

# Boise River Basin Feasibility Study 6-foot Anderson Ranch Dam Raise Engineering Summary Report

Boise Project, Idaho Columbia Pacific Northwest Region



## **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
су	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).

## 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.

## 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).



#### Figure 1. Boise Project



Figure 2. Land Management

## 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.

## 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 <sup>1</sup>/<sub>2</sub> 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



#### Figure 4. Road Closure and Detour

#### 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-ofway 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.

Design Element	Alternative 1: Downstream Raise	Alternative 2: MSE Wall Raise
Dam raise subtotal costs <sup>1</sup>	\$22,975,338	\$25,238,159
HD-131 Realignment <sup>2</sup>	\$700,000	\$700,000
Gate Hoist Deck <sup>3</sup>	\$250,000	\$250,000
Right Abutment Approach <sup>4</sup>	\$672,000	\$672,000
Road Maintenance and Repair <sup>5</sup>	\$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 <sup>6</sup>	\$6,000,000	\$7,000,000
TOTAL	\$44,000,000	\$48,000,000

Table 1. Anderson Ranch Dam raise field cost estimates

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 crosssection 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.

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).

Table 2. Recommended data collection and analyses for final design
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 <sup>1</sup> .
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.

<sup>1</sup> 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.

# 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 contractoracquired spatial data were compiled into base maps to evaluate data adequacy and accuracy and to inform the water surface rise simulations. Esri<sup>TM</sup> 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.

- 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



Figure 6. Roadway Project Locations

## 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, 3<sup>rd</sup> 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.

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

Table 3. Recommended roadway riprap project locations and quantities

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.

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

Table 4. Recommended roadway MSE wall project locations and quantities

## 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

## 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)

## 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 naturallyoccurring 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, 8<sup>th</sup> Edition (AASHTO 2017)
- Standard Specifications for Highway Bridges, 17th Edition (AASHTO 2002)
- *The Manual for Bridge Evaluation*, 3<sup>rd</sup> 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

#### 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 fourspan, 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*, 3<sup>rd</sup> 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*,  $3^{rd}$  *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

#### 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.</li>
  - 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
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Culvert	Rim Analysis Estimated Culvert Outlet Elevation <sup>1</sup> (feet)	Surveyed Culvert Outlet Elevation <sup>2</sup> (feet)	Surveyed Culvert Inlet Elevation <sup>2</sup> (feet)	Size (inches) <sup>2,5</sup>
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 <sup>3</sup>	4234.6	NA	NA	36
Unknown #4	4211.4	4199.24	4200.45	36
Unknown #4A <sup>4</sup>	NA	4204.03	4205.83	30
Unknown #5 <sup>3</sup>	4216.4	NA	NA	15
Wilson Creek <sup>3</sup>	4208.9	NA	NA	36

<sup>1</sup> Based on elevation data extracted from LiDAR-derived DEM product (Datum: NGVD29).

<sup>2</sup> Based on field survey data collected by the contractor in September 2019 (Datum: NGVD29).

<sup>3</sup> 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. <sup>4</sup> Culvert was not identified during the Rim Analysis but was observed and surveyed by the contractor in

September 2019 (Datum: NGVD29).

<sup>5</sup> 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.

Location	25-Year Peak Flood <sup>1</sup> (cfs)	100-Year Peak Flood <sup>1</sup> (cfs)	Drainage Area (square miles) <sup>1</sup>
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 <sup>2</sup>	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

Table 6. Hydrologic peak flow estimates

<sup>1</sup> Based on USGS StreamStats version 4 data compiled September 5, 2019.

<sup>2</sup> 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).

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

Table 7. Culvert hydraulics summary

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 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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#### 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 importing fill 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 inwater 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.

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 <sup>1</sup>	\$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

Table 10. Anderson Ranch Reservoir raise – field costs

<sup>1</sup> 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

ltem	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.

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

Table 13. Construction costs

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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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