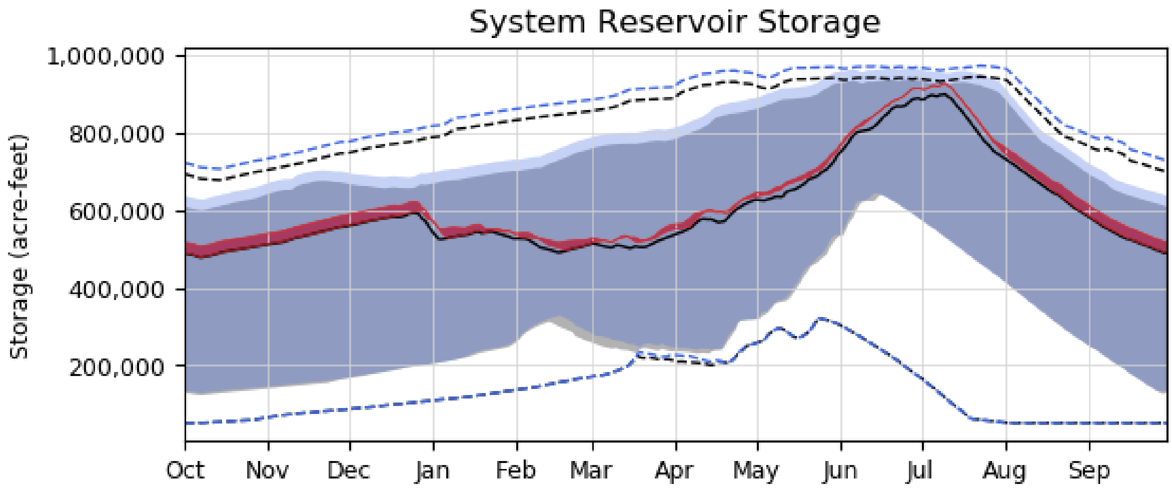

Figure A-1. Boise Reservoir System storage for the 50-year analysis period (1958 through 2008). This figure depicts the daily median storage content range for the 6-foot Raise Alternative (red region) and daily median for No Action (black line). The shaded blue region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed blue and black lines represent the daily minimum and maximum values. Storage values do not include 36,956 acre-feet of inactive powerhead space in Anderson Ranch Reservoir.

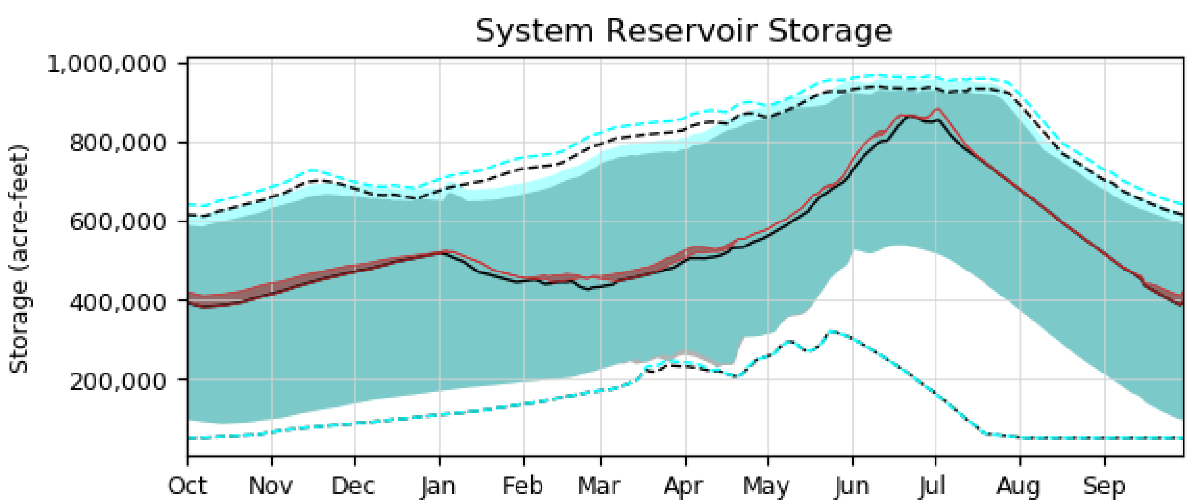

Figure A-2. Boise Reservoir System storage for the 28-year analysis period (1980 through 2008). This figure depicts the daily median storage content range for the 6-foot Raise (red region) and daily median for No Action (black line). The shaded turquoise region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed turquoise and black lines represent the daily minimum and maximum values. Storage values do not include 36,956 acre-feet of inactive powerhead space in Anderson Ranch Reservoir.

Similar to the differences shown for system storage volume, storage volume at Anderson Ranch Reservoir also exhibits lower carryover conditions, but similar refill potential in both analysis periods (Figure A-4). The 1980 through 2008 period results in conditions where the scenario storage volume range is closer to the baseline condition from the end of the irrigation season through mid-February.

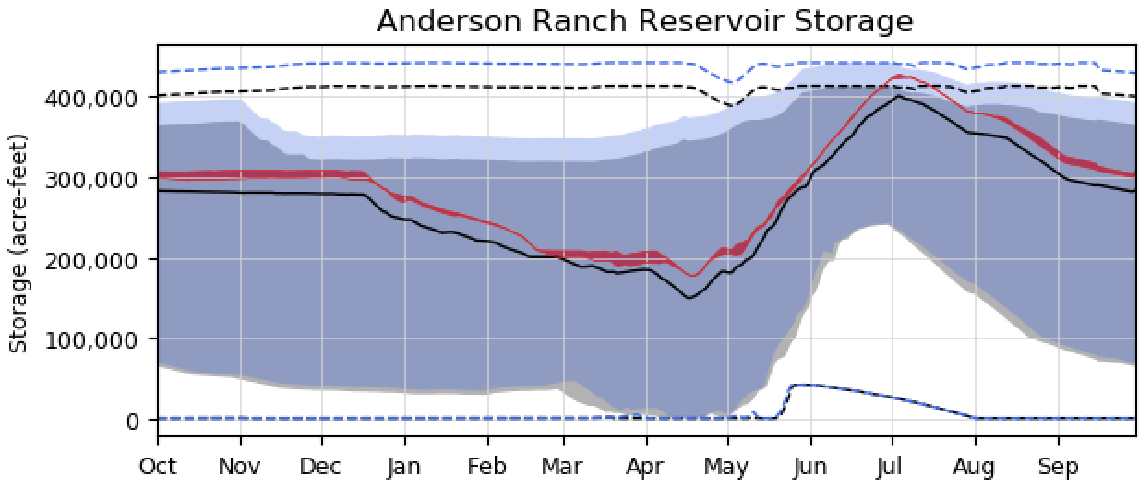

Figure A-3. Anderson Ranch Reservoir storage for the 50-year analysis period (1958 through 2008). This figure depicts the daily median storage content range for the 6-foot Raise (red region) and daily median for No Action (black line). The shaded blue region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed blue and black lines represent the daily minimum and maximum values. Storage values shown do not include 36,956 acre-feet of inactive powerhead space in Anderson Ranch Reservoir.

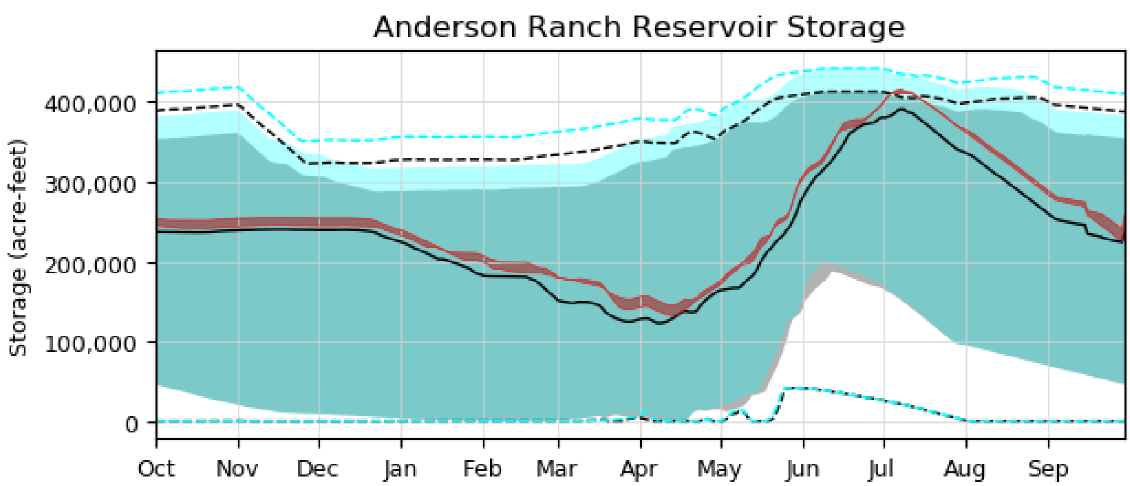

Figure A-4. Anderson Ranch Reservoir storage for the 28-year analysis period (1980 through 2008). This figure depicts the daily median storage content range for the 6-foot Raise (red region) and daily median for No Action (black line). The shaded turquoise region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed turquoise and black lines represent the daily minimum and maximum values. Storage values shown do not include 36,956 acre-feet of inactive powerhead space in Anderson Ranch Reservoir.

At Arrowrock Reservoir, an increased number of low runoff volume years in the shorter analysis period result in lower storage volumes and pool elevations through the winter compared to the longer analysis period. This is illustrated in Figure A-5 through Figure A-8. In both analysis periods, Arrowrock Reservoir is drawn down more deeply by the end of the irrigation season as it is used to satisfy downstream irrigation demands and to backfill Lucky Peak Reservoir.

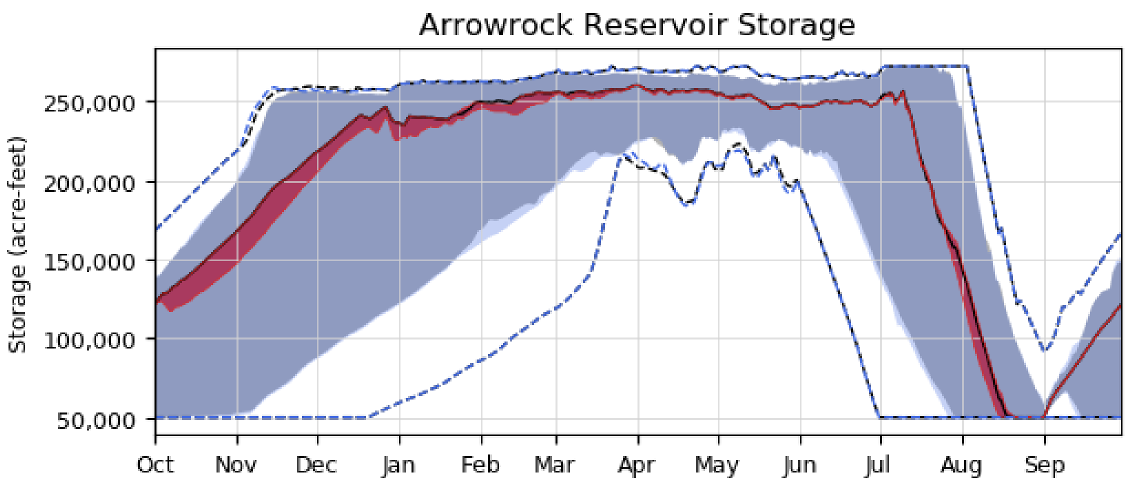

Figure A-5. Arrowrock Reservoir storage for the 50-year analysis period (1958 through 2008). This figure depicts the daily median storage content range for the 6-foot Raise (red region) and daily median for No Action (black line). The shaded blue region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed blue and black lines represent the daily minimum and maximum values.

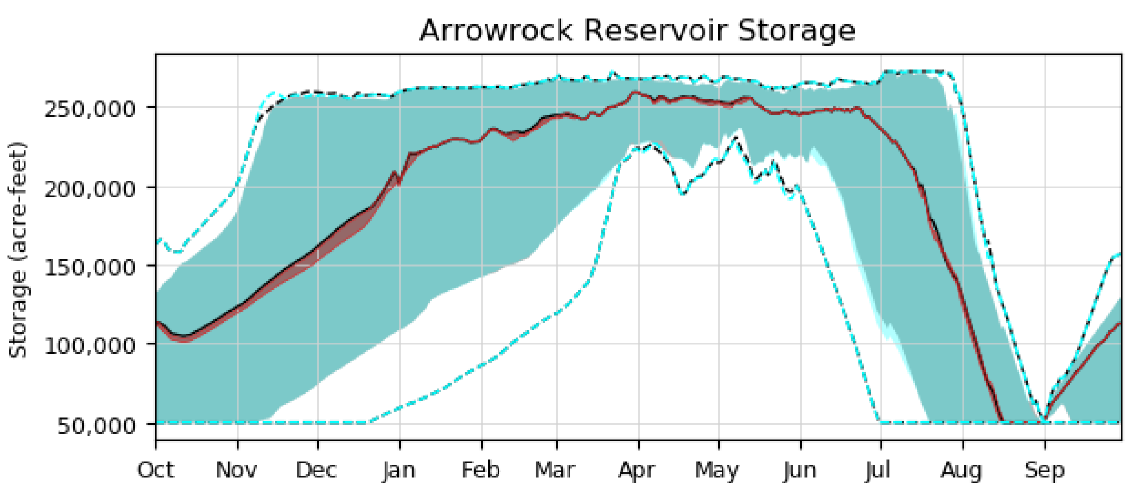

Figure A-6. Arrowrock Reservoir storage for the 28-year analysis period (1980 through 2008). This figure depicts the daily median storage content range for the 6-foot Raise (red region) and daily median for No Action (black line). The shaded turquoise region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed turquoise and black lines represent the daily minimum and maximum values.

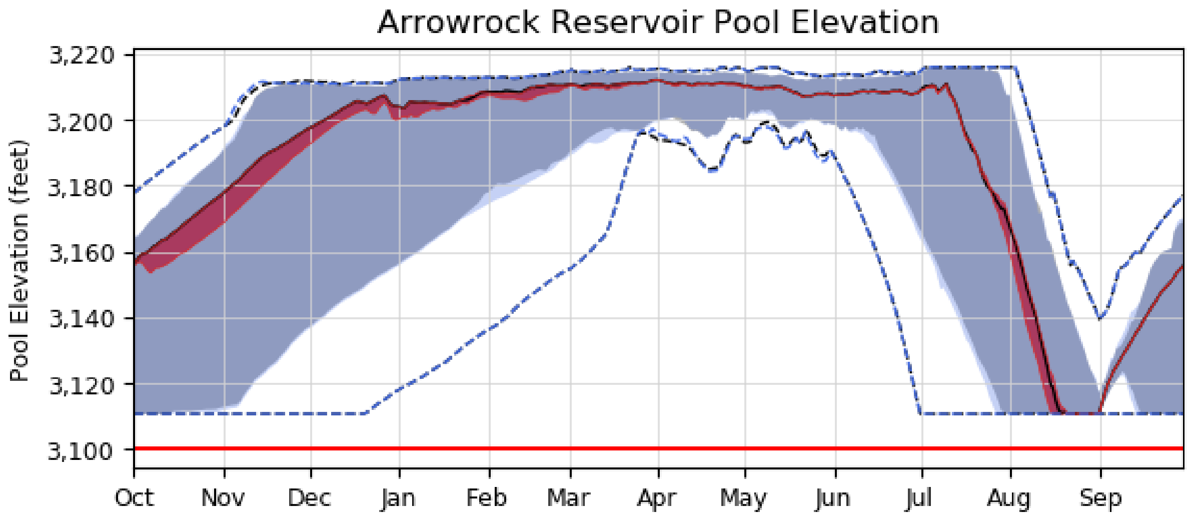

Figure A-7. Arrowrock Reservoir pool elevation for the 50-year analysis period (1958 through 2008). This figure depicts the daily median pool elevation range for the 6-foot Raise (red region) and daily median for No Action (black line). The shaded blue region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed blue and black lines represent the daily minimum and maximum values. The red line represents the threshold at which pool elevation conditions may adversely impact bull trout migration.

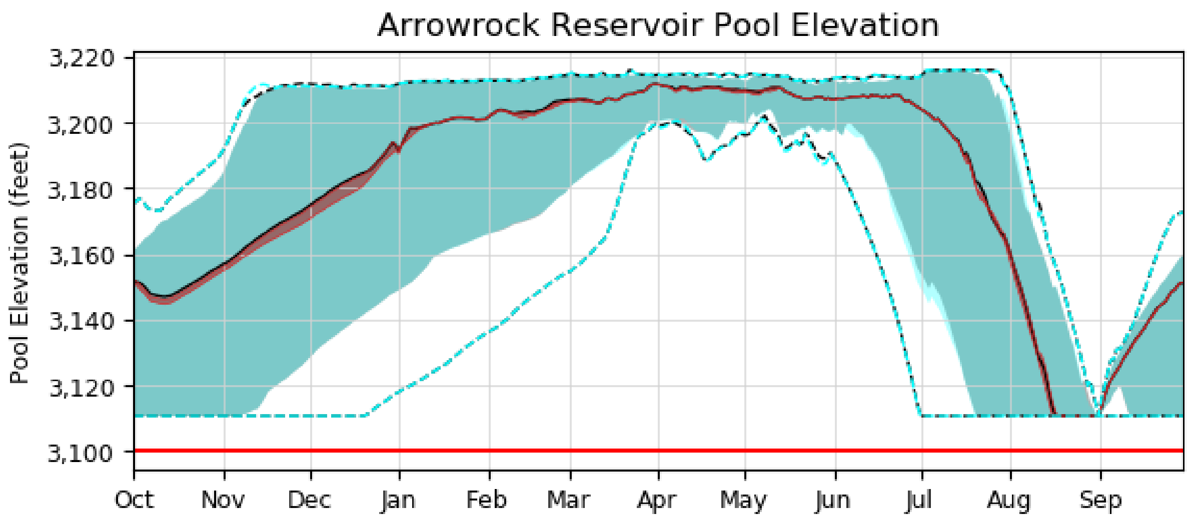

Figure A-8. Arrowrock Reservoir pool elevation for the 28-year analysis period (1980 through 2008). This figure depicts the daily median pool elevation range for the 6-foot Raise (red region) and daily median for No Action (black line). The shaded turquoise region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed turquoise and black lines represent the daily minimum and maximum values. The red line represents the threshold at which pool elevation conditions may adversely impact bull trout migration.

As shown in Figure A-9 and Figure A-10, Lucky Peak Reservoir storage is similar between both analysis periods, particularly in the 50th-percentile. The increased number of dry years in the shorter analysis period has the effect of reduced 90th-percentile storage during the fall months and reduced 10th-percentile storage during the summer months.

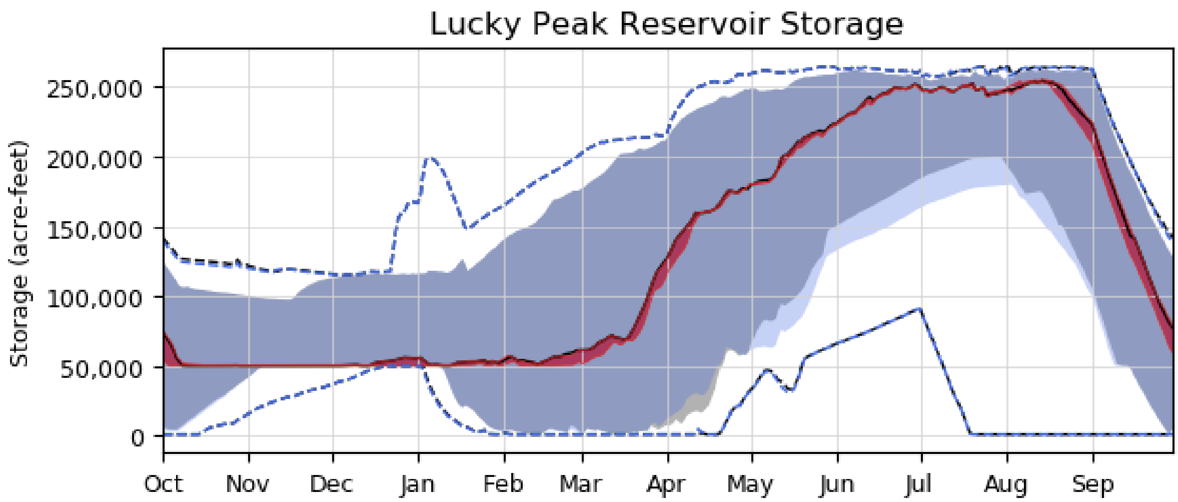

Figure A-9. Lucky Peak Reservoir storage for the 50-year analysis period (1958 through 2008). This figure depicts the daily median storage content range for the 6-foot Raise (red region) and daily median for No Action (black line). The shaded blue region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed blue and black lines represent the daily minimum and maximum values.

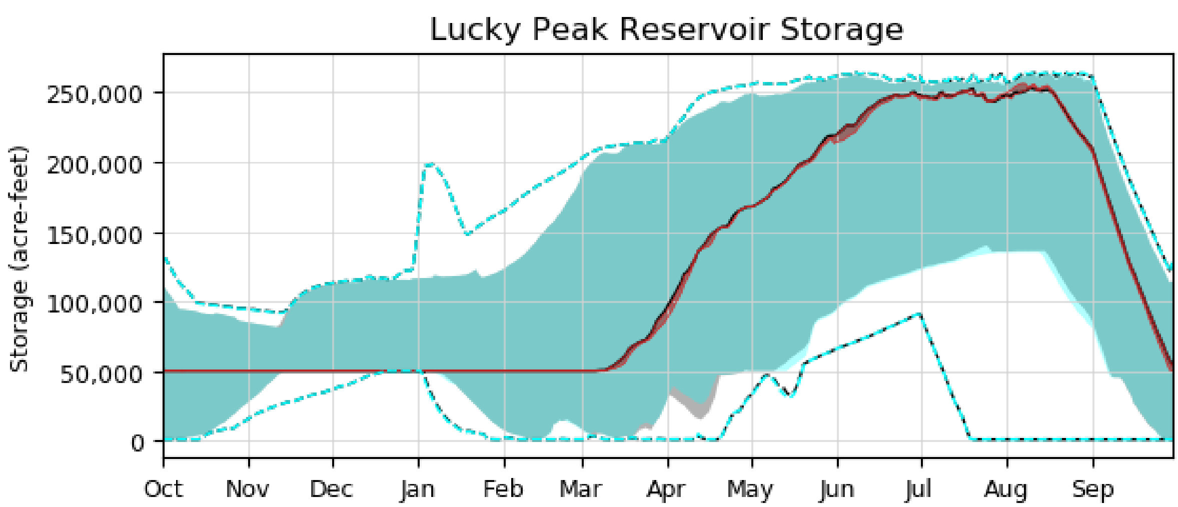

Figure A-10. Lucky Peak Reservoir storage for the 28-year analysis period (1980 through 2008). This figure depicts the daily median storage content range for the 6-foot Raise (red region) and daily median for No Action (black line). The shaded turquoise region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed turquoise and black lines represent the daily minimum and maximum values.

A.1.2 Alternative C – 3-foot Raise

Figure A-11 through Figure A-20 depict the daily 10th-, 50th-, and 90th-percentile storage values for the 3-foot Raise Alternative, along with the daily minimum and maximum values. All figures exhibit a trend of lower carryover and lower storage volumes through the winter months in the shorter 1980 through 2008 period compared to the 1958 through 2008 period, but similar peak refill volumes. As in the longer 1958 through 2008 period, 1980 through 2008 operations under the scenarios fall within the historical range. Differences in system storage between this Alternative and No Action are similar in magnitude for both analysis periods. For storage at individual reservoirs, differences between this Alternative and No Action are larger in the longer 50-year period than in the shorter 28-year period.

As shown in Figure A-12, the 1980 through 2008 period shows lower median system carryover volume at the end of the irrigation season compared to the longer 1958 through 2008 period shown in Figure A-11, but the two periods show the system reaching similar median peak fill volumes by the end of June. Differences between the scenarios and the baseline condition are similar in magnitude in both periods and are generally less than then 6-foot Raise.

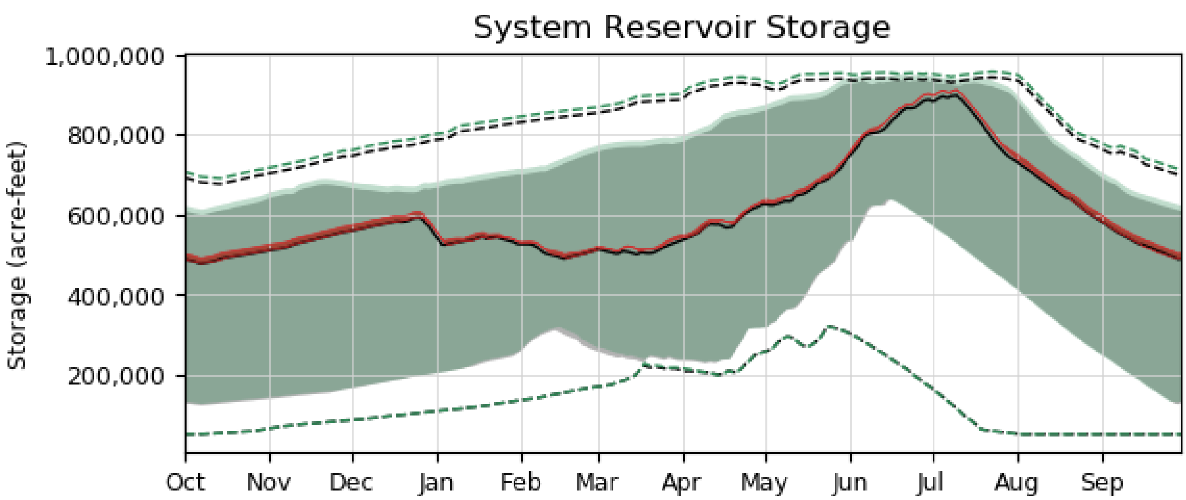

Figure A-11. Boise Reservoir System storage for the 50-year analysis period (1958 through 2008). This figure depicts the daily median storage content range for the 3-foot Raise Alternative (red region) and daily median for No Action (black line). The shaded green-gray region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed green-gray and black lines represent the daily minimum and maximum values. Storage values do not include 36,956 acre-feet of inactive powerhead space in Anderson Ranch Reservoir.

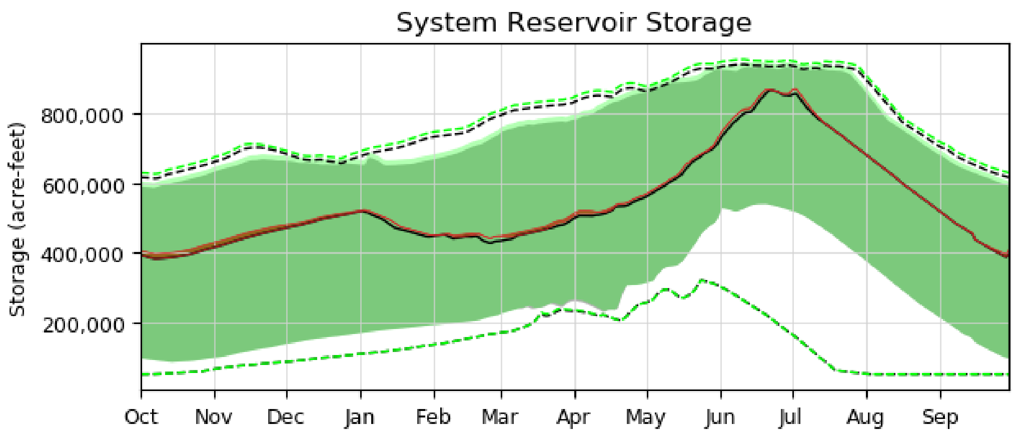

Figure A-12. Boise Reservoir System storage for the 28-year analysis period (1980 through 2008). This figure depicts the daily median storage content range for the 3-foot Raise (red region) and daily median for No Action (black line). The shaded green region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed green and black lines represent the daily minimum and maximum values. Storage values do not include 36,956 acre-feet of inactive powerhead space in Anderson Ranch Reservoir.

Similar to the differences shown for system storage volume, storage volume at Anderson Ranch Reservoir also exhibits lower carryover conditions, but similar refill potential in both analysis periods (Figure A-14). The 1980 through 2008 period results in conditions where the scenario storage volume range is closer to the baseline condition from the end of the irrigation season through mid-February.

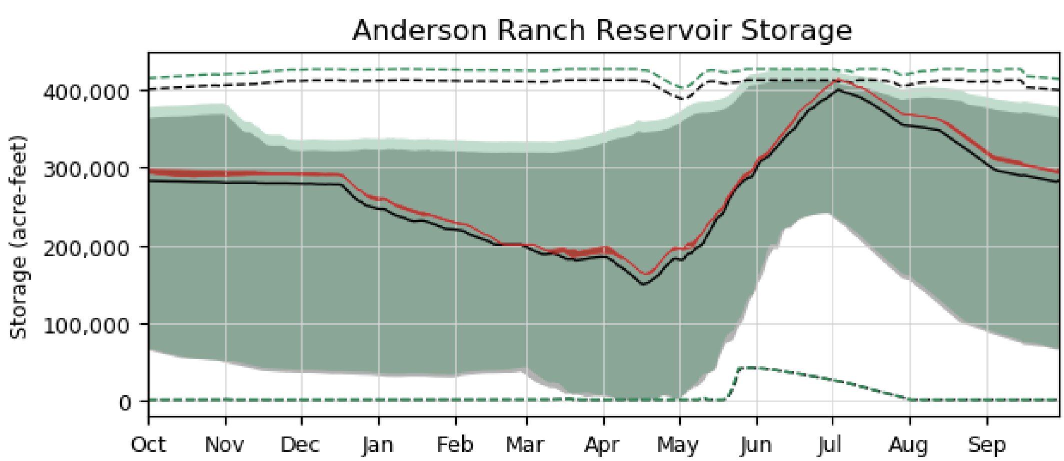

Figure A-13. Anderson Ranch Reservoir storage for the 50-year analysis period (1958 through 2008). This figure depicts the daily median storage content range for the 3-foot Raise (red region) and daily median for No Action (black line). The shaded green-gray region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed green-gray and black lines represent the daily minimum and maximum values. Storage values shown do not include 36,956 acre-feet of inactive powerhead space in Anderson Ranch Reservoir.

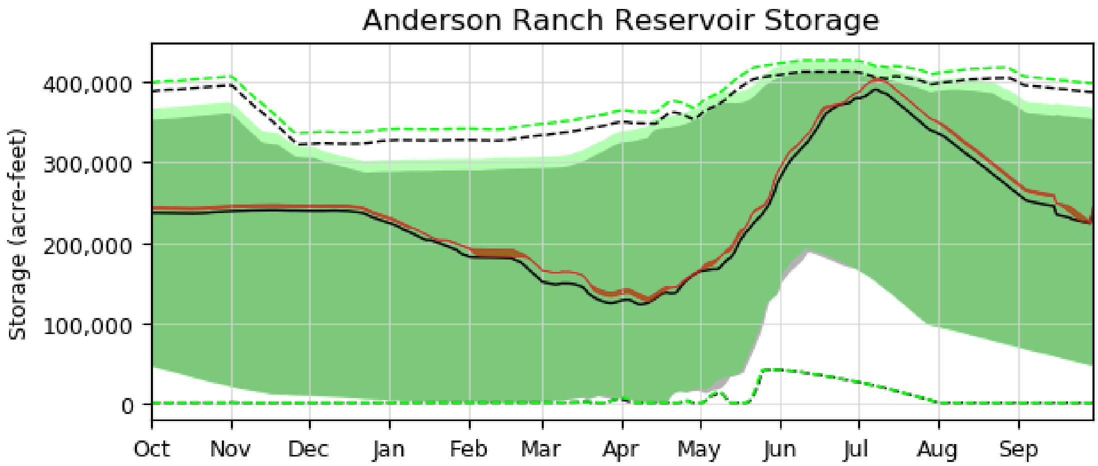

Figure A-14. Anderson Ranch Reservoir storage for the 28-year analysis period (1980 through 2008). This figure depicts the daily median storage content range for the 3-foot Raise (red region) and daily median for No Action (black line). The shaded green region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed green and black lines represent the daily minimum and maximum values. Storage values shown do not include 36,956 acre-feet of inactive powerhead space in Anderson Ranch Reservoir.

At Arrowrock Reservoir, an increased number of low runoff volume years in the shorter analysis period result in lower storage volumes and pool elevations through the winter compared to the longer analysis period. This is illustrated in Figure A-15 through Figure A-18. In both analysis periods, Arrowrock Reservoir is drawn down more deeply by the end of the irrigation season as it is used to satisfy downstream irrigation demands and to backfill Lucky Peak Reservoir.

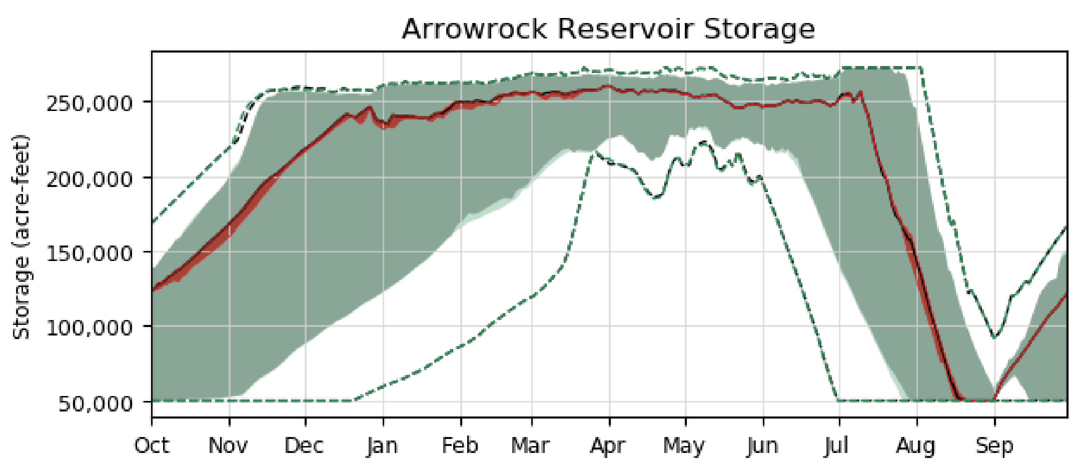

Figure A-15. Arrowrock Reservoir storage for the 50-year analysis period (1958 through 2008). This figure depicts the daily median storage content range for the 3-foot Raise (red region) and daily median for No Action (black line). The shaded green-gray region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed green-gray and black lines represent the daily minimum and maximum values.

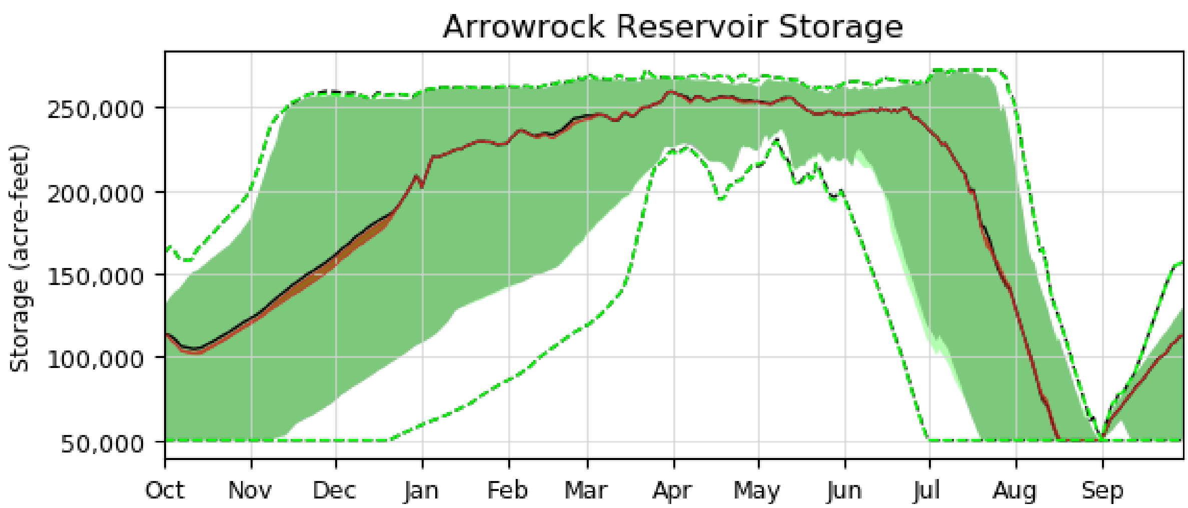

Figure A-16. Arrowrock Reservoir storage for the 28-year analysis period (1980 through 2008). This figure depicts the daily median storage content range for the 3-foot Raise (red region) and daily median for No Action (black line). The shaded green region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed green and black lines represent the daily minimum and maximum values.

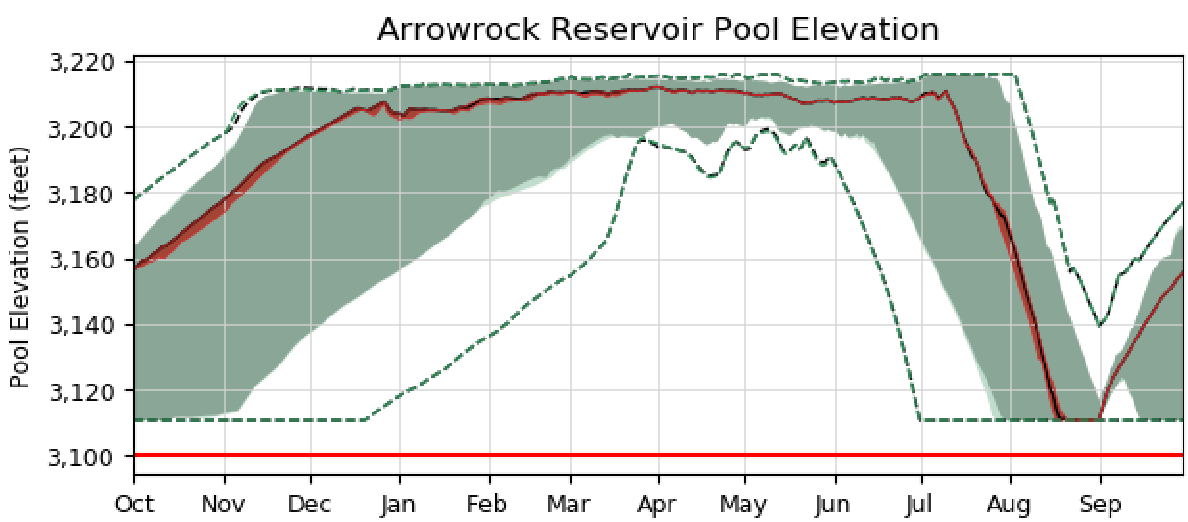

Figure A-17. Arrowrock Reservoir pool elevation for the 50-year analysis period (1958 through 2008). This figure depicts the daily median pool elevation range for the 3-foot Raise (red region) and daily median for No Action (black line). The shaded green-gray region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed green-gray and black lines represent the daily minimum and maximum values. The red line represents the threshold at which pool elevation conditions may adversely impact bull trout migration.

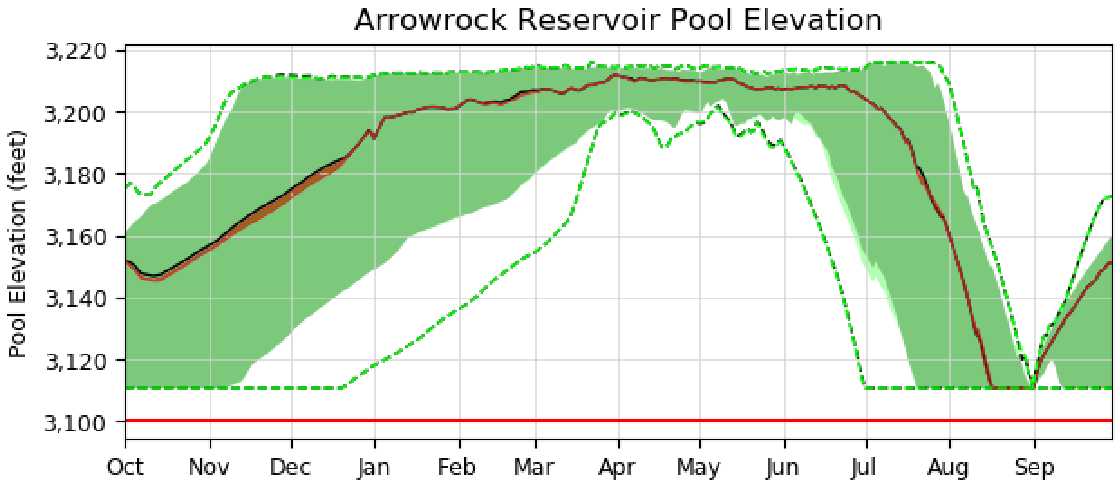

Figure A-18. Arrowrock Reservoir pool elevation for the 28-year analysis period (1980 through 2008). This figure depicts the daily median pool elevation range for the 3-foot Raise (red region) and daily median for No Action (black line). The shaded green region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed green and black lines represent the daily minimum and maximum values. The red line represents the threshold at which pool elevation conditions may adversely impact bull trout migration.

As shown in Figure A-19 and Figure A-20, Lucky Peak Reservoir storage is similar between both analysis periods, particularly in the 50th-percentile. The increased number of dry years in the shorter analysis period has the effect of reduced 90th-percentile storage during the fall months and reduced 10th-percentile storage during the summer months.

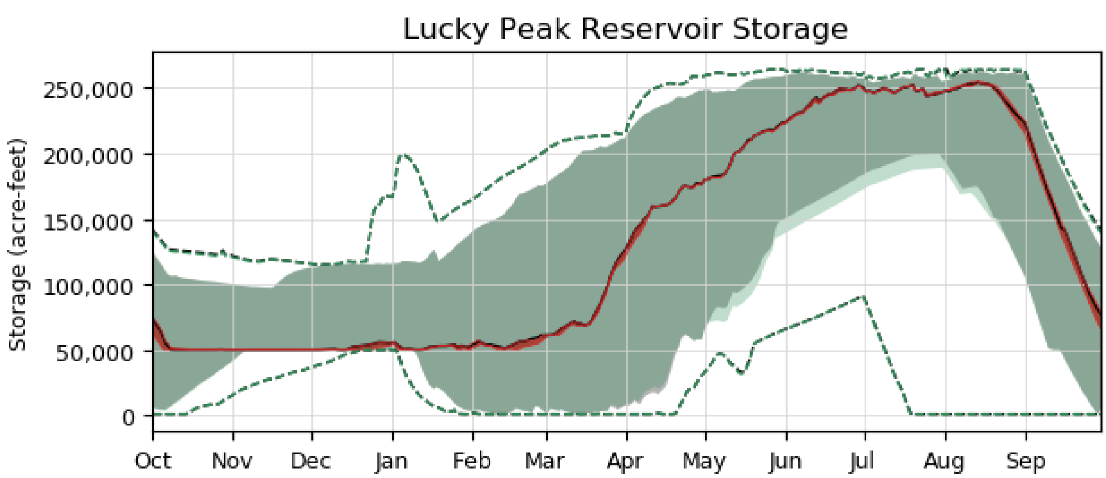

Figure A-19. Lucky Peak Reservoir storage for the 50-year analysis period (1958 through 2008). This figure depicts the daily median storage content range for the 3-foot Raise (red region) and daily median for No Action (black line). The shaded green-gray region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed green-gray and black lines represent the daily minimum and maximum values.

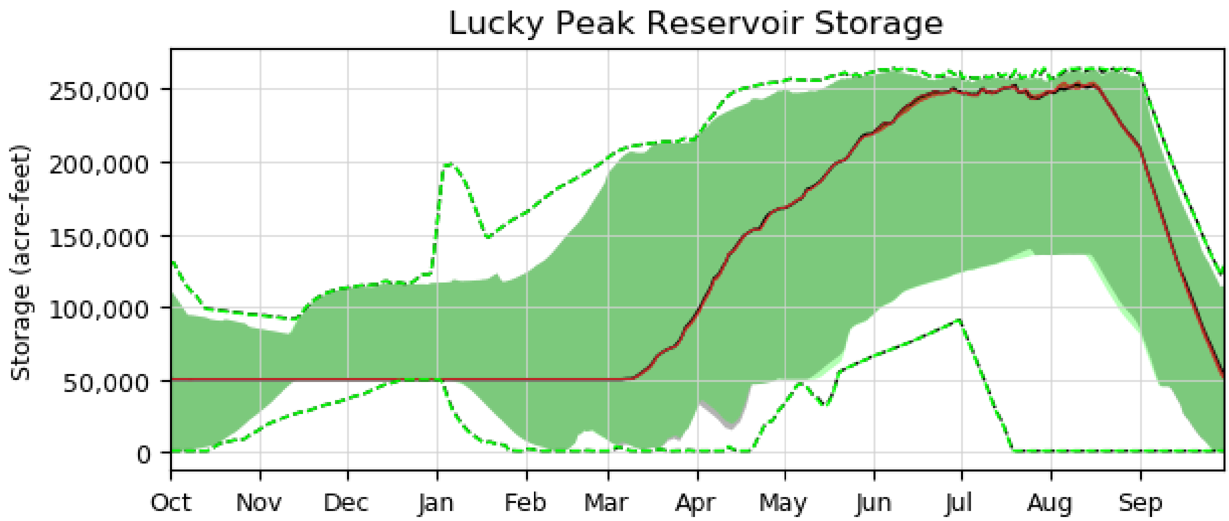

Figure A-20. Lucky Peak Reservoir storage for the 28-year analysis period (1980 through 2008). This figure depicts the daily median storage content range for the 3-foot Raise (red region) and daily median for No Action (black line). The shaded green region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed green and black lines represent the daily minimum and maximum values.

A.2 Streamflow Conditions

A.2.1 Alternative B – 6-foot Raise (Preferred)

Differences in streamflow between the two periods are shown in Figure A-21 through Figure A-24 for the 6-foot Raise. Streamflow below Anderson Ranch Dam (Figure A-21 and Figure A-22) are similar between both periods, with the largest difference occurring in the spring. During this time of year, the 1980 through 2008 analysis period results in lower 50th-percentile streamflow compared to the 1958 through 2008 analysis period. Both periods show similar differences between this Alternative and No Action.

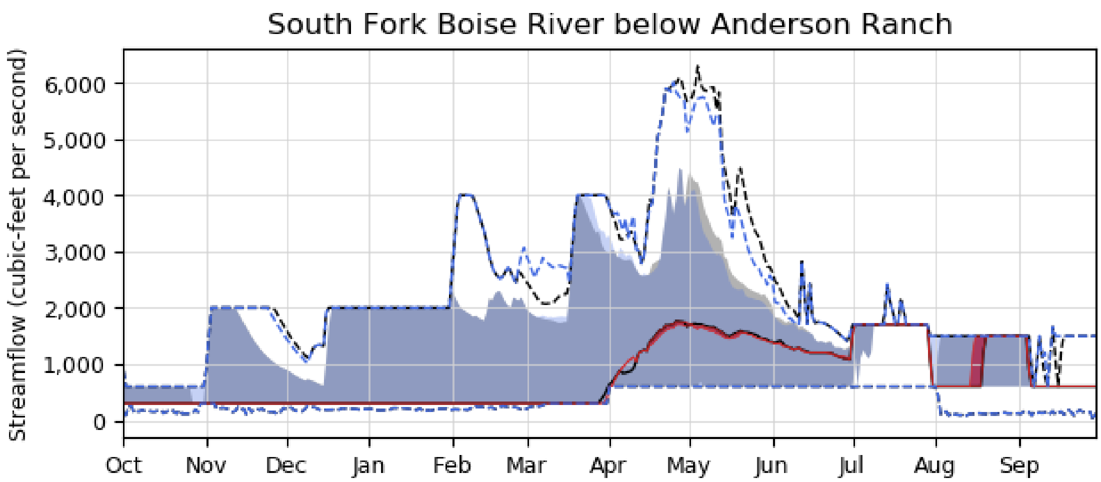

Figure A-21. South Fork Boise River below Anderson Ranch streamflow for the 50-year analysis period (1958 through 2008). This figure depicts the daily median streamflow range for the 6-foot Raise (red region) and daily median for No Action (black line). The shaded blue region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed blue and black lines represent the daily minimum and maximum values.

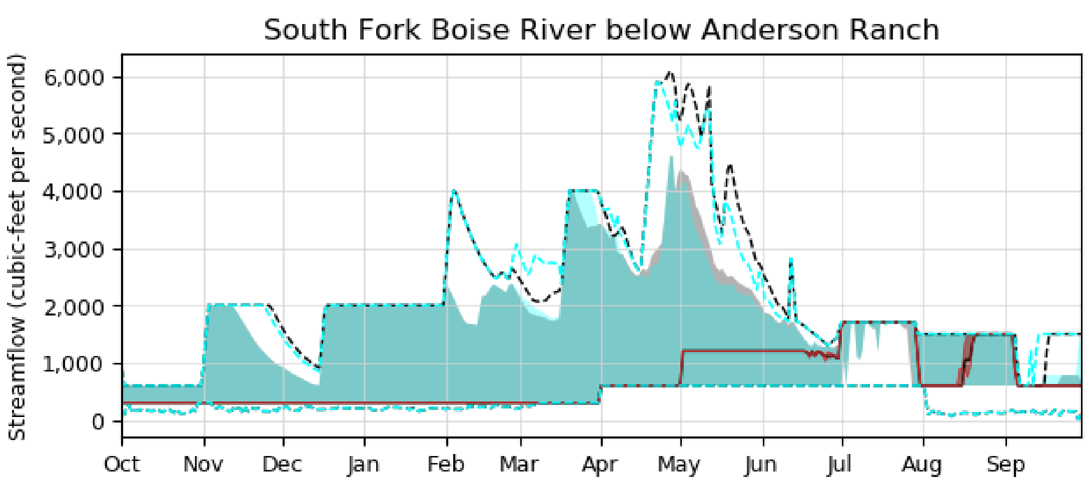

Figure A-22. South Fork Boise River below Anderson Ranch streamflow for the 28-year analysis period (1980 through 2008). This figure depicts the daily median streamflow range for the 6-foot Raise (red region) and daily median for No Action (black line). The shaded turquoise region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed turquoise and black lines represent the daily minimum and maximum values.

Boise River at Glenwood streamflow shows relatively little difference between the two analysis periods. Summary hydrographs for this location are shown in Figure A-23 and Figure A-24. As shown in these figures, the most notable difference between the two periods is the reduced occurrence of flows over 7,000 cfs and lower median July flows in the shorter 1980 through 2008 period. The increased number of low runoff years in the 1980 through 2008 period creates less need for high flood releases while also creating conditions where storage accounts used for July flow augmentation releases do not fill completely (resulting in lower flows in July).

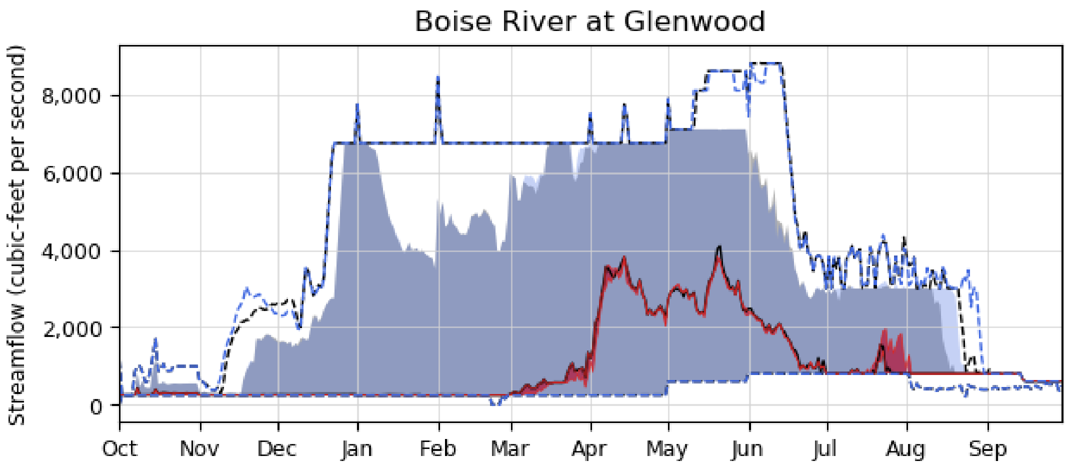

Figure A-23. Boise River at Glenwood streamflow for the 50-year analysis period (1958 through 2008). This figure depicts the daily median streamflow range for the 6-foot Raise (red region) and daily median for No Action (black line). The shaded blue region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot Raise and No Action, respectively. Dashed blue and black lines represent the daily minimum and maximum values. The negative values shown in late-February correspond to an anomaly in the gains at Glenwood. The increase in flows in late-July and early-August in this Alternative median condition (red) is associated with the potential for the new storage to be used for additional flow augmentation releases (see note, Page A-16).

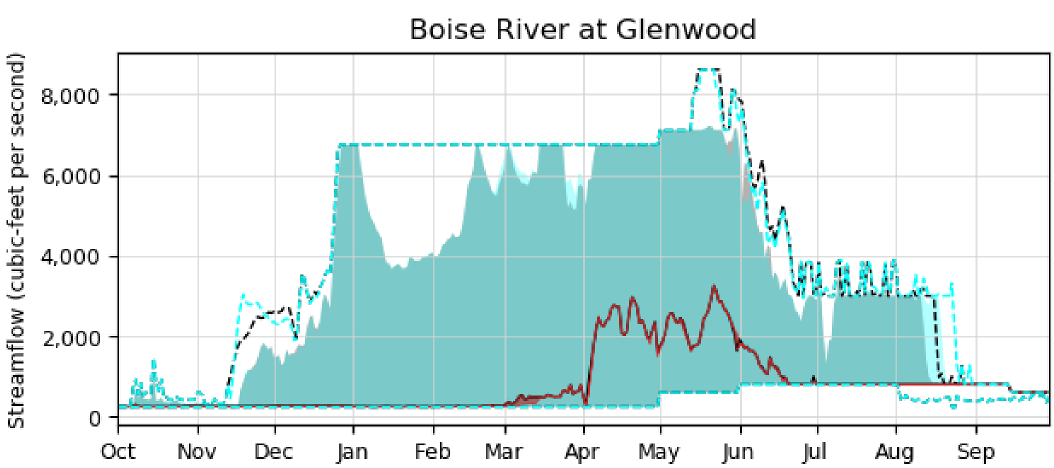

Figure A-24. Boise River at Glenwood for the 28-year analysis period (1980 through 2008). This figure depicts the daily median streamflow range for the 6-foot Raise (red region) and daily median for No Action (black line). The shaded turquoise region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 6-foot and No Action, respectively. Dashed turquoise and black lines represent the daily minimum and maximum values. The February and July anomalies are absent in the shorter time period, likely due to more reliable inflow datasets.

A.2.2 Alternative C – 3-foot Raise

Differences in streamflow between the two periods are shown in Figure A-25 through Figure A-28 for the 3-foot Raise. Streamflow below Anderson Ranch Dam (Figure A-25 and Figure A-26) are similar between both periods, with the largest difference occurring in the spring. During this time of year, the 1980 through 2008 analysis period results in lower 50th-percentile streamflow compared to the 1958 through 2008 analysis period. Both periods show similar differences between this Alternative and No Action.

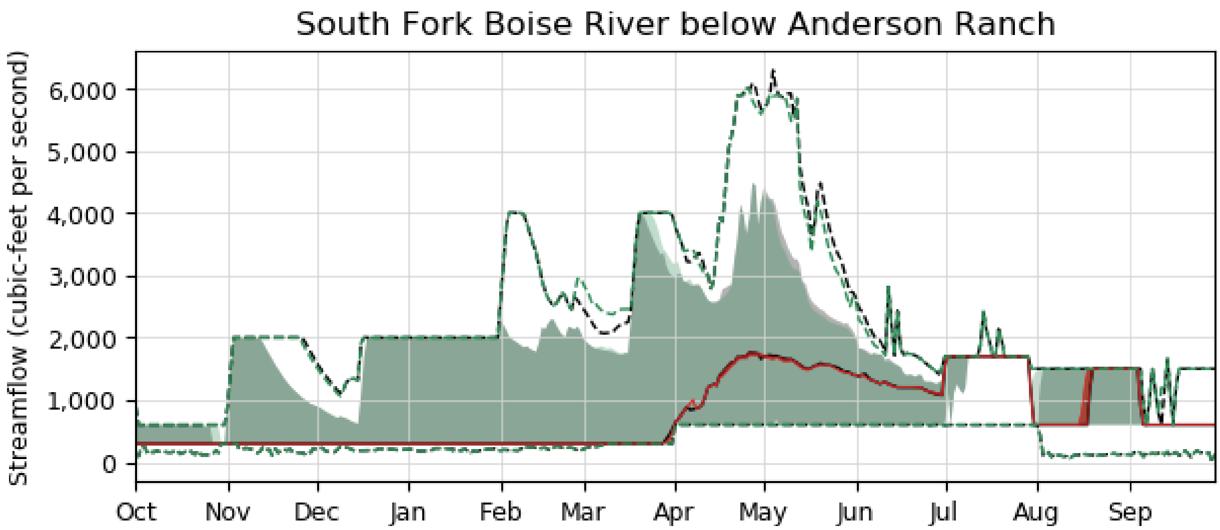

Figure A-25. South Fork Boise River below Anderson Ranch streamflow for the 50-year analysis period (1958 through 2008). This figure depicts the daily median streamflow range for the 3-foot Raise (red region) and daily median for No Action (black line). The shaded green-gray region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 3-foot Raise and No Action, respectively. Dashed green-gray and black lines represent the daily minimum and maximum values.

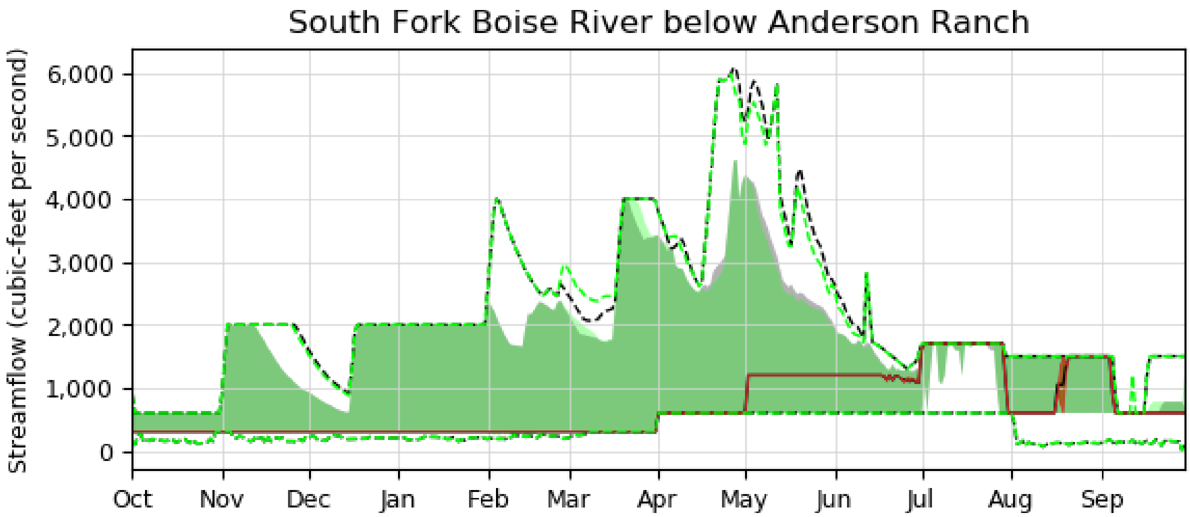

Figure A-26. South Fork Boise River below Anderson Ranch streamflow for the 28-year analysis period (1980 through 2008). This figure depicts the daily median streamflow range for the 3-foot Raise (red region) and daily median for No Action (black line). The shaded green region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 3-foot Raise and No Action, respectively. Dashed green and black lines represent the daily minimum and maximum values.

Boise River at Glenwood streamflow shows relatively little difference between the two analysis periods. Summary hydrographs for this location are shown in Figure A-27 and Figure A-28. As shown in these figures, the most notable difference between the two periods is the reduced occurrence of flows over 7,000 cfs and lower median July flows in the shorter 1980 through 2008 period. The increased number of low runoff years in the 1980 through 2008 period creates less need for high flood releases while also creating conditions where storage accounts used for July flow augmentation releases do not fill completely (resulting in lower flows in July).

Note: Since it is unknown at this time how the new storage will be allocated, four demand patterns were explored as a sensitivity analysis of how the new water could be used. The sensitivity analysis presented here in Appendix A was conducted per initial consideration of using the reserved space for flow augmentation. It was subsequently concluded that the reserved space was not to include flow augmentation as a federal purpose in this Study. This conclusion was developed in coordination with the Solicitor's Office, consistent with the goal of ensuring that a federal decision does not negatively affect an established federal action or decision. While the text of the Technical Memorandum reflects the results of that coordination, schedules did not allow for the Appendix A sensitivity analysis to be re-run. It is likely the results of a refined sensitivity analysis would not be significantly different from those for the existing sensitivity analysis.

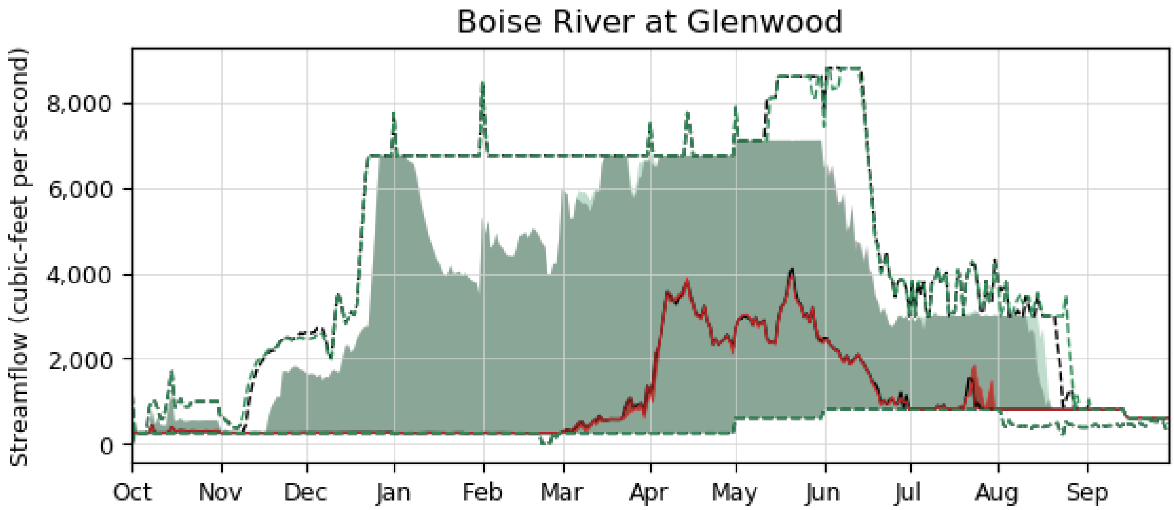

Figure A-27. Boise River at Glenwood streamflow for the 50-year analysis period (1958 through 2008). This figure depicts the daily median streamflow range for the 3-foot Raise (red region) and daily median for No Action (black line). The shaded green-gray region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 3-foot Raise and No Action, respectively. Dashed green-gray and black lines represent the daily minimum and maximum values. The negative values shown in late-February correspond to an anomaly in the gains at Glenwood. The increase in flows in late-July and early-August in the 3-foot Raise median condition (red) is associated with the potential for the new storage to be used for additional flow augmentation releases (see note, Page A-16).

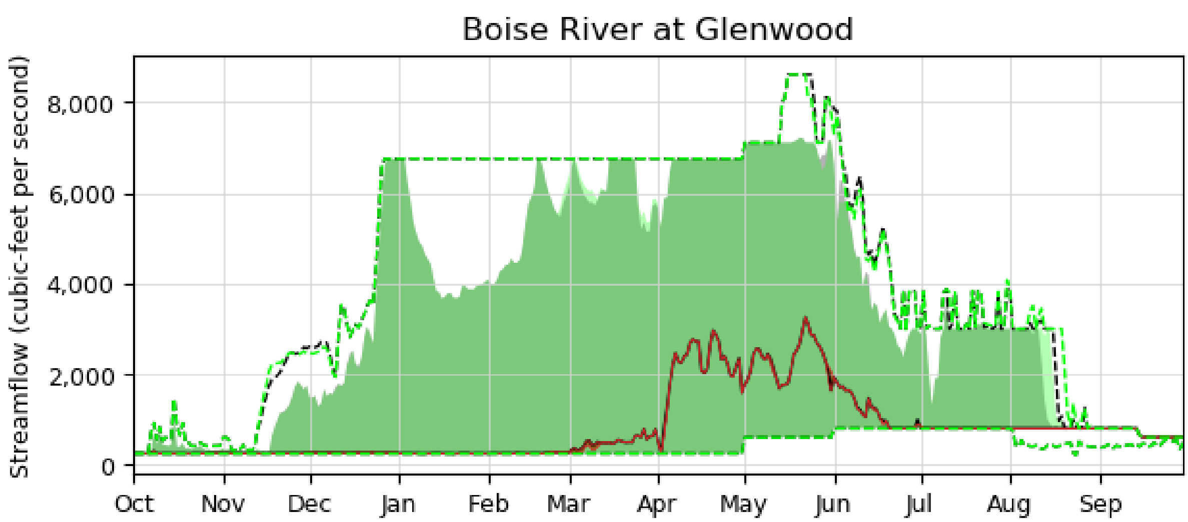

Figure A-28. Boise River at Glenwood for the 28-year analysis period (1980 through 2008). This figure depicts the daily median streamflow range for the 3-foot Raise (red region) and daily median for No Action (black line). The shaded green region and shaded gray region represent the 10th-percentile to 90th-percentile range captured by the 3-foot Raise and No Action, respectively. Dashed green and black lines represent the daily minimum and maximum values. The February and July anomalies are absent in the shorter time period, likely due to more reliable inflow datasets.

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Appendix B
Engineering Summary Report

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Boise River Basin Feasibility Study 6-foot Anderson Ranch Dam Raise Engineering Summary Report

Boise Project, Idaho
Columbia Pacific Northwest Region

U.S. Department of the Interior July 2020

Mission Statements

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

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

Cover photograph: Anderson Ranch Dam, Boise Project, Idaho.

Acronyms and Abbreviations

Acronym or Abbreviation	Meaning
AASHTO	American Association of State Highway and Transportation Officials
CFR	Code of Federal Regulations
cfs	cubic feet per second
cy	cubic yard
D	diameter
DEC	design, estimate, and construction
DEM	digital elevation model
FHWA	Federal Highway Administration
GIS	geographic information system
HD	Highway District
HW	headwater
IDEQ	Idaho Department of Environmental Quality
IDWR	Idaho Department of Water Resources
ITD	Idaho Transportation Department
Jacobs	Jacobs Engineering Group Inc.
ksi	kilopounds per square inch
LiDAR	light detection and ranging
Master Agreement	U.S. Forest Service Master Interagency Agreement No. 86-SIE-004
MSE	mechanically stabilized earth
NFS	National Forest System
NPDES	National Pollutant Discharge Elimination System
PFM	potential failure mode
RCEM	Reclamation Consequence Estimating Methodology
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
RFA	reservoir frequency analysis
Rim Analysis	*Boise River Storage Feasibility Study – Land, Structure, and Real Estate Survey/Analysis* (Jacobs 2019)
ROFA	Runway Object Free Area
RPZ	Runway Protection Zone

RSA	Runway Safety Area
RWS	reservoir water surface
SHPO	State Historic Preservation Office
SRAO	Snake River Area Office
TSC	Technical Service Center
USACE	U.S. Army Corps of Engineers
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

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1 Introduction

As part of the Boise River Basin Feasibility Study, the Bureau of Reclamation (Reclamation) developed feasibility-level design drawings, cost estimates, and construction schedules for the proposed 6-foot dam crest raise and the corresponding projects around the perimeter, or rim, of Anderson Ranch Reservoir that need modification, rehabilitation, or replacement as a result of increase in water surface elevation.

Design efforts were completed in two parts.

1. Reclamation's Technical Service Center (TSC) developed feasibility-level design drawings, cost estimate, and a construction schedule for each alternative for the proposed 6-foot dam raise. The TSC's design alternatives were limited to Anderson Ranch Dam, appurtenant structures, and roadways in the immediate vicinity of the dam impacted by a raise of the dam crest (approach roads) (Reclamation 2019a).
2. Reclamation contracted with the Sundance-EA Partners II, LLC—led for this task by its subconsultants Jacobs Engineering Group Inc. (Jacobs) and Quadrant Consulting, Inc.— to prepare feasibility-level designs, cost estimates, and schedules for projects around the reservoir rim that need modification, rehabilitation, or replacement as a result of the proposed 6-foot reservoir raise (Reclamation 2019c).

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2 Design, Estimate, and Construction Review

Per Reclamation Manual Directives and Standards FAC 10-01 (5)(A)(1), projects anticipated or estimated to have a total cost, at completion, of more than $10 million and are intended to meet a feasibility level of development, are required to undergo a design, estimate, and construction (DEC) review (Reclamation 2014).

The DEC review process provides independent oversight that ensures products related to design, cost estimating, and construction are technically sound and provide a credible basis for decision-making by Reclamation leadership and other decision makers. This includes an emphasis to ensure cost estimates for a project are appropriate for their intended purpose; potential fatal flaws in the designs, estimates, or schedules are identified; and major risk and uncertainties have been fully addressed in the estimates and schedules. These reviews are to be conducted with a broad corporate perspective in mind to identify policy, legal, partner/stakeholder, and/or public issues, impacts, and/or ramifications of a corporate nature.

After completing the feasibility-level design, a DEC review occurred February 3 to 7, 2020. The DEC team consisted of Reclamation and non-Reclamation personnel, independent from the project team, with expertise in engineering, cost estimating, and construction management. As a result of the DEC review, recommendations have been addressed in the cost estimates presented in this summary.

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3 Background

The initial authorization of the Payette-Boise Project (the name was changed to Boise Project in 1911) was made on March 27, 1905, under provisions of the Reclamation Act of 1902. Arrowrock Dam was authorized under the Reclamation Act on January 6, 1911. Anderson Ranch Dam and Anderson Ranch Reservoir were determined to be feasible and authorized for construction by the Secretary of the Interior on August 12, 1940, under provisions of the Reclamation Project Act of 1939 (Simonds 2009). Anderson Ranch Dam was constructed from 1941 to 1947 on the South Fork Boise River.

Releases from Anderson Ranch Dam flow down the South Fork Boise River into Reclamation's Arrowrock Reservoir, approximately 29 miles downstream from the dam. The U.S. Army Corps of Engineers (USACE) completed construction of Lucky Peak Dam in 1955, impounding Lucky Peak Reservoir, which extends upriver to Arrowrock Dam. Lucky Peak Dam is operated primarily for flood control purposes, and upstream irrigation releases from Arrowrock and Anderson Ranch reservoirs pass through Lucky Peak (Figure 1). Together, Lucky Peak, Arrowrock, and Anderson Ranch reservoirs on the Boise River system are operated jointly to fulfill irrigation, hydropower, and flood control requirements. The three reservoirs operate under a formal flood control rule curve.

Anderson Ranch Dam is a 456-foot-high multiple-purpose structure, impounding Anderson Ranch Reservoir, which is approximately 4,772 acres. Total storage at Anderson Ranch Reservoir is 474,940 acre-feet (active 413,074 acre-feet at reservoir elevation 4196.0 feet). The combined discharge capacity of the turbines is approximately 1,600 cubic feet per second (cfs) at normal reservoir water surface elevation 4196.0 feet.

Lands surrounding Anderson Ranch Reservoir area are largely Federal lands. These Federal lands are managed by Reclamation and the U.S. Forest Service (USFS) under Master Interagency Agreement Number 86-SIE-004 (Master Agreement). The Master Agreement, dated April 6, 1987, covers Reclamation-authorized projects within or adjacent to National Forest System lands. Through the Master Agreement, USFS has management and administration jurisdiction of Federal lands with the exception of the Reclamation Zone, which is the area that Reclamation designates as necessary for the operation of the Boise Project (Figure 2).

Roads surrounding the Anderson Ranch Reservoir area are referred to as Highway District (HD) roads which are maintained by the Glenns Ferry or Mountain Home highway districts under USFS agreement. In some cases, roads are referred to using both HD and National Forest System (NFS) Road designations for purposes of clarity (e.g., HD 131 or NFS 131).

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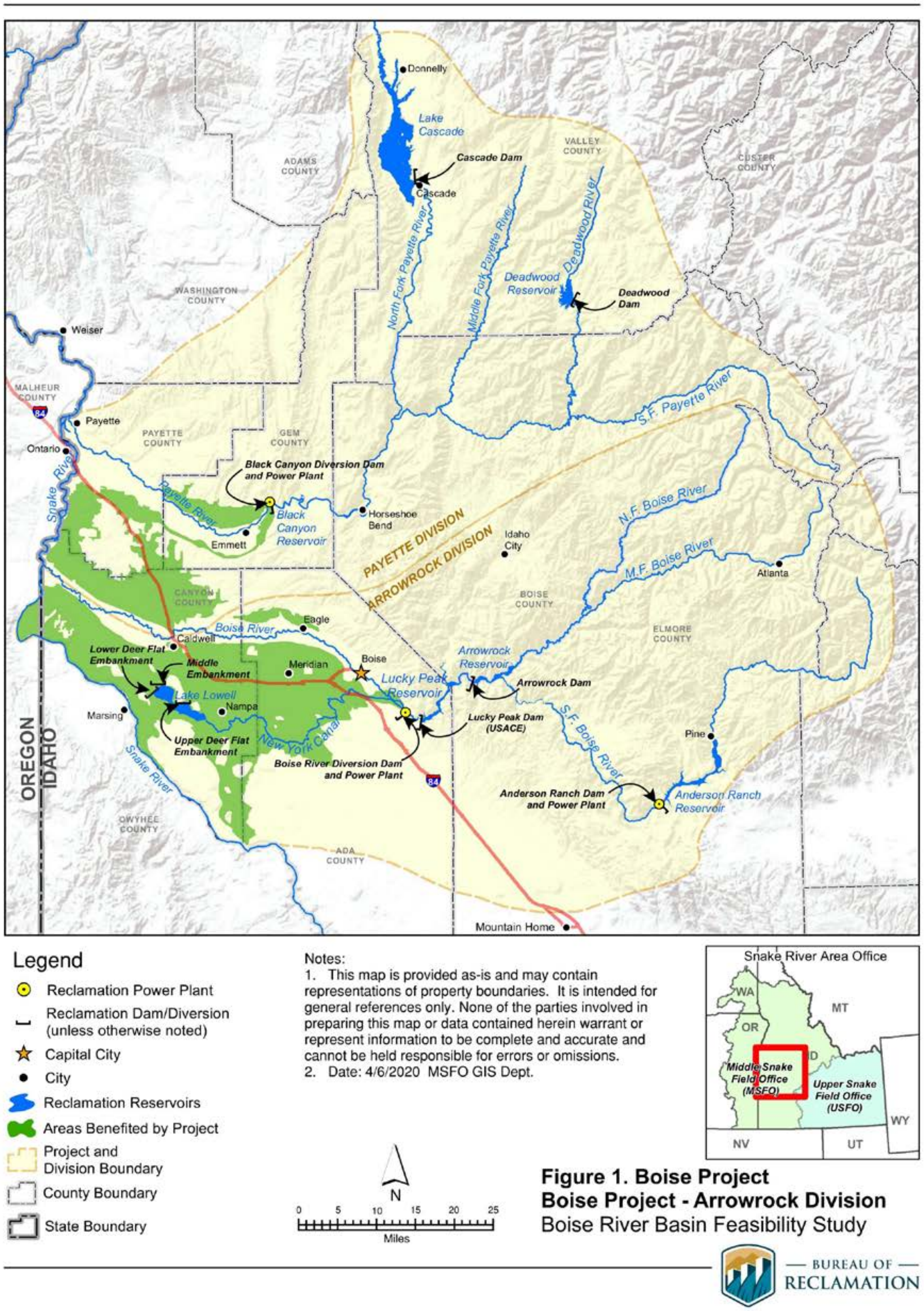

Figure 1. Boise Project

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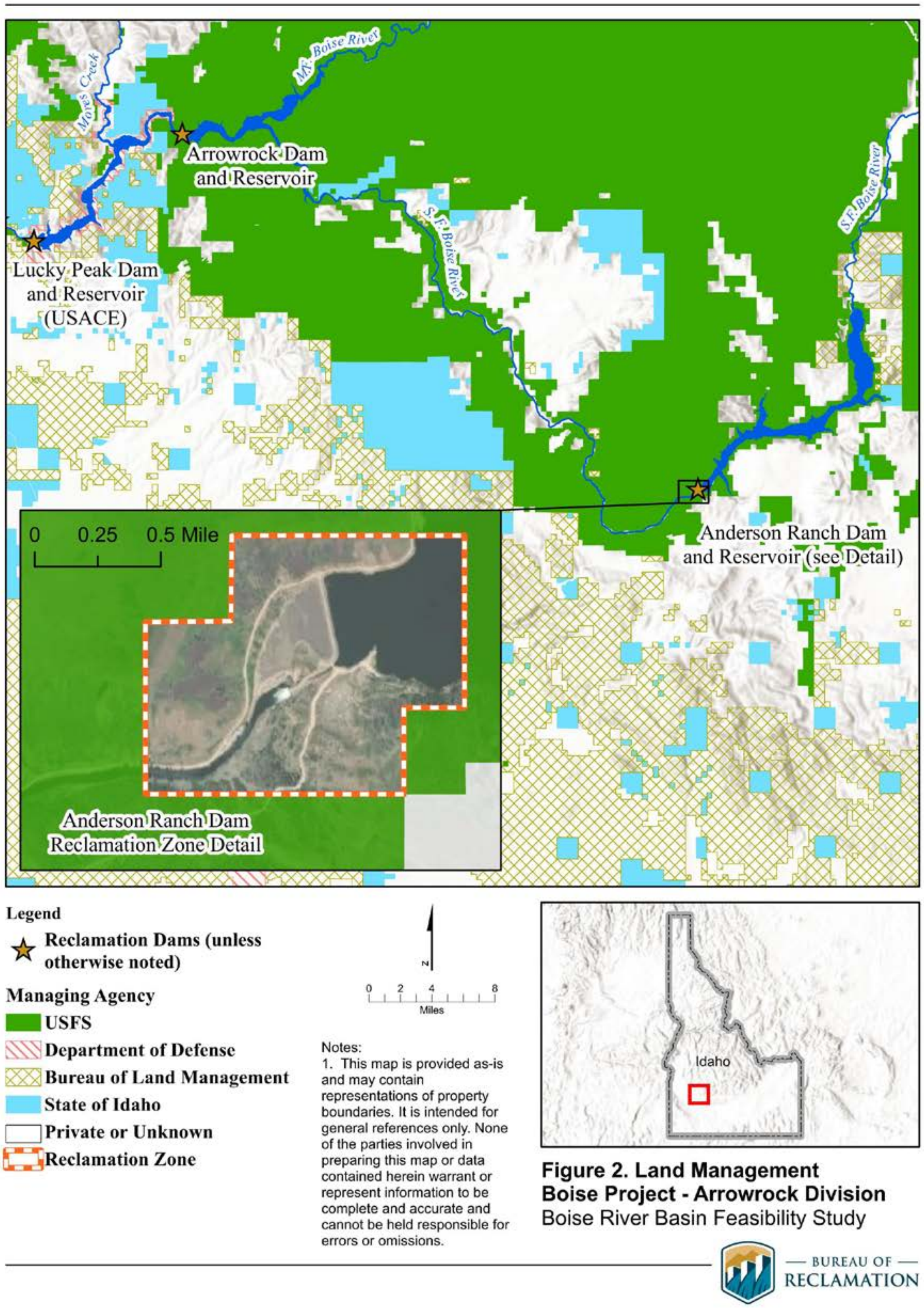

Figure 2. Land Management

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4 Geology

Anderson Ranch Dam is located near the southwestern edge of the Idaho Batholith, which is comprised of a series of closely related, coarse-grained intrusions. Major normal faulting in the region includes faults in and adjacent to the Batholith, faults bounding the northeast and southwest margin on the adjacent Snake River Plain, and faults forming Camas Prairie Basin east of the dam. These faults show a low to moderate seismic activity level. The dam is in a narrow, steep-sided valley cut through several hundred feet of igneous extrusive and intrusive rock. In the dam foundation, the rock was found to be intensely fractured and cut by numerous shears and fractures of varying widths. Several dikes were also found normal to the canyon axis. The dikes present a reduction for fractures and shears reducing the foundation permeability and making a tight foundation. Materials within the canyon include talus, colluvium, alluvium, residual soil, and intact rock. These materials form the foundation of the dam and have performed well with respect to deformation and seepage.

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5 Anderson Ranch Dam Raise, Feasibility-Level Design

The TSC prepared two design alternatives for the proposed 6-foot Anderson Ranch Dam raise and associated reservoir expansion as part of the Feasibility Study led by the Snake River Area Office (SRAO). The design alternatives are a downstream raise and parapet wall, and a mechanically stabilized earth (MSE) wall crest raise, which are further described in Sections 5.4.9 and 5.4.10, respectively. This design effort included the preparation of feasibility-level design alternatives, relevant analyses, cost estimates, construction schedules, and final design considerations. These design activities are summarized in this section.

The scope of the TSC's design alternatives were limited to Anderson Ranch Dam, appurtenant structures, and roadways in the immediate vicinity of the dam that are impacted by raising the dam crest (approach roads). Design alternatives were developed in accordance with the design constraints and considerations listed below.

- Modify Anderson Ranch Dam to increase top of active reservoir water surface (RWS) by 6 feet.
- Ensure modifications do not adversely impact serviceability of the existing Anderson Ranch Dam facilities.
- Raise modifications must be risk neutral with respect to current dam safety facility risk portrayal.
- Raise modification will restore two-lane traffic across the dam crest.
- Public driving grades and turning radii on approach roads will be optimized for public safety.
- Ensure modification will minimize environmental impacts.

The TSC proposed two alternatives for raising the reservoir 6 feet above its current top of active conservation (RWS elevation 4196.0 feet). The two alternatives are considered to be the most technically feasible and cost-effective measures for meeting the objectives described above. Other raise alternatives were screened out early in the conceptualization process because they either did not satisfy fully all the constraints listed above or were judged to cost significantly more than either of the two alternatives presented in this report.

The TSC performed a site visit to Anderson Ranch Dam on June 4, 2018, reviewed existing data and analyses, and developed a Field Exploration Request to gather additional data to support developing the reservoir raise alternatives. The field program included drilling, sampling, and rock permeability testing of abutment rock, soil sampling of the dam embankment along the crest, soil and rock sampling of potential borrow sites in the vicinity of the dam, and concrete core sampling of the existing spillway structure.

The SRAO furnished a point cloud file to the TSC to use in the design. The point cloud data were collected using airplane-mounted light detection and ranging (LiDAR) with an approximate accuracy of 10 centimeters. The TSC used Autodesk Civil 3D to generate a 3-D topographic surface model.

5.1 Summary of Dam and Appurtenances

Anderson Ranch Dam is a 456-foot-high multiple purpose structure, impounding Anderson Ranch Reservoir, which is approximately 4,472 acres. Total water storage at Anderson Ranch Reservoir is 474,940 acre-feet (active 413,074 acre-feet at reservoir elevation 4196.0 feet). The combined discharge capacity of the turbines is approximately 1,600 cfs at normal reservoir water surface elevation 4196.0 feet.

At the time of its construction, Anderson Ranch Dam was the highest earthfill dam in the world. The dam is a zoned earthfill embankment structure; it has structural and hydraulic heights of 456 feet and 330 feet, respectively; and a crest length of 1,350 feet at elevation 4210.0 feet. The crest of the dam was raised 4 feet in 2010; this crest raise was not designed as a water-retaining feature.

The spillway is located at the left abutment, extending from the top of the dam down the rock slope and over the outlet works. Most of the spillway is isolated from the embankment and is cut through left abutment granite. The spillway consists of a trapezoidal inlet channel, a concrete ogee crest section controlled by two 25-foot-wide by 22-foot-high radial gates, a steeply sloping concrete chute, and a stilling basin.

5.2 Hydrology

Updated hydrologic hazard estimates (Reclamation 2012a) were completed by the TSC's Flood Hydrology and Emergency Management Group in June 2012. It is assumed that there are no changes to the 2012 frequency flood data for the purposes of this feasibility-level design effort.

5.3 Flood Routing Analysis

Flood routings were performed in 2012 (Reclamation 2012b) based on a 2012 Hydraulic Hazard Analysis (Reclamation 2012a) which were then used to update and estimate the risk (Reclamation 2013) for Anderson Ranch Dam. The routings were performed using the Reclamation program Flood Route v1.6.

During construction of the crest raise, particularly for the spillway modification, there will likely be reservoir restriction, an upstream cofferdam, or some combination of both. The current feasibility-level design includes a cofferdam up to 20 feet high and a conservative reservoir restriction of 12 feet (RWS 4174 feet) which will be further analyzed and refined during the final design. Placing a cofferdam in front of the spillway would also provide construction access between the left abutment and the main embankment while the spillway is under construction.

The same suite of flood routings as the baseline case was also performed under a construction scenario, that is, without any flow through the spillway.

The hoist house was identified during the feasibility design phase to be impacted by the dam crest raise because of an increased chance of flooding the hoist house. There are no dam safety concerns with this occurring. Cost impacts are insignificant and physical impacts will be covered in final design.

5.4 Design Alternatives

Sections 5.4.1 through 5.4.8 discuss features that are applicable to both modification alternatives. Sections 5.4.9 and 5.4.10 are specific to each of the two design alternatives. The costs and design considerations are generally independent of the spillway modification and crest raise alternatives.

5.4.1 HD 131 Detour

Most of the detour route chosen is assumed to be acceptable for public access. A small section may need regrading to provide safe public access. This section currently has grades of more than 12 percent and tight curves that restrict visibility and limit trailered-vehicle access. An alternate route was chosen to mitigate the grade and access problems.

5.4.2 Borrow Areas and Contractor Use Areas

Field investigations and testing were performed to determine the soil index properties of the proposed borrow areas. The design team assumed that these borrow sites, listed below, are feasible based on field reconnaissance and geologic research.

- Dixie Borrow Pit located east of Anderson Ranch Dam on Anderson Ranch Dam Road.
- Downstream deposits along the canyon slopes located along tributary drainages of the South Forth Boise River and along the north side of the existing HD 121 (River Road/Anderson Ranch Dam Road). It should be noted that the easternmost proposed borrow area is located adjacent to the original Reclamation Camp. The design team recognizes that there may be State Historic Preservation Office (SHPO) considerations surrounding this area; however, for this feasibility-level design, the

design team has assumed that borrow development can be done to meet SHPO requirements.

- Along the toe of the canyon slopes downstream of Anderson Ranch Dam. It is judged that the riprap can be borrowed from this area using mechanical equipment and that blasting is not required. It is located approximately 25 feet from the right shoulder of HD 121 and is judged to be capable of being collected safely. Developing these sites may require public safety assessments because of immediate proximity to HD 121.

Potentially, borrow development operations may extend outside of these primary locations for reasons including but not limited to SHPO restrictions, environmental impacts, insufficient or low quality borrow, and/or site access development. A potential impact zone has been identified along the north bank of the South Fork Boise River from the downstream toe of the dam to 2½ miles downstream for permitting clearance purposes, shown as Secondary Borrow Area on Figure 3.

There is limited level and cleared space near the dam site that limits suitable contractor space. The design team proposed two sites suitable for contractor use. The first contractor use area is located adjacent to the Dixie Pit and is proposed to be an appropriate location for office trailers, employee parking, borrow development, refueling, and other staging activities. The second location is along the left abutment of the dam facility. This location was chosen for its moderate grades and relatively low vegetation density. This staging area may be suitable for stockpiling, water tanks, reinforcing and formwork laydown areas, and other staging activities. Both locations are estimated to require clearing, grubbing, and some level of grading.

5.4.3 Haul Roads

The proposed haul roads are identified based on estimated methods for delivery of fill material (Figure 4). The haul routes use existing HD roads 134, 120, and 121, as well as the Anderson Ranch Dam crest and spillway bridge. Most of the haul route is on unpaved roads and there are two high-grade roads on each downstream approach (8 percent to 12 percent). The total length of haul routes (from borrow areas to the construction site) is approximately 4 miles one way (not including the dam crest). A proposed turnaround is located at the boat ramp parking area approximately ½ mile upstream of the dam. It is estimated that grading work would be required to develop a haul route turnaround at the boat ramp parking area.

5.4.4 Approach Roads

The alternatives for the approach roads are similar in design. As many retaining structures as possible were eliminated from each alternative. The alternative with the higher crest elevation requires more retaining wall and fill than the alternative with the lower crest. Road design was restricted to 12 percent grade. The cross-section provides for two lane traffic and protection for steep shoulders by using guardrails.

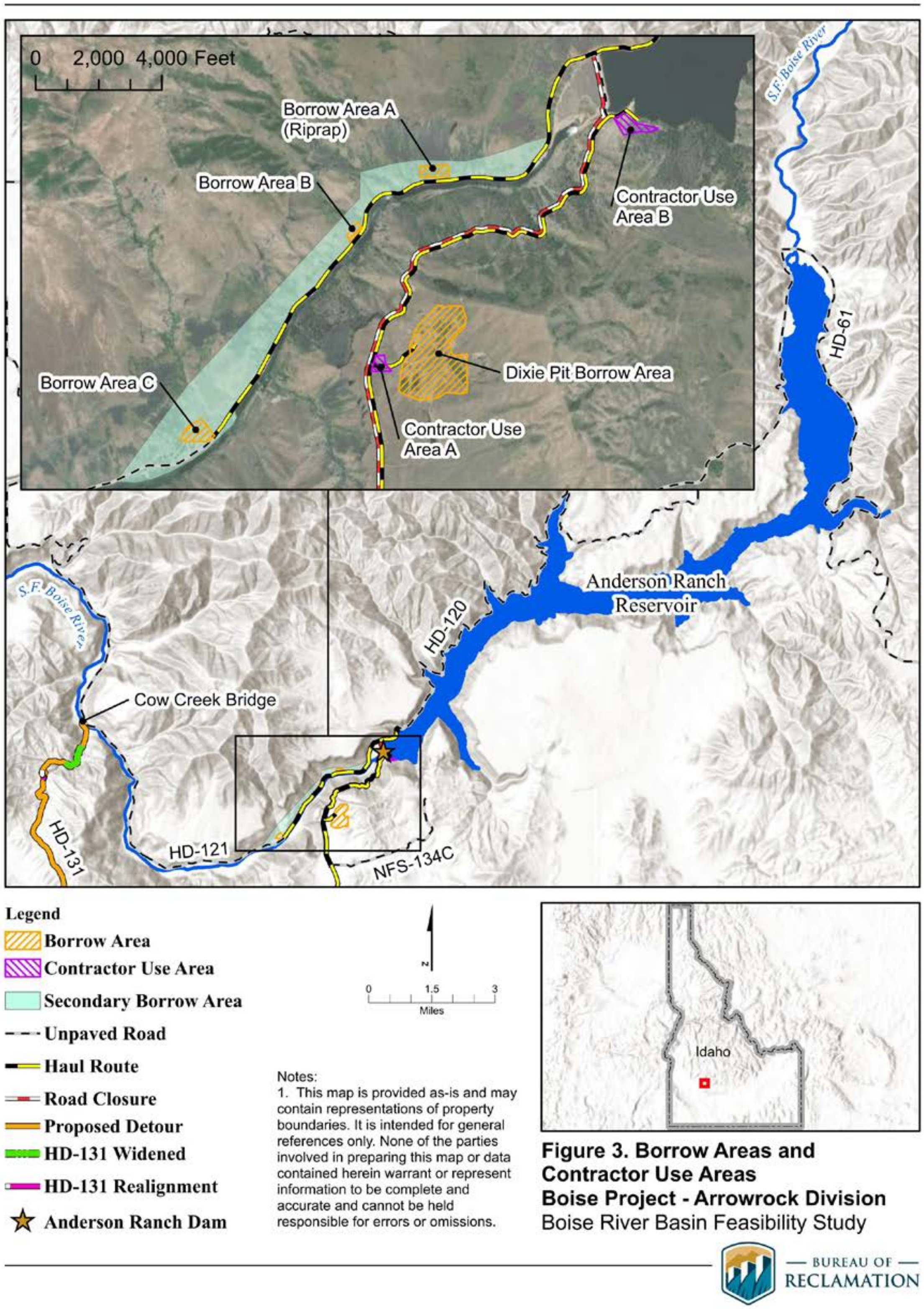

Figure 3. Borrow Areas and Contractor Use Areas

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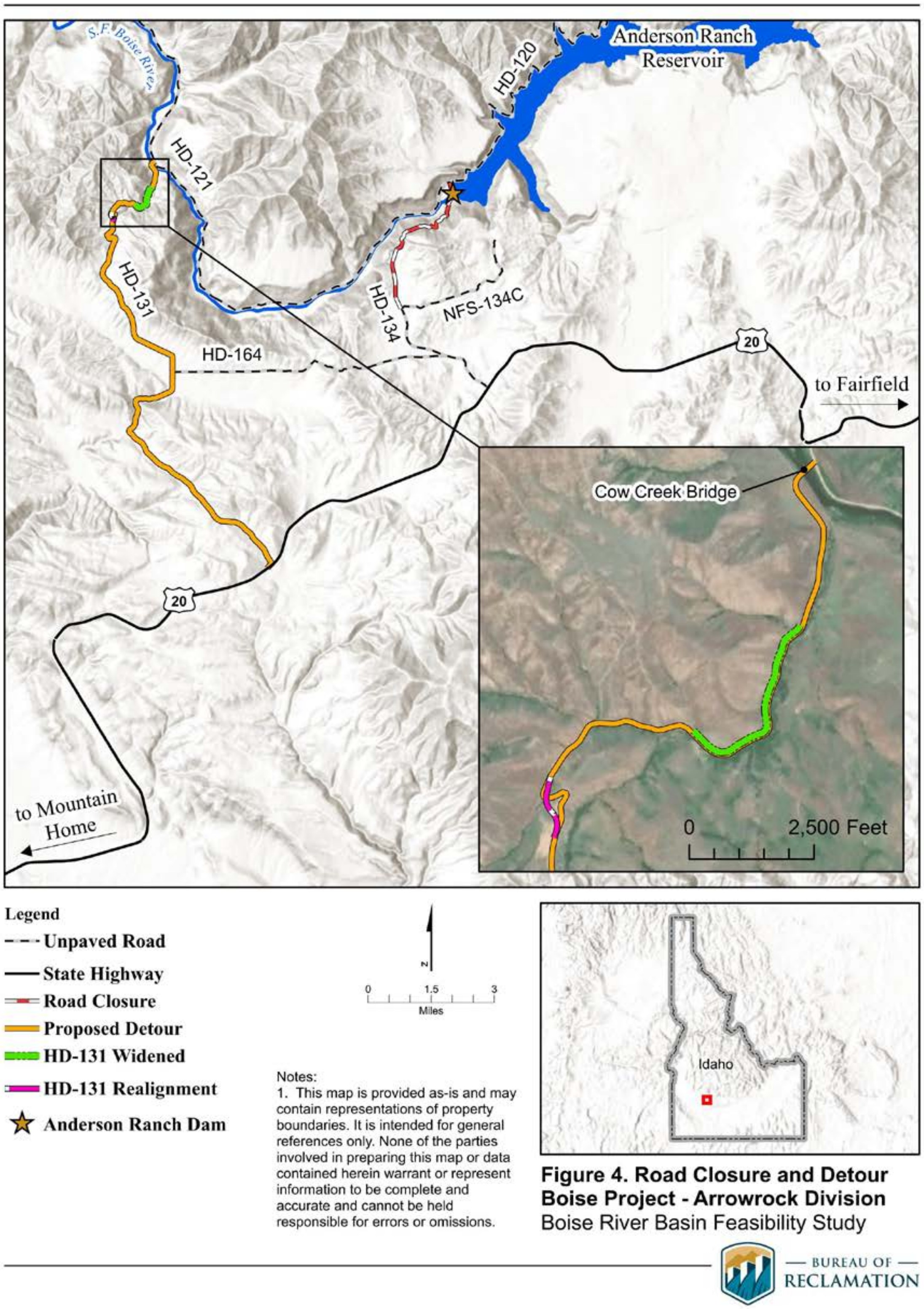

Figure 4. Road Closure and Detour

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5.4.5 Cofferdam

The design team assumed that a cofferdam upstream of the spillway will be required to mitigate construction risk and to facilitate construction access across the spillway. The current feasibility-level design includes a cofferdam up to 20 feet high and a conservative reservoir restriction of 12 feet to 22 feet (RWS 4174 feet), which will be further analyzed and refined during the final design.

5.4.6 Spillway Bridge

The spillway bridge is designed do that no hoist equipment will be stored or operated on deck.

5.4.7 Hoist House Modification

The most significant impact identified by the team to the hoist house is that some electrical boxes and wires would need to be relocated to prevent them from being submerged. Quantities for estimating impacts to the hoist house were not estimated because this issue was considered something that could be covered in final design with insignificant cost or design implications.

5.4.8 Mechanical Equipment

Raising the dam 6 feet will increase the net head to the turbines, which can cause increased cavitation rates due to operating in the upper hydraulic limit zone. The TSC recommends performing a unit performance test during final design to validate power output limitations. The TSC performed a preliminary hydraulic transient analysis of the turbines to identify possible concerns to be addressed during final design.

The proposed dam raise would include raising the spillway an equal amount. Feasibility-level calculations assessed the suitability of reusing the gates and determined that reusing the existing radial gates is appropriate. Consideration should be given to conducting rehabilitation work (including abrasive blasting, recoating, and replacement of seals) on the gates during construction.

The current feasibility-level design is based on the assumption that the existing fixed-wheel gate is to be reused after the dam raise. No modifications to the outlet works or its appurtenances will be required to accommodate the proposed 6-foot dam raise.

5.4.9 Embankment Alternative 1 – Downstream Raise and Parapet Wall

Embankment Alternative 1 is described as a downstream zoned earth raise and parapet wall.

5.4.9.1 Dam Raise Modification

Design components of the dam raise modification include crest and abutment excavation, foundation treatment, zoned earth fill, parapet wall, and downstream soil cement slope.

Materials for the embankment raise will be placed above the existing embankment material. Materials will be produced from the excavation phase of work or borrowed from nearby sources. Other materials are proposed to be commercially sourced. The city of Mountain Home (28 miles away) has a number of commercial borrow pits and concrete batching plants and is a likely candidate for supplying some of the zoned materials. At completion, the crest width will accommodate two-lane traffic and shoulder guard railing. The dam crest will be finished with road base and asphalt surfacing.

5.4.9.2 Spillway Modification

The spillway modification for Alternative 1 will allow additional fill to be placed against the spillway walls at the crest structure. To achieve this, the design team included removing and replacing some concrete portions of the spillway.

5.4.10 Embankment Alternative 2 – MSE Wall Raise

Embankment Alternative 2 is described as a centerline mechanically stabilized earth (MSE) wall crest raise.

5.4.10.1 Dam Raise Modification

An MSE wall is a retaining structure composed of reinforced compacted soil that can stand near vertically. Lifts of soil are compacted over horizontally placed reinforcing elements (i.e., geogrid, geotextile, steel straps, or welded wire mesh) such that the soil is internally stable. The reinforced unit of soil may then act as a gravity retaining structure. The MSE wall is typically finished with precast concrete panels or modular block facing units. MSE walls have been used in highway applications for several decades with excellent reliability. They are most useful in highway widening or bridge approach ramp applications where right-of-way is tight. MSE walls have been used to raise dam crests at Reclamation facilities, most notably Sherburne Dam and Stampede Dam. Zoned earthfill for the dam raise will be placed along the abutment sections where sufficient crest right of way exists. At completion, the crest width will accommodate two-lane traffic and shoulder guard railing. The dam crest will be finished with road base and asphalt surfacing.

5.4.10.2 Spillway Modification

Spillway modification for Alternative 2 will allow additional fill to be placed against the spillway walls at the crest structure. To achieve this, the design team included removing and replacing some concrete portions of the spillway.

5.5 Field Cost Estimates

Quantity estimate worksheets were assembled to reflect the scope of work and estimated quantities to develop feasibility-level cost estimates for the Anderson Ranch Dam raise alternatives. The cost estimates were prepared in accordance with Reclamation Manual

Directives and Standards FAC P09 and FAC 09-01 (Reclamation 2019d) and with Reclamation Manual Directives and Standards FAC 09-03 (Reclamation 2007).

The feasibility-level cost estimates help evaluate alternatives, select a preferred alternative, and determine the economic feasibility of a project. Feasibility-level cost estimates are suitable for requesting project authorization or construction fund appropriations from Congress.

Unit prices were developed using a semi-detailed method. Specific construction activities were identified for major cost drivers. Costs for labor, equipment, materials, and other resources were developed. Production rates, overheads, and taxes were applied to develop the applicable unit prices. Vendor quotations were obtained for materials deemed appropriate. Minor cost items were developed using historical bid and industry standard reference cost data. The estimates are intended to capture current pricing for materials, typical construction practices, procurement methods, current economic conditions, and specific site conditions. The cost estimates were prepared with less than complete designs and have inherent levels of risk and uncertainties.

Field cost estimates include construction contract costs and construction contingencies. Construction contract costs include itemized pay items, mobilization, and an allowance for design contingencies. Field cost estimates do not include non-contract costs (e.g., environmental studies, site investigations, design, construction management). Field cost estimates also do not include land acquisition, relocation, or right of way costs that may be required to construct the project features. Operations, maintenance, and replacement costs are also not included in field cost estimates.

5.5.1 Mobilization

Mobilization costs include mobilizing contractor personnel and equipment to the project site during initial project startup. The mobilization line item is a rounded value per Reclamation rounding criteria, which may cause the dollar value to deviate slightly from the actual percentage shown. A value of 5 percent was used for mobilization. This value was based on experience with similar projects and estimator judgment.

5.5.2 Design Contingency

In accordance with the Reclamation Manual Directives and Standards FAC 09-01(5)(E)(1) (Reclamation 2019d), design contingencies allow for uncertainties within the design and the respective level of detail and knowledge used to develop the estimated cost. Design contingencies are intended to account for three types of uncertainties inherent as a project advances from the planning stage through final design, which directly affect the estimated cost of the project. These include: 1) minor unlisted items, 2) minor design and scope changes, and 3) minor cost estimating refinements. For each alternative, a value of 15 percent was used for design contingencies based on the level of design.

5.5.3 Allowance for Procurement Strategies

In accordance with the Reclamation Manual Directives and Standards FAC 09-01 (5)(E)(2) (Reclamation 2019d), a line item allowance for procurement strategies (considerations) is often included in feasibility-level cost estimates to account for additional costs when solicitations for construction will be advertised and awarded under procurement strategies that limit competition, allow award for best value (other than the lowest bid or proposal), or include set-asides under socioeconomic programs. The allowance for procurement strategies was set at 5 percent.

5.5.4 Construction Contingency

Feasibility estimates include a percentage allowance for construction contingencies as a separate item to cover minor differences in actual and estimated quantities, unforeseeable difficulties at the site, changed site conditions, possible minor changes in plans, and other uncertainties. The allowance is based on engineering judgment of the major pay items in the estimate, reliability of the data, adequacy of the projected quantities, and general knowledge of site conditions. Construction contingencies are considered funds available in the budget to be used after award.

A value of 20 percent was used for construction contingencies based on the completeness and reliability of the engineering design data provided, geological information, and the general knowledge of the conditions at the site. This is in accordance with Reclamation Manual Directives and Standards FAC 09-01 (5)(E)(3) (Reclamation 2019d).

5.5.5 Field Costs

As defined in Reclamation Manual Directives and Standards FAC 09-01 (3)(C)(I) (Reclamation 2019d), field costs are an estimate of the capital costs of a feature or project from award to construction closeout. The field cost equals the contract cost plus construction contingencies. The field costs are a rounded value per Reclamation rounding criteria, which may cause the dollar value to slightly deviate from the actual percentage shown. Table 1 shows field costs developed for the 6-foot raise of Anderson Ranch Dam. Total costs shown are in 2025 dollars.

Following completion of the feasibility-level design, Reclamation worked with USFS as a One Federal Decision partner and identified a concern with the proposed bypass road along HD 131. The proposed realignment of the detour realigned the road in a USFS riparian conservation area. Following discussions with USFS, Mountain Home Highway District, and Elmore County, TSC provided a conceptual design for an alternate realignment. Following the DEC review, there were recommendations to account for potential areas/design elements that may have been underestimated. These estimates have been incorporated into this field cost estimate.

Table 1. Anderson Ranch Dam raise field cost estimates

Design Element	Alternative 1: Downstream Raise	Alternative 2: MSE Wall Raise
Dam raise subtotal costs[1]	$22,975,338	$25,238,159
HD-131 Realignment[2]	$700,000	$700,000
Gate Hoist Deck[3]	$250,000	$250,000
Right Abutment Approach[4]	$672,000	$672,000
Road Maintenance and Repair[5]	$500,000	$500,000
SUBTOTAL	$25,097,338	$27,360,159
Mobilization (5%)	$1,250,000	$1,350,000
Design Contingencies (20%)	$5,652,662	$5,289,841
Construction Contingencies (20%)	$6,000,000	$7,000,000
Escalation (3%) to 2025 notice to proceed[6]	$6,000,000	$7,000,000
TOTAL	$44,000,000	$48,000,000

1. Costs associated with the dam raise as stated in Reclamation's Feasibility Design Report (Reclamation 2019a). These subtotals do not include mobilization, contingencies, or escalation costs.
2. Conceptual realignment estimated to cost additional $700,000.
3. DECAND-03 finding, the gate hoist deck was missing from estimates. Estimated to cost $250,000.
4. DECAND-03 finding, may not be safe to place retaining walls on steep fill embankments. Alternate method estimated to cost additional $672,000.
5. DECAND-03 finding, additional road maintenance and repair may be needed for year-round maintenance. Estimated to cost additional $500,000.
6. DECAND-03 finding, escalation costs not accounted for in the TSC's field cost estimates. Estimated to cost additional $6-$7 million.

5.6 Risk Analysis Review

The TSC convened a risk analysis team from January 22 to 24, 2019. The scope of this risk analysis was to 1) qualitatively evaluate the risk neutrality of the proposed modification alternatives, and 2) perform a preliminary quantitative analysis of the dam safety-related construction risks.

5.6.1 Qualitative Risk Analysis

The qualitative risk analysis is intended to be a preliminary review of the modification design alternatives. The qualitative risk analysis evaluated how the increased reservoir affects the loadings for baseline potential failure modes (PFM), whether the proposed 6-foot dam raise and associated reservoir expansion or modifications introduce new PFMs, whether the proposed reservoir raise increases the population that may be affected by a breach flood, and how the modification design features are intended to address or mitigate any negative impacts to the baseline risk condition.

A qualitative review team broke down PFMs into a sequence of events that leads to a failure, and by evaluating which events are impacted by the proposed 6-foot dam raise and associated reservoir expansion. These evaluations were made using professional judgment and experience estimating risk in lieu of estimating probability values for failure modes. Each alternative was analyzed in this manner to make a qualitative determination that they are satisfactorily risk neutral and could continue to move forward for feasibility-level design.

The risk team identified improvements and provided comments with details or analysis of the modification alternatives. These comments were captured as considerations for final design that serve to improve on the constructability, robustness, maintainability, or costs of the design alternatives.

5.6.2 Dam Safety Construction Risks

The second major objective of the risk analysis was to begin preliminary quantitative analysis of dam safety-related construction risks. Reclamation's Public Protection Guidelines (Reclamation 2017) do not have specific requirements for acceptable risks during construction. Decisions on an acceptable level of increased risk during construction activities are made on a case-by-case basis and are based on numerous factors. These decisions are ultimately made by Reclamation's Dam Safety Office, Regional Office, and Area Office.

To manage foreseen construction risks, the design team assumed that the spillway construction and crest raise construction will take place in phases, with the spillway demolition and reconstruction taking place first. After the spillway is complete and operational, the cofferdam can be removed and the crest raise construction can take place.

5.7 Construction Considerations

During the constructability review performed by the TSC Construction Management and Specification Group, four findings were identified for consideration during final design.

5.7.1 HD 131 Detour

HD 131 road design will be verified to ensure that it meets the appropriate design standards. The road width of 24 feet is typically inside the guardrails. The grade of 12 percent may also exceed the typical maximum grade of 8 percent.

Both design alternatives call for importing 9,000 cubic yards (cy) of road fill. This is the equivalent of 900 truckloads transported on narrow roads with public traffic. Future designs should attempt to improve the balance of the cut/fill quantities. Also, if additional fill is needed, future designs should explore the possibility of a nearby borrow source.

5.7.2 Haul Roads & Approach Roads

This project will require about 20,000 round trips with 10 cy to 12 cy end dump trucks on gravel roads within a couple miles of the dam. It will also require up to 1,800 loads of material from a commercial supplier. The existing roads may need to be reinforced to withstand this traffic load or will require extensive maintenance and possibly reconstruction after the project is complete. Pullouts will be required to allow end dump trucks to pass each other. If the public is allowed on the same roads, traffic control will be required, especially where blind curves on the roads exist.

Mountain Home Highway District Design Standards (Elmore County 2018) require a maximum driving grade of 8 percent. There are permit procedures for higher grades for special circumstances for the Mountain Home Highway District. Reclamation will need to file for this exception to construct the road alignment presented in this feasibility-level design. In addition, a road width of 24 feet inside the guardrails will need to be maintained through the entire alignment.

5.7.3 Cofferdam

During final design of the cofferdam, consideration should be given to a homogeneous cross-section of material for easier construction. If the geomembrane is deemed necessary, it would be best to install it directly on the upstream face. Installing a geomembrane between the zoned layers would be very difficult and time consuming. Barriers will be required on top of the cofferdam during construction.

5.7.4 Spillway Construction

An on-site batch plant will be required due to the long distance to the nearest commercial batch plant that would have the capability to produce the amount of concrete required.

5.8 Considerations for Final Design

The data gathered for this feasibility-level design were considered sufficient for developing a feasibility-level design, construction schedule, and cost estimate. Should this proposed project move forward to final design, TSC recommends that more information, data, and analysis be performed to support a final design of the alternatives. Table 2 presents a summary of recommended data collection and analysis to support the final design.

Table 2. Recommended data collection and analyses for final design

Activity	Purpose
Terrestrial Survey of Dam, Detour Route, Borrow Areas, Haul Roads, Project Extents	This survey would add sufficient detail to develop final design details, cost estimates, and specifications. It would also be necessary for establishing control points for certain project features.
Stabilize Active Slide on HD 120	There is an active slide along HD 120 approximately 600 feet upstream of the right abutment of the dam. The slide is not a dam safety concern; however, it is a risk to public safety and the highway. The higher reservoir surface may contribute to aggravating slope movement. TSC recommends that stabilization measures be included in the final design.
Terrestrial Survey of Spillway Approach	This survey should be performed at lower RWS elevations. There are not sufficient topographic data for the upstream surface because the LiDAR shoot took place at higher reservoir elevations. A survey of this upstream area is necessary for laying out proposed cofferdam configurations.
Geotechnical Investigation of Approach Roads and Proposed Detour Route	Collecting subsurface information is recommended to complete final design of the approach roads where regrading is proposed and along the proposed detour route where new road alignment is proposed.
Geotechnical Investigation of Dam Crest	There is no as-built for the internal geometry of the embankment zoning. The select drill holes performed for feasibility did not determine the extents of the internal zones. Additional field investigation may be performed as test pits to adequately map the fill zone widths.
Geotechnical Investigation of Spillway Approach (Low Reservoir Level)	The foundation of the proposed cofferdam is expected to be embankment fill. However, the depths of embankment fill and limits of the native rock surface are not well known at this time. Determining the subsurface conditions is necessary for designing an effective cofferdam detail.
Reservoir Water Sampling and Testing	The reservoir water should be sampled and tested for suitability for use in concrete and soil cement production.
Seismic Response/Deformation Analysis for MSE Wall	The seismic response and deformations of an MSE wall on top of tall earthen dam are not well understood. Seismic Response and Finite Element or Finite Difference Analysis may help understand the development of seismic-related failure modes for the MSE Alternative (Alternative 2).

Activity	Purpose
Revised Inundation Mapping	The proposed reservoir raise will change the breach parameters for many, if not all, of the potential failure modes at Anderson Ranch Dam. The change is likely to be small; however, the inundation maps should accurately represent the raised condition.
Consequence Estimation using Reclamation Consequence Estimating Methodology (RCEM)	Consequence estimations should be revised using RCEM and revised inundation mapping as part of a final design risk analysis.
Determine Load Rating of Cow Creek Bridge	The Cow Creek Bridge was assumed to be adequate to handle the detour traffic; however, TSC did not determine the official load rating from the highway district. The suitability of the Cow Creek Bridge must be investigated further[1].
Reservoir Frequency Analysis (RFA)	An RFA will provide useful and more accurate inflow information to support construction risk analysis. The RFA can be used to select inflow volumes targeted around specific construction windows and allow for more flexible construction risk analysis.
Radial Gate Inspection	The condition of the radial gates as reported in the last comprehensive review is general. A thorough inspection would prepare the project for any rehabilitation work that may needed before the gates are installed in the new spillway.

[1] Following the completion of the TSC's feasibility-level design efforts, Jacobs, as part of their feasibility-level design for projects around the reservoir rim, performed a load rating analysis of the Cow Creek Bridge and concluded that the bridge can safely support the anticipated detour traffic loads during construction of the project.

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6 Anderson Ranch Reservoir Rim, Feasibility-Level Design

Reclamation contracted with Sundance-EA Partners II, LLC—led for this task by its subconsultants Jacobs Engineering Group Inc. (Jacobs) and Quadrant Consulting, Inc.— to prepare feasibility-level designs, cost estimates, and schedules for projects around the perimeter, or rim, of Anderson Ranch Reservoir that need modification, rehabilitation, or replacement as a result of Reclamation's and cooperating agencies' proposed enlargement of Anderson Ranch Dam and Anderson Ranch Reservoir.

In support of Reclamation's evaluation, CH2M Hill, Inc. (now Jacobs) completed a rim analysis, the results of which are in the *Boise River Storage Feasibility Study – Land, Structure, and Real Estate Survey/Analysis* (Rim Analysis; Jacobs 2019). The Rim Analysis involved using government-provided aerial imagery and topographic LiDAR data, as well as other available geographic information system (GIS) data (i.e., data related to property boundaries, easements, utility locations, septic systems, and other infrastructure) to evaluate and review potential impacts resulting from incremental increases in water surface elevations at Anderson Ranch, Arrowrock, and Lucky Peak reservoirs. Government- and contractor-acquired spatial data were compiled into base maps to evaluate data adequacy and accuracy and to inform the water surface rise simulations. Esri™ Model Builder was used to perform a spatial analysis against the layers gathered, compiled, and developed for this project, which calculated net increase in impacts due to increased water surface elevations based on the surface contours derived from the LiDAR-based digital elevation model (DEM). GIS data collected from various public and private entities generally varied in size, type, and level of detail. The spatial accuracy of GIS data is often insufficient to perform detailed engineering analyses, evaluations, or designs. Details regarding GIS data development, verification, and impact and classification criteria (i.e., how impacts were originally identified) are included in the Rim Analysis.

Areas of potential impact at Anderson Ranch Reservoir due to the proposed increase in reservoir pool elevation were identified in the Rim Analysis were considered and include the features listed below.

- Roadways.
- Pine Airstrip.
- Bridges.
- Culverts.
- Power utility infrastructure.
- Recreational facilities.

- Groundwater wells.
- Septic systems.

6.1 Design Criteria, Engineering Evaluations, and Feasibility-Level Designs

This section details the design criteria specifically established for each area of potential impact around the reservoir rim. Details of engineering evaluations are provided, along with a summary of the feasibility-level engineering designs for the proposed rim projects. An overview map of these projects is on Figure 5.

6.1.1 Roadways

Three primary roads provide vehicle access around the rim of Anderson Ranch Reservoir, as summarized below.

1. HD 61 (Pine-Featherville Road) extends north from its intersection with U.S. Highway 20, crosses the Lime Creek Bridge, follows the northeastern shore of the reservoir, and crosses the Pine Bridge to the communities of Pine and Featherville. The road is maintained year-round by Glenns Ferry Highway District.
2. HD 128 (Lester Creek Road) provides access from Pine south to Sloan’s Gulch and Lester Creek. The road is maintained by Mountain Home Highway District but is inaccessible past the Pine Airstrip area during winter months except by snowmobile.
3. HD 120 (Anderson Dam Road) from Anderson Ranch Dam to Fall Creek provides access to the northwestern shore of the reservoir. The road is maintained year-round by Mountain Home Highway District.

Five sections of roadway, varying in length from 50 feet to 600 feet, were identified in the Rim Analysis as areas for consideration that could potentially be impacted or require improvement due to the proposed increase in reservoir water surface elevation at Anderson Ranch Reservoir. Additionally, three existing MSE walls adjacent to HD 61 were identified by the Glenns Ferry Highway District, in coordination with Jacobs, as an additional area of concern. These areas are shown on Figure 6, along with locations of the proposed feasibility-level design improvements related to these roadways (Project 1 to Project 15).

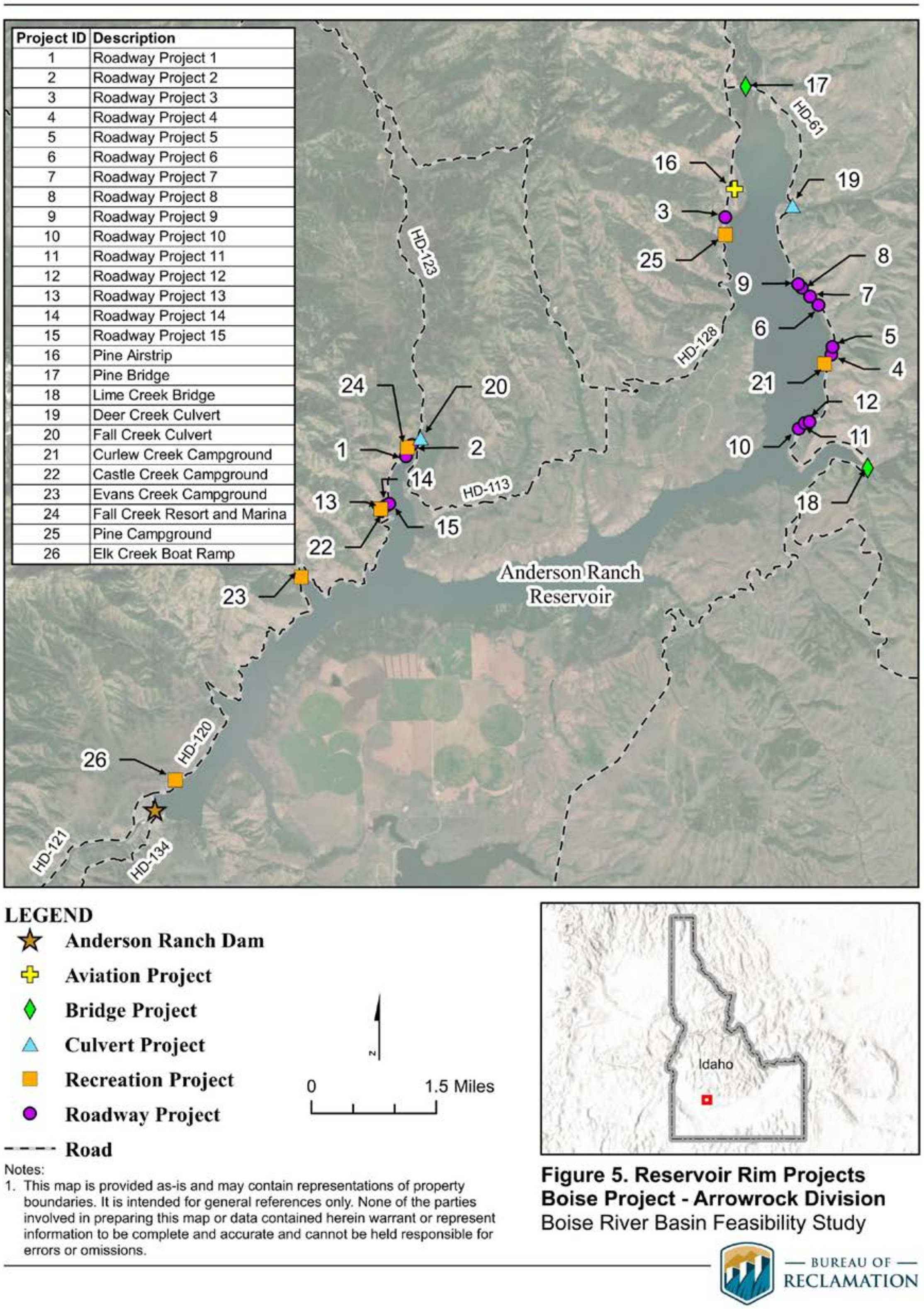

Figure 5. Reservoir Rim Projects

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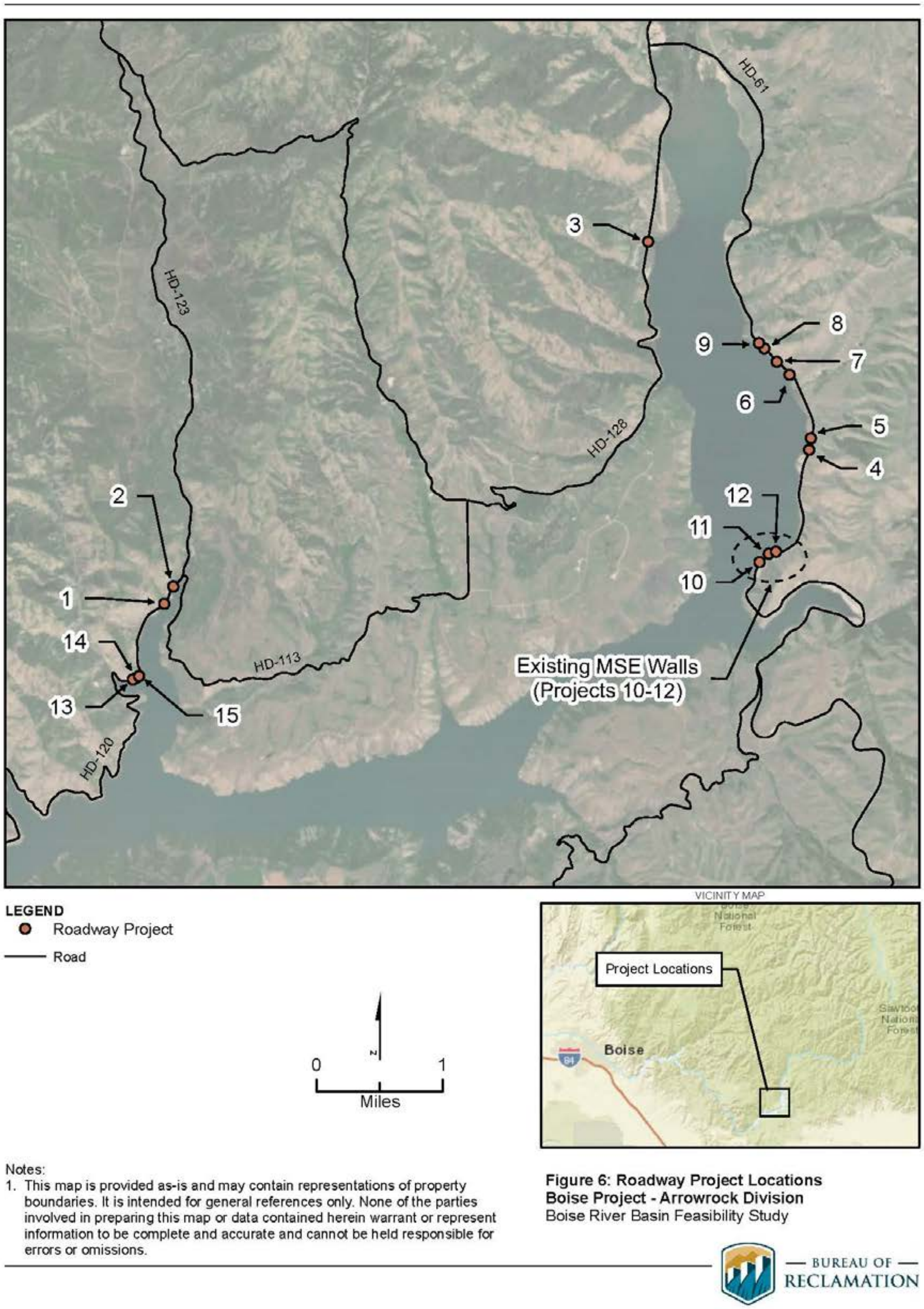

Figure 6. Roadway Project Locations

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6.1.1.1 Design Criteria and Engineering Evaluation

The following approach was used to establish proposed feasibility-level design improvements.

- Compare water surface elevations and freeboard to the roadway profiles.
  - Add a 3-foot minimum freeboard to the proposed top of active reservoir water surface elevation of 4202 feet. The freeboard elevation of 4205 feet was compared to the existing roadway profiles. Per Reclamation Design Standards for Embankment Dams, 3 feet is the minimum freeboard to prevent embankment dam overtopping due to wind loads (Reclamation 2012c); 3 feet also aligns closely with the maximum historical observed surcharge on Anderson Ranch Reservoir, plus an additional assumed structural roadway section depth.
  - If the finished grade of any existing roadway profile is below elevation 4205 feet, a feasibility-level design is provided to raise the grade and reconstruct the roadway to be above the elevation of 4205 feet.
- Consider shoreline and roadway embankment stability.
  - Review the horizontal proximity of the proposed top of active reservoir water surface along the roadway embankment slopes for the roadway segments that were identified in the Rim Analysis.
  - Determine slopes that require armoring or stabilization to prevent erosion or undermining of the current toe of existing slope (where the proposed waterline would be closer to the existing infrastructure).
  - Provide feasibility-level designs for rock armoring (riprap) or MSE walls to improve shoreline and roadway embankment stability. Where existing MSE walls have already been constructed to mitigate shoreline erosion along HD 61, taller walls will be necessary due to the increased water level in the reservoir. MSE wall reinforcement (or tie-back) length is determined partially as a function of the MSE wall height. Because as-built drawings were not available to evaluate the existing reinforcement length, it is assumed that a full demolition and reconstruction of the walls will be required to accommodate the raised wall height.

The current roadway widths and surface treatments will be maintained where the roadway profile needs to be raised, the shoreline or embankment needs to be armored, or an MSE wall constructed. Criteria for the design of roadway or slope improvements were based on guidelines from *The Manual for Bridge Evaluations, 3rd Edition* (American Association of State Highway and Transportation Officials [AASHTO] 2018a); *A Policy on Geometric Design of Highways and Streets* (also called the Green Book; AASHTO 2018b); *Guidelines for Geometric Design of Low-Volume Roads*, *2nd Edition* (AASHTO 2019); *Idaho*

Transportation Department (ITD) Roadway Design Manual (ITD 2013); and Mountain Home Highway District and Glenns Ferry Highway District standards.

6.1.1.2 Feasibility-Level Designs

Each roadway section was reviewed in detail and split into segments for design. Review of the existing roadway profiles indicated that all but one section (Lester Creek Road near the Pine Airstrip) is above the freeboard elevation of 4205 feet. This existing section of roadway is low enough that any surcharge above the top of active storage or significant wave runup at the proposed reservoir water surface elevation could compromise the roadway section. A feasibility-level design is provided for a 1-foot grade raise above the lowest existing point along the profile at this location. The proposed improvements (Project 3, Table 3) are approximately 800 feet in length and consist of a full width construction with new asphalt pavement, aggregate base course, and borrow. The horizontal alignment of the roadway remains the same, with only the profile elevations changing.

The review of roadway embankment slopes and proximity of the proposed full pool inundation also indicated locations that required riprap. Generally, most of the existing shoreline slopes are anticipated to remain stable and maintain the historical existing angles of natural repose. However, in some locations, riprap should be considered to armor the existing shoreline and roadway embankment slopes and protect existing roadway infrastructure (Project 1 through Project 9 and Project 13 through Project 15). Table 3 shows the locations of proposed riprap with the estimated quantity by site.

Table 3. Recommended roadway riprap project locations and quantities

Project Location	Length of Riprap (feet)	Area of Riprap (square yards)
Anderson Dam Road (near Fall Creek)	--	--
Project 1	500	953
Project 2	302	816
Lester Creek Road (near Pine Airstrip)	--	--
Project 3	802	4,666
Pine-Featherville Road (near Curlew Creek)	--	--
Project 4	400	1,604
Project 5	153	850
Project 6	88	941
Project 7	400	845
Project 8	224	630

Project Location	Length of Riprap (feet)	Area of Riprap (square yards)
Project 9	100	374
Anderson Dam Road (near Castle Creek)	--	--
Project 13	150	232
Project 14	125	115
Project 15	175	215
Totals	3,419	12,241

During the feasibility design process and in coordination with the local highway districts, three existing MSE retaining walls between Pine-Featherville Road and the existing reservoir were identified that would be overtopped by the proposed increase in reservoir water surface. Feasibility-level designs are provided for reconstruction of these three walls (Project 10 to Project 12 in Table 4) that will need to be demolished and reconstructed, so that the tops of the walls are at a higher elevation (assumed for the purposes of this effort to be 4206 feet).

Additionally, there is a location along Anderson Dam Road near Castle Creek where the existing road narrows noticeably between a large rock outcropping and the steep roadway embankment on the reservoir side of the roadway. In addition to shore stabilization with riprap, as identified previously, an MSE wall is proposed at this location to widen the roadway and to increase the stability of the roadway embankment and minimize slope erosion (Project 14). Table 4 shows the locations of proposed MSE wall projects with the estimated quantity by site.

Table 4. Recommended roadway MSE wall project locations and quantities

Project Location	Length of MSE Wall (feet)	Area of MSE Wall (square feet)
Pine-Featherville Road (near Curlew Creek)	--	--
Project 10	100	1400
Project 11	200	2800
Project 12	100	1200
Anderson Dam Road (near Castle Creek)	--	--
Project 14	125	1500
Totals	525	6,900

6.1.2 Pine Airstrip

The Pine Airstrip is owned and operated by the state of Idaho through the ITD Division of Aeronautics. It is located on land owned by Reclamation (2019b) and administered by USFS. It is an airport with one turf runway having a visual approach to each end, as shown in Figure 7. The proposed increase in reservoir water surface elevation at Anderson Ranch Reservoir would inundate a portion of the southern end of the existing runway (approximately 50 feet to 70 feet long) as well as the Runway Protection Zone (RPZ) at full pool. In coordination with ITD, a feasibility-level design was developed to relocate the existing runway with a different orientation and similar dimensions, keeping it out of the future water line after the proposed reservoir expansion.

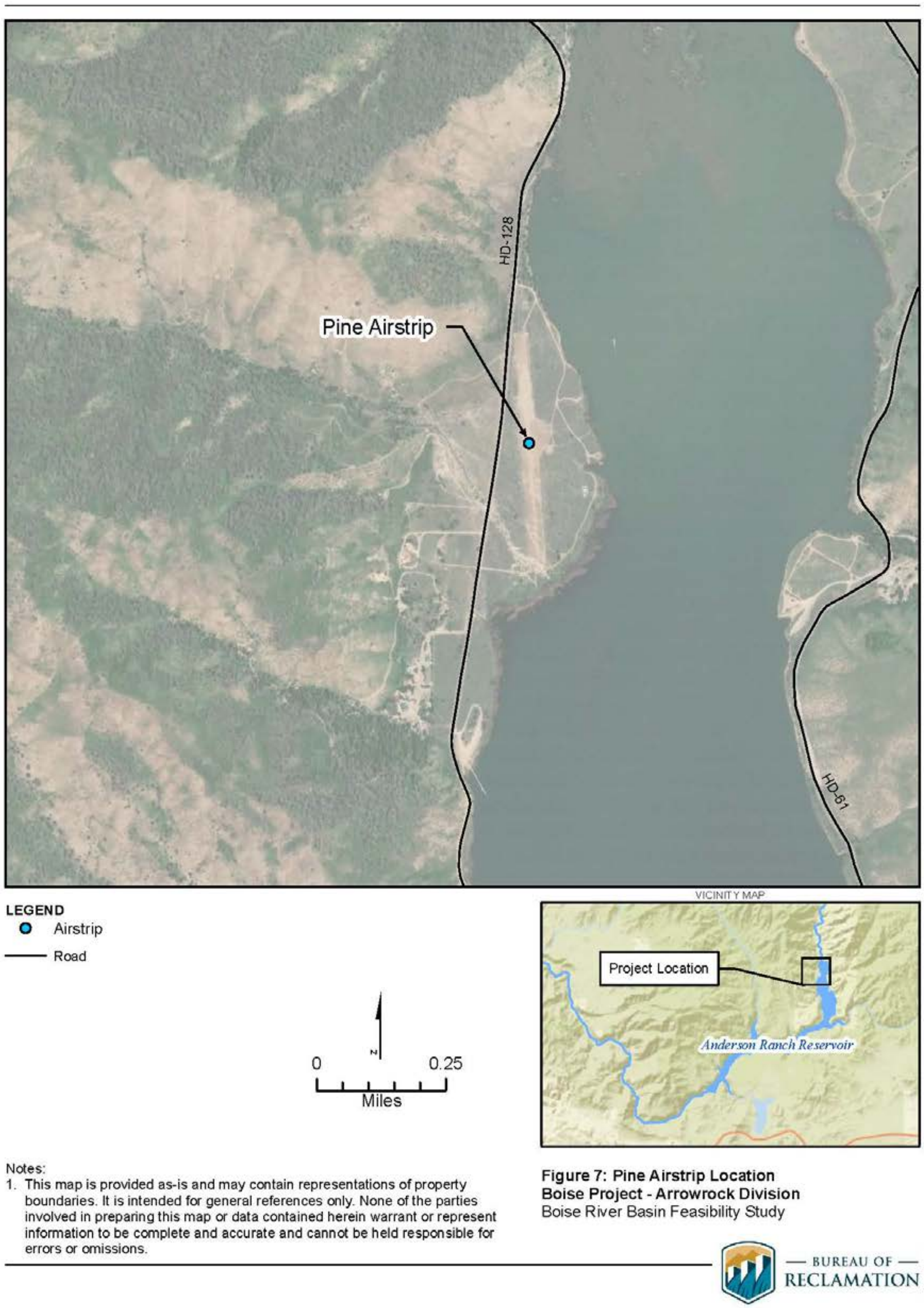

Figure 7. Pine Airstrip Location

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6.1.2.1 Design Criteria

Design criteria for this rim project (Project 16) were developed using the regulations and guidelines identified below.

- ITD *Airport Materials and Construction Manual*, Chapter 201—Minimum Dimensions for VFR Airports (ITD 2010).
- 14 Code of Federal Regulations (CFR) Part 77—Safe, Efficient Use, and Preservation of the Navigable Airspace, Subpart C Paragraph 77.19 (14 CFR Part 77).

Chapter 201 of the ITD Airport Manual (ITD 2010) was used to determine the dimensions and slopes of the proposed turf runway, as well as the dimensions of safety areas, including the Runway Safety Area (RSA), the Runway Object Free Area (ROFA), and the RPZ.

14 CFR Part 77 was used to determine the dimensions of the surfaces used to protect the airspace around the airstrip, including the primary surface, the approach surfaces, the transitional surface, the horizontal surface, and the conical surface. These surfaces help determine obstacles that may obstruct air navigation.

6.1.2.2 Feasibility-Level Designs

This section describes the proposed feasibility-level design of relocation of the Pine Airstrip as a result of the proposed increase in reservoir water surface elevation at Anderson Ranch Reservoir. Before completing the feasibility-level design, a meeting was held with ITD Airport Division staff to discuss alternatives for runway relocation or realignment, or both. The ITD-preferred alternative consists of realigning the runway such that the ROFA is completely above the 4202-foot elevation contour. The proposed relocation remains on the existing airport property and includes a shift of the runway as well as a new orientation.

Airport Layout Plan

The proposed runway will be the same surface type (turf) and dimensions as the existing runway, preserving its capacity and operational criteria. The proposed shift and orientation were determined to maintain the ROFA above the proposed top of active reservoir water surface at elevation 4202 feet. The proposed layout will not impact the existing Lester Creek Road immediately to the west.

The longitudinal slope and transversal slopes for the proposed runway meet design criteria as defined in Chapter 201 of the ITD Airport Manual (ITD 2010). Slopes were computed to minimize earthwork and verify proper drainage.

All safety areas associated with the proposed runway, including the RSA, ROFA, and RPZ, are clear of obstacles and meet design criteria.

A corrugated metal pipe culvert 232 feet long and 24 inches in diameter is proposed to be installed under the southern end of the runway for drainage purposes. Existing dirt tracks are used for access on and around the airstrip. Some of these tracks could be flooded because of the proposed dam raise and altered operations of the reservoir. The design plan shows proposed locations for new dirt tracks to maintain access to the airstrip.

Airspace

Imaginary surfaces (as defined in 14 CFR Part 77) for the proposed visual runway at Pine Airstrip are used to evaluate obstructions to air navigation.

Major obstacles located within the limits of these surfaces were evaluated for obstructions. Some minor ground penetrations occur in the proposed approach surfaces. However, after discussion with ITD, it was determined they would not impact the safety of air navigation.

Profiles

Plan and profile views were developed for the proposed runway and approach surfaces at each end of the proposed runway, with obstacles and ground surfaces.

The slope and dimensions for the approach surfaces follow the regulation 14 CFR Part 77 for unpaved visual runways. The longitudinal slope for the proposed runway follows design criteria as explained in Chapter 201 of the ITD Airport Manual (ITD 2010); this slope was computed to maintain proper drainage while limiting earthwork.

6.1.3 Hydraulic Evaluation of Pine Bridge and Nester's Private Campground

Jacobs performed a hydraulic analysis of the existing Pine Bridge over the South Fork Boise River relative to the proposed 6-foot dam raise and associated reservoir expansion at Anderson Ranch Reservoir. Using updated bridge and hydraulic data, the hydraulic analysis was completed to evaluate the potential impacts to the bridge resulting from the backwater effect from Anderson Ranch Reservoir.

The potential impact of increased reservoir elevation on Nester's Private Campground, immediately upstream of the Pine Bridge, was addressed. This campground is accessed via a narrow gravel road that spans multiple side channels of the river with small culvert and makeshift bridge structures. This hydraulic evaluation assessed potential impacts on the road, culverts, and bridges associated with the higher tailwater conditions.

Simulations were performed for four scenarios: 50-year and 100-year runoff events for both existing and proposed maximum reservoir water surface elevations, with conservative surcharge assumptions. The proposed increase in the reservoir water surface results in a backwater effect that extends up to the southern toe of the Pine-Featherville roadway embankment and the Pine Bridge during flood flows. The resulting increase in water surface elevation at the Pine Bridge due to the higher reservoir water surface elevation is 0.5 foot for both the 50-year and the 100-year events. Upstream of the Pine Bridge, however, there are very minimal observed increases in inundation (Figure 8). For the scope of this analysis, these areas upstream of the Pine Bridge that show an increased level of inundation can be removed from consideration. The general extents of floodplain inundation are similar for both the 50- and 100-year events, largely due to site and channel topography and similar simulated discharges.

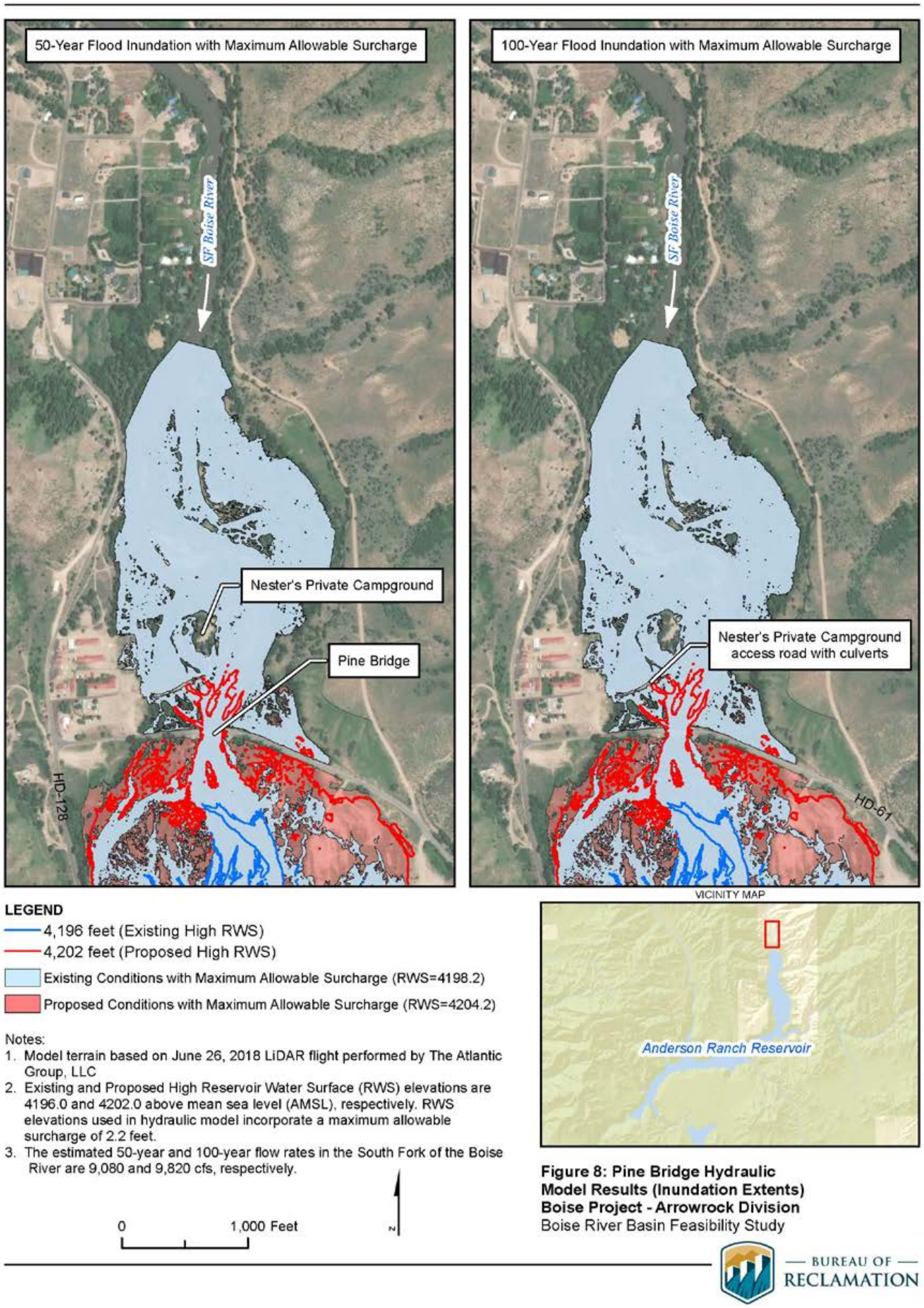

Figure 8. Pine Bridge Hydraulic Model Results (Inundation Extents)

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6.1.3.1 Conclusions

The likelihood of 50-year or 100-year runoff events, by definition, are 1 in 50 years (2 percent chance in any given year) and 1 in 100 years (1 percent chance in any given year), respectively. When considered in combination with a downstream high pool condition that was also conservatively assumed to be surcharged to the maximum allowable level, the likelihood of the actual conditions modeled for this analysis occurring was not able to be calculated, as future operations modeling is ongoing. However, the likelihood of the modeled conditions is much smaller than the recurrence interval of the design flow(s).

Model results indicate that, under the proposed high pool condition with maximum allowable surcharge (reservoir water surface elevation of 4204.2 feet), the resulting freeboard at the Pine Bridge for a 50-year flood would be reduced to 1.5 feet. This does not meet the ITD minimum freeboard requirement of 2 feet. While the likelihood is very low of a 50-year flood and high reservoir levels occurring simultaneously, Reclamation is pursuing a design standard variance for freeboard for the Pine Bridge (ITD *Roadway Design Manual*, Section 330). If obtained, this variance would negate the need for costly abutment modifications. If a variance for freeboard is not obtained, or if additional clearance for floating debris such as driftwood and fallen trees is required, the bridge should be raised more.

Generally, one can expect the existing culverts in the Nester's Private Campground area to become partially submerged under high flow conditions in the South Fork Boise River. The access road to the campground does not appear to overtop in the simulations evaluated for this analysis, with exception of a couple of certain low spots. As can be observed in Figure 8, the campground is located in the natural floodplain and is not protected from naturally-occurring floods. The results of this hydraulic analysis indicate that flooding impacts at Nester's Private Campground are the direct result of South Fork Boise River flows and not a result of backwater influence from the existing or the proposed reservoir elevations. This is also the case with the maximum reservoir surcharge condition considered, and increased reservoir water surface elevations do not measurably increase flood depths or inundation extents at Nester's Private Campground.

6.1.4 Bridges

The Lime Creek Bridge (ITD Bridge Key 19880) and the Pine Bridge over the South Fork Boise River (ITD Bridge Key 19886) were identified as the bridges that would be impacted by the proposed increase in reservoir water surface elevation at Anderson Ranch Reservoir. Locations for these two structures are shown in Figure 9. These structures were reviewed to identify necessary improvements to address the resulting impacts.

Additionally, the Cow Creek Bridge (ITD Bridge Key 27855) was identified as a structure along the proposed detour route for traffic during the construction of the dam improvements. This structure was analyzed to determine if it could support the anticipated detour traffic loads.

Bridge analyses and quantity estimates used applicable guidance from the sources listed below.

- Field observations.
- Original construction plan sets.
- Original design calculations.
- Current inspection reports.
- Current load rating summary sheet. The existing load rating summary sheet for Cow Creek was based on the previous professional judgment by others. This type of simplified rating is performed when plans are not found. During the review for this analysis, a partial plan set was found for Cow Creek, and the information available was used to produce a more accurate and reliable load rating for the structure.
- LiDAR topography completed by The Atlantic Group, LLC (Atlantic Group 2018).
- Global positioning system ground survey conducted in September 2019 (Quadrant 2019).
- *AASHTO LRFD Bridge Design Specifications, 8th Edition* (AASHTO 2017)
- *Standard Specifications for Highway Bridges, 17th Edition* (AASHTO 2002)
- *The Manual for Bridge Evaluation, 3rd Edition* (AASHTO 2018a)
- Latest editions of the *Bridge Design LRFD Manual* (ITD 2019) and *Idaho Manual for Bridge Evaluation* (ITD 2020).

The evaluations performed, their results, and associated feasibility-level designs (Project 17 and Project 18) are summarized for each bridge in the following subsections.

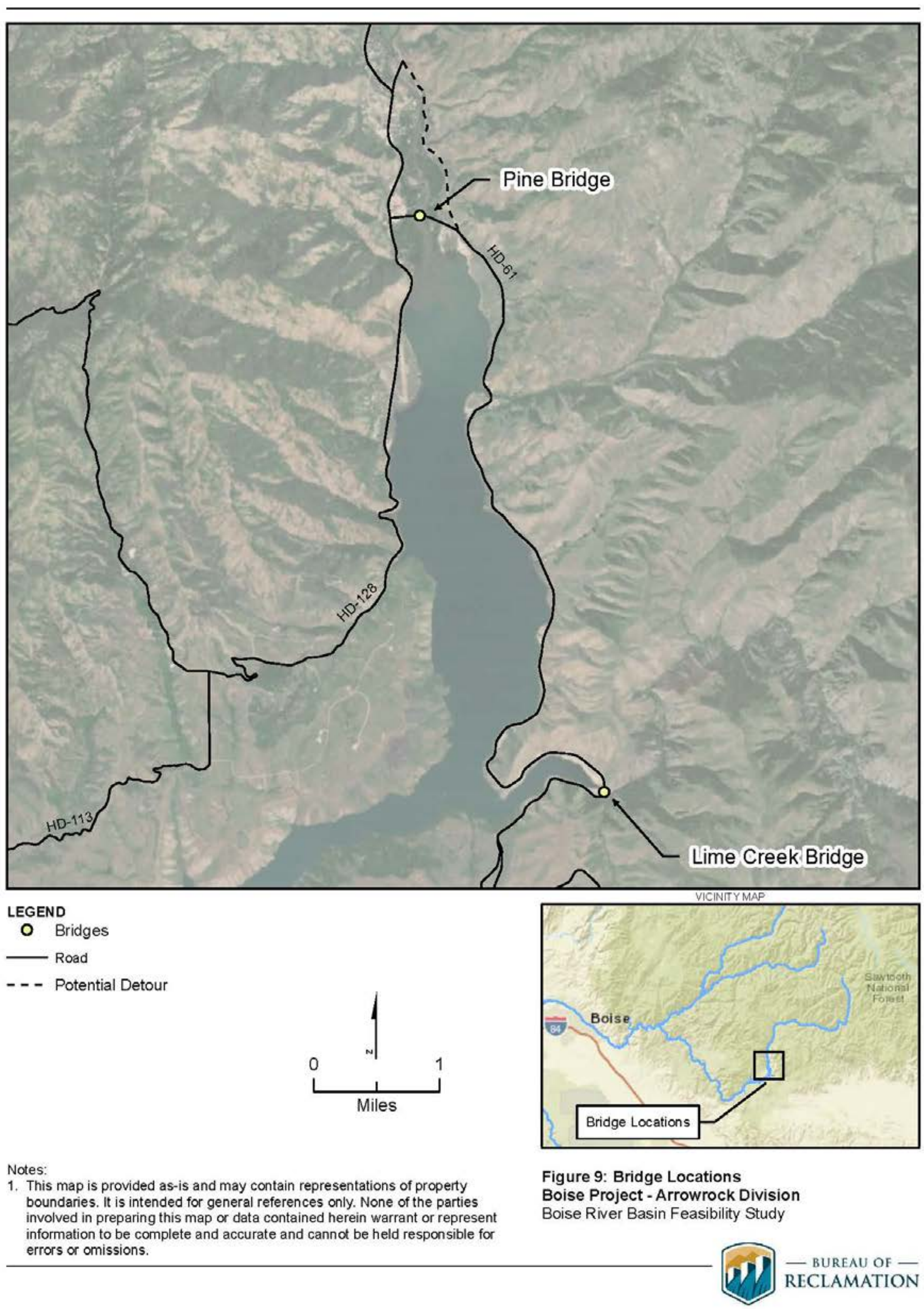

Figure 9. Bridge Locations

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6.1.4.1 Pine Bridge (ITD Bridge Key 19886)

Located along HD 61 (Pine-Featherville Road), the Pine Bridge is a single-span, steel girder bridge that was constructed in 2018. This bridge carries traffic between Mountain Home and Pine, Idaho, over the South Fork Boise River. The Pine Bridge is jointly maintained by Glenns Ferry Highway District (to the east) and Mountain Home Highway District (to the west), and the underlying land is Federally owned. The original plans show the minimum clearance between the 50-year high water elevation and the low chord at 2.5 feet. The proposed increase in reservoir water surface elevation could reduce this provided freeboard below the 2-foot minimum required by ITD during a 50-year flood event if the reservoir level is high when a flood event occurs. For this evaluation, it was assumed that a design standard variance allowing a violation of the minimum freeboard under extreme hydrologic conditions would not be granted. Reclamation acknowledges a low probability of these conditions occurring that would result in a reduction of freeboard and is pursuing a variance. If granted, the variance would negate the need for the proposed abutment modifications described in the remainder of this section.

Specific assumptions for the design of the Pine Bridge structure are summarized below.

1. The superstructure requires an elevation increase of 1 foot to satisfy the minimum ITD freeboard requirement of 2 feet.
2. The existing piles are unable to provide additional resistance beyond their current state.
3. New piles will be installed to increase the foundational capacity.
4. The integral abutments will require full demolition, and new semi-integral abutments will be constructed with reinforcement to transfer the loading across the entire pile group.
5. Existing piles will be protected and reused.
6. The superstructure will be reused.
7. With limited geotechnical information, the soil under the superstructure is assumed unsuitable to support mobilization efforts during temporary superstructure relocation.
8. The existing superstructure will be relocated by crane during the demolition of the existing abutments and reinstalled after the new abutments are constructed.
9. Existing rail end sections at approach slabs can be reused.
10. Riprap displaced during excavation will be reinstalled.
11. Construction will be completed during low flow and low reservoir conditions. Where necessary, water will be properly and completely diverted during all stages of the improvements. Installing and removing any required cofferdams will be subject to the provisions of a 404 Joint Permit from USACE and Idaho Department of Water Resources (IDWR) using sediment- and erosion-control measures.

For this analysis, the superstructure of the existing Pine Bridge was assumed to be raised by 1 foot to achieve the 2-foot minimum clearance between the low chord of the superstructure and the high-water surface elevation. To raise the superstructure by 1 foot, the abutment beam seats need to be elevated. By elevating the beam seats, the substructure experiences an increase in the magnitude of various externally-applied loads including earth pressure, vehicular braking forces, wind, temperature effects due to expansion and contraction, and earthquake forces.

Outside of the structural modifications required to address the freeboard requirements, the riprap limits for the site will need to be extended up the slope in response to the anticipated increase in water level. The riprap section currently installed is performing sufficiently and can be extended up the slope. Riprap removed during the construction of the new abutments has been assumed to be reinstalled.

As previously stated, the design modifications described for Pine Bridge (Project 17) assumed that a design standard variance allowing a violation of the minimum freeboard under extreme hydrologic conditions would not be granted. Considering the low probability of these conditions that would result in a reduction of freeboard, a design variance is being pursued.

6.1.4.2 Lime Creek Bridge (ITD Bridge Key 19880)

Located along HD 61 (Pine-Featherville Road), the Lime Creek Bridge is a three-span, prestressed concrete bridge that was constructed in 1984. This bridge carries traffic between Mountain Home and Pine, Idaho, over the intersecting waterways Lime Creek, Casey Creek, and Anderson Ranch Reservoir. The Lime Creek Bridge is maintained by Glenns Ferry Highway District and the underlying land is Federally owned. As reported in the 2018 ITD Inspection Report, current site conditions include critical scouring at the abutments and piers resulting from material being sloughed away over the life of the structure. The scour noted in the Inspection Report was verified during a contractor site visit in September 2019.

Currently, the abutment slopes contain minimal material resembling the original installed riprap. Thus, before any increase in water elevation, the abutment slopes need repair and installing new riprap. In addition to these repairs, and in response to the anticipated increase in water elevation, the riprap should be extended beyond the limits specified in the original design.

With the original riprap experiencing heavy erosion, new riprap installation is proposed with a woven geotextile fabric and meeting the requirements of Class V riprap. At the existing abutment slopes, it is important that the riprap installed contain the proper gradation and is angular enough to provide stability on the slope. Alternatively, a milder slope might be considered in future design phases.

The slope at the southeastern abutment, where Casey Creek joins Lime Creek, has experienced critical erosion, partially exposing the underside of the sloped wingwall and back of abutment. This slope will also need repair and riprap installation.

Construction will be completed during low flow and low reservoir conditions. Where necessary, water will be properly and completely diverted during all stages of the proposed improvements. Installation and removal of any required cofferdams will be subject to the provisions of a 404 Joint Permit from USACE and IDWR using sediment and erosion control measures.

The freeboard currently provided at the bridge exceeds 10 feet and with the anticipated increase in water elevation will not decrease below the required 2-foot minimum. As such, the elevation of the low chord of the girders for this structure is not a concern. Additional lateral force applied on the piers under the anticipated increased water elevation is assumed under low-velocity conditions with the reservoir being near full pool conditions. Regardless of the water velocity, the narrow width of the pier will keep the additional force negligible.

After evaluating potential impacts resulting from the proposed increase in reservoir water surface elevation, the work required at the Lime Creek Bridge (Project 18) will be limited to repairing the abutment slopes to the original slope and installing Class V riprap.

6.1.4.3 Cow Creek Bridge (ITD Bridge Key 27855)

In addition to the structures being impacted by the increased reservoir water surface elevation, the Cow Creek Bridge was analyzed to determine if it could support the anticipated detour traffic loads during construction of the proposed dam improvements. No design modifications for the Cow Creek Bridge are required.

Located along HD 131, the Cow Creek Bridge over the South Fork Boise River is a four-span, one-lane, reinforced concrete slab bridge that was constructed in 1959. This bridge has been identified along the proposed detour route for traffic during the construction.

Specific assumptions for the load rating analysis of the Cow Creek Bridge structure are summarized below.

1. Load rating was performed in accordance with ITD standards.
2. Load rating was performed with the AASHTOWare Bridge Rating (BrR) software (Version 6.8.3).
3. The bridge was designed with the load factor method, so the bridge was rated with the load factor rating method using the *Standard Specifications for Highway Bridges, 17th Edition* (AASHTO 2002).
4. Analysis was performed as directed by *The Manual for Bridge Evaluation, 3rd Edition* (AASHTO 2018a).
    a) The compressive strength was assumed to be 3.0 kilopounds per square inch (ksi) for unknown concrete constructed in 1959 or later.
    b) The reinforcement yield strength was assumed to be 40 ksi for unknown steel constructed during or after 1954.

5. Based on design plans typical to this structure's time, the clear cover on the plans was assumed dimensioned to the center of the reinforcement.
6. The slab was evaluated with a maximum depth of 23.5 inches and minimum depth of 17.5 inches.
7. With traffic directly on the surface of the slab, a 0.5-inch sacrificial wearing surface was considered, reducing the structural capacity of the slab.

The analysis for this bridge was limited to a load rating of the superstructure to confirm if it is suitable for the anticipated traffic. To accomplish this analysis, ITD standards were followed and the structure information was input into the AASHTOWare BrR software. Inputs were derived from the latest ITD inspection report or the available plan sheets, or they were based on assumptions following the guidance of *The Manual for Bridge Evaluation, 3rd Edition* (AASHTO 2018a).

Once the structure's rating model was complete and the accuracy of the inputs verified, the model was analyzed under the design vehicle as listed on the inspection report (*H-20*) and the standard vehicles required by ITD for load factor ratings: HS-20, Idaho Type 3, Idaho Type 3S2, Idaho Type 3-3, Idaho 121 kip (ITD 2019), and the notional rating load. Operating ratings, or rating factors, are greater than 1.0 for each anticipated vehicle type. Based on the assumptions and provided information, the Cow Creek Bridge can safely support the anticipated detour traffic loads during construction of the dam improvements.

6.1.5 Culverts

As part of the Rim Analysis, 13 culverts were identified through a preliminary GIS exercise, 9 of which were assumed to have outlet elevations near or immediately above the elevation of the proposed increase in reservoir water surface elevation at Anderson Ranch Reservoir. These culverts are located on drainages and streams that convey water under HD 61, HD 128, HD 120, and HD 113; are exclusive of the culverts previously described along the access road to Nester's Private Campground; and are located on Federal land administered by USFS. The Rim Analysis recommended that further evaluation of culvert-specific basin hydrology and hydraulics for these locations be performed to further assess potential impacts of the proposed dam raise project. Locations of the culverts are shown in Figure 10.

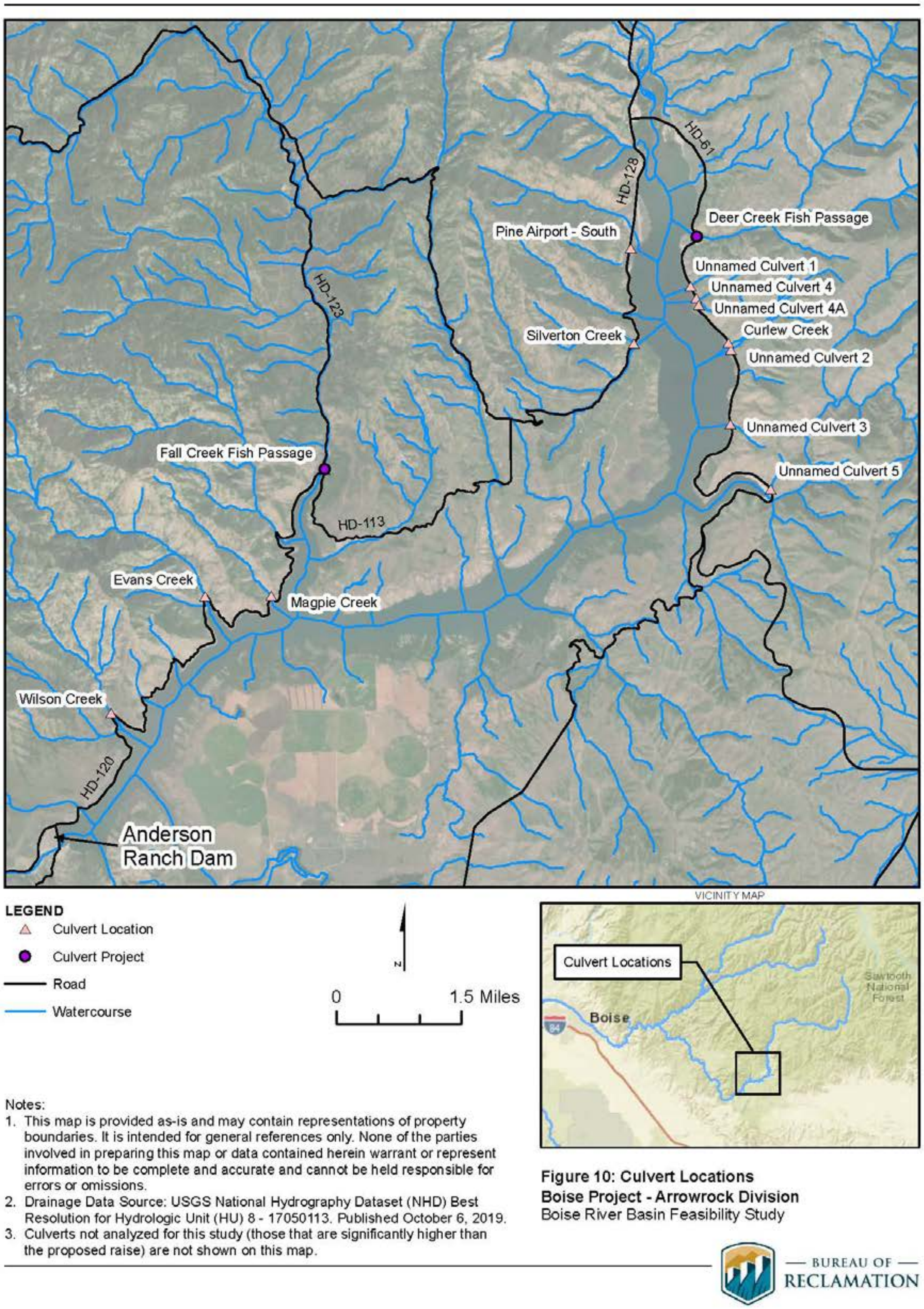

Figure 10. Culvert Locations

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6.1.5.1 Design Criteria and Engineering Evaluation

Analysis consisted of the steps identified below.

- Field observations (limited) and review of existing LiDAR topography completed by The Atlantic Group, LLC, in June 2018.
- Ground survey to confirm the elevations of the culverts identified in the Rim Analysis.
- Review of supplemental ground survey of stream channel geometry (upstream and downstream cross-sections).
- Hydrologic analysis based on the U.S. Geological Survey (USGS) StreamStats Web application for streamflow statistics and basin characteristics.
- Hydraulic analysis based on the Federal Highway Administration's (FHWA) HY-8 Culvert Analysis Program to complete headwater and normal depth calculations (FHWA 2010). Analysis criteria include the following elements, consistent with ITD and local highway district criteria.
    - Culverts sized to convey the 25-year peak flow event with a headwater (HW) to diameter (D) ratio of less than 1.25 (HW/D < 1.25) for the proposed reservoir water surface elevation of 4202 feet.
    - Culverts do not overtop the roadway under the 100-year peak flow event for the proposed reservoir water surface elevation of 4202 feet.

Ground Survey

The Rim Analysis used LiDAR-derived surface contours and aerial mapping for preliminary analysis. In September 2019, additional survey data were acquired by the contractor to supplement and inform the LiDAR topography at culvert locations from the Rim Analysis effort and at one additional culvert that was not identified during the Rim Analysis activity. Additional ground survey data were not collected at sites that are significantly higher than the proposed raise in water surface elevation based on the LiDAR data. The presence of an additional culvert (included in Figure 10 as Unnamed Culvert 4A) that was identified by the contractor while on the ground indicates that there could possibly be other culverts that were not identified during the Rim Analysis; the Rim Analysis identified the culvert locations based on available GIS data and a limited site visit.

The survey data were evaluated to compare previously used LiDAR data during the Rim Analysis to roadway crest elevations, culvert inverts, and culvert dimensions. Survey data showed that the roadway crest elevations established from LiDAR data were accurate; however, surveyed culvert inverts resulted in discrepancies from the LiDAR data that are likely attributed to vegetation in drainage bottoms. Table 5 shows the estimated outlet elevations from the Rim Analysis and the actual surveyed elevations, along with the surveyed culvert inlet elevations and dimensions.

Table 5. Culvert data

Culvert	Rim Analysis Estimated Culvert Outlet Elevation[1] (feet)	Surveyed Culvert Outlet Elevation[2] (feet)	Surveyed Culvert Inlet Elevation[2] (feet)	Size (inches)[2,5]
Curlew Creek (twin culverts)	4206.0	4198.91/ 4199.1	4201.02/ 4200.86	(two) 36
Deer Creek	4193.7	4194.79	4197.04	90
Evans Creek	4197.9	4198.26	4198.59	120 x 240 (box)
Fall Creek	4196.1	4190.46	4192.31	178
Magpie Creek	4205.3	4205.58	4210.62	42
Pine Airstrip - South	4199.8	4198.79	4201.71	30
Silverton Creek	4199.2	4202.23	4204.17	36
Unknown #1	4202.7	4206.44	4211.86	24
Unknown #2	4205.8	4200.82	4203.45	18
Unknown #3[3]	4234.6	NA	NA	36
Unknown #4	4211.4	4199.24	4200.45	36
Unknown #4A[4]	NA	4204.03	4205.83	30
Unknown #5[3]	4216.4	NA	NA	15
Wilson Creek[3]	4208.9	NA	NA	36

[1] Based on elevation data extracted from LiDAR-derived DEM product (Datum: NGVD29).
[2] Based on field survey data collected by the contractor in September 2019 (Datum: NGVD29).
[3] Culvert outlet elevation and dimension was not verified by the contractor in September 2019, as the culvert was considered to be obviously high enough in elevation to not be an impact based on LiDAR data. Stated diameters are from the Rim Analysis report and were estimated using available GIS data or field reconnaissance information.
[4] Culvert was not identified during the Rim Analysis but was observed and surveyed by the contractor in September 2019 (Datum: NGVD29).
[5] Culvert shape is circular unless otherwise stated.

Basin Hydrology

Estimation of various recurrence interval flood flows was performed using StreamStats (USGS 2017). This methodology is appropriate for a feasibility-level analysis and given the range of drainage basins analyzed, because the culvert sites are ungaged and there are no observed flow data available. StreamStats is a web-based application allowing users to generate flow statistics for selected sites by solving regression equations based on streamflow records from nearby stream-gaging stations and various drainage basin characteristics. Drainage areas and peak flow statistics from StreamStats for the 25- and 100-year flow events are summarized in Table 6.

Table 6. Hydrologic peak flow estimates

Location	25-Year Peak Flood[1] (cfs)	100-Year Peak Flood[1] (cfs)	Drainage Area (square miles)[1]
Curlew Creek	6	8	1
Deer Creek	231	296	19
Evans Creek	42	55	4
Fall Creek	740	937	56
Magpie Creek	4	5	0.6
Pine Airstrip – South[2]	0.8	1.0	0.1
Silverton Creek	4	5	0.6
Unknown #1	0.8	1.0	0.1
Unknown #2	0.6	0.8	0.1
Unknown #3	1	2	0.2
Unknown #4	2	2	0.3
Unknown #4A	1	1	0.1
Unknown #5	0.6	0.7	0.1
Wilson Creek	31	41	4

[1] Based on USGS StreamStats version 4 data compiled September 5, 2019.
[2] StreamStats report is not available at this site. Peak flow estimates are based on the results of Unknown #1 culvert, which has comparable basin characteristics (drainage area and mean annual precipitation).

Culvert Hydraulics

The FHWA Culvert Analysis Program HY-8 was used to complete headwater and normal depth calculations. The scenarios outlined below were evaluated for each culvert identified in Table 5 and Table 6.

- Existing full pool elevation of 4196 feet.
- Water surface elevation of 4202 feet (proposed 6-foot reservoir raise).

- Water surface elevation of 4206 feet (4-foot increase above the proposed full pool elevation of 4202 feet). The maximum allowed surcharge is 2.2 feet above top of active storage (Reclamation 2019a); therefore, the assumed maximum water surface elevation for the proposed 6-foot increase in reservoir water surface elevation is 4204.2 feet. Analysis of a full pool water surface elevation of 4206 feet provides a considerably conservative tailwater assumption for culvert hydraulics.

Results

All existing culverts evaluated convey the 25-year flow event with a ratio of HW/D < 1.25 and do not overtop the roadway under the 100-year flow event for the proposed 6-foot increase in reservoir water surface elevation at Anderson Ranch Reservoir.

Results for the 25-year flow event for the three scenarios that were evaluated are annotated on a single profile to compare the existing full pool hydraulics versus the proposed 6-foot reservoir water surface increase and a 4-feet surcharge level.

Table 7 summarizes key findings of the existing culvert hydraulic analysis. Nine of the culvert locations have downstream invert elevations that are greater than the proposed 4202 feet full pool water surface elevation; or they have no change in upstream headwater surface elevation under the proposed 4202 feet full pool elevation versus the current full pool elevation of 4196 feet; or both. Therefore, there is no upstream impact (at the culvert inlets) due to the raised tailwater condition (at the culvert outlets) for these nine culverts: Wilson Creek, Silverton Creek, Magpie Creek, Pine Airstrip – South, and five “name unknown” culverts (Unknown #1, #2, #3, #4A and #5).

Table 7. Culvert hydraulics summary

Location	Downstream Invert less than 4206 feet	Downstream Invert less than 4202 feet	Change in Culvert Headwater Elevation with Full Pool at 4202 feet vs. Existing Full Pool at 4196 feet	Road Overtopping for 100-year Flow Event at 4202 feet Full Pool Elevation
Curlew Creek	Yes	Yes	Yes	No
Deer Creek	Yes	Yes	Yes	No
Evans Creek	Yes	Yes	Yes	No
Fall Creek	Yes	Yes	Yes	No
Magpie Creek	Yes	No	No	No
Pine Airstrip - South	Yes	Yes	No	No
Silverton Creek	Yes	No	No	No
Unknown #1	No	No	No	No
Unknown #2	Yes	Yes	No	No
Unknown #3	No	No	No	No
Unknown #4	Yes	Yes	Yes	No
Unknown #4A	Yes	No	No	No
Unknown #5	No	No	No	No
Wilson Creek	No	No	No	No

The five remaining culvert locations (Curlew Creek, Deer Creek, Evans Creek, Fall Creek, and Unknown #4) show a change in upstream headwater elevations versus the existing reservoir full pool conditions following the proposed 6-foot increase in reservoir water surface elevation under the high flow events that were evaluated (25- and 100-year events). However, the impacts are negligible with regard to culvert hydraulics, and no additional action is recommended. Table 8 summarizes additional results for these five culvert locations where there are changes in headwater elevations under the proposed 6-foot increase in reservoir water surface elevation compared to the existing full pool.

Table 8. Changes in headwater for Curlew Creek, Deer Creek, Evans Creek, Fall Creek, and Unknown #4 culverts

Location	Change in Culvert Headwater Elevation (feet) Full Pool at 4202 feet vs. Existing Full Pool at 4196 feet	Notes
Curlew Creek	0.3	Negligible change in upstream water surface elevation.
Deer Creek	0.5	Negligible change in upstream water surface elevation; culvert is perched when water surface elevation is less than 4194.79 feet (aquatic organism barrier).
Evans Creek	2.6	6 feet of freeboard to top of concrete structure with tailwater conditions at 4202.0 feet; full pool at 4202.0 feet is 8 feet below roadway surface.
Fall Creek	2.2	Existing full pool extends through culvert; 2.25 feet of freeboard to top of culvert with tailwater conditions at 4202.0 feet; full pool at 4202.0 feet is 8 feet below the roadway surface.
Unknown #4	0.9	Negligible change in upstream water surface elevation.

Conclusions

Although no improvements are recommended based on existing culvert hydraulics or potential changes in upstream inundation area, the culvert projects identified below were carried forward for feasibility-level design.

- Replace the 30-inch-diameter Pine Airstrip South culvert that will be impacted by an approximate 12-inch raise in Lester Creek Road (HD 128). This culvert replacement is included in Project 3 (Lester Creek Road) and described in the Feasibility-Level Designs section of this report for the roadway project.
- The existing Deer Creek culvert under Pine-Featherville Road (HD 61) is perched on the downstream end, making it a barrier for aquatic organisms when the full pool water surface elevation is less than 4194.79. The Deer Creek sub-watershed is a high-priority migration corridor for bull trout between Anderson Ranch Reservoir and headwater streams. Therefore, although the Deer Creek culvert meets all the culvert

design criteria for hydraulic conveyance, a feasibility-level design was prepared to restore fish passage through the Deer Creek culvert (Project 19) and reduce habitat fragmentation for bull trout and other aquatic species.

- The existing Fall Creek culvert under HD 113 is perched on the downstream end, making it a barrier for aquatic organisms when the full pool water surface elevation is less than 4190.46 feet. Rocky Mountain Research Station environmental DNA data show positive bull trout detections in Meadow Creek and upper Fall Creek. In addition, a photo taken in in 2003 that was provided to Reclamation via U.S. Fish and Wildlife Service (USFWS), Idaho Fish and Wildlife Office, shows kokanee salmon schooled below the perched culvert at low water. For these reasons, although the Fall Creek culvert meets all the culvert design criteria for hydraulic conveyance, a feasibility-level design was prepared to restore fish passage through the Fall Creek culvert (Project 20) and reduce habitat fragmentation for bull trout and other aquatic species.

6.1.5.2 Feasibility-Level Designs

During a site visit performed as a part of the Rim Analysis in January 2019, the existing culvert at the mouth of Deer Creek was identified as a potential barrier to aquatic organism passage. In the fall of 2019, information was obtained from USFWS that confirms that the Fall Creek drainage is used as habitat for bull trout and other aquatic species. USFWS identified both the Deer Creek and Fall Creek watersheds as potential cold water refugia for native salmonids (Isaak et al. 2015). Both the Deer Creek and Fall Creek stream habitats are currently disconnected from downstream waters when Anderson Ranch Reservoir is at low pool because of multiple aquatic organism passage barrier mechanisms at the existing culverts.

Barrier mechanisms were determined through a low-flow culvert hydraulic analysis in HY-8. The low passage flow used for analysis was the 7-day, 2-year low flow, and the high passage flow was the 10 percent exceedance flow during the spawning migration period for bull trout. These flowrates were estimated using the USGS application StreamStats. The swimming capabilities of an adult trout, included in *HEC-26 Culvert Design for Aquatic Organism Passage* (FHWA 2010), informed the threshold values of maximum velocity, minimum depth, and maximum drop height at the culvert crossing. The results of this analysis indicated that the barrier mechanisms include excessive drop at the culvert outlet at all fish passage flows, insufficient depth in the culvert during low fish passage flows, and excessive velocities in the culvert at high fish passage flows.

Feasibility-level designs were prepared to restore fish passage to the existing Deer Creek culvert (Project 19) and the existing Fall Creek culvert (Project 20). Options considered for the Deer Creek culvert include replacing the existing culvert with an open-bottom culvert. These types of structures can be designed to preserve the natural substrate; however, they can be more costly than a traditional round culvert. In addition, the existing Deer Creek culvert is more than 30 feet below the road grade of HD 61, which is a primary traffic access route.

Because of the depth of the watercourse relative to the roadway, full culvert replacement would include significant temporary construction and public access issues and would also be more cost prohibitive. Rather, the project consists of retrofitting the existing culvert to allow for fish passage by performing some alterations to raise the existing grade at the culvert outlet so that the existing culvert is no longer perched. In addition to channel regrading, the project includes the construction of instream step pool weirs to increase the pool depths downstream of the culvert and provide grade control. The project also includes installing baffles in the existing culvert to increase the depths inside the existing culvert under low flows and reduce culvert velocities at high flows.

Options considered for the Fall Creek culvert include replacing the existing culvert with an open-bottom concrete structure. The existing culvert diameter is large (178-inch diameter); therefore, it is expected that a standard precast concrete structure is not available in the size required and that the cost of a custom concrete structure coupled with the significant temporary construction and public access issues would make this option more cost-prohibitive. For this reason, the project includes a similar approach to the Deer Creek site, which includes raising the existing grade at the culvert outlet so that the existing culvert is no longer perched, channel regrading, and constructing instream step pool weirs and baffles in the existing culvert.

6.1.6 Power Utility Infrastructure

Several segments of power utility infrastructure owned by Idaho Power Company (Idaho Power) were identified during the Rim Analysis, as shown in Figure 11. The contractor coordinated directly with Idaho Power to determine the extent and magnitude of potential impacts to Idaho Power infrastructure from the proposed increased in reservoir water surface elevation. Idaho Power has indicated that they hold a special use permit for occupying and maintaining this infrastructure on lands administered by USFS. Potential impacts are to an overhead powerline and an underground cable. Identified Idaho Power infrastructure that may need to be removed or relocated, or both, for reliability and maintenance purposes includes utility poles, an overhead power line, transformers, and an underground powerline in a conduit. Specific power pole locations would be addressed during a more definitive design phase. Based on contractor correspondence with Idaho Power, no additional capital projects or upcoming work related to the existing power utility infrastructure are anticipated. Feasibility-level cost estimates for the relocation of these facilities were developed in coordination with Idaho Power.

It is assumed that this work would be performed by Idaho Power, including any design work required for utility relocation. It is also assumed that no additional purchased easements will be required to execute the project and that this work would be executed within the existing special use permit so an additional utility agreement will not be required.

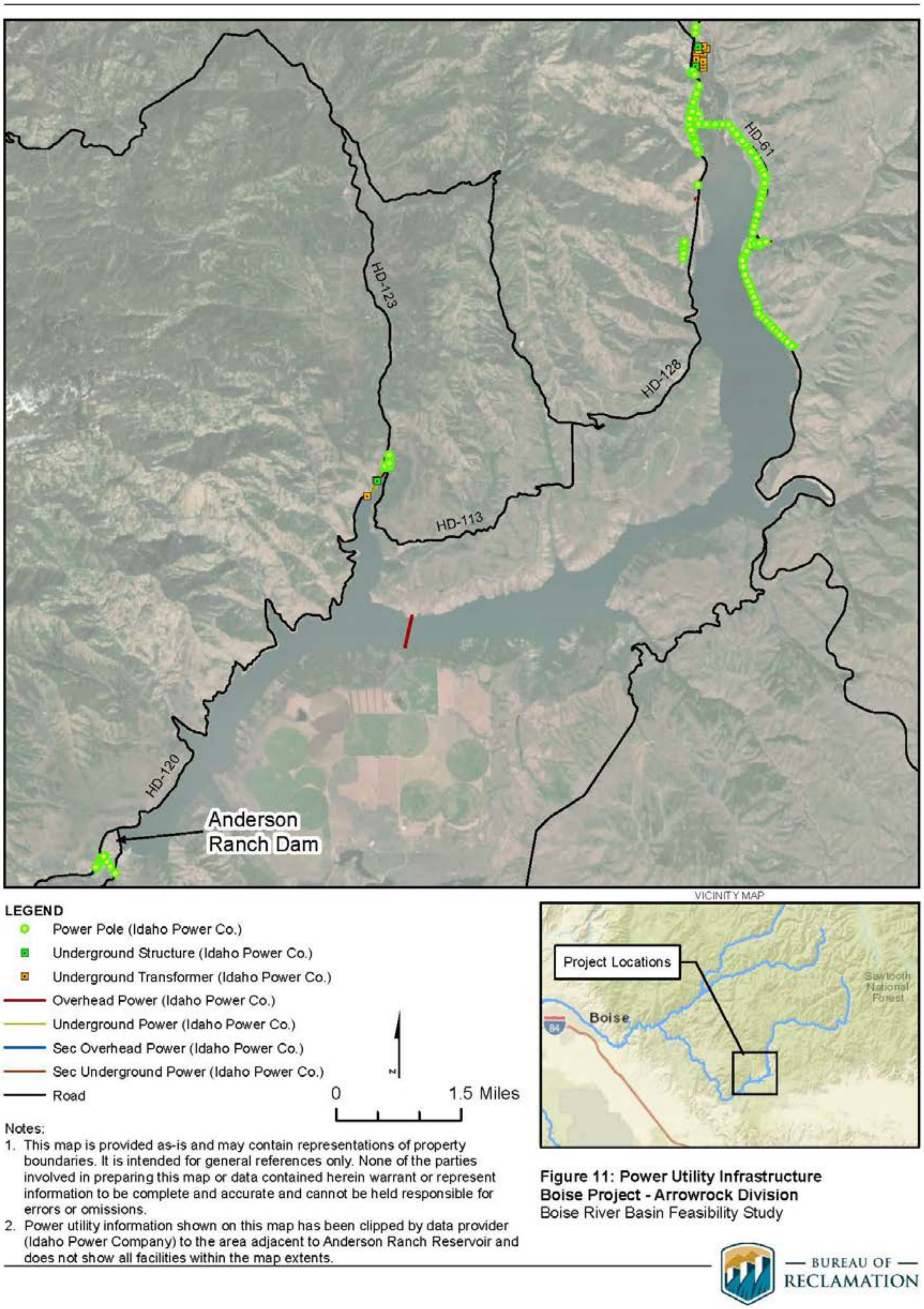

Figure 11. Power Utility Infrastructure

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6.1.7 Recreation Facilities

Recreational facilities reviewed as a part of this effort are listed below.

- Nester's Private Campground.
- Curlew Creek Campground.
- Castle Creek Campground.
- Evans Creek Campground.
- Fall Creek Resort and Boat Ramp.
- Deer Creek Boat Ramp.
- Pine Campground.
- Elk Creek Boat Ramp.

These facilities are shown in Figure 12. With the exception of Nester's Private Campground, the listed facilities are located on Federal land (Reclamation 2019b) and administered by USFS under the Master Agreement. Nester's Private Campground is privately owned and operated. The Fall Creek Resort is authorized by USFS through a special use permit.

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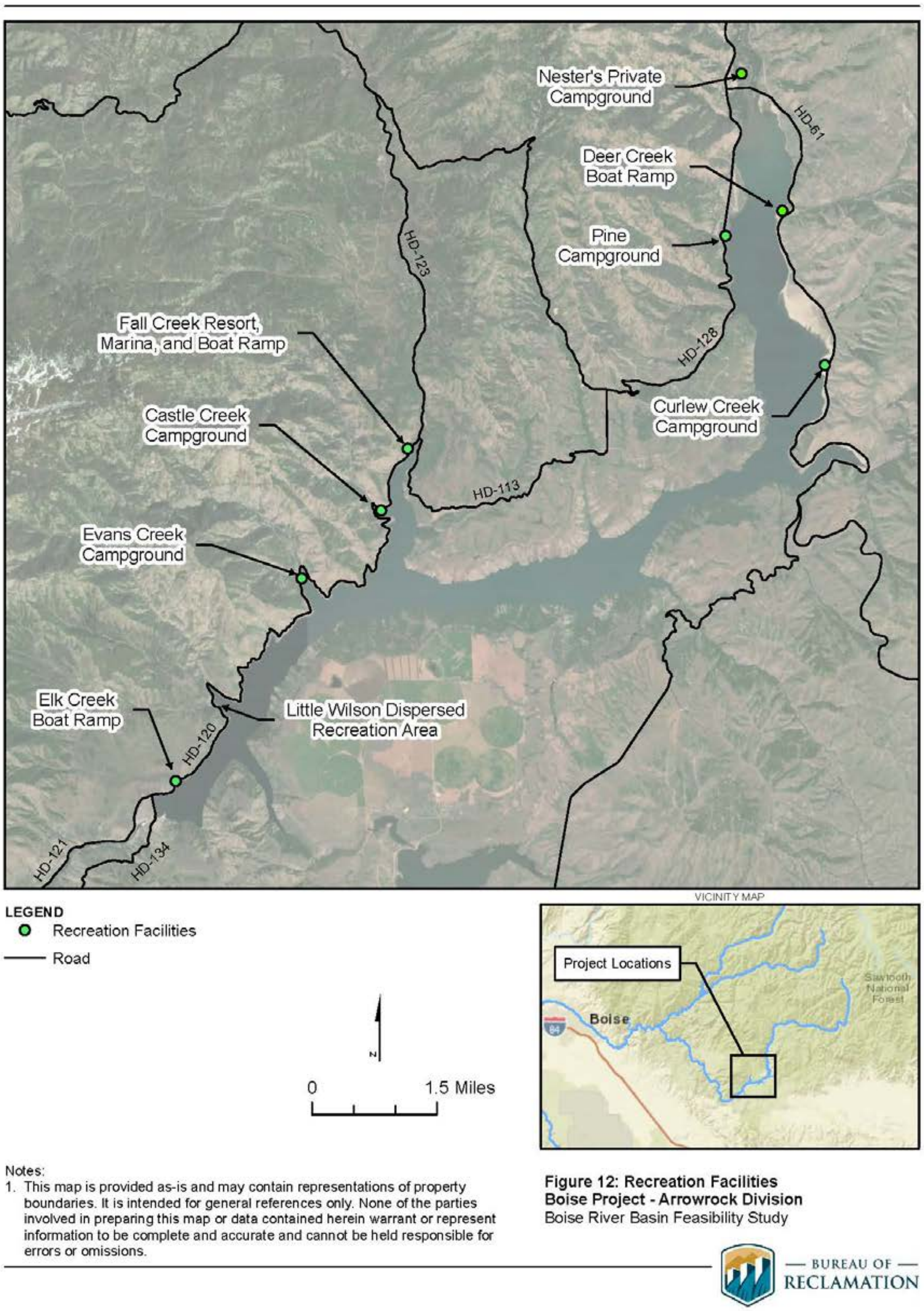

Figure 12. Recreation Facilities

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6.1.7.1 Design Criteria

Recreation facility impacts were quantified based on the proposed 6-foot dam raise and associated reservoir expansion from 4196 feet to 4202 feet, plus an additional 3 feet of freeboard to meet Reclamation Design Standards for Embankment Dams (Reclamation 2012a). All USFS facilities or infrastructure currently lower than elevation 4205 feet are proposed to be mitigated by raising the ground elevation to 4205 feet, relocating the facilities elsewhere within the recreation site, or relocating the facilities to a different recreation site. Idaho Department of Environmental Quality (IDEQ) setback requirements for recreational facility wells were adhered to where applicable. The minimum setback for a well from surface water is 50 feet (IDEQ 2019).

Design criteria for recreation facilities are based on maintaining the existing capacity of developed campgrounds, boat ramps, docks, and other facilities. The existing capacity of the developed USFS campgrounds is maintained at each site, and all other recreation site facilities are maintained at current levels (including boat ramps, docks, picnic shelters, sanitary facilities, and campsites) with the exception of Castle Creek Campground. The two campsites at Castle Creek will be abandoned and relocated to the Pine Campground. All parking lots and access roads will be rebuilt above the new full pool freeboard elevation. In some instances, this is accomplished by importing fill material and in other instances, this is accomplished by relocating impacted facilities away from the new full pool extents. Where fill material is exposed to wave action from the reservoir, the material will be graded to resist erosion. Trees at recreation sites that will be impacted by the facility modifications will be cut and removed. Larger trees (diameter at breast height greater than 6 inches) slated for removal will be mitigated by planting an equal quantity of new trees.

After completing feasibility-level designs, it was identified that designs did not include accessibility requirements. Accessibility design standards will be applied during final design. To account for increased costs, a 25 percent accessibility allowance was added to the recreation subtotal.

6.1.7.2 Feasibility-Level Designs

The proposed reservoir water surface elevation increase directly impacts Curlew Creek Campground, Castle Creek Campground, Evans Creek Campground, Fall Creek Resort and Boat Ramp, Pine Campground, and the Elk Creek Boat Ramp.

Nester's Private Campground and Deer Creek Boat Ramp are not impacted by the reservoir water surface elevation increase.

Nester's Private Campground

Nester's Private Campground is located upstream of the Pine Bridge and is privately owned and operated. The campground is within a Special Flood Hazard Area Zone AE relative to potential South Fork Boise River flooding per Flood Insurance Rate Map #1602120325B for Elmore County, Idaho, effective June 19, 1989.

A hydraulic modeling effort was completed to analyze potential adverse flooding effects at the campground due to the increase in reservoir pool elevation. The modeling effort indicates that flood risk potential at the campground is negligible relative to the hydraulic conditions developed by the proposed pool elevation increase.

The hydraulic modeling effort indicated that the access road to the campground will likely be disconnected from the adjacent Pine Resort under base flood conditions, but this condition is present under pre-project flooding scenarios. The hydraulic model also demonstrates that post-project flooding at the 50-year event leads to an increase in campground inundation of less than 1 percent, which is well within the margin of error for the modeling effort. Therefore, no improvements or modifications are proposed for the facilities at this campground.

Curlew Creek Campground and Boat Ramp

The Curlew Creek Campground includes nine existing campsites, eight of which will be impacted by the pool elevation rise. A day-use picnic site will also be impacted. Two campsites will be abandoned and relocated on site to areas outside of the new reservoir inundation extents. Fill material will be imported to raise the elevation of the other six campsites and one day-use site. The imported fill material gradation will be designed to resist wave erosion from the reservoir pool. Existing picnic tables and fire rings will be removed and new infrastructure will be installed at the new campsite locations. Approximately 60 trees more than 6 inches in diameter will need to be removed to facilitate the improvements at the campground. The removed trees will be replaced with 60 2-inch caliper trees planted to provide shade at the modified sites.

The existing boat dock infrastructure will be reset to accommodate the new pool elevation; two additional 16-foot dock sections will be required to maintain the current overall length of the dock. Signage at the existing boat dock will also need to be relocated. A new concrete dock access ramp will be installed at the top of the ramp.

The existing road loop at the boat ramp will be abandoned (approximately 2,000 square feet), and a new road will be constructed to align with the proposed extension of the boat dock.

The campground includes a drinking water well that will need to be relocated to maintain a minimum 50 feet of separation from surface water as required by IDEQ (2019). This well will be abandoned per IDWR requirements and reconstructed on site per IDEQ (2019) and IDWR standards. The existing vault toilet is not expected to be impacted.

Earthwork quantities are estimated to include 4,900 cy of imported fill and 1,200 cy of imported gravel.

Castle Creek Campground

The two existing campsites at Castle Creek will both be impacted by the pool elevation increase. The campground will be abandoned, and the two campsites will be relocated to the Pine Campground. Existing picnic tables, fire rings, and other appurtenances will be removed. No earthwork is required at the Castle Creek Campground site.

Evans Creek Campground and Boat Ramp

Of the eight existing campsites at Evans Creek, six will be impacted by the pool elevation increase. Imported fill material will be required to raise the elevation of the impacted campsites. The fill material gradation will be designed to resist wave erosion from the reservoir pool. Additionally, an existing seasonal stream channel passing through the campground will be retained. The adjacent campsites and imported fill material will be protected from erosion during runoff events with rock riprap as necessary. Existing picnic tables, fire rings, and other campsite appurtenances will be removed, and new infrastructure will be installed at the new campsite locations. Approximately 25 trees more than 6 inches in diameter will be removed to allow for placement of the fill material needed to increase the elevation of campsites. To mitigate for the loss of shade resulting from the tree removal, picnic shelters will be installed at each of the six new campsites. The removed trees will also be replaced with 25 2-inch caliper trees.

The existing vault toilet, access roads, and boat ramp are not expected to be impacted.

Earthwork quantities are estimated to be 5,200 cy of imported fill, 900 cy of imported gravel, and 220 cy of rock riprap.

Fall Creek Resort, Marina, and Boat Ramp Campsites

Fall Creek Resort is located on Federal land managed by Reclamation and USFS under the Master Agreement. The Master Agreement, dated April 6, 1987, covers all Reclamation-authorized projects within or adjacent to National Forest Service System Lands (Figure 13).

The purpose of the Master Agreement is to establish procedures for planning, developing, operating, and maintaining water resource projects and related Reclamation programs located on or affecting lands and resources administered by USFS, and for USFS planning and implementation of activities on NFS lands within the total area of project influence.

As part of the Master Agreement, Regional Directors and Regional Foresters are delegated authority to execute local project supplemental agreements developed within the scope of the Master Agreement. Supplemental Agreement Number 7-07-10-L0841, dated June 9, 1987, transfers jurisdiction of Reclamation-acquired and withdrawn lands around Anderson Ranch Reservoir to USFS, including the issuance of special use permits. The Fall Creek Resort and Marina is authorized by USFS through a special use permit issued and administered under their regulations.

Analysis of the proposed raise of Anderson Ranch Dam identifies an impact from the increased water surface elevation to the following improvements that are privately owned by the Fall Creek Resort and Marina permittee under special use agreement: five existing campsites at the outlet of Fall Creek, three campsites at the Fall Creek Boat Ramp, and the Fall Creek Marina.

Impacts of this proposed action to permittee improvements will be mitigated during project implementation, should the project be determined feasible and the special use permit still be in effect. Any potential mitigation activities will be subject to future National Environmental

Policy Act analysis that may be needed, will be consistent with the provisions of the special use permit and USFS regulations, and may include but not be limited to options such as:

- rebuilding existing features to their existing condition;
- relocate existing features to a suitable location; or
- compensation.

The existing restroom located near the impacted campsites at the Fall Creek Boat Ramp is not expected to be impacted. The Fall Creek Resort building across Anderson Dam Road from the reservoir will also not be impacted.

Fall Creek Boat Ramp

The Fall Creek Boat Ramp is located on Federal land managed by Reclamation and USFS under the Master Agreement. The boat ramp infrastructure is owned by USFS and is operated and maintained consistent with the Master Agreement.

The existing boat ramp will be abandoned and the existing concrete dock access ramp will be demolished. A proposed 250-foot long concrete boat ramp will be installed and re-oriented to better work with the higher reservoir pool elevation. Rock riprap will be placed along the ramp perimeter for scour protection. The existing floating dock will be removed from its current location and re-anchored to the new concrete ramp with four additional 16-foot sections. A new concrete dock access ramp and bollard will be installed.

Fill material will be required to raise the elevation of the parking area around the boat ramp and the ramp approach. An information sign and life jacket loaner station will be replaced at the new boat ramp location. The existing vault toilet at the boat ramp is not expected to be impacted.

Earthwork quantities are estimated to be 1,100 cy of imported fill, 230 cy of imported gravel, and 150 cy of rock riprap.

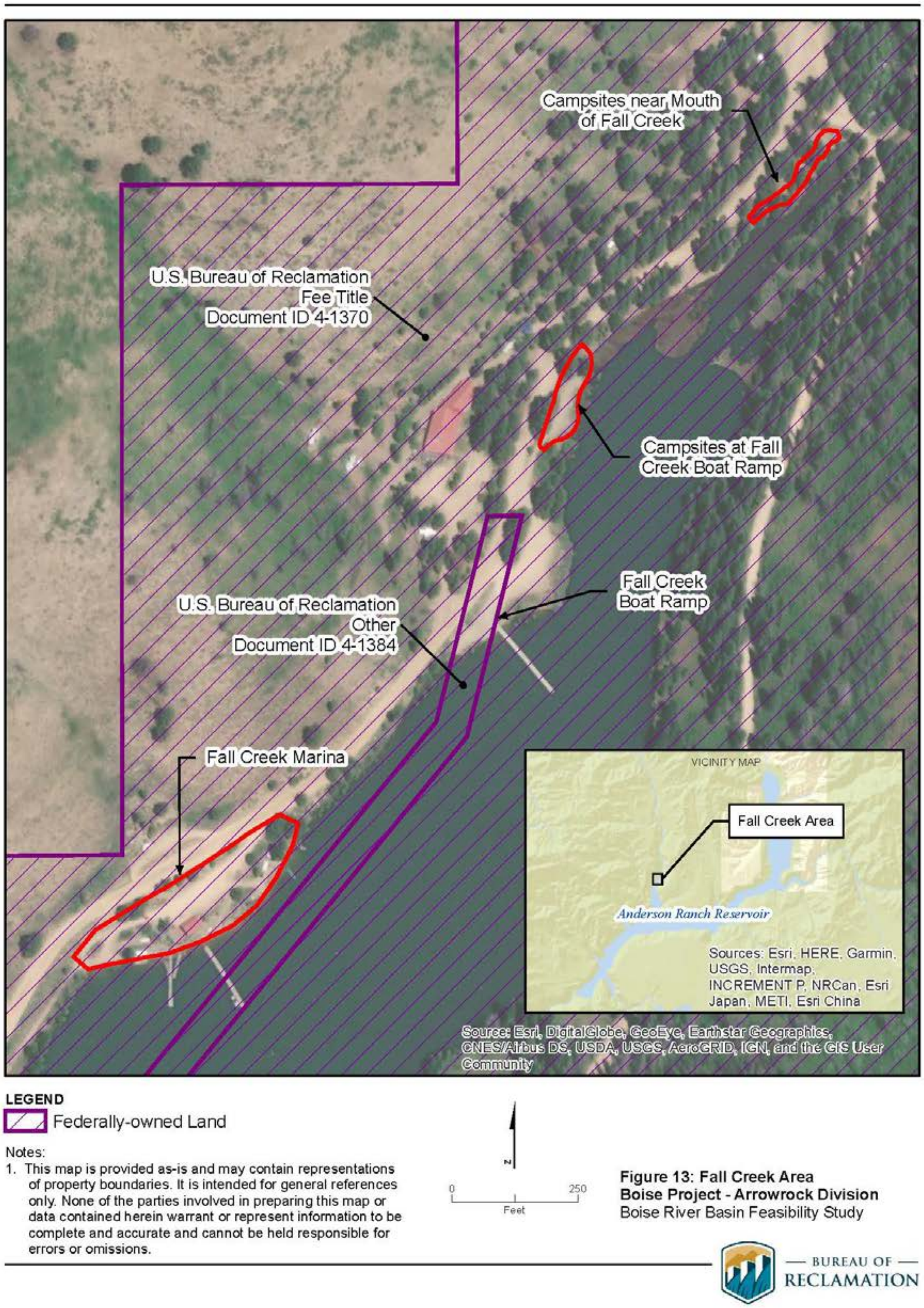

Figure 13. Fall Creek Area

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Deer Creek Boat Ramp

The concrete boat ramp at Deer Creek currently has an exposed length extending approximately 190 feet beyond the current full pool elevation of 4196 feet. With the pool elevation increase, the existing boat ramp will continue to extend 120 feet beyond the new full pool elevation (4202 feet) and 95 feet beyond the minimum 3-foot freeboard elevation of 4205 feet. This appears to maintain sufficient exposed length to ensure functionality of the boat ramp; therefore, no work is proposed at this site.

The existing vault toilet and parking areas are also not expected to be impacted, and no earthwork is required at the site.

Pine Campground

All seven of the existing campsites at Pine Campground will be impacted by the pool elevation increase. One campsite will be relocated and will require limited site grading. Imported fill material will be required to raise the elevation of the other six campsite locations. The fill material gradation will be designed to resist wave erosion from the reservoir pool. Additionally, two new campsites will be created to replace the abandoned campsites at Castle Creek Campground. Existing picnic tables, fire rings, and other campsite appurtenances will be removed and new infrastructure will be installed at the nine new campsite locations. Picnic shelters will also be installed at each of the new campsites.

The existing boat dock infrastructure will be adjusted to accommodate the new full pool elevation; four additional 16-foot dock sections will be required to maintain the current in-water useable length. The boat ramp will also be extended, requiring placing approximately 1,600 square feet of concrete. A new concrete dock access ramp will be installed at the top of the adjusted dock. The existing vault toilet is not expected to be impacted. Per the requirements set forth in Chapter 10 of USFS Handbook 2309.13 (USFS 2018), the additional campground capacity due to the two new campsites relocated from the Castle Creek Campground requires installing a second vault toilet at the campground. The new vault toilet will be located to provide convenient facility access to the new campsites.

Earthwork quantities are estimated to be 100 cy of cut, 3,600 cy of on-site and imported fill, and 1,200 cy of imported gravel.

Elk Creek Boat Ramp

The Elk Creek Boat Ramp will be extended to maintain ramp usability at the increased full pool elevation. This will require placing approximately 16 cy of concrete and importing fill material. The fill material gradation will be designed to resist wave erosion from the reservoir pool. The location of several existing boulders on the eastern side of the ramp will be adjusted to accommodate the ramp extension. The existing boat dock will be realigned to work with the new boat ramp extension, a new concrete dock access ramp will be installed, and an existing bollard will be removed and replaced at the top of the ramp. Additionally, three new 16-foot sections of boat dock will be required to maintain the in-water useable length of the dock. The existing vault toilet is not expected to be impacted.

Earthwork quantities are estimated to be 600 cy of imported fill and 20 cy of imported gravel.

6.1.8 Groundwater Wells

Using existing records and online mapping tools available from IDEQ and IDWR, as well as on-site investigation, public and private wells were investigated for potential impacts due to the proposed increase in reservoir water surface elevation at Anderson Ranch Reservoir.

The four public wells listed below are identified on the IDEQ Source Water Assessment and Protection Website.

1. Pine Resort Well No. 1.
2. Deer Creek Lodge Well No. 1.
3. USFS Curlew Creek Campground Well No. 1.
4. Fall Creek Resort Well No. 1.

Of those four public wells, USFS Curlew Creek Campground Well No. 1 is the only identified well to be affected by the surface water elevation increase. Abandonment and relocation of this well is addressed in Section 6.1.7.2.

Approximately 20 additional well logs are georeferenced surrounding the reservoir area on the Find a Well Map provided by IDWR. Actual well locations vary greatly as verified by field investigation. No private groundwater wells were identified within the project area and identified wells will continue to meet setback requirements.

6.1.9 Septic Systems

Because of the lack of available spatial data for existing septic systems, it was assumed that all private properties surrounding the reservoir had an accompanying septic system. The proposed inundation elevation of 4202 feet was compared to Reclamation project land ownership information to determine the approximate setback distance from private property lines to the proposed increased reservoir inundation extents. Based on this analysis, it was determined that the existing private septic systems adjacent to the reservoir will continue to meet minimum setback requirements per Idaho Code § 58.01.08, with the exception of a public use septic system located at the Fall Creek Resort. The Fall Creek Resort septic system will be mitigated during project implementation, should the project be determined feasible and the special use permit still be in effect.

Public vault style toilets maintained by USFS are located at six recreational facilities surrounding the reservoir and are addressed in Section 6.1.7.2. The proposed reservoir pool elevation increase is not expected to impact the existing vault toilets.

6.2 Field Cost Estimates

Feasibility-level cost estimates are based on information and data obtained during investigations for pre-authorization activity. These investigations provide sufficient information to begin preparing preliminary layouts and designs and are used to help select a preferred project alternative and the determine economic feasibility of a project. Feasibility-level cost estimates are suitable for seeking construction authorization from Congress.

Quantity estimates were assembled to inform the development of feasibility-level cost estimates for the rim projects. The cost estimates were prepared in accordance with Reclamation Manual Directives and Standards FAC 09-01, 09-02, and 09-03 (Reclamation 2019d; 2019e; and 2007).

All costs correspond to January 2020 dollars. Unit prices were developed by identifying specific construction activities for major cost elements of each rim project. Costs for labor, equipment, materials, and other resources were developed and grouped into work activities for the estimate worksheets following Reclamation's Estimating Guide. The labor rates embedded in the unit costs are the listed 2019 Davis-Bacon rates for Elmore County, Idaho, that were available at the time of this memorandum for General Decision Numbers ID20190020 and ID20190048 dated April 5, 2019; and for Boise under General Decision Numbers ID20190026 dated August 9, 2019; and ID20190071 dated March 29, 2019. Labor unit prices reflect a burdened rate, including workers' compensation, unemployment taxes, fringe benefits, and medical insurance.

The following resources were used in the development of the cost estimates: R.S. Means, CH2M Hill and Jacobs historical data, vendor quotations for equipment and materials where appropriate, and estimator judgment. The final costs of the project will depend on actual labor and material costs, competitive market conditions, final project costs, implementation schedule, and other variable factors. As a result, the final project costs will vary from the estimate presented herein.

6.2.1 Markups

The markups shown in Table 9 are built into unit prices and are based upon general assumptions about how the project will be contracted. Actual markup percentages used by the construction contractor for bidding may vary from those shown in the table.

Table 9. General contractor markups

Item	Markup (Percent)
Contractor General Conditions	10
Materials Sales and Use Tax	6
Local Adjustment Factor	10
Contractor's Overhead	10
Contractor's Profit	5
Bonds, Permits, and Insurance	2

6.2.2 Mobilization

Mobilization costs include costs for mobilizing construction contractor personnel and equipment to the rim project sites during initial project startup. This line item is a rounded value per Reclamation rounding guidance, which may cause the dollar value to deviate slightly from the actual percentage shown. A value of 5 percent was used for mobilization. This value is based on experience with similar projects and estimator judgment and is consistent with the mobilization value used in Reclamation's Feasibility Design Report for the proposed dam raise (Reclamation 2019a).

6.2.3 Design Contingency

In accordance with Reclamation Manual Directives and Standards FAC 09-01 (5)(E)(1) (Reclamation 2019d), design contingencies allow for uncertainties that are inherent within the design as the project advances from the planning stage through final design. These include: 1) unlisted items, 2) design and scope changes, and 3) cost estimating refinements. To account for these uncertainties, the feasibility-level cost estimates provided with this report contain a 5 percent allowance shown as a separate line item to account for the cost of these minor items. This value is consistent with the value used in Reclamation's Feasibility Design Report for the proposed dam raise (Reclamation 2019a).

6.2.4 Allowance for Procurement Strategies

In accordance with Reclamation Manual Directives and Standards FAC 09-01 (5)(E)(2) (Reclamation 2019d), a line item allowance for procurement strategies (considerations) is often included in feasibility-level cost estimates to account for additional costs in situations when solicitations for construction will be advertised and awarded under procurement strategies that limit competition, allow award for best value (other than the lowest bid or proposal), or include set-asides under socioeconomic programs. The allowance for procurement strategies was set at 5 percent, which is consistent with the value used in Reclamation's Feasibility Design Report for the proposed dam raise (Reclamation 2019a).

6.2.5 Contract Cost

Per Reclamation Manual Directives and Standards FAC 09-01 (3)(C)(E) (Reclamation 2019d), contract costs are intended to represent the estimated cost of the contract at time of bid or award. This value includes the previously mentioned allowances for design contingencies and procurement strategies, but not allowances for construction contingencies.

6.2.6 Construction Contingency

Construction contingencies are intended to account for costs that result from field design changes or differing site conditions encountered during construction, or both. This allowance is based on engineering judgment for the major pay items in the estimate, reliability of the data, adequacy of the projected quantities, and general knowledge of site conditions. A value of 20 percent was used for construction contingencies based on the completeness and reliability of the engineering design data used in this effort, uncertainties regarding subsurface geologic conditions, limited topographic ground survey data, and general knowledge of conditions at each rim project location. This is in accordance with Reclamation Manual Directives and Standards FAC 09-01 (5)(E)(3) (Reclamation 2019d).

6.2.7 Field Costs

Per Reclamation Manual Directives and Standards FAC 09-01 (3)(C)(I) (Reclamation 2019d), field costs are an estimate of the capital costs of a feature or project from award to construction closeout. The field cost equals the contract cost plus construction contingencies. The field costs are a rounded value per Reclamation rounding criteria, which may cause the dollar value to slightly deviate from the actual percentage shown. Table 10 shows the field costs developed for the projects necessary around the rim of the reservoir as result of the increased water surface elevation due to a dam raise. Total costs are shown in 2025 dollars.

Table 10. Anderson Ranch Reservoir raise – field costs

Item	Cost
Projects 1-15 – Roadways	$2,010,660
Project 16 – Pine Airstrip	$996,110
Project 17-18 –Bridges	$1.016,447
Project 19-20 – Culverts	$319,518
Projects 21-26 – Recreation[1]	$2,241,813
Power Utility Infrastructure	$360,000
Subtotal	$6,944,548
Mobilization (5%)	$350,000
Design Contingencies (20%)	$1,505,452
Construction Contingencies (20%)	$1,700,000
Escalation (3%) to 2025 notice to proceed	$1,500,000
TOTAL	$12,000,000

[1] Accessibility allowance (25%) added to the Rim Design Technical Memorandum (Reclamation 2019c) subtotal for recreation facilities.

6.3 Other Considerations

6.3.1 Schedule

The overall schedule for the rim projects was assumed to begin the same year as the overall dam raise construction with a notice to proceed in January 2025. An effort was made to schedule rim projects near water during lower flow periods and low reservoir conditions. For the purposes of this effort, this is assumed to be between August 1 and May 15, with the lowest reservoir period October–March. This timeframe, however, is balanced with other seasonal considerations such as snow and frozen ground, access needs, and recreational uses.

The rim projects were split into separate project groups in the overall schedule, but they could be completed by one contractor as one project. The individual projects were separated into categories of work of similar scope to allow for economies of scale. The roadway MSE wall and riprap construction projects (Project 1, Project 2, and Project 4 to Project 15) are sequenced such that only one roadway section is disturbed at a time, limiting impacts to traffic. The two bridge projects (Project 17 and Project 18) were combined, and it was assumed that a contractor could be working on the Pine Bridge and the Lime Creek Bridge projects at the same time if necessary. The work for Lime Creek Bridge could also be included with the roadway riprap projects because that is the bulk of the work. While a design exception for a freeboard variance is recommended for the Pine Bridge, it has been conservatively assumed for the purposes of scheduling that the bridge would be closed and that Project 17 would be constructed.

The Pine Airstrip (Project 16) and Lester Creek Road (Project 3) are combined because of the proximity of the sites and to reduce mobilization costs, and the roadway work includes additional items that the other riprap projects do not. Projects were also separated for the Deer Creek Fish Passage (Project 19) and the Recreation Facilities (Project 21 to Project 26). Recreation projects on the western side of the reservoir are scheduled to begin following completion of the Pine Bridge project and after the winter ground thaw. Recreation facility construction should be coordinated with other rim projects to minimize interruptions to local residents and recreationists. This will also reduce road use conflicts if multiple contractors are involved in the rim projects. It is recommended that most of the campgrounds and boat ramps remain open for public use throughout the construction period, especially during the peak use summer months between Memorial Day and Labor Day. This will limit impacts to recreationists and financial impacts that the recreation facilities contribute to the local economy.

Boat dock work should be done when the reservoir is at low pool to remove and replace anchoring infrastructure. Work directly impacting the Fall Creek Boat Ramp facility should only begin after their typical fall shutdown in early October of each year. All recreation site work must be accomplished before completing the dam raise and filling of the reservoir to the new full pool elevation.

Rim project construction durations are based on recent local projects of similar scope and scale. It was generally assumed (based on trucking, hauling, and local roadway capacities) that riprap could be installed at a rate of about 150 to 200 cy per day; MSE walls could be constructed at a rate of about 150 to 175 square feet per day; and general excavation and earthwork could occur at a rate of about 4,000 cy per day.

6.3.2 Constructability

This section contains a discussion regarding major construction activities for all rim projects and is intended to provide a better understanding of the practical elements of constructing the rim projects.

6.3.2.1 Permitting Requirements

Stormwater pollution prevention plans will be required to comply with stormwater discharge requirements and prevent discharging sediment and other pollutants directly into Anderson Ranch Reservoir, the South Fork Boise River, or any other watercourse potentially impacted by construction. Construction site operators will need to obtain discharge authorization under an appropriate National Pollutant Discharge Elimination System (NPDES) construction general permit through the applicable NPDES permitting authority.

The USACE, IDWR, and Idaho Department of Lands have established a joint process for activities impacting jurisdictional waterways that require review or approval, or both, of USACE and the State of Idaho. USACE permits are required by Section 404 of the Clean Water Act for discharging dredged or fill materials into waters of the United States, including adjacent wetlands. State permits are required under the Idaho Stream Protection Act (Title 42, Chapter 38, Idaho Code) and Lake Protection Act (Section 58, Chapter 13 et seq., Idaho Code). Installing and removing silt fences, cofferdams, and other construction activities affecting these jurisdictional waterways will be subject to the provisions of a 404 Joint Application for Permit and environmental requirements.

Land use management and utility agreements, as well as easement and right of way information in project locations, will assist with permitting requirements and coordination if the proposed dam raise and associated rim projects move forward into final design.

6.3.2.2 Traffic Control

Except for the Pine Bridge (Project 17), all other rim projects are not expected to close roadways and will allow continued access around the reservoir. As discussed in this report, the Pine Bridge project would not be needed if a design exception for a variance on the allowed minimum freeboard is obtained. If constructed, access across the South Fork Boise River would be available via a detour while the bridge is closed. This detour would be the same that was used during original construction and should not require additional work. The route follows an old logging road (NFS 114) up to the McCoy Bridge approximately 1.3 miles north of the Pine Bridge location. Continued access to private land and nearby homes could be provided during the construction of Lester Creek Road without the need for detours. Other rim projects would require traffic control for up to one lane closure, if needed, but would not limit access during the proposed construction.

6.3.2.3 Contractor Staging

Staging areas for construction activities will be on government-owned land above the proposed reservoir water surface elevation. As construction is to be completed during low-flow and low-reservoir conditions, there will generally be sufficient area for staging and stockpiling of construction materials adjacent to specific project locations. Staging for construction activities at recreation sites will take place at each individual site. It is assumed that the contractor will use their own means and methods in compliance with the permits for the project and area once it has been put out to bid.

6.3.2.4 Construction Activities

Earthwork-related activities for the rim projects generally consist of riprap placement, import of borrow and other fill materials, excavating and removing material to off-site location, rough site grading, and finish grading. These activities can be performed with a dozer, road grader, backhoe, or excavator, or a combination thereof. Hauling and placing material (import and disposal) would be completed with dump trucks with hauling size ranging from 10 cy to 20 cy. Suitable material will be delivered from a combination of borrow and contractor use areas previously identified by Reclamation or available from commercial sources if necessary, or both. Watering may be required during construction for dust control.

Construction activities specifically related to roadway reconstruction include importing suitable dirt borrow material, base course, aggregate, and asphalt concrete pavement; placing, grading, and compacting imported materials; and hauling excavated material off site where necessary.

For Project 10 to Project 12 and Project 14, MSE walls are required to maintain shoreline and roadway embankment stability for the proposed reservoir water surface. The proposed MSE wall on Anderson Dam Road (Project 14) may necessitate a brief closure of the road to provide the structural tieback anchoring.

Bridge-specific construction activities for the Pine Bridge (Project 17, if necessary) consist of demolishing abutments, relocating and storing the existing superstructure, installing new piles, constructing taller abutments, reinstalling the superstructure, and installing riprap. At the Lime Creek Bridge (Project 18), work is limited to repairing the abutment slopes with riprap.

Recreation facility site work will typically begin with clearing and grubbing for new campsite, parking, access, and boat ramp footprints. Work related to existing facilities slated for demolition, removal, or abandonment will be undertaken at this time. Trees and large brush will be cut to low stumps in newly inundated areas and removed off site where fill material will be placed. Infrastructure to be reused (including information signs, picnic tables, fire rings, lantern hangers, charcoal tables, picnic shelters, boat docks, bollards, and life jacket loaner stations) will be removed and temporarily stockpiled. Imported fill material and grading work will be completed to design elevations and extents. Imported gravel, concrete, and riprap will be placed at access roads and boat ramps.

Boat dock locations will be adjusted as needed, and any new boat dock sections will be installed. Final work will include planting new shade trees and site restoration and revegetation.

6.3.2.5 Utilities

Only known utilities in the project area are addressed in this memorandum. Other utility impacts, such as buried fiber optic lines (RTI-Rural Telecom) within existing road rights-of-way, are considered minor for the purposes of this feasibility-level effort and are incidental to any proposed rim project.

6.3.3 Considerations for Final Design

The data previously used to complete the Rim Analysis, and further refined through this additional analysis, evaluation, and design, are considered sufficient for a feasibility-level design, construction schedule, and cost estimate. If the proposed dam raise and associated rim projects move forward into final design, it is recommended that additional information, analysis, and data be considered to assist in supporting the final design efforts for the Rim Projects presented in this report. Table 11 presents a summary of key recommended action items, data collection, and analyses to support a final design effort.

Table 11. Recommended actions for final design

Activity	Purpose
Pursue a design exception for a variance on the allowed minimum freeboard for the Pine Bridge over the South Fork Boise River. This variance could be pursued through ITD Headquarters by Mountain Home Highway District.	As a result of the proposed increase in reservoir water elevation, freeboard at Pine Bridge could be reduced below the minimum 2-foot requirement to a value of 1.5 feet in the event of a 50-year event combined with a full reservoir that is surcharged to the maximum elevation. With the low probability of this extreme condition occurring and the high cost of the required modifications, a design variance is reasonable to request at this structure.
Conduct geotechnical investigation of the soils under Pine Bridge structure near the abutments.	More information on the existing soils may permit methods outside of the use of a crane for mobilization of the superstructure during potential abutment modifications.
Evaluate alternate structural modifications for the 1-foot raise of Pine Bridge (if necessary).	Alternate structural modifications, including but not limited to the use of lightweight concrete, may alleviate the need for additional piles.
Collect detailed topographical survey at all proposed roadway project locations and recreation facilities, and at the Deer Creek and Fall Creek Culverts.	Additional survey would provide additional detail sufficient to assist in developing and refining designs, quantities, cost estimates, and specifications. This would also help refine the downstream limits of the Deer Creek and Fall Creek Fish Passage projects. It would also be needed for establishing control points where necessary.
Excavate test pits and complete geotechnical evaluation at recreation facilities.	More information on the existing soils will assist in development of design requirements for improvements (such as gravel sections, concrete sections, and foundation design criteria).
Excavate test pits near the Pine Airstrip South culvert during high water.	Replacing existing Pine Airstrip South culvert is included in Project 3 because the existing culvert will be impacted by the proposed roadway project. The contributing drainage area to this culvert is small, and there is no defined drainage way to the culvert. There is

Activity	Purpose
	potential to infiltrate local runoff that is conveyed by this culvert, which could eliminate the need for the culvert. Eliminating this culvert could prevent minor nuisance flooding and ponding of water on the western side of Lester Creek Road when the reservoir is at high pool. It is recommended that future design efforts investigate the relationship between high water and the adjacent groundwater table to determine infiltration potential at this site.
Conduct geotechnical borings at proposed MSE wall locations.	Collecting detailed subsurface information is recommended to complete final design of the MSE walls along the roadways to confirm proper reinforcement length and embedment of wall footings.
Collect land use management and utility agreements, easement, and right of way information for project locations.	Documentation of land ownership, utility agreements, and any other special use authorizations at project locations will assist with required utility relocations, permitting requirements, and coordination with infrastructure owners and operators.
Coordinate with USFS.	Coordination is required to verify the nature, location, and extent of proposed recreation facility modifications.
Coordinate with IDWR.	Coordination is required to develop design criteria for abandonment of the existing well and construction of the new well at Curlew Creek Campground.
Complete additional investigation into Fall Creek Resort and Marina.	Determine the feasibility of mitigating impacts to the facility, dependent on the status of the existing special use permit through USFS.
Confirm detailed ground elevations within the extents of the approach surfaces at the proposed Pine Airport location.	Existing LiDAR data, while adequate for a feasibility-level design, does not cover the full extents of the proposed approach surfaces. Additional topographic data may be required.
Perform a detailed geomorphic assessment in the stream reaches upstream and downstream of the Deer Creek Culvert under HD 61.	This will assist in a better understanding of the channel characteristics and appropriate reference reaches and will result in a more successful design for sensitive aquatic species.
Perform a detailed geomorphic assessment in the stream reaches	This will assist in a better understanding of the channel characteristics and appropriate reference reaches and

Activity	Purpose
upstream and downstream of the Fall Creek Culvert under HD 113.	will result in a more successful design for sensitive aquatic species.
Conduct additional low-flow hydrologic analysis on the Deer Creek subwatershed.	Because no detailed hydrologic data were available for the watershed, additional low-flow analysis is recommended to better understand needs of target aquatic species and their target life stages.
Conduct additional low-flow hydrologic analysis on the Fall Creek subwatershed.	Because limited hydrologic data was available for the watershed, additional low-flow analysis is recommended to better understand needs of target aquatic species and their target life stages.
Conduct additional evaluation of typical reservoir operating levels.	Additional evaluation of proposed operations of the reservoir will assist in providing a more robust design as it relates to fish passage requirements.

7 Construction Cost Estimates

Per Reclamation Manual Directives and Standards FAC 09-01 (3)(C) (Reclamation 2019d), the construction cost (or construction cost estimate) consists of the contract costs plus non-contract costs.

7.1 Non-Contract Cost

Per Reclamation Manual Directives and Standards FAC 09-01 (5) (H) (Reclamation 2019d), non-contract costs refer to the costs of work or services provided by Reclamation staff or contractor personnel, or both, used to augment agency resources in support of the project during post-authorization and construction activities. Reclamation Manual Directives and Standards FAC 09-02 contains additional discussion on non-contract costs (Reclamation 2019e).

Non-contract post-authorization costs are pre-contract award activities including land acquisitions; permitting and compliance; cultural resource actions; relocation of existing real property; clearing and restoring lands; investigations; engineering (preparation of design and specifications); contract administration; and other general expenses.

Non-contract construction costs are post-contract award activities including construction management; engineering; contract administration; and other general expenses.

Non-contract costs were developed using a combination of methods. Reclamation program staff provided estimates for post-authorization and construction non-contract costs specific to the proposed project. These were then compared with the proportionate share of costs from a similar recent Reclamation dam raise project in eastern Idaho, and subsequently determined to be within the range of percentages of costs from TSC's cost estimating guidelines associated with Reclamation feasibility studies for like-type projects. Non-contract costs for the proposed project, for both post-authorization (escalated to January 2022 dollars) and construction activities (escalated to January 2025 dollars), are shown in Table 12.

Table 12. Non-contract costs

Item	Cost based on Dam Raise Field Costs of $44M (in 2025 U.S. dollars)	Cost based on Rim Projects Field Costs of $12M (in 2025 U.S. dollars)	Subtotal (in 2025 U.S. dollars)
Post-Authorization			
Mitigation (Cultural Resources, Land Acquisitions, Relocation of Existing Real Property)	$201,000	$220,000	$421,000
Design Data (Geologic Exploration and Surveying)	$810,000	$219,000	$1,029,000
Design	$4,070,000	$1,091,000	$5,161,000
Construction	$204,000	$110,000	$314,000
Acquisitions	$204,000	$220,000	$424,000
Permitting and Compliance	$403,000	$110,000	$513,000
Project Management	$604,000	$165,000	$769,000
Misc. Support	$604,000	$165,000	$769,000
Subtotal Post-Authorization Costs	$7,100,000	$2,300,000	$9,400,000
Construction			
Design	$440,000	$245,000	$685,000
Acquisitions	$440,000	$125,000	$565,000
Construction Management	$4,400,000	$1,210,000	$5,610,000
Project Management	$880,000	$490,000	$1,370,000
Misc. Support	$660,000	$305,000	$965,000
Postconstruction /Monitoring	$220,000	$125,000	$345,000
Mitigation (Reservoir Drawdown)	$8,360,000	$0	$8,360,000
Subtotal Construction Costs	$15,400,000	$2,500,000	$17,900,000
TOTAL	$22,500,000	$4,800,000	$27,300,000

7.2 Construction Costs

Table 13 shows the construction costs for the proposed 6-foot Anderson Ranch Dam raise and resulting projects around the reservoir rim due to increased water surface elevation.

Table 13. Construction costs

Cost Component	Cost (in 2025 U.S. dollars)
Field Costs – Anderson Ranch Dam Raise	$44,000,000
Field Costs – Anderson Ranch Reservoir Raise	$12,000,000
Non-contract Costs – Post-Authorization	$9,400,000
Non-contract Costs – Construction	$17,900,000
TOTAL	$83,300,000

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8 Operations, Maintenance, and Rehabilitation Cost

Any infrastructure impacted by the proposed dam raise is owned, operated, and maintained by Reclamation. Costs associated with operations and maintenance at Anderson Ranch Dam are assumed to be existing and perpetuated (unchanged) should the proposed project be constructed.

Any infrastructure impacted by the proposed reservoir rim projects is owned, operated, and maintained by others (such as USFS, ITD, or local highway districts). Any costs associated with operations and maintenance of these facilities are assumed to be existing and perpetuated (unchanged) should the proposed projects be constructed.

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9 Conclusions

9.1 Anderson Ranch Dam Raise

The TSC's Feasibility Design Report (Reclamation 2019a) documents the assumptions and analysis that went into developing feasibility level drawings, cost estimates, and construction schedules for two modification alternatives to raise the top of active conservation surface at Anderson Ranch Dam from elevation 4196 feet to 4202 feet (6 feet). The alternatives have been qualitatively evaluated to be risk neutral at this feasibility stage in the design process.

9.1.1 Alternative 1 – Soil Cement Downstream Raise

Alternative 1 includes the features summarized below.

- Establish a detour route along HD 131 that includes snow removal, moderate road improvements along alignment, and approximately 3,000 feet of new alignment construction.
- Realign approximately 2,200 feet of the right abutment approach road at a maximum grade of 12 percent.
- Construct an earthen cofferdam upstream of the existing spillway structure.
- Demolish the spillway ogee crest structure, bridge, center pier, spillway floor slabs, chute walls, and approach structure.
- Replace the ogee crest structure using reinforced mass concrete to elevation 4180 feet (6-foot raise).
- Replace the spillway approach, floor slabs, and chute walls to elevation 4212 feet.
- Replace center pier and precast concrete bridge.
- Remove, refurbish, coat, and reinstall the existing radial gates.
- Excavate the existing dam embankment crest.
- Excavate the cutoff key trench at the left and right abutments.
- Raise the dam crest to elevation 4212 feet using compacted zoned fill and compacted soil cement on the downstream face.
- Construct a reinforced concrete parapet wall along the upstream crest.

The total duration of construction for Alternative 1 is estimated to be approximately 51 months and the feasibility-level field costs are estimated to be $44,000,000.

9.1.2 Alternative 2 – MSE Wall Raise

Alternative 2 includes the features summarized below.

- Establish a detour route along HD 131 that includes snow removal, moderate road improvements along alignment, and approximately 3,000 feet of new alignment construction.
- Realign approximately 2,400 feet of the right abutment approach road at a maximum grade of 12 percent.
- Construct an earthen cofferdam upstream of the existing spillway structure.
- Demolish the spillway ogee crest structure, bridge, center pier, spillway floor slabs, chute walls, and approach structure.
- Replace the ogee crest structure using reinforced mass concrete to elevation 4180 feet (6-foot raise).
- Replace the spillway approach, floor slabs, and chute walls to elevation 4216 feet.
- Replace the center pier and precast concrete bridge.
- Remove, refurbish, coat, and reinstall the existing radial gates.
- Excavate the existing dam embankment crest.
- Excavate the cutoff key trench at the left and right abutments.
- Raise dam crest elevation 4216 feet using MSE wall finished with precast concrete paneling.
- Raise the dam abutment crest to elevation 4216 feet using compacted zoned fill.

The total duration of construction for Alternative 2 is estimated to be approximately 50 months and the feasibility-level field costs are estimated to be $48,000,000.

Regarding cost and schedule, Alternative 1 has a lower field cost than Alternative 2. Conversely, the estimated schedule shows Alternative 1 taking approximately 1 month longer than Alternative 2; however, this minor increase in schedule is considered to be low impact over the entire scope of the proposed project.

Regarding design and constructability, completing Alternative 2 would require more regrading work, which would also require additional retaining structures within the road alignment to maintain the maximum driving grade.

Regarding the dam safety risks, the expected performance of the downstream embankment raise (Alternative 1) during some of the potential failure modes was evaluated to have slightly more positive factors than the MSE wall raise.

Based on the feasibility-level cost estimates, construction schedules, construction contract risks, dam safety risks, and technical adequacy, Alternative 1 (downstream embankment raise) and Alternative 2 (MSE wall raise) are very comparable and viable modification alternatives. Overall, Alternative 1 compares slightly more favorably with less uncertainty with regard to dam safety risk evaluation. The TSC considers Alternative 1 (downstream embankment raise) to be the preferred alternative at this time.

9.2 Anderson Ranch Reservoir Raise

The Reservoir Rim Technical Memorandum prepared by Jacobs and Quadrant documents the engineering evaluations, analyses, and development of design criteria that went into the feasibility-level designs, cost estimates, and schedule for projects around the perimeter, or rim, of Anderson Ranch Reservoir that need modification, rehabilitation, or replacement as a result of the proposed increase to the top of active water surface elevation at Anderson Ranch Reservoir from elevation 4196 feet to 4202 feet (6 feet).

The rim projects include the major components identified below.

- In total, 12 locations around the perimeter of the reservoir, varying in length from 100 to 800 feet, require riprap roadway embankment or shoreline stabilization, or both, to prevent erosion and protect existing roadway infrastructure. The total estimated volume of riprap required is 12,200 cy.
- Three locations along HD 61 (between Curlew Creek and Lime Creek) require removing existing retaining walls and reinstalling them with a higher top of wall elevation to withstand the increased water surface elevation. The total length of existing wall to be replaced with MSE wall is 400 feet, with a wall surface area of 5,400 square feet.
- One additional location along HD 120 (near Castle Creek) requires a new MSE wall to protect the existing roadway from an increased water surface elevation. The total length of the new MSE wall is 125 feet, with a wall surface area of 1,500 square feet.
- A length of roadway along HD 128 (south of the Pine Airstrip) will require a grade raise of approximately 1 foot to properly impound the increased top of active water surface elevation of the reservoir. The roadway length that needs to be raised is approximately 800 feet long and consists of two 12-foot lanes with 2-foot shoulders.
- A rural airport with one turf runway would be relocated at a different orientation and similar dimensions, keeping it out of the future water line after the proposed dam raise. This project would be primarily an earthwork project, with a near net zero cut and fill balance.
- A potential raise of 1 foot is required for the Pine Bridge over the South Fork Boise River. This would require temporarily removing the superstructure, installing additional piles, reconstructing taller abutments to withstand additional loads, and reusing the existing superstructure. A design standard variance could be pursued and, if granted, would negate the need for this project.

- The abutment slopes at the Lime Creek Bridge require repairing to the original slopes and installing Class V riprap.
- The Deer Creek culvert at HD 61 and the Fall Creek culvert at HD 113 require retrofitting with channel regrading, constructing instream structures to increase the pool depths and provide grade control, and installing baffles in the existing culvert to facilitate fish passage.
- Removal and relocation, or removal only, is required of up to 24 power poles and associated overhead power distribution line, two transformers, and approximately 200 feet of underground powerline in conduit.
- USFS recreation facilities require relocation, including campgrounds and campsites, day-use areas, picnic tables, fire rings, boat dock and ramp infrastructure, access roads, and a drinking water well.
- Modifying an existing concrete boat ramp and floating dock in the Fall Creek area is required.

Feasibility-level field costs (i.e., contract cost plus construction contingencies) for all proposed rim projects (excluding Project 17 – Pine Bridge) are estimated to be $12 million.

The total duration of construction is estimated to be 24 months. Active construction activities are not anticipated on rim projects during the entire duration of the 24-month period.

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Appendix C
Economic Benefits Analysis

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Boise River Basin Feasibility Study – Appendix C

Economic Benefits Analysis

Boise Project, Idaho
Interior Region 9: Columbia-Pacific Northwest

U.S. Department of the Interior November 2020

Mission Statements

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

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

Boise River Basin Feasibility Study – Appendix C

Economic Benefits Analysis

Boise Project, Idaho

Interior Region 9: Columbia-Pacific Northwest

prepared by

Jacobs Engineering Group Inc.

Cover Photo: Bull trout, Salvelinus confluentus. (Joel Sartore/National Geographic Creative).

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Acronyms and Abbreviations

Acronym or Abbreviation	Meaning
707 DM 1 Handbook	Agency Specific Procedures For Implementing the Council on Environmental Quality's Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies
ASP	Agency Specific Procedures
CEQ	Council on Environmental Quality
CMP	Comprehensive
DCMI	domestic, commercial, municipal, industrial
DM	Departmental Manual
DOI	U.S. Department of the Interior
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
Feasibility Study	Boise River Basin Feasibility Study
FEIS	Final Environmental Impact Statement
FRM	flood risk management
Idaho Power	Idaho Power Company
IDWR	Idaho Department of Water Resources
IG	Interagency Guidelines
IWRB	Idaho Water Resource Board
Jacobs	Jacobs Engineering Group Inc.
kW	kilowatt
kWh	kilowatt-hour
Master Agreement	U.S. Forest Service Master Interagency Agreement No. 86-SIE-004
MWh	megawatt-hour
NMID	Nampa and Meridian Irrigation District
No.	number
NOAA	National Oceanic and Atmospheric Administration
OMB	Office of Management and Budget

Acronym or Abbreviation	Meaning
P&G	Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies
P&R	Principles and Requirements for Federal Investments in Water Resources
PR&G	Principles, Requirements and Guidelines for Water and Land Related Resources Implementation Studies
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
RMJOC	River Management Joint Operating Committee
RUVD	Recreational Use Value Database
SPF	SPF Water Engineering, LLC
Suez Water	Suez Water Idaho Inc.
U.S.	United States
USACE	U.S. Army Corps of Engineers
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service
WIIN	Water Infrastructure Improvements for the Nation

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Section 1 Introduction

1.1 Purpose and Scope of Economic Benefits Appendix

This appendix presents the quantifiable and monetizable public benefits associated with the U.S. Department of the Interior (DOI), Bureau of Reclamation (Reclamation) and cooperating agencies' evaluation of the proposed raise of Anderson Ranch Dam and enlargement of Anderson Ranch Reservoir. The findings in this appendix characterize the economic portion of the overall public benefit as defined in the Principles, Requirements and Guidelines for Federal Investments in Water Resources (PR&G) that encompass environmental, economic, and social goals (CEQ 2015). The PR&G defines the objective of Federal investment as striving to maximize public benefit, with appropriate consideration of costs. No hierarchical relationship exists among the three public benefit goals (environmental, economic, and social); nor are these three benefits mutually exclusive. For example, improving habitat for fish and wildlife is clearly an environmental benefit, but it is also an economic benefit when the public is willing to pay for it. Some social and environmental benefits are not readily quantified and monetized. Nonetheless, to meet the objective of Federal investment, all goals are assessed holistically for the Proposed Plan.

This document supports the Boise River Basin Feasibility Study (Feasibility Study) as an appendix to the Feasibility Report. The Feasibility Report, created for the Feasibility Study, along with the Final Environmental Impact Statement (FEIS), will be used to determine the type and extent of Federal interest in raising Anderson Ranch Dam and enlarging Anderson Ranch Reservoir. Sundance-EA Partners II, LLC is performing this work for Reclamation, Columbia-Pacific Northwest Region, and its subconsultant, Jacobs Engineering Group Inc. (Jacobs) is leading this particular task.

In addition to following the aforementioned Federal guidelines, consideration of the requirements of the *Water Infrastructure Improvements for the Nation Act* (or the WIIN Act; Public Law 114-322) is relevant to the Feasibility Study. Reclamation is conducting the Feasibility Study in partnership with the Idaho Water Resource Board (IWRB). Any State requirements relating to the economic benefits analysis, including current water laws and water rights, are also applicable.

1.2 Study Area

Anderson Ranch Dam is one of three primary dams located on the Boise River system, along with Arrowrock Dam and Lucky Peak Dam. Anderson Ranch Dam is a 456-foot-high multiple purpose structure that was authorized in 1940 for the primary purposes of irrigation water supply, power, and flood control, with dead storage space providing silt control, fish conservation, and recreation. Total storage at Anderson Ranch Reservoir is 474,942 acre-feet. Of this, 413,074 acre-feet provide active storage; 36,956 acre-feet are inactive space (powerhead space); and 24,912-acre-feet are considered dead pool. Reclamation owns and operates a two-unit powerplant of 40,000 kilowatts (kW) in Anderson Ranch Dam (Reclamation 1997).

Reclamation operates Anderson Ranch Dam in coordination with Arrowrock Dam to fulfill irrigation and flood control requirements, as well as to provide fish and wildlife protections downstream. The U.S. Army Corps of Engineers' (USACE's) Lucky Peak Dam is operated primarily for flood control purposes, and upstream releases for irrigation from Reclamation's Arrowrock and Anderson Ranch reservoirs pass through Lucky Peak. Together, Lucky Peak, Arrowrock, and Anderson Ranch reservoirs on the Boise River system are operated jointly to fulfill irrigation, hydropower, and flood control requirements. The three reservoirs operate under a formal flood risk management (FRM) requirement (Reclamation 1997).

Anderson Ranch Reservoir inundates approximately 4,772 acres when the reservoir pool is at the top of the active reservoir elevation of 4196 feet. Lands surrounding the Anderson Ranch Reservoir area are largely Federal lands. These Federal lands are managed by Reclamation and the U.S. Department of Agriculture (USDA), U.S. Forest Service (USFS) under Master Interagency Agreement Number (No.) 86-SIE-004 (Master Agreement) (Reclamation and USFS 1997). The Master Agreement, dated April 6, 1987, covers Reclamation-authorized projects within or adjacent to National Forest System lands. Through the Master Agreement, USFS has management and administration jurisdiction of Federal lands, except for the Reclamation Zone, which is the area that Reclamation designates as necessary for the operation of the Boise Project.

1.3 Final Plan Considered in the Feasibility Report

1.3.1 Without Plan Condition

The Without Plan condition represents the existing infrastructure and facilities in the study area and the existing water supply conditions in the Treasure Valley area. The Treasure Valley (Ada and Canyon counties) population is estimated to have increased 22% from 2010 to 2019 (USCB 2019), and population projections indicate significant continued growth.

Coinciding with population growth, extensive land use changes are occurring throughout the valley. Row-crop agriculture and pastoral lands are transitioning to residential and urban environments. These changes have increased the demand for domestic, commercial, municipal, and industrial (DCMI) water. A study prepared for IWRB and the Idaho Department of Water Resources (IDWR) concluded that current annual water supplies available in the Treasure Valley area are less than the projected annual water demand for DCMI uses (SPF 2016). The future water demand projections are evaluated in both the Without Plan and Proposed Plan conditions as a basis for understanding the benefits of the Proposed Plan.

In addition to a rapidly increasing demand on water resources for consumptive use, climate change is likely to stress existing water resources. Management of the Boise River system is highly dependent upon water stored in the form of snowpack in the watershed. The River Management Joint Operating Committee (RMJOC)-II Climate Change Study (RMJOC-II 2018) notes overall trends of increased fall and winter streamflow, earlier and higher spring peak runoff, and earlier streamflow recession. The study also suggests the potential for increased rain-on-snow events during the winter and spring, and annual runoff peaks shifting to several weeks earlier compared to historical conditions. The existing infrastructure and fixed storage capacity may not be adequate to manage these projected changes in precipitation patterns (that is, current storage capacity may be insufficient to capture water in wet years to offset dry years). Furthermore, the early streamflow recession in summer and fall may result in greater dependency on storage water, resulting in less reservoir carryover and an increase in groundwater pumping.

1.3.2 Proposed Plan

The Proposed Plan consists of a 6-foot raise of Anderson Ranch Dam and corresponding enlargement of Anderson Ranch Reservoir. The project would accomplish the following:

- Increase water storage capacity in Anderson Ranch Reservoir by approximately 29,000 acre-feet
- Increase the top of active reservoir elevation from 4196 feet by 6 feet to elevation 4202 feet above mean sea level
- Establish a detour route and associated maintenance for Highway District Road 131
- Incorporate projects around the perimeter, or rim, of Anderson Ranch Reservoir that need modification, rehabilitation, or replacement as a result of an increase in the water surface elevation

1.4 Project Objectives

This appendix describes the economic public benefit estimates for the Proposed Plan. The focus of the Feasibility Study is to accomplish the planning objectives described in this section.

1.4.1 Primary Planning Objectives

The Proposed Plan's primary planning objectives include the following:

- Increase storage capacity in the Boise River basin to help meet existing and future demand.
- Enhance fish and wildlife environment within the Boise River basin or downstream.

1.4.2 Secondary Planning Objectives

The Proposed Plan's secondary planning objective includes the following:

- Reduce flood risk within the Boise River basin.

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Section 2 Economic Principles and Methods

This analysis follows Federal economic principles and methods to estimate benefits of the Proposed Plan. In 2015, the Council on Environmental Quality (CEQ) released the PR&G, the culmination of an interagency effort to update the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G) (U.S. Water Resources Council 1983). The PR&G govern how Federal agencies evaluate proposed water resource developments and include the following components:

- The Principles and Requirements for Federal Investments in Water Resources (P&R) outline the overarching concepts that the Federal government seeks to achieve through policy implementations and requirements for inputs into analysis of Federal investment alternatives (CEQ 2013).
- The Interagency Guidelines (IG) provide guidance for determining the applicability of the P&R for affected Federal agencies, including DOI, USDA, U.S. Department of Commerce, the U.S. Environmental Protection Agency (EPA), USACE, Federal Emergency Management Agency, and Tennessee Valley Authority (CEQ 2014).
- Agency Specific Procedures (ASP) are used to identify which programs and activities are subject to the PR&G; DOI's *Agency Specific Procedures For Implementing the Council on Environmental Quality's Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies* (707 DM 1 Handbook) is its ASP (DOI 2015).

The P&R, IG, and ASP are not regulations but are statements of policy, intended to articulate expectations for the internal management of the Federal government. The P&R and IG do not impose any legally binding requirements on Federal agencies. The Feasibility Study is consistent with DOI's 707 DM 1 Handbook, which is also consistent with *Water and Related Resources Feasibility Studies, Reclamation Manual, Directives and Standards, CMP 09-02* (Reclamation 2019b).

PR&G includes two key concepts: Federal investment and public benefit. Federal investment includes "…those [investments] that by purpose, either directly or indirectly, affect water quality or water quantity, including ecosystem restoration or land management activities" (CEQ 2014). The total level of a given investment is determined on a present value basis over the life of the Federal investment. Public benefits include environmental, economic, and social goals, including monetary and non-monetary effects, and allow for both quantified and unquantified measures (CEQ 2013).

Economic evaluation provides a mechanism for understanding and evaluating tradeoffs that must be made with respect to objectives, investments, and other social goals. It also provides a means to confirm whether the Proposed Plan is acceptable, effective, efficient, and complete, and contributes the most favorably to national priorities.

2.1 Economic Valuation Approaches

The economic evaluation approach for Federal water resources projects must be consistent with the PR&G. Specifically, water and related land resource project planning should contribute to national economic development, while at the same time, protect the Nation's environment, pursuant to environmental statutes, executive orders, and other Federal planning requirements.

Each of the following subsections describes the type of economic benefits and valuation approaches used for the analysis. As stated in Section 1.4 of this appendix, the primary planning objectives of the Feasibility Study are to expand storage capacity in the Boise River basin and provide fish and wildlife public benefits. Additional water supply from expanded storage can provide economic benefits for DCMI and irrigation users. A secondary planning objective of the study is reduction of flood risk within the Boise River basin. Additional benefits evaluated in this appendix include hydropower and recreation.

The ASP for implementing the PR&G (707 DM 1 Handbook) categorizes two broad classifications of monetized economic values as *use* and *non-use* values. While the PR&G updated the 1983 P&G, the discussion related to quantifying and monetizing benefits in the PR&G and the P&G are not significantly different, and both offer clarity on economic valuation methods.

To the extent practicable, changes in use and non-use services resulting from the Proposed Plan are quantified. Whenever appropriate, quantified benefits are monetized. Monetization of quantified benefits follows economic principles and practices detailed in the Office of Management and Budget (OMB) *Circular A-4, Regulatory Analysis* (OMB 2003) and *Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* (OMB 2012), which provide examples of currently accepted monetization practices and a discussion of the opportunity cost and willingness to pay concepts of value. Discounting is used to convert future monetary values to present or annualized values, consistent with the statutory requirements for the agency and relevant agency or administration guidance (for example, Circular A-4 and Circular A-94 [OMB 2003 and 2012]). Services that cannot be acceptably quantified are qualitatively described in enough detail to assist in understanding the importance and magnitude of the changes.

2.1.1 Economic Analysis Parameters

The period of analysis is the time frame when benefits and costs are evaluated. The ASP states that the period of analysis should be the shorter of either the period of time over which the plan, project, or activity being analyzed can reasonably be expected to have beneficial or adverse effects, or a period of time not to exceed 100 years. Projects such as a reservoir expansion are expected to have a service life of at least 100 years.

Construction of the Proposed Plan is assumed to begin in 2025, with a 5-year construction horizon. Current planning, design, and other non-construction costs would continue from the time of final publication of the Feasibility Report to the completion of construction in 2030. The Proposed Plan benefits accrue at the beginning of operation, concurrently with completion of construction in 2030. With a Federal planning horizon of 100 years, the period of economic analysis starts in 2030 and ends in 2129.

The discount rate is the rate determined for Federal investment in water resources projects to calculate the tradeoff of present and future benefits. All economic public benefits were compared at a common point in time in average annual equivalent terms. This was accomplished by discounting future benefits and annual operations costs to the beginning of the period of analysis: 2030. The 2.75% fiscal year 2020 discount rate for Federal water-related planning projects was applied in the economics analysis (U.S. Treasury Department 2019).

Construction costs and annual benefits were adjusted to the same dollar-year of 2025. Where necessary, values that were in a dollar-year prior to 2019 were adjusted to the 2019 dollar-year using the consumer price index (Bureau of Labor Statistics 2019). Subsequently, values that were in or have been converted to the 2019 dollar-year were escalated at 3% annually to 2025 to be consistent with the Proposed Plan cost estimates provided in Appendix B of the Feasibility Report. Therefore, all benefit and cost estimates of the Proposed Plan are in the 2025 dollar-year for direct comparison.

A 3% escalation rate was chosen to represent expected changes due to inflation for the construction cost and annual benefit estimates. The escalation rate does not represent other underlying changes in the real values of the costs and benefits. This assumed escalation rate is an estimate of the change expected but is an assumption of the analysis that could differ from the rate of change that will occur over this time period. A 3% escalation rate is consistent with the long-term values published in federal guidance on future escalation, as provided in the Civil Works Construction Cost Index System (USACE 2020).

2.1.2 Domestic, Commercial, Municipal, and Industrial Water Supply

The Proposed Plan would provide water for potential DCMI users in the Treasure Valley study area. Future DCMI water demand in the study area is expected to be greater than the available water supply. The population of the Treasure Valley area has been estimated to increase to approximately 1.6 million people by 2065 (SPF 2016).

A key assumption in the quantification of benefits is assumed population growth and the related future DCMI water demand. The ability to meet future DCMI demand is uncertain, and shortages in DCMI water supply are likely to occur. The economic analysis applied a standard approach in water resources planning by estimating the willingness to pay to avoid shortages in DCMI water supply, which is a simulated market price economic valuation method.

2.1.3 Irrigation

The Proposed Plan would provide water for potential irrigation use in the Treasure Valley study area. Agriculture in the Treasure Valley is diverse and important to the State economy. Each county in the study area ranks high in agricultural market value relative to other counties, and the Treasure Valley region is a major contributor to Idaho’s agricultural activity (USDA 2019).

The economic benefit of irrigation water was estimated using two approaches: calculating the change in farm-level net income and through simulated market prices. The farm-level net income approach applies the Reclamation Farm Budget Tool (Reclamation 2019a). The simulated market prices approach references irrigators' willingness to pay values for surface water, estimated by Schmidt, Stodick, and Taylor in *Modeling Spatial Water Allocation and Hydrologic Externalities in the Boise Valley* (Reclamation 2009). The 2009 study focused on irrigators located in the Treasure Valley study area that are potential users of the irrigation water supply of the Proposed Plan; the study is referenced throughout this appendix as Schmidt et al.

2.1.4 Fish and Wildlife

The Proposed Plan would provide water that could allow more consistency in meeting environmental targets both within and across seasons. Consistency in meeting existing environmental targets could help Reclamation identify additional flexibility in operations that, when leveraged with existing water deliveries, could provide added fish and wildlife benefits. These are discussed in Chapter 2 of the Feasibility Report and Section 3.3 of this appendix.

An avoided cost approach is used to quantify the benefit of the water supply for fish and wildlife use. This approach is based on the principle that the non-market economic benefit related to fish and wildlife water supply can be measured by the avoided cost of obtaining the water from an alternative source. This approach uses the market value of water and assumes that the benefit from using the water is greater than the cost of acquiring the water. This approach is used when it is not possible to monetize all non-market values due to data limitations or uncertainty in resulting physical changes. Several previous studies and sources were used to generate the market value of water and likely cost to acquire water supply for environmental purposes.

2.1.5 Hydropower

The Proposed Plan would likely increase the amount of hydropower generated at the Anderson Ranch Dam hydropower facilities. The Proposed Plan provides increased storage capacity behind Anderson Ranch Dam, increasing the likelihood of additional head being available for power generation and increased generation from additional water supply passing through the turbines. A net increase in hydropower revenues generated by the Proposed Plan comprises the economic benefits.

2.1.6 Recreation

The Proposed Plan would provide recreation benefits to motorized boating visitors from an increased reservoir surface area, an extended season of increased surface area, and improved reservoir access. The recreation benefits to motorized boating visitors were evaluated using a benefit-transfer approach through an estimated change in dollar value per visitor day multiplied by visitor use. Changes in visitor days for other types of recreational activities were not estimated because of the limited historical visitor use data in the study area and the expectation that changes resulting from the Proposed Plan would likely be minor. Nonetheless, the anticipated changes to recreation outside of motorized boating are discussed qualitatively, including potential benefits to recreation activities downstream of the reservoir.

2.1.7 Other Potential Benefits

Implementation of the Proposed Plan may result in other potential benefits that are currently determined to have no change or a change that is not quantifiable at the time of the study. For example, flood control is a primary function of the system that includes Anderson Ranch Reservoir, and reduction of flood risk is a secondary planning objective of the Feasibility Study. Any other potential benefits are discussed qualitatively in Section 3.6 of this appendix.

2.2 Water Availability

Expansion of water storage is a primary objective of the Proposed Plan. This section describes the average annual water availability, in acre-feet, that exceeds the Without Plan condition. Physical changes are documented and quantified in Appendices A and B of the Feasibility Report.

2.2.1 Without Plan Condition

There would be no physical changes to the Boise River system without implementation of the Proposed Plan, so future water storage capacity would match existing conditions. Storage operations and stream flow impacts in the Boise River system were analyzed to project future water availability (Appendix A of the Feasibility Report provides more details). The analysis found that climate change projections generally exhibit overall trends of increased stream flow in the fall and winter seasons, earlier and higher spring peak runoff, and earlier stream flow recession. Climate change is discussed further in Section 4 of this appendix.

2.2.2 Proposed Plan

The Proposed Plan would increase the current storage capacity of Anderson Ranch Reservoir by approximately 29,000 acre-feet for a total active capacity of 442,074 acre-feet. Potential changes in reservoir storage and stream flow associated with new storage space in Anderson Ranch Reservoir were evaluated using historical and climate change hydrology, and a range of possible release rates and timing for water accrued to the new storage space. Potential impacts during the construction phase of the Proposed Plan were also considered. Model results for the historical period suggest that system operations with an additional 29,000 acre-feet of storage in Anderson Ranch Reservoir results in conditions that fall within the historical operating range.

Full details on water availability, refill probability, and modeling assumptions can be found in Appendix A of the Feasibility Report. In summary, a planning model was used to analyze the amount of water available for potential new water rights at or near Anderson Ranch Reservoir. At the time of this study, multiple proposals of new water rights for diversion from and storage in Anderson Ranch Reservoir were being considered. Given this uncertainty, a range of refill probabilities was analyzed, with details provided in Appendix A.

The estimated refill probability for other potential new water rights to have priority over new storage in Anderson Ranch Reservoir was evaluated and is discussed further in Section 4 of this appendix. It is the most conservative estimate of water availability, as it results in the lowest refill probability. Table 1 shows the annual refill probability and associated average annual delivery for the Proposed Plan. Section 4.1 of this appendix discusses the other refill probabilities.

Table 1. Refill Probability for 29,000 Acre-feet of New Storage in Anderson Ranch Reservoir

Hydrology	Refill Probability	Average Annual Delivery (acre-feet)
Proposed Plan	38%	11,020

2.2.3 Summary of Water Availability and Potential Uses

The primary planning objectives of the Proposed Plan are to increase storage capacity in the Boise River basin to help meet existing and future DCMI and irrigation water demands and to enhance the fish and wildlife environment within the Boise River basin or downstream. Due to uncertainty about the future contracting and distribution of the available water supply from the Proposed Plan, three potential water allocation scenarios for the Propose Plan were evaluated to estimate the range of benefits that could be realized under the Proposed Plan.

Table 2 summarizes the average annual water availability and how it might be allocated for each potential use for these potential use scenarios. Of the new storage space, 10% would be for Reclamation to manage for fish and wildlife purposes. The remaining 90% would be used for irrigation and DCMI; however, the allocation between these two uses is uncertain at the time of this publication. Though specific water users have not been identified, initial statements of interest point to approximately equal space interests from the irrigation and DCMI communities.

Benefit calculations rely on current data for irrigation and DCMI users in the Treasure Valley. Therefore, the following three Proposed Plan scenarios are analyzed and encompass the full range of potential uses to irrigation, DCMI, and fish and wildlife.

- Proposed Plan Scenario 1: Irrigation (irrigation 90%, and fish and wildlife 10%)
- Proposed Plan Scenario 2: DCMI (DCMI 90%, and fish and wildlife 10%)
- Proposed Plan Scenario 3: Mixed use (DCMI 45%, irrigation 45%, and fish and wildlife 10%)

Table 2. Estimated Average Annual Water Availability[a]

Potential Use Scenario	Estimated Average Annual Water Availability for Irrigation (acre-feet)	Estimated Average Annual Water Availability for DCMI (acre-feet)	Estimated Average Annual Water Availability for Fish and Wildlife (acre-feet)	Estimated Average Annual Water Availability Total (acre-feet)
Proposed Plan Scenario 1: Irrigation	9,918	0	1,102	11,020
Proposed Plan Scenario 2: DCMI	0	9,918	1,102	11,020
Proposed Plan Scenario 3: Mixed Use	4,959	4,959	1,102	11,020

[a] Estimate accounts for use beyond existing conditions that the Proposed Plan would provide.

The water allocation assumptions of each scenario provided the basis for each type of use to estimate economic benefits of the Proposed Plan. The economic benefit estimation approaches for irrigation, DCMI, and fish and wildlife are documented in Section 2.1 of this appendix.

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Section 3 Economic Benefits

The PR&G defines the objective of Federal investment as striving to maximize public benefits, including contributions toward environmental, economic, and social goals. No hierarchical relationship exists among the three types of goals, and the goals are not mutually exclusive. As mentioned previously, this appendix presents estimates of the economic benefits to address the economic feasibility of the Proposed Plan. Contributions toward social and environmental goals are included to the extent that they coincide with quantifiable and monetizable economic benefits. Otherwise, for a complete evaluation of public benefits (including environmental and social benefits) resulting from the Proposed Plan, the non-quantified public benefits are expressed in qualitative terms in the Feasibility Report.

In general, the economic goals of Federally financed water resources projects include enhancing the following:

- The value of the Nation's output of goods and services
- The quality of the environment
- The well-being of people in the United States
- Regional economic development

Economic benefits are the direct net benefits (that is, including use and non-use benefits) that would be expected to accrue in the study area and the rest of the Nation if the Proposed Plan is implemented. The economic benefits include increases in the net value of marketed and non-marketed goods and services to the public (DOI 2015).

3.1 Domestic, Commercial, Municipal, and Industrial Water Supply

A study prepared for IWRB and IDWR concludes that the most probable annual water demand for DCMI purposes would increase from 115,070 acre-feet in 2015 to 272,500 acre-feet by 2065 for Ada, Canyon, and Elmore counties. This increase of 157,430 acre-feet in DCMI demand from 2015 to 2065 corresponds with the most probable future DCMI demand estimate (SPF 2016). Ada and Canyon counties account for the increase in growth. Future population growth and related future DCMI water demand in Elmore County is uncertain, with the potential to decrease. Table 3 shows these future DCMI water demand estimates.

Table 3. Future DCMI Water Demand in Study Area

Year	Ada and Canyon Counties, Total (acre-feet)	Elmore County (acre-feet)	Total Annual Demand (acre-feet)
2015	110,200	4,870	115,070
2020	125,970	4,880	130,850
2025	141,740	4,805	146,545

Year	Ada and Canyon Counties, Total (acre-feet)	Elmore County (acre-feet)	Total Annual Demand (acre-feet)
2030	157,510	4,730	162,240
2035	173,280	4,711	177,991
2040	189,050	4,693	193,743
2045	204,820	4,674	209,494
2050	220,590	4,656	225,246
2055	236,360	4,637	240,997
2060	252,130	4,619	256,749
2065	267,900	4,600	272,500

Source: SPF 2016

Note:

Camas County is also included in the study area, but future DCMI water projections are not available.

The same report also concludes that the surface water supplies already in use for irrigation will not meet the net DCMI water demand. More specifically, the report finds that the population in the Treasure Valley is expected to increase, average temperatures could increase, and net DCMI water demand will increase, despite the possibility of substantial water demand reductions through conservation. The report offers several options for increasing the net DCMI water supply, including (SPF 2016):

- Diversions from the Boise and Snake rivers
- Development of Treasure Valley groundwater
- Reuse of treated municipal effluent
- Use of surface water from existing agricultural irrigation for indoor DCMI

The results of the *Treasure Valley DCMI Water-Demand Projections* (SPF 2016) were discussed in a case study, *Opportunities for Surface Water Right Marketing in Idaho's Rapidly Urbanizing Treasure Valley* (Fereday 2016). The thesis of the case study is that a substantial amount of the projected DCMI demand could be supplied by transferring, selling, or leasing unused and unneeded irrigation rights to DCMI users. There are assumptions made on average annual consumptive use per acre between agricultural land and land converted to urban (or DCMI) use across the Treasure Valley. The case study concludes that existing institutions could improve to increase the transfer of water rights from irrigation to DCMI. Few water rights sales have occurred in the Treasure Valley over the last 30 years, and there are recommendations on how to foster an increased exchange of water rights (Fereday 2016).

Both the *Treasure Valley DCMI Water-Demand Projections* (SPF 2016) and the case study (Fereday 2016) agree that a DCMI shortfall is expected in the study area due to the increasing population in the Treasure Valley. With uncertainty in the exact quantities of future DCMI water supply shortages, a unit value (dollars per acre-foot) of DCMI water supply was calculated to allow for quantification of DCMI water supply benefits across the three Proposed Plan potential use scenarios. A 1,000-acre-foot shortage from total anticipated demands presented in the *Treasure Valley DCMI Water-Demand Projections* was used as the basis for the calculation of the unit value (dollars per acre-foot) of new DCMI water supply. A 1,000-acre-foot shortage represents a marginal change in water supply and provides a unit of measurement to extrapolate a unit value from. As detailed in Section 2.2.3, due to uncertainty about the future contracting and distribution of the available water supply from the Proposed Plan, three potential water allocation scenarios were evaluated to estimate the range of benefits that could be realized under the Proposed Plan.

The shortage cost function estimates the DCMI user's (consumer's) willingness to pay to avoid a supply shortage. Shortage cost function parameters were used to estimate the demand function, which include existing estimates of price elasticities, regional DCMI water prices, and projected demand. Piper (2003) estimates an elasticity of demand coefficient of -0.32 as a United States average. Because specific water users have not been identified, a representative retail water price of $1.47 per 100 cubic feet was taken from Suez Water Idaho Inc.'s (Suez Water's) current master rate schedule (Suez Water 2020).

3.1.1 DCMI Water Supply Benefit Values

Implementation of the Proposed Plan would provide an increase in water supply available for DCMI, detailed previously in Table 2. Table 4 summarizes the annual DCMI water supply benefits that the Proposed Plan would provide, organized by split among potential uses for the new water supply. The per acre-foot unit value was calculated to be $748 in 2025 dollars.

Table 4. Average Annual DCMI Water Supply Benefit

Potential Use Scenario	Average Annual Water Available for DCMI (acre-feet)	Average Annual DCMI Water Supply Benefit at $748 per acre-foot (in 2025 U.S. Dollars)
Proposed Plan Scenario 1: Irrigation	0	$0
Proposed Plan Scenario 2: DCMI	9,918	$7,418,664
Proposed Plan Scenario 3: Mixed Use	4,959	$3,709,332

Table 5 presents the resulting present value total DCMI water supply economic benefit from the Proposed Plan. This represents the total of the average annual benefits, discounted using the fiscal year 2020 discount rate for Federal water-related planning projects, over the 100-year planning horizon.

Table 5. Present Value Total DCMI Water Supply Benefit

Present Value Economic Benefit	Without Plan (in 2025 U.S. Dollars)	Proposed Plan Scenario 1: Irrigation (in 2025 U.S. Dollars)	Proposed Plan Scenario 2: DCMI (in 2025 U.S. Dollars)	Proposed Plan Scenario 3: Mixed Use (in 2025 U.S. Dollars)
Present Value DCMI Water Supply Benefit	$0	$0	$258,798,000	$129,399,000

3.2 Irrigation

At the time of this study, no specific irrigators have been identified. Therefore, the farm-level net income approach that applies the Reclamation Farm Budget Tool calculates the change in net income on a representative farm within the study area, which was assumed to irrigate with water supply provided by the Proposed Plan. A second economic valuation approach references irrigators' willingness to pay values for surface water, estimated in the study area by Schmidt, Stodick, and Taylor in *Modeling Spatial Water Allocation and Hydrologic Externalities in the Boise Valley* (Reclamation 2009). The two approaches provide a lower and upper bound unit value (dollar per acre-foot) for surface water for irrigation. These irrigation benefit values are considered representative for a potential irrigator that may use the water supply provided by the Proposed Plan.

3.2.1 Farm Budget Tool

The Farm Budget Tool is a computer application developed by Reclamation to analyze farm-level crop budgets and calculate impacts for use in agricultural studies (Reclamation, 2019a). The Farm Budget Tool was used in this study to calculate the change in farm-level net income with the use of the irrigation water supply provided by the Proposed Plan. The Reclamation Farm Budget Tool inputs are representative of a farm in the study area using crop budgets produced by the University of Idaho (2019).

The University of Idaho developed crop budgets for a 1200-acre model farm located in Southwest Idaho. The total acreage of the representative farm for use in the Farm Budget Tool was adjusted to 960 acres, with the following crops in production:

- 240 acres in corn or corn sileage
- 240 acres of potatoes or sugar beets
- 240 acres of grain
- 120 acres of alfalfa hay or seed
- 120 acres of dry beans

Table 6 provides the budget year, the quantity yield per acre, unit, and price associated with each crop. The Farm Budget Tool has an internal index to convert all crop budget dollar years to a common year, 2019.

Table 6. Crop Prices and Yields Assumed in Farm Budget Tool

Crop	Crop Budget Year	Quantity Yield per Acre	Unit	Price (in 2019 U.S. Dollars)
Corn or Corn Silage	2017	32	Ton	$44.00
Potatoes and Sugar Beets	2019	505	Hundredweight	$8.00
Grain	2019	110	Bushel	$4.55
Alfalfa Hay or Seed	2019	7.5	Ton	$160.00
Dry Beans	2017	24	Hundredweight	$38.00

The University of Idaho crop budgets consider the general agricultural production practices observed in Southwest Idaho. Factors such as farm size, crop rotation, equipment, and management all influence overall production costs. For example, the crop budget for alfalfa seed or hay assumes specific establishment costs that are prorated based on a 5-year life cycle of the crop. Any specific assumptions on each crop are incorporated in the University of Idaho crop budgets, while maintaining the ability to generalize across Southwest Idaho for each crop type. Table 7 summarizes the net income per crop prior to irrigation and miscellaneous expenses.

Table 7. On-farm Net Income by Crop Before Irrigation and Miscellaneous Expenses

Crop	Area (acres)	Total Revenue (in 2019 U.S. Dollars)	Total Operating Costs (in 2019 U.S. Dollars)	Net Income Before Irrigation and Miscellaneous Expenses (in 2019 U.S. Dollars)
Corn or Corn Silage	240	$337,920	$235,387	$102,533
Potatoes and Sugar Beets	240	$969,600	$895,068	$74,532
Grain	240	$120,120	$195,082	($74,962)
Alfalfa Seed and Hay	120	$144,000	$117,600	$26,400
Dry Beans	120	$109,440	$99,731	$9,709
Total	960	$1,681,080	$1,542,868	$138,212

Unique water budgets were developed for the Proposed Plan and existing conditions and were each applied to the model farm to evaluate the change in net income. In 2016, the U.S. Geological Survey (USGS), in cooperation with the IWRB and IDWR, began a project to construct a numerical groundwater flow model of the aquifer system located in the Treasure Valley. In January 2020, the three-dimensional hydrogeologic framework model was published (Bartolino 2020). Alongside the framework, USGS also summarized previous efforts by Newton (1991), Urban (2004), and Reclamation's River and Reservoir Operations Group and IDWR's Planning Bureau (Reclamation 2008) to develop groundwater and combined groundwater to surface water budgets for the Treasure Valley.

Urban's (2004) water budgets for the Treasure Valley aquifer system for 1996 and 2000 were chosen for use in the farm budget analysis primarily because of the inclusion of acreages by crop type in the budgets, as well as the time frame of the data used. Urban's water budgets estimate the amount of water infiltrating to, and discharging from, the entire Treasure Valley aquifer system. The budgets consider seepage and discharge from and to surface water features, such as:

- Canals, drains, rivers, and streams
- Lake Lowell
- Infiltration of precipitation
- Seepage from septic systems
- Evapotranspiration
- Withdrawals for municipal, industrial, irrigation, rural domestic, and stock water applications

Urban's water budgets between 1996 and 2000 indicate an average of 260,500 acres of land irrigated with surface water in the Treasure Valley, and 39,650 acres of land irrigated with groundwater. This equates to a split of approximately 87% of irrigated land by surface water and 13% by groundwater. The model farm uses a concrete ditch and siphon tube irrigation system with water delivered to the farm from an irrigation district, which charges a flat fee per acre for water. The average on-farm application of irrigation water is 4.3 acre-feet per acre (Urban 2004). If the observed surface water and groundwater percentages are applied to the model farm, this would equate to around 0.6 acre-foot per acre of groundwater applied. Therefore, to measure the change in farm-level net income from increased availability of surface water, the conditions in Table 8 were applied to the Farm Budget Tool.

Table 8. On-farm Water Applied to Model Farm in Farm Budget Tool

Model Farm	Surface Water (acre-feet per acre)	Groundwater (acre-feet per acre)	Total Water Applied On-farm (acre-feet per acre)
Without Plan	3.7	0.6	4.3
Proposed Plan	4.3	Not applicable	4.3

The change in farm-level net income due to the Proposed Plan condition is driven by a reduction in groundwater pumping costs. The cost of irrigation by groundwater was determined primarily by the cost of pumping. Pumping costs in the Farm Budget Tool are based on power costs and pumping lift. Depth to water and pressure assumptions for groundwater pumpers were derived from information in *Hydro-Economic Modeling of Boise Basin Water Management Responses to Climate Change* (Reclamation 2013) and used in the Farm Budget Tool. The 2019 agricultural irrigation power rates of 5.8¢ per kilowatt-hour (kWh) were assumed for energy costs (Idaho Power 2020). The difference in net revenue for the model farm due to implementation of the Proposed Plan (resulting in a reduction in groundwater pumping cost) is $37 per acre-foot. Table 9 shows the Farm Budget Tool net income calculations, and Table 10 shows the associated results (unit value for irrigation water) in 2019 and 2025 dollars.

Table 9. Farm Budget Tool Net Income Calculations with Additional Expenses

Net Income Calculations with Additional Expenses	Without Plan (in 2019 U.S. Dollars)	With Plan (in 2019 U.S. Dollars)
Net Income Before Irrigation and Miscellaneous Expenses	$138,212	$138,212
Irrigation Expenses	$21,550	$574
Miscellaneous Expenses (2% of Variable)	$31,288	$30,869
Net Income After Additional Expenses	$85,374	$106,770

Table 10. Farm Budget Tool Irrigation Water Supply Unit Value Results

Farm Budget Result	Value
Change in Net Income between Without Plan and With Plan (in 2019 U.S. Dollars)	$21,396
Change in Applied Surface Water on Model Farm with Proposed Plan (960 acres multiplied by 0.6 acre-foot per acre of groundwater replaced by surface water)	576 acre-feet
Estimated unit value for Irrigation Water from Farm Budget Tool (in 2019 U.S. Dollars)	$37
Estimated unit value for Irrigation Water from Farm Budget Tool (in 2025 U.S. Dollars)	$44

This approach assumes that the amount of irrigation water supply provided by the Proposed Plan does not change cropping patterns or lead to an overall change in irrigable acres. This assumption is consistent with existing conditions of limited acreage reported as fallowed or waste acres related to limited water supply in the Treasure Valley (Urban 2004). Furthermore, the amount of irrigation water supply in the Proposed Plan is relatively small compared to the overall Treasure Valley irrigation water supply; therefore, the Proposed Plan is unlikely to cause a significant change in cropping patterns. To estimate the economic benefit of new supply for irrigation, a value of $44 per acre-foot is used as the lower bound unit value for irrigation water supply provided by the Proposed Plan.

3.2.2 Irrigator Willingness to Pay Values

Schmidt et al. (Reclamation 2009) analyzed the spatial distribution of surface and groundwater interactions in a specific portion of the Boise Project in the Lower Boise Valley. This hydrologic modeling effort specifically accounted for surface water and groundwater interactions resulting from canal seepage, groundwater pumping, and drain returns under various modeling assumptions. The model analyzed the hydrologic and economic impacts of water conservation measures and market-based water management approaches that would either eliminate or internalize the externalities (unpriced economic impacts to third parties) that result from Boise Project canal seepage.

Marginal demand prices for canal water were developed under various modeling assumptions and range from $65 to $80 per acre-foot in 2009 dollars. The range in values is a result of the various hydrologic interdependencies between surface and groundwater, and accounts for water demand from municipal and industrial pumpers. For example, the unit cost of canal water is less when losses due to seepage are reduced, but drain water and groundwater supply (and cost) is negatively impacted as a result. Table 11 provides the point estimates per acre-foot for irrigation water, taken from Schmidt et al. (Reclamation 2009).

Table 11. Price per Acre-foot Willingness to Pay for Irrigation Surface Water

2009 U.S. Dollars per Acre-feet Demand Price Low Estimate	2009 U.S. Dollars per Acre-feet Demand Price High Estimate	2009 U.S. Dollars per Acre-feet Demand Price Average of Estimates	2025 U.S. Dollars per Acre-feet Demand Price Average of Estimates
$65	$80	$72.50	$105

Source: Schmidt et al., Modeling Spatial Water Allocation and Hydrologic Externalities in the Boise Valley (Reclamation 2009)

Historical data on water market transactions regarding the prices irrigators pay for water are limited or have limited application to this study. Section 3.3.1 references several previous studies on observed market transactions. These values modeled by Schmidt et al. (Reclamation 2009) are consistent with the limited observations reported in Section 3.3.1, accounting for the differences in measurements. To estimate the economic benefit of new supply for irrigation, a value of $105 per acre-foot is used as the upper bound unit value for new irrigation water supply.

3.2.3 Irrigation Water Supply Benefit Values

Implementation of the Proposed Plan would provide an increase in water supply available for irrigation, detailed previously in Table 2. Table 12 shows the additional annual irrigation water supply benefits the Proposed Plan would provide, organized by split among potential uses for the new water supply and the range of values this analysis provided.

Table 12. Average Annual Irrigation Water Supply Benefit

Potential Use Scenario	Average Annual Water Available for Irrigation (acre-feet)	Lower Bound Average Annual Irrigation Water Supply Benefit (Farm Budget Tool) at $44 per Acre-foot (in 2025 U.S. Dollars)	Upper Bound Average Annual Irrigation Water Supply Benefit (Schmidt et al.) at $105 per Acre-foot (in 2025 U.S. Dollars)
Proposed Plan Scenario 1: Irrigation	9,918	$436,392	$1,041,390
Proposed Plan Scenario 2: DCMI	0	$0	$0
Proposed Plan Scenario 3: Mixed Use	4,959	$218,196	$520,695

Table 13 presents the resulting lower and upper bound present values of total irrigation water supply economic benefit from the Proposed Plan. This represents the total of average annual benefits, discounted using the fiscal year 2020 discount rate for Federal water-related planning projects, over the 100-year planning horizon. The upper bound Schmidt et al. value was selected as the benefit estimate to use in the benefits summary over the lower bound Farm Budget Tool because the estimate better represents the economic value, or benefit, of the irrigation water supply of the Proposed Plan. The Farm Budget Tool effectively calculates an avoided cost, a more conservative estimate of the actual economic value, while the Schmidt et al. approach directly estimates willingness to pay, which better captures the total economic benefit.

Table 13. Present Value Total Irrigation Water Supply Benefit

Present Value Economic Benefit	Without Plan (in 2025 U.S. Dollars)	Proposed Plan Scenario 1: Irrigation (in 2025 U.S. Dollars)	Proposed Plan Scenario 2: DCMI (in 2025 U.S. Dollars)	Proposed Plan Scenario 3: Mixed Use (in 2025 U.S. Dollars)
Present Value of the Lower Bound Irrigation Water Supply Benefit (Farm Budget Tool)	$0	$15,223,000	$0	$7,612,000
Present Value Upper Bound Irrigation Water Supply Benefit (Schmidt et al.)	$0	$36,329,000	$0	$18,164,000
Present Value of the Irrigation Water Supply Benefit for use in Benefits Summary (Schmidt et al.)	$0	$36,329,000	$0	$18,164,000

3.3 Fish and Wildlife

Implementation of the Proposed Plan provides water supply in Anderson Ranch Reservoir, which is managed as part of the Boise River system water operations. Current system operations consider environmental requirements from three active Endangered Species Act (ESA) consultations, including:

1. Bull trout (USFWS 2005)
2. Bull trout critical habitat (USFWS 2014)
3. Salmon augmentation flows (NOAA 2008)

In years when water is available to fill any portion of the increased storage space from the Proposed Plan, Reclamation could use water identified for environmental purposes. Additional water supply provided by the Proposed Plan could allow more consistency in meeting environmental targets both within and across seasons. Consistency in meeting existing environmental targets could help Reclamation identify additional flexibility in operations that, when leveraged with existing water deliveries, could provide added fish and wildlife benefits. Benefits to ESA-listed species with any volume of additional water could be realized, ultimately increasing the ecological wellness of the aquatic system. These environmental requirements, targets, and metrics are discussed in detail in Chapter 2 of the Feasibility Report.

3.3.1 Market Value of Water

The economic valuation approach for the fish and wildlife water supply benefits of the Proposed Plan is the avoided cost approach. While this approach does not monetize all non-market values of the fish and wildlife water supply, the approach provides a defensible value for evaluating the Proposed Plan. The avoided cost approach calculates the cost for the same quantity of water if purchased from a different source in the region. The underlying assumption is that the water would be purchased from this alternate source if not for the Proposed Plan. The economic value is the savings to the Federal government provided by the Proposed Plan.

The economic valuation was limited to this approach due to information requirements of more comprehensive non-market valuation approaches for estimating the public's non-use value for protecting and enhancing the aquatic ecosystem for fish and wildlife. At the time of this study, physical changes and related economic benefits of the potential applications of the Proposed Plan fish and wildlife water supply are not fully established. Therefore, the avoided cost approach is used in absence of more detailed information on the potential benefits.

Previous studies and observed market transactions in the Treasure Valley and the broader Snake River basin inform the market value of water. While it is not possible to predict the future market price of additional water supply, estimates from previous studies can be used to value the Proposed Plan fish and wildlife water supply.

3.3.1.1 Mutual Rescission and Restitution Agreement

In July 1996, Reclamation entered into a rescission agreement with Nampa and Meridian Irrigation District to buy back 35,000 acre-feet of active storage in Lucky Peak Reservoir. The entitlement that Reclamation purchased from the District was originally entered in 1966 and lasted 40 years until July 5, 2006. Restitution for the contract entitlement for the storage rights was set at $2,276,400 (NMID 2006). The unit value (dollar per acre-foot) of the 35,000 acre-feet for the remaining 10 years of the contract equates to $14 per acre-foot in 2025 dollars.

3.3.1.2 Snake River Flow Augmentation Impact Analysis

The Snake River Flow Augmentation Impact Analysis (Reclamation 1999) was part of USACE's Lower Snake River Juvenile Salmon Migration Study and FEIS. During that study, Reclamation conducted an analysis of Snake River flow augmentation upstream Lower Granite Dam. In the analysis, Reclamation attempted to estimate economic effects of acquiring natural flow rights and storage space to provide up to 1,427,000 acre-feet of water for flow augmentation (1 million acre-feet more than its current commitment).

The study cites acquisitions of storage supplies in the Snake River basin that range between $150 and $300 per acre-foot for a one-time cost for a permanent right. Applying the 2020 Federal discount rate of 2.75% for water project evaluation to a permanent basis calculates an annual equivalent cost of $8 to $15 per acre-foot per year and an average of $11.50 per acre-foot in 2025 dollars.

3.3.1.3 Elmore County Water Supply Alternatives

In a study prepared for the Elmore County Board of County Commissioners (SPF 2017), surface water in the Boise River watershed is discussed in the context of additional storage, as well as the possibility of acquiring existing water rights.

The authors state that permanent water right sales are anticipated to be on the order of $1,000 to $2,000 per acre-foot based on recent transactional data. Applying the 2020 Federal discount rate of 2.75% for water project evaluation to a permanent basis calculates an annual equivalent cost of $35 to $70 per acre-foot per year and an average of $52.50 per acre-foot in 2025 dollars.

3.3.1.4 Appraisal Report for Deadwood Reservoir Storage

In 2011, DOI's Office of Valuation Services procured an appraisal report for the market value of an existing title to a property and the associated water contract entitlement from Deadwood Reservoir located in Gem County, Idaho. The appraisal report informed Reclamation about the permanent acquisition of the water contract entitlement. The appraisal report details previously observed market transactions, including the rescission agreement described in Section 3.3.1.1, to inform the appraisal. The report appraisal for the permanent water acquisition was $500 per acre-foot in 2011. The appraisal relies on a finding of the report that the market value of water in the study area has a 12% annual growth rate (DOI 2011).

Projecting the 2011 market value of water in the study area of $500 per acre-foot to 2025 dollars appraises a permanent water sale at approximately $2,500 per acre-foot. The 2020 Federal discount rate of 2.75% for Federal water-related planning projects was applied to convert the permanent value to an annual equivalent, which results in an average annual value of approximately $70 per acre-foot in 2025 dollars.

3.3.1.5 Summary of the Market Value of Water Estimates

The estimates from the 1996 Rescission Agreement and the 1999 Snake River Flow Augmentation Impact Analysis are significantly less than the estimates in the 2017 Elmore County Report and the 2011 Appraisal Report. The 2017 estimates note that annualized costs for canal company water shares are typically less than what was cited in the Elmore County report because irrigation districts typically do not allow the transfer of permanent water rights outside of existing service areas (SPF 2017).

The 2011 Appraisal Report was determined to be the most applicable estimate of the market value of water due to the comprehensive nature of the appraisal and incorporation of more recent actual observed transactions than the other three estimates. Therefore, the estimated market value of water of $70 per acre-foot from the 2011 Appraisal Report (DOI 2011) was applied as the avoided cost for the benefits analysis for fish and wildlife water supply provided by the Proposed Plan.

3.3.2 Fish and Wildlife Water Supply Benefit Values

Table 14 shows the annual fish and wildlife water supply benefits for the Proposed Plan when compared to existing conditions.

Table 14. Average Annual Fish and Wildlife Water Supply Benefit

Potential Use Scenario	Average Annual Water Available for Fish and Wildlife (acre-feet)	Average Annual Fish and Wildlife Benefit at $70 per Acre-feet (in 2025 U.S. Dollars)
All Proposed Plan Scenarios	1,102	$77,140

Table 15 presents the resulting present value economic benefit of fish and wildlife water supply provided by the Proposed Plan. This represents the total of the average annual benefits using the fiscal year 2020 discount rate for Federal water-related planning projects over the 100-year planning horizon.

Table 15. Present Value Total Fish and Wildlife Water Supply Benefit

Present Value Economic Benefit	Without Plan (in 2025 U.S. Dollars)	Proposed Plan (in 2025 U.S. Dollars)
Present Value Fish and Wildlife Benefit for Use in Benefits Summary	$0	$2,691,000

3.3.3 Other Fish and Wildlife Benefits

Over the long term, beneficial impacts on aquatic species may result from implementation of the Proposed Plan when additional water is stored in Anderson Ranch Reservoir. Benefits are also anticipated as result of the proposed channel regrading and associated construction activities at the Fall Creek and Deer Creek culverts, both of which are currently perched when the reservoir is at lower pool elevations. Under the Proposed Plan, both culverts would provide passage. This additional access to forage habitat and other extended temporal access to tributaries entering Anderson Ranch Reservoir (as a result of higher pool elevations under certain conditions) is anticipated to benefit fish.

Increased area and duration of inundation with the Proposed Plan could cause mortality of large trees around the reservoir perimeter and eventually result in additional snags available for bird nesting. For example, special status species in the study area that nest in tree cavities include the flammulated owl (*Psiloscops flammeolus*), Lewis' woodpecker (*Melanerpes lewis*), and white-headed woodpecker (*Picoides albolarvatus*) (National Audubon Society 2020). However, the benefits associated with these changes have not been quantified or monetized for this analysis.

3.4 Hydropower

The Proposed Plan is expected to provide hydropower benefits from additional hydropower generation following construction of the Anderson Ranch Dam raise. The amount of additional generation would vary depending on reservoir operations. To quantify hydropower benefits, additional generation was calculated by considering a release of the full 6-foot new storage volume (29,000 acre-feet). At the power plant flow of 1,600 cubic feet per second, it would take an additional 9.1 days at the end of the summer (as described in Appendix A of the Feasibility

Report) to convey the full 29,000 acre-feet, and this additional flow would result in an approximately 3,850 megawatt-hours (MWh) generated in addition to typical power generation levels. In addition, 6 feet of additional head during full pool conditions can be expected to generate an approximate additional 2,460 MWh. However, the full volume of 29,000 acre-feet cannot be expected annually, so these calculations were factored by the estimated water availability to estimate the average expected additional hydropower revenue resulting from the Proposed Plan.

There are no changes to hydropower production expected Without Plan because no changes would occur to the existing dam height, reservoir level, operations, or equipment and facilities.

3.4.1 Hydropower Benefit Value

Using a 2018 average Mid-Columbia power rate of $37 per MWh (Reclamation, 2020a), the resulting additional power value of releasing the full 29,000 acre-feet at the end of the summer is $142,000. The additional 6 feet of head during full pool conditions results in an additional power value of $91,000. Realization of additional hydropower benefits from the Proposed Plan could be expected to result from reduced emissions from alternative carbon-based energy supplies. However, due to the relatively small expected hydropower benefit, these potential carbon emissions were not valued.

The additional revenue total ($142,000 + $91,000 = $233,000) was factored by the estimated water availability (38%, as described in Appendix A of the Feasibility Report) to arrive at an estimate for average expected additional hydropower revenue from implementation of the Proposed Plan. The additional hydropower revenue value is $88,540 in 2018 dollars. The annual hydropower benefit in 2025 dollars is $108,893, as shown in Table 16.

Table 16. Average Annual Hydropower Benefit

All Proposed Plan Scenarios	Proposed Plan (in 2025 U.S. Dollars)
Average Annual Hydropower Benefit	$108,893

The Proposed Plan annual hydropower benefit is held constant in 2025 dollars over the planning horizon because changes to future power prices are unknown. Table 17 presents the resulting present value total hydropower benefit from the Proposed Plan. This represents the total of the average annual benefits, discounted using the fiscal year 2020 discount rate for Federal water-related planning projects, over the 100-year planning horizon.

Table 17. Present Value Hydropower Benefit

Present Value Economic Benefit	Without Plan (in 2025 U.S. Dollars)	Proposed Plan (in 2025 U.S. Dollars)
Present Value Hydropower Benefit	$0	$3,799,000

3.5 Recreation

The Proposed Plan is anticipated to provide an improvement to recreation in the long term. The changes to reservoir conditions and elements of the constructed facilities would primarily improve the recreational value to motorized boating visitors. The Proposed Plan may provide a change to recreation value to other recreation groups outside of motorized boating and to recreation downstream of the reservoir, but these changes are expected to be minor and are not included in the benefits estimation. In general, estimating the economic value of the change to recreation from the Proposed Plan is limited by the lack of comprehensive historical visitation, minor changes for most recreation activities, and the lack of completed site-specific analyses. Therefore, a benefits-transfer approach to estimating the economic value of the change to recreation is used and is focused solely on the change to motorized boating recreation use value.

The improvement to motorized boating recreation use value in the Proposed Plan is primarily from an increased surface area, the duration of inundation, and improved access. An increase in reservoir surface area of up to 146 additional acres (a 3.1% increase) at full pool with the Proposed Plan would reduce boating congestion, which has been observed at Anderson Ranch Reservoir. The duration of inundation would provide an increased surface area later into the recreation season. Improved access would result from widening the two-lane roadway across the raised dam, which would offer safer passage and benefit motorists towing boats to the facilities. In addition, realignment of the USFS boat ramp at Fall Creek is expected to improve vehicle access.

Downstream of the reservoir along the South Fork Boise River, recreational activities include whitewater rafting, kayaking, and float boat fishing. These recreation groups may experience longer durations of typical summer flows with the Proposed Plan, for approximately 9 days during years when reservoir water storage levels reach full capacity. Trailhead access would not be affected by the Proposed Plan. Construction activities and related modifications to campgrounds around the reservoir are included in the Proposed Plan. Because these recreation categories outside of motorized boating are not quantified, are not well understood, or are considered minor, potential benefits were not quantified for this analysis. Therefore, the results are understood as a conservative approach to estimating the overall recreation benefit, as there may be some benefit in addition to motorized boating.

3.5.1 Recreation Benefit Values

The benefits-transfer approach applies a regional recreation use value to the Anderson Ranch Reservoir and the change from the Proposed Plan. The regional recreation use value is a per person economic value for a day of motorized boating recreation. This approach is standard when there is not an opportunity to conduct a site-specific study as part of the overall evaluation of a Proposed Plan. The Recreation Use Value Database (RUVD) from Oregon State University provides a regional per person value for a day of motorized boating in the western United States (Rosenberger 2016). This recreation use value, accompanied by the annual motorized boating visitation, provides the Without Plan annual economic value of motorized boating. This recreation benefits estimation assumes that the Proposed Plan would not result in a change in annual visitation to Anderson Ranch Reservoir. To analyze the change from the Proposed Plan, a percentage change was applied to the recreation use value, while assuming the same overall motorized boating visitation with the Proposed Plan and Without Plan.

The percent change to recreation use values is based on a point system developed and applied by USACE. Their unit day value point system provides guidance on relating recreation site characteristics and recreation experience to a recreation use value (USACE 2018). The point system assigns more points to a recreation use value when site characteristics change, such as reducing overuse (congestion) or for water-oriented activities if water-level changes occur. A 5% or 10% change in the recreation use value is associated with a minor improvement in site characteristics when using the USACE point system. This level of change is most applicable to the changes to motorized boating recreation use values with the Proposed Plan. If the Proposed Plan was considered to have more significant changes to recreation, the analysis would be expanded to understand how annual visitation numbers may change.

The RUVD estimates the average recreation use value for motorized boating in the western United States as $53.68 per person per day in 2016 dollars ($67.45 in 2025 dollars). A 5% increase in the recreation use value for motorized boating in the western United States was calculated as the lower bound recreation benefit of the Proposed Plan, and a 10% change for the upper bound. To quantify the annual recreation benefit with and without the Proposed Plan, the per person per day values were multiplied by the estimated number of motorized boating visitor days. The motorized boating visitor days were based on a 2016 study completed by Boise State University for Idaho Department of Parks and Recreation, which estimated 16,746 day trips and 5,036 overnight trips at an average of 2.89 days per overnight trip for a total of 31,300 motorized boating visitor days annually (Black et al. 2016).

Table 18 provides the recreation use value Without Plan, the lower and upper bound estimates of recreation benefit of the Proposed Plan, and the estimated annual motorized boating days in 2030.

Table 18. Average Annual Recreation Benefit

All Proposed Plan Scenarios	Without Plan Recreation Benefit (in 2025 U.S. Dollars)	Proposed Plan Lower Bound Average Annual Recreation Benefit (5% increase in recreation use value) (in 2025 U.S. Dollars)	Proposed Plan Upper Bound Average Annual Recreation Benefit (10% increase in recreation use value) (in 2025 U.S. Dollars)
Recreation Use Value (per person per day for motorized boating)	$67.45	increase of $3.37	increase of $6.75
2030 Annual Visitation	31,300	31,300	31,300
Average Annual Recreation Benefit with Proposed Plan	$0	$105,562	$211,125

As stated previously, the scope of the changes is minor for most recreation activities, and Anderson Ranch Reservoir is already a popular and often congested summertime destination for many recreators. For this reason, the annual recreation benefit estimates are held constant beyond 2030 through the remainder of the planning horizon in 2129. Growth projections were not applied to annual recreation visitation figures over the planning horizon primarily because the changes to the reservoir conditions as a result of the Proposed Plan are expected to improve the recreation value to motorized boating visitors but are not necessarily expected to directly increase visitation.

Probability of refill was not considered in the recreation benefit calculations due to the lack of dependence between certain physical changes and reservoir levels (for example, access) and the generality of the benefits-transfer approach. The overall increase in surface area of the reservoir as a result of the Proposed Plan would be less than 3% when complete refill is achieved and limited to the perimeter of the reservoir. In other words, the refill probability of the Proposed Plan is unlikely to effect a change in quality for recreation. The benefits-transfer approach has inherent uncertainty, and refining the analysis based on probability of refill would incorporate a level of detail beyond the level of accuracy necessary for this benefits valuation approach.

Table 19 presents the resulting present value total recreation economic benefit from the Proposed Plan. This represents the total of the average annual benefits, discounted using the fiscal year 2020 discount rate for Federal water-related planning projects, over the 100-year planning horizon.

Table 19. Present Value Recreation Benefit

Present Value Economic Benefit	Without Plan (in 2025 U.S. Dollars)	Proposed Plan (in 2025 U.S. Dollars)
Lower Bound Recreation Benefit	$0	$3,683,000
Upper Bound Recreation Benefit	$0	$7,365,000
Average of Lower Bound and Upper Bound Recreation Benefit for use in Benefits Summary	$0	$5,524,000

3.6 Other Potential Benefits

Consistent with the PR&G, both quantitative and qualitative information should be considered in evaluating plans and decision making. While the primary purpose of this appendix is to present the quantifiable and monetizable public benefits, other potential benefits, which are not quantified or monetized, are qualitatively discussed.

3.6.1 Flood Risk Reduction

A secondary planning objective of the Feasibility Study is flood risk reduction, and the Proposed Plan may indirectly provide some flood risk reduction. In a *Preliminary Hydrologic Evaluation Technical Memorandum*, Reclamation concluded that additional storage space may increase flexibility in operations, but that more detailed investigation is needed to more fully quantify the system benefit provided by additional storage (Reclamation 2017).

There are currently no plans to allocate space in the expanded reservoir to flood control or to modify current FRM operations. Furthermore, the proposed increase in storage volume at Anderson Ranch Reservoir would be relatively small (approximately 3% of the overall Boise River system). Therefore, the benefit associated with flood risk reduction has not been quantified or monetized for this analysis.

3.6.2 Water Quality

The Proposed Plan may indirectly provide some long-term water quality benefits. Reclamation developed the Anderson Ranch Reservoir Water Quality Model to characterize baseline water quality conditions in Anderson Ranch Reservoir and to evaluate how a 6-foot raise would affect water temperature in the South Fork Boise River below Anderson Ranch Dam (Appendix A of the Feasibility Report provides a brief discussion on this model). While there is potential that the proposed dam raise might contribute to colder water temperatures when water temperatures are typically the highest, this model and associated report have not been finalized at the time of this study. Therefore, the potential benefit associated with water quality has not been quantified or monetized for this analysis.

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Section 4 Risk and Uncertainty

With each aspect of this appendix, certain assumptions were made based on economic judgment using best available information, guidance, and valuation approaches. Careful consideration was given to the methods, evaluations, and tools used. Analyses were developed with advanced modeling and estimating tools using historical data and trends. While this is a standard method to help evaluate potential outcomes for future operations and costs, many uncertainties could affect the findings of this appendix, including the magnitude of economic benefits. Other uncertainties and risks associated with the economic benefit valuations are discussed in detail in the Feasibility Report.

4.1 Water Availability

4.1.1 Other Local Water Management Projects

As discussed previously, multiple proposals for new water rights for diversion from and storage in Anderson Ranch Reservoir were being considered at the time of this study. In addition to the IWRB water right permit application, the two new potential water right permits represented are Elmore County's South Fork Boise River Diversion Project and Cat Creek Energy.

Given the uncertainty regarding these proposals, a range of refill probabilities was analyzed in Appendix A of the Feasibility Report to evaluate the potential water availability. Additional descriptions of these additional water rights can be found in Appendix A and in Chapter 1 of the Feasibility Report. Table 20 provides a summary of the water availability analysis contained in Appendix A.

Table 20. Probability of Complete Refill for the Proposed Plan for Different Diversion Configurations

Diversion Configuration (Priority Order)	Percent Probability of Complete Refill (29,000 acre-feet)
1. Elmore County's South Fork Boise River Diversion Project 2. Cat Creek Energy 3. Anderson Ranch Reservoir	38%
1. Elmore County's South Fork Boise River Diversion Project 2. Anderson Ranch Reservoir 3. Cat Creek Energy	56%
1. Anderson Ranch Reservoir Only	62%

The diversion configuration column shows the priority order for each refill probability, with entities listed in order from most senior to most junior water right priority. This analysis considered the new potential storage space in Anderson Ranch Reservoir along with two other proposed water rights for Elmore County and Cat Creek Energy (38% probability of refill). It is possible that all the project elements associated with these water rights are not fully realized or undergo changes, which could increase the water availability to the project if the Proposed Plan is implemented. An increase in the water availability would increase the value of the economic benefits associated with the Proposed Plan.

4.1.2 Climate Change

Appendix A of the Feasibility Report provides an evaluation of Reclamation system operations for the existing conditions Without Plan and considering various future climate scenarios. Climate change hydrology was analyzed to evaluate how the system might perform under a wide range of potential future hydrologic conditions.

Each refill probability was simulated using the climate change scenarios described in Appendix A of the Feasibility Report. These 30-year scenarios include the Livneh simulated historical scenarios (1980 through 2009) (Livneh et al. 2013) and two 2060 scenarios (2050 through 2079) capturing a range of future conditions. The full Livneh simulated historical data set extends from 1950 through 2010. Similar to the historical results, evaluation of refill probability using the full historical period results in different refill probabilities compared to using the more recent 30-year period. Both climate change scenarios exhibit higher refill probabilities compared to the Livneh simulated historical data set. This can be attributed to the year-round increase in stream flow in both 2060 climate change conditions relative to the Livneh simulated historical conditions. Appendix A of the Feasibility Report provides tables of refill probabilities for new storage in Anderson Ranch Reservoir, as well as for the Elmore County and Cat Creek Energy diversions.

The Proposed Plan presents an opportunity to capture the projected increased availability of surface water resulting from climate change hydrology, while existing infrastructure Without Plan may not be able to do so. Increased availability of surface water from climate change would increase the value of the economic benefits associated with the Proposed Plan.

Climate change could also impact demand for water and associated economic value due to an increase in average temperature and corresponding evapotranspiration resulting from said temperature changes. Specific assumptions regarding climate change and impacts on demand for water are discussed in the *Treasure Valley DCMI Water-Demand Projections* (SPF 2016).

4.2 Water Demand Projections

The forecasts in the *Treasure Valley DCMI Water-Demand Projections* (SPF 2016) accounted for a future reduction in water use due to increased water conservation measures that could potentially result from public education, incentives, regulatory measures, or other approaches. Levels of conservation realized in the future may vary from those that have been projected depending on conservation goals, planning, and implementation in the Treasure Valley.

The *Treasure Valley DCMI Water-Demand Projections* also discuss the potential for "population capture" by adjacent counties (that is, people who work in Ada and Canyon counties but choose to live in adjacent counties, such as Gem or Elmore county), which could also impact results in the projections. Specific assumptions regarding population growth and future demand for DCMI water are discussed in the *Treasure Valley DCMI Water-Demand Projections* (SPF 2016).

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Section 5 Summary of Economic Benefits

This Feasibility Study appendix presents the estimated economic benefits of the Proposed Plan. Various economic valuation approaches were applied to monetize the economic benefit of each project purpose. Of the new storage space, 10% would be for Reclamation to manage for fish and wildlife purposes. The remaining 90% would be used for irrigation; DCMI: Proposed Plan Scenario 1 all for irrigation , Proposed Plan Scenario 2 all for DCMI use, and Proposed Plan Scenario 3 mixed use; or a combination of these.

Table 21 summarizes the present value benefits of each purpose as detailed in this appendix. These values were calculated from the total average annual benefits and are discounted over the 100-year planning horizon.

Table 21. Summary of Present Value Economic Benefits

Purpose	Economic Valuation Approach and Methodology	Proposed Plan Scenario 1: Irrigation (in 2025 U.S. Dollars)	Proposed Plan Scenario 2: DCMI (in 2025 U.S. Dollars)	Proposed Plan Scenario 3: Mixed Use (in 2025 U.S. Dollars)
DCMI	Willingness to pay: Shortage Cost Function ($748 per acre-feet)	$0	$258,798,000	$129,399,000
Irrigation	Willingness to pay: Schmidt et al. 2009 ($105 per acre-feet)	$36,329,000	$0	$18,164,000
Fish and Wildlife	Avoided Cost: Market Appraisal (DOI 2011) ($70 per acre-feet)	$2,691,000	$2,691,000	$2,691,000
Hydropower	Market Price: Revenue Generation ($37 per megawatt-hour)	$3,799,000	$3,799,000	$3,799,000
Recreation	Benefit-Transfer: Average of Upper and Lower Bound Estimates (increase of $5.06 per person per day)	$5,524,000	$5,524,000	$5,524,000
All	Total Present Value Benefit	$48,343,000	$270,812,000	$159,577,000

As stated previously, specific water users have not been identified at the time of this study. However, initial statements of interest point to approximately equal space interests from the irrigation and DCMI communities. This is represented by Proposed Plan Scenario 3 in Table 21 and is considered the most likely use of the water supply provided by the Proposed Plan. Therefore, the economic benefit values from Proposed Plan Scenario 3 are used in the Feasibility Report and Cost Allocation (Appendix D of the Feasibility Report).

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Appendix D
Cost Allocation Analysis

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BUREAU OF RECLAMATION

Boise River Basin Feasibility Study – Appendix D

Cost Allocation Analysis

Boise Project, Idaho
Interior Region 9: Columbia-Pacific Northwest

U.S. Department of the Interior November 2020

Mission Statements

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

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

Boise River Basin Feasibility Study – Appendix D

Cost Allocation Analysis

Boise Project, Idaho

Interior Region 9: Columbia-Pacific Northwest

prepared by

Jacobs Engineering Group Inc.

Cover Photo: Center pivot crop irrigation in the Treasure Valley, Idaho (Public Domain/Bureau of Reclamation).

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Acronyms and Abbreviations

Acronym or Abbreviation	Meaning
707 DM 1 Handbook	Agency Specific Procedures For Implementing the Council on Environmental Quality’s Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies
AJE	alternative justifiable expenditure
ASP	Agency Specific Procedures
CEQ	Council on Environmental Quality
CMP	Comprehensive
DCMI	domestic, commercial, municipal, and industrial
DM	Departmental Manual
DNA	deoxyribonucleic acid
DOI	U.S. Department of the Interior
Feasibility Study	Boise River Basin Feasibility Study
FRM	flood risk management
FWPRA	Federal Water Project Recreation Act of 1965
HD	Highway District
Idaho Power	Idaho Power Company
IDC	interest during construction
IG	Interagency Guidelines
Jacobs	Jacobs Engineering Group Inc.
kW	kilowatt
LCOE	levelized cost of energy
Master Agreement	Master Interagency Agreement Number 86-SIE-004
MWh	megawatt-hour
NCC	non-contract cost
OM&R	operations, maintenance, and replacement
P&R	Principles and Requirements for Federal Investments in Water Resources
PEC	Program Economics, Revenues and Contracts
PL	Public Law

Acronym or Abbreviation	Meaning
PR&G	Principles, Requirements and Guidelines for Water and Land Related Resources Implementation Studies
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
RMJOC-II	River Management Joint Operating Committee
SCRB	separable costs–remaining benefits
SPF	SPF Water Engineering, LLC
U.S.	United States
USACE	U.S. Army Corps of Engineers
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
WIIN	Water Infrastructure Improvements for the Nation

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Section 1 Introduction

1.1 Purpose and Scope of Cost Allocation Appendix

This appendix presents the cost allocation analysis associated with the U.S. Department of the Interior (DOI), Bureau of Reclamation (Reclamation) and cooperating agencies' evaluation of the proposed raising of Anderson Ranch Dam and enlargement of Anderson Ranch Reservoir. This analysis follows the *Principles, Requirements and Guidelines for Water and Land Related Resources Implementation Studies* (PR&G) (CEQ 2015), which govern how Federal agencies evaluate proposed water resource development projects and provide the basis for determining Federal investments in water resources.

This document supports the Boise River Basin Feasibility Study (Feasibility Study) as an appendix to the Feasibility Report. The Feasibility Report, created for the Feasibility Study, along with the Final Environmental Impact Statement (Reclamation 2020a), will be used to determine the type and extent of Federal interest in raising Anderson Ranch Dam and enlarging Anderson Ranch Reservoir. Sundance-EA Partners II, LLC is performing this work for Reclamation, Columbia-Pacific Northwest Region, and its subconsultant, Jacobs Engineering Group Inc. (Jacobs) is leading this particular task.

This analysis follows Federal economic principles and methods to allocate costs. In 2015, the Council on Environmental Quality (CEQ) released PR&G, the culmination of an interagency effort to update the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (U.S. Water Resources Council 1983). The PR&G include the following components.

- The Principles and Requirements for Federal Investments in Water Resources (P&R) outline the overarching concepts the Federal government seeks to achieve through policy implementations and requirements for inputs into the analysis of Federal investment alternatives (CEQ 2013).
- The Interagency Guidelines (IG) provide guidance to determine whether the P&R apply to affected Federal agencies, including DOI, U.S. Department of Agriculture (USDA), U.S. Department of Commerce, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers (USACE), Federal Emergency Management Agency, and Tennessee Valley Authority (CEQ 2014).
- Agency Specific Procedures (ASP) are used to identify which programs and activities are subject to the PR&G. DOI's *Agency Specific Procedures For Implementing the Council on Environmental Quality's Principles, Requirements, and Guidelines for Water and Land Related Resources Implementation Studies* (701 DM 1 Handbook) is its ASP (DOI 2015).

The P&R, IG, and ASP are not regulations but are statements of policy, intended to articulate the expectations for the internal management of the Federal government. The P&R and IG do not impose legally binding requirements on Federal agencies. The financial feasibility of a proposed

Federal project is determined using a detailed cost allocation analysis, as described in the IG and ASP, and is also consistent with *Water and Related Resources Feasibility Studies, Reclamation Manual, Directives and Standards, CMP 09-02* (Reclamation 2019a), and *Project Cost Allocations, PEC 01-02* (Reclamation 2019b). This appendix provides the cost allocation for the Proposed Plan following these Federal guidelines.

1.2 Study Area

Anderson Ranch Dam is one of three primary dams on the Boise River system; the other two include Arrowrock Dam and Lucky Peak Dam. Anderson Ranch Dam is a 456-foot-high multipurpose structure that was authorized in 1940, primarily for irrigation water supply, power, and flood control, with dead storage space providing silt control, fish conservation, and recreation. The total storage at Anderson Ranch Reservoir is 474,942 acre-feet. Of this, 413,074 acre-feet provide active storage; 36,956 acre-feet are inactive space (powerhead space); and 24,912 acre-feet are considered dead pool (Reclamation 1997).

Reclamation owns and operates a two-unit power plant of 40,000 kilowatts (kW) in Anderson Ranch Dam. Reclamation operates Anderson Ranch Dam in coordination with Arrowrock Dam to fulfill irrigation and flood control requirements, as well as to provide fish and wildlife protections downstream. Anderson Ranch Dam is a part of the Arrowrock Division of Reclamation's Boise Project and supplies water to the Treasure Valley (historically known as the Boise Valley) (Reclamation 1997).

The Corp's Lucky Peak Dam is operated primarily for flood control purposes; in addition, upstream releases for irrigation from Reclamation's Arrowrock and Anderson Ranch reservoirs pass through it.

Reclamation and USACE operate Lucky Peak, Arrowrock, and Anderson Ranch reservoirs on the Boise River system jointly to fulfill irrigation, hydropower, and flood control requirements. The three reservoirs operate under a formal flood risk management (FRM) requirement (Reclamation 1997).

When the Anderson Ranch Reservoir pool is at the top of its active reservoir elevation (4196 feet), it inundates 4,772 acres. Lands surrounding the Anderson Ranch Reservoir area are largely Federal lands. These Federal lands are managed by Reclamation and the USDA, U.S. Forest Service (USFS) under Master Interagency Agreement Number 86-SIE-004 (Master Agreement) (Reclamation and USFS 1997). The Master Agreement, dated April 6, 1987, covers Reclamation-authorized projects within or adjacent to National Forest System lands. Through the Master Agreement, USFS has management and administration jurisdiction of Federal lands; except for the Reclamation Zone, which is the area Reclamation designates as necessary for the operations of the Boise Project (Reclamation and U.S. Forest Service 1987).

1.3 Final Plan Considered in the Feasibility Report

1.3.1 Without Plan Condition

The Without Plan condition represents the existing infrastructure and facilities in the study area, as well as the existing water supply conditions in the Treasure Valley area. The Treasure Valley population has increased 22% from 2010 to 2019 (USCB 2019) and population projections indicate significant continued and future growth.

Coinciding with population growth, extensive land use changes are occurring throughout the valley. Row-crop agriculture and pastoral lands are transitioning to residential and urban environments. These changes have increased the demand for domestic, commercial, municipal, and industrial (DCMI) water. A study prepared for the Idaho Water Resource Board and the Idaho Department of Water Resources concluded current annual water supplies available in the Treasure Valley are less than the projected annual water demand for DCMI uses (SPF 2016). The future water demand projections are evaluated in both the Without Plan and Proposed Plan conditions as a basis for understanding the public benefits of the Proposed Plan.

In addition to a rapidly increasing demand on water resources for consumptive use, climate change is likely to stress existing water resources. The management of the Boise River system depends greatly on water stored in the form of snowpack in the watershed. The River Management Joint Operating Committee (RMJOC-II) Climate Change Study (RMJOC-II 2018) notes overall trends of increased fall and winter streamflow, earlier and higher spring peak runoff, and earlier streamflow recession. The study also suggests the potential for increased rain-on-snow events during the winter and spring, and annual runoff peaks shifting to several weeks earlier than historical conditions. The existing infrastructure and fixed storage capacity of the current Boise River system may not be adequate to manage these projected changes to current surface water supply and demand (that is, the current storage capacity may be insufficient to capture water in wet years to offset dry years).

1.3.2 Proposed Plan

The Proposed Plan consists of raising Anderson Ranch Dam by 6 feet and enlarging Anderson Ranch Reservoir. The project would:

- Increase the water storage capacity in Anderson Ranch Reservoir by approximately 29,000 acre-feet.
- Increase the top of the active reservoir elevation from 4196 feet by 6 feet to elevation 4202 feet above mean sea level.
- Establish a detour route and associated maintenance for Highway District (HD) Road 131.
- Incorporate projects around the perimeter, or rim, of the Anderson Ranch Reservoir that need modification, rehabilitation, or replacement as a result of increase in the water surface elevation.

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Section 2 Cost Allocation Process and Methods

2.1 Process Overview and Terms

Federal water resource project costs are identified and allocated so they are distributed equitably among the authorized project purposes, or the purposes proposed for authorization, in accordance with existing law. A fundamental premise of cost allocation is that the development of a combined project to serve multiple purposes realizes cost savings that should be shared equitably. As a result, the assignment of costs to each purpose in a multipurpose project is less than the cost of an alternative that achieves only a single purpose.

The analysis contained in this appendix provides an initial allocation of costs to implement the Proposed Plan. The following three basic steps are associated with cost allocation and assignment:

1. Identify costs to be allocated.
2. Allocate costs to project purposes.
3. Assign costs to purposes.

The cost allocation process provides an important intermediate step toward evaluating the financial feasibility of the Proposed Plan (Figure 1).

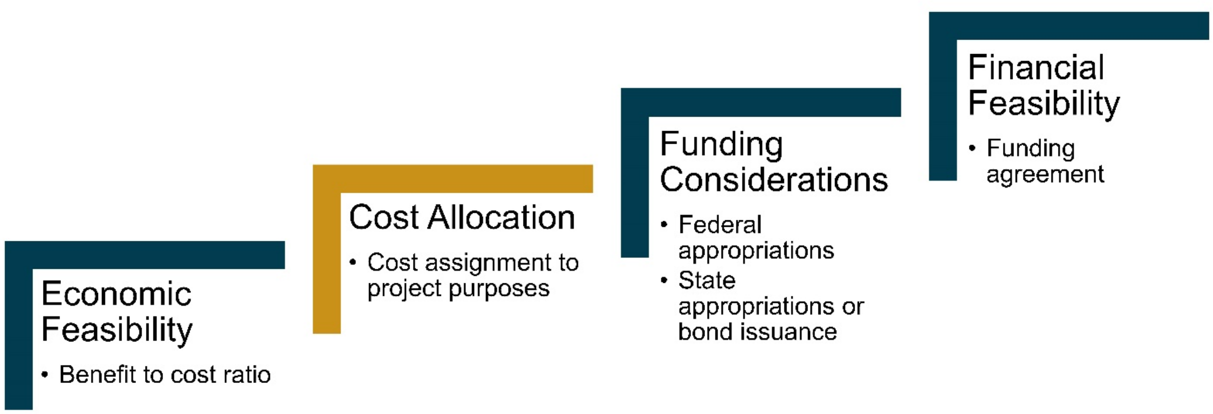

Figure 1. Financial Feasibility Evaluation

The total allocated project costs include construction costs; interest during construction (IDC); and annual operations, maintenance, and replacement (OM&R) costs. These costs are described in more detail in Section 4 of this appendix, as well as in Appendix B, and are summarized here:

- Construction costs include field costs and non-contract costs (costs of work or services in support of the project, such as design costs) to implement the necessary elements of the Proposed Plan to achieve the associated public benefits.

- IDC is a measurement of the opportunity cost of project expenditures before completion, when public benefits of the Proposed Plan have not yet been realized. This captures the economic tradeoff between investing in the Proposed Plan versus a different Federal investment.
- OM&R costs are those required to assure continued benefits over the life of the project.

Note, cost allocation is a financial and economic exercise; consequently, the presented project costs include IDC. The following definitions apply to commonly used cost allocation methods.

- Specific costs are associated with only one project purpose.
- Joint costs are associated with all project purposes and are equal to the total cost remaining after specific costs have been removed.

2.2 Methodology

There are three primary cost allocation methods for Federal water projects: (1) the separable costs–remaining benefits (SCRB) method; (2) the alternative justifiable expenditures (AJE) method; and (3) the use-of-facilities method.

2.2.1 Separable Costs – Remaining Benefits Method

The SCRB method (James 1971) is the preferred and most equitable cost allocation method. However, it is also the most complex method, because it requires intensive data and a great deal of time to complete. Although the SCRB method is preferred, budget and time constraints may require use of a different cost allocation method. The SCRB method distributes costs among the project purposes by identifying separable costs, which is the unique and time-intensive component of the method, because it requires an extensive cost estimation analysis. Separable costs are calculated for each purpose and represent the cost of the project, if solely providing each respective purpose. It is a measurement in the difference in cost between the multipurpose project and the project if serving as a single-purpose project, for each purpose. The SCRB method then allocates joint costs in proportion to each purpose's remaining justifiable expenditure.

2.2.2 Alternative Justifiable Expenditure

The AJE method (Ernst 1979) also distributes costs equitably. The AJE method is a simplified version of the SCRB method; it is less data- and time-intensive. Instead of using the separable cost for each purpose, the method considers specific costs and alternative justifiable expenditure, which is the cost of an alternative project or other method that meet the same objective. The AJE method is the preferred allocation method to apply when the data necessary to determine separable costs are not available or time or resources are otherwise constrained, or both. After specific costs are identified, the joint costs are allocated the same as the SCRB method. For multipurpose facilities, the AJE and SCRB methods are preferred over the use-of-facilities method.

2.2.3 Use-of-Facilities Method

The use-of-facilities method (Reclamation 1953) allocates cost based on the share of facilities used. This method is suitable when all project purposes use a share of the water supply or reservoir space. This method is not appropriate when project purposes do not have a dedicated supply or reservoir space (such as recreation). Therefore, the use-of-facilities method is generally not applied to allocate the costs of multipurpose projects, such as the Proposed Plan.

2.2.4 Selected Method

The cost allocation method must be consistent with the purposes of the proposed project. The multiple purposes of the Proposed Plan require either the SCRB method or AJE method, because the use-of-facilities method does not apply. For this analysis, The AJE method was selected due to time and resource constraints and the availability of specific costs. While the SCRB method is preferred, the use of separable costs requires an extensive cost estimation analysis.

The Proposed Plan includes the following existing authorized purposes of Anderson Ranch Dam: water supply, fish and wildlife enhancement, hydropower, and recreation. The Federal Water Project Recreation Act of 1965 (FWPRA), Public Law (PL) 89-72 authorizes fish and wildlife enhancement and recreation purposes and gives Reclamation authority to enter into cost allocations for these purposes, as well as to enter into management agreements with Federal partners to manage recreation and fish and wildlife enhancement facilities. Under PL 89-72, after a project is constructed, the lands adjacent to the U.S. Forest can be jurisdictionally transferred to USFS. Per Master Interagency Agreement Number 86-SEI-004 and supplemental site-specific agreement, if a project purpose must inundate these lands, Reclamation will replace facilities that are impacted as part of the new project at a ratio of one to one.

PL 89-72 contains specific cost-sharing requirements for fish and wildlife purposes by non-Federal sponsors unless the project purpose relates to an authorized Federal program for the conservation and development of fish and wildlife. The Feasibility Study planning objective to enhance fish and wildlife environment aligns with *Conservation Recommendation No. 8 of the 2005 Snake River Basin Biological Opinion* (U.S. Fish and Wildlife Service 2005) to:

> *"…cooperate with others, including the Service, Tribes, State of Idaho and Oregon, Forest Service, and others to take actions to improve or maintain high quality migratory corridors between Reclamation facilities and higher elevation habitats and spawning areas."*

Conclusions from the *Boise Feasibility Study Preliminary Hydrologic Evaluation Technical Memorandum* (Reclamation 2017) indicate that additional storage space may provide additional flexibility in operations. However, there are currently no plans to allocate space for flood control within the expanded reservoir or to modify current FRM operations, so flood control benefits have not been quantified and are not included in the cost allocation. Figure 2 is a conceptual demonstration of the AJE cost allocation method.

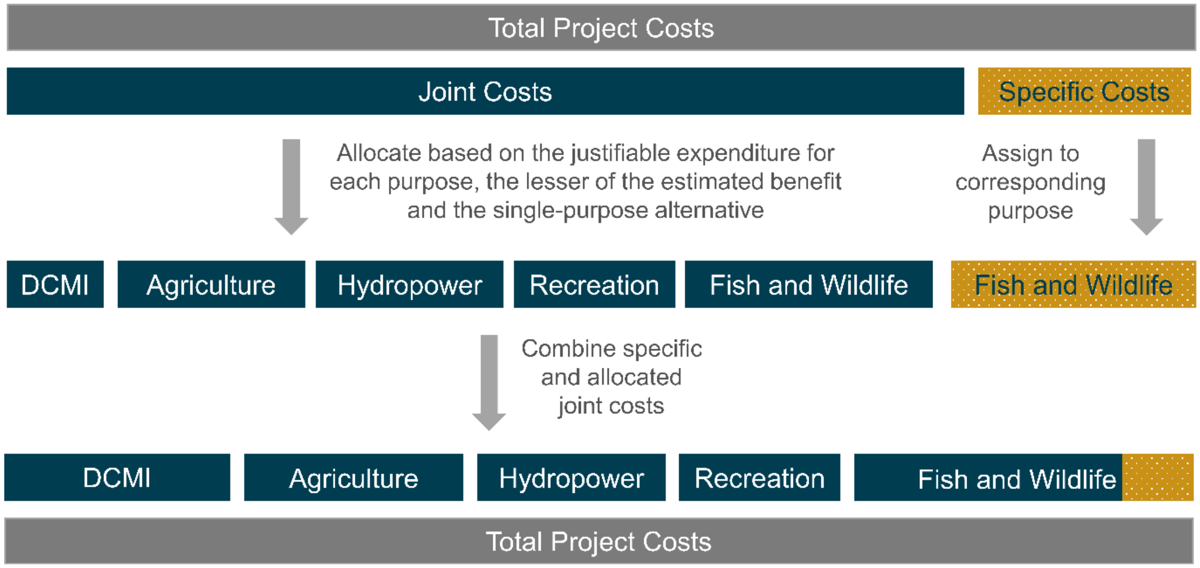

Figure 2. Alternative Justifiable Expenditures Cost Allocation Process

Section 3 Proposed Plan Economic Benefits

Per the PR&G, the objective of Federal investment is to maximize public benefit, including environmental, economic, and social goals. This section presents the economic benefits as they contribute to the overall economic goal of the public benefits associated with the Proposed Plan. Appendix C provides a detailed analysis of economic benefits. The main Feasibility Report provides a complete evaluation of public benefits (including environmental and social benefits) resulting from the Proposed Plan.

3.1 Domestic, Commercial, Municipal, and Industrial Water Supply

The Proposed Plan would provide water for potential DCMI users in the Treasure Valley study area. Future DCMI water demand in the study area is expected to exceed the available supply. As mentioned, the population of the Treasure Valley area has been estimated to increase to approximately 1.6 million people by 2065 (SPF 2016). The ability to meet future DCMI demand is uncertain, and the DCMI water supply will likely experience shortages. The economic analysis (Appendix C) applied a standard approach of estimating users' willingness to pay to avoid shortages in the DCMI water supply. This approach simulates a simulated market price economic valuation.

3.2 Irrigation

The Proposed Plan would provide water for potential irrigation use in the Treasure Valley study area. Agriculture in the Treasure Valley is diverse and important to the State economy. Each county in the Treasure Valley has high agricultural market value, and the region is a major contributor to Idaho's agricultural activity (USDA 2019). The value of irrigation water supply in the study area was estimated using two approaches: (1) by estimating a change in net income, and (2) by simulating market prices (Appendix C). The net-income approach applied the Reclamation Farm Budget Tool (Reclamation 2019c). The simulated-market-prices approach applied an irrigator's willingness to pay value for surface water, estimated by Schmidt, Stodick, and Taylor in *Modeling Spatial Water Allocation and Hydrologic Externalities in the Boise Valley* (Reclamation 2009).

3.3 Fish and Wildlife

The Proposed Plan would provide water that could allow more consistency in meeting environmental targets both within and across seasons. Consistency in meeting existing environmental targets could help Reclamation identify additional flexibility in operations that, when leveraged with existing water deliveries, could provide added fish and wildlife benefits. These are discussed in Chapter 2 of the Feasibility Report. An avoided-cost approach was used to quantify the benefit of the water supply for fish and wildlife use (Appendix C).

3.4 Hydropower

The Proposed Plan would likely increase the amount of hydropower generated at the Anderson Ranch Dam hydropower facilities. The Proposed Plan provides increased storage capacity behind the Anderson Ranch Dam, which increases the likelihood of additional head being available for power generation. It also increases the likelihood of increased generation from additional water passing through the turbines. The net increase in hydropower revenues generated by the Proposed Plan is metric of the economic benefit (Appendix C).

3.5 Recreation

The Proposed Plan would provide a recreation benefit to motorized boating visitors from an increased reservoir surface area, an extended season of increased surface area, and improved reservoir access. The recreation benefits to motorized boating visitors were evaluated through an estimated change in dollar value per visitor day multiplied by the visitor use using a benefit-transfer approach (Appendix C). This benefit-transfer approach is based on the limited historical visitor use data on other types of recreation in the study area, as well as overall minor changes to the other recreation types.

3.6 Summary of Project Benefits

Table 1 provides the valuation approach by purpose and the present value economic benefits of the Proposed Plan in 2025 dollars, as provided in Appendix C.

Table 1. Present Value Economic Benefits by Project Purpose

Purpose	Economic Valuation Approach and Methodology	Present Value Economic Benefits (in 2025 U.S. Dollars)
DCMI	Willingness to pay: Shortage Cost Function ($748 per acre-feet)	$129,399,000
Irrigation	Willingness to pay: Schmidt et al. 2009 ($105 per acre-feet)	$18,164,000
Fish and Wildlife	Avoided Cost: Market Appraisal (DOI 2011) ($70 per acre-feet)	$2,691,000
Hydropower	Market Price: Revenue Generation ($37 per megawatt-hour)	$3,799,000
Recreation	Benefit-Transfer: Average of Upper and Lower Bound Estimates (increase of $5.06 per person per day)	$5,524,000
	Total Present Value Economic Benefits	$159,577,000

Section 4 Proposed Plan Costs

Feasibility-level cost estimates for the Proposed Plan are summarized in Appendix B. Ongoing annual OM&R costs were also estimated based on existing OM&R costs (Reclamation 2020b).

4.1 Construction Costs

Table 2 shows the total feasibility-level design construction cost estimates associated with the Proposed Plan. The costs include those associated with raising the dam by 6 feet and the corresponding projects around the perimeter, or rim, of Anderson Ranch Reservoir that need modification, rehabilitation, or replacement as a result of an increase in the water surface elevation. The total design and construction cost, including non-contract costs (NCC), is estimated to be $83.3 million (in 2025 dollars), as detailed in Appendix B.

Table 2. Construction Cost Estimates for Proposed Plan

Component	Costs (in 2025 U.S. Dollars)
Field Costs – Dam Raise	$44,000,000
Field Costs – Rim Projects	$12,000,000
NCC – Dam Raise	$22,500,000
NCC – Rim Projects	$4,800,000
Total	$83,300,000

4.2 Interest during Construction

The Federal procedure for cost allocation includes calculating IDC. IDC represents the opportunity cost of capital incurred during the construction period and is included to confirm costs and benefits are evaluated on an equivalent time basis. IDC is calculated based on the total cost of construction, including field costs, NCCs, and post-authorization costs. Interest was calculated using the 2.75% fiscal year 2020 discount rate for Federal water-related planning projects (U.S. Treasury Department 2019). The inclusion of post-authorization costs in the IDC results in a 10-year period for the IDC calculation. The use of a 10-year period for IDC calculation does not change the 5-year construction period for the Proposed Plan, nor does it impact the IDC calculated during the 5-year construction period. Table 3 shows the project's total construction costs, IDC, and resulting present value total cost.

Table 3. Interest during Construction and Total Present Value

Total Construction Costs (in 2025 U.S. Dollars)	Interest during Construction (in 2025 U.S. Dollars)	Present Value Total Costs (in 2025 U.S. Dollars)
$83,300,000	$8,370,000	$91,670,000

4.3 Operations, Maintenance, and Replacement Costs

Reclamation does not anticipate additional OM&R costs with the Proposed Plan but recognizes that it would be difficult to quantify additional OM&R costs that would not already be incurred under existing conditions. Accordingly, this analysis assumed that no additional OM&R costs would be incurred under the Proposed Plan. However, if Reclamation later determined there are measurable incremental OM&R costs associated with the Proposed Plan, those costs would be assigned to the new storage space (as described herein) and further allocated among the Proposed Plan purposes, according to this appendix.

While no additional OM&R costs are expected to be associated with the Proposed Plan, there are ongoing annual OM&R costs associated with the existing operations of the facilities, which would need to be borne by participants of the Proposed Plan. OM&R costs include operator wages, energy costs, spare parts, supplies, and routine repair work, among other items. Average annual OM&R costs at Anderson Ranch Dam, for Fiscal Years 2014 through 2018, were $585,600 in 2025 dollars.

The Proposed Plan would be allocated 3.33% of the average annual OM&R cost at Anderson Ranch, based on the existing cost allocation method. The existing cost allocation method is the use-of-facilities method. Using this method, an average annual OM&R total of $19,520 (in 2025 dollars) would be allocated to the new storage space, as Table 4 shows. Section 6.3 specifies how this average annual OM&R total is allocated to each purpose of the Proposed Plan. Changes to the Federal assignment of existing or Proposed Plan OM&R costs will not form part of a Section 4007 Water Infrastructure Improvements for the Nation (WIIN) Act funding agreement.

Table 4. Average Annual Existing Operations, Maintenance, and Replacement Costs and Share for the Proposed Plan

Anderson Ranch OM&R Costs	Value (in 2025 U.S. Dollars)	Percentage
Average Annual Total Anderson Ranch OM&R Costs	$585,600	100%
Proposed Plan Assignment of Existing OM&R Costs	$19,520	3.33%

Section 5 Initial Cost Allocation

5.1 Single-purpose Alternative Costs

The AJE method uses the cost of a single-purpose alternative for each purpose of the Proposed Plan. The single-purpose alternative is the most economical alternative that would provide the same level of benefit for that purpose. It can be a project or service that would be reasonable for the Federal government to construct or purchase. The single-purpose alternative cost is used to determine the justifiable expenditure for each purpose. The justifiable expenditure for each purpose is the lesser of the identified single-purpose alternative and the benefit of the purpose.

A single-purpose alternative was evaluated for DCMI, irrigation, fish and wildlife, and hydropower. For existing water supply uses, such as DCMI and irrigation, developing a single-purpose alternative is more straightforward. Similarly, hydropower is associated with a more robust single-purpose alternative cost estimation. For fish and wildlife, the estimated benefit is included as the single-purpose alternative because the avoided-cost valuation approach detailed in Appendix C is equivocally a measurement of a single-purpose alternative. For recreation, no single-purpose alternative was evaluated. The scope and uniqueness of the physical changes and estimated benefits limit the ability to develop a reasonable recreation alternative and associated cost. Furthermore, a recreation single-purpose alternative is likely to exceed the estimated benefits and may only be feasible as part of a multipurpose project like the Proposed Plan.

For existing DCMI and irrigation water supply uses, a single-purpose alternative cost estimate was developed from a comparable dam raise alternative located in the same watershed as the Proposed Plan. Following the termination of the Boise General Investigation, an order-of-magnitude cost estimate for a 10-foot Arrowrock Dam raise was established when USACE and Reclamation were, at the request of the Idaho Water Resources Board, exploring the possibility of smaller dam raises using existing authorities. This project did not proceed past preliminary stages but was chosen for this analysis as a single-purpose alternative due to proximity and because it is a surface water supply project similar to the Proposed Plan. The order-of magnitude cost estimate of $225 million in 2016 dollars was established as a comparison point. This estimate was escalated for consistency with Appendices B and C, for a cost of $284 million in 2025 dollars. The inclusion of an estimated $12 million in IDC provides the present value cost for this single-purpose alternative at $296 million. The average annual yield for the 10-foot Arrowrock Dam Raise was estimated to be 18,200 acre-feet; therefore, the single-purpose alternative cost was adjusted in proportion to match the Proposed Plan average annual yield of 9,918 acre-feet (approximately 4,959 acre-feet for DCMI and 4,959 acre-feet for irrigation). The resulting single-purpose alternative present value cost for DCMI and irrigation water supply is $80,652,000 each ($296 million multiplied by 4,959 acre-feet divided by 18,200 acre-feet, rounded to the nearest thousand dollars).

In an effort to develop a hydropower single-purpose alternative, several cost estimates were evaluated for renewable energy projects (such as solar, wind, geothermal) near the Proposed Plan that generate a similar level of electricity as the hydropower purpose. The single-purpose alternative cost estimates were based on the levelized cost of energy (LCOE) price of renewable energy generation. The LCOE price represents the average net present value of the cost to generate electricity over the lifetime of an electricity-generating plant. LCOE estimates ranged from $26 per megawatt-hour (MWh) for solar and wind (Idaho Power 2019) to $91 per MWh for geothermal (U.S. Geothermal 2017) in 2025 dollars. The LCOE estimates result in a wide range of single-purpose alternative estimates: from $5.2 million for solar- and wind-generated power to $17.6 million for geothermal power. The present value economic benefit for hydropower in the Proposed Plan is less than the two single-purpose alternative estimates. Therefore, selecting either of these single-purpose alternatives does not change the justifiable expenditure for the hydropower purpose. Nevertheless, the present value cost for solar and wind power ($5.2 million) was included as the single-purpose alternative for hydropower to calculate the justifiable expenditure in the cost allocation.

Table 5 summarizes the single-purpose alternatives and associated present value costs.

Table 5. Single-purpose Alternative and Present Value Cost

Purpose	Single-purpose Alternative	Total Cost (in 2025 U.S. Dollars)
DCMI	10-foot Arrowrock Dam Raise	$80,652,000
Irrigation	10-foot Arrowrock Dam Raise	$80,652,000
Fish and Wildlife	Avoided Cost	$2,691,000
Hydropower	Evaluated Renewable Projects	$5,200,000
Recreation	Not evaluated	Not applicable

5.2 Specific Costs

As part of initial land and infrastructure assessments related to the Feasibility Study, culverts around Anderson Ranch Reservoir were evaluated (Appendix B). Information from field surveys and results of feasibility-level basin hydrology evaluations and culvert hydraulics analyses indicate the existing culverts do not require modification or replacement as result of the proposed increased water surface elevation. However, in alignment with the Feasibility Study planning objective to enhance fish and wildlife environment, and with *Conservation Recommendation No. 8 of the 2005 Snake River Basin Biological Opinion* (U.S. Fish and Wildlife Service 2005) to *"…cooperate with others, including the Service, Tribes, State of Idaho and Oregon, Forest Service, and others to take actions to improve or maintain high quality migratory corridors between Reclamation facilities and higher elevation habitats and spawning areas,"* an opportunity was identified to improve aquatic organism passage to Deer and Fall creeks by modifying the existing culverts.

The existing Deer Creek culvert under Pine-Featherville Road (HD 61) is seasonally perched on the downstream end, making it a potential barrier for the upstream passage of aquatic organisms when the water surface elevation is less than 4194.8. The Deer Creek subwatershed is a high-priority migration corridor for bull trout (*Salvelinus confluentus*) between Anderson Ranch Reservoir and headwater streams. The existing Fall Creek culvert under HD 113 is seasonally perched on the downstream end, making it a potential barrier for the upstream passage of aquatic organisms when the water surface elevation is less than 4190.5. Rocky Mountain Research Station environmental DNA (eDNA) data show positive bull trout detections in Meadow Creek and upper Fall Creek (Young et al. 2019). In addition, a 2003 photograph that was provided to Reclamation via U.S. Fish and Wildlife Service, Idaho Fish and Wildlife Office, shows kokanee salmon *(Oncorhynchus nerka)* schooled below the perched culvert at low water.

Therefore, although the Deer Creek and Fall Creek culverts meet the culvert design criteria for hydraulic conveyance, culvert modifications are being pursued (as part of the Project Plan) to improve the migratory corridor and reduce habitat fragmentation for bull trout and other aquatic species. Table 6 shows the key elements of the Proposed Plan and identifies the costs of these elements as either joint or specific.

Table 6. Allocation of Proposed Plan Costs

Proposed Plan Elements	Joint Cost	Specific Cost	Purpose	Cost (in 2025 U.S. Dollars)
Field Costs – Dam Raise	Yes	Not applicable	All	$44,000,000
Field Costs – Rim Projects	Not applicable	Not applicable	Not applicable	Not applicable
Roadways	Yes	Not applicable	All	$3,500,000
Pine Airstrip	Yes	Not applicable	All	$1,750,000
Bridges	Yes	Not applicable	All	$1,800,000
Culverts[a]	Not applicable	Yes	Fish and Wildlife	$560,000
Recreation Facilities	Yes	Not applicable	All	$3,900,000
Power Utility Infrastructure	Yes	Not applicable	All	$490,000
NCC[a]	Yes	Yes	All	$27,300,000
Total				**$83,300,000**

[a] NCC associated with culverts are included in the specific cost total for culverts in Table 7. For cost allocation, the fish- and wildlife-specific costs include the contract cost of culverts ($560,000), NCC for culverts ($224,000), and IDC ($85,000) for a total present value-specific cost of $869,000 ($560,000 + $224,000 + $85,000 = $869,000). Because specific fish and wildlife costs are aligned with a Conservation Recommendation from an active Endangered Species Act consultation, they are exempt from PL 89-72 non-Federal cost-sharing requirements.

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Section 6 Initial Cost Allocation Results

Figure 3 shows the initial cost allocation, which is detailed in this section. While joint costs are allocated to each of the Proposed Plan's purposes, the specific costs identified in Section 5.2 are assigned to a specific purpose (fish and wildlife). Once all Proposed Plan costs are allocated to each purpose, costs are assigned as Federal or non-Federal.

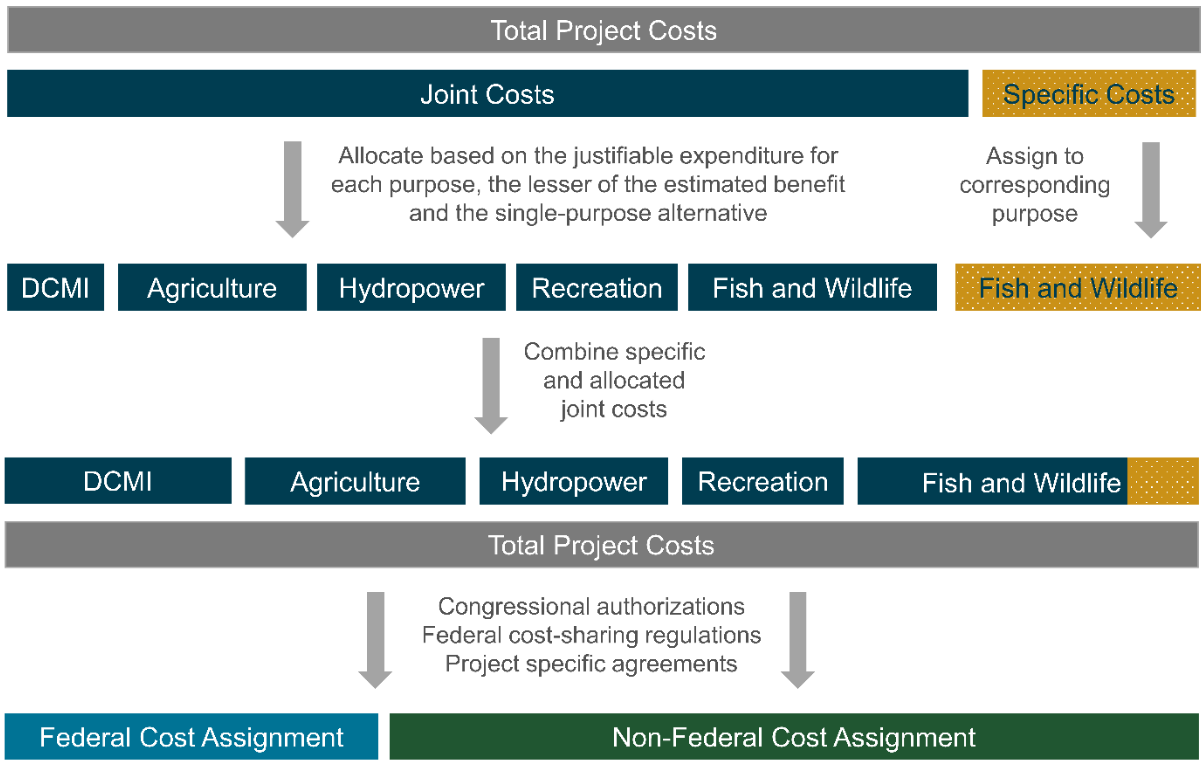

Figure 3. Cost Allocation and Cost Assignment Process

6.1 Calculation of Initial Cost Allocation

The AJE method removes the specific costs and allocates the remaining joint costs based on the justifiable expenditures. The full AJE calculation and resulting cost allocation involves the following nine steps as shown in Table 7:

1. Present Value Costs: Total costs to be allocated, including both construction and IDC, as described in Section 4.
2. Present Value Benefits: Total economic benefits over the 100-year planning horizon discounted back to start of project, as described in Section 3.
3. Single-purpose Alternative: Present value cost of single-purpose alternative, as described in Section 5.1.

4. Justifiable Expenditure: The lesser of the present value benefits and the single-purpose alternative.
5. Specific Costs: Components of the Proposed Plan included for specific purposes and excluded from the joint cost; specific costs are allocated to specific purposes, as described in Section 5.2.
6. Remaining Justifiable Expenditure: Justifiable expenditure, minus the specific costs.
7. Percent Distribution for Remaining Joint Costs: The percent remaining justifiable expenditure for each purpose of the total remaining justifiable expenditures; the percent distribution informs the distribution of the remaining joint cost.
8. Remaining Joint Cost: The present value costs, net specific costs divided among each purpose using the percent distribution.
9. Total Allocation: The total allocation for each purpose that is the sum of specific costs and remaining joint cost. Item 9a shows the allocation of the construction costs, and item 9b shows the allocation of IDC.

Table 7. Initial Cost Allocation

Item	Purpose DCMI (in 2025 U.S. Dollars)	Purpose Irrigation (in 2025 U.S. Dollars)	Purpose Fish and Wildlife (in 2025 U.S. Dollars)	Purpose Hydropower (in 2025 U.S. Dollars)	Purpose Recreation (in 2025 U.S. Dollars)	Total (in 2025 U.S. Dollars)
1. Present Value Costs	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	$91,670,000
2. Present Value Benefits	$129,399,000	$18,164,000	$2,691,000	$3,799,000	$5,524,000	$159,577,000
3. Single-purpose Alternative	$80,652,000	$80,652,000	$2,691,000	$5,200,000	Not applicable	Not applicable
4. Justifiable Expenditure	$80,652,000	$18,164,000	$2,691,000	$3,799,000	$5,524,000	$110,830,000
5. Specific Costs	$0	$0	$869,000	$0	$0	$869,000
6. Remaining Justifiable Expenditure	$80,652,000	$18,164,000	$1,822,000	$3,799,000	$5,524,000	$109,961,000
7. Percent Distribution for Remaining Joint Costs	73.3%	16.5%	1.7%	3.5%	5.0%	100%
8. Remaining Joint Cost	$66,557,000	$14,982,000	$1,544,000	$3,178,000	$4,540,000	$90,801,000
9. Total Allocation (9a plus 9b)	$66,557,000	$14,982,000	$2,413,000	$3,178,000	$4,540,000	$91,670,000
9a. Allocation of Construction Costs	$60,484,000	$13,615,000	$2,187,000	$2,888,000	$4,126,000	$83,300,000
9b. Allocation of IDC	$6,073,000	$1,367,000	$226,000	$290,000	$414,000	$8,370,000

6.2 Construction Cost Assignment

The construction cost assignment of each Proposed Plan purpose is consistent with Federal authority, described in Section 2.2.4, and Section 4007 of the WIIN Act. The construction costs assigned to the Federal government (fish and wildlife; recreation) are existing, authorized, and nonreimbursable Federal purposes of Anderson Ranch Dam. These two purposes are recognized as Federal benefits that can be assigned a Federal cost share as described in Section 4007 of the WIIN Act. Two Proposed Plan purposes are assigned a non-Federal cost share (DCMI and irrigation water supply), and per Section 4007 of the WIIN Act, an agreement is required to provide upfront funding by non-Federal cost share partners. Of the construction costs of the Proposed Plan assigned to the Federal cost share, the construction costs assigned to the Federal government (fish and wildlife; recreation) are nonreimbursable, while the construction costs allocated to power are reimbursable and subject to repayment in accordance with Federal Reclamation law. The Federal cost share identified as a hydropower benefit will be allocated to the Bonneville Power Administration as a reimbursable cost that will be included in long term repayment through existing agreements. Table 8 shows the construction cost assignment and does not include IDC. Section 4007 of the WIIN Act requires that at least a proportional share of the project benefits must be Federal benefits. The Federal nonreimbursable benefits are greater than the associated construction costs assigned to the Federal government. The percentage of the construction costs assigned to the Federal government is 11%, which is less than the 50% Federal cost share limit for Federally owned storage projects as required by Section 4007 of the WIIN Act.

Table 8. Construction Cost Assignment

Purpose	Total Construction Cost (in 2025 U.S. Dollars)	Federal Cost Share (in 2025 U.S. Dollars)	Non-Federal Cost Share (in 2025 U.S. Dollars)
DCMI	$60,484,000	$0	$60,484,000
Irrigation	$13,615,000	$0	$13,615,000
Fish and Wildlife	$2,187,000	$2,187,000	$0
Hydropower	$2,888,000	$2,888,000	$0
Recreation	$4,126,000	$4,126,000	$0
Total	$83,300,000	$9,201,000	$74,099,000

6.3 Operations, Maintenance, and Replacement Cost Allocation

The allocation of the OM&R costs for the Proposed Plan follows the AJE method, by allocating based on benefits and using the same distributions estimated for construction costs and IDC. The Proposed Plan average annual OM&R costs of $19,520 are calculated as 3.33% of the existing total Anderson Ranch Dam OM&R costs (refer to Section 4.3 for details). Specifically, Item 7

(Percent Distribution for Remaining Joint Costs) in Table 7 determines the distribution of OM&R costs in Table 9.

Table 9. Allocation of Existing Operations, Maintenance, and Replacement Costs to Proposed Plan Purposes

Project Purpose	Assignment	Percent Allocation (%)	Costs to be Allocated (in 2025 U.S. Dollars)
DCMI	Non-Federal	73.3%	$14,310
Irrigation	Non-Federal	16.5%	$3,220
Fish and Wildlife	Federal	1.7%	$330
Hydropower	Federal (reimbursable)	3.5%	$650
Recreation	Federal	5.0%	$980
Total Allocation		**100%**	**$19,520**

As Section 4.3 states, the existing OM&R costs for Anderson Ranch Dam are not anticipated to change with the Proposed Plan. However, the OM&R costs borne by existing participants would be reduced by 3.33% and allocated to the participants of the Proposed Plan. This reduction includes a 1.2% reduction in Federal assignment and a 2.13% reduction in non-Federal assignment, based on the existing cost allocation. However, there would also be a Federal OM&R cost assignment from the Proposed Plan. The net Federal OM&R costs are expected to decrease by 0.97%, because the 1.2% reduction in existing OM&R costs exceeds the 0.22% increase in the assigned OM&R costs as a participant of the Proposed Plan. Table 10 provides these calculations.

Table 10. Net Change in Federal Operations, Maintenance, and Replacement Cost Assignment

Item	Value (in 2025 U.S. Dollars)	Percentage
Average Annual Total Anderson Ranch OM&R costs	$585,600	100%
Existing Federal assignment of Anderson Ranch Dam OM&R costs	$213,160	36.4%
Existing Federal assignment decreased due to Proposed Plan	$206,150	35.2%
Change in existing Federal assignment due to Proposed Plan	-$7,010	-1.2%
Total Average Annual Anderson Ranch Dam OM&R costs in Proposed Plan	$19,520	3.33%
Federal assignment of Proposed Plan OM&R costs	$1,310	0.22%
Total Federal assignment – existing decreased and Proposed Plan	$207,460	35.43%
Net Change in Reclamation assignment of OM&R costs	-$5,700	-0.97%

Notes:

Table 10 calculations measure the change to the existing nonreimbursable OM&R cost assignment to Federal purposes (recreation, fish and wildlife, and flood control). They do not include existing or Proposed Plan reimbursable OM&R cost assignments to Federal purposes (irrigation, hydropower).

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Section 7 Funding Considerations

Section 4007 of the WIIN Act establishes that, at the request of any State; any department, agency, or subdivision of a State; or any public agency organized pursuant to State Law, the Secretary of the Interior may negotiate and enter into an agreement on behalf of the United States for the design, study, and construction or expansion of any Federally owned storage project. The agreement requires upfront funding by cost-sharing partners for any non-Federal cost assignments. Section 4007 of the WIIN Act limits overall Federal cost-sharing in a Federally owned storage project, such as Anderson Ranch Dam, to a maximum 50% of total costs.

In return for the Federal cost-sharing investment in the Federally owned storage project, at least a proportionate share of the project benefits are Federal benefits. These required criteria are met and detailed in the initial cost assignments in Table 8. Section 6.3 explains a change to existing Federal OM&R requirements; however, this is not expected to be a consideration with WIIN Act funding, as WIIN Act funding is not permitted to be used for OM&R costs.

The non-Federal cost-sharing partners are required to provide upfront funding for the non-Federal cost assignments, per the requirements of Section 4007 of the WIIN Act. On April 2, 2019, the Idaho State Legislature transmitted to Reclamation the *House Joint Memorial No. 4* adopted by the House of Representatives and the State Senate. The bill specifies support for the Proposed Plan. The State of Idaho House Bill Number 285 created a Water Management Account to facilitate State appropriations for qualifying water projects. It is anticipated that the remainder of the non-Federal cost-shared funds would be sought through further State appropriations or bond issuance. The State of Idaho, through the Idaho Water Resources Board, may recover the upfront cost share through contractual space assignment agreements.

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