APPENDIX D

INVESTIGATION AND ANALYSIS REPORTS

Investigation and Analysis Report for Cove Reservoir

Appendix D

Cove Reservoir Watershed
Kane County Water Conservancy District
Kane County, Utah

The purpose of the Investigation and Analysis Report is to present information that supports the formulation, evaluation, and conclusions of the Supplemental Watershed Plan No. 8 and Environmental Assessment (Plan-EA). The report is required and must be included as an appendix to the Plan-EA.

The procedures, techniques, assumptions, scope, and intensity of the investigations for each subject are described in sufficient detail so that a reader not familiar with the watersheds/dams or their deficiencies or issues can form an opinion on the adequacy of the Plan-EA. This report supplements information contained in the Plan-EA and is not intended to replace or duplicate information contained therein.

October 2020

TABLE OF CONTENTS

LIST OF TABLES

D.1 INTRODUCTION

The planning studies presented in this Investigation and Analysis Report (I&A Report) are based on standard methods, procedures, and computer programs used and approved for use by the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). The following information provides a summary of the investigation and analysis for the key planning studies in the preparation of the Plan-Environmental Assessment (Plan-EA) for the proposed Cove Reservoir Project. Additional information relevant to each of the sections provided in this report is available upon request as part of the Administrative Record for the project. Requests for additional information can be submitted to the following address:

USDA-NRCS
Wallace F. Bennett Federal Building
125 South State Street, Room 4010
Salt Lake City, Utah 84138-1100

The Cove Reservoir is located within the Cove Reservoir Watershed, situated approximately 1 mile west of the East Fork Virgin River in Kane County, Utah and approximately 1.5 miles southwest of downtown Orderville, Utah. The Cove Reservoir will be an off-stream reservoir consisting of an earthfill dam, low-level outlet works, piped principal spillway, and open channel auxiliary spillway (AS). Water will be kept within the reservoir year-round to be used as a drought and irrigation buffer.

Note on Vertical Datum: All elevations provided in this I&A Report for current conditions are in Utah Coordinate System of 1983, South Zone.

D.2 SEDIMENTATION

The site is located in the East Fork of the Virgin River Watershed at 37.273 degrees North 112.660 degrees West. The reservoir will serve as a multi-purpose structure including providing storage for irrigation, recreation, and drought.

The reservoir will have a storage capacity at the Principal Spillway crest (elevation 5545.5 feet) of 6,055 acre-feet and a maximum water depth of about 80 feet. The drainage area covers 4.7 square miles (3,034 acres). The reservoir site is in an alluvial valley that has been cut into Cretaceous and Tertiary sedimentary rocks consisting mostly of sandstone and shale. Residual soils are silt and sandy clay. The terrain adjacent to the basin valley has steep slopes. Ridges are capped with thin deposits of pebble gravel, cobbles of gray and red quartzite, gray to black chert, and gray limestone in a matrix of sand with silt. Vegetation in the drainage is sparse, consisting of brush and small trees. Using the National Engineering Handbook land cover designation, the majority of the drainage basin is comprised of Woods, Fair; with portions of Desert Shrub, Poor. The drainage areas are capable of producing flash flood conditions and large sediment volumes during intense rainfalls. For planning purposes, the reservoir has been conservatively assumed to contain all of the sediment (100-percent trap efficiency).

An initial estimate of sediment yield has been performed using two methods included in the Bureau of Reclamation Erosion and Sedimentation Manual (BOR 2006) and the Estimated Sediment Yield Rates for the State of Utah Map (USDA 1973). These methods are described in the subsequent sections.

D.2.1 Sediment Yield as a Function of Drainage Area

Empirical sediment yield equations have been developed strictly as a function of drainage area based on reservoir sediment survey data. Strand and Pemberton (1982) developed the following equation for the semiarid climate of the southwestern U.S.:

$Q = 1.84A_d^{-0.24}$

Where Q = sediment yield, acre-feet/square miles per year

A_d = drainage area, square miles

For the reservoir drainage area of 4.7 square miles, a sediment accumulation 6 acre-feet per year or 600 acre-feet over a 100-year period is computed.

D.2.2 Sediment Yield Classification Procedure

The Pacific Southwest Inter-Agency Committee developed a sediment yield classification procedure that estimates sediment yield as a function of nine individual drainage basin characteristics. Each characteristic is given a subjective numerical rating based on observation and experience and the sum of these ratings determines the basin classification and the annual sediment yield per unit area. Tables showing this procedure are included in the sediment supplemental documentation (Attachment 1). The sum of the basin characteristics ratings is 70, resulting in a classification number of 3, with annual sediment yield (acre-feet per square mile) ranging from 0.5 to 1.0.

For the drainage basin area of 4.7 square miles, using the upper end of the range results in an annual yield of 4.7 acre-feet and a sediment yield of 470 acre-feet over a 100-year life span.

D.2.3 Estimated Sediment Yield Rate Map

An estimated sediment yield rate map for the State of Utah was prepared by the USDA Soil Conservation Service in 1973 (USDA 1973). This map is a general area map with cautions that it is not to be used for specific sites since large variations may occur in the delineated areas. A copy of the map with the Cove Reservoir area enlarged is in the sediment supplemental documentation (Attachment 1). This area is in a Yield Class 4 which indicates yield rates ranging from 0.2 to 0.5 acre-foot per square mile per year. Using the upper end of the range results in an estimate of 2.35 acre-feet per year for the 4.7-square-mile drainage area and 235 acre-feet over a 100-year life span.

D.2.4 Recommended Sediment Yield for Project Planning

These initial estimate methods are considered to provide upper-end values of the sediment volume which will accumulate over the 100-year life of the structure. Ranging from 235 (USDA Sediment Yield Rate Map) to 600 acre-feet (empirical equation), these values represent 10 percent or less of the reservoir storage volume and more refined analyses are not deemed necessary for planning purposes.

For planning purposes, an average 100-year total sediment volume of 418 acre-feet has been used. Due to the predominance of shale materials within the drainage basin, the majority of the sediments which are transported into the reservoir will likely be fined grained. Fine-grained sediments will remain in suspension longer, and deposition of these sediments will likely be more uniform throughout the reservoir area compared to coarser grained sediments, which are generally deposited in the upper end of reservoirs. Since the majority of the sediments are likely to be transported into the reservoir during periods of high stream flow, it is anticipated that some of the sediments will be deposited as aerated sediment above the PS elevation. For planning purposes, it is assumed that sediments will be equally deposited throughout the reservoir area when the reservoir is filled to elevation 5,547.5 feet (2 feet above the PS elevation). The surface area of the reservoir at elevation 5,545.5 feet (PS elevation) will be about 188 acres and the surface area of the reservoir at elevation 5,547.5 feet will be about 195 acres. Assuming 418 acre-feet of sediment is deposited uniformly over an area 195 acres in size results in a sediment depth of 2.1 feet. Based on the assumptions described above, it is estimated that 403 acre-feet of the sediment will be submerged (deposited below the PS elevation) and 15 acre-feet will be aerated (deposited above the PS elevation).

The estimated sediment yield of 418 acre-feet in 100 years is equivalent to 1.7 watershed inches. Since this sediment yield is less than 2 watershed inches in 50 years (4 watershed inches in 100 years), evaluation to reduce sedimentation yield within the watershed is not required by NRCS TR-60.

D.3 FLOODING AND RISK ANALYSIS

The project design report developed by Alpha Engineering and RB&G Engineering (Attachment 2) included a breach inundation analysis. The inundation area encompasses 0.3 square mile, extending down through agricultural land, a state highway, and sporadic residential houses and into the East Fork Virgin River. The hazard classification of the dam is “high,” and the total population at risk is estimated to be 10 to 15 people. The inundation area includes four residential homes, appurtenant barns, and agricultural facilities. The maximum loss of life for the breach performed was determined to be 15 people.

D.4 GEOLOGY

D.4.1 Regional Geology

The Orderville area is located within the Grand Staircase section of the Colorado Plateau Physiographic Province. The Colorado Plateau Province covers areas of eastern and southern Utah, western Colorado, northwestern New Mexico, and northern Arizona. The Grand Staircase contains a series of terraces and cliffs which rise northward from the Grand Canyon to the High Plateaus. The Hurricane Fault bounds the section to the west and the Kiabab Monocline bounds the section to the east (Stokes 1986).

The Grand Staircase section is typified by a series of alternating step-like cliffs and flat areas. The upward steps in the staircase include the Vermillion Cliffs, White Cliffs, Gray Cliffs, and Pink Cliffs. The cliffs consist of more competent material, while the lowlands between them consist of generally softer, more erodible deposits (Stokes 1986).

The age of the deposits exposed above the Grand Canyon range from the Triassic age, 245 million years ago near the Vermillion Cliffs, to the younger Tertiary deposits of the Pink Cliffs to the north. The cliffs consist of more competent material, while the lowlands between them consist of generally softer, more erodible deposits (Stokes 1986).

The age of the deposits exposed above the Grand Canyon range from the Triassic age, 245 million years ago near the Vermillion Cliffs, to the younger Tertiary deposits of the Pink Cliffs to the north, deposited 15 million years ago. A large portion of the sediments in this section was derived from continental deposits.

D.4.2 Site Geology

Surficial deposits in the study area consist of Quaternary alluvial deposits overlying bedrock. Bedrock throughout the planned reservoir basin and dam abutments consists of the Cretaceous age Tropic Shale Formation (Doelling 2008). No competent outcrops of Tropic Shale from which strike and dip could be measured were observed at the site. Based on information from drill holes and topographic and structural geology maps, bedrock in the area appears to dip 2 to 3 degrees down toward the northeast (Doelling and Davis 1989). The strike of the bedrock appears to range from North 30 degrees West to North 60 degrees West, based on geologic maps.

The following descriptions of the surficial and rock units in the study area are taken from *The Geology of Kane County, Utah, Geology, Mineral Resources and Geologic Hazards* (Doelling and Davis 1989) and interim geologic map of the Kanab 30-foot by 60-foot Quadrangle (Doelling 1999). Deposits are listed from youngest to oldest, with comments relative to the study area in italics. Additional geologic data including a geologic map is included in the 2004 feasibility study located in Attachment 3.

- *Quaternary*
    - Qa Alluvium—Sand and silty clay with lenses of sandy silt and gravel sediments consisting of unconsolidated clay, silt, sand, and gravel, which was deposited in streambeds and floodplains. During the feasibility investigation, sand and gravel deposits appeared very limited and discontinuous. Deposits may be considered for embankment material
    - Qag Alluvial gravel—Poor to well-sorted gravel and sand with some silt and clay interbeds. Exposures are predominately terrace deposits along the east side of the East Fork Virgin River, which trends southeast along the east side of the highway. Sand and gravel may be considered for granular borrow source
- *Cretaceous*
    - Ks Straight Cliffs Formation—Yellow-gray very fine to fine-grained, medium- to thick-bedded, cliff forming, calcareous sandstone with interbedded less resistant sandstone, shale, and mudstone. This unit is exposed north and northwest of the site due to faulting on the north side of Orderville. The formation is exposed as a yellow cliff-forming cap rock above the Tropic Shale. Competent material may be suitable for rip rap but appears to have many interbedded weak layers
    - Kt Tropic Shale Formation—Dark gray, drab marine shale with some gray sandstone. This unit forms the bedrock for the dam abutments and reservoir basin. At this site the formation also contains several grayish-white bentonite layers which are exposed along the south (right) side of the reservoir basin. Septarian nodules/concretions are also common locally. Some minor gypsum lenses, stringers, and fracture infilling were noted during this study
    - Kd Dakota Formation—Interbedded sandy shale, carbonaceous shale, sandstone, conglomerate, and coal
- *Jurassic*
    - Jc Carmel Formation—Sandstone, siltstone, limestone, shaly limestone, and gypsum.
    - Divided into members:
        - Jcw Winsor and Wiggler Wash Members—Reddish or yellow slope-forming silty sandstone
        - Jcp Paria River Member—Gypsum, reddish siltstone and sandstone, with some limestone at top. South of site seen as a white gypsum cliff along highway
        - Jcc Crystal Creek Member—Brown banded sandstone. To the south of site this unit exposes a small fault zone in a road cut off of highway
        - Jck Co-op Creek Member—Thin to medium bedded light gray limestone and tan limestone shale. Unit forms ledges south of sewer lagoon off of highway and was used as rip rap for lagoon. This unit is also exposed just east of the highway on the east side of the Sevier fault on the northeast end of Orderville. This may be a source of rip rap

D.5 SEISMIC ANALYSIS

Bedrock in the Orderville area shows evidence of ancient and younger Quaternary normal faulting. The Colorado Plateau Province is less tectonically active and has been less disrupted by compressional forces from the Sevier Orogeny compared to the Basin and Range Province, which is located northwest of the project site.

The project area is located near the western edge of the Intermountain Seismic Belt, which is a zone within the western U.S. between northern Arizona and northern Montana where frequent seismic activity occurs.

The Sevier fault, which is the eastern most major extensional fault in southern Utah, is located about 2.7 kilometers (km) west of the site.

Probabilistic seismic analyses using the Dynamic: Conterminous U.S. 2014 (v4.1.1) online U.S. Geological Survey (USGS) Unified Hazard Tool estimate 5,000- and 10,000-year frequency Peak Ground Accelerations (PGA) at the site. This analysis resulted in estimated PGA values of 0.294 g and 0.418 g for the 5,000- and 10,000-year frequency events, respectively (USGS 2019).

An evaluation to determine ground motions that could occur at the site as a result of an earthquake generated by the Sevier section of the Sevier/Toroweap fault zone has been performed using the NGA West-2 Ground Motion Prediction Equations spreadsheet (v5.7) developed by the Pacific Earthquake Engineering Research Center. This section of the fault has been determined to be Quaternary age (Late Pleistocene, 10 to130,000 years ago) with no documented Holocene movement. The USGS states that the slip rate of this section is less than 0.2 millimeter per year, but no recurrence interval information is currently available. This section of the fault is about 89 km long and may be capable of generating a Maximum Credible Earthquake (MCE) with a magnitude of about 7.3. It is estimated that the MCE event of the Sevier section could generate a PGA of 1.02 g. The dam will be designed to prevent failure during this deterministically derived earthquake event.

D.5.1 Geologic Seismic Hazard Classification

Since failure of the Cove Reservoir Dam with the reservoir filled to the normal pool elevation may cause loss of life and serious damage to homes, important public utilities, and Highway 89, the seismic hazard classification of the dam will be High Hazard (NRCS 2005).

D.6 SUBSURFACE EXPLORATIONS

The characteristics of the subsurface material at the site were evaluated by drilling 5 borings during the 2004 feasibility study to depths ranging from 39 to 101 feet and excavating 2 test pits to depths of about 12 feet. Figure 4 from the 2004 feasibility study, which illustrates the locations of the test holes, is included in Attachment 4 for reference along with the logs for the borings and test pits. All five drill holes were completed within or very near the footprint of the proposed dam.

Both the drill holes and the test pits were used in evaluating the characteristics of the overburden material at the site. Bedrock core was recovered from four of the borings to assess the competency and condition of the foundation bedrock.

Three holes were drilled within the footprint of the dam and one hole was drilled on each of the abutments at the locations shown in Attachment 4. The test holes are also shown on the profile included in Attachment 4, which was Figure 5 in the 2004 feasibility report.

DH 04-1, 04-2, and 04-4 were drilled vertical and DH 04-3 and DH 04-5 were drilled at an angle of 60 degrees from horizontal. While the drill logs indicate the angles and direction the hole was drilled, the core is not classified as being “oriented;” hence, the actual direction of bedding and fractures seen in the core cannot always be determined. Terms on the drill logs such as vertical fractures and angles of bedding referring to how these features appear relative to the cored sample and not to actual vertical and horizontal planes.

D.6.1 Soil Profile

The depth of soil overburden varied from 20 to 47 feet at the locations of the borings drilled within the valley floor. Deeper deposits which were not encountered at the boring locations may be present. TP 04-5, excavated on the small knoll at the planned upstream toe of the dam near the maximum section, encountered heavily weathered shale bedrock at a depth of only 4 feet.

The soil overburden sampled from the drill holes and test pits consists predominantly of lean clay with interbedded layers and lenses of fat clay, sandy silt, and silty sand with pockets of gravel. The overburden is a combination of weathered material from the underlying Tropic Shale formation and alluvial material washed down from the surrounding slopes. The silt and clay deposits were heterogeneously layered, with some sections of the test pits showing distinct layers several inches in thickness and other sections of the test pits showing thin, closely spaced lenses less than an inch in thickness. When combined, these layers generally exhibit the characteristics of lean clay with medium plasticity and good workability. A close examination of the sidewall of the test pits showed that the interbedded layers of silty sand were generally fine grained and from 1 to 6 inches in thickness. Gravel particles tended to be sandstone or shale in origin with sub-angular to sub-rounded edges. Generally, the pockets of gravel were fine grained with a size range of 0.25 to 1 inch. The gravel layers which made up these scattered deposits were observed to be from 1 to 3 feet in thickness. A few cobbles and boulders up to 12 inches in size were encountered within the test pits. A pin-hole structure was readily evident in the silt- and clay-type deposits within the upper 10 feet of the soil profile at this site, and the moisture content of the samples collected varied from dry to very dry.

Standard Penetration Test values ranged from 6 to 55, indicating that the material is in a firm to hard condition. Thirteen disturbed samples and seven undisturbed samples were recovered from the bore holes. Some of the undisturbed samples recovered were not extracted intact due the very dry condition of the soil.

The overburden on the abutments was removed during construction of the access roads for DH 04-3 and DH 04-5. Drilling began directly in the weathered bedrock. It is estimated from the access road cut that the depth of overburden prior to its removal was between 1 and 3 feet.

D.6.2 Bedrock Profile

The quality of the bedrock is characterized by the percent of core recovered, along with the Rock Quality Designation (RQD). The RQD is the percent of material within a cored interval that is recovered in pieces at least twice the core diameter (~4 inches) in length. The recovered core generally consisted of gray mudstone (Tropic Shale Formation) with occasional bentonite layers. It will be noted from the boring logs that the percent recovery and RQD ranged from 63 to 100 in DH 04-1 and DH 04-2, which is located on the valley floor.

In DH 04-3 on the right abutment, the bedrock in the upper 25 feet was highly weathered and fractured, with the percent recovery ranging from 78 to 100 and the RQD varying from 18 to 65. Below 25 feet, the percent recovery ranged from 69 to 100 and the RQD varied from 42 to 100 except the layer between 32 and 38 feet, which had 0 percent RQD. Minor gypsum coating was observed on some joints in the upper 70 feet. Bentonite layers, approximately 1.5 feet thick, were encountered at 25, 75, and 95 feet.

In DH 04-5 on the left abutment, the bedrock in the upper 40 feet was highly fractured, with the percent recovery ranging from 0 to 96 and an RQD of 0. Below 40 feet, the bedrock was relatively competent, with the percent recovery ranging from 80 to 100 and the RQD varying from 60 to 100. A few random gypsum stringers were observed in the core between 28 and 46 feet. Bentonite layers ranging in thickness from 0.5 to 2 feet were encountered at 71, 77, and 89 feet.

D.6.3 Groundwater

The depth where groundwater was measured in the borings is shown on the boring logs and profile included in Attachment 4. It can be observed from the profile that the gradient is toward the center of the basin.

D.7 GEOTECHNICAL ANALYSIS

An earthfill dam will be the most efficient structure for the reservoir at this site due to 1) the characteristics of the foundation material, 2) an adequate source of embankment material within the basin, and 3) the lack of a good source of gravel and rock in close proximity to the site for construction of a roller-compacted concrete or rockfill-type structure. Therefore, geotechnical analyses have been limited to an earthfill-type embankment.

D.7.1 Embankment Cross Section

A conceptual embankment design cross section is included in Attachment 5. The plan and cross section were included as Figures 4 and 6 in the 2004 feasibility study. Per the cross section, a homogeneous embankment with an internal chimney filter/drain is proposed. Zone I will consist of relatively impervious material from the foundation excavation and the reservoir basin. The material will be predominately lean clay. Material within the dam footprint and reservoir basin is several percent below the optimum moisture, so moisture conditioning of the borrow materials will be required. Some mixing to blend silt and sand layers with the clay will also be required to produce a uniform embankment soil having at least 50 percent passing a No. 200 sieve. An 8-foot-wide chimney filter/drain will be located downstream of centerline and will be designed to protect the lean clay from piping and to intercept water, preventing saturation of the downstream embankment. Slope protection will be required, with rock riprap and bedding planned for the upstream slope and seeding planned for the downstream slope.

A 6-inch surface course of untreated road base will be placed to cap the crest of the dam to provide a finished surface. The crest will be sloped at 2 percent downward toward the reservoir to prevent ponding.

A crest width of 25 feet has been assumed, with an upstream slope of 3H:1V (Horizontal:Vertical) and downstream slope 2H:1V. The crest of the dam will be 6.5 and 2.8 feet above the crests of the PS and AS, respectively.

D.7.2 Stability Analysis

Preliminary steady-state reservoir full and instantaneous draw down slope stability analyses were performed during the 2004 feasibility study (Attachment 3). Calculated factors of safety were 1.51 and 2.18 for the downstream and upstream slopes, respectively, for reservoir full steady-state conditions. A factor of safety of 1.2 was calculated for the upstream slope instantaneous draw down condition. These calculated factors of safety are adequate to meet NRCS and Utah State Dam Safety requirements.

D.7.3 Settlement Analysis

A settlement analysis was performed for the maximum section of the embankment during the 2004 feasibility study. The analysis resulted in a calculated consolidation settlement of 48 inches beneath the center of the dam and 1 inch beneath the upstream and downstream toes if the proposed embankment were constructed on the native overburden soils without any treatment. The foundation treatment will include excavation and replacement of overburden deposits beneath the embankment footprint to reduce the expected consolidation and differential settlement, which could result in embankment cracking. The excavation depth will extend into bedrock in the cutoff trench at the dam centerline, transitioning to a depth of 10 feet at the embankment toes to reduce the estimated consolidation settlement to less than 6 inches.

D.7.4 Foundation Treatment

Due to the potential for collapse of the native overburden deposits, it is recommended that a portion of the overburden soil be excavated to limit settlement. The excavated material can be used as embankment fill. A cutoff trench will be required to extend through the weathered mudstone and into competent rock.

The field investigations revealed significant fracturing of the bedrock at select locations, principally on the abutments. The results of the permeability tests show that significant seepage loss can be expected through the bedrock abutments. Due to the nature of the foundation bedrock, it is believed that a majority of the seepage will be a result of secondary permeability through fractures and joints rather than by seepage through unbroken deposits (primary permeability). To mitigate the potential harmful effects of large seepage losses, the design will include the features described in the following subsections.

D.7.4.1 Impervious Clay Cut-Off Trench

The design will include an impervious clay cut-off trench extended through the overburden soil, weathered bedrock, and at least 5 feet of competent bedrock. Fractures and joints beneath the impervious cut-off and sand filter will be treated to prevent internal erosion. Final foundation treatment will need to be completed shortly after final excavation to prevent air slacking and cracking of the mudstone rock.

D.7.4.2 Grout Curtain

Based on the permeability test results and the condition of the recovered bedrock core, the design will include a foundation grouting program for the abutments. The conceptual design includes a triple-row grout curtain installed beneath the center of the embankment abutments.

D.7.4.3 Downstream Filter and Drain

Two separate but interrelated structures, a downstream filter and drainage blanket, have been included in the conceptual design to mitigate the potential for piping of embankment material and facilitate drainage of seepage which may bypass the cut-off.

A collector toe drain has also been included in the conceptual design. Manholes will be installed along the pipeline to facilitate seepage monitoring and allow drain access.

D.7.5 Groundwater

The groundwater gradient is currently toward the center of the valley. Impounding a reservoir at the site will likely result in a gradient sloping away from the reservoir. The primary impact of the change in gradient will be potential seepage through the dam and foundation. The seepage collection systems to be included in the design of the dam will mitigate the risks associated with these impacts.

D.8 WATER QUALITY

There is no permanent pool or perennial stream associated with the Cove Reservoir. The lower elevations of the drainage course appear to be intermittent while the higher reaches appear ephemeral. There is no culinary use or habitat use to be associated with the water discharged through the dam. There is a scarcity of information regarding current water quality at the project site. The reservoir will serve as a storage facility for diverted river flows. As discussed in Section D.2, the reservoir site is situated in an alluvial valley which will likely produce large sediment volumes during intense rainfalls. Water storage within the reservoir will allow sediment to settle out of the water before leaving the reservoir, thus improving downstream water quality conditions.

D.9 HYDROLOGIC ANALYSIS

The preliminary design report developed by Alpha Engineering and RB&G Engineering (Attachment 2) included the identification of general and local design floods per NRCS requirements in development of the PS and AS. The design floods include the FBH, SDH, and the PSH. The results are included in Table D-2.

Table D-1 Design Flood Information

Design Flood	Crest Elev.	Peak Water Elev.	Geometry	Peak Storage	Peak Res'v Inflow	Peak Res'v Outflow	Peak Depth over AS
FBH (General)	5549.2 ft (AS)	5551.8 ft	30 ft (AS width)	7,306 af	3,524 cfs	404 cfs	2.6 ft
FBH (Local)	5549.2 ft (AS)	5551.0 ft	30 ft (AS width)	7,141 af	6,395 cfs	256 cfs	1.8 ft
Auxiliary Spillway Hydrograph (ASH) (General)	5549.2 ft (AS)	5549.6 ft	30 ft (AS width)	6,855 af	1,766 cfs	71 cfs	0.4 ft
ASH (Local)	5549.2 ft (AS)	5548.6 ft	30 in (PS diameter)	6,655 af	2,180 cfs	41 cfs	0.0 ft
PSH	5545.5 ft (PS)	5548.2 ft	30 in (PS diameter)	6,575 af	850 cfs	39 cfs	0.0 ft

Additional results from the analysis indicate peak reservoir inflows for the following events:

- 2-/5-/10-/25-/50-/100-/500 year, 24-hour (AMC II) 89/175/261/396/506/632/ and 1,064 cfs
- 100-year, 6-/24-hour (AMC III) 2,280/1,031 cfs
- Local SEP Hydrograph 6,395 cfs
- General SEP Hydrograph 1,587 cfs

The total required freeboard based on Administrative Rules for Dam Safety and TR-60 was calculated and included the determination of the maximum wave runup during different scenarios combining 50-mile-per-hour (mph) and 100-mph winds with storm events. According to Dam Safety and TR-60 requirements, the total freeboard requirement is 6.3 feet above the PS crest elevation, or 5,551.8 feet. The top of dam for the Cove Reservoir has been set at 5,552.0 feet to accommodate hydrologic and freeboard constraints.

D.10 AUXILIARY SPILLWAY SUITABILITY AND INTEGRITY ANALYSIS

Flood routing analyses performed for the conceptual design indicates that the ASH Local (AS Hydrograph) can be routed through the proposed Cove Reservoir and PS without use of the AS; therefore, no erosion within the AS would occur as a result of the stability design storm, and the NRCS stability design requirements would be satisfied. An integrity design erosion analysis for the AS while passing the Freeboard Design Hydrograph was performed using the NRCS SITES computer program (version 2015.1.8). The estimated peak flow through the AS while routing the FBH through the reservoir is 378 cfs. NRCS requires that the spillway be designed to not breach during passage of the freeboard storm.

The boring completed on the left abutment nearest the proposed AS during the 2004 feasibility study (DH04-5) encountered weathered shale at the ground surface. Based upon a review of erosion parameters for weathered shale included in the SITES program Help menu, a head cut index of 0.2 and representative diameter of 1 inch was used to model the weathered shale materials. The results of the SITES analysis are illustrated in Attachment 7, and it will be noted that the estimated erosion as a result of the freeboard storm does not result in a spillway breach. The results of the analysis indicate that NRCS AS integrity requirements are satisfied.

D.11 DESIGN CRITERIA

NRCS TR-60, Earth Dams and Reservoirs (NRCS 2005), and Utah State Rule R655-11, Requirements for the Design, Construction, and Abandonment of Dams, will be the governing design criteria for the proposed Cove Reservoir Dam. In cases where the requirements of the two design criteria are different, the more conservative will be used for design of the Cove Dam and Reservoir.

D.12 AGENCY COORDINATION

During the preliminary scoping period for the project, scoping questions, comments, and concerns were requested from government agencies, both orally at public meetings and via written submittal of comments.

A scoping notice was mailed to interested parties, published in the local newspaper, and posted to the NRCS project website. The scoping comment period was open for 30 days and no comments were received.

A public notice of availability of the Draft Plan-EA will be mailed to interested parties, published in the local newspaper, and posted to the NRCS project website. The Draft Plan-EA will be released for public review and comment and a public meeting will be held.

Agency coordination and consultation is summarized and documented in Section 1.5, Section 5, and Appendix E of the Plan-EA.

D.13 ALTERNATIVES EVALUATION

The formulation process of alternatives for the construction of Cove Reservoir followed procedures outlined in the NRCS National Watershed Program Manual (NWPM) (NRCS 2014a) Parts 501 through 506, NRCS National Watershed Program Handbook (NRCS 2010) Parts 600 through 606, Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (USWRC 1983), and other NRCS watershed planning policy. Alternatives were developed by the project team based on the ability to address the purpose and need of the project and were formulated in consideration of four criteria outlined in the P&G (USWRC 1983): completeness, effectiveness, efficiency, and acceptability. No comments were received during the scoping period regarding the formulation process for the initial alternatives, and no suggested alternatives, including alternative sites for the proposed reservoir, were received.

According to the NWPM, the following relevant alternatives and expected consequences must be evaluated:

- No Action Alternative—Most likely future condition if none of the federally assisted action alternatives are selected
- National Economic Development (NED) Alternative—One of the alternatives, or a combination of them. This is the federally assisted alternative with the greatest economic benefits

D.13.1 Alternatives Eliminated from Detailed Study

As described in detail in Section 3.3 of the Plan-EA, alternatives were developed early in the process following the procedures identified above but were eliminated from detailed study due to environmental impacts, cost, effectiveness, and logistics. A description of the alternatives eliminated from detailed study is included below.

D.13.1.1 Alternative Reservoir Sites

Four potential dam sites were identified in the general vicinity of the project area. One site was located about 0.5 mile north of Orderville. However, it was determined that that the site was located on a complex fault structure with one major and two minor faults converging at the potential dam axis. Additionally, the depth to bedrock was determined to be excessive (UDWRe 1988). See Section 3.3 of the Plan-EA for a detailed discussion of this potential site.

Three other potential dam sites are located too far away to effectively meet the needs of the local water users. Additionally, development of these sites would be less efficient, more expensive, and more environmentally damaging primarily due to the need for much longer water transmission pipelines. Therefore, none of these sites were carried forward for analysis in the Plan-EA.

D.13.1.2 Non-Structural Alternatives

Non-structural alternatives, such as water conservation, water recycling, and utilizing other sources of water, were considered. These alternatives were determined to be infeasible because they would not meet the purpose and need of the project, which is to provide sufficient critical water storage capacity, more efficient and reliable water flow (particularly during dry summer months), and increased recreation opportunities. The Kane County Water Conservancy District (KCWCD) already implements water conservation measures for projects in their jurisdiction. No other water sources sufficient to meet the purpose and need of the Proposed Action are located near the project area. Groundwater resources in the project area are limited to current water rights that are already developed. Therefore, none of these non-structural alternatives were carried forward for analysis in the Plan-EA.

D.13.2 Alternatives Studied in Detail

This section discusses the evaluation of the alternatives for the proposed Cove Reservoir Project that was studied in detail. Two alternatives were evaluated in detail: 1) the No Action and 2) the development of Cove Reservoir and associated facilities. Concept design drawings for the Cove Reservoir alternative are included in Attachment 6.

Preliminary cost estimates developed for the alternatives taken forward used the following procedures:

- Cost estimates were based on August 2018 U.S. dollars
- Estimated quantities of construction materials and labor
- Costs associated with mitigation of potential environmental and cultural/historical impacts were not included

D.13.2.1 No Action Alternative

With implementation of the No Action Alternative, the proposed reservoir, associated recreation facilities, Glendale hydroelectric power plant, transmission line, access road, and new pipelines would not be authorized. Existing environmental conditions would remain the same. No direct costs would accompany the implementation of this alternative; however, financial opportunities would be foregone. The existing Glendale hydroelectric power plant and pipeline would remain in place. Any potential increase in power that would be generated by the new plant would not occur. Irrigation demand during summer months would continue to exceed water availability on approximately 1,109.06 acres of cropland. Recreation and related socioeconomic opportunities associated with the Proposed Action would not be realized. The up to 882 acre-feet of additional water for downstream endangered fish and flycatcher habitat would not be realized. An exact determination of revenue that would be lost as a result of implementing the No Action Alternative has not been determined.

D.13.2.2 Cove Reservoir Alternative

Implementation of this alternative would authorize the construction of the proposed reservoir, spillways, and associated recreation facilities, including an overnight camping area and boat ramp, new Glendale hydroelectric power plant, pipelines, transmission line, and access road. The estimated cost of the reservoir, access road, land rights, Glendale hydroelectric power plant, and pipeline is estimated to be approximately $28,949,000. Development of the recreation area is projected to cost approximately $1,033,000 which includes apportioned cost of the access road and land rights. In total, costs for the project would be approximately $29,982,000 (see Section 6 of the Plan-EA for details). Estimated project costs are shown in Table D-3 below. Construction activities would take approximately 15 months to complete (see Appendix E, Draft Plan of Development, in Plan-EA).

D.13.2.2.1 Reservoir and Dam

The proposed dam would be designed to meet current NRCS (NRCS 2019) and Utah Dam Safety regulations (Utah Office of Administrative Rules 2019) and engineering standards. The structure would be constructed using earth and rock fill with a central clay core. The length of the dam would be approximately 1,900 feet, with a maximum dam height of 90 feet. A 200- to 300-foot site located immediately below the dam would be used for instrumentation and additional staging. The reservoir would have a maximum capacity of approximately 6,055 acre-feet and would provide additional irrigation water to around 1,110 acres of cropland in Kane County and 4,958 acres in Washington County. Approximately 15 months would be required to complete dam and reservoir construction (see Appendix E, Draft Plan of Development, in Plan-EA). When fully operational, the reservoir would provide up to 882 acre-feet annually downstream to Washington County during the summer months to augment endangered fish and flycatcher habitat.

D.13.2.2.2 Conservation Pool/Fish Stock

A conservation pool of approximately 300 acre-feet of water (with a water depth of approximately 20 feet) would be maintained in the proposed reservoir. The conservation pool would have a surface area of approximately 34 acres and would support a cold-water trout fishery.

D.13.2.2.3 Downstream Water for Endangered Fish Species/Southwestern Willow Flycatcher

The proposed reservoir would provide up to 882 acre-feet of water annually during the summer months to augment endangered woundfin, Virgin River chub, and southwestern willow flycatcher habitat, including designated critical habitat for all three species beginning at Pah Tempe (La Verkin) Springs approximately 50 river miles downstream from the proposed reservoir and extending further downstream to the Utah-Arizona border. The additional water also would reduce the need to pump water from Quail Creek Reservoir up to the springs to meet habitat requirements.

D.13.2.2.4 Principal Spillway and Auxiliary Spillway

A 30-inch pipeline, approximately 870 feet in length, would be used as the PS. The spillway would include an intake screen and structure at the intake as well as an energy dissipater structure at the outfall. The pipeline would be located near the left abutment and would convey excess flow away from the dam structure. The AS would be approximately 1,070 feet in length and consist of a trapezoidal earthen channel, including a concrete weir structure near the base of the reservoir. The spillway would run from the left abutment of the dam and transition into an existing downstream drainage channel.

D.13.2.2.5 Recreation Area and Boat Ramp

Project implementation would include an outdoor recreation area. Approximately 4.1 acres would be used to construct a boat ramp, picnic facilities, pavilion, restrooms, and 20 overnight camping facilities. The timeline for the construction and installation of these amenities has not yet been determined. The proposed reservoir would provide water-based recreation activities such as swimming, small-engine/non-motorized boat use, and fishing.

D.13.2.2.6 Access Road

Approximately 3.2 miles of new and existing roads would be constructed or improved to provide and maintain access to properties surrounding the reservoir. Approximately 1.2 miles of existing roadway will be widened to a graveled width of 28 feet. Approximately 2.0 miles of new roadway will be constructed and graveled to a width of 28 feet. The road would be constructed to permit two-way traffic. A borrow ditch and culverts would be installed in drainages, as needed. The access road would be graded and graveled using a compact road base material. The access road would be constructed early in the construction process to provide access for upstream property owners. This would also facilitate construction of the dam.

D.13.2.2.7 Borrow Areas

Up to five borrow sources could be used to provide gravel and riprap for the Proposed Action. Potential gravel borrow sites include the existing Tait, Lamb, and Elbow pits. The potential riprap sites include the existing Bald Knoll pit and the new Black Knoll site. The Lamb and Tait sites are located on private land near U.S. Highway 89, close to the communities of Mount Carmel and Mount Carmel Junction. The Elbow, Bald Knoll, and Black Knoll sites are located on BLM-administered public land east of Glendale on the Glendale Bench Road. Transportation to and from the borrow areas would be by existing roads. Use of the existing pits and the new Black Knoll site for the project would result in approximately 12.2 acres of long-term surface disturbance. The total quantity of borrow material for the dam, spillways, and access road would be approximately 4,319,000 cubic yards.

D.13.2.2.8 Pipelines

The installation of two water transmission pipelines would be completed as part of the Proposed Action. The purpose of the pipelines would be to 1) convey water to the proposed reservoir and 2) convey East Fork Virgin River water to the proposed Glendale hydroelectric power plant site. The Cove Reservoir pipeline would be approximately 700 feet (0.13 mile) of new 24-inch pipeline. This line would extend from an existing pipeline that runs from the Orderville irrigation pipeline inlet and proposed Glendale hydroelectric power plant site to just below the proposed dam site. The new line would access the proposed reservoir at the dam site. This new extension would provide water from the East Fork Virgin River to fill the reservoir in the spring during high runoff. It would also be used to provide water from the reservoir to local irrigation users as needed during the summer months.

The Glendale hydroelectric power plant pipeline would replace the primary portion of the existing Glendale irrigation system. The pipeline would consist of approximately 8,980 feet (1.7 miles) of new 16-inch pipeline. This pipeline would run from the current Glendale hydroelectric power plant location to the site of the proposed Glendale hydroelectric power plant. The new pipeline would provide an additional 100 feet of pressure that would increase the production of the proposed plant by approximately 45 kilowatts (kW), doubling the output of the existing plant. Excess water from the proposed pipeline would be combined with water diverted from the Orderville Diversion Dam to fill the proposed reservoir.

D.13.2.2.9 Glendale Hydroelectric Power Plant and Transmission Line

Implementation of the Proposed Action would result in the relocation of the existing Glendale hydroelectric power plant to a point near the existing Orderville Diversion Dam. The new plant would consist of a small concrete building that would house a turbine and appurtenant facilities. The existing turbine, generator, and switchgear would be rebuilt and used at the new facility. A small parking area adjacent to the building would be leveled and graded. Minor utility work would be installed in conjunction with the building. Drainage and erosional controls would be incorporated, including Stormwater Pollution Prevention Plan measures to control stormwater.

A small overhead transmission line would be constructed. The line would extend from the new plant location approximately 600 feet to an existing transmission line. One new power pole would be required, and no surface disturbance would result from installation activities.

No modifications to the existing Orderville hydroelectric power plant would occur as part of the Proposed Action. However, water from the proposed reservoir would be made available to operate the plant during the summer season when the plant would normally be idle.

Table D-2. Cove Reservoir Cost Estimate

Item	NRCS PL 83-566 Funds	Other Funds*	Total
Construction	$18,114,000	$7,896,000	$26,010,000
Engineering	$3,252,000	N/A	$3,252,000
Miscellaneous	$60,000	$660,000	$720,000
Total	$21,426,000	$8,556,000	$29,982,000

*Funds contributed by KCWCD and Washington County Water Conservancy District in accordance with guidance contained in a Memorandum of Understanding. See Section 6.8 of the Plan-EA for details.

D.14 ECONOMIC EVALUATION

The NRCS NWPM (NRCS 2014a) was used as a reference for the economic analysis along with the P&G (U.S. Water Resources Council 1983). The P&G was developed to define a consistent set of project formulation and evaluation instructions for federal agencies that carry out water and related land resource implementation studies. The basic objective of the P&G is to determine whether or not benefits from the Proposed Action exceed project costs for federally funded projects. The P&G also requires that the NED alternative, which maximizes monetary net benefits, be selected for implementation unless there is an overriding reason for selecting another alternative based on federal, state, local, or international concerns related to the social and environmental accounts. The Proposed Action is the NED alternative for this project.

The following purposes were analyzed for the Cove Reservoir Plan-EA, according to the P&G and the NWPM:

- Agricultural Water Management (Irrigation)
- Recreation

Each of these purposes is analyzed in the following subsections. See **Tables 6-1, 6-2 6-2a and 6-4 in the Plan/EA. See Table 6-5, Comparison of NED Benefits and Costs,** for a summary of the average annual project costs and benefits.

The following Excel Workbooks with their sheets provide the detail for the economic analysis:

- Cost Estimates for Appendix D and E
- Cove SCRB – 082020
- Explanation of Economic Analysis Workbooks (read this first)
- Incremental Analysis
- Irrigation Benefit Analysis
- Recreation Analysis Spreadsheets
- Work Plan Tables - 10012020

D.14.1 Irrigation

Net returns in Kane County for alfalfa hay and oat hay are calculated based on Costs and Returns for Growing Alfalfa and Oat Hay, Kane County, 2006. Budget prepared by: E. Bruce Godfrey, Cody Bingham, and Kevin Heaton Utah State University Extension Economics. Go to: https://extension.usu.edu/apec/agribusiness-food/crops then scroll to *Kane* and click *Alfalfa*.

Net returns in Washington County for alfalfa hay and oat hay are calculated based on Costs and Returns for Growing Alfalfa and Oat Hay, Washington County, 2006. Budget prepared by: E. Bruce Godfrey, Cody Bingham, and Dean Miner Utah State University Extension Economics. Go to: https://extension.usu.edu/apec/agribusiness-food/crops then scroll to *Washington* and click *Alfalfa*.

Cost data for alfalfa and oat hay were brought to current value using a multiplier calculated from Producers Prices Paid Index 2006 to 2020. Value of hay (all hay) is based on USU level current normalized prices for 2020. A value of $149.07 per ton from Current Normalized Prices, USDA, was used in the analysis. Operating costs were increased in the With Project Implementation scenario to account for the increased production. Net return for alfalfa and oat hay was calculated based on returns net production costs. Ownership costs were held constant in the Without and With Project Implementation scenarios since hay production in the benefit area is a well-established, long-term, and on-going production activity. Producers have a full complement of machinery and wheel-line irrigation systems.

Irrigated acres in the Orderville, Mount Carmel, and Glendale area (Kane County) are approximately 1,110 acres, and the irrigated area in Washington County is 4,958. Project alfalfa production in Kane and Washington counties is 4.8 and 5.2 tons per acre, respectively. This was determined based on the reservoir water yield (1638 acre-feet) calculated by the Utah Department of Water Resources (UDWRe) and apportioned to the Kane County irrigators (756 acre-feet) and Washington County irrigators (882 acre-feet). We communicated with Kevin Heaton, County Director/Extension Professor, Kane and Garfield counties, and Benjamin Scow, Professional Practice Extension Assistant Professor, Washington County, and they said project yields would be 4.8 and 5.2 tons per acre.

The following emails explain the basis for the irrigation benefits (increased crop production in Kane and Washington counties).

Kane County Production

Brent Gardner <brentgardner@alphaengineering.com>
To: Scott Hoag Jr.
Cc: Michael Noel, Brian Parker
Tue, Oct. 6 at 1:54 PM

I wasn’t able to get with Merlin Esplin but spoke with Mike Noel and he got me on the phone with Kevin Heaton, Agriculture and Natural Resources, USU Extension Service - Garfield and Kane County Director.

He indicated that having the additional supply of water in the later summer months would allow the irrigators in Kane County to go from 2 ½ cuttings to 4 cuttings and increase production by 1 ½ tons per acre.

Brent E. Gardner, PE

Brent Gardner <brentgardner@alphaengineering.com>
To: Scott Hoag Jr., Michael Noel

Cc: Brian Parker
Wed, Oct. 7 at 10:45 AM

Scott,

I talked with Merlin Esplin last night and he indicated with the right amount of water and fertilizer he has no problem getting 5 to 6 tons per acre but when he is short of water at the end of the year he can’t get 4 cuttings and ends up with 3 or less.

Brent E. Gardner, PE

Washington County Production

Brent Gardner <brentgardner@alphaengineering.com>
To: Scott Hoag Jr., Brian Parker, Ron Bolander, Jared Madsen
Thu, Oct. 22 at 12:37 PM

I have done some more investigation into the Washington Fields and acreage under irrigation. I originally thought it was approximately 10,000 acres but found it included other use areas outside of the Washington Fields area. The allocated water right for irrigation in the Washington Fields area is 4,958.2 acres (round to 4,958) according to the Division of Water Rights Group Use Number 610649. Based on this information we need to update our B/C ratio. I am also updating the cost for the access road around the reservoir as we have modified the road location to satisfy property owners which has made it a little shorter.

As far as irrigation benefits for the Washington Fields I have modified my October 8th email to Scott Hoag as follows:

I was finally able to get with Ben Scow with Washington County USDA. We discussed the effects of LaVerkin Springs on crop production and I developed the following information.

1. During the latter part of the summer the main stream flow of the Virgin River reduces substantially. The LaVerkin Springs (Pah Temp Springs) introduces 10 to 12 cfs of 10,000 ppm TDS water into the Virgin River above the diversion to the St. George/Washington Canal. The TDS of the Virgin River is around 500 ppm TDS above the influence of the LaVerkin Springs. When the Virgin River flow at the St. George Washington Canal diversion reduces to 60 cfs there is less dilution of the LaVerkin Springs with the main stream flow. The dilution effect is 6:1. The Cove Reservoir yield of 882 AF provided to the WCWCD will allow the release of approximately 10 cfs for a 45-day period during this critical stage and the dilution factor would be 7:1. This would reduce TDS levels from 2100 ppm to 1850 ppm and provide an additional 10 cfs water supply to the 4,958 acres being irrigated.
2. It is difficult to establish the increased crop production from the increased water supply but it was felt the dilution of the salts would be as much benefit as the increased water supply. It would not be difficult to say that the combined benefit of reduced salinity and increased water supply during the critical growing season would provide for an increase of up to 1 ton per acre.

Brent E. Gardner, PE

Detailed calculations of the irrigation benefits are in the Excel Workbook titled Irrigation Benefit Analysis. This Workbook and associated sheets can be found in Appendix E.

D.14.2 Recreation

Various data sets and reports were reviewed to ascertain recreation use at Cove Reservoir. These included the Recreation Use Values Database for North America (Rosenberger 2016; SCORP 2014; NPS 2019; Utah State Parks 2019; FreeMapTools 2019; Noel 2018; and Davies and Goonan 2017). The procedures in this report provided the basis for calculating recreation use at Cove Reservoir.

Thirteen recreation activities were selected from the Recreation Use Values Database for North America to represent activities at Cove Reservoir. The 2016 values were updated to 2020 using a multiplier calculated from the Consumer Price Index. The values were summed, and an average value was calculated based on a weighted average of recreation days for each of the 13 activities. Use data for four Utah State Parks (Coral Sand Dunes State Park, Gunlock State Park, Sand Hollow State Park, and Quail Creek State Park) were tabulated. Total recreation visitor days were calculated and divided by total campsites and the divided by the number of parks (4) for an average number of visitors. This number (2,756) was multiplied by the weighted average recreation day value ($67.43) for Cove Reservoir to determine the Recreation Benefits ($185,900).

Detailed calculations of the recreation benefits are in the Excel Workbook titled Recreation Analysis Spreadsheets. This Workbook and associated sheets can be found in Appendix E.

D.14.3 Glendale Pipeline and Hydroelectric Power Plant

Brent Gardner <brentgardner@alphaengineering.com>
To: Scott Hoag Jr.
Cc: Brian Parker,Ron Bolander
Thu, Oct. 22 at 4:06 PM

Everything has changed with the UDWRe model. There is 882 AF now which to go through the Quail Creek Hydroplant. This will produce 223,315 kW-Hrs of energy (average of 11.1 cfs for 40 days with 330 feet of head). They are currently selling the water at a rate of $0.05 per kW-hr which would have an annual value of $11,165.

D.14.4 Fish and Wildlife Benefits

The Virgin River Program currently provides for the pumping of water from the Sand Hollow Reservoir to the confluence of the Virgin River with Ash Creek and LaVerkin Creek just below where the LaVerkin Hot Springs is located. The water is used to help cool the water from the hot springs for the benefit of the endangered fish species in the river when river flows are low. There are two pumps designed to pump 5,288 gallons per minute, each at a total design head of 400 feet. The pumps are not required when river flows are adequate. There will be an additional 882 acre-feet of water that will be available to be pumped from this system to provide additional cooling water for endangered fish species.

D.14.5 Project Costs

D.14.5.1 Irrigation

Project costs for irrigation are based on cost estimates for the multipurpose structure (dam), the Glendale piping option, and the access road. Each of these estimates are described in a memorandum dated May 31, 2019 (Alpha 2019). The cost estimate memorandum also includes estimates of operation, maintenance, and replacement costs.

The costs were allocated to the irrigation and recreation purposes according to the procedure in the National Resource Economics Handbook, Part 611 Water Resources Handbook for Economics, Chapter 6 Costs and

Cost Allocation (NRCS 2014b). The percentage of cost allocated to irrigation is 81.1 and the percentage allocated to recreation is 18.9. Work Plan-EA tables were constructed based on the calculated cost allocated to irrigation and recreation. Within each purpose the costs were shared between NRCS and the local and state entities as specified in the NWPM. Cost share for irrigation is 75 percent federal and 25 percent local. Cost share for recreation is 50 percent federal and 50 percent local. Within these guidelines, engineering is 100 percent federal; land rights allocated to recreation are 100 percent local; and operation, maintenance, and replacement is 100 percent local. The access road to the recreation facilities will cost $308,000 and the access road around the reservoir $1,310,000. The road cost is shared, as specified earlier. See Work Plan Table 6-2a in the Plan-EA for the results of the cost allocation/cost sharing process.

D.14.5.2 Recreation

The recreation facilities cost estimate is detailed in the memorandum dated May 31, 2019 (Alpha 2019). Table 6-2b in the Plan-EA provide details for the recreation development.

All costs were amortized at the Fiscal Year 2021 Federal Water Resource Discount of 2.5 percent for 103 years. AAC are computed as the sum of the amortized construction cost, the annual operation and maintenance cost, and the average annual value of the replacement cost. Engineers estimated two components would need to be replaced in 50 years. Therefore, the AAC of replacement is equal to the present value of replacement 50 years hence multiplied by the replacement cost amortized over 100 years. See Work Plan Tables 6-4 and 6-6 in the Plan-EA for the results of these computations.

D.15 ENVIRONMENTAL EVALUATION

The Environmental Evaluation is a NRCS planning process described in the NRCS National Planning Procedures Handbook (NRCS 2013). The Environmental Evaluation identifies and analyzes the economic, environmental, and social concerns for a project. This planning process is then summarized on the CPA-52 Environmental Evaluation form for Conservation Planning. This Environmental Evaluation planning process started with the identification of problems and opportunities and continues through the application and evaluation of the project. A CPA-52 Environmental Evaluation is provided in Appendix E of the Plan-EA.

D.16 REFERENCES

Alpha Engineering (Alpha). 2019. Email message from Jared Madsen, Professional Civil Engineer, Alpha Engineering to Scott Hoag, Jr., Cove Reservoir—Opinions of Probable Cost, Benefits, Operation and Maintenance Costs, Repair and Replacement Costs, and Cost Allocation.

Bureau of Reclamation (BOR) 2006. *Managing Water in the West: Erosion and Sedimentation Manual.* U.S. Department of the Interior. https://www.usbr.gov/tsc/techreferences/mands/mands-pdfs/Erosion%20and%20Sedimentation%20Manual.pdf.

Davies, Lisa and Kelly Goonan. 2017. *Chief Toquer Reservoir*. Campground Revenue Research Report. Southern Utah University, Outdoor Recreation in Parks and Tourism.

Doelling, Hellmut H. 2008. Geologic Map of the Kanab 30-foot by 60-foot Quadrangle. Kane and Washington Counties, Utah and Coconino and Mohave Counties, Arizona. Utah Geological Survey Miscellaneous Publication 08-2DM 2 pages.

____________. 1999. Interim Geologic Map of the Kanab 30-foot by 60-foot Quadrangle, Kane and Washington Counties, Utah, and Coconino and Mohave Counties, Arizona. Open File Report. 366. Utah Geological Survey.

Doelling, Hellmut H. and Fitzhugh D. Davis. 1989. The Geology of Kane County, Utah: Geology, Mineral Resources, Geologic Hazards. Utah Geological and Mineral Survey, a division of Utah Department of Natural Resources. Bulletin 124. http://digitallibrary.utah.gov/awweb/awarchive?type=file&item=28598.

FreeMapTools. 2019. FreeMapTools. https://www.freemaptools.com/find-population.htm.

Hoag Jr., Scott. 2019a. Email message from Scott Hoag, Jr., Watershed Economics and Natural Resources Consulting, detailing irrigation benefit calculations at 1,110 acres. Received August 2, 2019.

____________. 2019b. Email message from Scott Hoag, Jr., Watershed Economics and Natural Resources Consulting, detailing alfalfa production and recreation benefits. Received June 9, 2019.

Natural Resources Conservation Service (NRCS). 2019. Technical Release 210-60. Earth Dams and Reservoirs. USDA Natural Resources Conservation Service Conservation Engineering Service. March 2019. https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=43317.wba.

____________. 2014a. National Watershed Program Manual, 4th Edition, amended January 2015, Parts 500 through 506.

____________. 2014b. National Resource Economics Handbook, Part 611 Water Resources Handbook for Economics, Chapter 6 Costs and Cost Allocation (Originally issued January 1998).

____________. 2013. NRCS Part 600_National Planning Procedures Handbook. 1st Ed. Amend. 6-January 2013. https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=33232.

____________. 2010. NRCS10. Natural Resources Conservation Service. Issued January 2010.

____________. 2005. Earth, Dams, and Reservoirs. TR-60. NRCS. Conservation Engineering Division. July 2005. https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=24937.wba.

National Park Service. 2019. National Park Visitation Data. https://irma.nps.gov/Stats/SSRSReports/Park%20Specific%20Reports/Annual%20Park%20Recreation%20Visitation%20(1904%20-%20Last%20Calendar%20Year)?Park=ZION.

Noel, Michael. 2018. Executive Director, Kane County Water Conservancy District. Personal communication. November 29, 2018. Conference Call Discussion Regarding Recreation Use at Jackson Flat Reservoir near Kanab, Utah.

Rosenberger, Randall S. 2016. R. Oregon State University. College of Forestry. Recreation Use Values Database-Summary. 2016 Updated http://recvaluation.forestry.oregonstate.edu/sites/default/files/RECREATION_USE_VALUES_DATABASE_%20SUMMARY.pdf.

Stokes, WL. 1986. *Geology of Utah*. Utah Geological and Mineral Survey and Utah Museum of Natural History Occasional Paper No. 6.

Strand, R.I. and Pemberton, E.L. 1982. Reservoir Sedimentation. Technical Guideline for Bureau of Reclamation, U.S. Department of the Interior. https://usbr.gov/tsc/techreferences/reservoir/ReservoirSedimentationTechGuide10_1982.pdf.

U.S. Department of Agriculture (USDA). 2019. Economics, Statistics and Market Information System. http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1002. http://www.nass.usda.gov/Charts_and_Maps/graphics/data/pitw.txt.

____________. 1973. Summary of Reservoir Sediment Deposition Surveys Made in the United States through 1970. Miscellaneous Publication 1226. Washington DC: Sedimentation Committee, Water Resources Council.

U.S. Geological Survey (USGS). 2019. https://earthquake.usgs.gov/hazards/interactive/.

U.S. Water Resources Council (USWRC). 1983. Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. https://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=stelprdb1256524&ext=pdf.

Utah Division of Water Resources (UDWRe). 1988. Inventory of Reservoirs and Potential Dam Sites in the Virgin River Basin.

Utah Office of Administrative Rules. 2019. Utah Administrative Code. Rule R655-11. Requirements for the Design, Construction and Abandonment of Dams. As in effect on September 1, 2019. https://rules.utah.gov/publicat/code/r655/r655-011.htm.

Utah State Comprehensive Outdoor Recreation Plan (SCORP). 2014. Utah Department of Natural Resources, Division of Utah State Parks and Recreation 2014.

Utah State Parks. 2019. Park Visitation Data. Utah State Parks Visitation Data by Fiscal Year. https://stateparks.utah.gov/resources/park-visitation-data/.