APPENDIX E

SUPPORTING INFORMATION

APPENDIX E-1

STANDARD BEST MANAGEMENT AND STANDARD OPERATING PROCEDURES

Standard Best Management Practices and Standard Operating Procedures

As part of standard operating procedures, standard best management practices (BMPs) would be implemented throughout the project in order to reduce potential adverse environmental impacts. Most of the impacts are short-term and generally occur during the construction period. Project design and implementation of site-specific or selectively recommended BMPs would minimize the effect of the project where the potential for long-term, adverse impacts may occur. These BMPs were taken from the Draft Cove Reservoir Plan of Development (POD) (Appendix E, Plan of Development for Cove Reservoir).

Standard BMPs
1. All construction vehicle movement outside of the ROW would be restricted to pre-designated access roads, contractor-acquired access roads, or public roads.
2. The limits of construction activities would be predetermined, with activity restricted to and confined within those limits. No paint or permanent discoloring agents would be applied to rocks or vegetation to indicate survey or construction activity limits. The ROW boundary would be flagged in environmentally sensitive areas, described in the POD, to alert construction personnel that those areas would be avoided.
3. In construction areas where re-contouring is not required, vegetation would be left in place wherever possible to avoid excessive root damage and allow for resprouting.
4. In construction areas where ground disturbance is significant or where recontouring is required, surface restoration would occur as required by the landowner or land management agency. The method of restoration typically would consist of returning disturbed areas to their natural contour (to the extent practical) and reseeding or revegetating with native plants. Seed viability would be tested and seed mixes would be certified to contain no noxious weeds.
5. Prior to construction, all construction personnel would be instructed on the protection of cultural, paleontological, and ecological resources. To assist in this effort, the construction contract would address (a) federal and state laws regarding antiquities, fossils, and plants and wildlife, including collection and removal; and (b) the importance of these resources and the purpose and necessity of protecting them.
6. An initial intensive cultural resource inventory survey would be conducted prior to construction. Impact avoidance and mitigation measures developed in consultation with appropriate land management and regulatory agencies and other interested parties would be implemented subsequent to the completion of the National Environmental Policy Act (NEPA) compliance document.
7. Any cultural and/or paleontological resource discovered during construction by the Kane County Water Conservancy District (KCWCD) or any person working on their behalf on public or federal land would be reported immediately to the authorized officer. The KCWCD would suspend operations in the area until an evaluation is completed to prevent the loss of cultural or scientific values.
8. All construction and maintenance activities would be conducted in a manner that would minimize disturbance to vegetation, drainage channels, and intermittent and perennial stream banks. In addition, dust-control measures would be utilized as necessary during construction in sensitive areas. Any used existing roads would be left in a condition equal to or better than their condition prior to construction.
9. All requirements of those entities having jurisdiction over air quality matters would be adhered to and any necessary permits for construction activities would be obtained. Open burning of construction trash (cleared trees, etc.) would not be allowed on Bureau of Land Management- (BLM) or U.S. Forest Service- (USFS) administered lands.
10. Fences and gates, if damaged or destroyed by construction activities, would be repaired or replaced to their original pre-disturbed condition as required by the landowner or the land management agency. Temporary gates would be installed only with the permission of the landowner or the land management agency.
11. Totally enclosed containment would be provided for all hazardous materials (if needed) and trash. All construction waste including trash, litter, garbage, other solid waste, petroleum products, and other potentially hazardous materials would be removed to a disposal facility authorized to accept such materials.
12. Third-party environmental contractors would be used throughout the construction effort, from clearing through rehabilitation.
13. The KCWCD would trim trees, in preference to cutting trees, and would cut trees, in preference to bulldozing them.
14. Construction holes left open overnight would be covered to prevent livestock or wildlife from harm.

Standard BMPs
15. The contractor would clean off-road equipment (power or high-pressure cleaning) of all mud, dirt, and plant parts prior to moving equipment onto public land.

Additional Stipulations

The following additional stipulations would be implemented throughout the construction and operation of the project and would be included as part of the standard operating procedures.

Stipulations – Standard Operating Procedures
1. KCWCD would construct, operate, and maintain the facilities, improvements, and structures within this ROW in strict conformity with the POD, as it is approved. Any relocation, additional construction, or use that is not in accord with the approved POD would not be initiated without the prior written approval of the authorized officer. A copy of the complete ROW grant or acknowledgment, including all stipulations and approved POD, would be made available on the ROW area during construction, operation, and maintenance to the authorized officer. Noncompliance with the above shall be grounds for an immediate temporary suspension of activities if it constitutes a threat to public health and safety or a material threat to the environment.
2. This POD describes in detail the construction, operation, maintenance of the ROW and its associated improvements and/or facilities. An approved POD may be referred to for interpretation of the ROW grant.
3. KCWCD would contact the authorized officer at least 10 days prior to the anticipated start of construction and/or any surface-disturbing activities. The authorized officer may require and schedule a preconstruction conference with the KCWCD prior to commencement of construction and/or surface disturbing activities on the ROW. The KCWCD, its contractor(s), or agents involved with the construction and/or surface disturbing activities on the ROW should attend this conference to review the stipulations of the grant and the POD.
4. KCWCD would designate a representative(s) who would have the authority to act upon and implement instructions from the authorized officer within a reasonable time when construction or other surface disturbing activities are underway.
5. KCWCD would protect all survey monuments found within the ROW. Survey monuments include but are not limited to General Land Office and BLM Cadastral Survey Corners, reference corners, witness points, U.S. Coastal and Geological Survey benchmarks and triangulation stations, military control monuments, and recognizable civil (both public and private) survey monuments. In the event of obliteration or disturbance of any of the above, the KCWCD would immediately report the incident, in writing, to the authorized officer and the respective installing authority, if known. Where General Land Office or BLM ROW monuments or references are obliterated during operations, KCWCD shall secure the services of a registered land surveyor or a BLM cadastral surveyor to restore the disturbed monuments and references using surveying procedures found in the *Manual of Surveying Instructions for the Survey of the Public Lands of the United States*, latest edition. KCWCD shall record such survey in the appropriate county and send a copy to the authorized officer. If the BLM cadastral surveyors or other federal surveyors are used to restore the disturbed survey monument, KCWCD would be responsible for the survey cost.
6. The KCWCD or the successor in interest shall comply with Title VI of the Civil Rights Act of 1964 (42 U.S.C. 2000d et. seq.) and the regulations of the Secretary of Interior issued pursuant hereto.
7. KCWCD would mark the exterior boundaries of the ROW with a stake and/or lath. The intervals may be varied at the time of staking at the discretion of the authorized officer. The tops of the stakes and/or laths would be painted and the laths flagged in a distinctive color as determined by the holder. The survey station numbers would be marked on the boundary stakes and/or laths at the entrance to and exit from public land. Holder would maintain all boundary stakes and/or laths in place until final cleanup and restoration are completed and approved by the authorized officer. The stakes and/or laths would then be removed at the direction of the authorized officer.
8. KCWCD would conduct all activities associated with the construction, operation, and maintenance of the ROW within the authorized limits of the ROW and approved POD.
9. KCWCD would survey and clearly mark the centerline and/or exterior limits of the ROW, as determined by the authorized officer.

Stipulations – Standard Operating Procedures
10. All design, material, and construction, operation, maintenance, and termination practices would be in accordance with safe and proven engineering practices.
11. KCWCD would inform the authorized officer within 48 hours of any accidents on federal lands that require reporting to the Department of Transportation as required by 49 CFR Part 195.
12. During conditions of extreme fire danger, operations may be suspended or limited in certain areas.
13. KCWCD would be liable for damage or injury to the United States to the extent provided by 43 CFR Sec. 2803.1-4. KCWCD would be held to a standard of strict liability for damage or injury to the United States resulting from fire or soil movement (including landslides and slumps as well as wind- and water-caused movement of particles) caused or substantially aggravated by any of the following within the ROW or permit area: • Activities of the holder including but not limited to construction, operation and maintenance of the facility. • Activities of other parties acting under color of authority from the KCWCD, including but not limited to: o land clearing; o earth-disturbing and earth-moving work; and o blasting.
14. Within 30 days of completion, KCWCD would submit to the authorized officer, as-built drawings and a certification of construction verifying that the facility has been constructed (and tested) in accordance with the design, plans, specifications, and applicable laws and regulations.
15. Construction sites would be maintained in a sanitary condition at all times. Waste materials at those sites would be disposed of promptly at an appropriate waste disposal site. “Waste” means all discarded matter including but not limited to human waste, debris, garbage, refuse, oil drums, petroleum products, ashes, and equipment.
16. Prior to preconstruction activities on the subject parcel, KCWCD would identify all noxious weeds present. A list of the weeds would be provided to the authorized officer. A determination would be made by the authorized officer of any noxious weeds that may require flagging for treatment. KCWCD shall treat the noxious weeds as required by the authorized officer.
17. KCWCD would clean off-road equipment (power or high-pressure cleaning) of all mud, dirt, and plant parts prior to moving equipment onto public land authorized under this lease.
18. Gravel and/or fill material to be placed in relatively weed-free areas must come from weed-free sources. Prior to obtaining gravel and/or fill material, the authorized officer would inspect the source for weeds and determine adequacy of site.
19. KCWCD would identify a road maintenance program, which would include monitoring for noxious weeds. If KCWCD identifies any noxious weeds, KCWCD would notify the authorized officer immediately. A treatment program would be identified and KCWCD would be responsible for weed abatement.

APPENDIX E-2

BIOLOGICAL EVALUATION

BIOLOGICAL EVALUATION

Kane County Water Conservancy District's Cove Reservoir Project
Kane County, Utah

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INTRODUCTION

The Natural Resources Conservation Service (NRCS), with assistance of the Kane County Water Conservancy District (KCWCD) as the project sponsor, has initiated a Watershed Plan-Environmental Assessment (Plan-EA) for proposed improvements to be developed within the East Fork Virgin River Watershed. Currently, the proposed improvements include: the construction of a new, approximately 6,032-acre-foot capacity reservoir (Cove Reservoir); the replacement of an approximately 1.7-mile section of existing pipeline; and relocation of the Glendale hydroelectric power plant. The NRCS, KCWCD, and Alpha Engineering contracted Transcon Environmental, Inc. (Transcon) to develop the Plan-EA and analyze the project for impacts to natural and human resources including federally-listed species protected under the Endangered Species Act (ESA), BLM and Utah state sensitive species, and avian species protected under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) (special status species). This Biological Evaluation was prepared to evaluate potential impacts the project may have on special status species.

PROJECT DESCRIPTION

The NRCS and KCWCD are proposing to construct the Cove Reservoir Project to provide irrigation and agriculture water to local users in the Orderville, Glendale, and Mt. Carmel areas during dry summer months. Construction of the project would include the following components:

- 6,032-acre-foot capacity reservoir
- Approximately 90-foot by 1,900-foot earthen and rock fill dam
- Primary and auxiliary spillways
- Replacement of approximately 1.7 miles of existing irrigation pipeline in the Glendale irrigation system
- Relocation of the existing Glendale hydroelectric power plant
- Access road circumnavigating the reservoir
- Recreational area and boat ramp at the reservoir
- Approximately 0.2 of mile powerline from the Glendale hydroelectric power plant to the existing infrastructure
- Approximately 1.7 miles of new pipeline to the new Glendale hydroelectric power plant

Implementation of the proposed project would require the use of up to four active borrow sites—the Elbow, Tait, Lamb, and Bald Knoll pits—for project-related construction needs. The development of an additional new borrow site, the Black Knoll pit, is also proposed. The existing Elbow and Bald Knoll pits and the new Black Knoll pit are located along Glendale Bench Road on Bureau of Land Management- (BLM) administered public lands. The Lamb, and Tait pits are located on private lands near Mt. Carmel and Mount Carmel Junction. Because three of the borrow sites are located on BLM-administered lands, BLM will need to authorize their use prior to any material removal. As the BLM is a cooperating agency for this effort,the Cove Reservoir Plan-EA serves as the BLM EA for borrow pit use. Use of the BLM administered borrow sites complies with the 2008 BLM Kanab Field Office Resource Management Plan.

The purpose of this project is to provide the Glendale, Mt. Caramel, and Orderville irrigation companies with additional water storage capacity to meet present and future irrigation water demands, add new recreational opportunities in the region, and potentially providing benefits to federally-listed endangered species downstream. Final design plans have not yet been developed; however, all temporary and permanent areas of disturbance associated with construction of the proposed project would be contained within the study area depicted in **Figure 1** and analyzed within this report and the Plan-EA.

Several Applicant-committed Environmental Protection Measures and Best Management Practices have been identified for the proposed project and will be implemented as part of the project development. Measures have been identified for soil, air quality, water resources, vegetation, noxious weeds and invasive plant species, wildlife, threatened and endangered species, migratory birds including bald and golden eagles, riparian areas, historic and cultural resources, and visual resources. Issues such as traffic, noise, hazardous materials and wastes, public health and vector control, and site rehabilitation have also been addressed. A comprehensive list of these measures is detailed in the Plan-EA for the project. Those measures applicable to the conservation of plant and wildlife resources are also highlighted within this BE under the *Applicant Committed Conservation Measures* section below.

PROJECT LOCATION

The proposed project area is located within Township 40 South, Range 5 West, Section 28; Township 40 South, Range 7 West, Sections 23, 26, and 27; and Township 41 South, Range 7 West, Sections 5, 6, 19, and 31, Salt Lake Baseline and Meridian on the Bald Knoll, Orderville, Glendale, and Mt. Carmel, Utah 7.5-minute U.S. Geological Survey topographic quadrangles.

The survey area surrounding all components of the proposed project as a whole measures approximately 805.6 acres and is generally located along U.S. Route 89 (US-89) west of the towns of Glendale and Orderville. Two existing borrow pits (Elbow and Bald Knoll) and one new pit (Black Knoll) are located along the Glendale Bench Road east of Glendale, Utah. The existing Tait and Lamb pits are located along US Highway 89 near Mt. Carmel and Mt. Carmel Junction. The proposed new pipeline parallels US-89 south from milepost (MP) 89.4 to MP 87.9; the proposed hydroelectric plant is located west of US-89 at MP 87.9. Access to the proposed Cove Reservoir is along Cove Road between MP 84.9 and MP 85.

The project area is located on land under the jurisdiction of the Bureau of Land Management Kanab Field Office and private ownership. **Figure 1** shows the proposed project features study area and land jurisdictions.

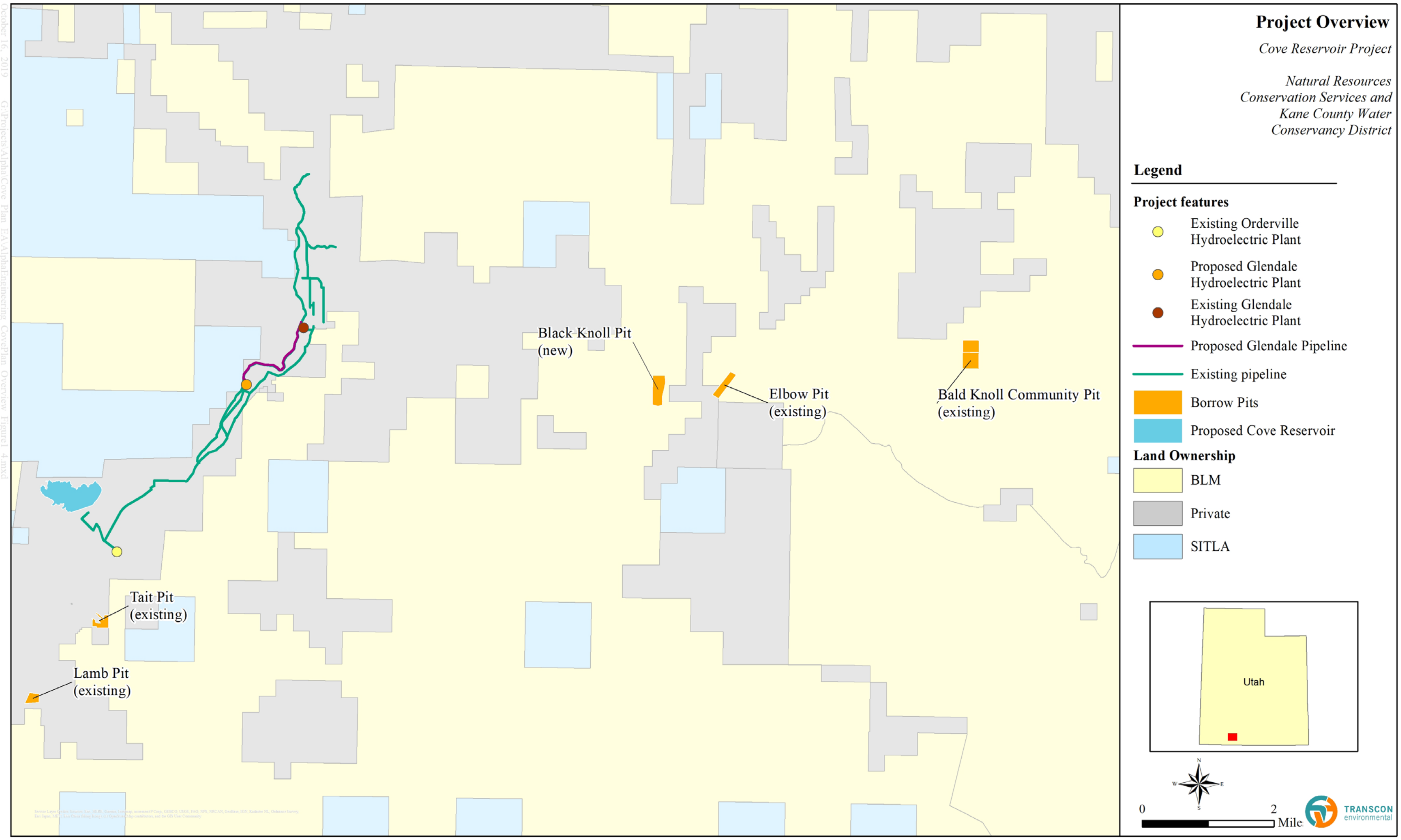

Figure 1. Project Overview Map

ACTION AREA

The action area is defined as the area that could be directly or indirectly affected by a federal action (50 CFR 402.02). The action area includes the project area—where all permanent and temporary areas of ground disturbance would occur—as well as species-specific buffers, which extend beyond the project area. Permanent ground disturbance would occur where the proposed reservoir, dam, primary and auxiliary spillways, hydroelectric plant, access roads, and recreational features (e.g., campsites, boat ramp, etc.) would be constructed. Permanent ground disturbance would also occur where existing borrow pit sites would be expanded, as well as where new borrow pits would be developed for project-related use. Temporary ground disturbance would occur during replacement of the existing pipeline and adjacent to where the permanent spillway would be constructed.

For the analysis of special status species, the action area has been extended to include species-specific buffers. These buffer distances are determined based on activities proposed to occur within the project footprint (i.e., the immediately impacted area) that may cause impacts extending beyond the footprint (e.g., noise, vibration, dust, etc.). Buffers include:

- Avian species: 0.5-mile buffer
- Plant species: 300-foot buffer
- Aquatic species:0.25-mile buffer

Determination of action area buffer distances follows recommendations from the U.S. Fish and Wildlife Service (USFWS) guidelines for raptor protection (USFWS 2002). These buffers were determined based on anticipated levels of construction-related disturbance, including noise, dust, and ground vibrations produced by vehicles and heavy equipment. Construction-related impacts are not expected to extend beyond these buffers, considering that habitats within or adjacent to the project area are subjected to existing levels of anthropogenic disturbance.

AFFECTED ENVIRONMENT

The proposed project area is located within the Grand Staircase subdivision of the Colorado Plateau physiographic region of southwestern Utah, immediately south of the Basin and Range–Colorado Plateau Transition Zone (Stokes 1977). The Grand Staircase subdivision is characterized by a series of slopes, cliffs, and terraces that extend from the Grand Canyon in Arizona, culminating in the High Plateaus of southern Utah. This region is further characterized by many unique linear cliffs that are distinctly colored and display several different geologic ages (Stokes 1977). Major drainage systems in the project area include the East Fork Virgin River and Muddy Creek, as well as unnamed washes, springs, and dry washes.

The project area begins north of Mount Carmel Junction at the Lamb pit, encompasses a large area west of Orderville at the proposed reservoir site (**Appendix A**–Photos 1 and 2), extends along the East Fork Virgin River at the area of the proposed new pipeline, and terminates northeast of Glendale by the Bald Knoll pit. The topography of the project area is generally flat with rolling hills, particularly bordering the proposed reservoir site. Most of the project extends along the Sevier Fault; Triassic and Jurassic rock formations are exposed in the region across the anticline, including the Glen Canyon Group of Moenave Formation, Kayenta Formation, and Navajo Sandstone. There are also Cretaceous rock formations west of the Sevier Fault in the project area, including the Wahweap and Straight Cliffs formations, Dakota Sandstone and Cedar Mountain Formation, and the Jurassic Carmel Formation (Williams et al. 2014).

The proposed new pipeline section of the project area is located within Long Valley along the Mount Carmel Scenic Byway, which lies west of Glendale Bench and the White Cliffs. The proposed reservoir section of the project area is located west of the town of Orderville adjacent to Cove Canyon and Deer

Hollow, and the Bald Knoll and proposed Black Knoll pits are located just above the Skutumpah Terrace. Elevations in the project area range from 5,230 feet above sea level (asl) near Lamb's pit to 6,542 feet asl in the vicinity of Bald Knolls community pit. Elevations in the proposed new pipeline area range from 5,600 to 5,721 asl.

Lands within and immediately adjacent to the project area contain a mix of developed and undeveloped areas, with a few municipal and residential developments along US-89. Land use consists primarily of farming, livestock grazing, and recreational activities such as hiking and off-highway vehicle use.

Vegetation

Vegetation found in the project area consists of greasewood-salt scrub and transitions into sagebrush-perennial grassland habitat and eventually, into a pinyon-juniper woodland in the higher elevations (**Appendix A**–Photo 3). The Project would utilize up to four existing and active borrow pits (Elbow, Tait, Lamb, and Bald Knoll) and one new site (Black Knoll). Vegetation at these sites consists of a mix of pinyon-juniper woodland, sagebrush, and oak brush communities. The area of the proposed new pipeline and hydroelectric plant is found in proximity to the East Fork Virgin River, and portions of this section of the project cross though agricultural fields and along a riparian environment with tamarisk, Russian olive, and cottonwood trees (**Appendix A**–Photo 4).

According to the U.S. Geological Service's Gap Analysis Program (USGS 2011), dominant ecological systems in the study area include Inter-Mountain Basins Big Sagebrush, Colorado Plateau Pinyon-Juniper Woodland, Introduced Upland Vegetation-Shrub, Shrubland, Inter-Mountain Basins Greasewood Flat, Rocky Mountain Lower Montane Riparian Woodland and Shrubland, Mogollon Chaparral, Disturbed/Successional—Shrub Regeneration, and Pasture/Hay. Species observed within or adjacent to the proposed project during field visits were characteristic of those ecosystems and included native shrubs, bunchgrasses, and trees.

Common vegetation observed within the action area includes Great Basin sagebrush *(Artemisia tridentata),* Mormon tea (*Ephedra viridis*)*,* blackbrush (*Coleogyne ramosissima*)*,* saltbush (*Atriplex* spp.)*,* rabbitbrush (*Chrysothamnus* spp.), narrowleaf willow (*Salix exigua*), cattail (*Typha latifolia*)*,* bluebunch wheatgrass (*Pseudoroegneria spicata*)*,* bottlebrush squirreltail (*Elymus elimoides*)*,* Indian ricegrass (*Oryzopsis hymenoides*), purple three-awn (*Aristida purpurea*)*,* needle-and-thread grass (*Hesperostipa comata*), two-needle pinyon pine (*Pinus edulis*)*,* and Utah juniper (*Juniperus osteosperma*).

Common non-native vegetation observed within the action area includes cheatgrass (*Bromus tectorum*) and Russian thistle (*Salsola* spp.).

Project activities associated with the construction of the pipeline and reservoir would result in the removal of plants and displacement of soil. Within the reservoir basin, dam, and spillways, vegetation would be permanently impacted once the dam and spillways are constructed and the reservoir filled. Long-term impacts would also occur where recreational features, the hydroelectric plant, and new access road around the reservoir would be constructed, including areas where cut and fill slopes would require the removal and burial of vegetation. Vegetation would also be temporarily impacted by replacement of the Glendale Pipeline and in areas surrounding the spillways. Outside of this ground disturbance, impacts would result from the transport and staging of vehicles, equipment, and materials; parking; and foot traffic.

Soils

The predominant soil types within the project area are classified under Map Unit Name UT642 as Upland Clay Loam, Sili-Sideshow-Gypsic Haplustepts complex (Upland Clay Loam), Zigzag family-Badland-

Quezcan complex (Upland Clay Loam), with smaller distributions of Quezcan (Upland Clay Loam), deep-Sideshow-Orderville complex, Catdraw-Quezcan-Vessilla complex, and Naplene-Teromote-Arboles-Oxyaquic Ustifluvents complex (NRCS 2016).

Water Resources

A review of the project area based upon a combination of aerial imagery, the USFWS Wetland Inventory Mapper (USFWS 2018a) and field surveys, identified potential jurisdictional Waters of the U.S., including two wetlands, six intermittent streams, and one perennial stream (East Fork Virgin River). One wetland is located south of the proposed reservoir and associated access road location and is an isolated, manmade pond. The second wetland is also an isolated, manmade pond located within the right-of-way (ROW) where the replacement of the existing irrigation pipeline would occur. Four of the intermittent streams are located within or in the vicinity of the proposed reservoir location, while the other two bisect the ROW for the pipeline replacement portion of the project. The East Fork Virgin River roughly parallels the alignment of the pipeline replacement ROW. The river bisects the project area where the proposed powerline from the Glendale hydroelectric power plant would be constructed; however, no construction activities would occur within the river or its bankfull width, and the river would not be affected by implementation of the proposed project. Detailed analysis of the water resources proximal to the project area are provided in a separate Preliminary Aquatic Resource Delineation Report for the project.

SPECIES ASSESSEMENT

This Biological Evaluation addresses special status species, including federally-listed species, BLM and Utah state sensitive species, and avian species protected under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) with potential to occur within the proposed project area. These species were identified using the USFWS Information for Planning and Conservation (IPaC) tool and the BLM and Utah state sensitive species lists (USWFS 2018b; UDWR 2017; BLM 2010; BLM 2011). The Utah Natural Heritage Program (UNHP) office was contacted to provide information on documented occurrences of sensitive species near the project area; a letter from the UNHP office is included as **Appendix B**.

A Transcon biologist conducted field visits of the project area between October 8 and 10, 2018, and on April 24 and September 20, 2019 to verify the desktop review, document vegetation, and assess habitat for potentially occurring special status species within the action area. The survey was requested by the NRCS and KCWCD to determine if any significant biological resources which could be affected by the project are present within the proposed project area. This BE evaluates potential impacts to species for which potential habitat, UNHP records of occurrence, or field observations exist in the project area.

Federally-listed Species

Desktop review using the USFWS IPaC site revealed that the following federally-listed species may occur within the proposed project area: California condor (*Gymnogyps californianus*), Mexican spotted owl (*Strix occidentalis lucida*), southwestern willow flycatcher (*Empidonax traillii extimus*), yellow-billed cuckoo (*Coccyzus americanus*), Virgin River chub (*Gila seminuda*), woundfin (*Plagopterus argentissimus*), and Jones cycladenia (*Cycladenia humilis* var. *jonesii*). Further analysis of habitat requirements and known ranges of these species determined that there is no suitable habitat within the project area for these species. This determination is supported by the letter provided by the UNHP noting a lack of any records of occurrence, recent or historical, for federally-listed species within 2 miles of the project area.

No designated critical habitat is located within or near the project area. However, three federally-listed species (woundfin, Virgin River chub and southwestern willow flycatcher), including their designated critical habitat, occur approximately 50 river miles downstream of the project area in Washington County and are discussed below. No other listed species would be affected by development of the proposed project. **Appendix C** contains a habitat suitability assessment table for all federally-listed species which may occur within the project area as identified by the IPaC site.

Woundfin and Virgin River Chub

Listed woundfin and Virgin River chub designated critical habitat exists approximately 50 river miles downstream from the project area in Washington County beginning at La Verkin (Pah Tempe) Hot Springs. Planned releases from the proposed reservoir could provide additional and cooler water to augment this habitat. An agreement with Zion National Park would restrict these releases to not exceed 25 cfs over short periods of time and not over 15 cfs over a long period of time. Any additional contributed water would reduce the need to maintain habitat by actively pumping water from nearby Quail Creek Reservoir to La Verkin Hot Springs. This indirect effect would be minor due the controlled amount of water released from the proposed reservoir and the distance the water would need to travel before reaching woundfin and Virgin River chub habitat. Therefore, implementation of the proposed project *May Affect, but would Not Likely Adversely Affect* the woundfin and Virgin River chub and their designated critical habitat due to potential beneficial effects.

Southwestern Willow Flycatcher

In Utah, designated critical habitat for the southwestern willow flycatcher extends along the Virgin River from the Arizona state line northeast approximately 29.5 miles to Berry Springs near Quail Creek Reservoir. Potential habitat likely continues from that point along the Virgin River and East Fork Virgin River through Zion National Park. However, the southwestern willow flycatcher is not specifically identified in Zion National Park planning documents as occurring in the park (National Park Service 2019). Favorable habitat does not occur within the project area. Still, the flycatcher could use portions of the river as stop-over areas during migration. It is not anticipated that flycatchers use the Virgin or East Fork Virgin Rivers beyond the designated critical habitat for breeding, nesting, or being present on more than a transient basis. The increased water flows from the proposed reservoir through the Park and down the Virgin River as described above may help stabilize riparian vegetation to a minor amount. Therefore, implementation of the proposed project *May Affect, but would Not Likely Adversely Affect* the southwestern willow flycatcher or its designated critical habitat due to potential beneficial effects.

TABLE 1
EFFECT DETERMINATION OF SPECIAL STATUS SPECIES AND CRITICAL HABITAT

Species	Species Effect Determination	Critical Habitat Effect Determination
California condor	No effect	No effect
Mexican spotted owl	No effect	No effect
Southwestern willow flycatcher	May affect, but is not likely to adversely affect	May affect, but is not likely to adversely affect
Yellow-billed cuckoo	No effect	Not applicable; critical habitat has been proposed; however, no final rule has been published.

Woundfin	May affect, but is not likely to adversely affect	May affect, but is not likely to adversely affect
Virgin River chub	May affect, but is not likely to adversely affect	May affect, but is not likely to adversely affect
Jones cycladenia	No effect	Not applicable; critical habitat has not been designated for this species.

BLM and State Sensitive Species

Known ranges and habitat requirements for BLM and State sensitive plant and wildlife species, including Conservation Agreement species, that may occur within Kane County were examined to assess their potential to occur within the action area and the likelihood that each species would be impacted by project-related activities. Based on desktop and field review of the project area, UNHP records of occurrence and species' habitat requirements, including suitable geologic formations, soils, vegetation communities, and elevation, it was determined that suitable habitat which may contain the following BLM and/or State sensitive plant and wildlife species may be present or near to the project area: Gooseberry leaf globemallow (*Sphaeralcea grossulariifolia*), bald eagle (*Haliaeetus leucocephalus*), desert sucker (*Catostomus clarkia*), Arizona toad (*Anaxyrus microscaphus*), Great Plains toad (Anaxyrus *cognatus*), ferruginous hawk (*Buteo regalis*), and Greater sage-grouse (*Centrocercus urophasianus*).

The UNHP database contains records of recent occurrence of bald eagle within 0.5 mile of the project area (**Appendix B**) and historical records of occurrence for desert sucker and Arizona toad within a 2-mile radius. Greater sage-grouse habitat exists near the three BLM administered borrow sites.

A habitat assessment of the above BLM and State sensitive species is presented in **Appendix D**.

Migratory Birds

Migratory birds are protected under the MBTA of 1918, as amended (16 USC 703-712). The MBTA states that it is unlawful to take, kill, or possess migratory birds, their eggs, parts, and/or nests that are listed under its protection, unless authorized under a valid permit (50 CFR 21.11). USFWS (2018b) noted ten migratory birds of conservation concern (excluding federally-listed species) that could occur near the project area. As discussed in the *State-listed Species* section above, the UNHP database contains recent and historical records of migratory bird occurrence within 2 miles of the project area (**Appendix B**).

Suitable nesting habitat that could be utilized by a variety of migratory bird species was observed within and adjacent to the project area, including abundant pinyon-juniper woodland habitat. Corridors of suitable riparian nesting habitat containing large cottonwood, Russian olive, and oak trees also exists adjacent to two small streams which bisect the pipeline portion of the project area. A large expanse of sagebrush shrub habitat which may provide suitable nesting habitat for smaller avian species exists within the proposed reservoir basin. This sagebrush habitat may also serve as suitable foraging for raptors and other larger species. Suitable cliff nesting habitat for species such as golden eagles or peregrine falcons is located approximately 1.5 miles east of the proposed project area (**Appendix A**–Photo 5). No cliff nesting habitat was observed within the action area.

Avian species observed within and adjacent to the project area during the field visit between October 8 and 10, 2018 include red-tailed hawk (*Buteo jamaicensis*), common raven (*Corvus corax*), and turkey vulture (*Cathartes aura*). It should be noted that surveys were conducted during poor weather conditions and at a time of year when avian activity in the region is typically low.

No raptor nests were observed within 0.5 mile of the project area during the field survey. If construction occurs during raptor nesting season (January 1 through August 31), a pre-construction survey would be completed within 2 weeks prior to construction to ensure no raptors are nesting within 0.5 mile of the project area. If a nest is found, the Utah Department of Wildlife Resources and/or USFWS, as appropriate, would be notified. Project activities would not occur within recommended spatial and seasonal buffers for raptors, unless otherwise approved. If existing topography limits line of sight between an active nest and construction activities, spatial and seasonal buffers may be reduced.

If construction activities occur during the migratory bird nesting period (April 1 through August 15), a migratory bird nesting survey would be completed in areas proposed for disturbance during this time period. Should an active migratory bird nest be discovered, KCWCD and the appropriate agency biologist would be notified and an appropriate buffer would be established around the nest until the migratory bird nesting period ends or young have fledged.

It is anticipated that there will be project-related impacts to migratory bird habitat, including the permanent removal of suitable nesting and foraging habitat within the reservoir, dam, access road, and spillway locations. However; these impacts would be minimal and are not anticipated to have any long-term, detrimental impacts on migratory bird species of concern considering that extensive suitable nesting and foraging habitat surrounding the proposed project area and vicinity would remain unaffected by the implementation of the project. Following completion of the project, the reservoir would eventually provide a limited amount of additional migratory bird habitat as the riparian area surrounding the reservoir becomes established.

Bald and Golden Eagles

Bald and golden eagles are protected under the BGEPA, originally passed in 1940 and amended in 1962. The BGEPA prohibits the take, possession, sale, purchase, barter, offer to sell, transport, export, or import of any bald or golden eagle, alive or dead, including any part, nest, and/or egg, unless allowed by permit (16 U.S.C. 668[a]; 50 CFR 22). The definition of take includes both direct take of individuals and take due to disturbance.

No bald or golden eagles or potential nests were observed during the field surveys. The UNHP database contains records of recent bald eagle occurrence within 0.5 mile (**Appendix B**). Lands surrounding the proposed project area are likely to support a variety of prey species (e.g., rabbit, rodents) and high levels of roadkill carrion, and therefore may serve as suitable foraging habitat for golden eagles (*Aquila chrysaetos*) as well as migrating/wintering habitat for bald eagles. No suitable nesting habitat for bald or golden eagles was observed within the action area.

Any impacts to bald and golden eagles would be minimal due to lack of suitable nesting habitat within 0.5 mile of the majority of the project area; however, if construction occurs during raptor nesting season (February 15 through August 31), a pre-construction raptor survey would be completed within 2 weeks prior to construction to ensure no bald eagle or golden eagle nests are located with 0.5 mile of the project area. If a bald or golden eagle nest is found, KCWCD would be notified. Project activities would not occur within recommended spatial and seasonal buffers for bald or golden eagles, unless otherwise approved. If existing topography limits line-of-sight between an active nest and construction activities, spatial and seasonal buffers may be reduced.

Following completion of the project, the reservoir would eventually provide a limited amount of additional bald and golden eagle habitat as the riparian area surrounding the reservoir becomes established, especially should larger trees become established. Fish stocked in the reservoir may also provide additional foraging for bald eagles during winter roosting.

Applicant Committed Conservation Measures

The following applicant committed conservation measures relative to listed, sensitive, or other plant and animal species would be implemented as part of the project. Construction activities will be limited to the smallest extent practicable within the project area.

- During construction activities, vehicle parking and material stockpiles will be located within designated staging areas.
- Upon completion of construction activities, the disturbed areas will be recontoured in order to: minimize erosion and compaction, restore natural ground cover, reestablish plant growth, and allow natural surface drainage.
- Silt fences, straw bales, and/or other appropriate Best Management Practices (BMPs) will be used to minimize erosion of disturbed areas if needed. Construction and staging areas will be assessed to determine the feasibility of straw bales, silt fences, and other appropriate sediment control BMPs will be implemented to prevent entry of sediment and other contaminants into downstream drainages.
- To ensure that accidental spills do not enter waters, the storage of petroleum-based fuels in addition to other hazardous materials as well as the refueling of construction machinery will be restricted to approved, designated staging/batch plant areas.
- Federal and state water quality standards and toxic effluent standards will be implemented to minimize potential adverse effects from discharges into WOTUS.
- Fueling of vehicles and equipment will be prohibited within 100 feet of any riparian area.
- Established cottonwood trees in riparian areas would be left in place for fish and wildlife habitat.
- Any unexpected encounters with a protected species will be immediately reported to UDWR, USFWS, and NRCS.
- Coordination will be maintained with WCWCD regarding construction activities and potential impacts to downstream Virgin River habitat.
- To prevent entrapment of wildlife during construction, all open pits or trenches will be monitored throughout the construction day.
- Excavated holes more than 2 feet deep will be covered at the close of each day or provided with one or more escape ramps. Alternatively, fencing may be erected around open pits or trenches. Before pits or trenches are filled, they will be inspected for trapped animals. If any animals are found, they will be moved out of harm's way by a qualified biologist approved by the UDWR or and NRCS.
- No rodenticides will be used on the project site.
- Where possible, construction activities, including habitat alteration and noise, will be conducted outside of Utah's migratory bird primary nesting season (April 1–July 15). In Utah, the migratory bird nesting season can extend from January 1–August 31 (especially for raptors). Therefore, for construction activities occurring after January 1 or prior to August 31, a preconstruction survey for nesting birds will be conducted by a qualified biologist approved by UDWR and NRCS no more than five days prior to when on-site work actually begins. After such surveys are performed and disturbance occurs, no additional disturbance during the avian breeding season will occur without first conducting another avian survey. If an active nest is identified, a no-activity buffer as approved by UDWR and NRCS will be established around the nest site and will remain in place until the young have fledged and/or the nest becomes non-active. Follow-up surveys, to confirm that all

young have successfully fledged, will be conducted by a qualified biologist prior to construction in that area.

- The transmission line will be designed and constructed according to raptor-safe design standards, which meet or exceed the Suggested Practices for the Protection of Raptors on Power Lines: The State of the Art in 2006 (Avian Power Line Interaction Committee 2006).
- Where seeding is required for rehabilitation, the applicant will use a NRCS-approved, weed-free seed mix.
- Vegetation and soil removal will be kept to the minimum amount necessary.
- The proposed reservoir site would be smoothed and cleaned of debris and trash prior to filling with water.
- Borrow sites would be cleaned, and any debris removed, per instructions of the owner.
- All equipment will be cleaned of soils, seeds, vegetation matter, and other debris prior to entering or reentering the project area.
- NRCS requires that contractors comply with all federal, state, and local laws/regulations pertaining to pollution and contamination of the environment to prevent pollution of surface water, groundwater, soil, and air with any hazardous materials.
- Construction sites, staging areas, and access roads will be kept orderly during construction.

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APPENDIX A

PROJECT AREA PHOTOGRAPHS

Photo 1. Project overview looking west where the proposed dam (left) and Cove Reservoir would be constructed (middle/right).

Photo 2. Project overview looking northeast across proposed dam site from the southwest end of dam.

Photo 3. View facing southeast from the northwest portion of the reservoir showing typical sagebrush habitat surrounded pinyon/juniper habitat where the proposed reservoir would be constructed.

Photo 4. View facing south where a small, intermittent stream crosses the pipeline replacement portion of the project area showing agricultural fields (left) and riparian habitat that exists within and adjacent to the project area.

Photo 5. View of typical sagebrush scrub habitat within the proposed reservoir basin. The nearest area of suitable cliff nesting habitat located outside of the action area is depicted in the far background of the photo.

Photo 6. View facing north of the Bald Knoll Borrow Pit.

Photo 7. View facing west of Bald Knoll expansion pit.

Photo 8. View facing north of the Lamb borrow pit.

Photo 9. View facing northwest of the proposed Black Knoll borrow pit.

Photo 10. View facing northeast of the Tait borrow pit.

Photo 11. View facing north of the Elbow borrow pit showing existing stockpiles that would be utilized for construction of the dam.

APPENDIX B

UNHP AND IPAC LETTERS

State of Utah
DEPARTMENT OF NATURAL RESOURCES
MICHAEL R. STYLER
Executive Director
Division of Wildlife Resources
MICHAL D. FOWLKS
Division Director

GARY R. HERBERT
Governor

SPENCER J. COX
Lieutenant Governor

October 1, 2018

Brian Parker
Transcon Environmental
1745 South Alma School Road, Suite 220
Phoenix, AZ 85210

Subject: Species of Concern Near the Reservoir and Watershed Improvement Project

Dear Brian Parker:

I am writing in response to your email dated September 25, 2018 regarding information on species of special concern proximal to the proposed reservoir and watershed improvement project located in Sections 23, 26 and 27 of Township 40 South, Range 7 West, and Sections 5 and 6 of Township 41 South, Range 7 West, SLB&M near Orderville in Kane County, Utah.

Within a ½-mile radius of the project area noted above, the Utah Division of Wildlife Resources (UDWR) has recent records of occurrence for bald eagle, and historical records of occurrence for desert sucker. In addition, within a two-mile radius there historical records of occurrence for Arizona toad. All of the aforementioned species are included on the Utah Sensitive Species List.

The information provided in this letter is based on data existing in the Utah Division of Wildlife Resources' central database at the time of the request. It should not be regarded as a final statement on the occurrence of any species on or near the designated site, nor should it be considered a substitute for on-the-ground biological surveys. Moreover, because the Utah Division of Wildlife Resources' central database is continually updated, and because data requests are evaluated for the specific type of proposed action, any given response is only appropriate for its respective request.

In addition to the information you requested, other significant wildlife values might also be present on the designated site. Please contact UDWR's assistant habitat manager for the southern region, Rhett Boswell, at (435) 865-6112 if you have any questions.

Please contact our office at (801) 538-4759 if you require further assistance.

Sincerely,

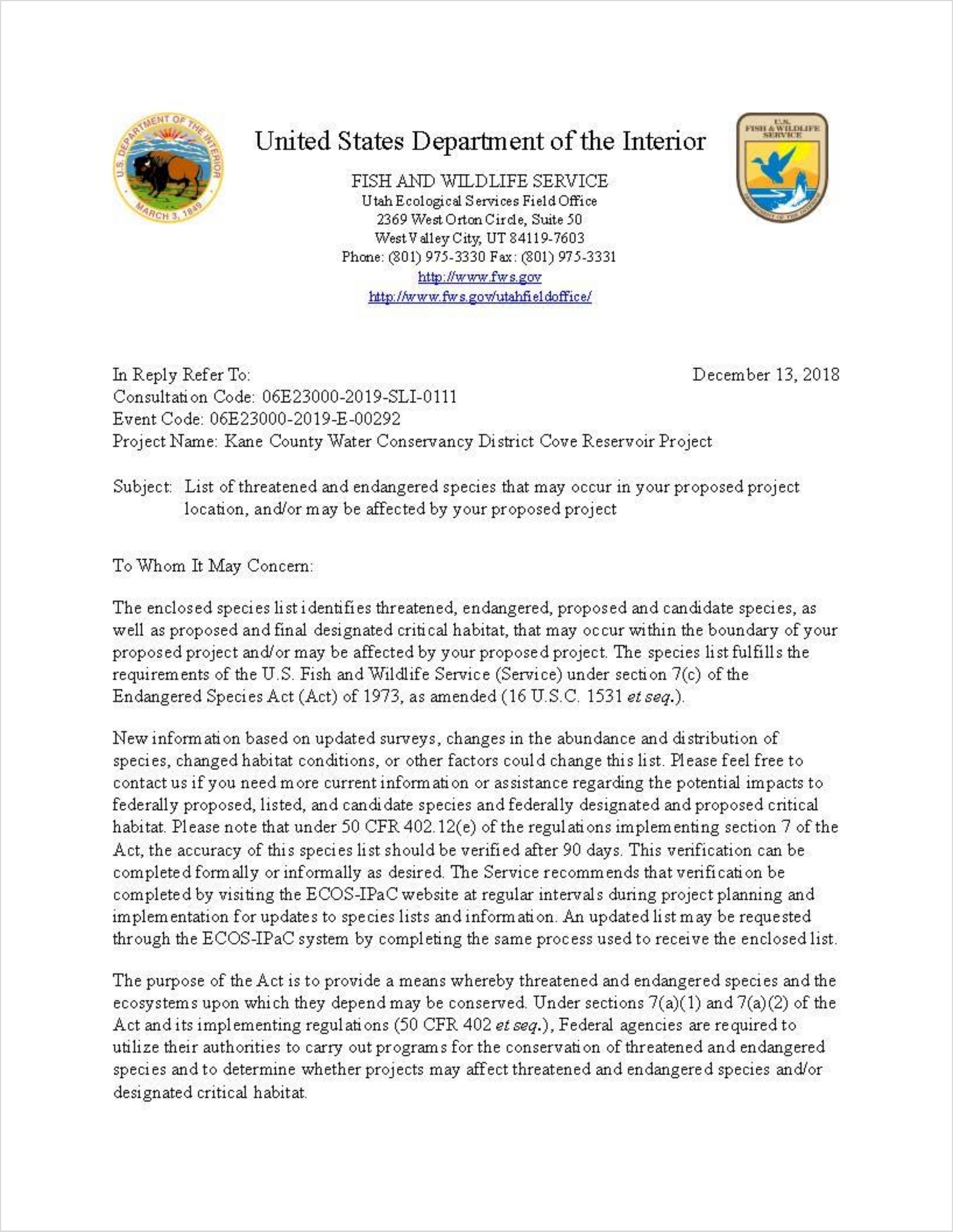
Sarah Lindsey

Sarah Lindsey
Information Manager
Utah Natural Heritage Program

cc: Rhett Boswell
Gary Bezzant

1594 West North Temple, Suite 2110, PO Box 146301, Salt Lake City, UT 84114-6301
telephone (801) 538-4700 • facsimile (801) 538-4709 • TTY (801) 538-7458 • *www.wildlife.utah.gov*

UTAH DNR WILDLIFE RESOURCES



United States Department of the Interior

FISH AND WILDLIFE SERVICE
Utah Ecological Services Field Office
2369 West Orton Circle, Suite 50
West Valley City, UT 84119-7603
Phone: (801) 975-3330 Fax: (801) 975-3331
http://www.fws.gov
http://www.fws.gov/utahfieldoffice/

In Reply Refer To: December 13, 2018
Consultation Code: 06E23000-2019-SLI-0111
Event Code: 06E23000-2019-E-00292
Project Name: Kane County Water Conservancy District Cove Reservoir Project

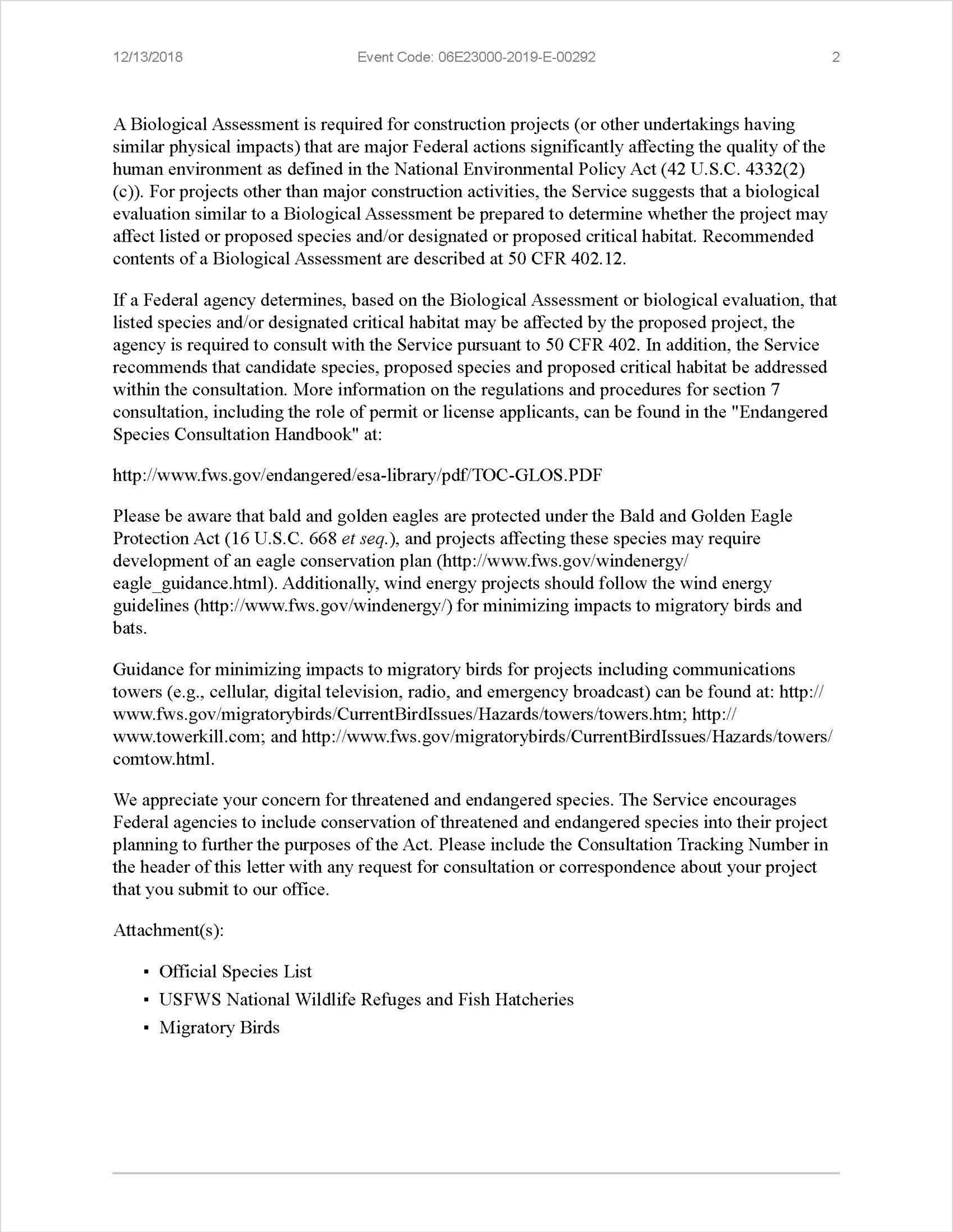
Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.



A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

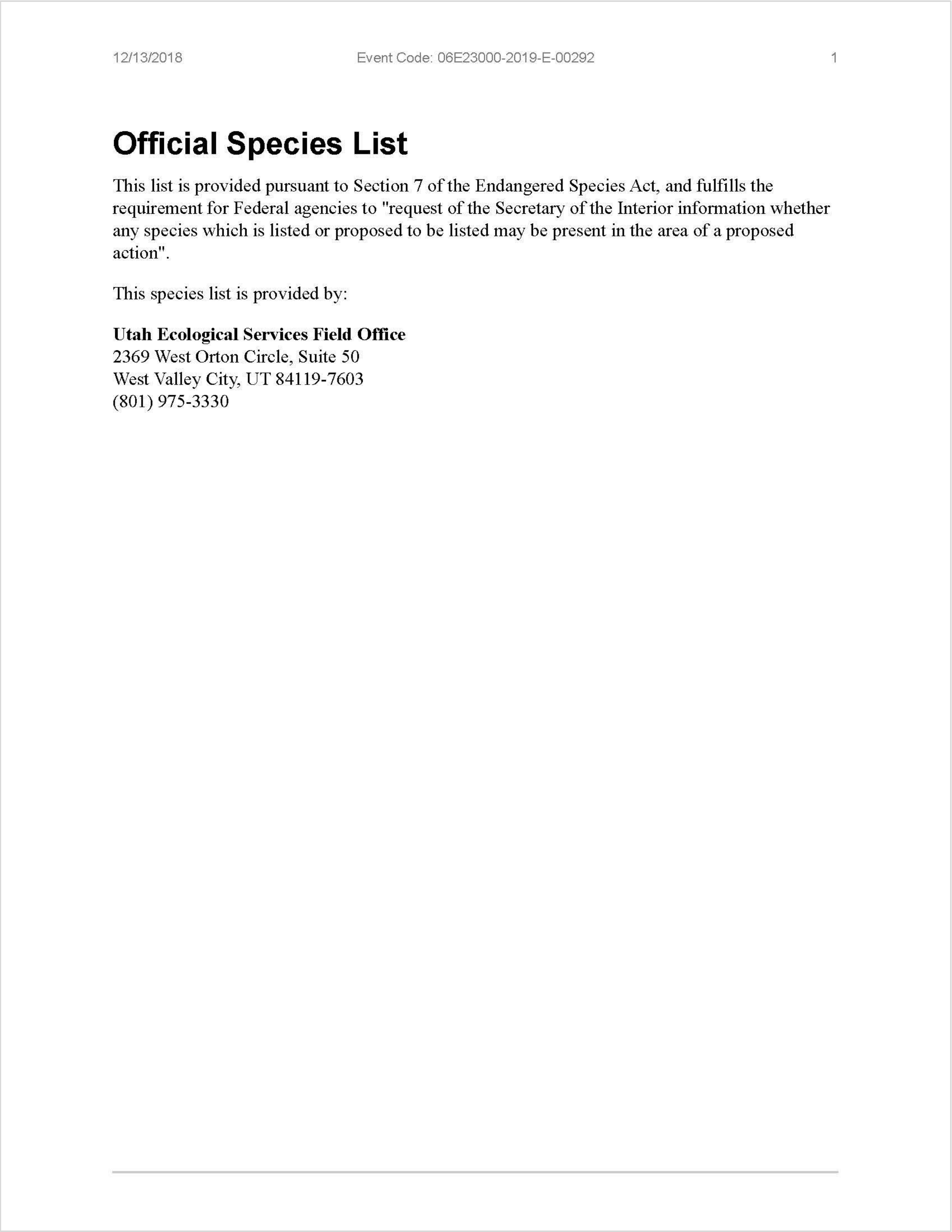
Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List
- USFWS National Wildlife Refuges and Fish Hatcheries
- Migratory Birds

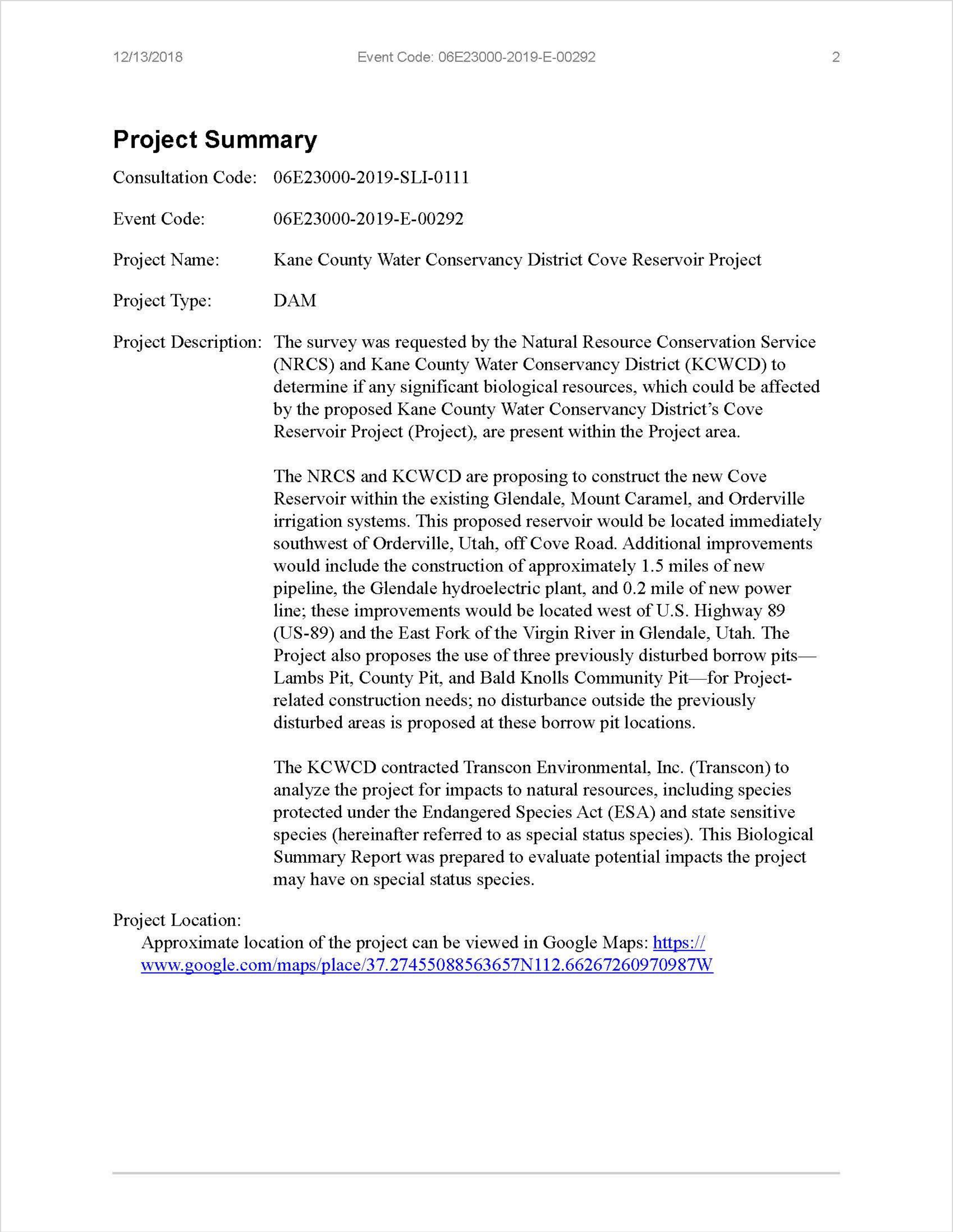


Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Utah Ecological Services Field Office
2369 West Orton Circle, Suite 50
West Valley City, UT 84119-7603
(801) 975-3330



Project Summary

Consultation Code: 06E23000-2019-SLI-0111

Event Code: 06E23000-2019-E-00292

Project Name: Kane County Water Conservancy District Cove Reservoir Project

Project Type: DAM

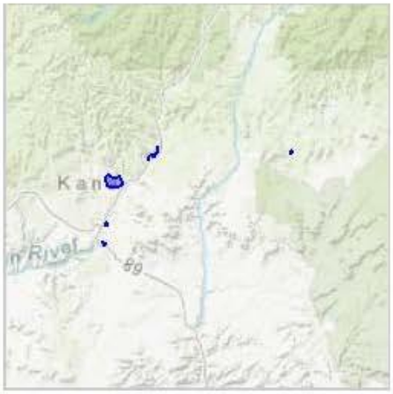
Project Description: The survey was requested by the Natural Resource Conservation Service (NRCS) and Kane County Water Conservancy District (KCWCD) to determine if any significant biological resources, which could be affected by the proposed Kane County Water Conservancy District's Cove Reservoir Project (Project), are present within the Project area.

The NRCS and KCWCD are proposing to construct the new Cove Reservoir within the existing Glendale, Mount Caramel, and Orderville irrigation systems. This proposed reservoir would be located immediately southwest of Orderville, Utah, off Cove Road. Additional improvements would include the construction of approximately 1.5 miles of new pipeline, the Glendale hydroelectric plant, and 0.2 mile of new power line; these improvements would be located west of U.S. Highway 89 (US-89) and the East Fork of the Virgin River in Glendale, Utah. The Project also proposes the use of three previously disturbed borrow pits—Lambs Pit, County Pit, and Bald Knolls Community Pit—for Project-related construction needs; no disturbance outside the previously disturbed areas is proposed at these borrow pit locations.

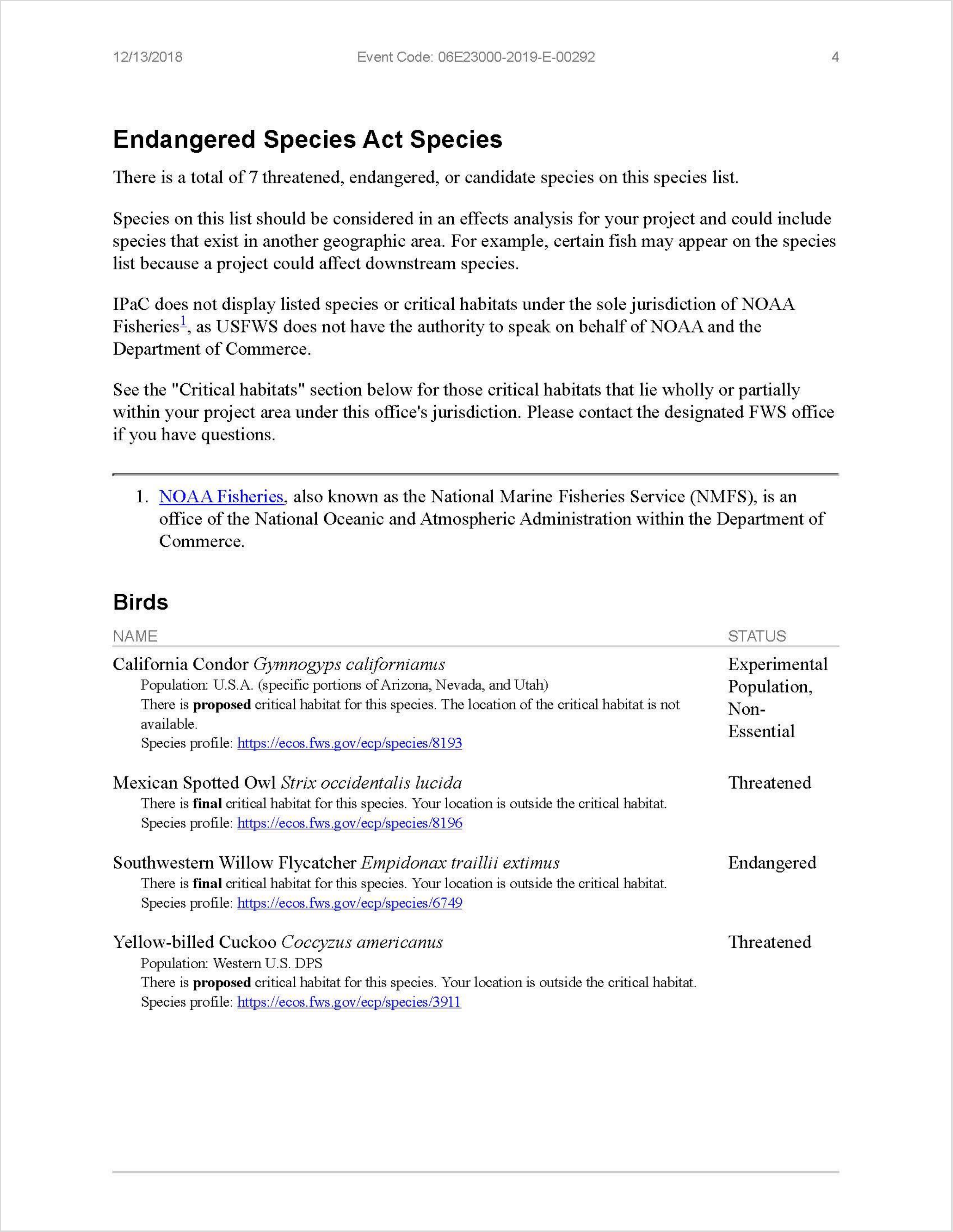
The KCWCD contracted Transcon Environmental, Inc. (Transcon) to analyze the project for impacts to natural resources, including species protected under the Endangered Species Act (ESA) and state sensitive species (hereinafter referred to as special status species). This Biological Summary Report was prepared to evaluate potential impacts the project may have on special status species.

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/place/37.27455088563657N112.66267260970987W



Counties: Kane, UT



Endangered Species Act Species

There is a total of 7 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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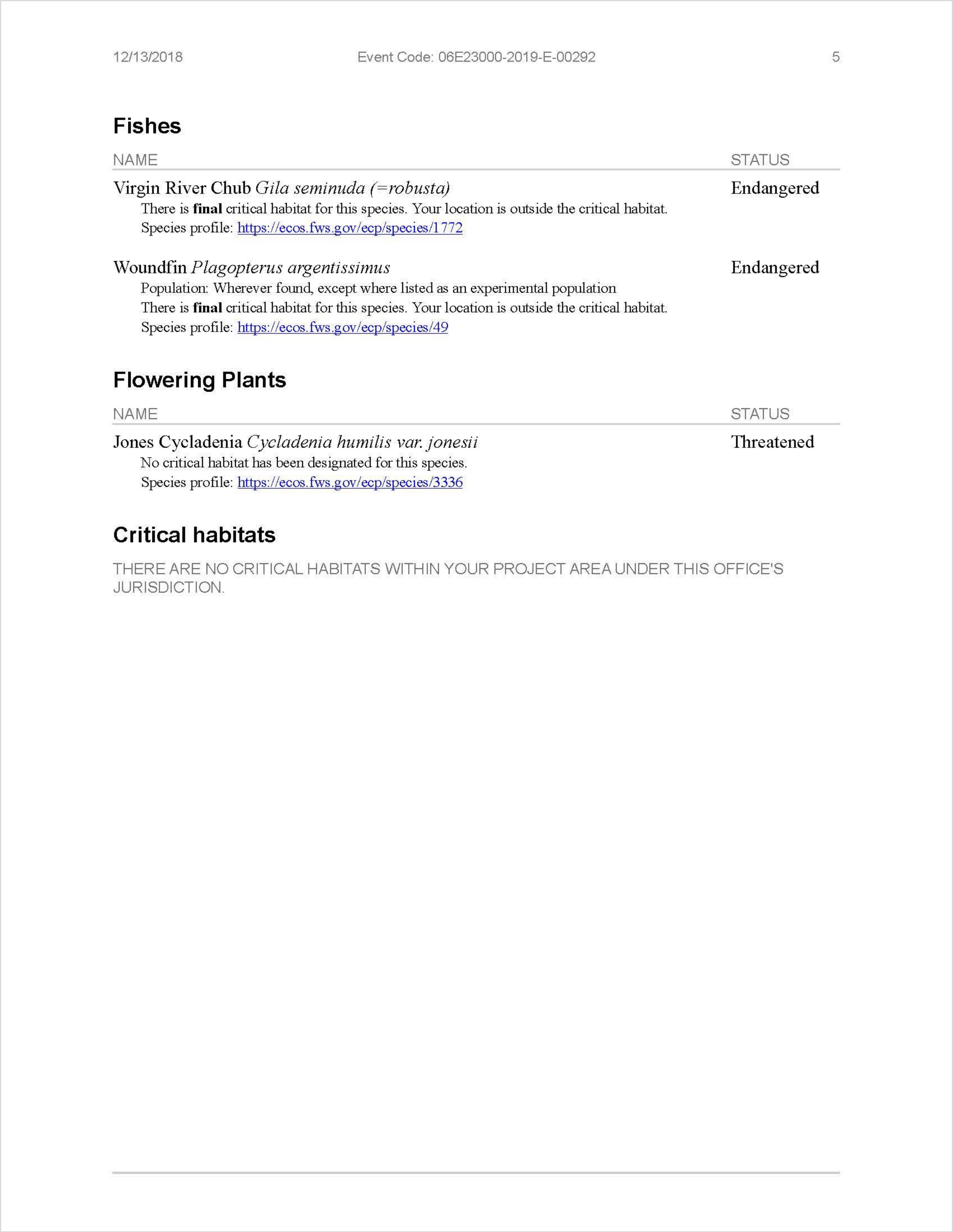
1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Birds

NAME	STATUS
California Condor *Gymnogyps californianus* Population: U.S.A. (specific portions of Arizona, Nevada, and Utah) There is **proposed** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/8193	Experimental Population, Non-Essential
Mexican Spotted Owl *Strix occidentalis lucida* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/8196	Threatened
Southwestern Willow Flycatcher *Empidonax traillii extimus* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/6749	Endangered
Yellow-billed Cuckoo *Coccyzus americanus* Population: Western U.S. DPS There is **proposed** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/3911	Threatened



Fishes

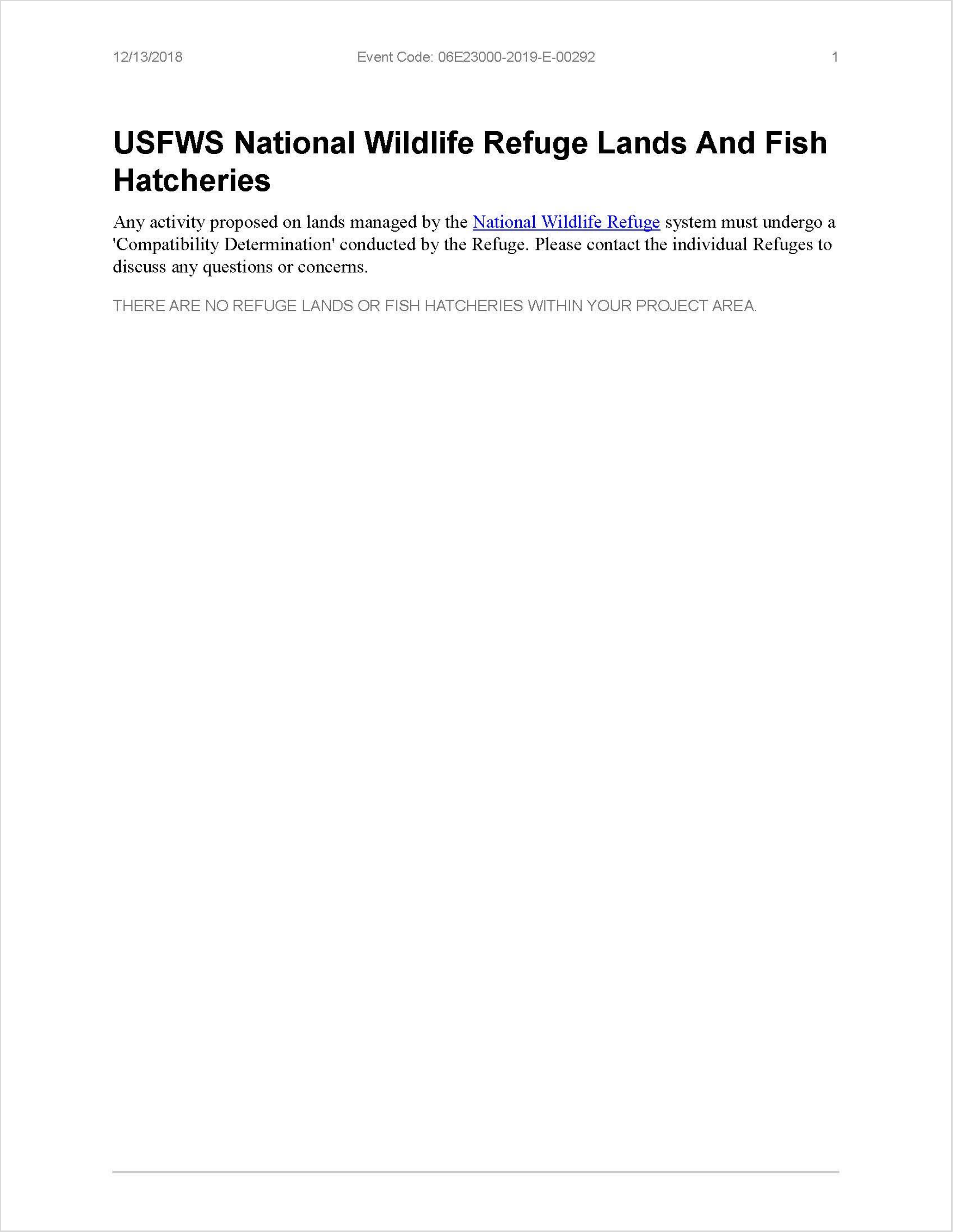
NAME	STATUS
Virgin River Chub *Gila seminuda (=robusta)* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/1772	Endangered
Woundfin *Plagopterus argentissimus* Population: Wherever found, except where listed as an experimental population There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/49	Endangered

Flowering Plants

NAME	STATUS
Jones Cycladenia *Cycladenia humilis var. jonesii* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/3336	Threatened

Critical habitats

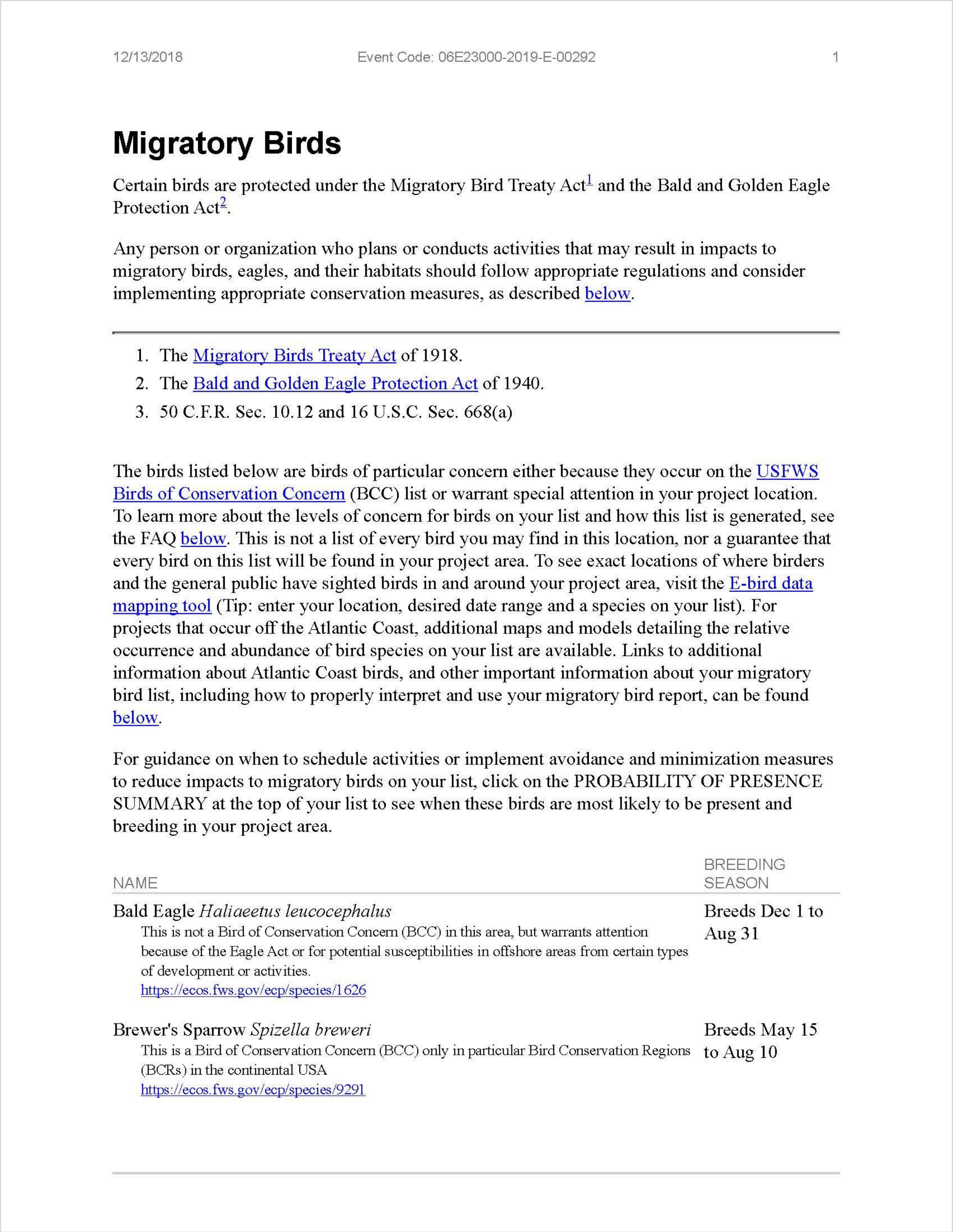
THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.



USFWS National Wildlife Refuge Lands And Fish Hatcheries

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS OR FISH HATCHERIES WITHIN YOUR PROJECT AREA.



Migratory Birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

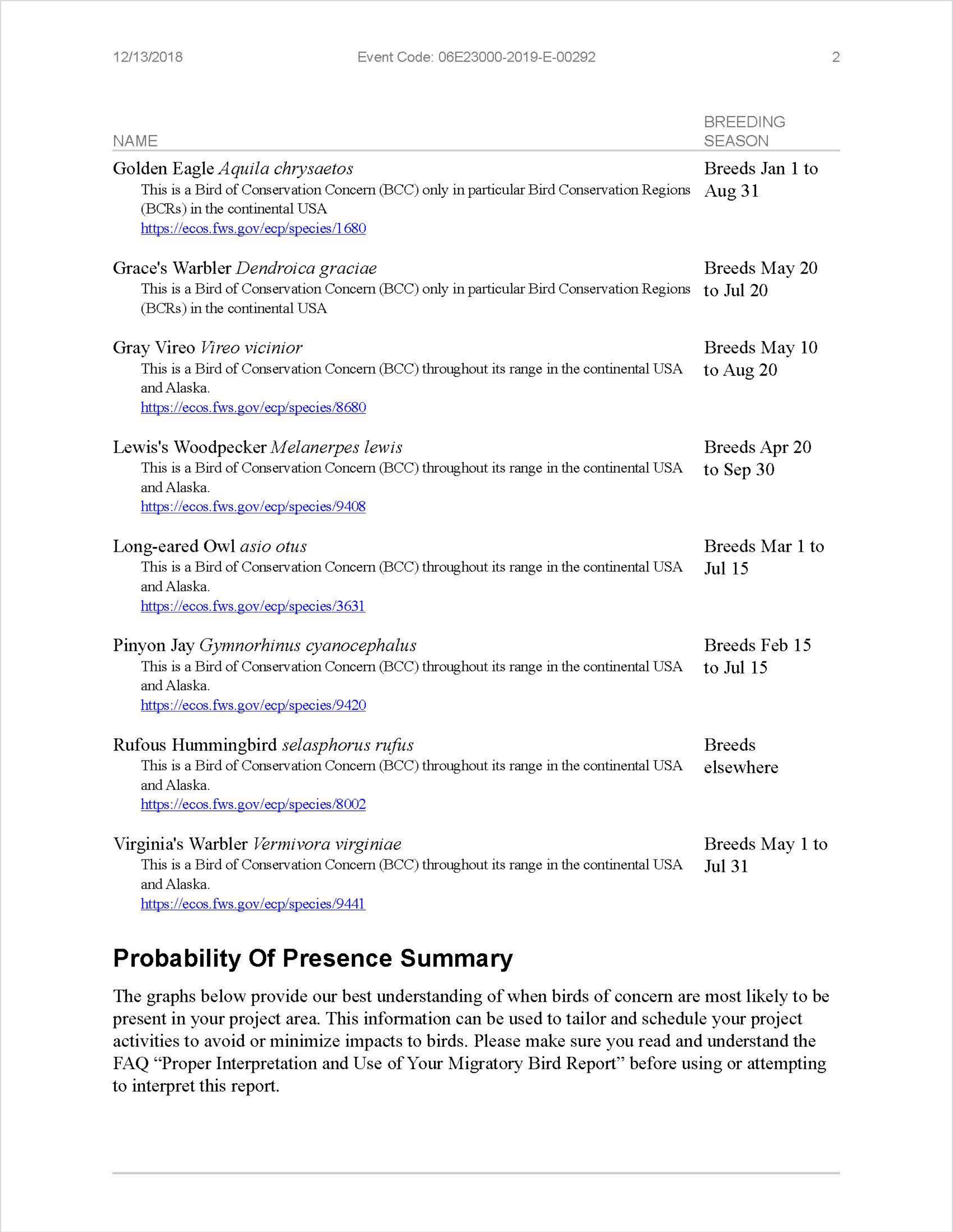
---

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
Bald Eagle *Haliaeetus leucocephalus* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1626	Breeds Dec 1 to Aug 31
Brewer's Sparrow *Spizella breweri* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/9291	Breeds May 15 to Aug 10



NAME	BREEDING SEASON
Golden Eagle *Aquila chrysaetos* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/1680	Breeds Jan 1 to Aug 31
Grace's Warbler *Dendroica graciae* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA	Breeds May 20 to Jul 20
Gray Vireo *Vireo vicinior* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/8680	Breeds May 10 to Aug 20
Lewis's Woodpecker *Melanerpes lewis* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9408	Breeds Apr 20 to Sep 30
Long-eared Owl *asio otus* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/3631	Breeds Mar 1 to Jul 15
Pinyon Jay *Gymnorhinus cyanocephalus* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9420	Breeds Feb 15 to Jul 15
Rufous Hummingbird *selasphorus rufus* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/8002	Breeds elsewhere
Virginia's Warbler *Vermivora virginiae* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9441	Breeds May 1 to Jul 31

Probability Of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ “Proper Interpretation and Use of Your Migratory Bird Report” before using or attempting to interpret this report.

Probability of Presence (🟩)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

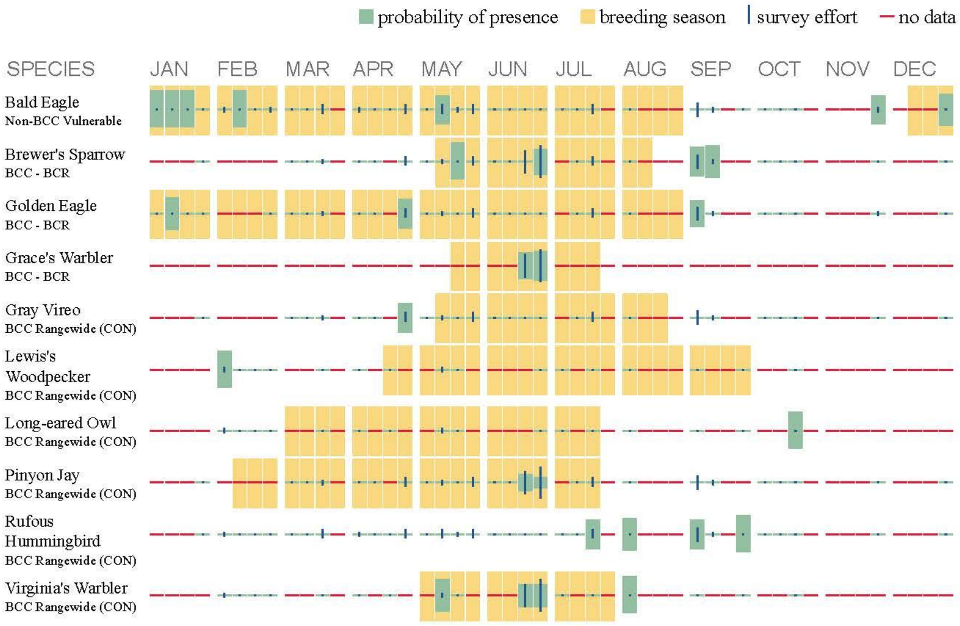
1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season (🟨)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

No Data (−)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.



Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

Migratory Birds FAQ

Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures and/or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?
The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

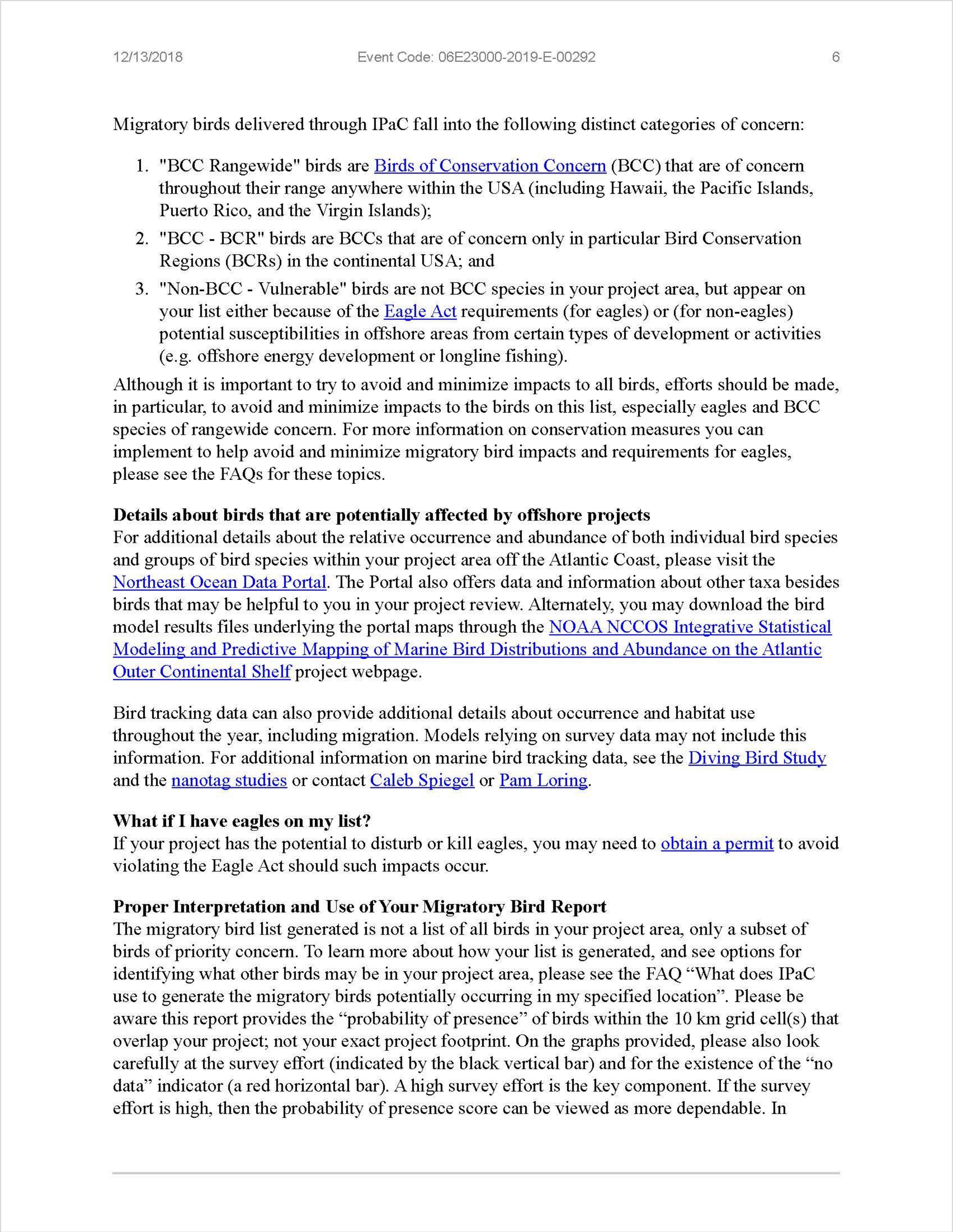
Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the E-bird Explore Data Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?
The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets .

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?
To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?



Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

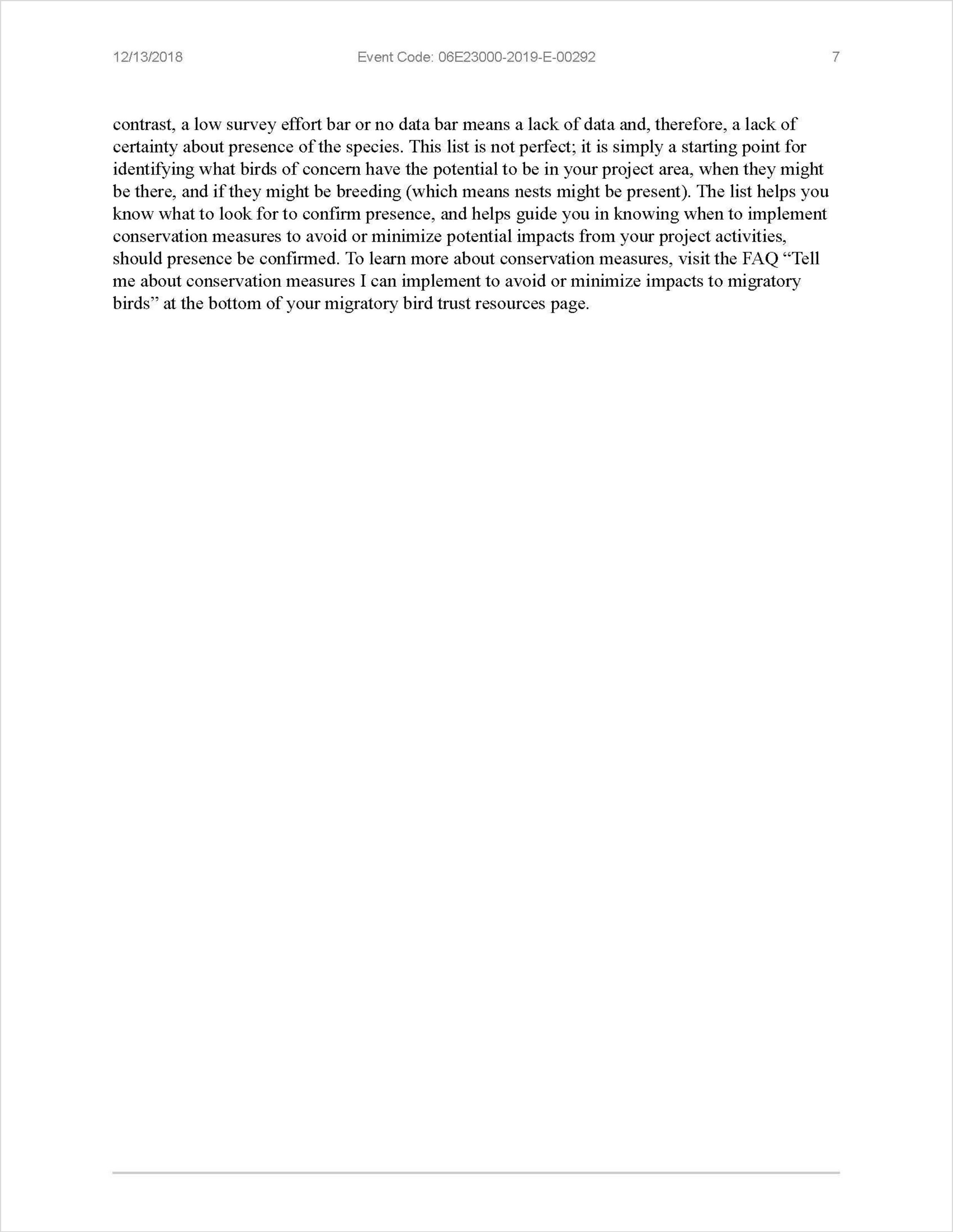
Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In



contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ “Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds” at the bottom of your migratory bird trust resources page.

APPENDIX C

THREATENED AND ENDANGERED SPECIES TABLE

HABITAT SUITABILITY ASSESSMENT FOR FEDERALLY-LISTED SPECIES IN KANE COUNTY			
Species	**Status***	**Known to Occur Within 2 Miles of the Project Area**	**Habitat Suitability Assessment and Determination of Effect**
California condor (*Gymnogyps californianus*)	E, EX	No	This species roosts in snags; tall, open-branched trees; and on cliffs It nests in scrubby chaparral or forested montane regions. An experimental population inhabits an area near Zion National Park approximately 14 miles west of the proposed project area. Rare sightings have also been documented near Bryce Canyon National Park, located approximately 34 miles northeast of the proposed project. All individuals within this population are closely monitored by biologists working on the species recovery. California condors are designated by federal regulation (61 FR 54044, October 16, 1996) as a 10(j) non-essential experimental population with no designated habitat in southern Utah and northern Arizona. California condors from the experimental population area frequently forage away from the Vermillion Cliffs of Arizona into southwestern Utah, though most California condors occur west of the project area near Zion National Park; no nests, roosts, or other special use areas for condors have been identified in the action area. Under the requirements of the National Environmental Policy Act (NEPA), when a proposed action may potentially affect the California condor 10(j) non-essential experimental population, the 10(j) population should be addressed (and their status defined) and the proposed action then not carried forward for further analysis within the NEPA document. No suitable nesting habitat occurs within the project area. Potentially suitable foraging habitat does exist within the project area; however, the condor's foraging range can be upwards of 100 miles a day, and construction of the proposed project would not significantly affect available foraging opportunity for the condor. **No Effect**
Mexican spotted owl (*Strix occidentalis lucida*)	T	No	In Utah, this species inhabits steep-walled canyons that provide an abundant prey base and caves or crevices for nesting and roosting. No suitable nesting or foraging habitat occurs within the project area. **No Effect**

HABITAT SUITABILITY ASSESSMENT FOR FEDERALLY-LISTED SPECIES IN KANE COUNTY			
Species	**Status***	**Known to Occur Within 2 Miles of the Project Area**	**Habitat Suitability Assessment and Determination of Effect**
Southwestern willow flycatcher (*Empidonax traillii extimus*)	E	No	This species breeds in relatively dense tracts of cottonwood, willow, and tamarisk in riparian and shrub communities below approximately 8,500 feet in elevation. No suitable habitat occurs within the action area and species would not be expected to inhabit the project area, Suitable habitat Increased water flows from the proposed reservoir through the Park and down the Virgin River as described above may help stabilize riparian vegetation to a minor amount. **May Affect, but is Not Likely to Adversely Affect (See further analysis above)**
Yellow-billed cuckoo (*Coccyzus americanus*)	T	No	This species inhabits large tracts (generally greater than 200 acres) of riparian habitat with dense shrubs and a developed canopy. The canopy is often composed of cottonwood, willow, and sycamore trees. It is considered an extremely rare breeder in Utah but has been known to nest in riparian areas between 2,500 and 6,000 feet in elevation throughout the state. No suitable habitat occurs within the project area. Small patches of riparian habitat do exist along the banks of the East Fork Virgin River; however, these patches are too small to be considered suitable for nesting and too distant from suitable nesting habitat to be considered suitable foraging or migratory habitat. Critical habitat has been proposed but has not yet been designated for this species. **No Effect**

HABITAT SUITABILITY ASSESSMENT FOR FEDERALLY-LISTED SPECIES IN KANE COUNTY			
Species	**Status***	**Known to Occur Within 2 Miles of the Project Area**	**Habitat Suitability Assessment and Determination of Effect**
Woundfin (*Plagopterus argentissimus)*	E	No	This small (4 inches), rare species of minnow is restricted to the Virgin River system from La Verkin Hot Springs near the lower portion of La Verkin Creek and the Virgin River confluence, downstream to Lake Mead, Nevada. It inhabits shallow, turbid, fast-flowing water with warm temperatures. No suitable habitat exists within the action area. Appropriate sediment and erosion control best management practices (BMPs) would be implemented during construction to prevent project-related impacts to the East Fork Virgin River, which is tributary to the mainstem Virgin River, and suitable habitat found approximately 50 miles downstream. Project activities are not anticipated to negatively impact aquatic species or habitat. However, releases from the dam may provide benefits to suitable habitat downstream by providing cooler water and maintaining instream flows during periods of low flow. **May Affect, but is Not Likely to Adversely Affect (See further analysis above)**
Virgin River chub (*Gila seminuda*)	E	No	This rare species of minnow only occurs in the mainstream Virgin River system of southwestern Utah from La Verkin Hot Springs near the lower portion of La Verkin Creek and the Virgin River confluence, downstream to the Mesquite Diversion in northwest Arizona. It inhabits deeper, fast-flowing water with temperatures below 86 degrees Fahrenheit. No suitable habitat exists within the action area. Appropriate sediment and erosion control BMPs would be implemented during construction to prevent project-related impacts to the East Fork Virgin River, which is tributary to the mainstem Virgin River, and suitable habitat found approximately 50 miles downstream. Project activities are not anticipated to negatively impact aquatic species or habitat. However, releases from the dam may provide benefits to suitable habitat downstream by providing cooler water and maintaining instream flows during periods of low flow. **May Affect, but is Not Likely to Adversely Affect (See further analysis above)**

HABITAT SUITABILITY ASSESSMENT FOR FEDERALLY-LISTED SPECIES IN KANE COUNTY

Species	Status*	Known to Occur Within 2 Miles of the Project Area	Habitat Suitability Assessment and Determination of Effect
Jones cycladenia (*Cycladenia humilis* var. *jonesii*)	T	No	This small member of the Dogbane family (growing 4 to 6 inches tall) is a long-lived herbaceous perennial found in mixed desert scrub, juniper, or wild buckwheat-Mormon tea plant communities. It has wide, oval or elliptical leaves and produces pink or rose-colored trumpet flowers that bloom from mid-April through early June. It occurs solely on gypsiferous, saline soils of Cutler, Summerville, and Chinle geologic formations within elevations ranging from 4,390 feet up to 6,000 feet asl. In Utah, Jones cycladenia is known to occur in Emery, Grand, and Garfield counties. No suitable soils or habitat exist within the proposed project area, and this species is not known to currently occur within Kane County, Utah. No critical habitat has been designated for this species. **No Effect**

***Note:** USFWS categories: **Endangered (E)**—Taxa in danger of extinction throughout all or a significant portion of its range; **Threatened (T)/Proposed Threatened (PT)**—Taxa likely to become endangered within the foreseeable future throughout all or a significant portion of its range; **Experimental (EX)**—Species considered to be experimental and non-essential in its designated use areas.
Sources: Tilley et al. 2010, USFWS 1996, 2018b

APPENDIX D

BLM AND STATE SENSITIVE SPECIES TABLE

HABITAT SUITABILITY ASSESSMENT FOR BLM and STATE SENSITIVE SPECIES

Species	**BLM Status**	**State Status**	**Description**	**Known Occurrence Within 2 Miles of the Project Area**	**Habitat Suitability Assessment**	**Impact Assessment**
Gooseberry leaf globemallow (*Sphaeralcea grossulariifolia*)	SS	N/A	Found on dry, open or brushy, alkaline valleys and foothills, and disturbed areas. Typically in dry, often volcanic or alkaline soils between 3,000 to 7,600 ft. Sometimes found on mesas and slopes, often in pinyon-juniper woodlands, sometimes descending along streams to lower elevations. Flowers from April-October.	No	Suitable habitat for this species is found within the project area. However, none were observed during field habitat assessments conducted and occurrence of the species is not known within 2 miles of the project area.	No direct or indirect impacts to this species are anticipated to occur as a result of implementation of the project. No species were observed during field assessments and none have been documented within 2 miles of the project area and this species was not indicated on the BLM ID Team Checklist as a species of concern. However, should individuals be discovered within the footprint of the project area, direct impacts could include mortality due to vegetation and soil removal associated with construction of the dam/reservoir, access roads, installation of the pipeline and the utilization and expansion of borrow pits. Indirect impacts to species should they be located outside of the project area but within 300 feet, could include reduced reproductive fecundity and/or reduced photosynthetic ability due to dust resulting from project-related ground disturbance.
Desert sucker (*Catostomus clarkii*)	SS	SPC	Native to parts of the Colorado River system. Limited distribution occurs only in the Virgin River system in southwestern Utah. They are bottom dwellers (benthic); primarily eat algae, and occasionally insects and other invertebrates. Spawning occurs in riffles during winter and spring.	Historical records of occurrence within 0.5 mile of the project area.	Suitable habitat is found within the East Fork Virgin River, which bisects the proposed powerline component of the proposed project area.	No direct or indirect impacts to species or suitable habitat are anticipated to occur as result of implementation of the project. The East Fork Virgin River where suitable habitat exists, including all tributaries within the project area, would be protected from increased erosion and sedimentation by the appropriate use of BMPs.
Arizona toad (*Anaxyrus microscaphus*)	SS	SPC	Found only in the southwestern portion of Utah. Common to streams, washes, irrigated crop lands, reservoirs, and uplands adjacent to water. Inactive in cold weather, adults are known to be primarily nocturnal; however, young are active during daylight hours. Eggs are laid on the bottoms of shallow, slow-moving streams.	Historical records of occurrence within a 2-mile radius of the project area.	Suitable habitat exists within the proposed project area. This habitat is found within numerous washes within the Cove Reservoir portion of the project area and along two small, slow-moving intermittent streams which bisect the Glendale Pipeline portion of the project area. Uplands within the project area adjacent to these aquatic features may also provide suitable habitat.	No direct or indirect impacts to species are anticipated to occur as result of implementation of the project and species have not been documented within 0.5 mile of the project and are not anticipated to occur. Some potentially suitable habitat found adjacent to intermittent streams would be impacted as result of construction of the dam and inundation of the reservoir. However, this habitat is marginal and ample suitable habitat exist outside of the footprint of the project area.
Great Plains toad (Anaxyrus *cognatus*)	SS	SPC	Occurs in scattered areas throughout the state, where they prefer desert, grassland, and agricultural habitats. In cold winter months, they burrow underground and become inactive. They breed in shallow water after rains during spring and summer months.	No	Suitable habitat associated with wetlands, streams and agricultural areas is found within and near to the project area; however, no suitable habitat is located on BLM-managed lands.	No direct or indirect impacts to species are anticipated to occur as result of implementation of the project and species have not been documented within 0.5 mile of the project and are not anticipated to occur. Some potentially suitable habitat found adjacent to agricultural areas would be temporarily impacted as result of construction Glendale pipeline. However, this habitat is marginal and ample suitable habitat exist outside of the footprint of the project area.
Bald eagle (*Haliaeetus leucocephalus*)	SS	SPC	Nests near coastlines, rivers, large lakes, or streams that support an adequate food supply. Nesting substrates often include mature or old-growth trees, snags, cliffs, rock promontories, on the ground (rarely), and on human-made structures (more frequently).	Records exist of recent occurrence within 0.5 mile of the project area.	Suitable foraging habitat located within and adjacent to the proposed project area supports a variety of raptors, potentially including bald eagles. Bald eagles do occasionally nest in southern Utah but are typically present during their winter migration. Bald eagles may utilize trees adjacent to the East Fork Virgin River for winter roosting and stopover habitat during migration periods.	No direct or indirect impacts to this species are anticipated to occur as a result of implementation of the project. Species occurrence has been documented within 0.5-mile of the project area; however, no species were observed during field assessments. Bald eagles would likely only inhabit the area during the winter. Construction of the dam may provide additional wintering habitat and food sources (stocked fish).

HABITAT SUITABILITY ASSESSMENT FOR BLM and STATE SENSITIVE SPECIES						
Species	**BLM Status**	**State Status**	**Description**	**Known Occurrence Within 2 Miles of the Project Area**	**Habitat Suitability Assessment**	**Impact Assessment**
Ferruginous hawk (*Buteo regalis*)	SS	SPC	Can be found in most counties in Utah. Prefers to winter in grasslands and shrub steppes in the Western and central US. In Utah, they eat mostly prairie dogs. During breeding, flat and rolling terrain in grassland or shrub steppe is most often used. They avoid high elevations, forests, and narrow canyons, choosing to live in grasslands, agriculture lands, sagebrush/slatbush/greasewood shrub lands, and at the periphery of pinyon-juniper forests. They prefer elevated nest sites like cliffs, buttes, and creek banks. In winter they prefer open areas like farmlands, grasslands, or deserts.	No	Suitable habitat near agricultural lands adjacent to pinyon-juniper woodland exists within the project area, particularly where the Glendale Pipeline and Cove Reservoir components of the project would be constructed. However, prairie dogs are not commonly found near to the project area and as this is the species' primary food source, occurrence of the ferruginous hawks would be expected to be very low and likely only migratory in nature.	No direct or indirect impacts to this species are anticipated to occur as a result of implementation of the project. No species were observed during field assessments and none have been documented within 2 miles of the project area and this species was not indicated on the BLM ID Team Checklist as a species of concern. However, suitable nesting and foraging habitat does exist within and adjacent to the project area and occurrence of individuals is a possible. To reduce project-related impacts, preconstruction avian nest clearance surveys would be conducted to locate and identify all nesting species of birds. Should an occupied or active nest be discovered, a species-specific no-activity buffer would be applied during construction and would remain in place until young have successfully fledged.
Greater sage-grouse (*Centrocercus urophasianus*)	CN	SPC	Greater sage-grouse inhabit sagebrush plains, foothills, and mountain valleys. The species is an herbivore and insectivore, and is associated with both tall and short sagebrush types. Sagebrush habitat, with an understory of grasses and forbs, and associated wet meadow areas are essential for optimum habitat. Sage-grouse use the same breeding ground or leks for several consecutive breeding seasons.	No	The Panguitch Greater sage-grouse Priority Habitat Management Area (PHMA) extends into Kane County near the three BLM borrow pit locations. The existing Elbow borrow site is located within the PHMA. The existing Bald Knoll and proposed Black Knoll sites are located outside of, but adjacent to, the PHMA. The remainder of the project area including the proposed reservoir, pipeline, access road, and Glendale and Orderville hydroelectric power plants are not located near sage grouse habitat.	No direct or indirect impacts are anticipated to occur to sage grouse species or suitable habitat. No suitable habitat exists within the footprint of the project and no records of occurrence for sage grouse exists within 2 miles of the project area.

Sources: UDWR 2017; UDWR Conservation Data Center (http://dwrcdc.nr.utah.gov/ucdc/default.asp); BLM 2010; BLM 2011.
Key: SS = BLM Sensitive Species; CN = Candidate Species; CA/CS = Conservation Agreement Species; SPC = Wildlife Species of Concern (State)

APPENDIX E-3

AQUATIC RESOURCE DELINATION REPORT

REQUEST FOR AQUATIC RESOURCES DELINEATION VERIFICATION

OR JURISDICTIONAL DETERMINATION

A separate jurisdictional determination (JD) is not necessary to process a permit. An Approved Jurisdictional Determination (AJD) is required to definitively determine the extent of waters of the U.S. and is generally used to disclaim jurisdiction over aquatic resources that are not waters of the U.S., in cases where the review area contains no aquatic resources, and in cases when the recipient wishes to challenge the water of the U.S. determination on appeal. Either an Aquatic Resources Delineation Verification or a Preliminary Jurisdictional Determination (PJD) may be used when the recipient wishes to assume that aquatic resources are waters of the U.S. for the purposes of permitting. In some circumstances an AJD may require more information, a greater level of effort, and more time to produce. If you are unsure which product to request, please speak with your project manager or call the Sacramento District's general information line at (916) 557-5250.

I am requesting the product indicated below from the U.S. Army Corps of Engineers, Sacramento District, for the review area located at:

Street Address: U.S. Highway 89 (see attached maps for project sites) City: Orderville and Glendale, Utah County: Kane County
State: Utah Zip: 84758 Section: ______ Township: ______ Range: ______
Latitude (decimal degrees): 37.272142° Longitude (decimal degrees): -112.662825°
The approximate size of the review area for the JD is 264.6 acres. **(Please attach location map)**

Choose one:
○ I own the review area
○ I hold an easement or development rights over the review area
○ I lease the review area
● I plan to purchase the review area
○ I am an agent/consultant acting on behalf of the requestor
○ Other: ______

Choose one product:
○ I am requesting an Aquatic Resources Delineation Verification
● I am requesting an Approved JD
○ I am requesting a Preliminary JD
○ I am requesting additional information to inform my decision about which product to request

Reason for request: (check all that apply)
☒ I need information concerning aquatic resources within the review area for planning purposes.
☐ I intend to construct/develop a project or perform activities in this review area which would be designed to avoid all aquatic resources.
☐ I intend to construct/develop a project or perform activities in this review area which would be designed to avoid those aquatic resources determined to be waters of the U.S.
☐ I intend to construct/develop a project or perform activities in this review area which may require authorization from the Corps; this request is accompanied by my permit application.
☐ I intend to construct/develop a project or perform activities in a navigable water of the U.S. which is included on the district's list of navigable waters under Section 10 of the Rivers and Harbors Act of 1899 and/or is subject to the ebb and flow of the tide.
☐ My lender, insurer, investors, local unit of government, etc. has indicated that an aquatic resources delineation verification is inadequate and is requiring a jurisdictional determination.
☐ I intend to contest jurisdiction over particular aquatic resources and request the Corps confirm that these aquatic resources are or are not waters of the U.S.
☐ I believe that the review area may be comprised entirely of dry land.
☒ Other: Intend to construct within the study area and need the Corps' determination on what is jurisdictional

Attached Information:
☒ Maps depicting the general location and aquatic resources within the review area consistent with Map and Drawing Standards for the South Pacific Division Regulatory Program (Public Notice February 2016, http://www.spd.usace.army.mil/Missions/Regulatory/Public-Notices-and-References/Article/651327/updated-map-and-drawing-standards/)
☒ Aquatic Resources Delineation Report, if available, consistent with the Sacramento District's Minimum Standards for Acceptance (Public Notice January 2016, http://1.usa.gov/1V68IYa)

By signing below, you are indicating that you have the authority, or are acting as the duly authorized agent of a person or entity with such authority, to and do hereby grant Corps personnel right of entry to legally access the review area. Your signature shall be an affirmation that you possess the requisite property rights for this request on the subject property.

*Signature: Michael E. Noel Date: 11/12/2020
Name: MICHAEL E. NOEL Company name: Kane County Water Conservancy District
Address: 725 E. Kaneplex Drive
Kanab, UTAH 84741
Telephone: Email:

***Authorities:** Rivers and Harbors Act, Section 10, 33 USC 403; Clean Water Act, Section 404, 33 USC 1344; Marine Protection, Research, and Sanctuaries Act, Section 103, 33 USC 1413; Regulatory Program of the U.S. Army Corps of Engineers; Final Rule for 33 CFR Parts 320-332.
Principal Purpose: The information that you provide will be used in evaluating your request to determine whether there are any aquatic resources within the project area subject to federal jurisdiction under the regulatory authorities referenced above.
Routine Uses: This information may be shared with the Department of Justice and other federal, state, and local government agencies, and the public, and may be made available as part of a public notice as required by federal law. Your name and property location where federal jurisdiction is to be determined will be included in the approved jurisdictional determination (AJD), which will be made available to the public on the District's website and on the Headquarters USACE website.
Disclosure: Submission of requested information is voluntary; however, if information is not provided, the request for an AJD cannot be evaluated nor can an AJD be issued.

PRELIMINARY AQUATIC RESOURCE DELINEATION REPORT

Cove Reservoir Project
Kane County, Utah

Prepared for:

Kane County Water Conservancy District
725 East Kaneplex Drive
Kanab, Utah 84741

and

United States Department of Agriculture
Natural Resource Conservation Service
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TRANSCON
environmental

November 2019
*Revised October 2020

EXECUTIVE SUMMARY

An aquatic resource delineation study has been conducted for the Cove Reservoir Project in accordance with the 1987 U.S. Army Corps of Engineers (USACE) Wetland Delineation Manual, and Interim Regional Supplement to the USACE Wetland Delineation Manual: Arid West Region (USACE 2008).

Transcon Environmental, Inc. conducted an aquatic impact assessment within the proposed project area to identify potential impacts to jurisdictional Waters of the United States (WOTUS), pursuant to Section 404 of the Clean Water Act. The survey encompassed approximately 805.6 acres along areas near U.S. Highway 89 (US-89) and Glendale Bench Road in the vicinity of the towns of Glendale and Orderville, both in Kane County, Utah. Fieldwork was conducted between October 8, 2018 and October 10, 2018 with supplementary surveys conducted on April 24 and September 20, 2019. Within this report, the term “project area” refers specifically to the project footprint where construction activities would occur; “study area” refers to the project footprint plus all adjacent areas and waters that were investigated for their potential to be directly impacted by construction of the proposed project. This delineation is based on site conditions and information available at the time of the site visits. The results of this delineation are preliminary until verified by the USACE.

One scientist performed wetland and ordinary high watermark delineations, recorded site information, and photographed site conditions. Within the 805.6-acre study area, the proposed project area totals approximately 264.6 acres. Within the project area approximately 2.97 acres (9,716 linear feet) were identified as potentially jurisdictional intermittent or ephemeral streams. One perennial feature, the East Fork Virgin River, also crosses a portion of the study area. Additionally, man-made wetlands were discovered within the overall study area, but these wetlands were isolated, man-made features and are not considered jurisdictional WOTUS.

The proposed Cove Reservoir Project is anticipated to impact approximately 2.97 acres of potentially jurisdictional WOTUS consisting of approximately 9,716 linear feet of streams. Approximately 2.96 acres (9,646 linear feet) of these streams occur within the footprint of the reservoir and adjacent project components; 0.01 acres (70 linear feet) of these streams occur within the pipeline portion of the project. No impacts to wetlands or the East Fork Virgin River are anticipated.

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SECTION 1 INTRODUCTION

1.1 Contact Information

Kane County Water Conservancy District
725 East Kaneplex Drive
Kanab, Utah 84741

1.2 Purpose of Assessment

The U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), with assistance of the Kane County Water Conservancy District (KCWCD) as the project sponsor, is considering proposed improvements within the East Fork Virgin River Watershed. Currently, the proposed improvements include: the construction of a new, approximately 6,032-acre-foot capacity reservoir (Cove Reservoir); the replacement of an approximately 1.7-mile section of existing pipeline; and relocation of the Glendale Hydroelectric Plant. These new facilities would provide the Glendale, Mt. Carmel, and Orderville irrigation companies with additional water storage capacity to meet present and future irrigation water demands. Future improvements within the existing Glendale, Mt. Carmel, and Orderville irrigation systems within the East Fork Virgin River Watershed are also anticipated; however, those improvements have not been identified at this time and are not analyzed within this report. Alpha Engineers contracted Transcon Environmental, Inc. (Transcon) to analyze the project for potential impacts to wetlands and potentially jurisdictional Waters of the United States (WOTUS).

In October 2018, Transcon conducted an aquatic resource impact assessment within the proposed project area to identify potential impacts to wetlands and other potentially jurisdictional WOTUS, pursuant to Section 404 of the Clean Water Act (CWA). Supplementary visits were also conducted on April 24 and September 20, 2019

Section 404 of the CWA gives the U.S. Environmental Protection Agency and the USACE regulatory and permitting authority regarding discharge of dredged or filled material into "navigable waters of the United States." Section 502(7) of the CWA defines navigable waters as "waters of the United States, including territorial seas." Section 328 of Chapter 33 in the Code of Federal Regulations (CFR) defines WOTUS as they apply to the jurisdictional limits of USACE authority under the CWA. A summary of this definition in 33 CFR 328.3 includes: 1) waters used for commerce; 2) interstate waters and wetlands; 3) "Other waters of the United States" (other waters) such as intrastate lakes, rivers, streams, and wetlands; 4) impoundments of waters; 5) tributaries to the above waters; 6) territorial seas; and 7) wetlands adjacent to waters. For the purposes of determining USACE jurisdiction under the CWA, "navigable waters," as defined in the CWA, are the same as "waters of the United States" as defined in the CFR above. The limits of USACE jurisdiction under Section 404, as given in 33 CFR Section 328.4, are as follows: a) territorial seas—3 nautical miles in a seaward direction from the baseline; b) tidal WOTUS—high tide line or to the limit of adjacent non-tidal waters; c) non-tidal WOTUS—ordinary high watermark (OHWM) or to the limit of adjacent wetlands; d) wetlands—to the limit of the wetland.

1.3 Project Description and Location

KCWCD proposes to construct the Cove Reservoir and other improvements within the existing Glendale, Mt. Carmel, and Orderville irrigation systems. Other improvements would include the replacement of approximately 1.7 miles of irrigation pipeline, relocation of the Glendale Hydroelectric Plant, and construction of approximately 0.2 mile of new, overhead electric transmission line to tie into the relocated hydroelectric plant. All improvements are located west of U.S. Highway 89 (US-89) and the East Fork Virgin River in Orderville and Glendale. The project also proposes the use of up to four previously disturbed borrow pits for project-related construction needs: Elbow pit, Tait pit, Lamb pit, and Bald Knoll community pit. No disturbance outside of the previously disturbed areas is proposed at the Elbow pit location. The use of one new borrow pit, Black Knoll, is proposed.

The primary purpose of the proposed Cove Reservoir is to provide critical water storage capacity in Kane County and to provide reliable irrigation water delivery to agricultural users in rural areas specifically near the communities of Glendale, Mt. Carmel, and Orderville. Local users continue to experience a water shortage for irrigation and agricultural uses in the late summer months after spring runoff has passed. Irrigation water demand during the summer months cannot be met by current systems as existing irrigation facilities have limited capabilities to divert water from the East Fork Virgin River and store water during high flows. There is currently no capacity for storage during non-use and high-flow periods with the existing irrigation systems. As such, rural producers throughout Kane County are unable to get full production from their fields. The proposed project would increase water availability by collecting and storing water during non-use periods and providing flows during the irrigation season.

The Cove Reservoir would also improve irrigation efficiency by providing a more consistent, reliable flow for existing, pressurized irrigation systems. The relocation and improvement of the Glendale hydroelectric power plant would provide additional green energy for local communities whose populations are expected to continue to increase in the near future. The existing Orderville hydroelectric power plant currently only generates power during the winter months. With the implementation of the proposed project, additional water would be available to the plant during the summer months. This would allow the plant to maintain a more consistent energy output.

Another purpose of the proposed project would be to provide for additional recreation opportunities in the area. Recreation activities are in high demand in Kane County. Water-based recreation facilities currently located in this portion of Kane County are limited. The proposed project would respond to this need by providing boating, fishing, and camping facilities that are currently not available. It is anticipated that use of the reservoir would provide economic opportunities to the area and provide an important additional recreation site during busy summer months.

Water from the proposed reservoir would be released to supplement Virgin River flows in Washington County. This additional water would improve habitat for two federally-listed fish species, the Virgin River chub and woundfin. This would particularly apply to the area around La Verkin Hot Springs (also known as Pah Tempe Hot Springs) where the water temperature is higher than in other parts of the river. The Washington County Water Conservancy District currently pipes water upstream from Quail Creek Reservoir to the area in order to decrease the water temperature and improve fish habitat. Water coming from the proposed Cove Reservoir would help this effort.

Water resulting from occasional flash floods in the Cove Reservoir drainage reaches the East Fork Virgin River, resulting in short-term, high-sediment loads as well as increased (sometimes very high) water flows. Many flood control sediment ponds located above the proposed reservoir site are small and have limited functionality. Therefore, the proposed reservoir could play a role in flood control and the maintenance of water quality in the Virgin River.

Construction of the proposed Cove Reservoir Project is expected to include the following activities:

- Construction of an approximately 6,032-acre-foot capacity reservoir
- Construction of an earthen and rock fill dam
- Installation of primary and auxiliary spillways
- Development of access roads, including construction of segments of new access road and improvements to existing access roads which would circumnavigate the reservoir

- Construction of recreational features such as parking areas, camping, and boat ramps (design yet to be determined)
- Extension of existing feeder pipeline to proposed reservoir location
- Replacement of approximately 1.7 miles of existing irrigation pipeline in the Glendale Irrigation System
- Relocation of the existing Glendale Hydroelectric Plant south near the existing Orderville Diversion Dam
- Construction of approximately 0.2 mile of electric transmission collector line from the new hydroelectric plant

Within the study area, permanent ground disturbance is anticipated to occur where: the reservoir, dam, new reservoir access road, borrow pit expansion, recreational features and primary/auxiliary spillways, electric transmission collector line, and hydroelectric plant would be constructed. Temporary disturbance is anticipated for all pipeline installation/replacement and road improvement activities. Construction of the electric transmission line would cross the East Fork Virgin River; however, no disturbance within the OHWM of the river is anticipated. All temporary staging areas would be located within the reservoir basin and would not require additional disturbance outside of permanently impacted areas.

1.4 Interstate of Foreign Commerce Connection

The water bodies in the study area are not directly connected to interstate or foreign commerce, and are not used for the transportation of goods.

SECTION 2 AQUATIC RESOURCE LOCATION AND ACCESS

A total of six potentially jurisdictional, intermittent stream systems and two isolated wetlands are found within the overall study area. Four of the intermittent streams and one wetland are located within the study area associated with the reservoir. The remaining two intermittent streams and one wetland are found within the study area associated with the Glendale Hydroelectric Plant and pipeline. Neither of the two wetlands are considered jurisdictional because they are isolated, likely defunct agricultural water storage ponds. No intermittent streams or wetlands were observed within or near the six borrow pit locations. One perennial stream, the East Fork Virgin River, crosses the project area where the proposed electric transmission collector line would be installed. However, no project activities would occur within the OHWM of the East Fork Virgin River.

The proposed project area is located near the towns of Glendale and Orderville, both in Kane County, Utah. The total survey area for all project components is approximately 805.6 acres in area and is located within Township 40 South, Range 7 West, Sections 23, 26, and 27; Township 41 South, Range 7 West, Sections 5, 6, 19, and 31; Township 40 South, Range 5 West, Section 28 of the Salt Lake Baseline and Meridian on the Bald Knoll, Orderville, Glendale, and Mt. Carmel, Utah 7.5-minute U.S. Geological Survey (USGS) topographic quadrangles (**Figure 1**).

The proposed project area, where construction of the dam, reservoir, and other improvements would occur, is located west of US-89 and the East Fork Virgin River near Glendale and Orderville. Of the four existing borrow pits, as well as one new pit that will be utilized for construction material (e.g., rip rap, gravel, etc.), two borrow pits (Tait and Lamb) are located east of US-89 on private land and three borrow pits (Black Knoll, Elbow, and Bald Knoll) are located east of US-89 along Glendale Bench Road on Bureau of Land Management- (BLM) administered public land. The proposed Cove Reservoir can be accessed from Cove Road off of US-89 between milepost (MP) 84.9 and MP 85, and the Glendale Hydroelectric Plant and pipeline can be accessed via a number of private roads west of US-89 between MP 87.9 and MP 89.4. The

Lamb Pit is accessed east of US-89 from a dirt road at MP 81.4. The Tait borrow pit can be accessed, east of Mt. Carmel and US-89, via Tait Lane. The potential Black Knoll borrow pit site in addition to the existing Elbow pit and Bald Knoll pits are accessed from Glendale Bench Road on Kane County Road. Access to Glendale Bench Road is located east of US-89 at MP 90. Access to all aquatic features is located on land under the jurisdiction of the BLM Kanab Field Office, Utah School and Institutional Trust Lands Administration, or private ownership.

Project Overview
Cove Reservoir Project
Natural Resources Conservation Services and Kane County Water Conservancy District
Legend
Project features
Existing Orderville Hydroelectric Plant
Proposed Glendale Hydroelectric Plant
Existing Glendale Hydroelectric Plant
Proposed Glendale Pipeline
Existing pipeline
Borrow Pits
Proposed Cove Reservoir
Land Ownership
BLM
Private
SITLA
Utah
0
2
Mile
TRANSCON environmental
Black Knoll Pit (new)
Elbow Pit (existing)
Bald Knoll Community Pit (existing)
Tait Pit (existing)
Lamb Pit (existing)

Figure 1

SECTION 3 STUDY METHODS

3.1 Delineation Survey Methods

A focused evaluation of WOTUS located within the study area was performed between October 8, 2018 and October 10, 2018 and follow-up field visits to evaluate additional borrow pits were conducted on April 24 and September 20, 2019. The methods used to delineate potentially jurisdictional WOTUS and locate any other potential aquatic features (including wetlands) within the study area were based on the USACE Jurisdictional Determination Form Instructional Guidebook (USACE 2007); A Field Guide to the Identification of the Ordinary High Water Mark in the Arid West Region of the Western United States (Lichvar and McColley 2008); USACE Wetland Delineation Manual (USACE 1987); and the Interim Regional Supplement to the USACE Wetland Delineation Manual: Arid West Region. A site survey was also conducted to verify the presence of suitable habitat.

Transcon used two methods to identify wetlands and waters:

1) Locations with previously mapped wetlands and waters were identified in the field and investigated.
2) The study area was traversed and inspected for signs of wetlands and waters (e.g., changes in vegetation, depressions holding water, or channels), and investigated.

Methods for evaluating the presence of wetlands and other waters employed during the routine determination are described in detail below.

3.1.1 Existing Data

Existing data were reviewed before conducting a field assessment. Information reviewed included:

- Recent aerial photography
- U.S. Fish and Wildlife Service (USFWS) National Water Inventory (NWI) (USFWS 2018)
- U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) soil maps (NRCS 2018)

3.1.2 Clean Water Act (CWA) Wetlands Definition

The study area was evaluated for the presence or absence of indicators of the 3 wetland parameters described in the USACE Manual (USACE 1987) and the Arid West Regional Supplement (USACE 2008): the presence of 1) hydrophytic vegetation, 2) wetland hydrology, and 3) hydric soils.

Section 328.3 of the Federal CFR defines wetlands as:

> *"Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."*

According to the USACE Manual, for areas not considered "problem areas" or "atypical situations":

> *"….evidence of a minimum of one positive wetland indicator from each parameter (hydrology, soil, and vegetation) must be found in order to make a positive wetland determination."*

Data on vegetation, hydrology, and soils collected at sample points during the site visit was reported on Wetland Determination Data Form–Arid West Region forms (**Appendix B**). Once an area was determined to be a potential jurisdictional wetland, its boundaries were delineated using a GPS and mapped on a topographic, aerial map. Indicators described in the Arid West Regional Supplement were used to make wetland determinations at each sample point in the study area and are summarized below.

Vegetation

This report discusses botanical species with both their scientific and common names. Plant species identified within the study area were assigned a wetland status according to the USFWS list of plant species that occur in wetlands (Lichvar et al 2016). This wetland classification system is based on the expected frequency of species occurrence in wetlands as follows:

OBL	Occur almost always in wetlands under natural conditions	>99% frequency
FACW	Usually occur in wetlands	67–99%
FAC	Equally likely to occur in wetlands or non-wetlands	34–66%
FACU	Usually occur in non-wetlands	1–33%
UPL	Occur almost always in non-wetlands under natural conditions	<1%

The Arid West Regional Supplement requires a three-step process to determine if hydrophytic vegetation is present. The procedure first requires the delineator to apply the 50/20 Rule (Indicator 1) described in the manual. To apply the 50/20 Rule, dominant species are chosen independently from each stratum of the community including four strata: tree, sapling/shrub, herbaceous, and woody vine[1]. In general, dominant species are determined for each vegetation stratum from a sampling plot of an appropriate size surrounding the sample point. Dominant species are generally the most abundant species that individually or collectively account for more than 50 percent of total vegetative cover in the stratum, plus any other species that, by itself, accounts for at least 20 percent of the total cover. If greater than 50 percent of the dominant species has an OBL, FACW, or FAC status, the sample point meets the hydrophytic vegetation criterion.

If the sample point fails the application of Indicator 1, and both hydric soils and wetland hydrology are absent, then the sample point does not meet the hydrophytic vegetation criterion, unless the site is a problematic wetland situation. However, if the sample point fails Indicator 1 but hydric soils and wetland hydrology are both present, the delineator must apply Indicator 2.

Indicator 2 is the Prevalence Index, which is a weighted average of the wetland indicator status for all plant species within the sampling plot. Each indicator status is given a numeric code: OBL=1, FACW=2, FAC=3, FACU=4, and UPL=5. Application of Indicator 2 requires the delineator to estimate the percent cover of each species in every stratum of the community and sum the cover estimates for any species that are present in more than one stratum. The delineator must then organize all species into groups according to their wetland indicator status and calculate the Prevalence Index using the following formula, where “A” equals total percent cover.

$$PI = \frac{A_{OBL} + 2A_{FACW} + 3A_{FAC} + 4A_{FACU} + 5A_{UPL}}{A_{OBL} + A_{FACW} + A_{FAC} + A_{FACU} + A_{UPL}}$$

The Prevalence Index will yield a number between one and five. If the Prevalence Index is equal to or less than three, the sample point meets the hydrophytic vegetation criterion. However, if the community is greater than three, the delineator must proceed to Indicator 3.

---

[1] The tree stratum includes woody plants, excluding woody vines, approximately 20 feet or more in height and 3 inches or larger in diameter at breast height (DBH). The sapling/shrub stratum includes woody plants, excluding woody vines, less than 3 inches DBH, regardless of height. The herb stratum includes all herbaceous (non-woody) plants, including herbaceous vines regardless of size, and woody plants, except woody vines, less than approximately 3 feet in height. The woody vine stratum includes all woody vines regardless of height (USACE 2008).

Application of Indicator 3 assesses presence of morphological adaptations. If more than 50 percent of the individuals of a FACU species have morphological adaptations for life in wetlands, that species is considered to be a hydrophyte and its indicator status should be reassigned to FAC. If such observations are made, the delineator must recalculate Indicators 1 and 2 using a FAC indicator status for this species. The sample point meets the hydrophytic vegetation criterion if either test is satisfied.

This three-step process was utilized to determine if sample points within the project met the hydrophytic vegetation criterion.

Hydrology

The USACE jurisdictional wetland hydrology criterion is satisfied if an area is inundated or saturated long enough to create anoxic soil conditions during the growing season (i.e., a minimum of 14 days in the Arid West Region). Evidence of wetland hydrology can include primary indicators, such as visible inundation or saturation, drift deposits, oxidized root channels, or salt crusts; or secondary indicators such as the FAC-neutral test, the presence of a shallow aquitard, or frost-heave hummocks. The Arid West Regional Supplement contains 18 primary hydrology indicators and 9 secondary hydrology indicators (USACE 2008). Only one primary indicator is required to meet the wetland hydrology criterion. If secondary indicators are used, at least two secondary indicators must be present to conclude that an area has wetland hydrology.

The presence or absence of the primary or secondary indicators described in the Arid West Regional Supplement was utilized to determine if sample points within the delineation study area met the wetland hydrology criterion.

Soils

NRCS defines a hydric soil as follows:

> *"A hydric soil is a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part."*
>
> (Vasilas et al. 2010)

Soils formed over long periods of time under wetland (anaerobic) conditions often possess characteristics that indicate they meet the definition of hydric soils. Hydric soils can have a hydrogen sulfide (i.e., rotten egg) odor, low chroma matrix color (designated 0, 1, or 2), presence of redox concentrations, gleyed or depleted matrix, or high organic matter content.

Specific indicators that can be used to determine whether a soil is hydric for the purpose of wetland delineation are provided in the NRCS Field Indicators of Hydric Soils in the United States (Vasilas et al. 2010). The Arid West Regional Supplement provides a list of 19 hydric soil indicators that are known to occur in the Arid West Region (USACE 2008). Where possible, soil samples were collected and described according to the methodology provided in the Arid West Regional Supplement (see Difficult Wetlands Situations in Section 3.2 below). Soil chroma and values were determined by utilizing a standard Munsell soil chart (Munsell 2009).

Hydric soils were determined to be present if any of the soil samples met 1 or more of the 19 hydric soil indicators described in the Arid West Regional Supplement.

3.1.3 Other Waters of the United States

WOTUS are defined by Title 40 of the CFR 230.3 and by 33 CFR 328.3 as:

- All waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce
- All interstate waters, including interstate wetlands
- All impoundments of waters otherwise identified as WOTUS
- All tributaries of interstate waters or territorial seas
- All waters adjacent to an identified WOTUS, including wetlands, ponds, lakes, oxbows, impoundments, and similar waters
- All waters determined to have a 'significant nexus' to WOTUS

The term 'significant nexus' is defined in 40 CFR 203.3 and 33 CFR 328.3 as:

> *"…a water, including wetlands, either alone or in combination with other similarly situated waters in the region, significantly affects the chemical, physical, or biological integrity of a water identified..." as a WOTUS. "For an effect to be significant, it must be more than speculative or insubstantial. Waters are similarly situated when they function alike and are sufficiently close to function together in affecting downstream waters."*
>
> Federal Register Vol. 80, No. 124
> Part 230.3(c) and 328.3 (c). June 29, 2015

This delineation evaluated the presence of other waters potentially subject to USACE jurisdiction under Section 404 of the CWA. Waters subject to USACE jurisdiction include lakes, rivers, and streams (including intermittent streams), in addition to all areas below the high tide line in areas subject to tidal influence. Jurisdiction in non-tidal areas extends to the OHWM, defined as:

> *"…that line on the shore established by the fluctuations of water and indicated by physical characteristics such as clear, natural line impresses on the bank, shelving, changes in the characteristics of the soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas."*
>
> Federal Register Vol. 51, No. 219
> Part 328.3 (e). November 13, 1986

Additionally, if adjacent wetlands are present, USACE jurisdiction extends beyond the OHWM to the limit of the adjacent wetland.

Identification of the OHWM followed the USACE Regulatory Guidance Letter Number 05-05, OHWM Identification (USACE 2005). The extent of the OHWM was determined using a combination of aerial imagery and field assessment. OHWM data gathered in the field was identified by a break between upland and wetland characteristics, as identified in the Arid West Regional Supplement. Topographic information from ArcGIS software Esri ArcMap 10.4.1 was used to extend the break throughout the entire feature.

Channel lengths approximate the centerline of main channel flow. Widths and depths were measured from cross-channel measurements conducted in the field, general field observations, and post-field calculations. Delineation of the OHWM of all washes was conducted using handheld sub-meter GPS, in combination with available aerial imagery, to provide an accurate representation of the OHWM at the time survey. All OHWM data collected at sample points during the site visit were recorded on Arid West Ephemeral and Intermittent Streams OHWM Datasheets (**Appendix B**).

3.2 Areas Outside of Section 404 Jurisdiction

Some areas that meet the technical criteria for wetlands or other waters may not be jurisdictional under the CWA. Included in this category are some man-induced wetlands, which are areas that have developed at least some characteristics of naturally-occurring wetlands due to either intentional or incidental human activities. Examples of man-induced wetlands may include, but are not limited to, irrigated wetlands, impoundments, drainage ditches excavated in uplands, wetlands resulting from filling of formerly deep-water habitats, dredge material disposal areas, and depressions within construction areas.

In addition, some isolated wetlands and other waters may be considered outside of USACE jurisdiction as a result of the Supreme Court's decision in Solid Waste Agency of Northern Cook County versus USACE (531 U.S. 159 [2001]). Isolated wetlands and other waters are those areas that do not have a surface or groundwater connection to and are not adjacent to a navigable "waters of the United States" and do not otherwise exhibit an interstate commerce connection.

SECTION 4 EXISTING CONDITIONS

4.1 Existing Field Conditions, Land Use, and Landscape Setting

4.1.1 Existing Field Conditions

The study area has an arid, desert climate, with an average yearly precipitation total of approximately 14.67 inches. The majority of surveys of the study area were conducted between October 8, 2018 and October 10, 2018. Supplementary field reviews of additional borrow pit locations were conducted on April 24 and September 20, 2019. The monthly average precipitation for October is 1.47 inches (Weather Underground 2018). Weather at the time of the surveys was mostly clear, with some shorter periods of cloudiness with scattered showers. Winds averaged 5–10 miles per hour and average temperatures ranged in the low-60s (degrees Fahrenheit). Surveys occurred approximately 24–36 hours following a significant rain event and evidence of flooding (e.g., sheet flow, heavy debris, and sedimentation of streams) was abundant throughout the study area.

4.1.2 Land Use

The proposed project area is located within the Grand Staircase subdivision of the Colorado Plateau physiographic region of southwestern Utah, immediately south of the Basin and Range–Colorado Plateau Transition Zone (Woods et al 2001). The Grand Staircase subdivision is characterized by a series of slopes, cliffs, and terraces that extend from the Grand Canyon in Arizona culminating in the High Plateaus of southern Utah. This region is further characterized by many unique linear cliffs that are distinctly colored and display several different geologic ages (Stokes 1977). Major drainage systems in the project area include the East Fork Virgin River and Muddy Creek, as well as numerous unnamed intermittent and ephemeral streams, springs, and dry washes.

The project area begins south of Mount Carmel Junction at the UDOT borrow pit, encompasses a large area west of Orderville at the proposed reservoir site, extends along the East Fork Virgin River at the area of the proposed new pipeline, and terminates northeast of Glendale by the Bald Knoll borrow pit (**Figure 1**). The topography of the region is characterized by steep slopes, cliff faces, and various rock formations, and is situated in a distinctive geological area surrounded by the Coral Pink Sand Dunes State Park to the south, Zion National Park to the west, Cedar Breaks National Monument to the northwest, the Grand Staircase-Escalante National Monument to the east, and Bryce Canyon National Park to the northeast. Most of the project extends along the Sevier Fault; Triassic and Jurassic rock formations are exposed in the region across the anticline, including the Glen Canyon Group of Moenave Formation, Kayenta Formation, and Navajo Sandstone. There are also Cretaceous rock formations west of the Sevier Fault in the project area, including the Wahweap and Straight Cliffs formations, Dakota Sandstone and Cedar Mountain Formation, and the Jurassic Carmel Formation (Williams et al. 2014).

The project area associated with the reservoir is primarily utilized for livestock grazing and recreation, including hiking and off-highway vehicle use. East and south of the proposed project area are agricultural fields located on privately owned lands. Much of the project area, associated with the Glendale hydroelectric power plant and pipeline replacement, is located along an existing access road. North of this alignment are steep, forested hills while south of the project is mainly agricultural fields and private residences. Portions of the pipeline traverse through some of these agricultural fields.

4.1.3 Landscape Setting

The proposed new pipeline section of the project area is located within Long Valley along the Mt. Carmel Scenic Byway (US-89), which lies west of Glendale Bench and the White Cliffs. The proposed reservoir section of the project area is located south and west of the town of Orderville adjacent to Cove Canyon and Deer Hollow, and Bald Knoll pit is located just above the Skutumpah Terrace. Elevations in the project area range from 5,230 feet above sea level (asl) near Lamb's Pitt to 6,542 feet asl in the vicinity of Bald Knoll pit. Elevations in the proposed new pipeline area range from 5,600 to 5,721 asl.

Vegetation

Vegetation found in the project area consists of greasewood-salt scrub and transitions into sagebrush-perennial grassland habitat and, eventually, into pinyon-juniper woodland in the higher elevations. The project proposes the use of four existing borrow pits (Elbow, Tait, Lamb, and Bald Knoll). One new borrow pit (Black Knoll), consists of a mix of pinyon-juniper woodland and sagebrush communities. The area of the proposed new pipeline and hydroelectric plant is found in proximity to the East Fork Virgin River, and portions of this section of the project cross though agricultural fields and along a riparian environment with tamarisk (*tamarix sp.*) , Russian olive (*Elaeagnus angustifolia*), and cottonwood trees (*Populus fremontii*).

Dominant ecological systems in the study area include Inter-Mountain Basins Big Sagebrush, Colorado Plateau Pinyon-Juniper Woodland, Introduced Upland Vegetation-Shrub, Shrub land, Inter-Mountain Basins Greasewood Flat, Rocky Mountain Lower Montane Riparian Woodland and Shrub land, Mogollon Chaparral, Disturbed/Successional – Shrub Regeneration, and Pasture/Hay (USGS 2018). Species observed within or adjacent to the project area were characteristics of these ecosystems and included a mix of native and non-native trees, shrubs, forbs, and grasses. Dominant native vegetation observed within the study area included: two-needle pinyon pine (*Pinus edulis*), Utah juniper (*Juniperus osteosperma*), sagebrush (*Artemesia tridentata*), salt bush (*Atriplex confertifolia*), greasewood (*Sarcobatus vermiculatus*), narrowleaf willow (*Salix exigua*), cattail (*Typhus latifolia*), blue bunch wheatgrass (*Pseudoroegneria spicata*), western wheatgrass (*Pascopyrum smithii*), and bottlebrush squirreltail (*Elymus elymoides*).

Activities associated with the project would have direct impacts to vegetation communities in the project area.

Regional Hydrology

The project is located within the Upper Virgin River Watershed, with the East Fork Virgin River intersecting the project limits. Within the project limits, the East Fork Virgin River is considered perennial, and flowing water was observed during field reconnaissance. Water in the East Fork Virgin River is derived from runoff via rainfall and snowmelt, and from groundwater entering via seeps and springs. The water from snowmelt makes up the largest percentage of streamflow and usually causes the highest monthly flows to occur in March through May, while most low-flow periods occur from June through October (Glancy and Van Denburgh 1969). Water collected within or upstream of the reservoir and pipeline portions of the proposed project area eventually drains into the East Fork Virgin River.

National Wetlands Inventory (NWI)

The general location of potential wetlands and potentially jurisdictional WOTUS was identified using NWI data provided by the USFWS (USFWS 2018). **Table 1** lists the feature types that intersect with the study area, as reported by NWI. Features shown to intersect the study area include four wetlands and nine intermittent stream systems.

TABLE 1
NWI FEATURE TYPES WITHIN AND NEAR THE 805.6-ACRE STUDY AREA

NWI Wetland ID (South to North)	NWI Feature Type	Feature Type NWI*	Mapped Area (Acres)
1	Riverine (intermittent)	R4SBJ	30.08
2	Riverine (intermittent)	R5UBFx	0.91
3	Freshwater Pond	PABFh	0.10
4	Freshwater Pond	PABFh	0.10
5	Riverine (intermittent)	R4SBC	5.13
6	Riverine (intermittent)	R4SBC	1.41
7	Riverine (Perennial; East Fork Virgin River)	R3UBG	16.11
8	Riverine (intermittent)	R4SBC	1.23
9	Riverine (intermittent)	R4SBC	2.26
10	Freshwater Emergent Wetland	PEM1Fh	0.27
11	Freshwater Pond	PABFh	0.47
12	Riverine (intermittent)	R4SBC	1.27
13	Riverine (intermittent)	R4SBC	4.62

***Note**: Wetlands and Deepwater Habitats Classification (Cowardin et al. 1979). **System**—P: Palustrine; R: Riverine; **Subsystem**—3: Upper Perennial; 4: Intermittent **Class**—AB: Aquatic Bed; EM: Emergent; SB: Streambed; UB: Unconsolidated Bottom; **Subclass**—1: Persistent; **Modifiers**—C: Seasonally Flooded; F: Semipermanently Flooded; G: Intermittently Exposed; J: Intermittently Flooded; **Special Modifiers**—h: Diked/Impounded; x: Excavated

Soils

USDA NRCS soil surveys indicate 14 native soil types in the study area (NRCS 2018). **Table 2** lists the soil types and whether they meet the NRCS hydric soils criteria. None of the soil types found within the study area are listed as an NRCS hydric soil type. NRCS custom resource reports including a description and map for all soils contained within the study area listed below are located in **Appendix C.**

TABLE 2
NATIVE SOIL TYPES IN THE STUDY AREA

Map Unit Name	Acres in Study Area	Percent of Study Area	NRCS Hydric Soil
Naplene-Teromote-Arboles-Oxyaquic Ustifluvents complex, 2- to 8-percent slopes	36.6	4.5	No

TABLE 2
NATIVE SOIL TYPES IN THE STUDY AREA

Map Unit Name	Acres in Study Area	Percent of Study Area	NRCS Hydric Soil
Quezcan, deep-Sideshow-Orderville complex, 15- to 35-percent slopes	176.3	21.9	No
Sili-Sideshow-Gypsic Haplustepts complex, 2- to 15-percent slopes	258.5	32.1	No
Zigzag family-Badland-Quezcan complex, 35- to 90-percent slopes	107.7	13.4	No
Catdraw family-Orderville-Quezcan family complex, 15- to 35-percent slopes	0.3	0.02	No
Catdraw-Quezcan-Vessilla complex, 35- to 60-percent slopes	8.4	1.0	No
Parkelei-Quagmeier-Fraguni complex, 2 to 35 percent	29.4	3.6	No
Elpedro-Plumasano-Teromote family-Flatnose complex, 0- to 8-percent slopes	0.7	0.1	No
Wetoe family-Flugle-Royosa family-Lava flows complex, 2- to 60-percent slopes	118.9	14.8	No
Pinepoint-Waumac-Royosa complex, 0- to 4-percent slopes	11.4	1.4	No
Pinepoint-Pana-Parkwash complex, 2- to 8-percent slopes	20.7	2.6	No
Tonalea family-Barnac complex, 15- to 65-percent slopes	36.7	4.6	No

4.2 Aquatic Resources Within the Study Area

4.2.1 Overview

Based on our desktop review and field surveys of the overall 805.6-acre study area conducted between October 8, 2018 and October 10, 2018, April 24, 2019, and September 20, 2019, it has been determined that within the approximately 264.4-acre project area that 6 potentially jurisdictional intermittent or ephemeral streams currently exist. Although two isolated wetland features were discovered and delineated, these features were determined to be isolated, man-made features and are not considered jurisdictional WOTUS (**Table 3**). A total of 2.97 acres, or 9,716 linear feet, were identified as potentially jurisdictional intermittent or ephemeral streams (**Table 4**). All WOTUS identified were located within the project areas associated with the Cove Reservoir and Glendale pipeline portions of the proposed project. Five borrow pits, Black Knoll (**Appendix A**–Sheet 12), Elbow (**Appendix A**–Sheet 13), Bald Knoll (**Appendix A**, Sheet 14), Tait (**Appendix A**–Sheet 15**)**, and Lamb (**Appendix A**–Sheet 16) pits were all investigated and no WOTUS were identified. During our field review, it was also noted that prior anthropogenic disturbances had altered a number of streams that were identified by NWI, and now no longer exist or no longer exhibit connectivity to other aquatic features downstream. These disturbances included roads, residential developments, and cattle ponds. Cattle ponds that had been filled in with silt were discovered during field surveys and were investigated for wetland characteristics; however, none exhibited the required vegetation, hydrology, or soils to be considered wetlands. Representative photos of all potential aquatic resources observed within the study area are included in **Appendix D**.

Isolated Wetlands

Wetland 1 (W1) is a small, approximately 0.03-acre, artificial pond located approximately 200 feet south of the existing Cove Road, south of the proposed reservoir location and project area (**Appendix A**–Sheet 7). Upon field review, W1 was observed to contain a virtual monoculture of cattail, a wetland obligate species, and was confirmed to contain the necessary hydrophytic vegetation to be classified as a wetland

(**Appendix D**–Figure 10). Investigations of hydrologic and soil conditions resulted in the positive identification of wetland indicators confirming its status as a wetland, with inundation visible on aerial imagery and abundant redox depressions throughout the soil sample at the site. Underground irrigation hoses were observed around the pond and it appeared that it was artificially fed in the past. No outlet or connectivity to other aquatic features was observed and this appears to be an artificially created isolated wetland feature. Boundaries of the wetland were well defined and surrounding vegetation directly adjacent to W1 consisted of upland dominant species.

Wetland 2 (W2) is an approximately 0.73-acre, man-made pond located within the ROW for the Glendale pipeline portion of the project area and is adjacent to privately-owned agricultural pastures (**Appendix A–** Sheet 11). Field review showed the wetland to contain primarily narrowleaf willow, a facultative wetland species, with a mix of unknown grass species at the herbaceous stratum (**Appendix D**–Figure 32). Due to the time of year field surveys were conducted, species and thus wetland indicator statuses for these grasses was not attainable. However, because willow was abundant and noticeably dominant throughout the pond at the sapling/shrub stratum, application of the Dominance Test confirmed that hydrophytic vegetation was present. Investigations of the hydrologic and soil conditions also confirmed its status as a wetland, with surface soil cracks present throughout the pond basin and redox depressions throughout the soil sample. No inlet, outlet, or connectivity to other aquatic features was observed and this appears to be an artificially created isolated wetland feature. Boundaries of the wetland were well defined and surrounding vegetation directly adjacent to W2 consisted of upland dominant species.

Perennial, Intermittent and Ephemeral Streams

Potentially jurisdictional aquatic feature, or PJD 1, is a largely ephemeral drainage which bisects the project area in a southeasterly direction through where the proposed reservoir would be constructed (**Appendix A–** Sheets 1, 2, 6, and 7). Sediment and flow carried within this drainage are collected from terrain northwest of the proposed project area and eventually lead south and out of the project area, debouching into the East Fork Virgin River. The northeast portion of PJD 1 within the project area is situated at the bottom of an approximately 25- to 30-foot deep canyon. Here the OHWM was well-defined with large debris and deposition evident of significant flow from the heavy precipitation experienced in the area days prior to survey. The channel was relatively clear, with some vegetation and sediment consisting of a mix of boulders and clay (**Appendix D–**Figures 1-3). Average width of PJD 1 here was 17 feet. Further downstream, the width of the OHWM and channel characteristics remain the same and terrain opens up into a large valley (**Appendix D**–Figures 4-5). No flowing water was observed, although there were numerous areas of pooling and the active floodplain was deeply saturated, making walking the stream difficult to impossible. PJD1a is a smaller intermittent stream tributary to PJD 1 which carries precipitation and snowmelt from mountains directly adjacent and north of the proposed reservoir and access road location (**Appendix A–** Sheet 2). This stream has a well-defined channel and deposition at the OHWM (**Appendix D**–Figures 13 and 14). No flowing water was observed within this stream at the time of field surveys. Both PJD 1 and PJD 1a exhibited a clear OHWM and evidence of recent flow and likely have jurisdictional status as WOTUS.

PJD 2 is an ephemeral drainage which bisects the reservoir portion of the project area in a southerly direction along the eastern boundary of where the proposed reservoir would be constructed (**Appendix A–** Sheets 3 and 7). Sediment and flow carried within this drainage are collected from terrain northeast of the proposed project area, leading to the confluence with PJD 1 and eventually to the East Fork Virgin River downstream (**Appendix D**–Figure 6). The upper reaches of PJD 2 are characterized by 50- to 60-foot deep slot canyon walls and a narrow channel with some upland vegetation observed growing in the active floodplain and along canyon walls (**Appendix D–**Figure 18). Channels were not walked on foot in this area during field surveys because of safety concerns due to the unstable cliff walls; however, the conditions of the channel could be easily viewed from above the edge of the canyon. Downstream, PJD 2 opens up into an open valley landscape where widths of the active floodplain are similar to its upstream segment, but there is more terracing, banks are less steep, and more significant vegetation was present within the channel and floodplain (**Appendix D**–Figures 19-20)**.** Average width of PJD 2 was 14 feet. PJD 2a is a tributary ephemeral drainage which feeds into the upper reach of PJD 2 within the project area, upstream of where the proposed reservoir would occur (**Appendix A–**Sheet 3). This tributary is formed by sheet flow and runoff north of the study area that is diverted into a set of 2 non-functional sediment ponds (**Appendix D–**Figure 15) which then spills into an approximately 50-foot canyon and confluence with PJD2. Average width of PJD 2a was 17 feet. Saturation was evident throughout PJD 2 and PJD 2a, though no flowing water was observed. Due the likelihood of sustained flow events, as indicated by the deep canyons upstream, and the indirect connectivity to the East Fork Virgin River located approximately 0.75 mile downstream, PJD 2 and PJD 2a likely have jurisdictional as WOTUS.

PJD 3 and PJD 3a (PJD3a is tributary to PJD 3) is an ephemeral stream system located at the southwest boundary of where the proposed reservoir would be constructed and runs in a generally easterly direction (**Appendix A**–Sheets 5 and 6). Sediment and flow carried within this small drainage are collected from upland terrain west of the proposed project area, but does not maintain definition or connectivity downstream. Upstream, PJD 3 and PJD 3a exhibited a clear channel, banks, and a well-defined OHWM (**Appendix D–**Figures 21 and 22). Below the confluence of PJD 3 and PJD 3a, this ephemeral stream reaches an existing dirt road downhill of where the OHWM is delineated and all definition of a channel and OHWM disappear (**Appendix D–**Figure 23). Prior to creation of the road, PJD3 may have had surficial connectivity with PJD 1. Currently flow and sediment carried in the upper reaches of PJD 3 dissipate into sheet flow, roughly following the alignment of the road, and likely only reach PJD1 during heavy or extended precipitation or snowmelt events. Average width of PJD 3 and PJD 3a, where an OHWM was observed, was approximately 2 feet. No flowing water was observed during field surveys. Because of its lack of a continuous OHWM or connectivity to other potential WOTUS, PJD 3 and PJD 3a likely do not have jurisdictional status as a WOTUS.

PJD 4 is a short, ephemeral drainage which runs in a southerly direction and is located within the study area, but west of the project area where activities would occur. Flow and sediment carried within this drainage, collected from terrain northwest of the proposed project area, runs in a southerly direction and, similar to PJD 3 and 3a, does not maintain definition or connectivity to other aquatic features downstream. Sheet flow originating from upstream of PJD 4 (**Appendix D–**Figure 24) is funneled from adjacent hillsides into a steep-walled gorge where the OHWM and channel are well-defined (**Appendix D**–Figures 25-26). The OHWM here was defined by the presence of debris and deposition along the stream banks. As terrain flattens out, the drainage opens up into another section of sheet flow which is gathered in a series of three sediment or watering ponds (**Appendix D**–Figures 27, 28, 30 and 31). No evidence of an OHWM beyond where terrain opens up nor surface connectivity beyond the lower of the three ponds was observed during field surveys. Average width of PJD 4 where the OHWM was observed was approximately 9 feet. Saturation of soils was evident throughout the area, but no flowing water was observed in PJD 4 during field surveys. Because of its lack of a continuous OHWM or connectivity to other potential WOTUS, PJD 4 likely does not have jurisdictional status as a WOTUS. It should be noted that following consultation with the USACE, this stream was determined to not have jurisdictional status, nor would it be impacted by the project. Therefore, delineation of this stream is not displayed on the maps in Appendix A.

PJD 5 is an intermittent stream located west of W2 which runs in southerly direction and bisects the ROW for the Glendale pipeline portion of the project area (**Appendix A**–Sheet 11). Flow and sediment carried within this stream is collected from mountains directly north of the project area. The stream had flowing water in its approximately 3-foot-wide channel during the time of surveys and showed evidence of recent heavier flow indicated by downed vegetation and large debris deposition at the OHWM (**Appendix D–**Figures 33 and 34). Vegetation surrounding PJD 5 was a mix of upland and riparian species including cottonwood, two-needle pinyon pine, Utah juniper, and oak (*Quercus sp.*). Average width of the OHWM for PJD 5 within the pipeline ROW was approximately 11 feet. PJD 5 was one of only two streams that had flowing water in the study area, despite the occurrence of heavy rains a few days prior to field surveys. Flow is likely maintained within this stream much of the year, at least seasonally, and because of its proximity and connectivity to the East Fork Virgin River, located approximately 0.2 mile south, PJD 5 likely has jurisdictional status as a WOTUS.

PJD 6 is an intermittent stream located west of W2 and PJD 5 and north of the proposed hydroelectric plant location. PJD 6 runs in a southerly direction and bisects the ROW for the Glendale pipeline portion of the project area (**Appendix A–**Sheet 11). Flow and sediment carried within this stream is collected from mountains directly north of the project area. Like PJD 5, PJD 6 had flowing water in its channel during the time of surveys and showed evidence of recent flood events as indicated by downed, matted vegetation, and debris deposition at the OHWM (**Appendix D–**Figures 35-36). Vegetation was observed within the channel of the intermittent stream which consisted of smaller herbaceous species and grasses. Vegetation surrounding the stream consisted of a mix of upland and riparian species including oak, cottonwood, and cattail. Average width of the OHWM for PJD 6 within the project area was 5 feet. Flow is likely maintained within this stream much of the year, though likely less that PJD 5 as the channel contained vegetation and was significantly smaller. Because of observation in the field of flowing water, a clear OHWM and connectivity to the East Fork Virgin River approximately 0.2 mile south, PJD 6 likely has jurisdictional status as a WOTUS.

A short section of the East Fork Virgin River crossed the proposed ROW for the electric transmission line which leads from the proposed Glendale Hydroelectric Plant location southeast to roughly US-89. The East Fork Virgin River is classified by NWI as an upper perennial riverine feature and is formed from precipitation and snowmelt collected from mountains and valleys north of Glendale. At the time of surveys, this section of the river had a low gradient characterized by flat water with no pools or riffles. Riparian vegetation was abundant including mixed stands of cottonwood, tamarisk, Russian olive, and willow. The East Fork Virgin River's location is labeled on the maps in **Appendix A**; however; the OHWM was not delineated, as project activities are not anticipated to occur within or directly adjacent to the river or its banks.

TABLE 3
DELINEATED WETLAND FEATURES

ID	Latitude	Longitude	Wetland Type	Wetland Type NWI*	Acres
W1	37.269568	-112.65711	Isolated Wetland (Non-Jurisdictional)	PABFh	0.03
W2	37.303818	-112.614124	Isolated Wetland (Non-Jurisdictional)	PABFh/PEM1Fh	0.73

***Note**: Wetlands and Deepwater Habitats Classification **System—**P: Palustrine; **Class—**AB: Aquatic Bed; EM: Emergent; **Modifiers—**F: Semipermanently Flooded; **Special Modifiers—**h: Diked/Impounded (Cowardin et al. 1979).

TABLE 4
POTENTIALLY JURISDICTIONAL AQUATIC FEATURES WITHIN THE PROJECT AREA

Feature Name	Latitude	Longitude	Distinct Banks/ Channel-ization	Connection to Water Body	Average Width (feet)	Length (feet)	Potential Disturbance (Acres)
PJD 1	37.273763	-112.663389	Yes	Yes	16	5,700	1.920
PJD 1a	37.274738	-112.663199	Yes	Yes	3	306	0.021
PJD 2	37.276115	-112.657022	Yes	Yes	14	2,988	0.970

TABLE 4
POTENTIALLY JURISDICTIONAL AQUATIC FEATURES WITHIN THE PROJECT AREA

Feature Name	Latitude	Longitude	Distinct Banks/ Channel-ization	Connection to Water Body	Average Width (feet)	Length (feet)	Potential Disturbance (Acres)
PJD 2a	37.278365	-112.655583	Yes	Yes	17	21	0.010
PJD 3	37.272185	-112.668303	Yes	No	2	598	0.040
PJD 3a	37.271801	-112.668842	Yes	No	2	33	0.001
PJD 5	37.303370	-112.614455	Yes	Yes	11	32	0.004
PJD 6	37.301501	-112.616446	Yes	Yes	5	38	0.010

4.2.2 Impacts

The proposed project is expected to permanently impact 2.96 acres, or 9,646 linear feet, and temporarily impact approximately 0.01 acres, or 70 linear feet, of potentially jurisdictional intermittent and ephemeral streams. Although the proposed project area crosses through one wetland at the Glendale pipeline portion of the project area this wetland is an isolated, man-made feature and is not considered jurisdictional. The East Fork Virgin River will remain in its current configuration and impacts within the river or its banks are not anticipated as a result of construction of the proposed project. Total impacts to potentially jurisdictional WOTUS delineated within the project area totals approximately 2.97 acres (2,716 linear feet). Impacts to each identified WOTUS are summarized in **Table 5.**

Although designs of the project have not been finalized, the majority of project features are not anticipated to deviate significantly from their currently proposed locations. Permanent impacts would occur to potentially jurisdictional WOTUS where the reservoir, dam, access road, spillways, recreational features (designs yet to be determined) and hydroelectric plant would be constructed. All WOTUS within the boundaries of the proposed reservoir would be disturbed during construction and would be permanently inundated once the dam is complete and the reservoir is filled. Access road construction would also necessitate cut and fill slope in steeper terrain resulting in permanent impacts outside of the 16-foot travel surface. Impacts to intermittent streams during construction of the access road would also occur should bridges or culverts be constructed or fill be installed at stream crossings. An approximate 80-foot by 80-foot area of permanent disturbance would be associated with the installation of the Glendale hydroelectric power plant's new proposed location.

All impacts associated with the Glendale pipeline portion of the study area during pipeline replacement, would be temporary. Staging of material and equipment during construction is anticipated to take place within the reservoir basin and would not require additional temporary disturbance. No impacts within OHWM of the East Fork Virgin River are anticipated. Development of the five borrow pits would result in a total new surface disturbance of approximately 5.7 acres; however no WOTUS are found within the boundaries of these pits and none would be impacted by the use or development of the borrow pits. Temporarily disturbed areas would be returned to pre-construction conditions following construction activities. Applicant-committed best management practices (BMPs) would be employed to minimize long-term surface disturbance.

TABLE 5 IMPACTS TO POTENTIALLY JURISDICTIONAL WOTUS			
ID	**Acres within Study Area**	**Impacts (acres)**	**Impacts (linear feet)**
PJD 1	2.686	1.92	5,700
PJD1a	0.021	0.021	306
PJD 2	1.218	0.97	2,988
PJD2a	0.150	0.01	21
PJD 3	0.055	0.043	598
PJD 3a	0.004	0.002	33
PJD 5	0.018	0.004	32
PJD 6	0.022	0.01	38
TOTAL POTENTIAL IMPACTS		2.97	9,716

SECTION 5 CONCLUSION

Based on our desktop review and field reconnaissance, it has been determined that a total of 2 wetlands, 6 potentially jurisdictional intermittent streams, and 1 perennial river exist within the 805.6-acre study area. It is anticipated that within the 264.4-acre project area footprint, total impacts would be limited to approximately 2.97 acres or 9,716 linear feet within the OHWM of potentially jurisdictional intermittent and ephemeral streams and that no jurisdictional wetlands would be impacted. Although plans for project activities have not yet been finalized, all disturbances would be contained within the study area analyzed within this report. To limit impacts outside of the proposed project footprint, all aquatic features, both within and near the study area, would be further protected through the implementation of BMPs to limit erosion and prevent increased sedimentation.

Field surveys of the study area were conducted 2–3 days following a significant rain event in the region. Evidence of mass sheet flow and flooding were present throughout the study area. Within most of the intermittent streams delineated, large debris and deposition clearly marked the location of the OHWM and much of this delineation was based on where this deposition occurred. Only two intermittent streams contained active flow at the time of surveys (PJD 5 and PJD 6) which may indicate these are fed through a spring or seep and flow does not solely rely on precipitation and snowmelt accumulation or runoff. The two wetlands identified are artificial features and artificially fed. Neither showed to have an outlet or connectivity to other aquatic features and both appeared to no longer be in use, or have not been used in the recent past. The perennial feature is the East Fork Virgin River which has jurisdictional status as a WOTUS and is subject to regulation by the USACE under Section 404 of the CWA following review by the USACE; however, construction is not anticipated to impact areas within the river or its banks and would be avoided. No wetlands or other potentially jurisdictional WOTUS were discovered at any of the six borrow pits.

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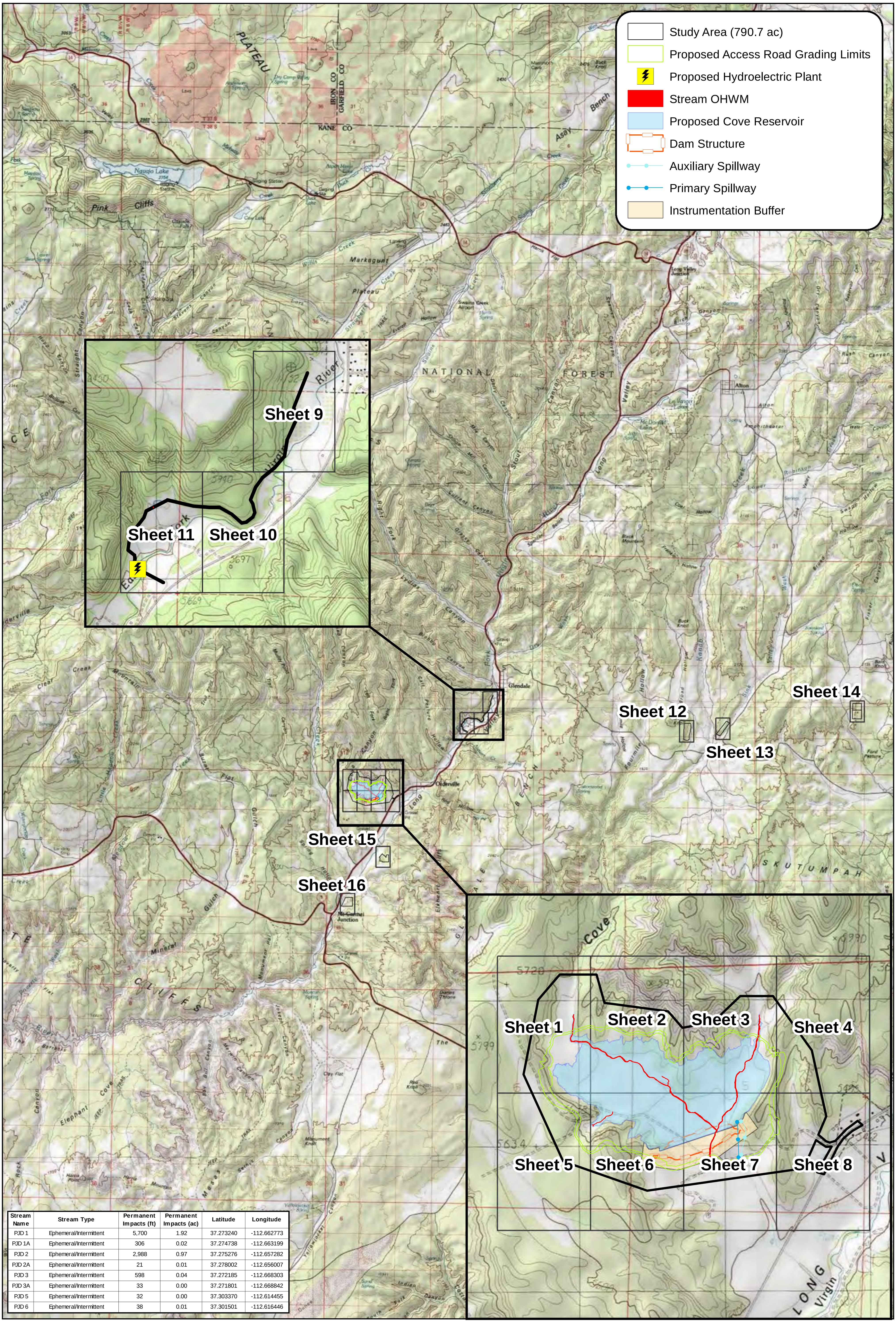
APPENDIX A

AQUATIC RESOURCE DELINEATION MAPS



Stream Name	Stream Type	Permanent Impacts (ft)	Permanent Impacts (ac)	Latitude	Longitude
PJD 1	Ephemeral/Intermittent	5,700	1.92	37.273240	-112.662773
PJD 1A	Ephemeral/Intermittent	306	0.02	37.274738	-112.663199
PJD 2	Ephemeral/Intermittent	2,988	0.97	37.275276	-112.657282
PJD 2A	Ephemeral/Intermittent	21	0.01	37.278002	-112.656007
PJD 3	Ephemeral/Intermittent	598	0.04	37.272185	-112.668303
PJD 3A	Ephemeral/Intermittent	33	0.00	37.271801	-112.668842
PJD 5	Ephemeral/Intermittent	32	0.00	37.303370	-112.614455
PJD 6	Ephemeral/Intermittent	38	0.01	37.301501	-112.616446

APPENDIX A
POTENTIALLY JURISDICTIONAL WATERS OF THE U.S.
INDEX MAP

SCALE(H):1"
SCALE(V):

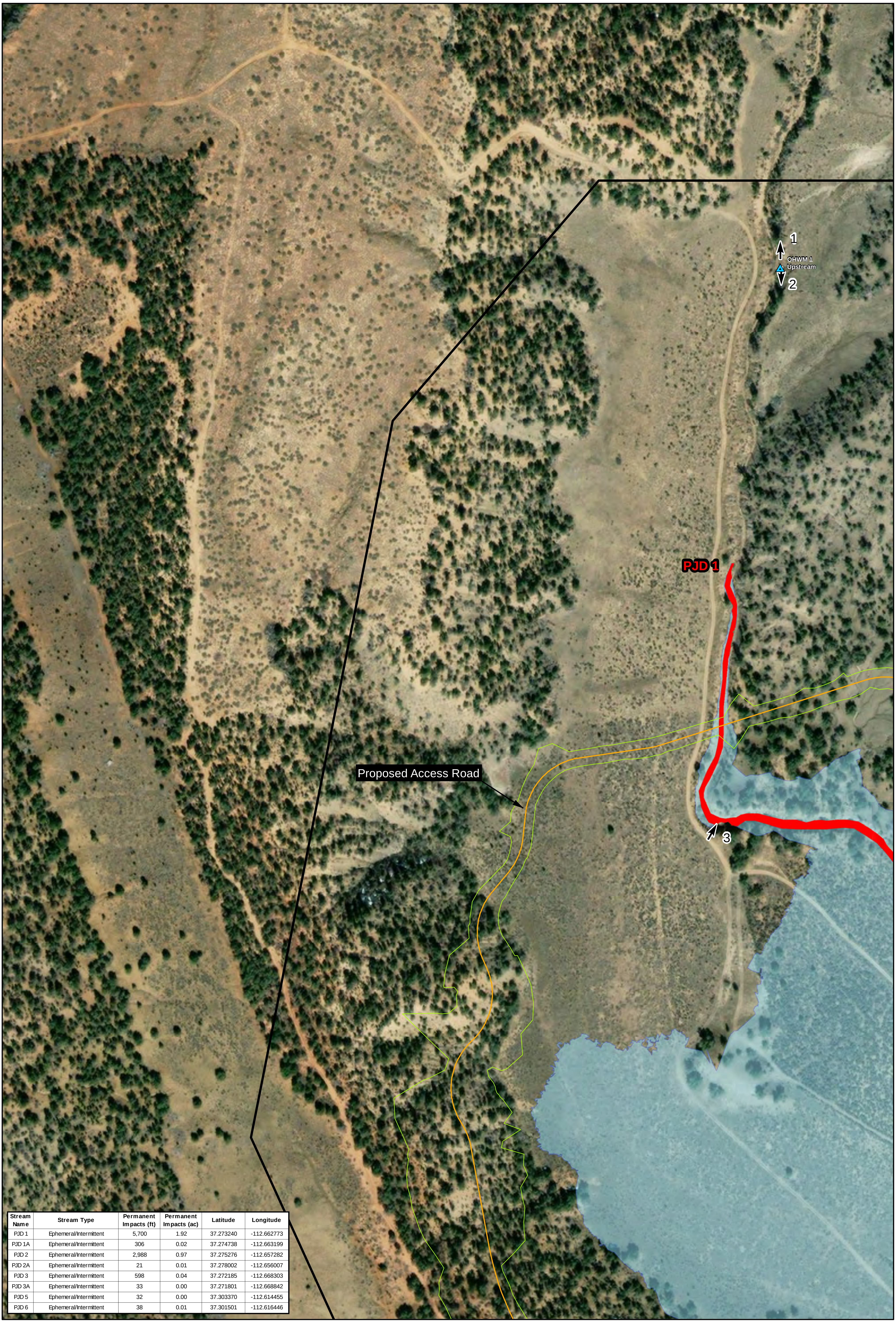
COVE RESERVOIR

DRAWN BY: CJM
DATE: 10/8/2020

Transcon environmental | Planners & Scientists

NO.	REVISION	BY	DATE	APPR.

October 8, 2020 P:\Open Projects\D38-02 Cove Reservoir EA\GIS\Maps\Figure3_PJD_Map2.mxd



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PJD 1A	Ephemeral/Intermittent	306	0.02	37.274738	-112.663199
PJD 2	Ephemeral/Intermittent	2,988	0.97	37.275276	-112.657282
PJD 2A	Ephemeral/Intermittent	21	0.01	37.278002	-112.656007
PJD 3	Ephemeral/Intermittent	598	0.04	37.272185	-112.668303
PJD 3A	Ephemeral/Intermittent	33	0.00	37.271801	-112.668842
PJD 5	Ephemeral/Intermittent	32	0.00	37.303370	-112.614455
PJD 6	Ephemeral/Intermittent	38	0.01	37.301501	-112.616446

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0 25 50 100 150 200
Feet

APPENDIX A
POTENTIALLY JURISDICTIONAL WATERS OF THE U.S.
(SHEET 1 OF 16)

SCALE(H):1"= 200'
SCALE(V):

COVE RESERVOIR

DRAWN BY: CJM
DATE: 10/8/2020

▭ Study Area (790.7 ac)	▭ Proposed Cove Reservoir
↑ Photo Location/Direction	▭ Instrumentation Buffer
▲ OHWM Data Plot	▭ Proposed Access Road Grading Limits
★ Soil Pit	🟥 Stream OHWM

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October 8, 2020 P:\Open Projects\D38-02 Cove Reservoir EA\GIS\Maps\Figure3_PJD_Map2.mxd

Stream Name	Stream Type	Permanent Impacts (ft)	Permanent Impacts (ac)	Latitude	Longitude
PJD 1	Ephemeral/Intermittent	5,700	1.92	37.273240	-112.662773
PJD 1A	Ephemeral/Intermittent	306	0.02	37.274738	-112.663199
PJD 2	Ephemeral/Intermittent	2,988	0.97	37.275276	-112.657282
PJD 2A	Ephemeral/Intermittent	21	0.01	37.278002	-112.656007
PJD 3	Ephemeral/Intermittent	598	0.04	37.272185	-112.668303
PJD 3A	Ephemeral/Intermittent	33	0.00	37.271801	-112.668842
PJD 5	Ephemeral/Intermittent	32	0.00	37.303370	-112.614455
PJD 6	Ephemeral/Intermittent	38	0.01	37.301501	-112.616446

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0 25 50 100 150 200
Feet

APPENDIX A
POTENTIALLY JURISDICTIONAL WATERS OF THE U.S.
(SHEET 2 OF 16)

SCALE(H):1"= 200'
SCALE(V):

COVE RESERVOIR

DRAWN BY: CJM
DATE: 10/8/2020

▭	Study Area (790.7 ac)	🟦	Proposed Cove Reservoir
↑	Photo Location/Direction	🟧	Instrumentation Buffer
▲	OHWM Data Plot	🟩	Proposed Access Road Grading Limits
★	Soil Pit	🟥	Stream OHWM

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NO.	REVISION	BY	DATE	APPR.

October 8, 2020

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Stream Name	Stream Type	Permanent Impacts (ft)	Permanent Impacts (ac)	Latitude	Longitude
PJD 1	Ephemeral/Intermittent	5,700	1.92	37.273240	-112.662773
PJD 1A	Ephemeral/Intermittent	306	0.02	37.274738	-112.663199
PJD 2	Ephemeral/Intermittent	2,988	0.97	37.275276	-112.657282
PJD 2A	Ephemeral/Intermittent	21	0.01	37.278002	-112.656007
PJD 3	Ephemeral/Intermittent	598	0.04	37.272185	-112.668303
PJD 3A	Ephemeral/Intermittent	33	0.00	37.271801	-112.668842
PJD 5	Ephemeral/Intermittent	32	0.00	37.303370	-112.614455
PJD 6	Ephemeral/Intermittent	38	0.01	37.301501	-112.616446

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0 25 50 100 150 200
Feet

APPENDIX A
POTENTIALLY JURISDICTIONAL WATERS OF THE U.S.
(SHEET 3 OF 16)

SCALE(H):1"= 200'
SCALE(V):

COVE RESERVOIR

DRAWN BY: CJM
DATE: 10/8/2020

▭ Study Area (790.7 ac)	🟦 Proposed Cove Reservoir
↑ Photo Location/Direction	▭ Instrumentation Buffer
△ OHWM Data Plot	▭ Proposed Access Road Grading Limits
☆ Soil Pit	🟥 Stream OHWM

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Stream Name	Stream Type	Permanent Impacts (ft)	Permanent Impacts (ac)	Latitude	Longitude
PJD 1	Ephemeral/Intermittent	5,700	1.92	37.273240	-112.662773
PJD 1A	Ephemeral/Intermittent	306	0.02	37.274738	-112.663199
PJD 2	Ephemeral/Intermittent	2,988	0.97	37.275276	-112.657282
PJD 2A	Ephemeral/Intermittent	21	0.01	37.278002	-112.656007
PJD 3	Ephemeral/Intermittent	598	0.04	37.272185	-112.668303
PJD 3A	Ephemeral/Intermittent	33	0.00	37.271801	-112.668842
PJD 5	Ephemeral/Intermittent	32	0.00	37.303370	-112.614455
PJD 6	Ephemeral/Intermittent	38	0.01	37.301501	-112.616446

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0 25 50 100 150 200
Feet

APPENDIX A
POTENTIALLY JURISDICTIONAL WATERS OF THE U.S.
(SHEET 4 OF 16)

SCALE(H):1"= 200'
SCALE(V):
COVE RESERVOIR
DRAWN BY: CJM
DATE: 10/8/2020

- ▭ Study Area (790.7 ac)
- ↑ Photo Location/Direction
- ▲ OHWM Data Plot
- ★ Soil Pit
- 🟦 Proposed Cove Reservoir
- ▭ Instrumentation Buffer
- ▭ Proposed Access Road Grading Limits
- 🟥 Stream OHWM

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October 8, 2020 P:\Open Projects\D38-02 Cove Reservoir EA\GIS\Maps\Figure3_PJD_Map2.mxd

Stream Name	Stream Type	Permanent Impacts (ft)	Permanent Impacts (ac)	Latitude	Longitude
PJD 1	Ephemeral/Intermittent	5,700	1.92	37.273240	-112.662773
PJD 1A	Ephemeral/Intermittent	306	0.02	37.274738	-112.663199
PJD 2	Ephemeral/Intermittent	2,988	0.97	37.275276	-112.657282
PJD 2A	Ephemeral/Intermittent	21	0.01	37.278002	-112.656007
PJD 3	Ephemeral/Intermittent	598	0.04	37.272185	-112.668303
PJD 3A	Ephemeral/Intermittent	33	0.00	37.271801	-112.668842
PJD 5	Ephemeral/Intermittent	32	0.00	37.303370	-112.614455
PJD 6	Ephemeral/Intermittent	38	0.01	37.301501	-112.616446

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Feet

APPENDIX A
POTENTIALLY JURISDICTIONAL WATERS OF THE U.S.
(SHEET 5 OF 16)

SCALE(H):1"= 200'
SCALE(V):

COVE RESERVOIR

DRAWN BY: CJM
DATE: 10/8/2020

▭ Study Area (790.7 ac)
↑ Photo Location/Direction
▲ OHWM Data Plot
★ Soil Pit
🟦 Proposed Cove Reservoir
▭ Instrumentation Buffer
🟩 Proposed Access Road Grading Limits
🟥 Stream OHWM

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October 8, 2020

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Stream Name	Stream Type	Permanent Impacts (ft)	Permanent Impacts (ac)	Latitude	Longitude
PJD 1	Ephemeral/Intermittent	5,700	1.92	37.273240	-112.662773
PJD 1A	Ephemeral/Intermittent	306	0.02	37.274738	-112.663199
PJD 2	Ephemeral/Intermittent	2,988	0.97	37.275276	-112.657282
PJD 2A	Ephemeral/Intermittent	21	0.01	37.278002	-112.656007
PJD 3	Ephemeral/Intermittent	598	0.04	37.272185	-112.668303
PJD 3A	Ephemeral/Intermittent	33	0.00	37.271801	-112.668842
PJD 5	Ephemeral/Intermittent	32	0.00	37.303370	-112.614455
PJD 6	Ephemeral/Intermittent	38	0.01	37.301501	-112.616446

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Feet

APPENDIX A
POTENTIALLY JURISDICTIONAL WATERS OF THE U.S.
(SHEET 6 OF 16)

SCALE(H):1"= 200'
SCALE(V):

COVE RESERVOIR

DRAWN BY: CJM
DATE: 10/8/2020

▭ Study Area (790.7 ac)	🟦 Proposed Cove Reservoir
↑ Photo Location/Direction	▭ Instrumentation Buffer
▲ OHWM Data Plot	▭ Proposed Access Road Grading Limits
☆ Soil Pit	🟥 Stream OHWM

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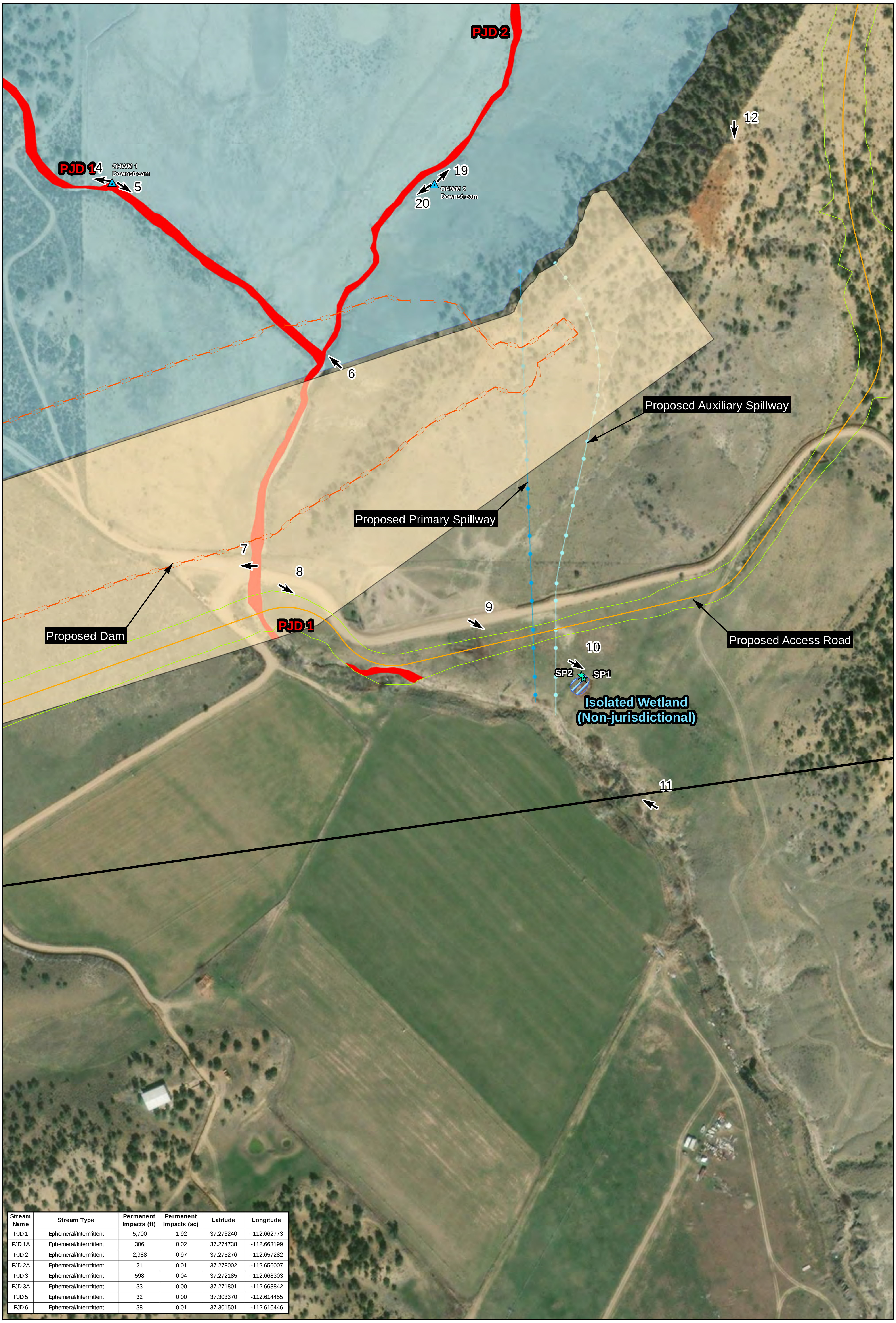
NO.	REVISION	BY	DATE	APPR.

October 8, 2020 P:\Open Projects\D38-02 Cove Reservoir EA\GIS\Maps\Figure3_PJD_Map2.mxd



Stream Name	Stream Type	Permanent Impacts (ft)	Permanent Impacts (ac)	Latitude	Longitude
PJD 1	Ephemeral/Intermittent	5,700	1.92	37.273240	-112.662773
PJD 1A	Ephemeral/Intermittent	306	0.02	37.274738	-112.663199
PJD 2	Ephemeral/Intermittent	2,988	0.97	37.275276	-112.657282
PJD 2A	Ephemeral/Intermittent	21	0.01	37.278002	-112.656007
PJD 3	Ephemeral/Intermittent	598	0.04	37.272185	-112.668303
PJD 3A	Ephemeral/Intermittent	33	0.00	37.271801	-112.668842
PJD 5	Ephemeral/Intermittent	32	0.00	37.303370	-112.614455
PJD 6	Ephemeral/Intermittent	38	0.01	37.301501	-112.616446

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Feet

APPENDIX A
POTENTIALLY JURISDICTIONAL WATERS OF THE U.S.
(SHEET 7 OF 16)

SCALE(H):1"= 200'
SCALE(V):

COVE RESERVOIR

DRAWN BY: CJM
DATE: 10/8/2020

- ▭ Study Area (790.7 ac)
- ↑ Photo Location/Direction
- ▲ OHWM Data Plot
- ★ Soil Pit
- 🟦 Proposed Cove Reservoir
- ▭ Instrumentation Buffer
- 🟩 Proposed Access Road Grading Limits
- 🟥 Stream OHWM

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Stream Name	Stream Type	Permanent Impacts (ft)	Permanent Impacts (ac)	Latitude	Longitude
PJD 1	Ephemeral/Intermittent	5,700	1.92	37.273240	-112.662773
PJD 1A	Ephemeral/Intermittent	306	0.02	37.274738	-112.663199
PJD 2	Ephemeral/Intermittent	2,988	0.97	37.275276	-112.657282
PJD 2A	Ephemeral/Intermittent	21	0.01	37.278002	-112.656007
PJD 3	Ephemeral/Intermittent	598	0.04	37.272185	-112.668303
PJD 3A	Ephemeral/Intermittent	33	0.00	37.271801	-112.668842
PJD 5	Ephemeral/Intermittent	32	0.00	37.303370	-112.614455
PJD 6	Ephemeral/Intermittent	38	0.01	37.301501	-112.616446

APPENDIX A
POTENTIALLY JURISDICTIONAL WATERS OF THE U.S.
(SHEET 8 OF 16)

SCALE(H):1"= 200'
SCALE(V):

COVE RESERVOIR

DRAWN BY: CJM
DATE: 10/8/2020

▭ Study Area (790.7 ac)	🟦 Proposed Cove Reservoir
↑ Photo Location/Direction	▭ Instrumentation Buffer
▲ OHWM Data Plot	▭ Proposed Access Road Grading Limits
☆ Soil Pit	🟥 Stream OHWM

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NO.	REVISION	BY	DATE	APPR.

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Stream Name	Stream Type	Permanent Impacts (ft)	Permanent Impacts (ac)	Latitude	Longitude
PJD 1	Ephemeral/Intermittent	5,700	1.92	37.273240	-112.662773
PJD 1A	Ephemeral/Intermittent	306	0.02	37.274738	-112.663199
PJD 2	Ephemeral/Intermittent	2,988	0.97	37.275276	-112.657282
PJD 2A	Ephemeral/Intermittent	21	0.01	37.278002	-112.656007
PJD 3	Ephemeral/Intermittent	598	0.04	37.272185	-112.668303
PJD 3A	Ephemeral/Intermittent	33	0.00	37.271801	-112.668842
PJD 5	Ephemeral/Intermittent	32	0.00	37.303370	-112.614455
PJD 6	Ephemeral/Intermittent	38	0.01	37.301501	-112.616446

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Feet

APPENDIX A
POTENTIALLY JURISDICTIONAL WATERS OF THE U.S.
(SHEET 9 OF 16)

SCALE(H):1"= 200'
SCALE(V):

COVE RESERVOIR

DRAWN BY: CJM
DATE: 10/8/2020

- ▭ Study Area (790.7 ac)
- ↑ Photo Location/Direction
- ▲ OHWM Data Plot
- ★ Soil Pit
- 🟦 Proposed Cove Reservoir
- ▭ Instrumentation Buffer
- 🟩 Proposed Access Road Grading Limits
- 🟥 Stream OHWM

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NO.	REVISION	BY	DATE	APPR.

October 8, 2020 P:\Open Projects\D38-02 Cove Reservoir EA\GIS\Maps\Figures3_PJD_Map2.mxd

Stream Name	Stream Type	Permanent Impacts (ft)	Permanent Impacts (ac)	Latitude	Longitude
PJD 1	Ephemeral/Intermittent	5,700	1.92	37.273240	-112.662773
PJD 1A	Ephemeral/Intermittent	306	0.02	37.274738	-112.663199
PJD 2	Ephemeral/Intermittent	2,988	0.97	37.275276	-112.657282
PJD 2A	Ephemeral/Intermittent	21	0.01	37.278002	-112.656007
PJD 3	Ephemeral/Intermittent	598	0.04	37.272185	-112.668303
PJD 3A	Ephemeral/Intermittent	33	0.00	37.271801	-112.668842
PJD 5	Ephemeral/Intermittent	32	0.00	37.303370	-112.614455
PJD 6	Ephemeral/Intermittent	38	0.01	37.301501	-112.616446

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Feet

APPENDIX A
POTENTIALLY JURISDICTIONAL WATERS OF THE U.S.
(SHEET 10 OF 16)

SCALE(H):1"= 200'
SCALE(V):

COVE RESERVOIR

DRAWN BY: CJM
DATE: 10/8/2020

▭ Study Area (790.7 ac)
↑ Photo Location/Direction
▲ OHWM Data Plot
★ Soil Pit
▭ Proposed Cove Reservoir
▭ Instrumentation Buffer
▭ Proposed Access Road Grading Limits
🟥 Stream OHWM

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NO.	REVISION	BY	DATE	APPR.

October 8, 2020

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Stream Name	Stream Type	Permanent Impacts (ft)	Permanent Impacts (ac)	Latitude	Longitude
PJD 1	Ephemeral/Intermittent	5,700	1.92	37.273240	-112.662773
PJD 1A	Ephemeral/Intermittent	306	0.02	37.274738	-112.663199
PJD 2	Ephemeral/Intermittent	2,988	0.97	37.275276	-112.657282
PJD 2A	Ephemeral/Intermittent	21	0.01	37.278002	-112.656007
PJD 3	Ephemeral/Intermittent	598	0.04	37.272185	-112.668303
PJD 3A	Ephemeral/Intermittent	33	0.00	37.271801	-112.668842
PJD 5	Ephemeral/Intermittent	32	0.00	37.303370	-112.614455
PJD 6	Ephemeral/Intermittent	38	0.01	37.301501	-112.616446

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0 25 50 100 150 200
Feet

APPENDIX A
POTENTIALLY JURISDICTIONAL WATERS OF THE U.S.
(SHEET 11 OF 16)

SCALE(H):1"= 200'
SCALE(V):

COVE RESERVOIR

DRAWN BY: CJM
DATE: 10/8/2020

▭	Study Area (790.7 ac)	🟦	Proposed Cove Reservoir
↑	Photo Location/Direction	▭	Instrumentation Buffer
▲	OHWM Data Plot	▭	Proposed Access Road Grading Limits
★	Soil Pit	🟥	Stream OHWM

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Stream Name	Stream Type	Permanent Impacts (ft)	Permanent Impacts (ac)	Latitude	Longitude
PJD 1	Ephemeral/Intermittent	5,700	1.92	37.273240	-112.662773
PJD 1A	Ephemeral/Intermittent	306	0.02	37.274738	-112.663199
PJD 2	Ephemeral/Intermittent	2,988	0.97	37.275276	-112.657282
PJD 2A	Ephemeral/Intermittent	21	0.01	37.278002	-112.656007
PJD 3	Ephemeral/Intermittent	598	0.04	37.272185	-112.668303
PJD 3A	Ephemeral/Intermittent	33	0.00	37.271801	-112.668842
PJD 5	Ephemeral/Intermittent	32	0.00	37.303370	-112.614455
PJD 6	Ephemeral/Intermittent	38	0.01	37.301501	-112.616446

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0 25 50 100 150 200
Feet

APPENDIX A
POTENTIALLY JURISDICTIONAL WATERS OF THE U.S.
(SHEET 12 OF 16)

SCALE(H):1"= 200'
SCALE(V):

COVE RESERVOIR

DRAWN BY: CJM
DATE: 10/8/2020

- ▭ Study Area (790.7 ac)
- ↑ Photo Location/Direction
- ▲ OHWM Data Plot
- ★ Soil Pit
- 🟦 Proposed Cove Reservoir
- ▭ Instrumentation Buffer
- ▭ Proposed Access Road Grading Limits
- 🟥 Stream OHWM

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Stream Name	Stream Type	Permanent Impacts (ft)	Permanent Impacts (ac)	Latitude	Longitude
PJD 1	Ephemeral/Intermittent	5,700	1.92	37.273240	-112.662773
PJD 1A	Ephemeral/Intermittent	306	0.02	37.274738	-112.663199
PJD 2	Ephemeral/Intermittent	2,988	0.97	37.275276	-112.657282
PJD 2A	Ephemeral/Intermittent	21	0.01	37.278002	-112.656007
PJD 3	Ephemeral/Intermittent	598	0.04	37.272185	-112.668303
PJD 3A	Ephemeral/Intermittent	33	0.00	37.271801	-112.668842
PJD 5	Ephemeral/Intermittent	32	0.00	37.303370	-112.614455
PJD 6	Ephemeral/Intermittent	38	0.01	37.301501	-112.616446

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Feet

APPENDIX A
POTENTIALLY JURISDICTIONAL WATERS OF THE U.S.
(SHEET 13 OF 16)

SCALE(H):1"= 200'
SCALE(V):
COVE RESERVOIR
DRAWN BY: CJM
DATE: 10/8/2020

▭ Study Area (790.7 ac)
↑ Photo Location/Direction
▲ OHWM Data Plot
☆ Soil Pit
▭ Proposed Cove Reservoir
▭ Instrumentation Buffer
▭ Proposed Access Road Grading Limits
🟥 Stream OHWM

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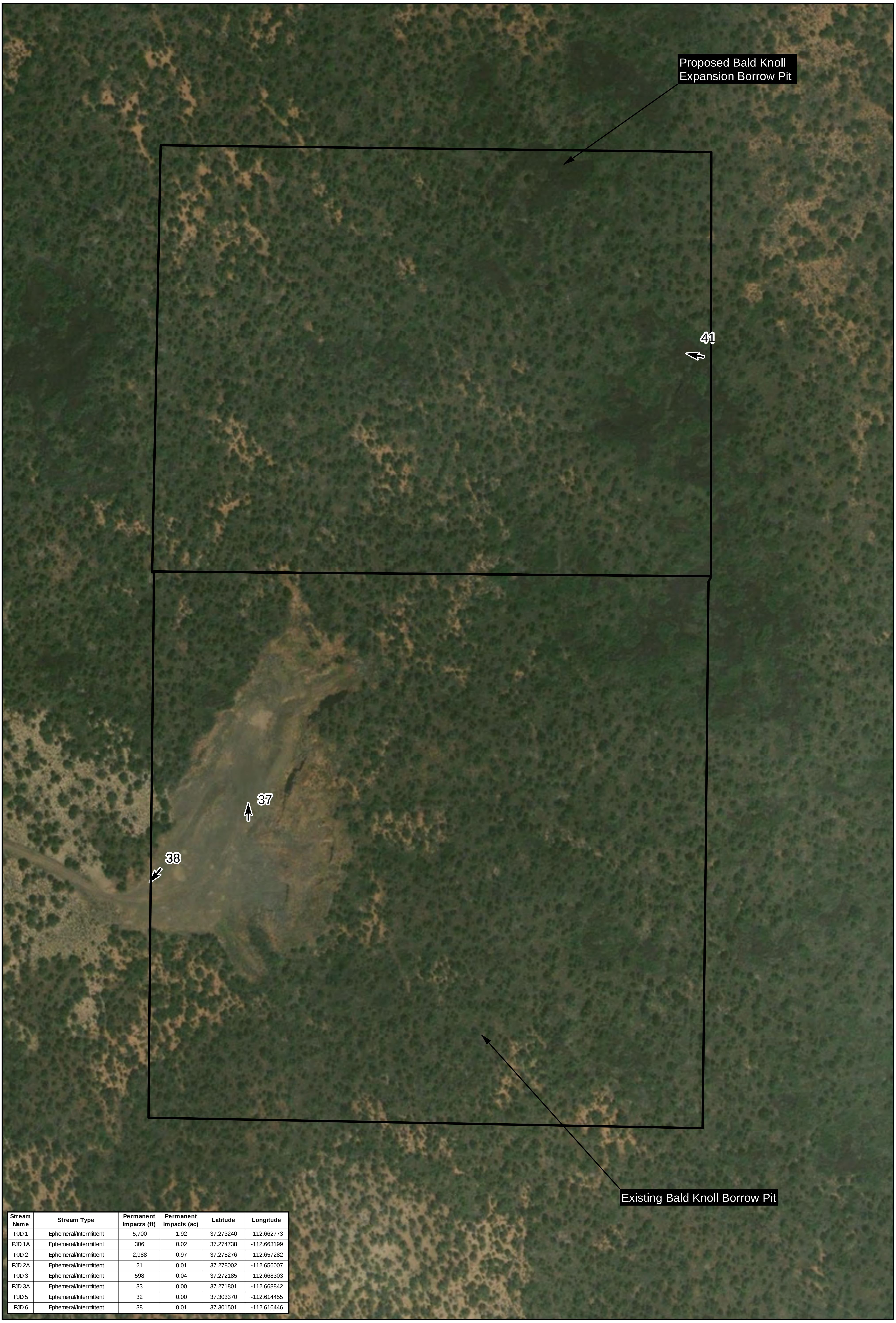

Stream Name	Stream Type	Permanent Impacts (ft)	Permanent Impacts (ac)	Latitude	Longitude
PJD 1	Ephemeral/Intermittent	5,700	1.92	37.273240	-112.662773
PJD 1A	Ephemeral/Intermittent	306	0.02	37.274738	-112.663199
PJD 2	Ephemeral/Intermittent	2,988	0.97	37.275276	-112.657282
PJD 2A	Ephemeral/Intermittent	21	0.01	37.278002	-112.656007
PJD 3	Ephemeral/Intermittent	598	0.04	37.272185	-112.668303
PJD 3A	Ephemeral/Intermittent	33	0.00	37.271801	-112.668842
PJD 5	Ephemeral/Intermittent	32	0.00	37.303370	-112.614455
PJD 6	Ephemeral/Intermittent	38	0.01	37.301501	-112.616446

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Feet

APPENDIX A
POTENTIALLY JURISDICTIONAL WATERS OF THE U.S.
(SHEET 14 OF 16)

SCALE(H):1"= 200'
SCALE(V):

COVE RESERVOIR

DRAWN BY: CJM
DATE: 10/8/2020

▭	Study Area (790.7 ac)
↑	Photo Location/Direction
▲	OHWM Data Plot
☆	Soil Pit
🟦	Proposed Cove Reservoir
▭	Instrumentation Buffer
🟩	Proposed Access Road Grading Limits
🟥	Stream OHWM

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Stream Name	Stream Type	Permanent Impacts (ft)	Permanent Impacts (ac)	Latitude	Longitude
PJD 1	Ephemeral/Intermittent	5,700	1.92	37.273240	-112.662773
PJD 1A	Ephemeral/Intermittent	306	0.02	37.274738	-112.663199
PJD 2	Ephemeral/Intermittent	2,988	0.97	37.275276	-112.657282
PJD 2A	Ephemeral/Intermittent	21	0.01	37.278002	-112.656007
PJD 3	Ephemeral/Intermittent	598	0.04	37.272185	-112.668303
PJD 3A	Ephemeral/Intermittent	33	0.00	37.271801	-112.668842
PJD 5	Ephemeral/Intermittent	32	0.00	37.303370	-112.614455
PJD 6	Ephemeral/Intermittent	38	0.01	37.301501	-112.616446

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0 25 50 100 150 200
Feet

APPENDIX A
POTENTIALLY JURISDICTIONAL WATERS OF THE U.S.
(SHEET 15 OF 16)

SCALE(H):1"= 200'
SCALE(V):

COVE RESERVOIR

DRAWN BY: CJM
DATE: 10/8/2020

- ▭ Study Area (790.7 ac)
- ↑ Photo Location/Direction
- ▲ OHWM Data Plot
- ☆ Soil Pit
- ▭ Proposed Cove Reservoir
- ▭ Instrumentation Buffer
- ▭ Proposed Access Road Grading Limits
- 🟥 Stream OHWM

Transcon environmental | Planners & Scientists

NO.	REVISION	BY	DATE	APPR.

October 8, 2020   P:\Open Projects\D38-02 Cove Reservoir EA\GIS\Maps\Figure3_PJD_Map2.mxd

Stream Name	Stream Type	Permanent Impacts (ft)	Permanent Impacts (ac)	Latitude	Longitude
PJD 1	Ephemeral/Intermittent	5,700	1.92	37.273240	-112.662773
PJD 1A	Ephemeral/Intermittent	306	0.02	37.274738	-112.663199
PJD 2	Ephemeral/Intermittent	2,988	0.97	37.275276	-112.657282
PJD 2A	Ephemeral/Intermittent	21	0.01	37.278002	-112.656007
PJD 3	Ephemeral/Intermittent	598	0.04	37.272185	-112.668303
PJD 3A	Ephemeral/Intermittent	33	0.00	37.271801	-112.668842
PJD 5	Ephemeral/Intermittent	32	0.00	37.303370	-112.614455
PJD 6	Ephemeral/Intermittent	38	0.01	37.301501	-112.616446

APPENDIX A
POTENTIALLY JURISDICTIONAL WATERS OF THE U.S.
(SHEET 16 OF 16)

SCALE(H):1"= 200'
SCALE(V):

COVE RESERVOIR

DRAWN BY: CJM
DATE: 10/8/2020

▭ Study Area (790.7 ac)	🟦 Proposed Cove Reservoir
↑ Photo Location/Direction	▭ Instrumentation Buffer
▲ OHWM Data Plot	▭ Proposed Access Road Grading Limits
☆ Soil Pit	🟥 Stream OHWM

Transcon environmental | Planners & Scientists

NO.	REVISION	BY	DATE	APPR.

APPENDIX B

WETLAND DELINEATION FORMS AND OHWM DATA SHEETS

WETLAND DETERMINATION DATA FORM – Arid West Region

Project Site: Cove Reservor   City/County: Orderville/Kane   Sampling Date: 10/8/18

Applicant/Owner: Kane County Water Conservancy District   State: UT   Sampling Point: W1

Investigator(s): Brian Parker   Section, Township, Range: _____

Landform (hillslope, terrace, etc.): depression   Local relief (concave, convex, none): concave   Slope (%): 1

Subregion (LRR): D   Lat: _____   Long: Datum: Nad 83 Zone 12N

Soil Map Unit Name: _____   NWI classification: IFreshwater Pond

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation ☐, Soil ☐, or Hydrology ☐ significantly disturbed? Are “Normal Circumstances” present? Yes ☒ No ☐

Are Vegetation ☐, Soil ☐, or Hydrology ☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒	No ☐	**Is the Sampled Area within a Wetland?**	**Yes ☒ No ☐**
Hydric Soil Present?	Yes ☒	No ☐		
Wetland Hydrology Present?	Yes ☒	No ☐		

Remarks: Wetland is the product of a man-made pond. The pond has not natural outlet and is artificially fed through underground and above ground irrigation. Isolated. No surface water appeared to be present at the time of survey and it appears that the pond is no longer used regularly.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size:1000 sq.ft.)	Absolute % Cover	Dominant Species?	Indicator Status
1. *N/A*			
2.			
3.			
4.			
50% = _____, 20% = _____	0	= Total Cover	
Sapling/Shrub Stratum (Plot size:1000 sq.ft.)			
1. *N/A*			
2.			
3.			
4.			
5.			
50% = _____, 20% = _____	0	= Total Cover	
Herb Stratum (Plot size:1000 sq.ft.)			
1. *Typha latifolia*	99	yes	OBL
2.			
3.			
4.			
5.			
6.			
7.			
8.			
50% = _____, 20% = _____	99	= Total Cover	
Woody Vine Stratum (Plot size:1000 sq.ft.)			
1. *N/A*			
2.			
50% = _____, 20% = _____	0	= Total Cover	
% Bare Ground in Herb Stratum 0	% Cover of Biotic Crust 0		

Dominance Test Worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC:	1	(A)
Total Number of Dominant Species Across All Strata:	1	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	100	(A/B)

Prevalence Index worksheet:

	Total % Cover of :	Multiply by:	
OBL species	_____	x1 =	_____
FACW species	_____	x2 =	_____
FAC species	_____	x3 =	_____
FACU species	_____	x4 =	_____
UPL species	_____	x5 =	_____
Column Totals:	_____ (A)		_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

- ☒ Dominance Test is >50%
- ☐ Prevalence Index is ≤3.0[1]
- ☐ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ☒ No ☐

Remarks: Vegetaton is almost completely cattail w/ some unknown grasses around the edge of the pond.

Project Site: Cove Reservoir

SOIL

Sampling Point: W1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (Moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-4	6/10BG Gley2	80	6/4 10YR	20			clay	
0-4	Plant material	20						
4-20	6/10BG Gley2	99	6/4 10YR	20			clay	Plant material mostly absent

[1]Type: C= Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

☐ Histosol (A1)
☐ Histic Epipedon (A2)
☐ Black Histic (A3)
☐ Hydrogen Sulfide (A4)
☐ Stratified Layers (A5) (**LRR C**)
☐ 1 cm Muck (A9) (**LRR D**)
☐ Depleted Below Dark Surface (A11)
☐ Thick Dark Surface (A12)
☐ Sandy Mucky Mineral (S1)
☐ Sandy Gleyed Matrix (S4)
☐ Sandy Redox (S5)
☐ Stripped Matrix (S6)
☐ Loamy Mucky Mineral (F1)
☒ Loamy Gleyed Matrix (F2)
☐ Depleted Matrix (F3)
☐ Redox Dark Surface (F6)
☐ Depleted Dark Surface (F7)
☒ Redox Depressions (F8)
☐ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

☐ 1 cm Muck (A9) **(LRR C)**
☐ 2 cm Muck (A10) **(LRR B)**
☐ Reduced Vertic (F18)
☐ Red Parent Material (TF2)
☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (Inches): _____

Hydric Soils Present? **Yes** ☒ **No** ☐

Remarks: Redox features present throughout sample pit and around roots.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

☐ Surface Water (A1)
☐ High Water Table (A2)
☐ Saturation (A3)
☐ Water Marks (B1) **(Nonriverine)**
☐ Sediment Deposits (B2) **(Nonriverine)**
☐ Drift Deposits (B3) **(Nonriverine)**
☐ Surface Soil Cracks (B6)
☒ Inundation Visible on Aerial Imagery (B7)
☐ Water-Stained Leaves (B9)
☐ Salt Crust (B11)
☐ Biotic Crust (B12)
☐ Aquatic Invertebrates (B13)
☐ Hydrogen Sulfide Odor (C1)
☒ Oxidized Rhizospheres along Living Roots (C3)
☐ Presence of Reduced Iron (C4)
☐ Recent Iron Reduction in Tilled Soils (C6)
☐ Thin Muck Surface (C7)
☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

☐ Water Marks (B1) **(Riverine)**
☐ Sediment Deposits (B2) **(Riverine)**
☐ Drift Deposits (B3) **(Riverine)**
☐ Drainage Patterns (B10)
☐ Dry-Season Water Table (C2)
☐ Crayfish Burrows (C8)
☐ Saturation Visible on Aerial Imagery (C9)
☐ Shallow Aquitard (D3)
☐ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): _____

Water Table Present? Yes ☐ No ☒ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches): _____

Wetland Hydrology Present? **Yes** ☒ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Aerial imagery and evidence of periodic artificial fed indundation (irrigation hoses/lines around pond) indicate that the pond occasionally has surface water.

WETLAND DETERMINATION DATA FORM – Arid West Region

Project Site: Cove Reservor City/County: Orderville/Kane Sampling Date: 10/8/18

Applicant/Owner: Kane County Water Conservancy District State: UT Sampling Point: UPL1

Investigator(s): Brian Parker Section, Township, Range: _____

Landform (hillslope, terrace, etc.): hillslope Local relief (concave, convex, none): none Slope (%): 1

Subregion (LRR): D Lat: _____ Long: Datum: Nad 83 Zone 12N

Soil Map Unit Name: _____ NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation ☐, Soil ☐, or Hydrology ☐ significantly disturbed? Are “Normal Circumstances” present? Yes ☒ No ☐

Are Vegetation ☐, Soil ☐, or Hydrology ☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☐ No ☒	**Is the Sampled Area within a Wetland?** **Yes** ☐ **No** ☒
Hydric Soil Present?	Yes ☐ No ☒	
Wetland Hydrology Present?	Yes ☐ No ☒	

Remarks: **Location is adjacent and slightly upslope of the man made pond/wetland feature.**

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size:200 sq. ft.)	Absolute % Cover	Dominant Species?	Indicator Status
1. *N/A*	_____	____	____
2. _____	_____	____	____
3. _____	_____	____	____
4. _____	_____	____	____
50% = _____, 20% = _____	0	= Total Cover	
Sapling/Shrub Stratum (Plot size:200 sq..ft.)			
1. *N/A*	_____	____	____
2. _____	_____	____	____
3. _____	_____	____	____
4. _____	_____	____	____
5. _____	_____	____	____
50% = _____, 20% = _____	0	= Total Cover	
Herb Stratum (Plot size:200 sq. ft.)			
1. *Atriplex confertifolia*	5	no	FAC
2. *Pascopyrum smithii*	5	no	FAC
3. *Hesperotstipa comata*	35	yes	NL (UPL)
4. *Symphyotrichum spathulatum*	10	no	UPL
5. _____	_____	____	____
6. _____	_____	____	____
7. _____	_____	____	____
8. _____	_____	____	____
50% = _____, 20% = _____	55	= Total Cover	
Woody Vine Stratum (Plot size:200 sq. ft.)			
1. *N/A*	_____	____	____
2. _____	_____	____	____
50% = _____, 20% = _____	0	= Total Cover	

% Bare Ground in Herb Stratum 45 % Cover of Biotic Crust 0

Dominance Test Worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC:	0	(A)
Total Number of Dominant Species Across All Strata:	1	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	0	(A/B)

Prevalence Index worksheet:

	Total % Cover of :	Multiply by:	
OBL species	_____	x1 =	_____
FACW species	_____	x2 =	_____
FAC species	_____	x3 =	_____
FACU species	_____	x4 =	_____
UPL species	_____	x5 =	_____
Column Totals:	_____ (A)		_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

- ☐ Dominance Test is >50%
- ☐ Prevalence Index is ≤3.0[1]
- ☐ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ☐ **No** ☒

Remarks: Vegetaton is almost completely cattail w/ some unknown grasses around the edge of the pond.

Project Site: Cove Reservoir

SOIL

Sampling Point: UPL1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (Moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-20	4/3 2.5 YR	100	N/A					

[1] Type: C= Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2] Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR C**)
- ☐ 1 cm Muck (A9) (**LRR D**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR C)**
- ☐ 2 cm Muck (A10) **(LRR B)**
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (Inches): _____

Hydric Soils Present? **Yes** ☐ **No** ☒

Remarks: Soil slightly moist; likely due to heavy rain a few days prior to field survey (massive sheet flow, flash flooding in area)

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1) **(Nonriverine)**
- ☐ Sediment Deposits (B2) **(Nonriverine)**
- ☐ Drift Deposits (B3) **(Nonriverine)**
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Biotic Crust (B12)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water Marks (B1) **(Riverine)**
- ☐ Sediment Deposits (B2) **(Riverine)**
- ☐ Drift Deposits (B3) **(Riverine)**
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): _____

Water Table Present? Yes ☐ No ☒ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches): _____

Wetland Hydrology Present? **Yes** ☐ **No** ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Hillside above pond

WETLAND DETERMINATION DATA FORM – Arid West Region

Project Site: Glendale Pipeline City/County: Orderville/Kane Sampling Date: 10/9/18
Applicant/Owner: Kane County Water Conservancy District State: UT Sampling Point: W2
Investigator(s): Brian Parker Section, Township, Range: _____
Landform (hillslope, terrace, etc.): pond basin Local relief (concave, convex, none): concave Slope (%): 0
Subregion (LRR): D Lat: _____ Long: Datum: Nad 83 Zone 12N
Soil Map Unit Name: _____ NWI classification: N/A
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)
Are Vegetation ☐, Soil ☐, or Hydrology ☐ significantly disturbed? Are “Normal Circumstances” present? Yes ☒ No ☐
Are Vegetation ☐, Soil ☐, or Hydrology ☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒	No ☐	**Is the Sampled Area within a Wetland?**	**Yes** ☒	**No** ☐
Hydric Soil Present?	Yes ☒	No ☐			
Wetland Hydrology Present?	Yes ☒	No ☐			

Remarks: **Location is within the basin of a man-made pond**

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size:1000 sq. ft.)	Absolute % Cover	Dominant Species?	Indicator Status
1. *N/A*			
2.			
3.			
4.			
50% = _____, 20% = _____	0	= Total Cover	
Sapling/Shrub Stratum (Plot size:1000 sq..ft.)			
1. *Salix exigua*	70	yes	FACW
2.			
3.			
4.			
5.			
50% = _____, 20% = _____	0	= Total Cover	
Herb Stratum (Plot size:1000 sq. ft.)			
1. *Unknown grass*	40	yes	NO
2. *Symphyotrichum spathulatum*	20	yes	FAC
3.			
4.			
5.			
6.			
7.			
8.			
50% = _____, 20% = _____	45	= Total Cover	
Woody Vine Stratum (Plot size:1000 sq. ft.)			
1. *N/A*			
2.			
50% = _____, 20% = _____	0	= Total Cover	
% Bare Ground in Herb Stratum 20	% Cover of Biotic Crust 0		

Dominance Test Worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC:	3	(A)
Total Number of Dominant Species Across All Strata:	3	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	100	(A/B)

Prevalence Index worksheet:

	Total % Cover of :	Multiply by:	
OBL species	_____	x1 =	_____
FACW species	_____	x2 =	_____
FAC species	_____	x3 =	_____
FACU species	_____	x4 =	_____
UPL species	_____	x5 =	_____
Column Totals:	_____ (A)		_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

☒ Dominance Test is >50%
☐ Prevalence Index is ≤3.0[1]
☐ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ☒ **No** ☐

Remarks: Unable to identify grass species outside of flowering/seeding season. Assumed to be OBL, FACW, or FAC..

Project Site: Glendale Pipeline

SOIL

Sampling Point: W2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (Moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-20	6/2 5YR	100	5/6 7.5YR	10			clay	redox throughout entire sample

[1] Type: C= Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2] Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

☐ Histosol (A1)
☐ Histic Epipedon (A2)
☐ Black Histic (A3)
☐ Hydrogen Sulfide (A4)
☐ Stratified Layers (A5) (**LRR C**)
☐ 1 cm Muck (A9) (**LRR D**)
☐ Depleted Below Dark Surface (A11)
☐ Thick Dark Surface (A12)
☐ Sandy Mucky Mineral (S1)
☐ Sandy Gleyed Matrix (S4)
☐ Sandy Redox (S5)
☐ Stripped Matrix (S6)
☐ Loamy Mucky Mineral (F1)
☐ Loamy Gleyed Matrix (F2)
☐ Depleted Matrix (F3)
☐ Redox Dark Surface (F6)
☐ Depleted Dark Surface (F7)
☒ Redox Depressions (F8)
☐ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

☐ 1 cm Muck (A9) **(LRR C)**
☐ 2 cm Muck (A10) **(LRR B)**
☐ Reduced Vertic (F18)
☐ Red Parent Material (TF2)
☐ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (Inches): _____

Hydric Soils Present? **Yes** ☒ **No** ☐

Remarks: Soil slightly moist

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

☐ Surface Water (A1)
☐ High Water Table (A2)
☐ Saturation (A3)
☐ Water Marks (B1) **(Nonriverine)**
☐ Sediment Deposits (B2) **(Nonriverine)**
☐ Drift Deposits (B3) **(Nonriverine)**
☒ Surface Soil Cracks (B6)
☒ Inundation Visible on Aerial Imagery (B7)
☐ Water-Stained Leaves (B9)
☐ Salt Crust (B11)
☐ Biotic Crust (B12)
☐ Aquatic Invertebrates (B13)
☐ Hydrogen Sulfide Odor (C1)
☐ Oxidized Rhizospheres along Living Roots (C3)
☐ Presence of Reduced Iron (C4)
☐ Recent Iron Reduction in Tilled Soils (C6)
☐ Thin Muck Surface (C7)
☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

☐ Water Marks (B1) **(Riverine)**
☐ Sediment Deposits (B2) **(Riverine)**
☐ Drift Deposits (B3) **(Riverine)**
☐ Drainage Patterns (B10)
☐ Dry-Season Water Table (C2)
☐ Crayfish Burrows (C8)
☐ Saturation Visible on Aerial Imagery (C9)
☐ Shallow Aquitard (D3)
☐ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): _____
Water Table Present? Yes ☐ No ☒ Depth (inches): _____
Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches): _____

Wetland Hydrology Present? **Yes** ☒ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Likely seasonal inundation during periods of irrigation and/or heavy precipitation

WETLAND DETERMINATION DATA FORM – Arid West Region

Project Site: Glendale Pipeline   City/County: Orderville/Kane   Sampling Date: 10/9/18

Applicant/Owner: Kane County Water Conservancy District   State: UT   Sampling Point: UPL2

Investigator(s): Brian Parker   Section, Township, Range: _____

Landform (hillslope, terrace, etc.): pond basin   Local relief (concave, convex, none): concave   Slope (%): 0

Subregion (LRR): D   Lat: _____   Long: Datum: Nad 83 Zone 12N

Soil Map Unit Name: _____   NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation ☐, Soil ☐, or Hydrology ☐ significantly disturbed? Are “Normal Circumstances” present? Yes ☒ No ☐

Are Vegetation ☐, Soil ☐, or Hydrology ☐ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☐ No ☒	**Is the Sampled Area within a Wetland?** **Yes** ☐ **No** ☒
Hydric Soil Present?	Yes ☒ No ☐	
Wetland Hydrology Present?	Yes ☐ No ☒	

Remarks: **Location is above pond on relatively flat terrace**

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size:100 sq.ft)	Absolute % Cover	Dominant Species?	Indicator Status
1. *N/A*	_____	____	____
2. _____	_____	____	____
3. _____	_____	____	____
4. _____	_____	____	____
50% = _____, 20% = _____	0	= Total Cover	
Sapling/Shrub Stratum (Plot size:100 sq..ft.)			
1. *Chrysothamnus viscidiflorus*	20	yes	NL (UPL)
2. *Purshia tridentata*	20	yes	NL (UPL)
3. _____	_____	____	____
4. _____	_____	____	____
5. _____	_____	____	____
50% = _____, 20% = _____	40	= Total Cover	
Herb Stratum (Plot size:100 sq. ft.)			
1. *Sphaeralcea sp.*	10	no	NL (UPL)
2. *Salsola tragus*	5	no	FACU
3. *Erodium cicutarium*	10	no	NL (UPL)
4. _____	_____	____	____
5. _____	_____	____	____
6. _____	_____	____	____
7. _____	_____	____	____
8. _____	_____	____	____
50% = _____, 20% = _____	25	= Total Cover	
Woody Vine Stratum (Plot size:100 sq. ft.)			
1. *N/A*	_____	____	____
2. _____	_____	____	____
50% = _____, 20% = _____	0	= Total Cover	
% Bare Ground in Herb Stratum 20	% Cover of Biotic Crust 0		

Dominance Test Worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC:	0	(A)
Total Number of Dominant Species Across All Strata:	2	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	0	(A/B)

Prevalence Index worksheet:

	Total % Cover of :	Multiply by:	
OBL species	_____	x1 =	_____
FACW species	_____	x2 =	_____
FAC species	_____	x3 =	_____
FACU species	_____	x4 =	_____
UPL species	_____	x5 =	_____
Column Totals:	_____ (A)		_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

☒ Dominance Test is >50%

☐ Prevalence Index is ≤3.0[1]

☐ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ☐ **No** ☒

Remarks: Edge of man-made pond structure

Project Site: Glendale Pipeline

SOIL

Sampling Point: UPL2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (Moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-8	5/4 2.5YR	100	N/A				Sandy	
8-20	8/3 5Y	100	6/6 7.5YR	5			Sandy	hard soil area

[1]Type: C= Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR C**)
- ☐ 1 cm Muck (A9) (**LRR D**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☒ Redox Depressions (F8)
- ☐ Vernal Pools (F9)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR C)**
- ☐ 2 cm Muck (A10) **(LRR B)**
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (Inches): _____

Hydric Soils Present? **Yes** ☒ **No** ☐

Remarks: Redox feature present below 8 inches may have existed prior to human disturbance as there is evidence of sandy soil above hard layer indicating that the soil has probably been turned over or disturbed above. Lacks hydrology and wetland veg.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1) **(Nonriverine)**
- ☐ Sediment Deposits (B2) **(Nonriverine)**
- ☐ Drift Deposits (B3) **(Nonriverine)**
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Biotic Crust (B12)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water Marks (B1) **(Riverine)**
- ☐ Sediment Deposits (B2) **(Riverine)**
- ☐ Drift Deposits (B3) **(Riverine)**
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): _____

Water Table Present? Yes ☐ No ☒ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches): _____

Wetland Hydrology Present? **Yes** ☐ **No** ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

12

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Cove Reservoir
Project Number:
Stream: PJD 1 (downstream)
Investigator(s): Brian Parker

Date: 10/8/14
Town: Orderville
Photo begin file#:

Time: 1730
State: UT
Photo end file#:

Y ☑ / N ☐ Do normal circumstances exist on the site?

Y ☐ / N ☒ Is the site significantly disturbed?

Location Details:
lower reach of PJD 3

Projection: ~~NAD 83~~ UTM **Datum:** ~~UTM~~ NAD 83
Coordinates: 12S 0352740 ; 4126424

Potential anthropogenic influences on the channel system:

None @ this reach of PJD 3

Brief site description:

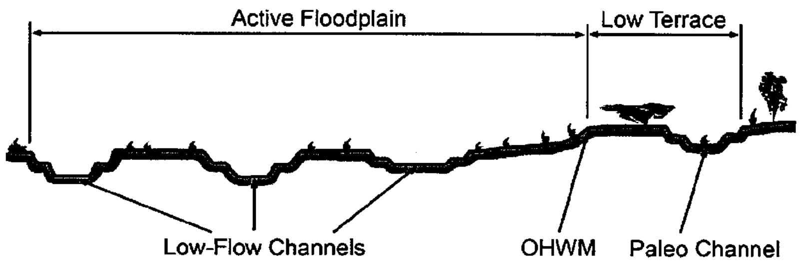
lower reach of Intermittent stream before confluence w/ PJD 2. Evidence of heavy flood event last week (large shrubs layed down or uprooted, Debris)

Checklist of resources (if available):

☒ Aerial photography
Dates:
☑ Topographic maps
☐ Geologic maps
☐ Vegetation maps
☒ Soils maps
☒ Rainfall/precipitation maps
☐ Existing delineation(s) for site
☑ Global positioning system (GPS)
☐ Other studies

☐ Stream gage data
Gage number:
Period of record:
- ☐ History of recent effective discharges
- ☐ Results of flood frequency analysis
- ☐ Most recent shift-adjusted rating
- ☐ Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event

Hydrogeomorphic Floodplain Units



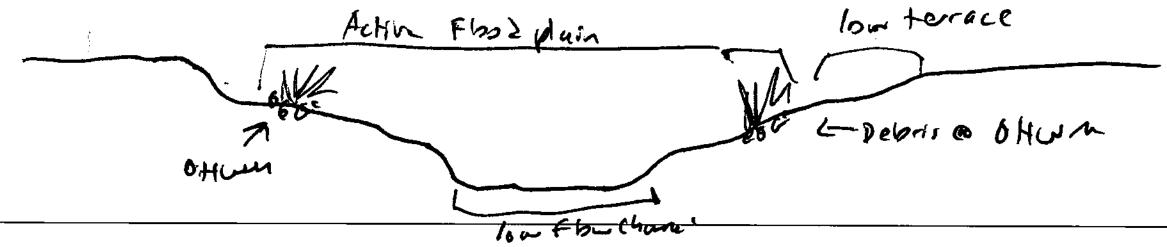
Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:

☒ Mapping on aerial photograph ☒ GPS
☑ Digitized on computer ☐ Other:

Project ID: Love **Cross section ID:** PJD1 downstream **Date:** 10/9/18 **Time:** 1730

Cross section drawing:



OHWM

GPS point: 12S 0352739; 4126426

Indicators:

☐ Change in average sediment texture
☐ Change in vegetation species
☒ Change in vegetation cover
☒ Break in bank slope
☐ Other: ____________
☐ Other: ____________

Comments:

Significant debris observed @ OHWM. May be larger than normal flood event that occurred last week/weekend. Approx. width ~~5~~ 20 feet

Floodplain unit: ☒ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: 12S 0352737; 4126422

Characteristics of the floodplain unit:

Average sediment texture: pebble

Total veg cover: 0 % Tree: ____ % Shrub: ____ % Herb: ____ %

Community successional stage:

☒ NA
☐ Early (herbaceous & seedlings)
☐ Mid (herbaceous, shrubs, saplings)
☐ Late (herbaceous, shrubs, mature trees)

Indicators:

☒ Mudcracks
☒ Ripples
☐ Drift and/or debris
☐ Presence of bed and bank
☐ Benches
☐ Soil development
☐ Surface relief
☐ Other: ____________
☐ Other: ____________
☐ Other: ____________

Comments:

Mix of sand, cobble and boulders

Project ID: Cove **Cross section ID:** RSD3 downstream **Date:** 11/8/18 **Time:** 1730

Floodplain unit: ☐ Low-Flow Channel ☒ Active Floodplain ☐ Low Terrace

GPS point: 12S 0352735, 4126419

Characteristics of the floodplain unit:

Average sediment texture: Medium sand

Total veg cover: 30 % Tree: X % Shrub: 25 % Herb: 5 %

Community successional stage:

☐ NA

☒ Early (herbaceous & seedlings)

☒ Mid (herbaceous, shrubs, saplings)

☒ Late (herbaceous, shrubs, mature trees)

Indicators:

☐ Mudcracks

☐ Ripples

☒ Drift and/or debris

☒ Presence of bed and bank

☒ Benches

☐ Soil development

☐ Surface relief

☐ Other:

☐ Other:

☐ Other:

Comments:

Large flood event may have ~~[illegible]~~ widened floodplain as evident by scouring of banks and uprooting / laydown of medium sized shrubs.

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☒ Low Terrace

GPS point: 12S 0352733, 4126414

Characteristics of the floodplain unit:

Average sediment texture: Fine sand / silt

Total veg cover: 50 % Tree: X % Shrub: 45 % Herb: 5 %

Community successional stage:

☐ NA

☐ Early (herbaceous & seedlings)

☒ Mid (herbaceous, shrubs, saplings)

☒ Late (herbaceous, shrubs, mature trees)

Indicators:

☐ Mudcracks

☐ Ripples

☐ Drift and/or debris

☐ Presence of bed and bank

☐ Benches

☒ Soil development

☐ Surface relief

☐ Other:

☐ Other:

☐ Other:

Comments:

Evidence of sheet flow ~~[illegible]~~ from recent event.

⑰

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Cove Reservoir
Project Number:
Stream: PJD 1 (upstream)
Investigator(s): Brian Parker

Date: 10/9/18
Town: Orderville
Photo begin file#:

Time: 1230
State: UT
Photo end file#:

Y ☒ / N ☐ Do normal circumstances exist on the site?

Y ☐ / N ☒ Is the site significantly disturbed?

Location Details: Upstream canyon reach of PJD 1

Projection: UTM **Datum:** NAD 83

Coordinates: 12S 0351949; 4127317

Potential anthropogenic influences on the channel system:

None

Brief site description:

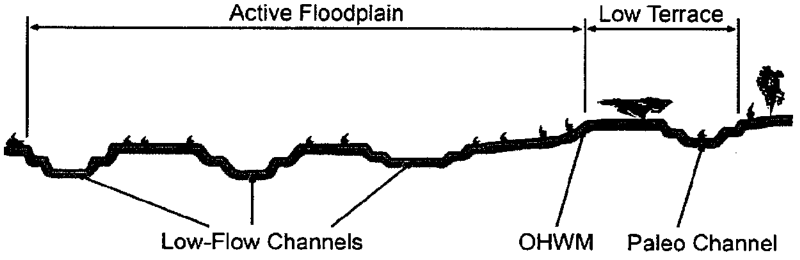
Deep canyon (~25-30 ft.) in pinyon-juniper habitat

Checklist of resources (if available):

☒ Aerial photography
Dates:
☒ Topographic maps
☐ Geologic maps
☐ Vegetation maps
☒ Soils maps
☐ Rainfall/precipitation maps
☐ Existing delineation(s) for site
☒ Global positioning system (GPS)
☐ Other studies

☐ Stream gage data
Gage number:
Period of record:
- ☐ History of recent effective discharges
- ☐ Results of flood frequency analysis
- ☐ Most recent shift-adjusted rating
- ☐ Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event

Hydrogeomorphic Floodplain Units



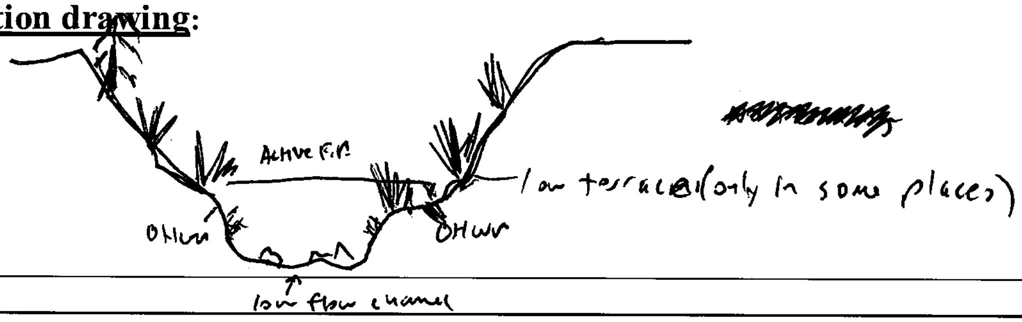
Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:

☒ Mapping on aerial photograph ☒ GPS
☒ Digitized on computer ☐ Other:

Project ID: Cove **Cross section ID:** POD 2 (upstream) **Date:** 10/9/18 **Time:** 1230

Cross section drawing:



OHWM

GPS point: 12S 0351948 ; 4127317

Indicators:

☐ Change in average sediment texture
☐ Change in vegetation species
☑ Change in vegetation cover
☑ Break in bank slope
☐ Other: ______
☐ Other: ______

Comments:

Well defined. Mix of clay + boulders

Floodplain unit: ☒ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: 12S 0351944 ; 4127314

Characteristics of the floodplain unit:

Average sediment texture: Boulder
Total veg cover: 0 % Tree: ____% Shrub: ____% Herb: ____%
Community successional stage:

☒ NA
☐ Early (herbaceous & seedlings)
☐ Mid (herbaceous, shrubs, saplings)
☐ Late (herbaceous, shrubs, mature trees)

Indicators:

☑ Mudcracks
☑ Ripples
☑ Drift and/or debris
☐ Presence of bed and bank
☐ Benches
☐ Soil development
☐ Surface relief
☐ Other: ______
☐ Other: ______
☐ Other: ______

Comments:

Project ID: Cove **Cross section ID:** QSD1 upstream **Date:** 10/9/19 **Time:** 1230

Floodplain unit: ☐ Low-Flow Channel ☒ Active Floodplain ☐ Low Terrace

GPS point: 12S 0351944, 4127314

Characteristics of the floodplain unit:

Average sediment texture: Medium sand / Cobble

Total veg cover: 20 % Tree: 0 % Shrub: 10 % Herb: 10 %

Community successional stage:

☐ NA

☒ Early (herbaceous & seedlings)

☒ Mid (herbaceous, shrubs, saplings)

☐ Late (herbaceous, shrubs, mature trees)

Indicators:

☐ Mudcracks

☐ Ripples

☐ Drift and/or debris

☒ Presence of bed and bank

☒ Benches

☐ Soil development

☐ Surface relief

☐ Other:

☐ Other:

☐ Other:

Comments:

Small, narrow floodplain above low flow due to steep canyon walls

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Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☒ Low Terrace

GPS point: 12S 0351944; 4127313

Characteristics of the floodplain unit:

Average sediment texture:

Total veg cover: 50 % Tree: % Shrub: 30 % Herb: 20 %

Community successional stage:

☐ NA

☐ Early (herbaceous & seedlings)

☒ Mid (herbaceous, shrubs, saplings)

☒ Late (herbaceous, shrubs, mature trees)

Indicators:

☐ Mudcracks

☐ Ripples

☐ Drift and/or debris

☐ Presence of bed and bank

☐ Benches

☒ Soil development

☐ Surface relief

☐ Other:

☐ Other:

☐ Other:

Comments:

Terracing only in a few places along this stretch

1a

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Cove Reservoir
Project Number:
Stream: PJD 1a
Investigator(s):

Date: 10/8/18
Town: Orderville
Photo begin file#:

Time: 1300
State: UT
Photo end file#:

Y ☒ / N ☐ Do normal circumstances exist on the site?

Y ☐ / N ☒ Is the site significantly disturbed?

Location Details:
Tributary to PJD 1

Projection: UTM **Datum:** NAD 83
Coordinates: 12S 352531; 412 6665

Potential anthropogenic influences on the channel system:

None

Brief site description:

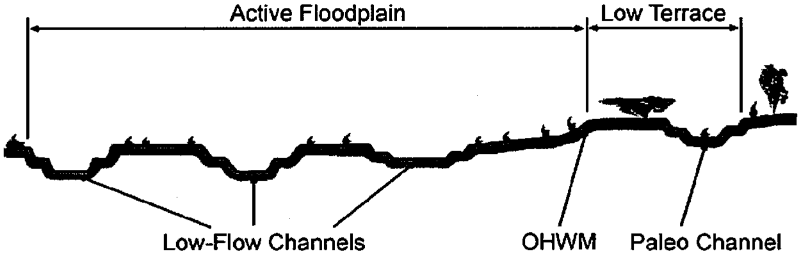
Small tributary w/ approx 2-3 ft' wide channel. Medium sloped banks; clear channel and OHWM

Checklist of resources (if available):

☑ Aerial photography
✓ Dates:
☑ Topographic maps
☐ Geologic maps
☐ Vegetation maps
☑ Soils maps
☐ Rainfall/precipitation maps
☐ Existing delineation(s) for site
☑ Global positioning system (GPS)
☐ Other studies

☐ Stream gage data
Gage number:
Period of record:
☐ History of recent effective discharges
☐ Results of flood frequency analysis
☐ Most recent shift-adjusted rating
☐ Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event

Hydrogeomorphic Floodplain Units



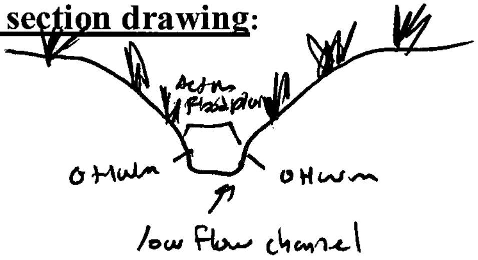
Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:

☒ Mapping on aerial photograph
☒ Digitized on computer
☒ GPS
☐ Other:

Project ID: Love **Cross section ID:** PJD 19 **Date:** 10/9/18 **Time:** 1300

Cross section drawing:



OHWM

GPS point: 12S 352531; 4126663

Indicators:

☐ Change in average sediment texture
☐ Change in vegetation species
☑ Change in vegetation cover
☒ Break in bank slope
☐ Other: ___________
☐ Other: ___________

Comments:

Clean channel. No veg. Evidence of recent flow

Floodplain unit: ☒ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: 12S 352530; 4126663

Characteristics of the floodplain unit:

Average sediment texture: Medium sand
Total veg cover: 0 % Tree: ____% Shrub: ____% Herb: ____%
Community successional stage:

☒ NA
☐ Early (herbaceous & seedlings)
☐ Mid (herbaceous, shrubs, saplings)
☐ Late (herbaceous, shrubs, mature trees)

Indicators:

☒ Mudcracks
☒ Ripples
☐ Drift and/or debris
☐ Presence of bed and bank
☐ Benches
☐ Soil development
☐ Surface relief
☐ Other: ___________
☐ Other: ___________
☐ Other: ___________

Comments:

No vegetation in channel

Project ID: Cove **Cross section ID:** PJD 1a **Date:** 10/9/18 **Time:** 1300

Floodplain unit: ☐ Low-Flow Channel ☒ Active Floodplain ☐ Low Terrace

GPS point: 12S 352531; 4126663

Characteristics of the floodplain unit:
Average sediment texture: Medium sand
Total veg cover: 15 % Tree: 0 % Shrub: 10 % Herb: 5 %
Community successional stage:
☐ NA
☒ Early (herbaceous & seedlings)
☒ Mid (herbaceous, shrubs, saplings)
☐ Late (herbaceous, shrubs, mature trees)

Indicators:
☐ Mudcracks
☐ Ripples
☐ Drift and/or debris
☒ Presence of bed and bank
☐ Benches
☐ Soil development
☐ Surface relief
☐ Other: ______
☐ Other: ______
☐ Other: ______

Comments:

Narrow floodplain due to deep and steep banks

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☒ Low Terrace

GPS point: N/A

Characteristics of the floodplain unit:
Average sediment texture: ______
Total veg cover: ____ % Tree: ____ % Shrub: ____ % Herb: ____ %
Community successional stage:
☐ NA
☐ Early (herbaceous & seedlings)
☐ Mid (herbaceous, shrubs, saplings)
☐ Late (herbaceous, shrubs, mature trees)

Indicators:
☐ Mudcracks
☐ Ripples
☐ Drift and/or debris
☐ Presence of bed and bank
☐ Benches
☐ Soil development
☐ Surface relief
☐ Other: ______
☐ Other: ______
☐ Other: ______

Comments:

No terracing

2↓

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Cove Reservoir
Project Number:
Stream: PJD 2 (downstream)
Investigator(s): Brian Parker

Date: 10/8/18
Town: Orderville
Photo begin file#: [redacted]

Time: 13:45
State: UT
Photo end file#: [redacted]

Y ☒ / N ☐ Do normal circumstances exist on the site?

Y ☐ / N ☒ Is the site significantly disturbed?

Location Details: Cove Reservoir footprint

Projection: UTM **Datum:** NAD 83
Coordinates: 12S 6352964 ; 412 6425

Potential anthropogenic influences on the channel system:
Irrigation downstream ; grazing

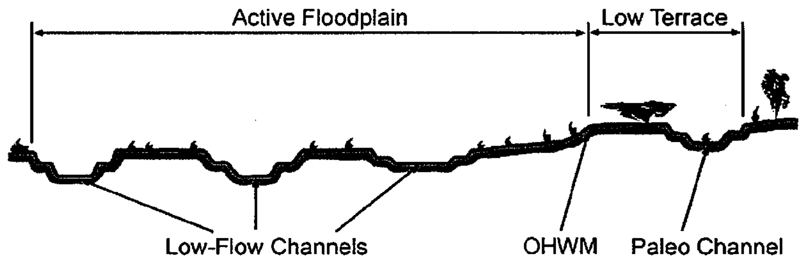
Brief site description:
Intermittent stream running West to East. [illegible] Looks to drain large watershed beyond the footprint of the project.

Checklist of resources (if available):

☒ Aerial photography
Dates:
☒ Topographic maps
☐ Geologic maps
☒ Vegetation maps
☐ Soils maps
☐ Rainfall/precipitation maps
☐ Existing delineation(s) for site
☒ Global positioning system (GPS)
☐ Other studies

☐ Stream gage data
Gage number:
Period of record:
☐ History of recent effective discharges
☐ Results of flood frequency analysis
☐ Most recent shift-adjusted rating
☐ Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event

Hydrogeomorphic Floodplain Units



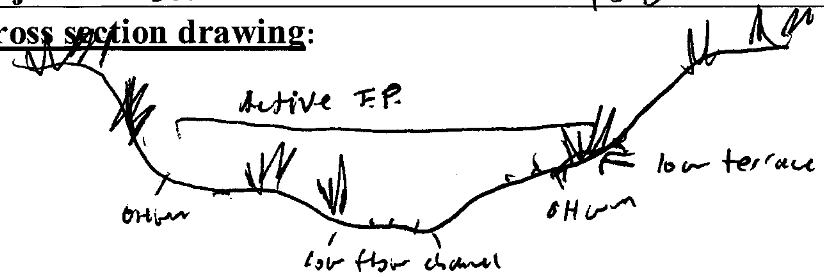
Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:

☒ Mapping on aerial photograph ☑ GPS
☒ Digitized on computer ☐ Other:

Project ID: Cove **Cross section ID:** PJD 2 **Date:** 10/8/18 **Time:** 1345

Cross section drawing:



OHWM

GPS point: 12S 0352970; 4126430

Indicators:

☒ Change in average sediment texture
☐ Change in vegetation species
☒ Change in vegetation cover

☒ Break in bank slope
☐ Other: __________
☐ Other: __________

Comments:

Medium to steep walled banks above OHWM funnel flow fairly consistently with litte ability to meander.

Floodplain unit: ☒ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: 12S 6352968; 4126432

Characteristics of the floodplain unit:

Average sediment texture: Clay
Total veg cover: 30 % Tree: 0 % Shrub: 20 % Herb: 10 %
Community successional stage:

☐ NA
☒ Early (herbaceous & seedlings)

☒ Mid (herbaceous, shrubs, saplings)
☐ Late (herbaceous, shrubs, mature trees)

Indicators:

☒ Mudcracks
☑ Ripples
☑ Drift and/or debris
☐ Presence of bed and bank
☐ Benches

☐ Soil development
☐ Surface relief
☐ Other: __________
☐ Other: __________
☐ Other: __________

Comments:

Recent flow. Channel has some herbaceous seedlings and grasses

Project ID: Cora **Cross section ID:** PJD 2 **Date:** 10/8/18 **Time:** 1345

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☒ Low Terrace

GPS point: 12S 0352970; 4126428

Characteristics of the floodplain unit:

Average sediment texture: Clay

Total veg cover: 41 % Tree: 1 % Shrub: 20 % Herb: 20 %

Community successional stage:

- ☐ NA
- ☒ Early (herbaceous & seedlings)
- ☒ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☐ Mudcracks
- ☐ Ripples
- ☐ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: ______
- ☐ Other: ______
- ☐ Other: ______

Comments:

Terraces only in some areas, Mostly on ~~[illegible]~~ larger bends. Evidence of grazing throughout edges of stream and surrounding valley

---

Floodplain unit: ☐ Low-Flow Channel ☒ Active Floodplain ☐ Low Terrace

GPS point: 12S 0352965; 4126434

Characteristics of the floodplain unit:

Average sediment texture: Clay

Total veg cover: 50 % Tree: 0 % Shrub: 40 % Herb: 10 %

Community successional stage:

- ☐ NA
- ☒ Early (herbaceous & seedlings)
- ☒ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☐ Mudcracks
- ☐ Ripples
- ☐ Drift and/or debris
- ☑ Presence of bed and bank
- ☒ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: ______
- ☐ Other: ______
- ☐ Other: ______

Comments:

Floodplain is more prominent in areas along the inside of bends in the stream

27

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Cove Reservoir
Project Number:
Stream: PJD 2 (upstream)
Investigator(s): Brian Parker
Date: 10/8/18
Time: 1630
Town: Orderville
State: UT
Photo begin file#:
Photo end file#:

Y ☒ / N ☐ Do normal circumstances exist on the site?

Y ☐ / N ☒ Is the site significantly disturbed?

Location Details: upstream portion of PJD 2
Projection: NAD 83
Datum: UTM
Coordinates: 12S 6353122; 4126795

Potential anthropogenic influences on the channel system:
Numerous flood control retention ponds upstream

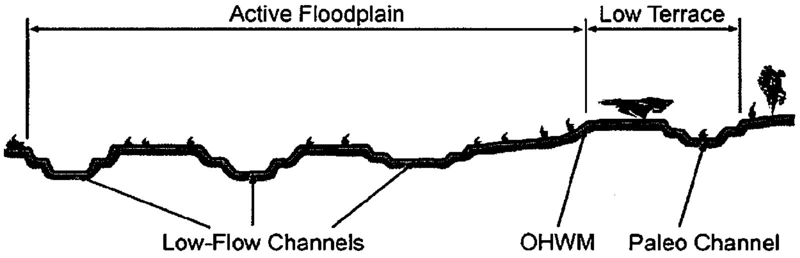
Brief site description:
steep canyon portion of PJD 2 (upstream). this northern section is very deep with a narrow 'slot' channel at the bottom.

Checklist of resources (if available):

☒ Aerial photography
Dates:
☒ Topographic maps
☐ Geologic maps
☐ Vegetation maps
☒ Soils maps
☐ Rainfall/precipitation maps
☐ Existing delineation(s) for site
☒ Global positioning system (GPS)
☐ Other studies

☐ Stream gage data
Gage number:
Period of record:
☐ History of recent effective discharges
☐ Results of flood frequency analysis
☐ Most recent shift-adjusted rating
☐ Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event

Hydrogeomorphic Floodplain Units

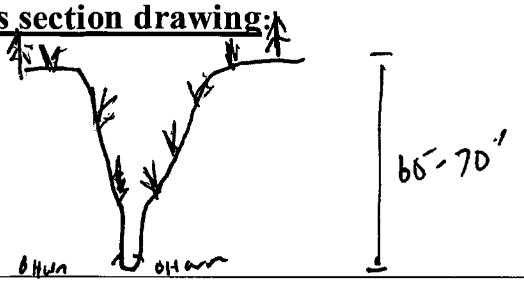


Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:
   ☒ Mapping on aerial photograph ☒ GPS
   ☒ Digitized on computer ☐ Other:

Project ID: Cove **Cross section ID:** PJD2 (upstream) **Date:** 8/8/18 **Time:** 1630

Cross section drawing:



OHWM

GPS point: ____________________

Indicators:

☐ Change in average sediment texture
☐ Change in vegetation species
☐ Change in vegetation cover
☒ Break in bank slope
☐ Other: ____________
☐ Other: ____________

Comments:

Slot canyon at bottom, progressively deeper as you go upstream

Floodplain unit: ☒ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: ____________________

Characteristics of the floodplain unit:

Average sediment texture: Clay
Total veg cover: 10 % Tree: 0 % Shrub: 5 % Herb: 5 %
Community successional stage:

☐ NA
☒ Early (herbaceous & seedlings)
☒ Mid (herbaceous, shrubs, saplings)
☐ Late (herbaceous, shrubs, mature trees)

Indicators:

☒ Mudcracks
☒ Ripples
☒ Drift and/or debris
☐ Presence of bed and bank
☐ Benches
☐ Soil development
☐ Surface relief
☐ Other: ____________
☐ Other: ____________
☐ Other: ____________

Comments:

Some veg. growing in slot channel.

Project ID: Cove **Cross section ID:** PJD2 (upstream) **Date:** 10/8/14 **Time:** 1630

Floodplain unit: ☐ Low-Flow Channel ☒ Active Floodplain ☐ Low Terrace

GPS point: ____________________

Characteristics of the floodplain unit:

Average sediment texture: Clay

Total veg cover: 20 % Tree: _____% Shrub: 15 % Herb: 5 %

Community successional stage:

☐ NA
☒ Early (herbaceous & seedlings)
☒ Mid (herbaceous, shrubs, saplings)
☐ Late (herbaceous, shrubs, mature trees)

Indicators:

☐ Mudcracks
☐ Ripples
☐ Drift and/or debris
☒ Presence of bed and bank
☒ Benches
☐ Soil development
☐ Surface relief
☐ Other: ____________________
☐ Other: ____________________
☐ Other: ____________________

Comments:

Some benches where stream meanders. Not a continous floodplain

Mostly just a channel @ the bottom of the canyon

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☐ ~~Low Terrace~~ N/A

GPS point: ____________________

Characteristics of the floodplain unit:

Average sediment texture: ____________________

Total veg cover: _____% Tree: _____% Shrub: _____% Herb: _____%

Community successional stage:

☐ NA
☐ Early (herbaceous & seedlings)
☐ Mid (herbaceous, shrubs, saplings)
☐ Late (herbaceous, shrubs, mature trees)

Indicators:

☐ Mudcracks
☐ Ripples
☐ Drift and/or debris
☐ Presence of bed and bank
☐ Benches
☐ Soil development
☐ Surface relief
☐ Other: ____________________
☐ Other: ____________________
☐ Other: ____________________

Comments:

No terrace. Only steep canyon walls

2a

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Cove Reruvdr
Project Number:
Stream: PJD 2a
Investigator(s): Brian Parker

Date: 10/8/18
Town: Orderville
Photo begin file#:

Time: 1500
State: UT
Photo end file#:

Y ☒ / N ☐ Do normal circumstances exist on the site?

Y ☐ / N ☒ Is the site significantly disturbed?

Location Details: East fork above PJD 2
Projection: UTM **Datum:** NAD83
Coordinates: 12S 035 3214; 4127015

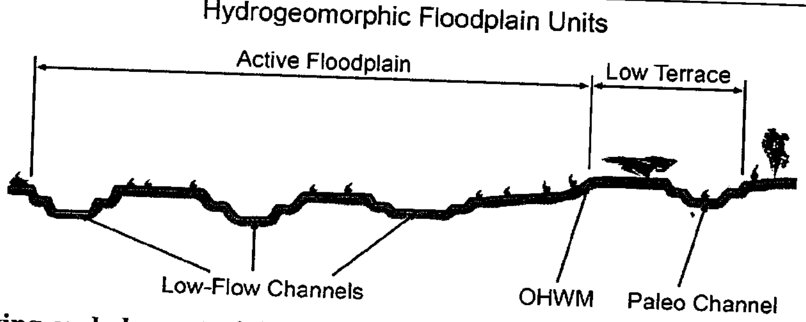
Potential anthropogenic influences on the channel system:
upstream, 2 retention ponds are found which collect wate that would normally flow downstream. Water in this small canyon only flows from adjacent sheet flow runoff and during heavy rains where the ponds overflow

Brief site description:
Small tributary canyon (~50 ft. deep) leading to PJD 2

Checklist of resources (if available):

☒ Aerial photography
Dates:
☒ Topographic maps
☐ Geologic maps
☐ Vegetation maps
☒ Soils maps
☐ Rainfall/precipitation maps
☐ Existing delineation(s) for site
☒ Global positioning system (GPS)
☐ Other studies

☐ Stream gage data
Gage number:
Period of record:
☐ History of recent effective discharges
☐ Results of flood frequency analysis
☐ Most recent shift-adjusted rating
☐ Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event


Hydrogeomorphic Floodplain Units

Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

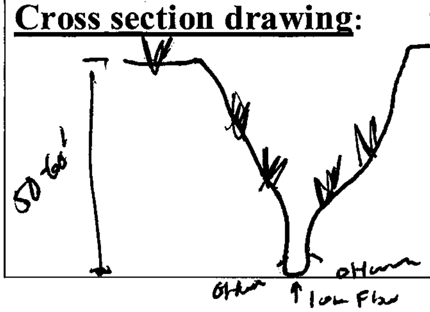
1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:

☒ Mapping on aerial photograph
☒ Digitized on computer

☒ GPS
☐ Other:

Project ID: Cove **Cross section ID:** PJD 2a **Date:** 10/8/18 **Time:** 1500

Cross section drawing:



OHWM

GPS point: 12S 0353212; 4127018

Indicators:
- ☐ Change in average sediment texture
- ☐ Change in vegetation species
- ☒ Change in vegetation cover
- ☒ Break in bank slope
- ☐ Other: __________
- ☐ Other: __________

Comments:

50-60' deep canyon. Not traversible by foot. Observations from above indicated a clear channel ~~[illegible]~~. ~~[illegible]~~ Approximately 8 ft. wide @ bottom here.

Floodplain unit: ☒ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: 12S 0353212; 4127019

Characteristics of the floodplain unit:

Average sediment texture: Clay

Total veg cover: 0 % Tree: ___ % Shrub: ___ % Herb: ___ %

Community successional stage:
- ☒ NA
- ☐ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:
- ☑ Mudcracks
- ☒ Ripples
- ☐ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: __________
- ☐ Other: __________
- ☐ Other: __________

Comments:

Project ID: Cove **Cross section ID:** PJD 2a **Date:** 10/8/18 **Time:** 1500

Floodplain unit: ☐ Low-Flow Channel ☒ Active Floodplain ☐ Low Terrace

GPS point: 12S 0353212; 4127018

Characteristics of the floodplain unit:
Average sediment texture: Clay
Total veg cover: 5 % Tree: ___ % Shrub: 3 % Herb: 2 %
Community successional stage:
☐ NA
☑ Early (herbaceous & seedlings)
☒ Mid (herbaceous, shrubs, saplings)
☐ Late (herbaceous, shrubs, mature trees)

Indicators:
☐ Mudcracks
☐ Ripples
☐ Drift and/or debris
☐ Presence of bed and bank
☐ Benches
☐ Soil development
☐ Surface relief
☐ Other: ___
☐ Other: ___
☐ Other: ___

Comments:

Some veg. lining walls of canyon

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☐ ~~Low Terrace~~ N/A

GPS point: 12S 0353214; 4127015 (@ edge of upper canyon)

Characteristics of the floodplain unit:
Average sediment texture: ___
Total veg cover: ___ % Tree: ___ % Shrub: ___ % Herb: ___ %
Community successional stage:
☐ NA
☐ Early (herbaceous & seedlings)
☐ Mid (herbaceous, shrubs, saplings)
☐ Late (herbaceous, shrubs, mature trees)

Indicators:
☐ Mudcracks
☐ Ripples
☐ Drift and/or debris
☐ Presence of bed and bank
☐ Benches
☐ Soil development
☐ Surface relief
☐ Other: ___
☐ Other: ___
☐ Other: ___

Comments:

No terrace. Steep canyon walls contain all flow to slot-like canyon.

3

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Cove Reservoir
Project Number:
Stream: PJD 3
Investigator(s): Brian Parker

Date: 10/9/18
Town: Orderville
Photo begin file#:

Time: 11:30
State: UT
Photo end file#:

Y ☒ / N ☐ Do normal circumstances exist on the site?

Y ☐ / N ☒ Is the site significantly disturbed?

Location Details: upstream portion of PJD 5

Projection: UTM **Datum:** NAD83

Coordinates: 12S 0352081 ; 4126364

Potential anthropogenic influences on the channel system:

None upstream. Dowstream is a dirt road that has been constructed where flow naturally occurs. Recent sheet flow due to flooding in the area appers to have obscurred a clearly defined channel

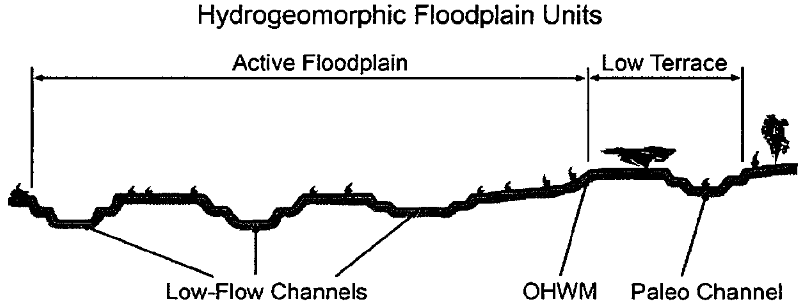
Brief site description:

Gully or deeply eroded channel ; moderately deep (2-3 ft.) w/ cut bank

Checklist of resources (if available):

☒ Aerial photography
Dates:
☒ Topographic maps
☐ Geologic maps
☐ Vegetation maps
☒ Soils maps
☐ Rainfall/precipitation maps
☐ Existing delineation(s) for site
☒ Global positioning system (GPS)
☐ Other studies

☐ Stream gage data
Gage number:
Period of record:
- ☐ History of recent effective discharges
- ☐ Results of flood frequency analysis
- ☐ Most recent shift-adjusted rating
- ☐ Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event



Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

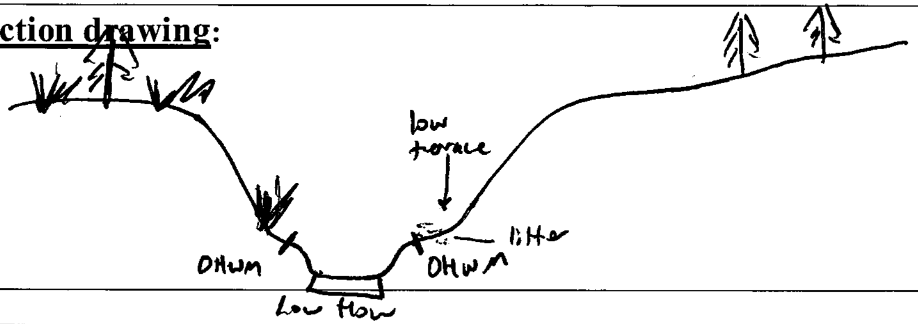
1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:

☒ Mapping on aerial photograph
☒ Digitized on computer

☒ GPS
☐ Other:

Project ID: Cove **Cross section ID:** PJD 3 **Date:** 10/9/18 **Time:** 11:30

Cross section drawing:



OHWM

GPS point: 12S 0352080; 4126366

Indicators:

☐ Change in average sediment texture
☐ Change in vegetation species
☒ Change in vegetation cover
☐ Break in bank slope
☐ Other: ______
☐ Other: ______

Comments:

Clear channel. No water observed in channel.

Floodplain unit:

☒ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: 12S 0352080; 4126365

Characteristics of the floodplain unit:

Average sediment texture: Clay

Total veg cover: 0 % Tree: ____ % Shrub: ____ % Herb: ____ %

Community successional stage:

☒ NA
☐ Early (herbaceous & seedlings)
☐ Mid (herbaceous, shrubs, saplings)
☐ Late (herbaceous, shrubs, mature trees)

Indicators:

☒ Mudcracks
☒ Ripples
☒ Drift and/or debris
☐ Presence of bed and bank
☐ Benches
☐ Soil development
☐ Surface relief
☐ Other: ______
☐ Other: ______
☐ Other: ______

Comments:

Project ID: Cove **Cross section ID:** PJD3 **Date:** 10/9/18 **Time:** 11:30

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: 12S 0352081; 4126364

Characteristics of the floodplain unit:

Average sediment texture: Clay / fine silt

Total veg cover: 5 % Tree: 0 % Shrub: 5 % Herb: 0 %

Community successional stage:

☐ NA

☒ Early (herbaceous & seedlings)

☐ Mid (herbaceous, shrubs, saplings)

☐ Late (herbaceous, shrubs, mature trees)

Indicators:

☐ Mudcracks

☐ Ripples

☐ Drift and/or debris

☒ Presence of bed and bank

☒ Benches

☐ Soil development

☐ Surface relief

☐ Other: ________

☐ Other: ________

☐ Other: ________

Comments:

Narrow floodplain. Floodplain is mostly [illegible] synonomous with the chanel in most places

---

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☒ Low Terrace

GPS point: 12S 06352081; 4126363

Characteristics of the floodplain unit:

Average sediment texture: Clay

Total veg cover: 25 % Tree: 0 % Shrub: 20 % Herb: 5 %

Community successional stage:

☐ NA

☐ Early (herbaceous & seedlings)

☒ Mid (herbaceous, shrubs, saplings)

☐ Late (herbaceous, shrubs, mature trees)

Indicators:

☐ Mudcracks

☐ Ripples

☐ Drift and/or debris

☐ Presence of bed and bank

☐ Benches

☒ Soil development

☐ Surface relief

☐ Other: ________

☐ Other: ________

☐ Other: ________

Comments:

Larger shrubs here

④

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Cove Reservoir
Project Number:
Stream: PJD 4
Investigator(s): Brian Parker

Date: 10/8/18
Town: Orderville
Photo begin file#:

Time: 11:20
State: UT
Photo end file#:

Y ☒ / N ☐ Do normal circumstances exist on the site?

Y ☐ / N ☒ Is the site significantly disturbed?

Location Details:
PJD 1 ' North of Reservoir + access road

Projection: UTM NAD 83 **Datum:**
Coordinates: 12S 0353659; 4126944

Potential anthropogenic influences on the channel system:
Retention Ponds (2) downstream

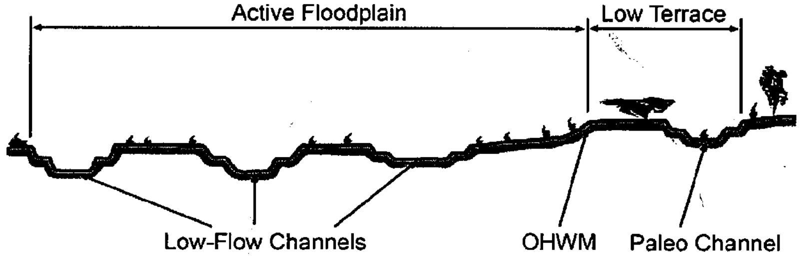
Brief site description:
Steep walled intermittent stream draining adjacent hillsides and leading to retention ponds downstream. Little to no surficial connectivity downstream of ponds

Checklist of resources (if available):

☒ Aerial photography
Dates:
☐ Topographic maps
☑ Geologic maps
☐ Vegetation maps
☑ Soils maps
☐ Rainfall/precipitation maps
☐ Existing delineation(s) for site
☑ Global positioning system (GPS)
☐ Other studies

☐ Stream gage data
Gage number:
Period of record:
- ☐ History of recent effective discharges
- ☐ Results of flood frequency analysis
- ☐ Most recent shift-adjusted rating
- ☐ Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event

Hydrogeomorphic Floodplain Units



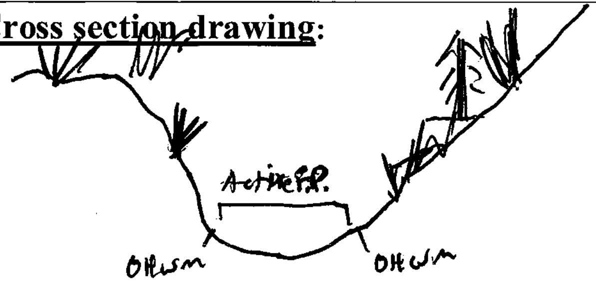
Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:

☑ Mapping on aerial photograph ☑ GPS
☒ Digitized on computer ☐ Other:

Project ID: Cove **Cross section ID:** JJD 4 **Date:** 10/8/14 **Time:** 11:20

Cross section drawing:



OHWM

GPS point: 12S 0353490 ; 4126985

Indicators:

- ☒ Change in average sediment texture
- ☐ Change in vegetation species
- ☒ Change in vegetation cover
- ☒ Break in bank slope
- ☐ Other: ____________
- ☐ Other: ____________

Comments:

Steep walled banks. Channel void of Vegetation .

Floodplain unit: ☒ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: 12S 0353490 ; 4127009

Characteristics of the floodplain unit:

Average sediment texture: fine silt

Total veg cover: 0 % Tree: ____ % Shrub: ____ % Herb: ____ %

Community successional stage:

- ☒ NA
- ☐ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☒ Mudcracks
- ☒ Ripples
- ☒ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: ____________
- ☐ Other: ____________
- ☐ Other: ____________

Comments:

Recent flow due to heavy rainfall in the days prior to survey

Project ID: Cove **Cross section ID:** PJD 4 **Date:** 10/8/18 **Time:** 11:20

Floodplain unit: ☐ Low-Flow Channel ☒ Active Floodplain ☐ Low Terrace

GPS point: 12S 0353490, 4136985

Characteristics of the floodplain unit:

Average sediment texture: Clay

Total veg cover: 5 % Tree: 0 % Shrub: 2 % Herb: 3 %

Community successional stage:

☐ NA ☒ Mid (herbaceous, shrubs, saplings)

☒ Early (herbaceous & seedlings) ☐ Late (herbaceous, shrubs, mature trees)

Indicators:

☐ Mudcracks

☐ Ripples

☐ Drift and/or debris

☐ Presence of bed and bank

☒ Benches

☐ Soil development

☐ Surface relief

☐ Other: ________

☐ Other: ________

☐ Other: ________

Comments:

Steep walled bank @ floodplain edge

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☐ ~~Low Terrace~~ N/A

GPS point: ________

Characteristics of the floodplain unit:

Average sediment texture: ________

Total veg cover: ___ % Tree: ___ % Shrub: ___ % Herb: ___ %

Community successional stage:

☐ NA ☐ Mid (herbaceous, shrubs, saplings)

☐ Early (herbaceous & seedlings) ☐ Late (herbaceous, shrubs, mature trees)

Indicators:

☐ Mudcracks

☐ Ripples

☐ Drift and/or debris

☐ Presence of bed and bank

☐ Benches

☐ Soil development

☐ Surface relief

☐ Other: ________

☐ Other: ________

☐ Other: ________

Comments:

No Low terrace here.

5

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Cove Reservoir
Project Number:
Stream: PJD 5
Investigator(s): Brian Parker

Date: 10/9/18
Town: orderville
Photo begin file#:

Time: 1745
State: UT
Photo end file#:

Y ☒ / N ☐ Do normal circumstances exist on the site?

Y ☐ / N ☒ Is the site significantly disturbed?

Location Details:
Stream above irrigated farmland

Projection: UTM
Datum: NAD83
Coordinates: 12S 0356914 ; 4129955

Potential anthropogenic influences on the channel system:
Dirt road, pipelines installed (irrigation)

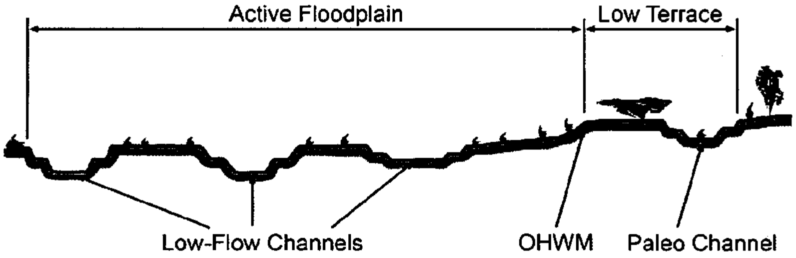
Brief site description:
Running stream above pastureland. Cottonwood, oaks and pinyon/juniper adjacent to stream

Checklist of resources (if available):

☑ Aerial photography
Dates:
☑ Topographic maps
☐ Geologic maps
☑ Vegetation maps
☑ Soils maps
☐ Rainfall/precipitation maps
☐ Existing delineation(s) for site
☑ Global positioning system (GPS)
☐ Other studies

☐ Stream gage data
Gage number:
Period of record:
☐ History of recent effective discharges
☐ Results of flood frequency analysis
☐ Most recent shift-adjusted rating
☐ Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event

Hydrogeomorphic Floodplain Units



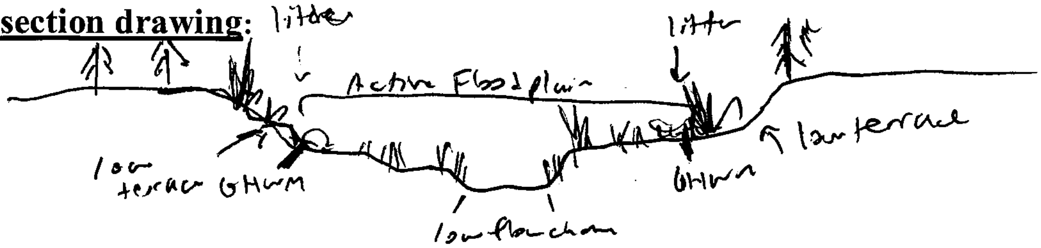
Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:

☑ Mapping on aerial photograph
☒ Digitized on computer
☒ GPS
☐ Other:

Project ID: COVE **Cross section ID:** PJD 5 **Date:** 10/9/18 **Time:** 1745

Cross section drawing:



OHWM

GPS point: 12S 0356914 ; 4129756

Indicators:

☐ Change in average sediment texture
☑ Change in vegetation species
☑ Change in vegetation cover
☑ Break in bank slope
☐ Other: __________
☐ Other: __________

Comments:

Flowing water in channel @ time of survey.

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☑ Low Terrace

GPS point: 12S 0356914 ; 4129746

Characteristics of the floodplain unit:

Average sediment texture: Medium Sand
Total veg cover: 60 % Tree: 25 % Shrub: 25 % Herb: 10 %
Community successional stage:
☐ NA
☐ Early (herbaceous & seedlings)
☑ Mid (herbaceous, shrubs, saplings)
☑ Late (herbaceous, shrubs, mature trees)

Indicators:

☐ Mudcracks
☐ Ripples
☐ Drift and/or debris
☐ Presence of bed and bank
☐ Benches
☑ Soil development
☐ Surface relief
☐ Other: __________
☐ Other: __________
☐ Other: __________

Comments:

/

Project ID: COVE **Cross section ID:** PSD #5 **Date:** 10/9/18 **Time:** 1745

Floodplain unit: ☐ Low-Flow Channel ☒ Active Floodplain ☐ Low Terrace

GPS point: 12 S 0356908 ; 4129750

Characteristics of the floodplain unit:

Average sediment texture: Me brown silt

Total veg cover: 40 % Tree: 0 % Shrub: 5 % Herb: 35 %

Community successional stage:

☐ NA
☒ Early (herbaceous & seedlings)
☒ Mid (herbaceous, shrubs, saplings)
☐ Late (herbaceous, shrubs, mature trees)

Indicators:

☐ Mudcracks
☐ Ripples
☒ Drift and/or debris
☐ Presence of bed and bank
☐ Benches
☐ Soil development
☐ Surface relief
☐ Other: ____
☐ Other: ____
☐ Other: ____

Comments:

Vegetation layed down due to recent flow

Floodplain unit: ☒ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: 12S 0356909 ; 4129751

Characteristics of the floodplain unit:

Average sediment texture: Cobble

Total veg cover: 0 % Tree: ____ % Shrub: ____ % Herb: ____ %

Community successional stage:

☒ NA
☐ Early (herbaceous & seedlings)
☐ Mid (herbaceous, shrubs, saplings)
☐ Late (herbaceous, shrubs, mature trees)

Indicators:

☒ Mudcracks
☒ Ripples
☐ Drift and/or debris
☐ Presence of bed and bank
☐ Benches
☐ Soil development
☐ Surface relief
☐ Other: ____
☐ Other: ____
☐ Other: ____

Comments:

Flowing water. 3ft wide chanel.

(6)

Arid West Ephemeral and Intermittent Streams OHWM Datasheet

Project: Cove Rervoir
Project Number:
Stream: DJD # 6
Investigator(s): Brian Parker

Date: 10/9/18
Town: Glendale
Photo begin file#:

Time: 1800
State: UT
Photo end file#:

Y ☒ / N ☐ Do normal circumstances exist on the site?

Y ☐ / N ☒ Is the site significantly disturbed?

Location Details: Stream adjacent to farmland
Projection: UTM **Datum:** NAD83
Coordinates: 12S 0356736 ; 4129546

Potential anthropogenic influences on the channel system:
Irrigated farmland adjacent to stream. Northern bank has been built up likely for flood control of farmland

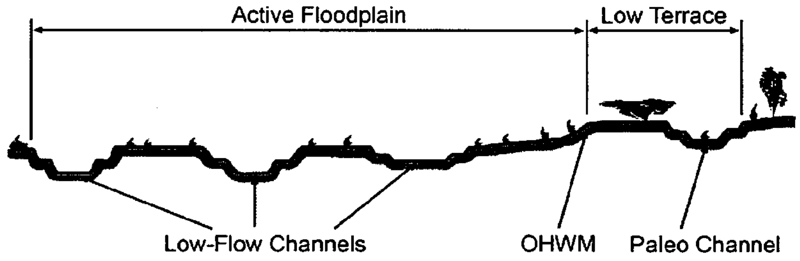
Brief site description:
Running stream south of irrigated farmland towards southern end of Glendale Pipeline. Wooded (Oak, cottonwood, Sycamore)

Checklist of resources (if available):

- ☑ Aerial photography
  Dates:
- ☒ Topographic maps
- ☐ Geologic maps
- ☑ Vegetation maps
- ☒ Soils maps
- ☐ Rainfall/precipitation maps
- ☐ Existing delineation(s) for site
- ☑ Global positioning system (GPS)
- ☐ Other studies

- ☐ Stream gage data
  Gage number:
  Period of record:
  - ☐ History of recent effective discharges
  - ☐ Results of flood frequency analysis
  - ☐ Most recent shift-adjusted rating
  - ☐ Gage heights for 2-, 5-, 10-, and 25-year events and the most recent event exceeding a 5-year event

Hydrogeomorphic Floodplain Units

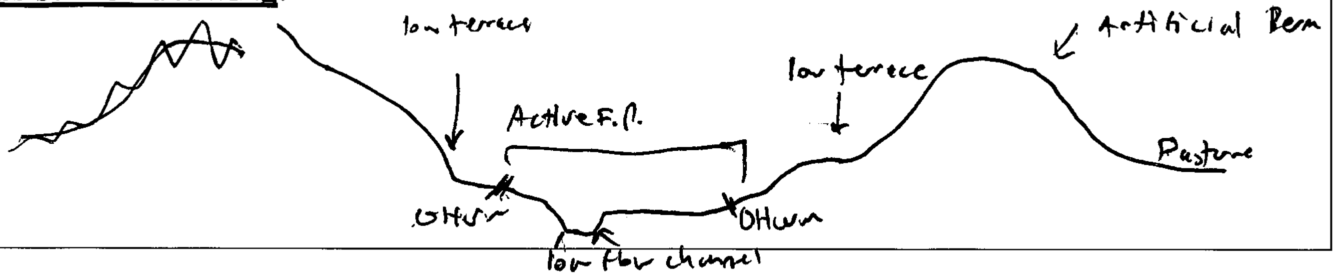


Procedure for identifying and characterizing the floodplain units to assist in identifying the OHWM:

1. Walk the channel and floodplain within the study area to get an impression of the geomorphology and vegetation present at the site.
2. Select a representative cross section across the channel. Draw the cross section and label the floodplain units.
3. Determine a point on the cross section that is characteristic of one of the hydrogeomorphic floodplain units.
   a) Record the floodplain unit and GPS position.
   b) Describe the sediment texture (using the Wentworth class size) and the vegetation characteristics of the floodplain unit.
   c) Identify any indicators present at the location.
4. Repeat for other points in different hydrogeomorphic floodplain units across the cross section.
5. Identify the OHWM and record the indicators. Record the OHWM position via:
   ☒ Mapping on aerial photograph ☒ GPS
   ☑ Digitized on computer ☐ Other:

Project ID: Cove **Cross section ID:** PDD 6 **Date:** 10/9/18 **Time:** 1800

Cross section drawing:



OHWM

GPS point: 12S 0356735; 4129559

Indicators:

- ☐ Change in average sediment texture
- ☐ Change in vegetation species
- ☐ Change in vegetation cover
- ☒ Break in bank slope
- ☐ Other: ______
- ☐ Other: ______

Comments:

Veg. layed down and litter/debris present

Floodplain unit: ☐ Low-Flow Channel ☒ Active Floodplain ☐ Low Terrace

GPS point: 12S 0356735; 4129559

Characteristics of the floodplain unit:

Average sediment texture: Medium Sand

Total veg cover: 25 % Tree: 0 % Shrub: 2 % Herb: 23 %

Community successional stage:

- ☐ NA
- ☒ Early (herbaceous & seedlings)
- ☐ Mid (herbaceous, shrubs, saplings)
- ☐ Late (herbaceous, shrubs, mature trees)

Indicators:

- ☐ Mudcracks
- ☒ Ripples
- ☒ Drift and/or debris
- ☐ Presence of bed and bank
- ☐ Benches
- ☐ Soil development
- ☐ Surface relief
- ☐ Other: ______
- ☐ Other: ______
- ☐ Other: ______

Comments:

Project ID: Cove **Cross section ID:** PSD# 6 **Date:** 10/9/18 **Time:** 1800

Floodplain unit: ☒ Low-Flow Channel ☐ Active Floodplain ☐ Low Terrace

GPS point: 12S 0356731; 4129555

Characteristics of the floodplain unit:

Average sediment texture: Coarse sand

Total veg cover: 10% Tree: 0% Shrub: 0% Herb: 10%

Community successional stage:

☐ NA
☒ Early (herbaceous & seedlings)
☐ Mid (herbaceous, shrubs, saplings)
☐ Late (herbaceous, shrubs, mature trees)

Indicators:

☒ Mudcracks
☒ Ripples
☒ Drift and/or debris
☐ Presence of bed and bank
☐ Benches
☐ Soil development
☐ Surface relief
☐ Other: ________
☐ Other: ________
☐ Other: ________

Comments:

Floodplain unit: ☐ Low-Flow Channel ☐ Active Floodplain ☒ Low Terrace

GPS point: 12S 0356733; 4129555

Characteristics of the floodplain unit:

Average sediment texture: Coarse silt

Total veg cover: 50 % Tree: 15 % Shrub: 15 % Herb: 20 %

Community successional stage:

☐ NA
☐ Early (herbaceous & seedlings)
☒ Mid (herbaceous, shrubs, saplings)
☒ Late (herbaceous, shrubs, mature trees)

Indicators:

☐ Mudcracks
☐ Ripples
☐ Drift and/or debris
☐ Presence of bed and bank
☒ Benches
☒ Soil development
☐ Surface relief
☐ Other: ________
☐ Other: ________
☐ Other: ________

Comments:

APPENDIX C

NRCS CUSTOM SOIL REPORTS

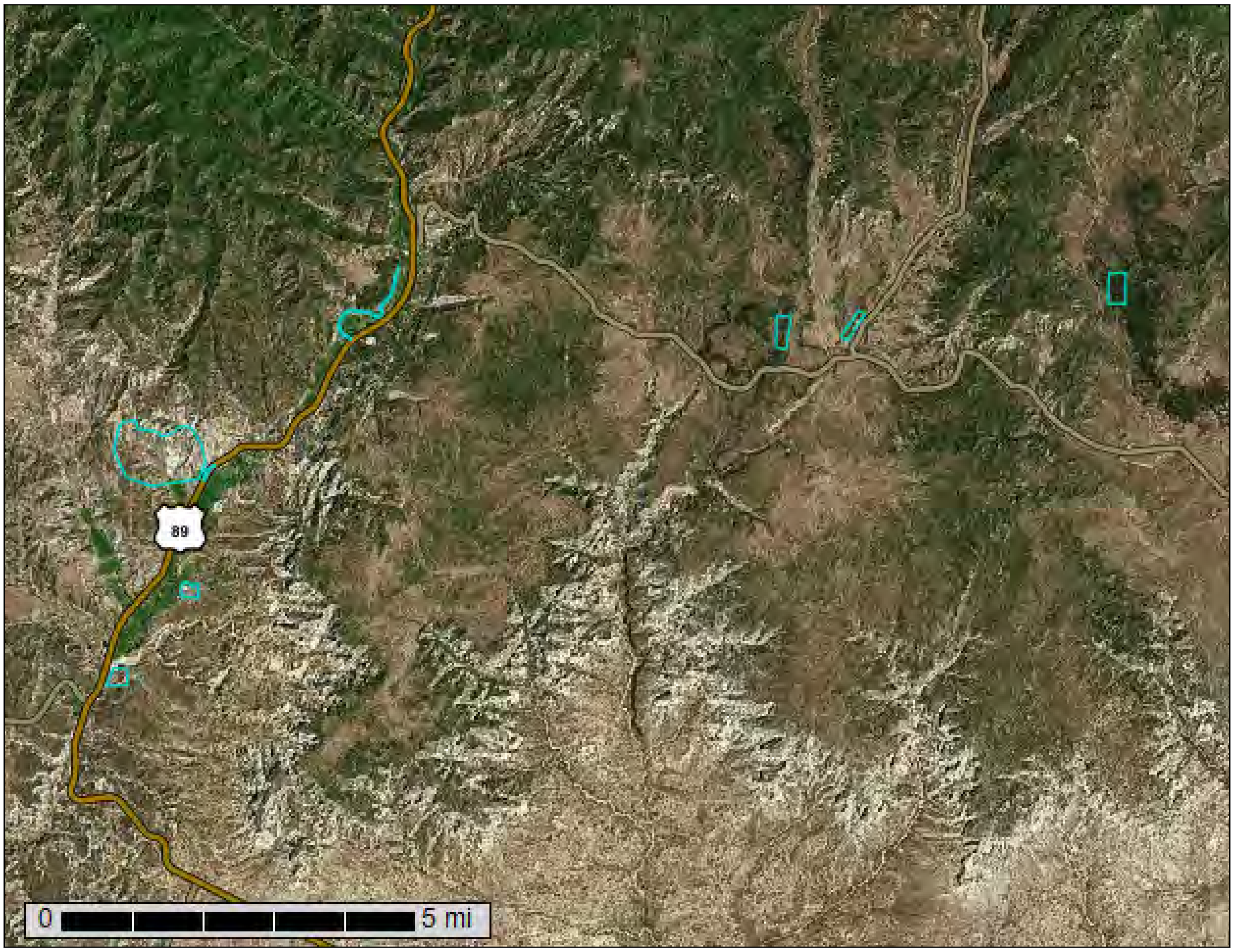
United States
Department of
Agriculture

Natural
Resources
Conservation
Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Kane County Area, Utah



October 29, 2019

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

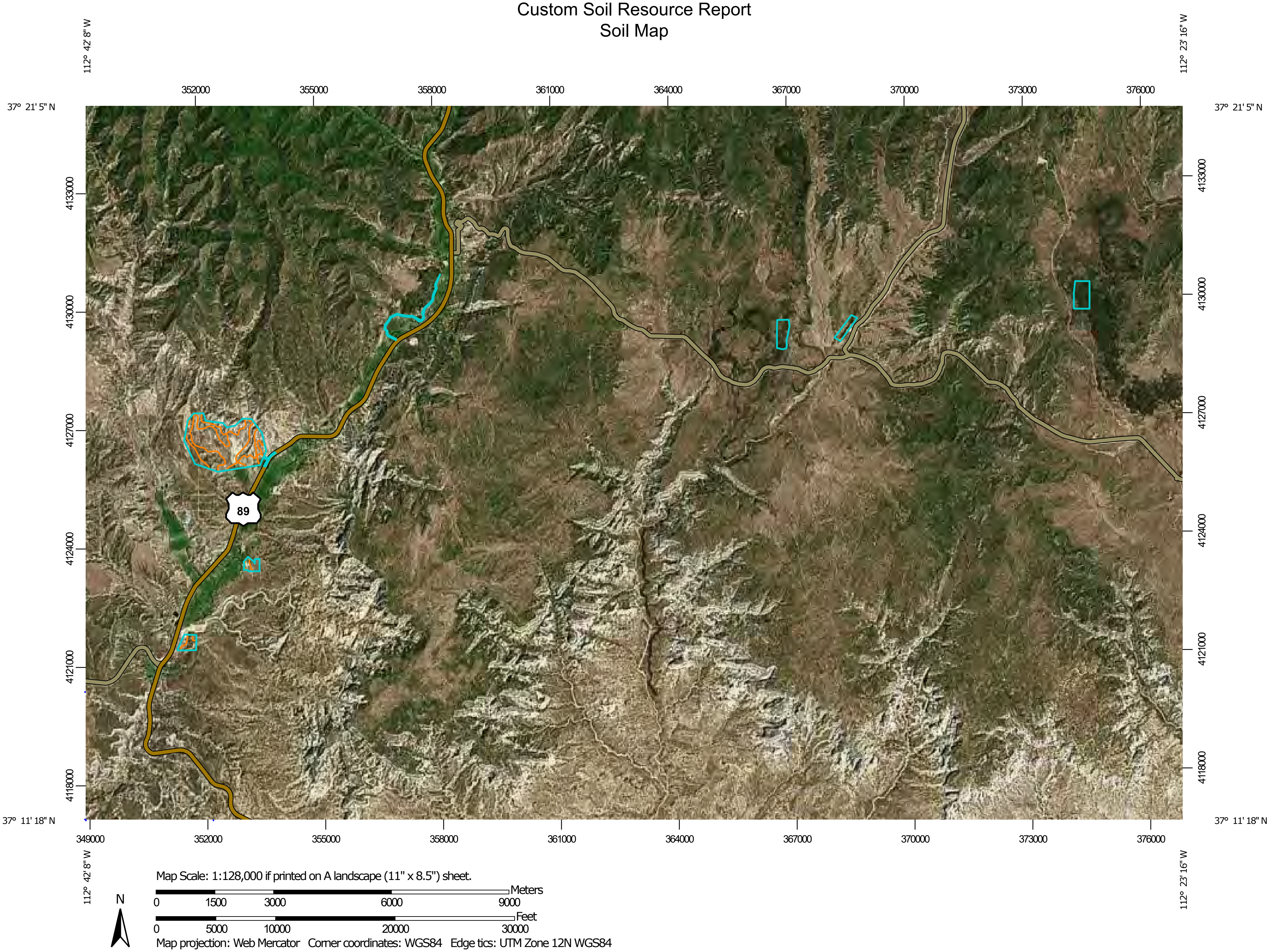
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:128,000 if printed on A landscape (11" x 8.5") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:63,400.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Kane County Area, Utah
Survey Area Data: Version 4, Sep 16, 2019

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 15, 2013—Aug 13, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
12	Catdraw family-Orderville-Quezcan family complex, 15 to 35 percent slopes	0.3	0.0%
13	Catdraw-Quezcan-Vessilla complex, 35 to 60 percent slopes	8.4	1.0%
28	Elpedro-Plumasano-Teromote family-Flatnose complex, 0 to 8 percent slopes	0.7	0.1%
55	Naplene-Teromote-Arboles-Oxyaquic Ustifluvents complex, 2 to 8 percent slopes	36.6	4.5%
58	Parkelei-Quagmeier-Fraguni complex, 2 to 35 percent slopes	29.4	3.6%
68	Pinepoint-Waumac-Royosa complex, 0 to 4 percent slopes	11.4	1.4%
69	Pinepoint-Paria-Parkwash complex, 2 to 8 percent slopes	20.7	2.6%
72	Quezcan, deep-Sideshow-Orderville complex, 15 to 35 percent slopes	176.3	21.9%
94	Sili-Sideshow-Gypsic Haplustepts complex, 2 to 15 percent slopes	258.5	32.1%
98	Tonalea family-Bamac complex, 15 to 65 percent slopes	36.7	4.6%
105	Wetoe family-Flugle-Royosa family-Lava flows complex, 2 to 60 percent slopes	118.9	14.8%
110	Zigzag family-Badland-Quezcan complex, 35 to 90 percent slopes	107.7	13.4%
Totals for Area of Interest		**805.6**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Kane County Area, Utah

12—Catdraw family-Orderville-Quezcan family complex, 15 to 35 percent slopes

Map Unit Setting

National map unit symbol: 2ndzc
Elevation: 5,350 to 7,550 feet
Mean annual precipitation: 14 to 17 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 100 to 119 days
Farmland classification: Not prime farmland

Map Unit Composition

Catdraw family and similar soils: 40 percent
Orderville and similar soils: 30 percent
Quezcan family and similar soils: 15 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Catdraw Family

Setting

Landform: Structural benches
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Colluvium derived from sandstone and shale over residuum weathered from sandstone and shale

Typical profile

AC - 0 to 4 inches: loam
C1 - 4 to 9 inches: loam
C2 - 9 to 27 inches: fine sandy loam
R - 27 to 37 inches: bedrock

Properties and qualities

Slope: 15 to 35 percent
Depth to restrictive feature: 24 to 39 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 3 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C

Ecological site: Upland Loam (Mountain Big Sagebrush) (R035XY308UT)
Hydric soil rating: No

Description of Orderville

Setting

Landform: Structural benches
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium derived from sandstone and shale over residuum weathered from sandstone and shale

Typical profile

A - 0 to 4 inches: silty clay loam
Bw - 4 to 12 inches: clay loam
Bk1 - 12 to 23 inches: silt loam
Bk2 - 23 to 33 inches: silt loam
Bk3 - 33 to 61 inches: silt loam

Properties and qualities

Slope: 15 to 35 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 12.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: Upland Loam (Mountain Big Sagebrush) (R035XY308UT)
Hydric soil rating: No

Description of Quezcan Family

Setting

Landform: Structural benches
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Colluvium derived from sandstone and shale over residuum weathered from sandstone and shale

Typical profile

A - 0 to 4 inches: clay loam
BC - 4 to 15 inches: clay
C1 - 15 to 21 inches: clay loam
C2 - 21 to 24 inches: gravelly clay loam
R - 24 to 34 inches: bedrock

Properties and qualities

Slope: 15 to 35 percent
Percent of area covered with surface fragments: 7.0 percent
Depth to restrictive feature: 24 to 33 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: Upland Clay Loam (Pinyon - Juniper) (R035XY304UT)
Hydric soil rating: No

Minor Components

Unnamed soils

Percent of map unit: 15 percent

13—Catdraw-Quezcan-Vessilla complex, 35 to 60 percent slopes

Map Unit Setting

National map unit symbol: 2nd10
Elevation: 5,540 to 7,700 feet
Mean annual precipitation: 14 to 17 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 100 to 119 days
Farmland classification: Not prime farmland

Map Unit Composition

Catdraw and similar soils: 40 percent
Quezcan and similar soils: 25 percent
Vessilla and similar soils: 15 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Catdraw

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Colluvium derived from sandstone and shale over residuum weathered from sandstone and shale

Typical profile

AC - 0 to 3 inches: gravelly sandy clay loam
C1 - 3 to 15 inches: gravelly silty clay loam
C2 - 15 to 34 inches: silty clay loam
Cy - 34 to 60 inches: silty clay loam

Properties and qualities

Slope: 35 to 60 percent
Percent of area covered with surface fragments: 15.0 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 10.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Ecological site: Upland Dissected Slope (Twoneedle Pinyon-Utah Juniper) (R035XY302UT)
Hydric soil rating: No

Description of Quezcan

Setting

Landform: Escarpments
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Residuum weathered from sandstone and shale

Typical profile

AC - 0 to 5 inches: gravelly silt loam
C1 - 5 to 19 inches: very paragravelly clay
C2 - 19 to 26 inches: very paragravelly silt loam
R - 26 to 35 inches: bedrock

Properties and qualities

Slope: 35 to 60 percent

Percent of area covered with surface fragments: 4.0 percent
Depth to restrictive feature: 22 to 33 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 3.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Ecological site: Upland Steep Stony Loam (Utah Juniper-Pinyon) (R035XY317UT)
Hydric soil rating: No

Description of Vessilla

Setting

Landform: Escarpments
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Residuum weathered from sandstone and shale

Typical profile

AC - 0 to 7 inches: gravelly fine sandy loam
R - 7 to 17 inches: bedrock

Properties and qualities

Slope: 35 to 60 percent
Depth to restrictive feature: 4 to 16 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 0.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Ecological site: Upland Shallow Loam (Pinyon-Utah Juniper) AWC <3 (R035XY315UT)
Hydric soil rating: No

Minor Components

Unnamed soils

Percent of map unit: 20 percent

28—Elpedro-Plumasano-Teromote family-Flatnose complex, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2mhbz
Elevation: 5,940 to 7,400 feet
Mean annual precipitation: 13 to 17 inches
Mean annual air temperature: 47 to 52 degrees F
Frost-free period: 130 to 147 days
Farmland classification: Farmland of statewide importance, if irrigated

Map Unit Composition

Elpedro and similar soils: 30 percent
Plumasano and similar soils: 30 percent
Teromote family and similar soils: 20 percent
Flatnose and similar soils: 10 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Elpedro

Setting

Landform: Terraces, alluvial flats
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sedimentary rock

Typical profile

A - 0 to 4 inches: silt loam
Bt - 4 to 11 inches: silty clay loam
Btk1 - 11 to 49 inches: silty clay loam
Btk2 - 49 to 65 inches: silt loam

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches

Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.7 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: Upland Loam (Mountain Big Sagebrush) (R035XY308UT)
Hydric soil rating: No

Description of Plumasano

Setting

Landform: Alluvial flats, terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sedimentary rock

Typical profile

A - 0 to 5 inches: fine sandy loam
Bw1 - 5 to 13 inches: loam
Bw2 - 13 to 36 inches: fine sandy loam
Bk - 36 to 60 inches: fine sandy loam

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 8.8 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: Upland Loam (Mountain Big Sagebrush) (R035XY308UT)
Hydric soil rating: No

Description of Teromote Family

Setting

Landform: Alluvial flats, terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear

Across-slope shape: Linear
Parent material: Alluvium derived from sedimentary rock

Typical profile

A - 0 to 6 inches: fine sandy loam
Bw - 6 to 19 inches: silt loam
Bk - 19 to 32 inches: sandy clay loam
2C1 - 32 to 41 inches: silt loam
2C2 - 41 to 52 inches: silty clay loam
2C3 - 52 to 63 inches: silty clay loam

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.0 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: Upland Loam (Mountain Big Sagebrush) (R035XY308UT)
Hydric soil rating: No

Description of Flatnose

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sedimentary rock

Typical profile

C1 - 0 to 2 inches: loamy fine sand
C2 - 2 to 10 inches: sandy clay loam
C3 - 10 to 25 inches: fine sandy loam
C4 - 25 to 59 inches: gravelly loamy sand

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Frequent

Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 5.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: Upland Loam (Basin Big Sagebrush) (R035XY306UT)
Hydric soil rating: No

Minor Components

Unnamed soils

Percent of map unit: 10 percent

55—Naplene-Teromote-Arboles-Oxyaquic Ustifluvents complex, 2 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2nczn
Elevation: 6,290 to 7,250 feet
Mean annual precipitation: 14 to 17 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 100 to 119 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Naplene and similar soils: 45 percent
Teromote and similar soils: 20 percent
Arboles and similar soils: 15 percent
Oxyaquic ustifluvents and similar soils: 10 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Naplene

Setting

Landform: Stream terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sedimentary rock

Typical profile

A - 0 to 7 inches: silt loam

C1 - 7 to 12 inches: silt loam
C2 - 12 to 33 inches: silt loam
C3 - 33 to 43 inches: silt loam
C4 - 43 to 45 inches: loam
C5 - 45 to 59 inches: loam

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.5 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: Upland Loam (Mountain Big Sagebrush) (R035XY308UT)
Hydric soil rating: No

Description of Teromote

Setting

Landform: Alluvial flats
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sedimentary rock

Typical profile

A - 0 to 6 inches: silt loam
Bw - 6 to 20 inches: clay loam
Bk - 20 to 36 inches: loam
C - 36 to 59 inches: fine sandy loam

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 10.9 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: Upland Loam (Mountain Big Sagebrush) (R035XY308UT)
Hydric soil rating: No

Description of Arboles

Setting

Landform: Alluvial flats
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sedimentary rock

Typical profile

A - 0 to 3 inches: clay loam
Bss1 - 3 to 21 inches: clay
Bss2 - 21 to 30 inches: clay
Ck - 30 to 32 inches: clay
2C - 32 to 43 inches: silty clay loam
3C - 43 to 59 inches: silt loam

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 10.7 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: Upland Clay Loam (Low Sagebrush) (R035XY301UT)
Hydric soil rating: No

Description of Oxyaquic Ustifluvents

Setting

Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sedimentary rock

Typical profile

A - 0 to 5 inches: silt loam
AC1 - 5 to 11 inches: silt loam
AC2 - 11 to 22 inches: silt loam

C1 - 22 to 33 inches: silt loam
C2 - 33 to 39 inches: silt loam
C3 - 39 to 49 inches: silt loam
Cg - 49 to 59 inches: silt loam

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very high (about 12.1 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: B
Ecological site: Semiwet Fresh Meadow (R035XY010UT)
Hydric soil rating: No

Minor Components

Unnamed soils

Percent of map unit: 10 percent

58—Parkelei-Quagmeier-Fraguni complex, 2 to 35 percent slopes

Map Unit Setting

National map unit symbol: 2mhd4
Elevation: 6,000 to 7,580 feet
Mean annual precipitation: 14 to 17 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 100 to 119 days
Farmland classification: Farmland of statewide importance, if irrigated

Map Unit Composition

Parkelei and similar soils: 45 percent
Quagmeier and similar soils: 30 percent
Fraguni and similar soils: 20 percent
Minor components: 5 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Parkelei

Setting

Landform: Fan remnants
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from limestone and sandstone

Typical profile

A - 0 to 6 inches: very fine sandy loam
Bt - 6 to 24 inches: clay loam
Btk - 24 to 59 inches: loam

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.2 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: Upland Loam (Mountain Big Sagebrush) (R035XY308UT)
Hydric soil rating: No

Description of Quagmeier

Setting

Landform: Fan remnants
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from limestone and sandstone

Typical profile

A - 0 to 4 inches: gravelly fine sandy loam
Btk - 4 to 17 inches: very gravelly loam
Bk1 - 17 to 25 inches: gravelly loam
Bk2 - 25 to 59 inches: very gravelly sandy clay loam

Properties and qualities

Slope: 2 to 35 percent
Percent of area covered with surface fragments: 1.0 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 47 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 6.6 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Upland Stony Loam (Pinyon-Utah Juniper) (R035XY321UT)
Hydric soil rating: No

Description of Fraguni

Setting

Landform: Fan remnants
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sandstone

Typical profile

A - 0 to 4 inches: fine sandy loam
Bt - 4 to 32 inches: fine sandy loam
Btk - 32 to 59 inches: fine sandy loam

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 4 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 8.4 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: Upland Loam (Mountain Big Sagebrush) (R035XY308UT)
Hydric soil rating: No

Minor Components

Unnamed soils

Percent of map unit: 5 percent

68—Pinepoint-Waumac-Royosa complex, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 2mz0b
Elevation: 4,530 to 6,360 feet
Mean annual precipitation: 13 to 17 inches
Mean annual air temperature: 47 to 52 degrees F
Frost-free period: 130 to 147 days
Farmland classification: Not prime farmland

Map Unit Composition

Pinepoint and similar soils: 50 percent
Waumac and similar soils: 25 percent
Royosa and similar soils: 20 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pinepoint

Setting

Landform: Sand sheets on alluvial flats
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sandstone

Typical profile

C1 - 0 to 17 inches: loamy fine sand
C2 - 17 to 71 inches: fine sand

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 4.1 inches)

Interpretive groups

Land capability classification (irrigated): 3s
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A

Ecological site: Upland Sand (Mountain Big Sagebrush) (R035XY307UT)
Hydric soil rating: No

Description of Waumac

Setting

Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sandstone

Typical profile

C - 0 to 8 inches: loamy fine sand
2C - 8 to 17 inches: sandy clay loam
3C1 - 17 to 54 inches: fine sandy loam
3C2 - 54 to 69 inches: loamy fine sand

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (0.20 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: Rare
Calcium carbonate, maximum in profile: 4 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 7.8 inches)

Interpretive groups

Land capability classification (irrigated): 3s
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: Upland Loam (Basin Big Sagebrush) (R035XY306UT)
Hydric soil rating: No

Description of Royosa

Setting

Landform: Sand sheets on alluvial flats
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sandstone

Typical profile

A - 0 to 4 inches: loamy fine sand
C1 - 4 to 13 inches: loamy fine sand
C2 - 13 to 27 inches: loamy fine sand
C3 - 27 to 61 inches: loamy sand

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Very low

Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 5.4 inches)

Interpretive groups

Land capability classification (irrigated): 3s
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: Upland Sand (Mountain Big Sagebrush) (R035XY307UT)
Hydric soil rating: No

Minor Components

Unnamed soils

Percent of map unit: 5 percent

69—Pinepoint-Paria-Parkwash complex, 2 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2ml1v
Elevation: 5,040 to 7,030 feet
Mean annual precipitation: 13 to 17 inches
Mean annual air temperature: 47 to 52 degrees F
Frost-free period: 130 to 147 days
Farmland classification: Not prime farmland

Map Unit Composition

Pinepoint and similar soils: 60 percent
Parkwash and similar soils: 15 percent
Paria and similar soils: 15 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pinepoint

Setting

Landform: Sand sheets, alluvial flats
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sandstone

Typical profile

A - 0 to 4 inches: loamy sand

C1 - 4 to 17 inches: loamy sand
C2 - 17 to 48 inches: loamy sand
C3 - 48 to 62 inches: loamy sand

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 4.2 inches)

Interpretive groups

Land capability classification (irrigated): 3s
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: Upland Sand (Mountain Big Sagebrush) (R035XY307UT)
Hydric soil rating: No

Description of Parkwash

Setting

Landform: Sand sheets
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sandstone over residuum weathered from sandstone

Typical profile

C1 - 0 to 5 inches: loamy sand
C2 - 5 to 12 inches: fine sand
R - 12 to 22 inches: bedrock

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: 8 to 19 inches to lithic bedrock
Natural drainage class: Excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 0.7 inches)

Interpretive groups

Land capability classification (irrigated): 7s
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D

Ecological site: Upland Shallow Sand (Pinyon-Utah Juniper) (R035XY314UT)
Hydric soil rating: No

Description of Paria

Setting

Landform: Sand sheets
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian sands derived from sandstone

Typical profile

C1 - 0 to 7 inches: loamy fine sand
C2 - 7 to 33 inches: loamy fine sand
R - 33 to 43 inches: bedrock

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: 20 to 39 inches to lithic bedrock
Natural drainage class: Excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 2.3 inches)

Interpretive groups

Land capability classification (irrigated): 6s
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: Upland Sand (Mountain Big Sagebrush) (R035XY307UT)
Hydric soil rating: No

Minor Components

Unnamed soils

Percent of map unit: 10 percent

72—Quezcan, deep-Sideshow-Orderville complex, 15 to 35 percent slopes

Map Unit Setting

National map unit symbol: 2pfbl
Elevation: 5,370 to 7,570 feet
Mean annual precipitation: 14 to 17 inches

Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 100 to 119 days
Farmland classification: Not prime farmland

Map Unit Composition

Quezcan, deep, and similar soils: 35 percent
Orderville and similar soils: 25 percent
Sideshow and similar soils: 25 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Quezcan, Deep

Setting

Landform: Structural benches
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium derived from shale over residuum weathered from shale

Typical profile

A - 0 to 3 inches: clay loam
Bk - 3 to 20 inches: clay loam
Ck1 - 20 to 33 inches: silty clay
Ck2 - 33 to 61 inches: silty clay

Properties and qualities

Slope: 15 to 35 percent
Percent of area covered with surface fragments: 0.0 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 10.4 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: Upland Clay Loam (Pinyon - Juniper) (R035XY304UT)
Hydric soil rating: No

Description of Sideshow

Setting

Landform: Structural benches
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium derived from shale over residuum weathered from shale

Typical profile

A - 0 to 4 inches: silty clay
Bwss1 - 4 to 20 inches: clay
Bwss2 - 20 to 31 inches: clay
By - 31 to 53 inches: clay
C - 53 to 61 inches: silty clay loam

Properties and qualities

Slope: 15 to 35 percent
Percent of area covered with surface fragments: 0.0 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 9.4 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: Upland Clay Loam (Pinyon - Juniper) (R035XY304UT)
Hydric soil rating: No

Description of Orderville

Setting

Landform: Structural benches
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium derived from shale over residuum weathered from shale

Typical profile

A - 0 to 4 inches: silt loam
Bw - 4 to 19 inches: silty clay loam
Bk1 - 19 to 46 inches: silty clay loam
Bk2 - 46 to 63 inches: silty clay loam

Properties and qualities

Slope: 15 to 35 percent
Percent of area covered with surface fragments: 0.0 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None

Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 12.0 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: Upland Loam (Gambel Oak) (R035XY305UT)
Hydric soil rating: No

Minor Components

Unnamed soils

Percent of map unit: 15 percent

94—Sili-Sideshow-Gypsic Haplustepts complex, 2 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2nd0z
Elevation: 5,430 to 7,450 feet
Mean annual precipitation: 14 to 17 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 100 to 119 days
Farmland classification: Farmland of statewide importance, if irrigated

Map Unit Composition

Sili and similar soils: 40 percent
Sideshow and similar soils: 35 percent
Gypsic haplustepts and similar soils: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sili

Setting

Landform: Structural benches
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium derived from shale over residuum weathered from shale

Typical profile

Ap - 0 to 5 inches: silty clay
Bw - 5 to 41 inches: silty clay
By - 41 to 50 inches: silty clay
Cy - 50 to 61 inches: silty clay

Properties and qualities

Slope: 2 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Gypsum, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: Upland Clay Loam (Low Sagebrush) (R035XY301UT)
Hydric soil rating: No

Description of Sideshow

Setting

Landform: Structural benches
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium derived from shale over residuum weathered from shale

Typical profile

Ap - 0 to 7 inches: silty clay loam
Bss - 7 to 17 inches: silty clay loam
Bw - 17 to 44 inches: silty clay loam
By1 - 44 to 56 inches: silty clay
By2 - 56 to 61 inches: silty clay loam

Properties and qualities

Slope: 2 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 10.1 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: Upland Clay Loam (Pinyon - Juniper) (R035XY304UT)
Hydric soil rating: No

Description of Gypsic Haplustepts

Setting

Landform: Structural benches
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium derived from shale over residuum weathered from shale

Typical profile

A - 0 to 5 inches: clay loam
Bw - 5 to 24 inches: clay loam
By1 - 24 to 37 inches: clay loam
By2 - 37 to 63 inches: clay loam

Properties and qualities

Slope: 2 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.5 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: Upland Clay Loam (Low Sagebrush) (R035XY301UT)
Hydric soil rating: No

98—Tonalea family-Bamac complex, 15 to 65 percent slopes

Map Unit Setting

National map unit symbol: 2q7f1

Elevation: 5,190 to 5,980 feet
Mean annual precipitation: 13 to 17 inches
Mean annual air temperature: 47 to 52 degrees F
Frost-free period: 130 to 147 days
Farmland classification: Not prime farmland

Map Unit Composition

Tonalea family and similar soils: 50 percent
Bamac and similar soils: 30 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tonalea Family

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Colluvium derived from sandstone and/or residuum weathered from sandstone

Typical profile

A - 0 to 2 inches: gravelly loamy fine sand
C - 2 to 43 inches: loamy fine sand
R - 43 to 53 inches: bedrock

Properties and qualities

Slope: 15 to 65 percent
Percent of area covered with surface fragments: 3.0 percent
Depth to restrictive feature: 39 to 49 inches to lithic bedrock
Natural drainage class: Excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 3.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: Upland Stony Loam (Pinyon-Utah Juniper) (R035XY321UT)
Hydric soil rating: No

Description of Bamac

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Convex

Parent material: Colluvium derived from sandstone

Typical profile

AC - 0 to 2 inches: gravelly loamy fine sand
C1 - 2 to 7 inches: very gravelly loamy fine sand
C2 - 7 to 63 inches: very cobbly loamy fine sand

Properties and qualities

Slope: 15 to 65 percent
Percent of area covered with surface fragments: 16.0 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: Upland Stony Loam (Pinyon-Utah Juniper) (R035XY321UT)
Hydric soil rating: No

Minor Components

Unnamed soils

Percent of map unit: 20 percent

105—Wetoe family-Flugle-Royosa family-Lava flows complex, 2 to 60 percent slopes

Map Unit Setting

National map unit symbol: 2ml1y
Elevation: 5,960 to 7,010 feet
Mean annual precipitation: 13 to 17 inches
Mean annual air temperature: 47 to 52 degrees F
Frost-free period: 130 to 147 days
Farmland classification: Not prime farmland

Map Unit Composition

Wetoe family and similar soils: 40 percent
Flugle and similar soils: 30 percent

Lava flows: 15 percent
Royosa family and similar soils: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wetoe Family

Setting

Landform: Lava flows
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Residuum weathered from basalt

Typical profile

A - 0 to 4 inches: very cobbly fine sandy loam
Bt - 4 to 21 inches: very cobbly fine sandy loam
R - 21 to 31 inches: bedrock

Properties and qualities

Slope: 2 to 35 percent
Percent of area covered with surface fragments: 25.0 percent
Depth to restrictive feature: 20 to 39 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.01 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 1.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: B
Ecological site: Upland Stony Loam (Pinyon-Utah Juniper) (R035XY321UT)
Hydric soil rating: No

Description of Flugle

Setting

Landform: Lava flows
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from basalt over residuum weathered from basalt

Typical profile

A - 0 to 4 inches: fine sandy loam
Bt1 - 4 to 26 inches: loam
Bt2 - 26 to 33 inches: loam
Bt3 - 33 to 59 inches: gravelly loam

Properties and qualities

Slope: 2 to 35 percent
Percent of area covered with surface fragments: 0.0 percent
Depth to restrictive feature: More than 80 inches

Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 10.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Upland Loam (Mountain Big Sagebrush) (R035XY308UT)
Hydric soil rating: No

Description of Lava Flows

Setting

Landform: Lava flows
Parent material: Residuum weathered from basalt

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8

Description of Royosa Family

Setting

Landform: Cinder cones
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Colluvium derived from pumice over residuum weathered from pumice

Typical profile

A - 0 to 7 inches: gravelly sandy loam
C1 - 7 to 39 inches: gravelly loamy sand
C2 - 39 to 59 inches: gravelly loamy sand

Properties and qualities

Slope: 35 to 60 percent
Percent of area covered with surface fragments: 25.0 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High to very high (2.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 3.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: Upland Stony Loam (Wyoming Big Sagebrush, Indian Ricegrass) (R035XY318UT)
Hydric soil rating: No

110—Zigzag family-Badland-Quezcan complex, 35 to 90 percent slopes

Map Unit Setting

National map unit symbol: 2nczh
Elevation: 5,440 to 7,480 feet
Mean annual precipitation: 13 to 17 inches
Mean annual air temperature: 47 to 52 degrees F
Frost-free period: 130 to 147 days
Farmland classification: Not prime farmland

Map Unit Composition

Zigzag family and similar soils: 35 percent
Quezcan and similar soils: 25 percent
Badland: 25 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Zigzag Family

Setting

Landform: Escarpments
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Residuum weathered from shale

Typical profile

A - 0 to 4 inches: parachannery silty clay loam
Cy1 - 4 to 13 inches: very paragravelly silty clay
Cy2 - 13 to 19 inches: very paragravelly silty clay
Cr - 19 to 29 inches: bedrock

Properties and qualities

Slope: 35 to 90 percent
Percent of area covered with surface fragments: 1.0 percent
Depth to restrictive feature: 12 to 19 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)

Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very low (about 2.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Hydric soil rating: No

Description of Quezcan

Setting

Landform: Escarpments
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Colluvium derived from shale and/or residuum weathered from shale

Typical profile

A - 0 to 6 inches: paragravelly silty clay
C1 - 6 to 11 inches: paragravelly silty clay loam
C2 - 11 to 22 inches: silty clay
Cr - 22 to 31 inches: bedrock

Properties and qualities

Slope: 35 to 90 percent
Percent of area covered with surface fragments: 10.0 percent
Depth to restrictive feature: 20 to 28 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Ecological site: Upland Clay Loam (Pinyon - Juniper) (R035XY304UT)
Hydric soil rating: No

Description of Badland

Setting

Landform: Escarpments
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Residuum weathered from shale

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8

Minor Components

Unnamed soils

Percent of map unit: 15 percent

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APPENDIX D

PROJECT PHOTOGRAPHS

Figure 1: View facing north (upstream) of the upstream reaches of PJD 1 showing the clear channel and vegetation lining the banks at the OHWM.

Figure 2: View facing south (downstream) of the upstream portion of PJD 1.

Figure 3: View facing northeast showing the intermittent stream channel and canyon landscape surrounding the upstream portion of PJD 1. No water was observed flowing in PJD 1 despite heavy rains 48–72 hours prior to field surveys.

Figure 4: View facing northwest (upstream) of the lower portion of PJD 1 showing the clear channel and OHWM with evidence of recent flow of precipitation and sediment.

Figure 5: View facing southeast (downstream) of the lower portion of PJD 1 showing the surrounding valley landscape further downstream.

Figure 6: View facing northwest of the confluence of PJD 1 (left) and PJD 2 (right) at the location where the proposed dam structure would be constructed.

Figure 7: View facing west showing where sheet flow originating from the surrounding valley and PJD 3 further uphill flow along Cove Road and meet PJD 1 (right side; out of view). No OHWM was observed along the road and PJD no longer has significant surficial connectivity downstream.

Figure 8: View facing southwest of an old man-made pond feature. NWI maps indicated that this may be a wetland; however, field investigations determined that it lacked the necessary indicators characteristic of a wetland.

Figure 9: View facing southeast of a stand of coyote willow adjacent to a cattle trough south of Cove Road. Though vegetation here is FACW, the site lacked any indicators of wetland hydrology or hydric soils.

Figure 10: View facing south of Wetland 1 south of Cove Road. This man-made feature exhibited the necessary vegetation, hydrology and soil indicators to be considered a wetland.

Figure 11: View facing northwest (upstream) of PJD 1 at the southern end of the study area.

Figure 12: View facing south overlooking the proposed location of Cove Reservoir.

Figure 13: View facing northwest (upstream) of PJD 1a showing the clear channel and deposition at the OHWM.

Figure 14: View facing north (upstream) of the confluence of PJD 1 (bottom) and PJD 1a.

Figure 15: View facing east of a sediment pond just above PJD2a**.** The pond's basin was observed to be mostly full of sediment and does not appear to be currently functional. No wetland indicators were observed here.

Figure 16: View facing northeast (upstream) of PJD2a. The channel (not shown) was at the bottom of this approximately 50-foot canyon.

Figure 17: View facing southwest (downstream) of PJD2a.

Figure 18: View facing south (downstream) of the upper reach of PJD 2. The channel (not shown) was at the bottom of this approximately 50–60-foot

Figure 19: View facing northeast (upstream) of the lower reach of PJD 2 showing the channel and steep-walled banks. Early successional vegetation in the channel indicated that flow within PJD 2 is likely ephemeral.

Figure 20: View facing south (downstream) of the lower reach of PJD 2 showing the channel, active floodplain and steep-walled banks.

Figure 21: View facing northeast (downstream) of PJD3 west of the proposed reservoir location. PJD3 and PJD3a were small ephemeral streams, but showed to have a defined channel and OHWM.

Figure 22: View facing southwest (upstream) of PJD3.

Figure 23: View facing southeast of sheet flow along Cove Road originating from PJD 3. Here, PJD 3 loses all definition of a bed and bank.

Figure 24: View facing north upstream of PJD 4 showing where sheet flow forms from runoff from the adjacent hillsides. This sheetflow is eventually funneled into PJD 4 (south and out of view).

Figure 25: View facing northeast of PJD 4. Here, precipitation and snowmelt are funneled into a steep-walled gorge and form a well-defined OHWM and channel.

Figure 26: View facing southwest of PJD 4 showing the clear channel and OHWM

Figure 27: View facing southwest of where PJD 4 opens up and loses a defined OHWM.

Figure 28: View facing south of the uppermost sediment pond south of PJD 4. No defined inlet or outlet was observed at this pond. The second pond below is shown in the background.

Figure 29: View facing northeast showing the access to the reservoir portion of the project area at the intersection of US-89 and Cove Road (background).

Figure 30: View facing south of the lower of the three sediment ponds found below PJD 4 and west of the proposed reservoir location.

Figure 31: View facing west of the second sediment pond found below PJD 4 and west of the proposed reservoir location.

Figure 32: View facing southwest of Wetland 2. Replacement of the Glendale pipeline would occur within this wetland.

Figure 33: View facing northwest (upstream) of PJD 5 showing flowing water in the channel and matted vegetation due to high flow caused by recent heavy rains.

Figure 34: View facing southeast (downstream) of PJD 5.

Figure 35: View facing northwest (upstream) of PJD 6.

Figure 36: View facing southeast of PJD 6 showing flowing water and matted vegetation due to heavy rains prior to field surveys.

Figure 37: View facing north of the Bald Knolls Borrow Pit. No potentially jurisdictional WOTUS were observed here.

Figure 38: View facing southwest of the Bald Knolls Borrow Pit. No potentially jurisdictional WOTUS were observed here.

Figure 39: View facing north of the Lamb's Borrow Pit. No potentially jurisdictional WOTUS were observed here.

Figure 40: View facing northwest of where the Tait Borrow Pit could be expanded to. No potentially jurisdictional WOTUS were observed here.

Figure 41: View facing west of Bald Knoll Expansion borrow pit.

Figure 42: View facing northwest of the proposed Black Knoll borrow pit.

Figure 43: View facing northeast of the Tait borrow pit.

Figure 44: View facing north of the Elbow borrow pit.

Figure 45: View of the soil pit sample for Wetland 1 redox depressions and some gleyed matrix.

Figure 46: View of the soil pit for Wetland 1.

Figure 47: View of paired upland soil pit investigated for the delineation of Wetland 1.

Figure 48: View of soil pit investigated for Wetland 2.

Figure 49: View of soil sample for Wetland 2 showing redox depressions.

Figure 50: View of paired upland soil pit investigated for the delineation of Wetland 2.

APPENDIX E-4

EAST FORK VIRGIN RIVER INSTREAM FLOW MEMORANDUM OF UNDERSTANDING

E. Fk Virgin River

East Fork Virgin River Instream Flow

Memorandum of Understanding

Between

Kane County Water Conservancy District
Orderville Irrigation Company
Utah Division of Wildlife Resources
United States Fish and Wildlife Service

September 12, 2001

East Fork Virgin River Instream Flow Memorandum of Understanding Between Kane County Water Conservancy District, Orderville Irrigation Company, Utah Division of Wildlife Resources, and United States Fish and Wildlife Service

This Memorandum of Understanding (MOU) between the Kane County Water Conservancy District (KCWCD), the Orderville Irrigation Company (OIC), the Utah Division of Wildlife Resources (UDWR), and the United States Fish and Wildlife Service (USFWS) is entered into for the purpose of regulating water flows on the East Fork Virgin River beginning at the OIC water diversion structure and continuing downstream for 3.2 miles to the Mt. Carmel Irrigation Company (MCIC) diversion.

Background Information

On February 17, 2000, the KCWCD filed an Application to Appropriate Water with the Utah Division of Water Rights. The application is for a non-consumptive use of water for the purpose of diverting water through a hydro-electric plant to produce electrical power. The applicant (KCWCD) proposes to divert water from the East Fork Virgin River at the point where the OIC currently diverts (N 1600 ft, E 100 ft from SW cor, sec 26, T40S, R7W, SLBM) water for their pressurized irrigation system. As a result of the application submitted to the Utah Division of Water Rights, a protest was submitted by the UDWR listing their concerns with de-watering a 3.2 mile reach of the river and the potential negative effects on the habitat of two native fish species; the speckled dace (*Rhinichthys osculus*), and desert sucker (*Catostomus clarki*). After the protest was filed with the State Engineer's office, the KCWCD met with representatives from the UDWR to discuss the protest and work out an agreement wherein the subject fish habitat could be maintained while allowing the Hydroplant project to go forward. In the meeting, both parties agreed that Watershed Systems Group, a private consulting firm from Logan, Utah with extensive knowledge of the fish species and fish habitat in the Virgin River, would be retained to prepare a report on the project proposal with recommendations for mitigation.

The KCWCD applied for and received a grant from the Utah Department of Natural Resources Species Mitigation Fund to help defer the costs of the study. A draft report was completed the second week in March of 2001, and shortly thereafter a meeting was held with representatives from the KCWCD, OIC, UDWR, USFWS, and Watershed Systems. A copy of the study entitled "East Fork Virgin River Instream Flow Study" was made available for review by all of the affected entities. At the meeting the report was critically reviewed with Watershed Systems Group. It was agreed that the hydroelectric project could go forward with a number of stipulations in place that would mitigate potential harmful impacts to the fish habitat. In accordance with the agreements made at that March 8, 2001 meeting, the KCWCD was given the task of developing this MOU for approval by all the parties.

The Parties to the MOU agree that:

1. As of the date of this MOU, the parties agree that the "East Fork Virgin River Instream Flow Study" prepared by Watershed Systems Group of Logan, Utah is incorporated herein by reference and is an accurate representation of the fish habitat and flow relationships within the permanently watered section of river between the OIC diversion (N 1600 ft, E 100 ft from SW cor, sec 26, T40S, R7W, SLBM) and the MCIC diversion (S 60 ft E 260 ft from NW cor, sec9, T41S, R7W), a 3.2 mile study reach.

2. The data presented in the Watershed Systems Group "East Fork Virgin River Instream Flow Study" of March 2001 is accepted as the primary basis for the water discharge rates agreed to in the subject MOU, notwithstanding that further flow studies could modify the conclusions and recommendations in the report, which could then alter water discharge timing and volume.

3. The parties agree that to maintain stream channel dimensions and aquatic habitat features, a channel maintenance flow regime of 70% of existing bankfull flow days be maintained. Bankfull flows are approximately 33 cfs in the study reach. In order to maintain 70% of existing bankfull flow days, the KCWCD, in cooperation with the OIC, will reduce or stop diversions of water to the hydro-plant (this does not include the OIC irrigation water right of 4.7 cfs) for a 10 day period each spring (between March - June) when high flows exist in the channel, thus allowing a 33 cfs in-stream flow to pass through the study reach for the ten day period. If stream flows are less than 33 cfs, all flows will be allowed to pass through the study reach (this does not include the OIC irrigation water right of 4.7 cfs). During this 10 day period, any water flows exceeding 33 cfs may be diverted to the hydro-plant, however, the diverted flows can not exceed the KCWCD water right of 18 cfs, plus the OIC water right of 4.7 cfs (total 22.7cfs). KCWCD will notify UDWR when the 10 day release period begins.

4. Under current Water Rights, MCIC diverts 6.58 cfs of water, or their proportional share of flows, at S 60 ft E 260 ft from NW cor, sec 9, T41S, R7W, SLBM for irrigation purposes. During the irrigation period all water appropriated to the MCIC will flow past the OIC diversion to be diverted at the MCIC diversion. When the MCIC and/or OIC is not diverting water for irrigation uses (normally during the winter period), OIC and KCWCD will allow a minimum of

3.5 cfs of water to flow past the OIC diversion; and if stream flows are less than 3.5 cfs, all water will be allowed to flow past the OIC diversion.

5. On a yearly basis several pools in the subject reach will be monitored to determine if they are maintaining their dimensions (width, depth). Relatively stable pool monitoring locations will be determined by the UDWR. A cross-sectional profile and a longitudinal transect (along the thalwag) will be measured through each pool to determine if pool dimensions are changing or the pool is moving downstream over time. If obvious changes in pool depth occur (e.g. pools begin filling in) adjustments to the channel maintenance flow regime will be made. If pools are filling with sediment, then the channel maintenance flows referred to in paragraph 3 of this MOU will be extended longer than 10 days. If no change occurs in pools, channel maintenance flows can be decreased from 10 days. The monitoring program will continue for a period of not less than three years to determine if the flow regime is working. At the end of the three year period, the program will be evaluated by all of the participants and a decision will be made to continue with monitoring at the same levels, discontinue the monitoring, or modify the monitoring. Adjustments of channel maintenance flows will continue until all parties agree on the length of time (number of days) necessary to maintain channel and pool dimensions. Monitoring of pools is the responsibility of KCWCD. Representatives from all interested parties, including the UDWR and USFWS will be invited on the field examinations of these pools. Pool monitoring will be conducted between June 15 - July 15. A yearly report of pool monitoring will be completed and sent to the Utah Division of Wildlife Resources, P.O. Box 606, Cedar City, Utah 84720, prior to January 1 of each year.

6. When this MOU is signed by the parties, the UDWR agrees to remove its protest on the KCWCD Application to Appropriate Water with the Utah State Engineer.

7. This MOU may be amended from time to time as need may arise, provided all such amendments are in writing and agreed to by all parties.

8. If any provision of this MOU is found to be invalid, the remaining provisions of this MOU shall not be affected thereby.

9. In the event UDWR becomes aware of a violation or potential violation by KCWCD or OIC of any condition or restriction in this MOU, UDWR may notify the responsible party in writing of such violation, potential violation, damage or potential damage. Upon receipt of such notice, the responsible party agrees to immediately take action to prevent or stop the activity which potentially or actually violates the terms or intent of this MOU. If the responsible party fails to take corrective action within thirty (30) days of receipt of such notice, UDWR may undertake appropriate action, including legal action, to effect such corrections.

10. This MOU sets forth the entire agreement of the parties. It is intended to supersede all prior discussions or understandings.

11. This MOU shall be effective on the date executed by the parties and shall remain in force until such time as the hydro-electric plant referred to in KCWCD's application is no longer in operation or no longer requires the appropriated 18 cfs of water, the MOU or KCWCD's 18 cfs water right is terminated by judicial or administrative order, or the MOU is terminated by mutual agreement of the parties.

This East Fork Virgin River Instream Flow MOU is entered into by representatives of the subject county, private, state, and federal entities on the dates identified below.

Michael E. Noel 10-2-2001

Michael E. Noel Date
Executive Director, Kane County Water Conservancy District

Brad Adair 10-2-2001

Brad Adair Date
President, Orderville Irrigation Company

John Kimball 09-21-01

John Kimball Date
Director, Utah Division of Wildlife Resources

H. R. Maddux 9/24/01

Henry R. Maddux Date
Utah Field Supervisor, United States Fish and Wildlife Service

APPENDIX E-5

ZION NATIONAL PARK WATER RIGHTS SETTLEMENT AGREEMENT

Zion National Park

Water Rights Settlement Agreement

This Agreement is made and entered into by and among the United States of America (United States), the State of Utah (Utah), the Washington County Water Conservancy District (Washington District), and the Kane County Water Conservancy District (Kane District).

RECITALS

A. Utah, pursuant to Chapter 4, Title 73, Utah Code Ann. 1953, as amended, initiated a statutory adjudication of water rights on July 21, 1980, in the Fifth Judicial District Court of the State of Utah in and for Washington County, Civil No. 800507596, which encompasses all the rights to the use of water, both surface and underground, within the drainage area of the Virgin River and its tributaries in Utah.

B. The United States has been joined as a party to this statutory adjudication pursuant to the provisions of 43 U.S.C. § 666. A "Statement of Water User's Claims on behalf of the United States of America on Lands Administered by the Department of the Interior, National Park Service, for Division No. 3," was filed on May 18, 1987.

C. In order to remove causes of present and future controversy over the waters of the Virgin River system without further litigation, the United States, Utah and the Washington and Kane Districts have conducted extensive negotiations regarding the settlement of reserved water right claims filed by the United States for Zion National Park (or Park).

D. These negotiations have resulted in the recognition of the reserved water rights of the United States for Zion National Park and also the agreement of the United States to subordinate its reserved water rights to existing State water rights, and to allow for some potential future development of water above Zion National Park, as set forth herein.

E. Pursuant to the terms of this Agreement, the Washington District has agreed to abandon two major reservoir sites above Zion National Park, the Bullock site on the Upper North Fork Virgin River and a site in the Barracks area of Parunuweap Canyon on the East Fork Virgin River (East Fork). Steps have also been taken which have resulted in the elimination of a proposal to divert water out of the Virgin River Basin from points above the Park. The Washington District has identified potential projects below the Park, which include: (1) the Sand Hollow Reservoir Project; (2) a collection system and pipeline to divert the flows of Pah Tempe (La Verkin) Springs; (3) securing a reduction in the minimum flows required in the Virgin River from 86 to 50 cubic feet per second (cfs) during the period of November 1 to March 31; and (4) the Ash Creek Project. A more detailed description of each of these four projects is set forth in the draft Virgin River Management Plan dated May 2, 1996.

F. The terms and provisions of the Zion National Park Settlement Agreement are set forth below.

NOW, THEREFORE, based on the mutual promises contained herein, the parties agree as follows:

AGREEMENT

Article 1: Federal Reserved Water Rights for Zion National Park

A. To fulfill the purposes for which lands now comprising Zion National Park were reserved from the public domain, the United States has water rights for all federal lands within the present boundaries of Zion National Park that were reserved and withdrawn from settlement, occupancy, or disposal under the laws of the United States. This federal reserved water right originates and is defined in federal law. The aliquot part descriptions of these reserved lands are set forth in the applicable proclamations, executive orders, and legislation identified below and in Appendix A. The United States has a reserved right to all water underlying, originating within or flowing through Zion National Park, including perennial, intermittent, and ephemeral streams, springs, seeps, lakes, ponds, ground water, and other natural sources of water, pertaining or belonging to the reserved lands, that was unappropriated as of the dates of reservation of the lands now within the boundaries of the park, which waters are to remain in a free flowing condition, subject to present and future administrative uses necessary to fulfill reservation purposes. The date of priority for either in-stream or administrative uses of the United States' federal reserved water rights for Zion National Park will be the date on which the place of use was first reserved from the public domain.

B. By virtue of mesne conveyances and appropriations, the United States also holds state appropriative rights in wells, springs and surface diversions on streams, at the locations, in the amounts, and for the uses indicated in the table attached as Appendix B. Water diverted and used for present and future administrative purposes necessary to fulfill reservation purposes will first be satisfied from existing state appropriative rights held by the United States for Zion National Park. In addition to the water provided by the state appropriative rights listed in Appendix B, at least 466 acre-feet per year (AFY) may be diverted and used from those waters reserved for Park purposes, in order to satisfy the administrative needs of the Park. At least 180 days prior to placing any increment of this federal reserved water right for administrative purposes to use or changing the use thereof, the United States agrees to provide notice to the State Engineer concerning the location and means of diversion, the source, quantity, and diversion rate of water, depth and diameter of well (if applicable), the nature of use, the anticipated effective date, and a map depicting the existing system and proposed modifications. This information will be publicly available. The total amount of water available for Park administrative purposes under state and federal reserved rights combined shall not exceed 1295 AFY. The state appropriative rights identified in this paragraph and in Appendix B, and the federal reserved water rights for administrative purposes identified in this paragraph, are not subject to the subordination set forth in Article 11.

C. The purposes for which Zion National Park was established and priority dates to water reserved therefor are as identified in Presidential Proclamation No. 877, 36 Stat. 2498, dated July 31, 1909; Presidential Proclamation No. 1435, 40 Stat. 760, dated March 18, 1918; the Act of November 19, 1919, 41 Stat. 356; Executive Order No. 418 1, dated March 24, 1925; Executive Order No. 5037, dated January 28, 1929; the Act of June 13, 1930; 46 Stat. 582; Presidential Proclamation No. 2221, 50 Stat. 1809, dated January 22, 1937; the Act of July 11, 1956, 70 Stat. 527; the Act of February 20, 1960, 74 Stat. 4; the Antiquities Act of June 8, 1906, 59 Stat. 225, 16 U.S.C. § 431; the Act of October 21, 1976, 90 Stat. 2732; and the National Park Service Establishment Act, 64 Stat. 225, 16 U.S.C. § 1. The purposes and uses of the reserved water rights include the preservation of extraordinary examples of canyon erosion, preservation of the area for scientific research, protection of objects of historic and scientific interest and, pursuant to the National Park Service Establishment Act, conservation of "the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." 16 U.S.C. § 1 . Accordingly, for enforcement purposes, the federal reserved water right for Zion National Park shall be deemed to comprise those waters in the Virgin River Basin as set forth in Article I.A. and I.B., less those quantities subject to the subordinations set forth below. The federal reserved water rights recognized hereby include all water rights of every nature and description derived from the reserved water rights doctrine, from all sources of water, both surface and underground, and includes all types and kinds of uses whatsoever, and encompasses all claims asserted by or through the United States for Zion National Park as now constituted.

Article 11. Subordination of Federal Reserved Water Rights

A. The United States subordinates the non-administrative federal reserved water rights described in Article LA., subject to the limitations contained herein, to all valid existing perfected water rights and approved applications with priority dates prior to January 1, 1996, and to certain new diversions and depletions, as set forth more specifically below.

B. Generally

1. No reservoir shall be located upstream of Zion National Park on the main stems of the East Fork, the North Fork of the Virgin River (North Fork), La Verkin Creek, Deep Creek, Crystal Creek, or on any tributary of the North Fork or East Fork, except as specifically provided herein.

2. Any flood control structure constructed upstream of the Park shall be designed only to attenuate high flows which are dangerous to life or property. The parties agree to consult on flood control proposals and will develop operational guidelines by mutual consent which are consistent with this Agreement and which will protect the resources of Zion National Park.

3. A ground water protection zone shall be established as shown in Appendix C for the drainage basins of the

East and North Forks, located up gradient and within 2 miles of the park boundary. Development of ground water within this zone shall be limited to a diversion rate of 35 gallons per minute (gpm) or less per well, shall withdraw no more than 15 AFY per well, and is subject to the overall limitations on depletions contained in Articles II.C.1. and ILDA., respectively.

C. North Fork of the Virgin River and Certain Other Streams

1. Subject to the limitations contained herein, the United States' subordination extends to new diversions and depletions from surface and ground water sources of up to but not to exceed a total depletion of 6,000 AFY, with no more than 2,500 AFY occurring from surface water, within the composite comprising the drainage basin of the North Fork above the southern boundary of Zion National Park near Springdale, Utah, and the portions of the drainage basins of Ash Creek, La Verkin Creek, North Creek, and Shunes Creek located upstream of Zion National Park (see Appendix D), distributed as described below.

a) There may be up to 3,750 AFY of new depletion in the drainage basin of the Upper North Fork (North Fork Virgin River above the confluence with Deep Creek), Crystal Creek, Deep Creek, and Kolob Creek, with no more than 1,000 AFY occurring in each the Upper North Fork and Crystal Creek, no more than 2,000 AFY in Kollob Creek, and no more than 750 AFY in Deep Creek (excluding Crystal Creek) with a maximum of 250 AFY being taken from surface water in Deep Creek, resulting from the new development of water resources, except that

i) if the Washington District develops a project which diverts Crystal Creek flows to Kolob Reservoir (Water Right Number 81-355, A29398 or other subsequent application filed to cover this project) and such diversions exceed 1,000 AFY, then no other new depletions within the Crystal Creek drainage are allowed. All depletion of water attributable to the Crystal Creek/Kolob Reservoir project shall be charged against the overall depletion limit of 6,000 AFY for the drainage basin of the North Fork Virgin River and other streams set forth in Article 11.C. 1.,

ii) the maximum diversion rate from Crystal Creek to Kolob Reservoir shall not exceed 50 cfs,

iii) the average annual diversion from Crystal Creek to Kolob Reservoir shall not exceed 4,000 acre-feet (AF) less any amounts exchanged to ground water development, based on a 5-year moving average,

iv) the maximum annual diversion from Crystal Creek shall not
exceed 6,000 AF, less any amounts exchanged to ground water development,

v) the active storage capacity of Kolob Reservoir shall not be increased beyond its present capacity by more than 4,000 AF,

vi) the flow of Crystal Creek immediately below its confluence with Spanish Hollow shall be maintained at no less than 0.5 cfs when diversions are being made from Crystal Creek,

vii) new surface water diversions from Deep Creek and its tributaries downstream of the confluence of Deep Creek and Crystal Creek shall not cumulatively exceed 1 cfs,

viii) new surface water diversions on the Upper North Fork shall not exceed the lesser of a) one-half of the existing flow, measured immediately upstream of the diversion, or b) that rate of diversion which maintains a flow of 2 cfs in the channel immediately below the diversion,

ix) the regulated discharge from Kolob Reservoir shall not exceed 35 cfs, except for matters involving dam safety.

b) There may be up to 750 AFY of new depletion per drainage, with no more than 250 AFY per drainage from surface water, from La Verkin Creek, North Creek, and Orderville Canyon, and up to 250 AFY of new depletion per drainage from surface and groundwater combined, from Camp Creek, Clear Creek, Goose Creek, Echo Canyon, Shunes Creek, and Taylor Creek.

c) No new reservoirs upstream of the Park with individual total storage capacities of more than 20 AF shall be constructed in any of the drainages covered by Article II.C., with the exception of the proposed enlargement of Kolob Reservoir.

d) New reservoirs upstream of the Park with individual total storage capacities which are less than or equal to 20 AF and located in any of the drainages covered by Article II.C. shall not be limited as to number but shall be subject to the overall limitation upon depletion contained in Article II.C.1.

D. East Fork of the Virgin River

1. Subject to the limitations contained herein, the United States' subordination also extends to new diversions and depletions from surface and ground water sources in the East Fork upstream or up gradient of the eastern boundary of Zion National Park, of up to but not to exceed a total depletion of 5,000 AFY (see Appendix D), with no more than 3,250 AFY occurring from surface water, as set forth more specifically below.

a) One or more new reservoirs with cumulative active storage capacity of up to but not to exceed 6,750 AF may be constructed on Stout Creek, Lydia's Canyon, Muddy Creek or Cove Canyon (not both), East Fork above Stout Canyon, and on other tributaries of the East Fork upstream of Glendale (see Appendix E).
b) The number of new reservoirs at the locations described in Article II.D.l.a) above, having individual total storage capacities greater than 20 AF, shall not exceed 10.
c) New reservoirs with individual total storage capacities which are less than or equal to 20 AF shall not be limited as to number but shall be subject to the overall limitation upon depletion in Article II.D.1.
2. New surface water diversions on the East Fork or its tributaries shall not cumulatively exceed 60 cfs.
3. The existing flow or 2 cfs, whichever is less, shall be maintained immediately below any new surface water diversion to reservoirs constructed on streams defined in Article II.D.l.a).
4. The existing flow or 1 cfs (including seepage), which ever is less, shall be maintained immediately below any new reservoir constructed on streams defined in 11.D.1.a).
5. Cumulative releases from new reservoirs constructed on streams defined in II.D.l.a) above, shall not increase the flow measured at the U.S. Geological Survey (USGS) gage on the East Fork Virgin River near Springdale (USGS No. 09404900), by more than 25 cfs during any 7-day period and shall not exceed the long-term monthly average at the Springdale gage by more than 15 cfs. As measured at said gage, the maximum instantaneous flow attributable to releases from such reservoirs shall not exceed 50 cfs, except for matters involving dam safety.
6. Surface water diversions to new reservoirs described in II.D.l.a) above shall not occur except during the period from November 1 to May 31, subject to the by-pass flow requirements described above.

Article III: Other Provisions
A. During the month of March each year, a meeting will be scheduled between Zion National Park and the Washington District to discuss forecasted runoff, water levels in Kolob Reservoir and the anticipated schedule and duration for that year's reservoir releases. Other details concerning Kolob Reservoir releases will be worked out by separate agreement, if necessary.
B. This Agreement shall be effective immediately upon the completion of a land exchange between the U.S. Bureau of Land Management (BLM) and the Washington District, whereby the Washington District acquires title to BLM public lands at the site of the proposed Sand Hollow Reservoir.
C. If any federal legislative or administrative action hereafter prevents the State of Utah from permitting development and use of water in any drainage or subdrainage subject to the subordination of the United States' federal reserved water right for Zion National Park herein contained, the undeveloped remainder of the water herein listed as available for future development in such drainage or subdrainage shall be made available in one or more other drainages covered by this Agreement. In the event of such federal legislative or administrative action, the parties hereto shall attempt to agree as to the drainage or drainages in which any such relocated quantity may be developed and how the limitations of the United States' subordination will be modified to facilitate the transfer of such water, provided that such development must occur within the drainages herein identified, and that no party will unreasonably withhold consent to such relocation.
D. The subordination to listed quantities and locations of future water development shall not be effective to the extent and upon proof that specific wells have caused, are causing, or may cause specific and significant adverse impacts to an identifiable resource or resources of Zion National Park. This notwithstanding, the provisions of this paragraph shall not apply to any groundwater rights presently perfected or approved under State law, with priority dates prior to January 1, 1996.
E. If any provision of this Agreement is found to be unlawful and of no effect, the remaining provisions shall remain in effect and fully binding on the parties, and if necessary, the parties hereto shall resume negotiations to revise any such unlawful provision.
F. Upon a proper showing of necessity, the provisions of this Agreement may be modified, with proper notice and concurrence of the Court, only upon the mutual consent of the parties to this Agreement, which consent shall not be unreasonably withheld.
G. Because of the unique nature of Zion National Park, nothing in this Agreement shall constitute an admission, waiver or precedent as to any party for any other federal reserved water right claim in the State of Utah.
H. Nothing in this Agreement shall be construed or interpreted to:
1. in any way affect the water rights of the United States in the Virgin River Basin for agencies and interests other than Zion National Park;

2. establish any standard to be used for the quantification of federal reserved water rights in any other judicial or administrative proceeding;
3. limit in any way the rights of the parties or any person to litigate any issue or question not resolved by this Agreement;
4. restrict the power of the United States to reserve water in the future, or to acquire additional rights to the use of water under the laws of the State of Utah; or
5. restrict the power of the State of Utah or the State Engineer in allocating, administering or distributing the waters of the State.

I. Upon becoming effective, this Agreement will be the subject of a separate proposed determination of water rights issued by the State Engineer specifically covering the portion of the Virgin River Basin encompassing Zion National Park, and the parties hereto will cooperate to obtain an interlocutory decree covering same. If the parties hereto are not successful in securing such interlocutory decree, this Agreement shall nevertheless remain binding as among the parties hereto until a final decree issues covering these water rights. The water rights of the United States, as set forth and quantified herein, shall be protected under State law in the same manner as any water right originating under State law, without losing its character as or the attributes of a federal reserved water right as provided under federal law.

J. The provisions of this Agreement, and particularly the provisions of Article 11 hereof, shall be taken into consideration by the State Engineer in acting upon applications, under State law, for new appropriations or change applications upstream or up gradient of Zion National Park and shall be afforded the same consideration in such proceedings as state appropriative rights; however, the United States shall have the primary responsibility for protecting its own rights and for filing appropriate protests in any proceedings before the State Engineer.

K. Upon entry of a decree covering the water rights of the United States for Zion National Park, the East Entrance Well and the Taylor Creek Well, described in Appendix F, will be administered with priority dates of June 13, 1930, and January 22, 1937, respectively, pursuant to the terms of Article I.A., and the State appropriative water rights thereon will be withdrawn.

L. Upon written request from the United States, the State Engineer will provide information regarding new diversions and total depletions of water in the respective drainages above the Park pursuant to Article 11 of this Agreement.

M. Depletion amounts attributable to specific diversions, as well as to usage and storage patterns, shall be determined by procedures approved by the parties hereto.

N. This Agreement is executed in quintuplicate. Each of the five copies bearing original signatures shall be deemed an original.

Article IV: Definitions

Acre-foot - The amount of water necessary to cover one acre of land to a depth of one foot, equivalent to 43,560 cubic feet or 325,851 gallons.

Active Storage Capacity - The volume of water available for release from a reservoir between the bottom of the outlet and the bottom of the spillway. This shall not include any storage designated as dead storage or a conservation pool.

Annual - Period of time which begins on October 1 and ends on September 30 (water year).

Depletion - The amount of water which is consumptively used by any action or process or otherwise removed from a drainage basin and not returned thereto.

Diversion - The removal of water from its natural source by means of a dam, ditch, canal, flume, bypass, pipeline, conduit, well, pump, or other act of man, that results in a decrease in the amount of water in the source at the point of such removal.

Existing Flow - Annual, monthly and daily flows which exist as of the effective date of this Agreement, which reflect historical diversions and depletions associated with existing perfected water rights and approved applications (except for Water Right No. 81-355, A29398 on Crystal Creek), as determined from available stream gage records and accepted hydrologic methods.

Ground Water - Water beneath the surface of the earth in pores, crevices, and space s in rock and soil, under saturated conditions and in sufficient quantities to supply water to wells, springs, seeps, rivers, streams, creeks, and natural lakes. New - After January 1, 1996.

Reservoir - A man-made impoundment for storing water from which water may be withdrawn for beneficial purposes. Impoundments constructed solely for flood control or sediment retention are specifically excluded.

Surface Water - Water on the surface of the earth in rivers, streams, creeks, channels, lakes, reservoirs and other water bodies. Wells within the 500-year floodplain of the East and North Forks of the Virgin River, Camp Creek, Clear Creek, Crystal Creek, Deep Creek, Echo Canyon, Goose Creek, Kolob Creek, La Verkin Creek, Orderville Canyon, Shunes Creek, or Taylor Creek, which are less than 100 feet in depth, shall be considered to draw from surface water.

Year - A calendar year commencing January 1 and ending December 31. It being resolved and agreed to as delineated above, the undersigned parties express their mutual agreement hereto this 4th day of December, 1996.

It being resolved and agreed to as delineated above, the undersigned parties express their mutual agreement hereto this 4th day of December, 1996.

For the State of Utah:

Michael O. Leavitt
Governor, State of Utah

Ted Stewart
Director, Utah Department of Natural Resources

Robert L. Morgan,
Utah State Engineer

Michael M. Quealy
Chief, Natural Resources
Attorney General's Office

John H. Mabey, Jr.
Assistant Attorney General

For the United States:

Bruce Babbitt
Secretary of the Interior

Donald Flavey
Superintendent, Zion National Park

John D. Leshy
Solicitor
Department of Interior

Lois J. Schiffer
Assistant Attorney General
Department of Justice

Andrew F. Walch
Department of Justice

For the Washington County Water Conservancy District:

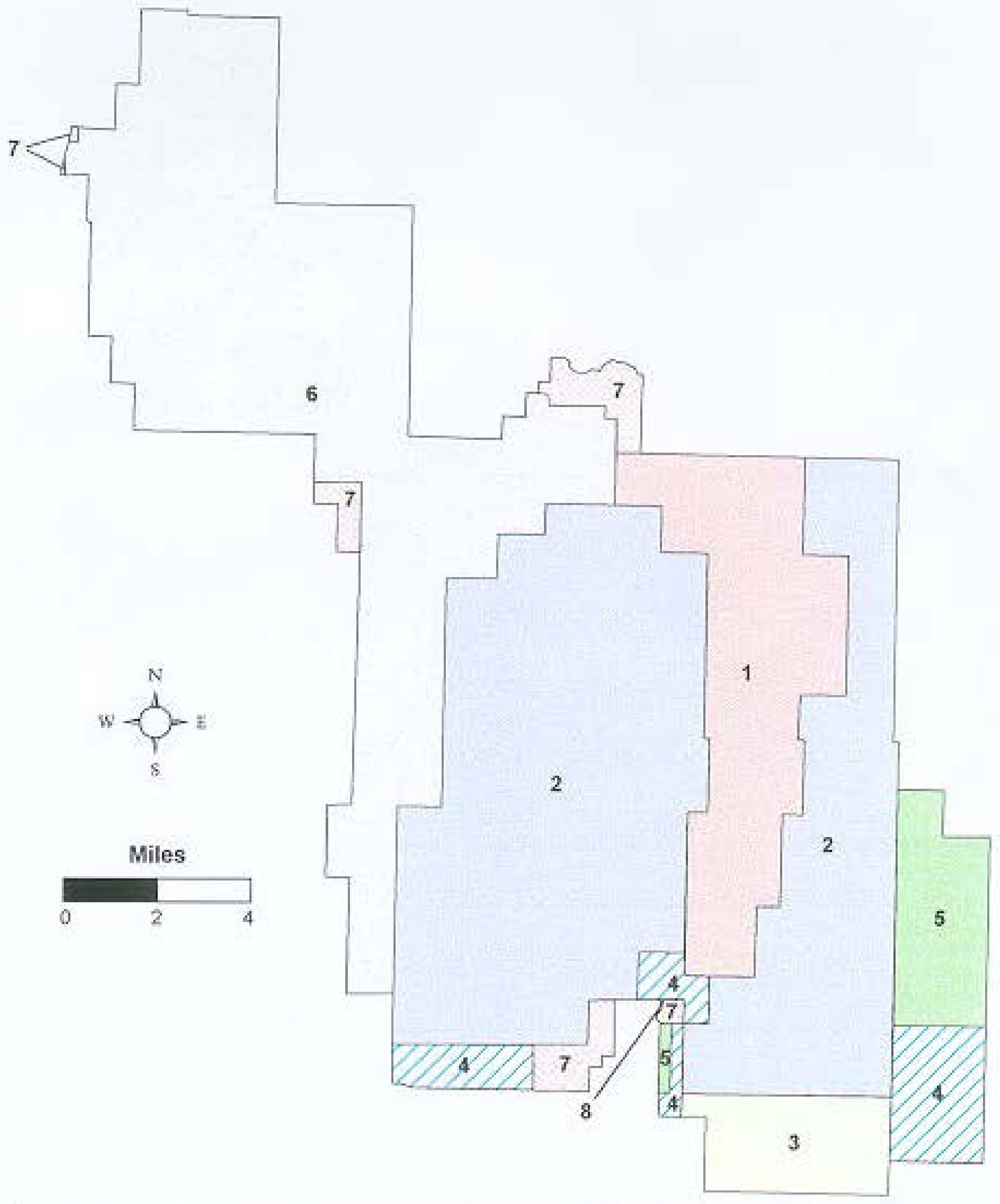
Ronald W. Thompson

For the Kane County Water Conservancy District:

APPENDIX A

DATES OF LAND RESERVATIONS

ZION NATIONAL PARK



LEGEND: Lands Reserved from the Public Domain

1 National Monument withdrawal by Presidential Proc. 877, dated July 31, 1909 (36 Stat. 2498). Designated a National Park by the Act of November 19, 1919 (41 Stat. 356).

2 National Monument withdrawal by Presidential Proc. 1435, dated March 18, 1918 (40 Stat. 1760). Designated a National Park by the Act of November 19, 1919 (41 Stat. 356).

3 National Monument withdrawal by Executive Order 4181, dated March 24, 1925. Designated a National Park by the Act of June 13, 1930 (46 Stat. 582).

4 National Monument withdrawal by Executive Order 5037, dated January 28, 1929. Designated a National Park by the Act of June 13, 1930. (46 Stat. 582)

5 Withdrawal for National Park by the Act of June 13, 1930 (46 Stat. 582).

6 National Monument withdrawal by Presidential Proc. 2221, dated January 22, 1937 (50 Stat. 1809). Designated a National Park by Act of July 11, 1956 (70 Stat. 527).

7 Added to and made part of the National Park by the Act of February 20, 1960 (74 Stat. 4).

8 Added to and made part of the National Park by the Act of October 21, 1976 (90 Stat. 2732).

APPENDIX B
STATE APPROPRIATIVE WATER RIGHTS
ZION NATIONAL PARK

WUC No.	Right Evidenced BY:	Priority Date	Diversion Works	Water Source	Legal Location (Salt Lake Basin & Meridian)	Type of Use	Period of Use	Diversion Rate (cfs)	Irrigated Acres in Original Decree	Volume of Use-(acre-feet)
81-1128	CERT. a222, Award No. 66 of the Virgin River Decree	1877	[Zion Canyon Water System]* CRAWFORD DITCH GIFFORD DITCH OAK CK. SPG. AREA BIRCH CK. SPG. AREA SINAWAVA SPRINGS SCOUT LKOUT PIPELINE UPPER GROTTO SPG. A. LOWER GROTTO SPG. WYLIE RETRT. SPG. A.	North Fk. Virgin R. North Fk. Virgin R. Oak Ck. Springs Birch Ck. Springs Sinawava Spg. Scout Lookout Spg. Upper Grotto Spg. Lower Grotto Spg. Wylie Retreat Spg.	N.50 deg. 29'E. 1998 ft. from NE Cor., See. 21, T41S, R10W N.41deg.28'45" E. 4233.80 ft. from NE Comer, Sec.21, T41S, R1OW S.86deg.23'W. 8633.70 ft. from NE Comer, Sec. 21, T41 S, R10W N.21deg.56'E. 9151.95 ft. from NE Comer, Sec. 21, T41S, R10W N.18deg.43'E. 27901.20 ft. from NE Comer, Sec. 21, T41 S, R10W N.16deg.59'E. 25095.34 ft. from NE Comer, Sec. 21, T41S, R10W N.29deg.47'E. 17059.55 ft. from NE Comer, Sec. 21, T41S, R10W N.31deg.39'E. 18223.11 ft. from NE Comer, Sec. 21, T41S, R10W N.32deg.25'25" E. 13167.50 ft. from NE Comer, Sec. 21, T41S, R10W	MUNICIPAL	01/01-12/31	1.21	66.7	266.8
81-1124	CERT. a224, Award No. 63 of the Virgin River Decree	1881	[Zion Canyon Water SystLm]* Same As Cert. a222	Same As Cert. a222	Same As Cert. a222	MUNICIPAL	01/01-12/31	0.53	29.4	117.6
81-1129	CERT. a223, Award No. 65 of the Virgin River Decree	1894	[Zion Canyon Water System]* Same As Cert. a222	Same As Cert. a222	Same As Cert. a222	MUNICIPAL	01/01-12/31	0.53	29.0	116
81-117	A10618 a1657 CERT. a221	05/31/29	[Zion Canyon Water System]* Same As Cert. a222	Same As Cert. a222	Same As Cert. a222	MUNICIPAL	01/01-12/31	0.01	—	3.15
81-3608	Award No. 67 of the Virgin River Decree	1880	FLANIGAN DITCH	North Fk. Virgin R.	S. 550 ft. and E. 950 ft. from the NW Comer, Sec. 22, T41N, R10W	IRRIGATION	01/01-12/31	1.38	75.9	303.6

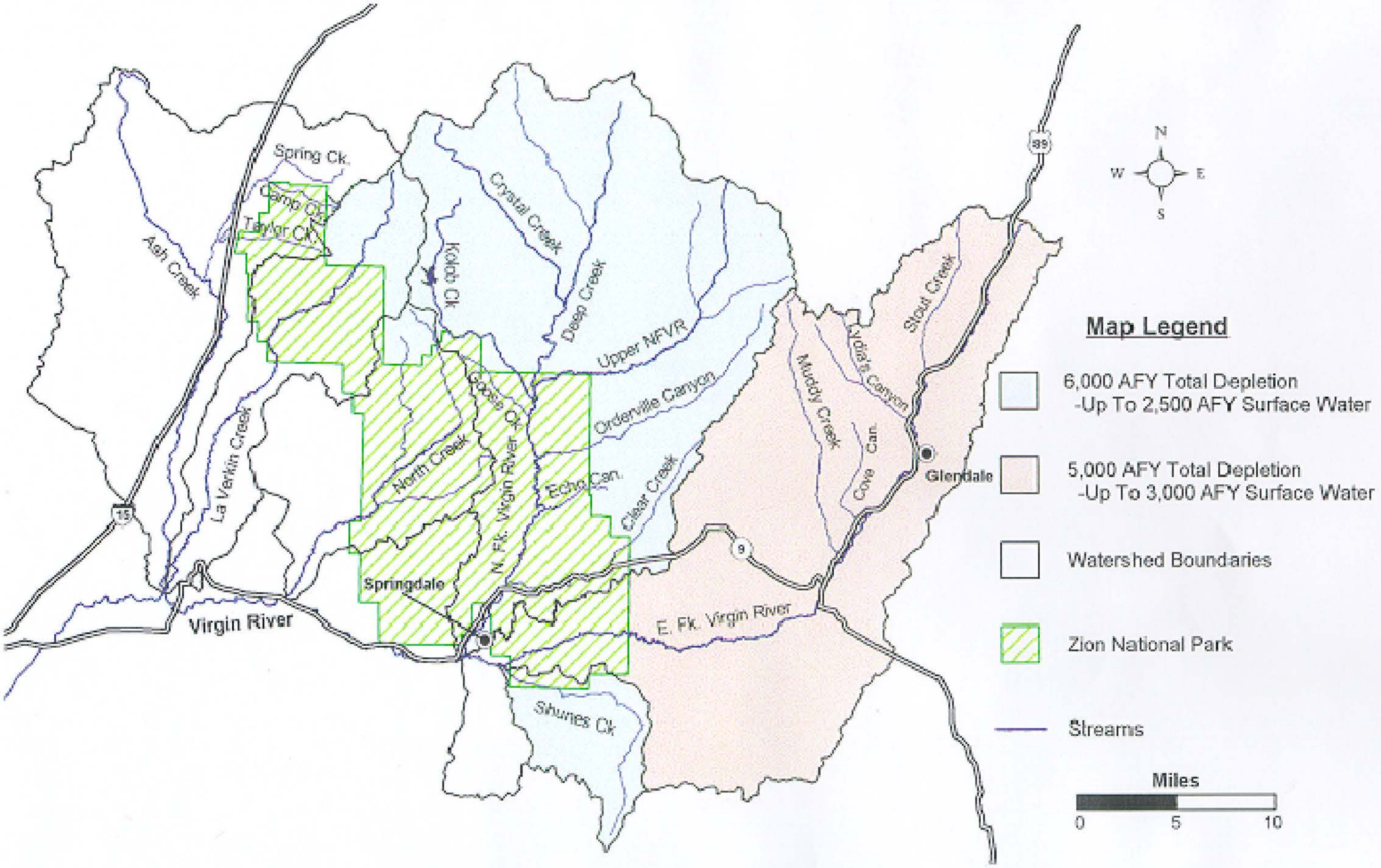
81-728	DILIGENCE CLAIM No. 1031	1900		EARL SPRING	S. 340 ft. and E. 900 ft. from NW Comer, Sec. 9, T40S, R1 I W	DOMESTIC & STOCK WATER	03/01-11/30	0.092	—	1.73
81-113	A8113 CERT. 1197	05/24/19		UNNAMED SPRING	S. 957 ft. and W. 841.5 ft. from NE Comer, Sec. 5, T40S, R1 1W	DOMESTIC	01/01-12/31	0.0002	—	0.14
81-327	A28355 NPR	07/18/56	10 INCH DIAMETER WELL 68 FEET DEEP	SPENDLOVE WELL	N. 1700 ft. and W. 600 ft. from SE Comer, Sec. 8, T40S, R1 1W	DOMESTIC	03/01-11/30	0.015	—	0.34
81-514	A34269 a10851 Cert. 10754	05/03/62	8 INCH DIAMETER WELL 925 FEET DEEP	EAST ENTRANCE WELL	S.75 deg.54'20" W., 6382 ft. from N 1/4 cor Sec. 21 T41 S, R9W	IRRIGATION, STOCKWATER, DOMESTIC & OTHER	01/01-12/31	0.0223	—	10
81-1373	A36328a a7522 Cert. 9697	08113164	7 INCH DIAMETER WELL 367 FEET DEEP	HAMILTON WELL	S.2810.7 ft. and E. 1857.4 ft. from E 1/4 cor Sec. 8, T40S, R1 1W	IRRIGATION & DOMESTIC	01/01-12/31	—	0.25	1.73
	A36782 Approved Proof filed 10/14/92	02/23165	6 IN H DIAMETER WELL 206 FEET DEEP	TAYLOR CREEK WELL	N. 3348 ft. and E. 2873 ft. from SW Comer, Sec. 29, T38S, R 1 2W	DOMESTIC & OTHER	01/01-12/31	0.0688	—	7.94

Total Volume: 829 acre-fee

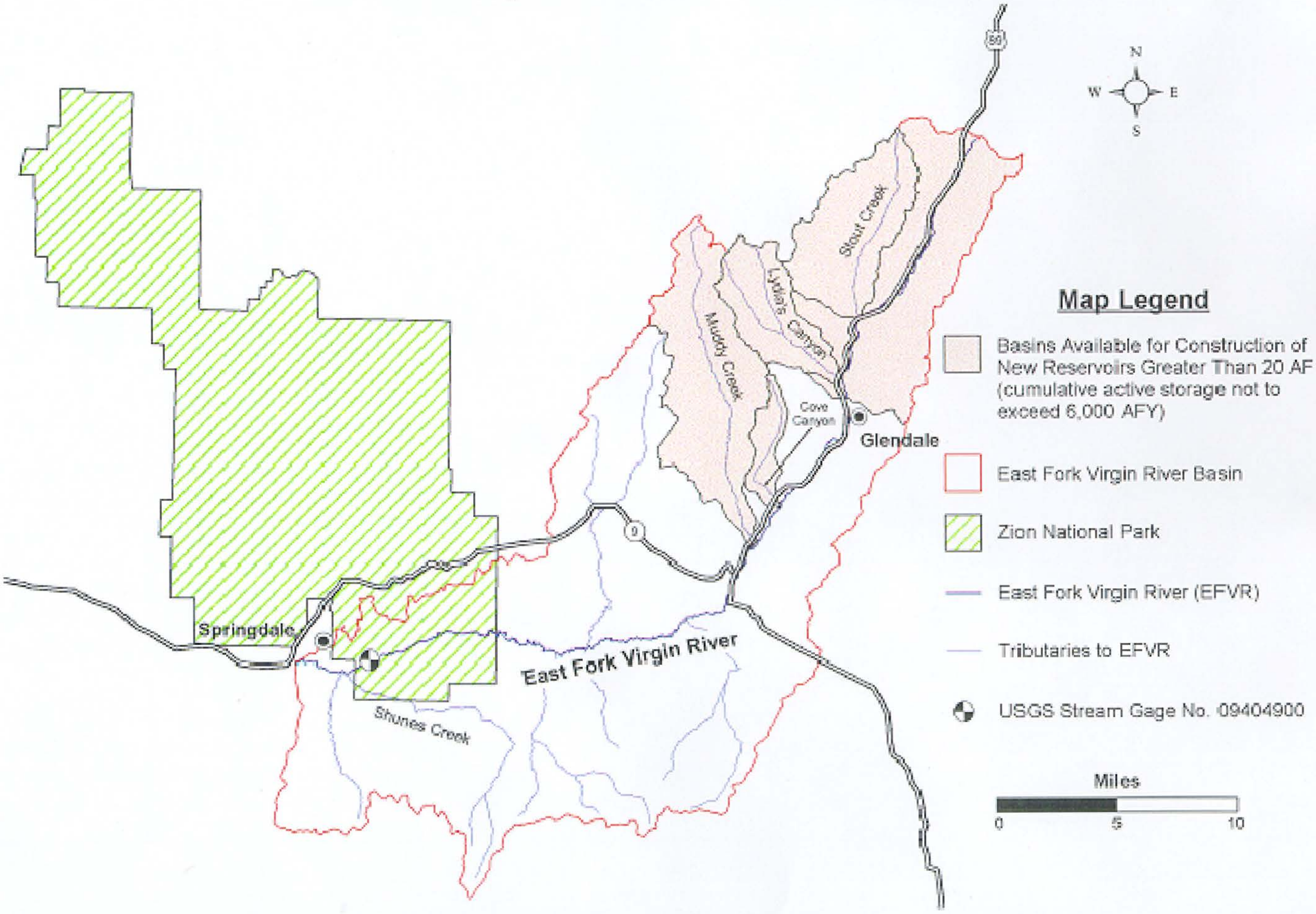
Water is diverted from various sources and comingled in the ZION CANYON WATER SYSTEM. The water rights, as described in each of the individual certificates, entities the United States to "...divert the water at any, each, or all of the... described points of diversion..."
Water Right Volumes are calculated using the following assumptions: -a water duty of 4 ac-ft per acre is used for irrigable land -a value of 0.45 ac-ft per year per family of four is used for domestic use -a value of 10 gallons per visitor is used for use by park visitors (EPA -570-9-82-004) -a value of 2.8 ac-ft per one-hundred head of livestock is used for stockwater use

APPENDIX D

Allowable Depletion Levels for the East and North Forks of the Virgin River, and North, La Verkin and Ash Creeks, Draining Above, and Through, Zion National Park



APPENDIX E
Basins Available for Construction of New Reservoirs (Greater Than 20 Acre-Feet)
East Fork Virgin River Above Zion National Park



APPENDIX F DIVERSION WORKS ASSOCIATED WITH FEDERAL RESERVED WATER RIGHTS
ZION NATIONAL PARK

Water Source	Diversion Works	Priority Date	Legal Location Type of Use (Salt Lake Basin & Meridian)	Period of Use	Diversion Rate (cfs)
EAST ENTRANCE WELL	8 INCH DIAMETER WELL 925 FEET DEEP	06/13/30	S.75 deg.54'20"W 63 ft. from N 1/4 cor Sec. 21 T41S, R9W IRRIGATION, STOCKWATER, DOMESTIC & OTHER	01/01-12/31	0.0223
TAYLOR CREEK WELL	6 INCH DIAMETER WELL 206 FEET DEEP	01122/37	N. 3348 ft. and E. 2873 ft. from SW Corner, Sec. 29, T38S, R12V\ IRRIGATION, DOMESTIC & OTHER	01/01-12/31	0.0688

APPENDIX E-6

BLM INTERDISCIPLINARY TEAM ANALYSIS RECORD CHECKLIST

INTERDISCIPLINARY TEAM ANALYSIS RECORD CHECKLIST

Project Title: Proposed Cove Reservoir and the Bald Knoll and Black Knoll borrow pits

NEPA Log Number:

File/Serial Number:

Project Leader: James Holland (BLM project leader)

Project Proposal:

FOR EAs/CXs: NP: not present; NI: resource/use present but not impacted; PI: potentially impacted
FOR DNAs only: NC: no change (anticipated resource impacts not changed from those analyzed in the NEPA document on which the DNA is based)

STAFF REVIEW OF PROPOSAL:

NP/NI/PI NC	Resource	Date Reviewed	Signature	**Review Comments** (required for all NIs and PIs. PIs require further analysis.)
CRITICAL ELEMENTS				
NI	Air Quality *(C. Gubler)*	08/01/19	/s/ C. Gubler	Emissions would be expected as part of the project however because it is a short term project impacts to air quality would be negligible.
NP	Areas of Critical Environmental Concern *(D. Gunn)*	06/10/19	/s/ Dan Gunn	There are no ACEC's identified within the project area.
NI	Cultural Resources *(B.Storm)*	9/13/19	/s/ Brian Storm	A cultural resources Class III inventory (project # U18TN0544) was conducted in the Black Knoll rip rap pit project area and Bald Knoll community pit in June 2019. The June 2019 inventory resulted in the identification of two new sites (42KA8972 and 42KA8973) and two isolated finds in the Black Knoll project area. Both sites are small surface lithic scatters sans diagnostic artifacts or features; the sites are recommended not eligible for inclusion to NRHP. Isolated finds (IO-6, IO-7) consisted of one and four flakes, respectively. The isolates have been fully documented, are not eligible for inclusion to the NRHP, and no additional research or preservation is required. A cultural resources Class III inventory (project # U84BL0697) was completed in the project area in July 1984. The original inventory identified two sites (42KA2677 and 42KA2678) within the project area. Neither site was located during the June 2019 inventory or during a 2018 inventory (project # U18ES0434). The sites were recommended not eligible for inclusion to the NRHP. The June 2019 inventory resulted in no new cultural resources being identified in the Bald Knoll project area. A cultural resources Class III inventory (project # U07BL0560) was completed for the initial pit in May 2007. The inventory resulted in the identification of two new sites (42KA6331 and 42KA6332) at the south end of the project area. Both sites are recommended as eligible for inclusion to the NRHP. Site 42KA6331 was visited in 2019. Expansion of the Bald Knoll community pit to the north will result in no adverse effect to historic properties, but the boundary of the pit needs to be

NP/NI/PI NC	Resource	Date Reviewed	Signature	**Review Comments** (required for all NIs and PIs. PIs require further analysis.)
				updated/altered to exclude these two sites to ensure adverse effects to the historic properties will be avoided by all future use of the pit.
NI	Environmental Justice *(C. Stewart))*	8/2/19	/s/ Clay Stewart	The proposed action would not have a disproportionate effect on low income or minority communities because these communities, in general, do not exist near the project areas.
NP	Farmlands (Prime or Unique) *(J. Reese)*	8/28/19	/s/ J. Reese	There are no farmlands within the proposed project area.
NI	Floodplains *(J. Holland)*	7/24/2019	/s/ James R Holland	No floodplains exist in the proposed project area.
NI	Invasive, Non-native Species *(L. Lefevre)*	7/24/19	/s/ Levi L. LeFevre	There are some invasive species present in the area, but are unlikely to be significantly impacted by the proposed action
PI	Native American Religious Concerns *(B.Storm)*	9/13/19	/s/ Brian Storm	Native American religious concerns will be identified by Tribal response to NEPA mailing as part of the Proposed Cove Reservoir Project EA. Such concerns are usually associated with potential impacts to prehistoric archaeological sites of their ancestors, which they consider as traditional cultural properties. As long as project stipulations are followed and traditional cultural properties including but not limited to prehistoric archaeological sites are avoided, no concerns are anticipated. Access and ceremonial use of any sacred site or traditional cultural property both known and unknown to the BLM will not be limited by proceeding with this project.
NP	Threatened, Endangered or Candidate Plant Species *(C. Gubler)*	08/01/2019	/s/ C. Gubler	
NI	Threatened, Endangered or Candidate Wildlife Species *(L. Church)*	7/24/19	/s/ L. Church	
NP	Wastes (hazardous or solid) *(T. Linton)*	9/9/19	/s/ T. Linton	No known or visible hazardous waste apparent at these locations.
NI	Water Quality *(J. Holland)*	7/24/2019	/s/ James R Holland	Because of the distance to surface water, the depth to ground water in the proposed project area, and the type of action that is being proposed, it is highly unlikely that any water resources would be affected.
NP	Wetlands/Riparian Zones *(L. Church)*	7/25/19	/s/L. Church	
NP	Wild and Scenic Rivers *(D. Gunn)*	6/10/19	/s/ Dan Gunn	There are no Wild and Scenic Rivers within the project area.
NP	Wilderness *(D. Gunn)*	6/10/19	/s/ Dan Gunn	There is no designated wilderness within the project area.
		OTHER RESOURCES / CONCERNS*		
NI	Rangeland Health Standards and Guidelines *(C. Gubler)*	07/25/19	/s/ C. Gubler	Impacts to Rangeland health are not expected rip rap pits are in volcanic areas. Mining these areas for rock should not have an overall impact on rangeland health.
NI	Livestock Grazing *(J. Reese)*	08/28/2019	/s/ J. Reese	Impacts to Livestock grazing are expected to be minimal. The proposed sites consist mostly of Rock and do not produce enough forage to impact livestock grazing.
NI	Woodland / Forestry *(J. Reese)*	08/28/2019	/s/ J. Reese	Sites consist mainly of Pinyon and Juniper and are considered invaded sites not woodlands.

NP/NI/PI NC	**Resource**	**Date Reviewed**	**Signature**	**Review Comments** (required for all NIs and PIs. PIs require further analysis.)
NI	Vegetation *(J. Reese)*	08/28/2018	/s J. Reese	Impacts to vegetation would be minimal on these sites because they have mostly been invaded by Pinyon and Juniper and because of the rock content they are not expected to produce much vegetation.
NI	Fish and Wildlife *(L. Church)*	7/25/19	/s/ L. Church	Construction and maintenance that included vegetation removal in species that could support neotropical migratory birds should occur after neotropical Migratory bird nesting periods to prevent the potential for impacts to nesting birds April 15 –Aug 15, if clearance work by a qualified biologist precludes presence construction and maintenance outside of emergency maintenance could occur
NI	Soils *(J. Reese)*	08/28/2019	/s/ J. Reese	BMP's for soils should be included in the project design and stipulations. If BMP's are adhered to impacts to soils in the project areas would be minimal.
NI	Recreation *(D. Gunn)*	6/10/19	/s/ Dan Gunn	Recreational opportunities exist within the project area but are unlikely to be significantly impacted by approval and implementation of this project.
NI	Visual Resources *(D. Gunn)*	6/10/19	/s/ Dan Gunn	The project area lies within lands classified as VRI Classes III and IV, which allow for moderate to high levels of change to the characteristic landscape. The 2008 Kanab Field Office RMP states that VRM Class III and IV objectives "are applied as necessary to allow for exploration and the associated infrastructure to support mineral resource development in accordance with the Energy Policy and Conservation Act…"
NI	Geology /Paleontology *(J. Holland)*	7/24/2019	/s/ James R Holland	No unique geology exists within the proposed project area. Because of the igneous rock type found in the proposed pit area, no paleontological resources are present.
NI	Lands / Access *(Brandon Johnson)*	9/11/2019	/s/ Brandon Johnson	No rights-of-way or conflicting land use authorizations exist within the proposed project area. Access to pits would be off of existing roads on the KFO travel management plan.
NI	Fuels / Fire Management *(C. Gubler)*	08/01/19	/s/ C. Gubler	No impacts to fuels or fire management are forseen as a result of implementation of the proposed action.
NI	Socio-economics *(C. Stewart)*	8/2/19	/s/ Clay Stewart	The economic base for the area is primarily ranching and some mining. Nearby communities are supported by tourism (including outdoor recreation), construction, and light industry. There would be no displacements or disruption to established business or uses of the area.
NP	*BLM Natural Areas* *(D. Gunn)*	6/10/19	/s/ Dan Gunn	There are no BLM Natural Areas within the project area.

FINAL REVIEW:

Reviewer Title	Date	Signature	Comments
NEPA Coordinator (C. Stewart)	9/24/19	for	
Field Manager (W. Bunting)	9/24/19	Clay Stewart (for)	

<u>**NOTE:**</u> Review Comments should include information explaining how the specialist came to their conclusion - how does he/she know the element/resource is not present (site visit and date of visit, familiarity with location, etc.). For all 'NIs' give a brief explanation as to why that element/resource would not be impacted.

* The list of Other Resources / Concerns to be considered may vary by individual field office. Note: Native American Trust Responsibilities should be considered for FO's with Indian Mineral interests.

APPENDIX E-7

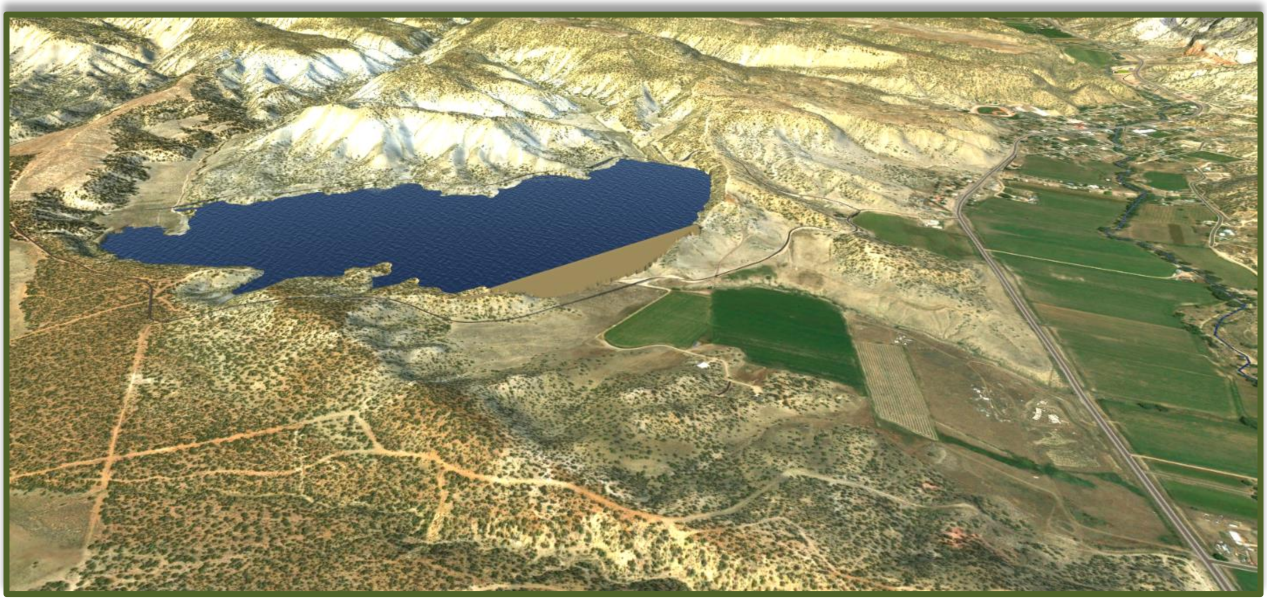
PLAN OF DEVELOPMENT FOR COVE RESERVOIR

Plan of Development

Cove Reservoir

Draft

Kane County Water Conservancy District



Submitted to
Natural Resources
Conservation Service
125 South State Street, Room 4010
Salt Lake City, Utah 84138

Submitted by
Kane County Water
Conservancy District
725 E Kaneplex Drive
Kanab, Utah 84741

July 2019

ALPHA ENGINEERING

RB&G ENGINEERING, INC.

Table of Contents

Part I. Introduction

A. Background

The Kane County Water Conservancy District (KCWCD) is proposing to construct a reservoir with associated facilities on property owned by the KCWCD as well as additional private land located near Orderville, Utah. Material borrow areas for construction of the dam are located on Bureau of Land Management (BLM) lands and private land. The dam is situated 0.6 miles from Highway 89 southwest of downtown Orderville (see **Figure 1**). As proposed, the reservoir would be constructed by the KCWCD. The Washington County Water Conservancy District (WCWCD) may participate in funding a portion of the water storage created by the project. The WCWCD participation would provide for: 1) storage of their water rights at higher elevation to reduce evaporation rates; 2) water releases during periods of low stream flows to augment peak summer uses and provide in stream flows for native and threatened and endangered fish species; and 3) more efficient use of the Quail Lake and Sand Hollow pipeline delivery system by releasing water when there is excess capacity in the pipeline system. This site was identified in the mid- to late-1980s during a reconnaissance level inventory of potential dam sites associated with tributaries of the Virgin River. Starting in 1996, the KCWCD and WCWCD have further explored constructing a dam at this location.

A feasibility study of the dam was performed in 2004 by RB&G Engineering. There were five borings along the dam alignment and 13 test pits completed during the investigation. The report concluded that the site is suitable for a dam and reservoir, there are available materials within a five- to 20-mile radius and the reservoir would be cost effective to construct. A preliminary feasibility report including information from the RB&G study was performed in 2013 by Alpha Engineering for the dam and is included in **Appendix B**.

The project will serve current water right holders and store water from the East Fork of the Virgin River during months with high river flow and then provide water during months with high demand. The components of the project include (see **Figure 2a** and **Figure 2b**):

- Reservoir
- Dam
- Low Level Outlet
- Principal Spillway
- Auxiliary Spillway
- Pipeline
- Hydro plant
- Access Road
- Borrow Areas
- Recreation Area

The dam will be designed to maximize storage capacity with principal/auxiliary spillways to sustain the improvements during storm events. At full capacity, the reservoir would have a surface elevation of approximately 5545.5 feet above mean sea level (amsl) and a capacity of approximately 6,055 acre-feet. Rock, gravel, and clay borrow sources from nearby pits will be utilized to construct the facility. Approximately 3.2 miles of new and existing roads will be constructed and/or improved to provide access around the reservoir and replace access to properties surrounding the reservoir. Approximately 1.2 miles of existing roadway will be graded and improved from its current width of approximately 12 to 16 feet and improved with road base to a width of 28 feet. Approximately 2.0 miles of new roadway will be constructed to a width of 28 feet of road base.

Approximately 700 feet of large diameter pipe is required to extend from the existing irrigation transmission line, near the reservoir, to the outlet works of the reservoir. This extension will allow the use of the existing diversion dam and transmission line to fill the reservoir and allow use of the stored water during the irrigation season. This extension will also serve as the emergency drain for the reservoir. It is also proposed to replace approximately 1.7 miles of existing 4-inch to 8-inch lines in the Glendale irrigation system with a larger transmission line from the current hydro plant location to a new location next to the Orderville Diversion Dam. This will provide an additional 100 feet of head to increase the production of the hydro plant by approximately 45 kW, double its current output. Excess water from the Glendale Irrigation System will then be combined with water diverted from the Orderville Diversion Dam to provide use of the existing irrigation pipeline system to fill the Cove Reservoir.

The existing Glendale and Orderville irrigation systems have limited capacity to deliver flows from the river and no capacity for storage during non-use and high flow periods. The Orderville Hydro Plant currently uses excess head available from the piping system and will continue to be used after the construction of the Cove Reservoir. Currently the hydro plant generates power during the winter months. With the construction of the Cove Reservoir, water will be stored during the winter and released during the irrigation season as water is needed for irrigation and to generate power during the summer. The Glendale Hydro Plant will be relocated and improved to double its capacity with the proposed project. The construction of the proposed Cove Reservoir with its associated facilities provide a drought buffer, improve water quality, increase and maintain a more consistent reliable flow for the pressurized irrigation system, provide a water-energy nexus, and provide for more efficient irrigation methods. This will allow the KCWCD to take advantage of existing water rights and provide a more stable and sustainable supply of water for the area. Water storage at higher elevations also reduces evaporation losses that occur in lower reservoirs operated by the WCWCD. In addition, water can be released from the reservoir to provide for in-stream flows during periods of low flow in the Virgin River for endangered fish species.

This Plan of Development (POD) includes descriptions of and guidelines for the design, construction, operation, maintenance, and reclamation of the Project. The KCWCD and WCWCD would construct and operate the project in conformity with the approved POD.

B. Diversion & Water Rights

The proposed system will store water from the Glendale Irrigation Company, the Orderville Irrigation Company and the Mt. Carmel Irrigation Company. Water rights held by the respective irrigation companies include points of diversion from the East Fork Virgin River.

The water rights that would be stored in the proposed reservoir are summarized in **Table 1**. The preliminary feasibility report that has been performed for the project (**Appendix B**) includes additional information and maps regarding the water rights within its appendices.

User	Flow	Volume	Acreage
Glendale Irrigation Company	13.02 cfs	1,709.0 ac-ft*	427.26
Orderville Irrigation Company	4.685 cfs	1,144.2 ac-ft	286.05
Mt. Carmel Irrigation Company	6.58 cfs	1,583.0 ac-ft*	395.75
Total	**24.285 cfs**	**4,436.2 ac-ft**	**1,109.06**

Table 1 Water Rights Summary

** Where a maximum diverted volume is not dictated by the respective water right, the volume was calculated using 4 acre-feet per allowable acre outlined in the water right.*

Based on the maximum water volume dictated in the water rights, the consumptive use was calculated for each irrigation company. The consumptive use values were taken from a study by Utah State University and can be verified at http://extension.usu.edu/irrestimator. The consumptive use value for each diversion by month is shown in **Table 2**:

Diversion	Irrigation Required, acre-feet					
	Apr	May	Jun	Jul	Aug	Sep
Glendale	3.18	370.04	359.86	500.38	264.49	202.82
Orderville	2.13	247.74	240.93	335.00	177.08	135.79
Mt. Carmel	2.94	342.75	333.33	463.48	244.99	187.86

Table 2 Consumptive Use by Diversion

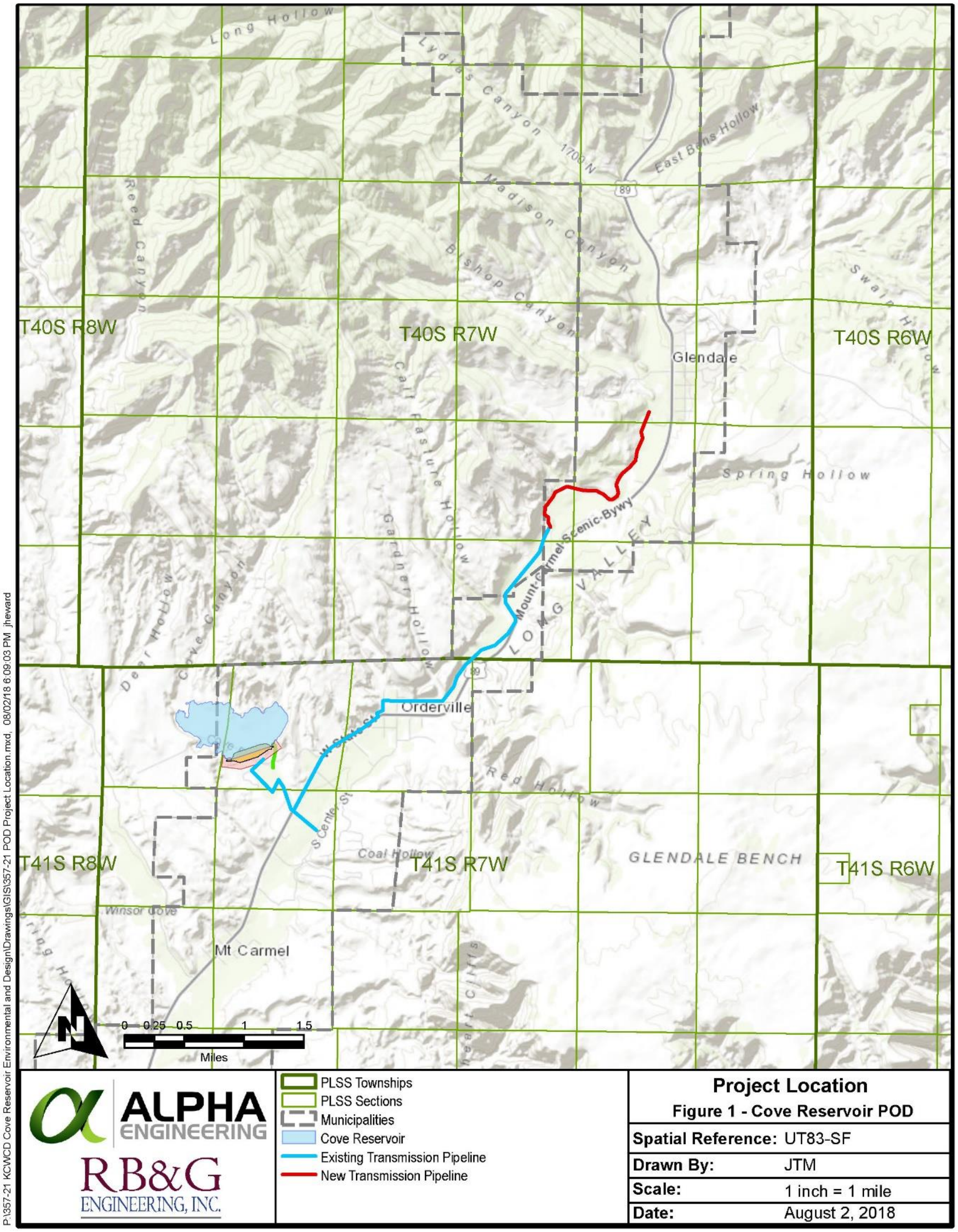


Figure 1: Project Location

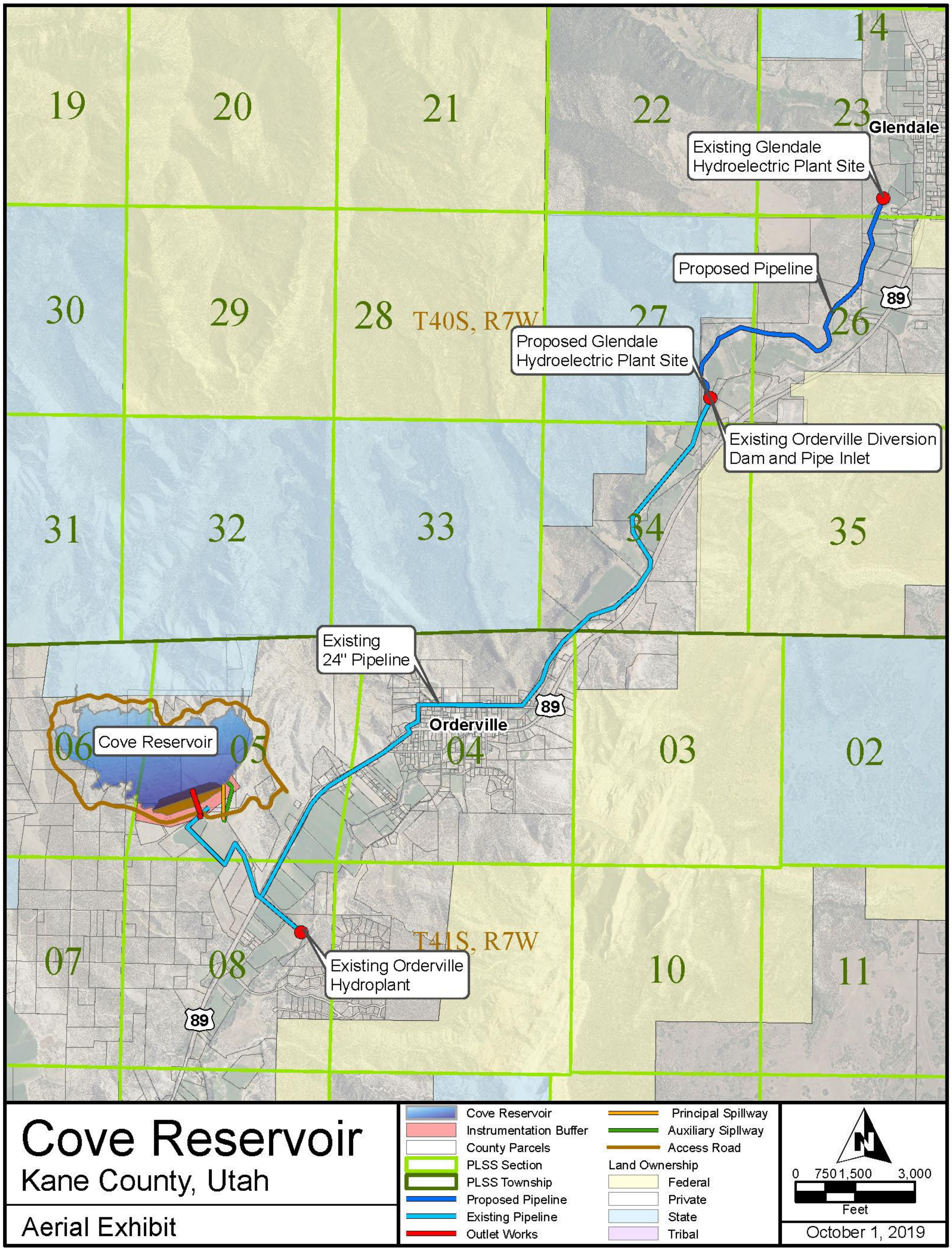


Figure 2a: Overall Project Components

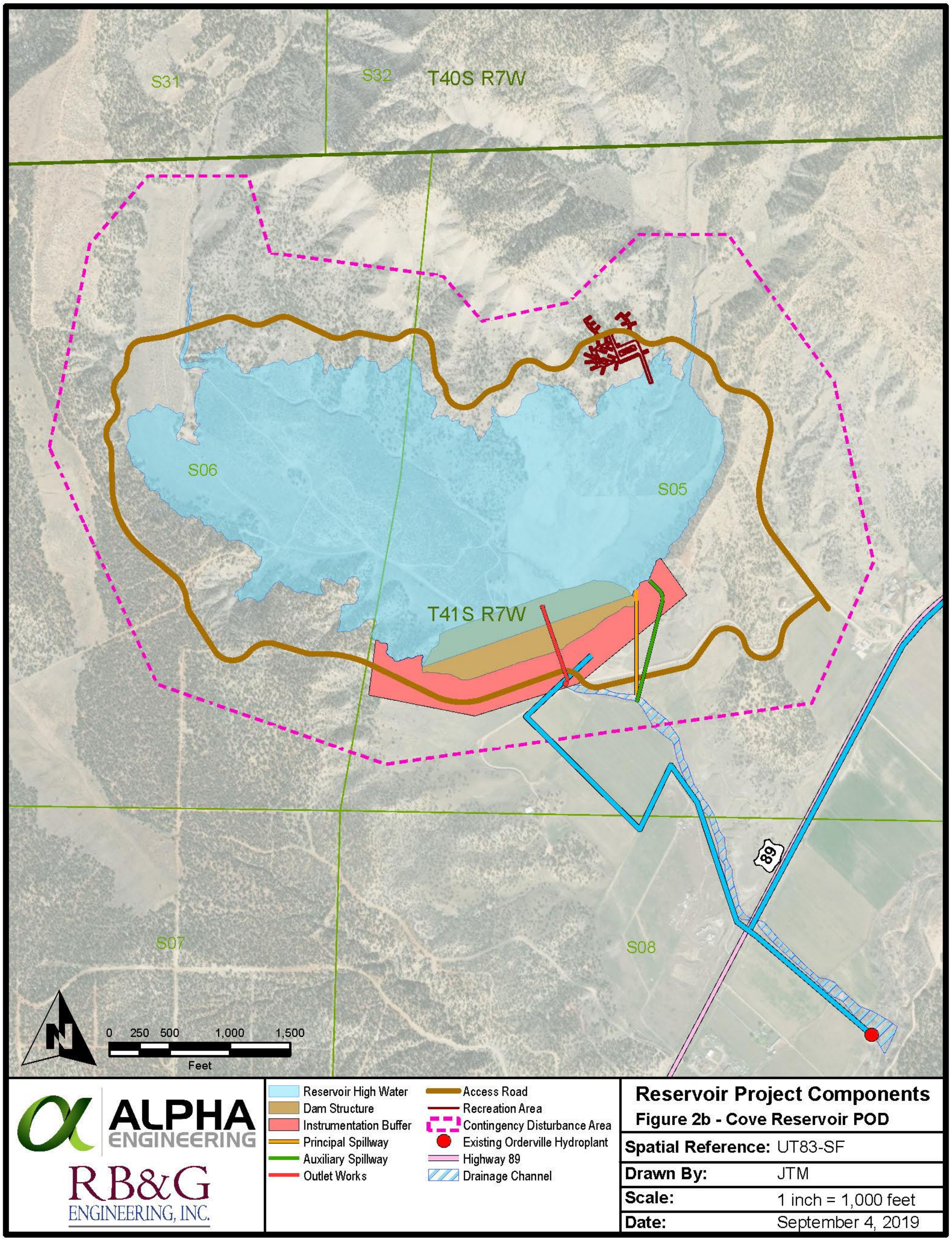


Figure 2b: Reservoir Project Components

Part II. Purpose and Need for Facility

The primary purpose of the project is to serve the current water users by providing for enhanced conservation and beneficial use of water. This purpose would be achieved by increasing water availability through collecting and storing water during non-use periods and providing flows during the irrigation season. As mentioned, the existing irrigation facilities have limited capabilities to divert water from the East Fork Virgin River and store water during high flows. This project creates a drought buffer for sustained time periods of low flows in the East Fork Virgin River. The water storage can also provide recreation opportunities for the area including fishing, camping, and small watercraft. In addition, flows from the reservoir may be released during drought conditions to provide additional instream flows in the Virgin River to help decrease high water temperatures that affect certain threatened and endangered species.

Secondary to water conservation, there are other purposes for the reservoir. The relocated hydro plant on the Glendale Irrigation system will be able to double its current output and provide increased power production. The existing Orderville Hydro Plant will also maintain a more consistent output with the creation of the reservoir to allow generation with releases from the reservoir which otherwise may not be available during drought conditions. The reservoir allows for storage of water at higher elevations, which reduces evaporation rates. The reservoir improves water conditions for water users as water quality is a concern in the area due to periodic high sediment loads from the upstream basin. Finally, the water surface elevation will provide pressure head that will increase and maintain pressures throughout the irrigation system. With improved water quality and pressure, more efficient irrigation methods are enabled for the system users.

Part III. Project Description and Land Ownership

A. Project Description and Land Ownership

The proposed reservoir and pipelines would be located on private lands. Permanent facilities would consist of a 190-acre reservoir, principal and auxiliary spillways, an access road, recreation facilities and pipelines. **Table 3** depicts the length, width and acreage for each of the facility components with permanent and temporary disturbance, including a final right-of-way required for each facility. The project layout with land ownership is shown on **Figure 2a**.

B. Right of Way

A 560-acre area would is potentially required for construction of the reservoir and dam, shown as the Contingency Disturbed Area in **Figure 1**. The temporary disturbance, permanent disturbance and right-of-ways for each component of the project are listed below.

- The reservoir area is comprised of the maximum water surface area, the dam and the low level outlet. A buffer area has been approximated to allow for instrumentation, which is also included in the reservoir area. Finally, portions of the spillways and recreation area are included in the reservoir area. The reservoir area requires 235 acres of temporary disturbance, permanent disturbance and right-of-way.
- The principal spillway is 870 lineal feet in length. 385 lineal feet of the spillway is accounted for within the reservoir disturbance and right-of-way. The principal spillway requires 100 feet of temporary disturbance and 14 feet of permanent disturbance (road) with a 50-foot right-of-way.
- The auxiliary spillway is 1,070 lineal feet in length. 355 lineal feet of the spillway is accounted for within the reservoir disturbance and right-of-way. The auxiliary spillway requires 100 feet of temporary disturbance and 30 feet of permanent disturbance (channel) with a 30-foot right-of-way.
- The pipeline is 8,980 lineal feet in length and requires 50 feet of temporary disturbance but would not create permanent disturbance or require additional right-of-way as it will be located within an existing roadway.
- The hydro plant requires an 80-foot by 80-foot, or 0.1-acre, area for temporary disturbance, permanent disturbance and right-of-way. Pertinent utility extensions, including a 700-foot power line, will be located within already disturbed areas and right-of-ways.

- The access road around the reservoir is 16,900 lineal feet in length. It will be located within existing roads where possible. Approximately 6,200 lineal feet of road will be located within existing dirt roads without a dedicated right-of-way and 10,700 lineal feet of road will be new roadway. The access road requires 100 feet for construction disturbance and 36 feet of permanent disturbance (road) with a 50-foot right-of-way.
- There are a total of five borrow areas required for the project. Two borrow areas (Lamb Pit and Tait Pit) are located on private property within existing pits and will require additional permanent disturbance and right-of-way of approximately 0.5 acres for Lamb Pit and 0.7 acres for Tait Pit. One of these pits will be selected for the project so there will be a maximum disturbance of 0.7 acres. Black Knoll Pit is located on BLM-administered property in an undisturbed area and will potentially require up to 5.0 acres of permanent disturbance and right-of-way. Elbow Pit is located on BLM-administered property within an existing pit and will not require additional permanent disturbance and right-of-way. The fifth site (Bald Knolls Pit) is located on BLM-administered property within an existing pit that will be required to be expanded with this project to include an additional 5.0 acres of permanent disturbance and right-of-way. Either the Bald Knoll or the Black Knoll Pit will be used so the maximum disturbance will be 5.0 acres.
- The recreation area will require approximately 4.3 acres of area. 0.2 acres of the recreation area is accounted for within the reservoir disturbance and right-of-way. It requires 4.1 acres of temporary disturbance, permanent disturbance and right-of-way.

Table 3 provides disturbance and right-of-way acreages for the project components. The temporary disturbance acreages shown in the table are calculated as the additional area after the permanent disturbance acreages have been calculated. The right-of-way acreages do not take into account any disturbance acreages. In total, the project requires 259.2 acres of permanent disturbance, 36.5 acres of temporary additional disturbance and 264.6 acres of right-of-way.

Component	**Linear ROW (feet)**	**Permanent Disturbance (acres)**			**Add'l Temporary Disturbance (acres)**			**ROW (acres)**		
		Private	**BLM**	**Total**	**Private**	**BLM**	**Total**	**Private**	**BLM**	**Total**
Reservoir	-	235.0	0.0	**235.0**	0.0	0.0	**0.0**	235.0	0.0	**235.0**
Principal Spillway	385	0.1	0.0	**0.1**	0.8	0.0	**0.8**	0.1	0.0	**0.1**
Auxiliary Spillway	355	0.2	0.0	**0.2**	0.6	0.0	**0.6**	0.2	0.0	**0.2**
Pipeline	8,980	0.0	0.0	**0.0**	10.3	0.0	**10.3**	0.0	0.0	**0.0**
Hydro Plant	-	0.1	0.0	**0.1**	0.0	0.0	**0.0**	0.1	0.0	**0.1**
Access Road	16,900	14.0	0.0	**14.0**	24.8	0.0	**24.8**	19.4	0.0	**19.4**
Borrow Areas	-	0.7	5.0	**5.7**	0.0	0.0	**0.0**	0.7	5.0	**5.7**
Recreation Area	-	4.1	0.0	**4.1**	0.0	0.0	**0.0**	4.1	0.0	**4.1**
Total	**26,620**	254.2	5.0	**259.2**	36.5	0.0	**36.5**	259.6	5.0	**264.6**

Table 3 Summary of Surface Disturbance.

C. Government Agencies Involved

The government agencies potentially involved include:

- Kane County Water Conservancy District
- Washington County Water Conservancy District
- Bureau of Land Management
- Utah Division of Wildlife Resources
- Kane County
- Town of Orderville
- Town of Glendale
- US Army Corps of Engineers
- Utah State Division of Water Rights, Dam Safety

Part IV. Facility Construction & Design

A. Schedule

Construction would commence after necessary permits are obtained and all plans are finalized. Construction of the pipelines and reservoir is estimated to take up to 15 months to complete. Construction of the pipelines and reservoir would occur simultaneously. **Table 4** provides an estimated sequence of construction activities:

Reservoir	Other Facilities
Clear & Grub Vegetation	Access Road
Develop Staging Areas	Install Pipeline
Construct Dam Trench	Construct Hydro Plant
Install Outlet Works	Principal & Auxiliary Spillway
Construct Dam (Haul Clay, Rock and Filter)	Recreation Area

Table 4 Estimated Sequence of Construction Activities

B. Construction of Facilities

i. Reservoir and Dam

The reservoir would be created by the construction of an earthen and rock fill dam having a central clay core. The length of the dam would be approximately 1,900 feet with a maximum dam height of 90 feet and a crest elevation of 5552 feet amsl.

Staging areas for the construction of the dam would be located within the footprint of the reservoir and will eventually be covered with water. An additional 200- to 300-foot buffer downstream of the dam will be used for instrumentation and additional staging. Construction of the dam would require large earth moving machinery, a portable gravel pit operation, water and multiple personnel.

The initial phase of construction would be to prepare the foundation, which will include excavation of overburden soils to varying degrees to mitigate settlement, excavation of a cutoff trench extending into bedrock, and installation of a grout curtain where conditions warrant, expected as a minimum, to be up both abutments. Borrow sources for the materials to construct the dam are discussed in **Section vii**, and large machinery will make continual trips between the reservoir and borrow sites as the dam is constructed. Operations to separate and produce engineer-specified material to be used for the dam will occur on-site within the project staging areas. Watering activities will continue throughout the construction of the dam as necessary to allow optimum compaction of the excavated material and maintain air quality.

A concrete encased pipeline will be used as the low level outlet works with a screened intake structure at the upstream end and an energy dissipater structure at the downstream end. The outlet works excavation will extend to bedrock through the embankment footprint, near the left abutment, and will be constructed in conjunction with the dam.

The estimated personnel and equipment required for the construction of the reservoir and dam are shown in **Table 5**.

Task	# of People	Equipment
Construction Engineering	4 - People	3 - Pickup Trucks, 1 - Four-wheeler
Foundation Preparation	9 - People	1 - Bulldozer, 1 - Track hoe, 2 - Scrapers, 2 - Pickup Trucks 1 - Drill, 1- Grout Plant
Dam Embankment	6 - People	1 - Bulldozer, 1 - Compactor, 1 - Grader, 1 - Water Truck
Embankment Borrow	6 - People	1 - Bulldozer, 1 - Track Hoe, 4 - Scrapers
Filter and Drain	3 - People	2 - Dump Trucks, 1 - Compactor
Outlet Works	4 - People	1 - Concrete Truck

Table 5 Estimated Personnel and Equipment for Reservoir and Dam Construction

ii. Principal Spillway

A pipeline will be used as the principal spillway, including an intake screen and structure at the intake and an energy dissipater structure at the outfall. The alignment for the pipeline will be located near the left abutment and will convey flows away from the dam structure. This pipeline has an approximate length of 870 lineal feet.

Pipeline installation activities would include staking, clearing and grubbing, trenching, hauling equipment and materials, pipeline assembly, backfill and access road construction, in this order. Prior to construction, the exact centerline of the pipeline ROW would be staked. The ROW boundaries would also be flagged in some areas (e.g., thick vegetation). Following staking, vegetation within the ROW would be cleared and grubbed to the extent necessary to provide for equipment clearance, construction, and maintenance operations.

The pipeline would be bedded and buried to a minimum depth of four feet to the top of pipe. The trench width and depth would vary depending upon the final design of the pipeline but will be sloped to gravity drain. The trench would generally be two feet wider than the pipe.

In areas where the pipelines would parallel or be within existing roads, the surface would be brought back to an as-good-as or better condition or replaced according to the governing agency's recommended specifications and requirements. The estimated personnel and equipment required for the construction of the principal spillway are shown in **Table 6**.

Task	# of People	Equipment
Survey and Staking	2 - People	1 - Pickup Truck
Trenching	1 - People	1 - Track Hoe
Pipe and Materials Hauling	2 - People	1 - Semi-truck and Flatbed Trailer
Pipeline Assembly & Burying	4 - People	1 - Bulldozer, 3 - Track Hoe, 1 - Dump Truck, 1 - Loader, 2 - Pickup Trucks
New Road Construction	1 - People	1 - Bulldozer

Table 6 Estimated Personnel and Equipment for Principal Spillway Construction

iii. *Auxiliary Spillway*

The auxiliary spillway will comprise a trapezoidal earthen channel, including a concrete weir structure a few hundred feet west of the left abutment of the dam. The auxiliary spillway will extend into an existing drainage channel west of the dam. Where the grade of the spillway becomes too steep for natural stabilization, additional armoring or riprap will be installed to prevent erosion of the spillway or adjacent grades.

The spillway will be constructed simultaneously with the dam as needed for additional access to the left abutment. This will allow easier access for the construction of the dam. The spillway ROW will be staked and cleared of all vegetation. The estimated personnel and equipment required for the construction of the spillway are shown in **Table 7**.

Task	# of People	Equipment
Survey and Staking	2 - People	1 - Pickup Truck
Concrete Weir Construction	2 - People	1 - Concrete Mixer
Channel Grading	3 - People	1 - Bulldozer, 1 - Track Hoe

Task	# of People	Equipment
Channel Armoring	2 - People	1 - Track Hoe

Table 7 Estimated Personnel and Equipment for Auxiliary Spillway Construction

iv. Pipeline

Additional pipeline is required to meet the project objectives. The additional pipeline will complete the transmission system to and from the reservoir in addition to provide a delivery system into the hydro plant. The pipeline will be located at the south end of the Town of Glendale near the East Fork Virgin River. The pipeline would replace the existing 4 to 8-inch pipelines and be installed adjacent to the existing lines.

Appropriate air valves would be installed along the pipeline at approximately 1/2-mile intervals and at major grade changes. In-line valves would be required at all pipeline intersections. Drain-lines or blow-off valves would also be located periodically along the pipeline at low points in the pipeline and would drain to existing channels. The pipeline would also be provided with tracer wire for locating the underground piping. Above-ground fiberglass markers would also be placed at strategic locations to provide public notice of the underground piping to avoid conflicts with future construction.

Pipeline installation activities would include staking, clearing and grubbing, trenching, hauling equipment and materials, pipeline assembly, and backfill, in this order. Prior to construction, the exact centerline of the pipeline ROW would be staked. The ROW boundaries would also be flagged in some areas (e.g., thick vegetation). Following staking, vegetation within the ROW would be cleared and grubbed to the extent necessary to provide for equipment clearance, construction, and maintenance operations.

Where the pipeline parallels existing utilities, care would be taken to protect existing infrastructure and coordination would take place among affected entities. Where the pipeline would be installed under existing asphalt or where it would cross paved roads, asphalt would be replaced according to the governing agency’s recommended specifications and requirements.

In areas where the pipelines would parallel or be within existing non-paved roads, the surface would be brought back to an as-good-as or better condition, or replaced according to the governing agency’s recommended specifications and requirements. Where there would be air valves or other pipeline appurtenances, construction would follow standard safety guidelines, including distance from roads or installation of barriers.

The pipelines would be bedded and buried to a minimum depth of three feet to the top of pipe and deeper under streambed crossings. The trench width and depth would vary depending upon the size of the pipe being installed. The trench would generally be two feet wider than the pipe. The estimated personnel and equipment required for the construction of the pipeline are shown in **Table 8**.

Task	# of People	Equipment
Survey and Staking	2 - People	1 - Pickup Truck
Trenching	1 - Person	1 - Track Hoe
Pipe and Materials Hauling	2 - People	1 - Semi-truck and Flatbed Trailer
Pipeline Assembly & Burying	4 - People	1 - Bulldozer, 3 - Track Hoe, 1 - Dump Truck, 1 - Loader, 2 - Pickup Trucks
New Road Construction	1 - Person	1 - Bulldozer

Table 8 Estimated Personnel and Equipment for Pipeline Construction

v. *Hydro Plant*

The existing Glendale Hydro Plant will be relocated to a point near the existing Orderville Diversion Dam. Existing 4- to 8-inch transmission lines upstream of the existing hydro plant will be replaced with a new larger transmission line and extended to the new hydro plant location. The hydro plant will consist of a small concrete building that will house the turbines and appurtenant facilities. The existing turbine, generator and switchgear will be rebuilt and used at the new location. A small parking area will be graded adjacent to the hydro plant but will otherwise use existing roads and access points to provide access to the site. Utility work, including a 700-foot long power transmission line from an existing adjacent power feed, will be installed in conjunction with the building. Drainage and erosional considerations will also be incorporated into the construction of the facility. The Orderville Hydro Plant will continue use at its present location and no further modifications will be necessary.

Construction of the hydro plant will consist of clearing and grubbing the site in preparation for the foundation and construction access. The building and parking areas will be staked. Temporary fencing will be installed around the site to prevent vandalism and for safety purposes. Watering equipment will be kept on-site for compaction and to control air quality, and SWPPP measures will be enforced to control storm water runoff. Where the site is adjacent to existing private properties, coordination with the adjacent property owners will take place to ensure smooth construction. The estimated personnel and equipment required for the construction of the hydro plant are shown in **Table 9**.

Task	# of People	Equipment
Survey and Staking	2 - People	1 - Pickup Truck
Clearing and Grubbing	1 - People	1 - Track Hoe
Hydro Plant Construction	4 - People	1 - Concrete Mixer, 1 - Pickup Truck, 1 - Track Hoe

Table 9 Estimated Personnel and Equipment for Hydro Plant Construction

vi. Access Road

The access road will be located around the perimeter of the reservoir using existing roads where possible. Approximately 3.2 miles of new and existing roads will be constructed and/or improved to provide access around the reservoir and replace access to properties surrounding the reservoir. Approximately 1.2 miles of existing roadway will be graded and improved from its current width of approximately 12 to 16 feet and improved with road base to a width of 28 feet. Approximately 2.0 miles of new roadway will be constructed to a width of 28 feet of road base. The cross-section of the roadway would be constructed to permit two-way traffic for the construction and access of the dam. Due to the hilly terrain, a minimal section will be used in order to reduce cuts and fills. A borrow ditch and culverts will be installed as needed to allow drainage without damage to the access road. The access road will be covered with a graded and compacted road base material.

The access road will be constructed early in the construction process to allow access for upstream property owners. This will also facilitate construction of the dam. The road ROW and grade slopes will be staked and cleared of all vegetation. Watering equipment will be kept on-site for compaction and to control air quality. The estimated personnel and equipment required for the construction of the access road are shown in **Table 10**.

Task	# of People	Equipment
Survey and Staking	2 - People	1 - Pickup Truck
Rough Grading	2 - People	1 - Track Hoe, 1 – Bulldozer, 1 - Water Truck
Final Road Grading	2 - People	1 – Bulldozer, 1 - Dump Truck

Table 10 Estimated Personnel and Equipment for Access Road Construction

vii. Borrow Areas

Borrow sources would include (1) the Lambs Pit located 0.5 miles north of Mt Carmel Junction off of Highway 89; (2) the Tait Pit located 2.0 miles north of Mt Carmel Junction off of Highway 89; (3) the Black Knoll Pit located 6.0 miles east of the Town of Glendale off of Glendale Bench Road (partial dirt road); (4) the Elbow Pit located 7.1 miles east of the Town of Glendale off of Glendale Bench Road (partial dirt road); and (5) the Bald Knolls Community Pit located 11 miles east of the Town of Glendale off of Glendale Bench Road (partial dirt road). The transportation path to and from the borrow areas will run along existing roadways, including smaller county dirt roads. Additional right-of-ways to access the borrow areas will not be required. The approximate quantities for the dam are provided in **Table 11**.

Type	Quantity
Clay	1,080,000 cubic-yards
Earthfill	3,035,000 cubic-yards
Sand Filter	110,000 cubic-yards
Gravel Drain	66,000 cubic-yards
Riprap	28,000 cubic-yards
Total	**4,319,000 cubic-yards**

Table 11 Estimated Borrow Quantities

viii. Recreation Area and Boat Ramp

Initial discussions have identified the area as an overnight and day-use facility equipped with picnic tables, restrooms, campgrounds, RV hookups, a pavilion and a boat ramp for small-engine (trolling motors) boat access. A detailed recreation plan would be prepared by a committee that involves all stakeholders. The KCWCD would anticipate contracting with a separate state or local governmental entity to manage the recreation area. A parking area and boat ramp have been identified on Figure 2b. A camp host for overnight camping, who would maintain the facility, is being considered.

Approximately 1.2 miles of buried transmission line and water pipeline would be constructed to provide electricity and potable water to the recreation area. Both the transmission line and the pipeline would be buried in the borrow area of the access road. The pipeline would be an 8-inch line with fire hydrants located every 500 feet. No additional disturbance would result from the installation of the transmission line.

C. Resource Value and Environmental Concerns

KCWCD will contract the services of an environmental consultant to complete required resource surveys and to prepare National Environmental Policy Act (NEPA) related documents.

Cultural resources that would be directly or indirectly impacted would be subject to evaluation and determination through Section 106 consultation (under the National Historic Properties Act). Project engineers would work with archaeologists to avoid or minimize impacts to any identified cultural resources. As necessary, specific mitigation measures for biological resources would also be developed as part of the EA, and if necessary, additional surveys and Section 7 consultation (under the Endangered Species Act) would be conducted.

Implementation of the project would comply with all applicable federal and state laws and any local zoning and building ordinances during all phases of the project. Potential impacts to the environment are expected to be minimal as standard Best Management Practices (BMPs) would be followed (**Appendix A**) and the Environmental Protection Measures (EPMs) listed below would be implemented. EPMs would also apply to operation and maintenance of the completed facility. The NRCS is expected to inspect the project both during and after project completion to ensure compliance with EPMs and other requirements.

Air Resources: The generation of fugitive dust from surface activities, including earth moving and hauling and handling of materials, would be controlled by implementing BMPs. When needed, water would be applied during construction to control fugitive dust levels on access roads and construction sites.

Water Resources: BMPs would be used as needed to control storm water discharges. These practices would include material handling and temporary storage procedures that minimize the exposure of potential pollutants to storm water, spill prevention and response, sediment and erosion controls, and physical storm water controls. Site runoff would be controlled and managed in accordance with regulation. A Storm Water Pollution Prevention Plan would be prepared prior to construction and followed during construction.

Hazardous Materials and Wastes: Construction sites, staging areas, and access roads would be kept in an orderly condition throughout construction. Refuse and trash, including stakes and flags, would be removed and disposed. Covered dumpsters located in the Project Area would contain all refuse. Refuse would be removed on a regular basis to an approved disposal facility. No open burning of construction trash would occur. Portable toilets would be used on site, and would be maintained on a regular schedule.

No construction equipment oil or fuel would be drained on the ground. Oils or chemicals would be hauled to an approved site for disposal. The only significant sources of potential petroleum or other hazardous material spills are from mobile equipment. If a fuel/oil or other hazardous material spill were to occur, the required regulatory agencies would be contacted as soon as possible, and actions would be taken to minimize the amount and spread of the spill material. Such measures may include straw bale plugs, earthen berms, or use of other absorbent materials. If necessary, soil remediation would be conducted and would include the removal of contaminated soils to an approved facility and a soil sample(s) would be taken to verify the success of the site remediation. In addition, the KCWCD would follow any other local, state, or Federal regulations related to the use, handling, storing, transporting, and disposing of hazardous materials.

Fire Prevention and Protection: All construction personnel would have fire tools and extinguishers available at all times for use if the occasion arises. Construction staff would adhere to any local fire prevention and suppression requirements.

Cultural Resources: If during any project activities, cultural, historical, or prehistoric resources, including any of Native American religious interest, are inadvertently discovered, the appropriate authorized officer would be notified, and all work in the area would cease. A professionally trained archeologist would work with the SHPO and affiliated or interested Tribes to determine eligibility for the National Register of Historic Places. If needed, a mitigation plan would be developed in consultation with the SHPO, KCWCD, construction crews, and interested Tribes. Construction personnel would be instructed to watch for cultural artifacts while working on the project. In the event significant vertebrate paleontological resources are discovered, including human remains, the authorized officer would be notified.

Human Health and Safety: Blasting will not be allowed at the dam site, however it may be an option for the Hydro Plant. The contractor performing blasting would comply with applicable regulations and standards established by the regulatory agencies, codes, and professional societies, including the rules and regulations for storage, transportation, delivery, and use of explosives. Whenever blasting operations are in progress, explosives would be stored, handled, and used as provided by law, including safety and health regulations for construction. No explosives would be stored on the Project Area.

Construction sites would be managed to prevent harm to any person and property. During construction, all employees, project managers, supervisors, inspectors, contractors, and subcontractors would be required to conform to contractor safety procedures. All personnel would be adequately trained to perform their tasks. Heavy equipment would be outfitted with Occupational Safety and Health Administration (OSHA) required safety devices such as backup warnings and seat belts. Hard hats, safety boots, ear and eye protection, and other personal safety equipment would be available to any personnel requesting it. All accidents and injuries would be reported to the appropriate contractor safety officer.

Noxious Weeds/Invasive Species: All equipment, including pickup trucks and passenger vehicles, would be cleaned of soils, seeds, vegetative matter, or other debris or matter that could contain or hold noxious seeds prior to entering the Project Area. The cleaning of equipment would also be done any time thereafter if the equipment leaves the Project Area, is used on another project, and reenters the Project Area. The KCWCD would follow any regulations pertaining to control of noxious weeds on state- or federal-administered land. Vegetation in the Project Area would be monitored periodically for the establishment of noxious weeds or undesirable plant species. The KCWCD would be responsible for any future weed control work, if needed, as a result of the implementation of this Project. Any use of herbicides would comply with local requirements.

Stabilization and Rehabilitation: All areas subject to temporary ground disturbance would be restored to original contours to the extent determined by the governing agency. Temporarily disturbed areas would be seeded using a certified weed-free seed mix approved by the governing agency. Seed would be hand broadcasted and lightly covered with soil by hand using a rake or by pulling a chain-link fence with an all-terrain vehicle. All soil removed during construction would be reused. Vegetation removal would be kept to that necessary to construct the project. Any brush removed during construction would be used as mulch after reclamation activities. Any trees felled would either be left on site as down woody debris or removed if preferred by the governing agency. The reservoir area would be smoothed and cleaned up prior to filling the reservoir with water. The borrow areas would be cleaned up of all debris and smoothed out.

Raptors and Migratory Birds: In order to avoid or reduce impacts on nesting success of raptors, activities would not occur within recommended spatial and seasonal buffers, and would follow Utah BLM BMPs for Raptors and Their Associated Habitats in Utah [BLM 2006]. If existing topography limits actual line-of-sight of between an active nest (i.e., the nest has eggs or young) and construction activities, the spatial and seasonal buffer may be reduced.

To avoid or minimize potential short-term and long-term impacts to migratory birds, construction activities would be either limited during the migratory bird nesting period (generally defined as 15 May – July 15 [BLM 2008], but could start as early as March/April depending on elevation and latitude), or a migratory bird nesting survey would be completed in areas proposed for disturbance during this time period. If an active nest were discovered, the appropriate agency biologist would be notified and an appropriate buffer area around the nest would be established to prevent nest abandonment until after the migratory bird nesting period is over and/or young have fledged.

Wildlife: No firearms, air guns, or archery equipment would be allowed on the project sites. No pets would be permitted on project sites. To prevent entrapment of wildlife during construction, any open pits or trenches would be monitored throughout the construction day. Excavated pits and trenches more than 2 feet deep would be covered at the close of each day. Alternatively, fencing may be erected around open pits or trenches. At the beginning of the construction day and before pits or trenches are filled, they would be inspected for trapped animals. If any animals are found, they would be moved out of harm's way. No rodenticides would be used on project sites. Encounters with a protected species (e.g., raptors, migratory birds, listed or sensitive species) would be reported to the appropriate oversight agency (e.g., USFWS). Any contractor or employee who inadvertently kills or injures a protected species would immediately report the incident to the appropriate oversight agencies.

D. Operation and Maintenance

It is anticipated that routine maintenance would include the following, and as summarized in **Table 12**:

- The reservoir requires water management practices of maintaining water levels.
- The reservoir dam would require regular inspection and maintenance.
- A grader would be used to grade the spillway as necessary to maintain functionality.
- The pipeline air valves would need to be inspected at least annually to ensure that they are functioning properly.
- The pipeline would likely need to be cleaned with a poly pig on an annual basis.
- The pipeline system is estimated to have a 50-year life before major pipeline repair would be required.
- The hydro plant would require regular inspection and maintenance to maintain turbines, valves, and other mechanical equipment.
- The recreation area would require regular inspection and maintenance to maintain hard surfaces and erosional protection and to keep site free of debris and excessive vegetation.

Task	Number of People	Equipment
Reservoir Inspection & Maintenance	1 - Person	1 - Pickup Truck
Dam Inspection & Maintenance	1 - Person	1 - Pickup Truck
Flushing Pipeline	2 - People	1 - Pickup Truck
Road Maintenance	1 - Person	1 - Grader 1 - Pickup Truck
Pipeline Maintenance	2 - People	1 - Pickup Truck

Task	Number of People	Equipment
Hydro Plant Inspection & Maintenance	1 - Person	1 - Pickup Truck
Recreation Area	1 - Person	1 - Pickup Truck

Table 12 Estimated Personnel and Equipment to Perform Operation and Maintenance

E. Termination and Restoration

If the project is to be terminated or abandoned, a joint inspection would be held with the authorized officer(s) of the NRCS prior to termination. This would be held to agree upon an acceptable rehabilitation plan for the area.

Part V. References

Bureau of Land Management (BLM). 2006. Best management practices for raptors and their associated habitats in Utah. Recommendations for implementing the U.S. Fish and Wildlife Service, Utah Field Office's Guidelines for Raptor Protection from Human and Land Use Disturbances [Romin and Muck 2002]. BLM Utah State Office, Salt Lake City. August 2006.

Bureau of Land Management. 2008. Instruction Memorandum No. 2008-050: Migratory Bird Treaty Act – Interim Management Guidance.

Appendix A. Best Management Practices

Best Management Practices

As part of standard operating procedures, standard BMPs would be implemented throughout the project in order to reduce potential adverse environmental impacts. Most of the impacts are short term and generally occur during the construction period. Project design and implementation of site-specific or selectively recommended BMPs would minimize the effect of the project where the potential for long-term, adverse impacts may occur.

STANDARD BMPs
1. All construction vehicle movement outside of the right-of-way would be restricted to pre-designated access, contractor acquired access, or public roads.
2. The limits of construction activities would be predetermined, with activity restricted to and confined within those limits. No paint or permanent discoloring agents would be applied to rocks or vegetation to indicate survey or construction activity limits. The right-of-way boundary would be flagged in environmentally sensitive areas described in the plan of development to alert construction personnel that those areas would be avoided.
3. In construction areas where re-contouring is not required, vegetation would be left in place wherever possible to avoid excessive root damage and allow for re-sprouting.
4. In construction areas where ground disturbance is significant or where re-contouring is required, surface restoration would occur as required by the landowner or land management agency. The method of restoration typically would consist of returning disturbed areas to their natural contour (to the extent practical) and reseeding or re-vegetating with native plants. Seed viability would be tested and seed mixes would be certified to contain no noxious weeds.
5. Prior to construction, all construction personnel would be instructed on the protection of cultural, paleontological, and ecological resources. To assist in this effort, the construction contract would address (a) federal and state laws regarding antiquities, fossils, and plants and wildlife, including collection and removal; and (b) the importance of these resources and the purpose and necessity of protecting them.
6. An initial intensive cultural resource inventory survey would be conducted prior to construction. Impact avoidance and mitigation measures developed in consultation with appropriate land management and regulatory agencies and other interested parties would be implemented subsequent to the completion of the NEPA compliance document.
7. Any cultural and/or paleontological resource discovered during construction by the KCWCD or any person working on their behalf on public or federal land would be reported immediately to the authorized officer. The KCWCD would suspend operations in the area until an evaluation is completed to prevent the loss of cultural or scientific values.
8. All construction and maintenance activities would be conducted in a manner that would minimize disturbance to vegetation, drainage channels, and intermittent and perennial stream banks. In addition, dust-control measures would be utilized as necessary during construction in sensitive areas. Any used existing roads would be left in a condition equal to or better than their condition prior to construction.

STANDARD BMPs
9. All requirements of those entities having jurisdiction over air quality matters would be adhered to and any necessary permits for construction activities would be obtained. Open burning of construction trash (cleared trees, etc.) would not be allowed on BLM- or USFS-administered lands.
10. Fences and gates, if damaged or destroyed by construction activities, would be repaired or replaced to their original pre-disturbed condition as required by the landowner or the land management agency. Temporary gates would be installed only with the permission of the landowner or the land management agency.
11. Totally enclosed containment would be provided for all hazardous materials (if needed) and trash. All construction waste including trash, litter, garbage, other solid waste, petroleum products, and other potentially hazardous materials would be removed to a disposal facility authorized to accept such materials.
12. Third-party environmental contractors would be used throughout the construction effort, from clearing through rehabilitation.
13. The KCWCD would trim trees in preference to cutting trees, and would cut trees in preference to bulldozing them.
14. Construction holes left open overnight would be covered to prevent livestock or wildlife from harm.
15. The contractor would clean off-road equipment (power or high-pressure cleaning) of all mud, dirt, and plant parts prior to moving equipment onto public land.

ADDITIONAL STIPULATIONS

The following additional stipulations would be implemented throughout the construction and operation of the project and would be included as part of the standard operating procedures.

STIPULATIONS – STANDARD OPERATING PROCEDURES
1. KCWCD would construct, operate, and maintain the facilities, improvements, and structures within this ROW in strict conformity with the plan of development as it is approved. Any relocation, additional construction, or use that is not in accord with the approved plan of development would not be initiated without the prior written approval of the authorized officer. A copy of the complete ROW grant or acknowledgment, including all stipulations and approved plan of development, would be made available on the ROW area during construction, operation, and maintenance to the authorized officer. Noncompliance with the above shall be grounds for an immediate temporary suspension of activities if it constitutes a threat to public health and safety or a material threat to the environment.
2. This plan of development describes in detail the construction, operation, maintenance of the ROW and its associated improvements and/or facilities. An approved plan of development may be referred to for interpretation of the right-of-way grant.
3. KCWCD would contact the authorized officer at least 10 days prior to the anticipated start of construction and/or any surface-disturbing activities. The authorized officer may require and

STIPULATIONS – STANDARD OPERATING PROCEDURES
schedule a preconstruction conference with the KCWCD prior to commencement of construction and/or surface-disturbing activities on the ROW. The KCWCD, its contractor(s), or agents involved with the construction and/or surface-disturbing activities on the ROW should attend this conference to review the stipulations of the grant and the plan(s) of development.
4. KCWCD would designate a representative(s) who would have the authority to act upon and implement instructions from the authorized officer within a reasonable time when construction or other surface-disturbing activities are underway.
5. KCWCD would protect all survey monuments found within the right-of-way. Survey monuments include but are not limited to General Land Office and BLM Cadastral Survey Corners, reference corners, witness points, U.S. Coastal and Geodetic benchmarks and triangulation stations, military control monuments, and recognizable civil (both public and private) survey monuments. In the event of obliteration or disturbance of any of the above, the KCWCD would immediately report the incident, in writing, to the authorized officer and the respective installing authority, if known. Where General Land Office or BLM ROW monuments or references are obliterated during operations, KCWCD shall secure the services of a registered land surveyor or a BLM cadastral surveyor to restore the disturbed monuments and references using surveying procedures found in the *Manual of Surveying Instructions for the Survey of the Public Lands of the United States*, latest edition. KCWCD shall record such survey in the appropriate county and send a copy to the authorized officer. If the BLM cadastral surveyors or other federal surveyors are used to restore the disturbed survey monument, KCWCD would be responsible for the survey cost.
6. The KCWCD or the successor in interest shall comply with Title VI of the Civil Rights Act of 1964 (42 U.S.C. 2000d et. seq.) and the regulations of the Secretary of Interior issued pursuant hereto.
7. KCWCD would mark the exterior boundaries of the ROW with a stake and/or lath. The intervals may be varied at the time of staking at the discretion of the authorized officer. The tops of the stakes and/or laths would be painted and the laths flagged in a distinctive color as determined by the holder. The survey station numbers would be marked on the boundary stakes and/or laths at the entrance to and exit from public land. Holder would maintain all boundary stakes and/or laths in place until final cleanup and restoration are completed and approved by the authorized officer. The stakes and/or laths would then be removed at the direction of the authorized officer.
8. KCWCD would conduct all activities associated with the construction, operation, and maintenance of the right-of-way within the authorized limits of the ROW and approved plan of development.
9. KCWCD would survey and clearly mark the centerline and/or exterior limits of the ROW, as determined by the authorized officer.
10. All design, material, and construction, operation, maintenance, and termination practices would be in accordance with safe and proven engineering practices.
11. KCWCD would inform the authorized officer within 48 hours of any accidents on federal lands that require reporting to the Department of Transportation as required by 49 CFR Part 195.
12. During conditions of extreme fire danger, operations may be suspended or limited in certain areas.
13. KCWCD would be liable for damage or injury to the United States to the extent provided by 43 CFR Sec. 2803.1-4. KCWCD would be held to a standard of strict liability for damage or injury to the

STIPULATIONS – STANDARD OPERATING PROCEDURES
United States resulting from fire or soil movement (including landslides and slumps as well as wind and water-caused movement of particles) caused or substantially aggravated by any of the following within the ROW or permit area: • Activities of the holder including but not limited to construction, operation and maintenance of the facility. • Activities of other parties acting under color of authority from the KCWCD, including but not limited to: - land clearing - earth-disturbing and earth-moving work - blasting
14. Within 30 days of completion, KCWCD would submit to the authorized officer, as-built drawings and a certification of construction verifying that the facility has been constructed (and tested) in accordance with the design, plans, specifications, and applicable laws and regulations.
15. Construction sites would be maintained in a sanitary condition at all times; waste materials at those sites would be disposed of promptly at an appropriate waste disposal site. “Waste” means all discarded matter including but not limited to human waste, debris, garbage, refuse, oil drums, petroleum products, ashes, and equipment.
16. Prior to preconstruction activities on the subject parcel, KCWCD would identify all noxious weeds present. A list of the weeds would be provided to the authorized officer. A determination would be made by the authorized officer of any noxious weeds that may require flagging for treatment. KCWCD shall treat the noxious weeds as required by the authorized officer.
17. KCWCD would clean off-road equipment (power or high-pressure cleaning) of all mud, dirt, and plant parts prior to moving equipment onto public land authorized under this lease.
18. Gravel and/or fill material to be placed in relatively weed-free areas must come from weed-free sources. Prior to obtaining gravel and/or fill material, the authorized officer would inspect the source for weeds and determine adequacy of site.
19. KCWCD would identify a road maintenance program, which would include monitoring for noxious weeds. If KCWCD identifies any noxious weeds, KCWCD would notify the authorized officer immediately. A treatment program would be identified and KCWCD would be responsible for weed abatement.

Appendix B. Preliminary Design

APPENDIX E-8

KCWCD PL83-566 FUNDING REQUEST PROPOSAL

Kane County
Water Conservancy
District

"Developing and protecting our water resources one drop at a time."

August 25, 2017

Mr. Tim Wilson
State Conservationist
Natural Resources Conservation
Service (NRCS)
Wallace F. Bennett Federal Building
125 South State Street Room 4010
Salt Lake City, UT 84138-1100

RE: Watershed Protection and Flood Prevention – Funding Assistance Request for Cove Reservoir

Dear Mr. Wilson,

Congress provided $150 million in new funding to the NRCS through the PL83-566 Watershed Protection and Flood Prevention program (Watershed Act). The Kane County Water Conservancy District (KCWCD) requests Federal assistance under the provisions of this act to construct a water storage reservoir near Orderville, Utah in Kane County, Utah. This area is subject to extreme drought on occasion and the proposed reservoir will provide a full water right to the agricultural users in the area as well as augment flows in the Virgin River for protection of endangered fish species. Side benefits will also include the generation of power through an existing hydroelectric facility to provide additional green power for the area, and an additional recreation facility for boating and fishing.

As an existing project sponsor, the KCWCD is committed to undertake all of the sponsor responsibilities for the project. The diversion and water conveyance facilities to the reservoir have already been constructed. Ground for the dam and reservoir has already been purchased and the project is shovel ready without extensive environmental issues.

We were recently successful in completing the Jackson Flat Reservoir near Kanab, Utah and have the necessary personnel in place to complete this project. Please feel free to contact me at any time regarding this critical project for the KCWCD.

Sincerely,

Mike Noel, Director
Kane County Water Conservancy District

Cc: Bronson Smart, Norm Evenstad, Lance Smith, NRCS

725 E. Kaneplex Dr. • Kanab, UT 84741 • (435) 644-3997 • Fax (435) 644-8679
www.kcwcd.com • kcwcd@kanab.net

Item or Concern	No Action	Alternative 1
Fluctuating flows in East Fork Virgin River	Low flow seasons for irrigators and endangered fish; warmer river temperatures	Provide water storage for irrigators to aid in providing full water rights; augment stream flows for endangered fish; reduce river water temperature to improve conditions for endangered fish
INSTALLATION COSTS		
NRCS Contribution	$0	$14,400,000
Sponsor(s) Contribution	$0	$4,800,000
Total	$0	$19,200,000
ENVIRONMENTAL IMPACTS		
Soil	No direct effect	SHORT TERM: Off stream construction disturbance areas will re-vegetate. LONG TERM: No effect
Potable water supply forecast	No direct effect	No direct effect
Surface - Quantity	No direct effect	SHORT/LONG TERM: The reservoir will release water to increase stream flow during low flow periods.
Wetlands	No direct effect	Potential for wetlands may exist. A wetland delineation will be completed prior to permitting
Air Quality	No direct effect	SHORT TERM: Fugitive dust expected during construction activities - mostly from equipment accessing the site on gravel/dirt roads; LONG TERM: No direct effect
Plants	SHORT TERM: Existing management and land use practices would continue. LONG TERM: Future cutbank areas of the East Fork Virgin River would be vulnerable to establishment of noxious and/or invasive plants. There is a system in place for the public to identify noxious/invasive weeds and report them to the state for authentication.	SHORT TERM: Disturbed areas would be temporarily exposed to some invasive growth. Disturbed areas would be re-seeded per NRCS guidelines with an approved seed mix. LONG TERM: No Effect. Equipment brought into the area would be cleaned prior to commencing work to minimize the risk of spreading invasive plants. There is a system in place for the public to identify noxious/invasive weeds and report them to the state for authentication.
Threatened and endangered species	No direct effect	No Adverse Impacts to federal or state sensitive species are expected.
Historic and cultural resources	No direct effect	Impacts to cultural resource artifacts potentially in the vicinity of the proposed reservoir will be avoided as much as practical or mitigated.

Item or Concern	No Action	Alternative 1
Public Land Use	No direct effect	Green energy will be produced from water released from the reservoir as well as benefits derived from the addition of a recreational facility for boating, fishing and swimming.
Tribal, religious, or sacred site	No direct effect	Impacts to cultural resource artifacts potentially in the vicinity of the proposed reservoir will be avoided as much as practical or mitigated.

APPENDIX E-9

CPA-52 ENVIRONMENTAL EVALUATION WORKSHEET

U.S. Department of Agriculture NRCS-CPA-52
Natural Resources Conservation Service 6/2010

ENVIRONMENTAL EVALUATION WORKSHEET

A. Client Name: Kane County Water Conservancy District

B. Conservation Plan ID # (as applicable): Cove Reservoir 2017
Program Authority (optional): PL 83-566 - WFPO 2017

C. Identification # (farm, tract, field #, etc as required):
East Fork Virgin River - West of Orderville, Utah, Sections 5 & 6, Township 41 South, Range 7 West, Salt Lake Base and Meridian. Section within the East Fork Virgin River PL566 Watershed, Kane County, Utah. HUC: 150100080203

D. Client's Objective(s) (purpose):
The purpose of the project is to provide water storage for the KCWCD to aid in providing a full water right to the irrigators in the area as well as releases of water to augment stream flows during low flow periods in the Virgin River system for endangered fish.

E. Need for Action:	**G. Alternatives**		
	No Action √ if RMS ☐	***Alternative 1*** √ if RMS ☐	***Alternative 2*** √ if RMS ☐
The proposed Cove Reservoir will release stored water, to minimize water shortages, during the summer months to meet consumptive use requirements for agriculture as well as supplement flows to the Virgin River for endangered species fish habitat	No Federal Assistance. Not acceptable as the water storage is necessary to sustain agricultural production and the system will also provide additional stream flow for endangered fish species in the Virgin River when flows are below normal.	**Preferred:** **1)** Construct ~6,032 ac-ft storage capacity reservoir. Estimated Cost: Total Cost: $19,200,000 PL 83-566 Funds: $14,400,000 (75%) Other Funds - KCWCD $4,800,000 (25%)	Several alternative dam alignments were considered in the project area but the proposed alternative was selected based on geologic conditions of the site and construction cost of the reservoir.

Resource Concerns

In Section "F" below, analyze, record, and address concerns identified through the Resources Inventory process.
(See FOTG Section III - Resource Quality Criteria for guidance).

F. Resource Concerns and Existing / Benchmark Conditions (Analyze and record the existing/benchmark conditions for each identified concern)	**H. Effects of Alternatives**					
	No Action		***Alternative 1***		***Alternative 2***	
	Amount, Status, Description (short and long term)	√ if does NOT meet QC	Amount, Status, Description (short and long term)	√ if does NOT meet QC	Amount, Status, Description (short and long term)	√ if does NOT meet QC
SOIL						
No resource concern identified	No direct effect	NOT meet QC ☐	Short term: Off stream construction disturbance areas will re-vegetate. Long term: no direct effect.	NOT meet QC ☐	Same as Alternative #1	NOT meet QC ☐
WATER						
Quantity (Insufficient Flows in Water Courses) Storm events will continue to be conveyed through the existing river channel. The proposed off stream reservoir will augment flows in the Virgin River drainage during low flow periods.	No direct effect	☐ NOT meet QC	Short & Long Term: Water released from the reservoir will increase stream flow during low flow periods.	☐ NOT meet QC	Same as Alternative #1	☐ NOT meet QC

F. Resource Concerns and Existing / Benchmark Conditions (Analyze and record the existing/benchmark conditions for each identified concern)	**H. (continued)**					
	No Action		***Alternative 1***		***Alternative 2***	
	Amount, Status, Description (short and long term)	√ if does NOT meet QC	Amount, Status, Description (short and long term)	√ if does NOT meet QC	Amount, Status, Description (short and long term)	√ if does NOT meet QC
AIR						
Quality [Particulate Matter < 10μm diameter ("PM 10")] No Effect	No Effect	NOT meet ☐ QC	Short term: fugitive dust expected during construction activities - mostly from equipment accessing the site on gravel/dirt roads; Long term: no effect	NOT meet ☐ QC	Same as Alternative #1	NOT meet ☐ QC
PLANTS						
Other Flowering Plants in work area: Jones Cycladia = critical habitat; Siler Pincushion Cactus = critical habitat. (IPaC Report access - 8/24/17). https://ecos.fws.gov/ipac/	Short term: Minor loss of vegetation (grasses, shrubs) at channel cutbank areas due to lateral bank recession; Long term: no effect	☐ NOT meet QC	Short term: Impact to area for construction of the reservoir and piping. Long term: disturbed areas will re-vegetate with seedings.	☐ NOT meet QC	Same as Alternative #1	☐ NOT meet QC
Condition (Noxious and Invasive Plants) Kane County Noxious Weed = Russian Olive. **Class 1B:** Goatsrue, Elongated mustard, Common St. Johnswort, Cutleaf vipergrass // **Class 2**: Spotted knapweed; Purple loosestrife; Yellow starthistle; Diffuse knapweed; Dalmation toadflax; **Class 3:** Russian knapweed; Houndstounge; Perennial pepperweed (Tall whitetop); Tamarisk (Saltcedar); Hoary cress; Canada thistle; Poison hemlock; Musk thistle Perennial Sorghum; Johnson Grass (Sorghum halepense) and Sorghum almun; Scotch thistle (Cotton thistle) Field bindweed (Wild Morning-glory) . Puncturevine (Goathead) (*Ref. Kane Co RMP, p.17, May 2017*) .	Short Term: Existing management and land use practices would continue. Long Term: Future cutbank areas of the East Fork Virgin River would be vulnerable to establishment of noxious and/or invasive plants. There is a system in place for the public to identify noxious/invasive weeds and report them to the state for authentication.	☐ NOT meet QC	Short term: Disturbed areas would be temporarily exposed to some invasive growth. Disturbed areas would be re-seeded per NRCS guidelines with an approved seed mix. Long term: No Effect. Equipment brought into the area would be cleaned prior to commencing work to minimize the risk of spreading invasive plants. There is a system in place for the public to identify noxious/invasive weeds and report them to the state for authentication.	☐ NOT meet QC	Same as Alternative #1	☐ NOT meet QC

[Final]

ANIMALS						
Fish and wildlife (Impacts to Endangered or Threatened Animals) Flow will continue to be conveyed through the existing river channel. The proposed off stream reservoir will augment flows in the Virgin River drainage during low flow periods, to improve aquatic habit for endangered species.	Federal Species = No effect State Species = No effect	☐ NOT meet QC	Federal Species = No effect State Species 1) Bald Eagle= No nesting habitat present-however birds may fly over the project area & likely forage in suitable habitat adjacent to the proposed reservoir; 2) Black swift = No nesting or foraging habitat present; 3) Smooth glenwood pyrg = Only occurs in two spring sites in Utah--No suitable habitat present; 4) Carinate glenwood pyrg = Only occurs in two spring sites in Utah--No suitable habitat present; 5) Townsends big-eared bat = No suitable nesting habitat in project area - suitable foraging habitat exists above and along the river - no meaningful impact anticipated to their preferred food source (insects) -- little risk of disturbance during construction	☐ NOT meet QC	(Same as Alt-1).	☐ NOT meet QC
		NOT		NOT		NOT
HUMAN - Economic and Social Considerations						
Land Use The proposed reservoir will create energy and outdoor recreation.	No Effect		Green energy will be produced from water released from the reservoir as well as benefits derived from the addition of a recreational facility for boating, fishing and swimming.		Same as Alternative #1	

Special Environmental Concerns: Environmental Laws, Executive Orders, policies, etc.

In Section "I" complete and attach applicable Environmental Procedures Guide Sheets for documentation. Items with a "●" may require a federal permit or consultation/coordination between the lead agency and another government agency. In these cases, effects may need to be determined in consultation with another agency. Planning and practice implementation may proceed for practices not involved in consultation

I. Special Environmental Concerns	**J. Impacts to Special Environmental Concerns**					
(Document compliance with Environmental Laws, Executive Orders, policies, etc.)	***No Action***		***Alternative 1***		***Alternative 2***	
	Status and progress of compliance. (Complete and attach Guide Sheets as applicable)	√ if needs further action	Status and progress of compliance. (Complete and attach Guide Sheets as applicable)	√ if needs further action	Status and progress of compliance. (Complete and attach Guide Sheets as applicable)	√ if needs further action
●Clean Air Act No effect.	Upon Review, No Action Needed	☐	Upon Review, No Effect	☐	Upon Review, No Effect	☐
●Clean Water Act / Waters of the U.S. No effect.	Upon Review, No Action Needed	☐	Upon Review, No Effect	☐	Upon Review, No Effect	☐
●Coastal Zone Management	Upon Review, Not Applicable	☐	Upon Review, Not Applicable	☐	Upon Review, Not Applicable	☐
Coral Reefs	Upon Review, Not Applicable	☐	Upon Review, Not Applicable	☐	Upon Review, Not Applicable	☐
●Cultural Resources / Historic Properties	Upon Review, No Action Needed	☐	Other Not anticipated but full evaluation to be completed with Plan-EA NEPA process if funded.	☐	Upon Review, Not Applicable	☐
●Endangered and Threatened Species Ref. IPaC Rpt 5/26/17: **BIRDS**: California Condor(**EXPN**-no critical habitat); Mexican Spotted Owl (**T**-loc outside critical habitat); Southwest Willow Flycatcher (**E**-loc overlaps designated critical habitat); Yellow-billed Cuckoo(**T**-loc outside critical habitat). FISH:Virgin River Chub (**E**), Woundfin (**E**) = both outside critical habitat // **PLANTS**: Jones Cycladenia(**T**)-no crit hab; Siler Pincushion(**E**)-no crit habitat.	See Attached Documentation	☐	See Attached Documentation Updated Consult to be completed with USFWS before construction if funding approved. No critical habitat in the general project area (IPaC Report access - 7/26/17). To be addressed in further NEPA documentation and consultation.	☑	See Attached Documentation Updated Consult to be completed with USFWS before construction if funding approved. No critical habitat in the general project area (IPaC Report access - 7/26/17). To be addressed in further NEPA documentation and consultation.	☑
Environmental Justice	Upon Review, No Action Needed	☐	No Effect-see documentation	☐	No Effect-see documentation	☐
●Essential Fish Habitat	Upon Review, Not Applicable	☐	Upon Review, Not Applicable	☐	Upon Review, Not Applicable	☐
Floodplain Management	Upon Review, No Action Needed	☐	No Effect-see documentation	☐	No Effect-see documentation	☐
Invasive Species	No Effect-see documentation	☐	See Attached Documentation Disturbed areas will be replanted-reseeded per agency/partner consultation. To be addressed in further NEPA doc.	☑	See Attached Documentation Disturbed areas will be replanted-reseeded per agency/partner consultation. To be addressed in further NEPA doc.	☑

[Final]

•Migratory Birds/Bald and Golden Eagle Protection Act **Ref. IPaC Rpt 8/24/17:** Bald Eagle (Wintering); Bendire's Thrasher (Breeding); Black Rosy-finch(Year-round); Black-chinned Sparrow(Breeding Brewer's Sparrow(Breeding); Burrowing Owl(Breeding); Calliope Hummingbird(Migrating); Cassin's Finch(Year-round); Costa's Hummingbird(Year-round Ferruginous Hawk(Year-round); Flammulated Owl(Breeding); Golden Eagle(Year-round); Grace's Warbler(Breeding); Gray Vireo(Breeding); Juniper Titmouse(Year-round) Lewis's Woodpecker(Year-round	Upon Review, No Action Needed	☐	See Attached Documentation If work is required during the migratory bird breeding/nesting period, a site specific survey for nesting birds will be performed starting at least 2 weeks prior to vegetation treatments. If nesting birds are found during the survey, appropriate spatial buffers will be established around nests in coordination with USFWS and UDWR. Established nests with eggs or young will not be moved, and the birds will not be harassed until all young have fledged and are capable of leaving the nest site. Confirmation that all young have fledged will be made by a qualified biologist prior to construction.	☑	See Attached Documentation If work is required during the migratory bird breeding/nesting period, a site specific survey for nesting birds will be performed starting at least 2 weeks prior to vegetation treatments. If nesting birds are found during the survey, appropriate spatial buffers will be established around nests in coordination with USFWS and UDWR. Established nests with eggs or young will not be moved, and the birds will not be harassed until all young have fledged and are capable of leaving the nest site. Confirmation that all young have fledged will be made by a qualified biologist prior to construction.	☑
Prime and Unique Farmlands No effect	Upon Review, Not Applicable	☐	Upon Review, Not Applicable	☐	Upon Review, Not Applicable	☐
Riparian Area East Fork Virgin River is a perennial stream.	See Attached Documentation	☐	See Attached Documentation Diversion structure will be constructed at the East Fork Virgin River. Some channel protection measures may be needed in the vicinity of the structure.	☑	See Attached Documentation Diversion structure will be constructed at the East Fork Virgin River. Some channel protection measures may be needed in the vicinity of the structure.	☑
•Wetlands No effect	No Effect-see documentation Waters of the U.S. - channel	☐	See Attached Documentation Waters of the U.S present. Detailed check will be carried out with planning process - NEPA Plan-EA.	☑	Upon Review, Not Present Waters of the U.S. present. Detailed check will be carried out with planning process - NEPA Plan-EA.	☑
•Wild and Scenic Rivers Virgin River is the only designated Wild & Scenic River in Utah.	Upon Review, Not Applicable	☐	Upon Review, Not Applicable	☐	Upon Review, Not Applicable	☐

K. Other Agencies and Broad Public Concerns	***No Action***	***Alternative 1***	***Alternative 2***
Easements, Permissions, Public Review, or Permits Required and Agencies Consulted. Coordinate with the Utah Division of Wildlife Res. & USFWS for alternatives. BLM SF-299/Spec Use Permit needed.	None needed	USFWS: T&E species ; UDivWildRes: Coord for other alternatives to protect road; UDWaterRts: Stream Alt Permit-contact C.Williamson; State Sp Status Species: See attached Table; UDNR: Aquatic Info - Matt Briggs-435-340-0140. Native American consultation. ACOE consultation & 401 WQ/NPDES Cert: To be completed before construction.	Same as Alt -1.

K. (continued) Other Agencies and Broad Public Concerns	***No Action***	***Alternative 1***	***Alternative 2***
Cumulative Effects Narrative (Describe the cumulative impacts considered, including past, present and known future actions regardless of who performed the actions)	None needed	Based on review of the Proposed Action, it is determined this action would not have a significant adverse cumulative effect on any resources.	Based on review of the Proposed Action, it is determined this action would not have a significant adverse cumulative effect on any resources.
L. Mitigation	None	TBD with USFWS consultation	TBD with USFWS consultation

M. Preferred Alternative	√ preferred alternative	☐	☑	☐
	Supporting reason	Not acceptable	This alternative is the most cost effective location for the reservoir.	Not acceptable

N. Context (Record context of alternatives analysis)	local	local	local

The significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality.

O. Determination of Significance or Extraordinary Circumstances

Intensity: Refers to the severity of impact. Impacts may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.

If you answer ANY of the below questions "yes" then contact the State Environmental Liaison as there may be extraordinary circumstances and significance issues to consider and a site specific NEPA analysis may be required.

Yes	No	
☐	☑	• Is the preferred alternative expected to cause significant effects on public health or safety?
☐	☑	• Is the preferred alternative expected to significantly effect unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas?
☐	☑	• Are the effects of the preferred alternative on the quality of the human environment likely to be highly controversial?
☐	☑	• Does the preferred alternative have highly uncertain effects or involve unique or unknown risks on the human environment?
☐	☑	• Does the preferred alternative establish a precedent for future actions with significant impacts or represent a decision in principle about a future consideration?

[Final]

☐	☑	• Is the preferred alternative known or reasonably expected to have potentially significant environment impacts to the quality of the human environment either individually or cumulatively over time?
☐	☑	• Will the preferred alternative likely have a significant adverse effect on ANY of the special environmental concerns? Use the Evaluation Procedure Guide Sheets to assist in this determination. This includes, but is not limited to, concerns such as cultural or historical resources, endangered and threatened species, environmental justice, wetlands, floodplains, coastal zones, coral reefs, essential fish habitat, wild and scenic rivers, clean air, riparian areas, natural areas, and invasive species.
☐	☑	• Will the preferred alternative threaten a violation of Federal, State, or local law or requirements for the protection of the environment?

P. The information recorded above is based on the best available information:
In the case where a non-NRCS person (i.e. a TSP) assists with planning they are to sign the first signature block and then NRCS is to sign the second block as the responsible federal agency for the planning action.

Alpha Engineering-B.Gardner	Staff	8/24/2017
Signature (TSP if applicable)	**Title**	**Date**
Norm Evenstad	WRC	8/25/2017
Signature (NRCS)	**Title**	**Date**

The following sections are to be completed by the Responsible Federal Official (RFO)

Q. NEPA Compliance Finding (check one)

The preferred alternative: **Action required**

☐	1) is **not a federal action** where the agency has control or responsibility.	Document in "R.1" below. No additional analysis is required
☐	2) is a federal action that is **categorically excluded** from further environmental analysis **and** there are no extraordinary circumstances.	Document in "R.2" below. No additional analysis is required
☐	3) is a federal action that has been **sufficiently analyzed** in an existing Agency state, regional, or national NEPA document **and** there are no predicted significant adverse environmental effects or extraordinary circumstances.	Document in "R.1" below. No additional analysis is required.
☐	4) is a federal action that has been sufficiently analyzed in another Federal agency's NEPA document (EA or EIS) that addresses the proposed NRCS action and its' effects **and has been formally adopted by NRCS**. NRCS is required to prepare and publish the agency's own Finding of No Significant Impact for an EA or Record of Decision for an EIS when adopting another agency's EA or EIS document. **Note: This box is not applicable to FSA.**	Contact the State Environmental Liaison for list of NEPA documents formally adopted and available for tiering. Document in "R.1" below. No additional analysis is required
☑	5) is a federal action that has **NOT** been sufficiently analyzed or may involve predicted significant adverse environmental effects or extraordinary circumstances and may require an EA or EIS.	Contact the State Environmental Liaison. Further NEPA analysis required.

R. Rationale Supporting the Finding

R.1 Findings Documentation	Plan-EA or EIS will be required for this project using PL566 Watershed Program authorities, policies and regulations outlined in the National Watershed Program Manual and it's associated references.
R.2 Applicable Categorical Exclusion(s) (more than one may apply)	

I have considered the effects of the alternatives on the Resource Concerns, Economic and Social Considerations, Special Environmental Concerns, and Extraordinary Circumstances as defined by Agency regulation and policy.

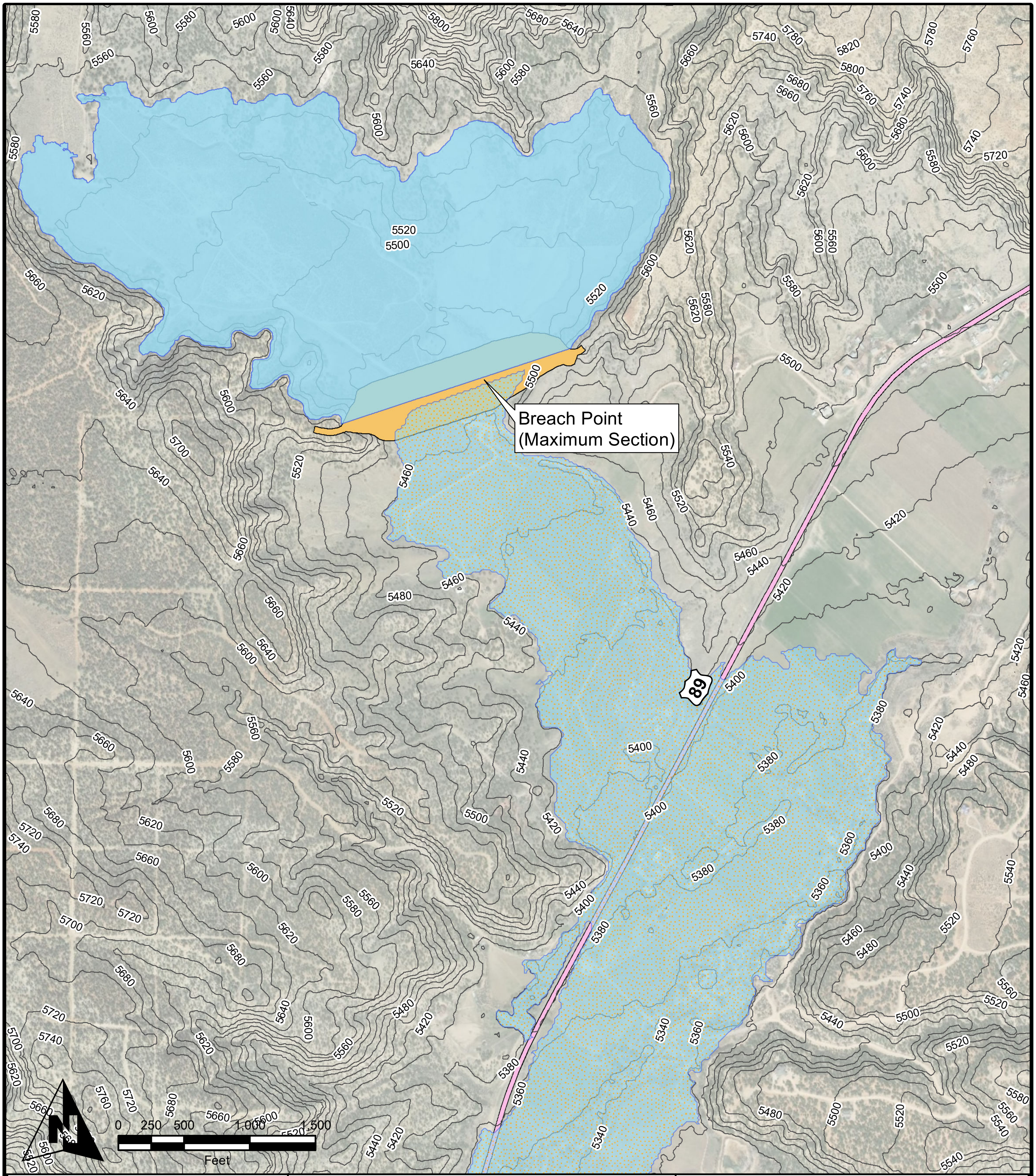
S. Signature of Responsible Federal Official:

Signature	**Title**	**Date**

Additional notes

APPENDIX E-10

BREACH INUNDATION SIMULATION MAPS



ALPHA ENGINEERING

RB&G ENGINEERING, INC.

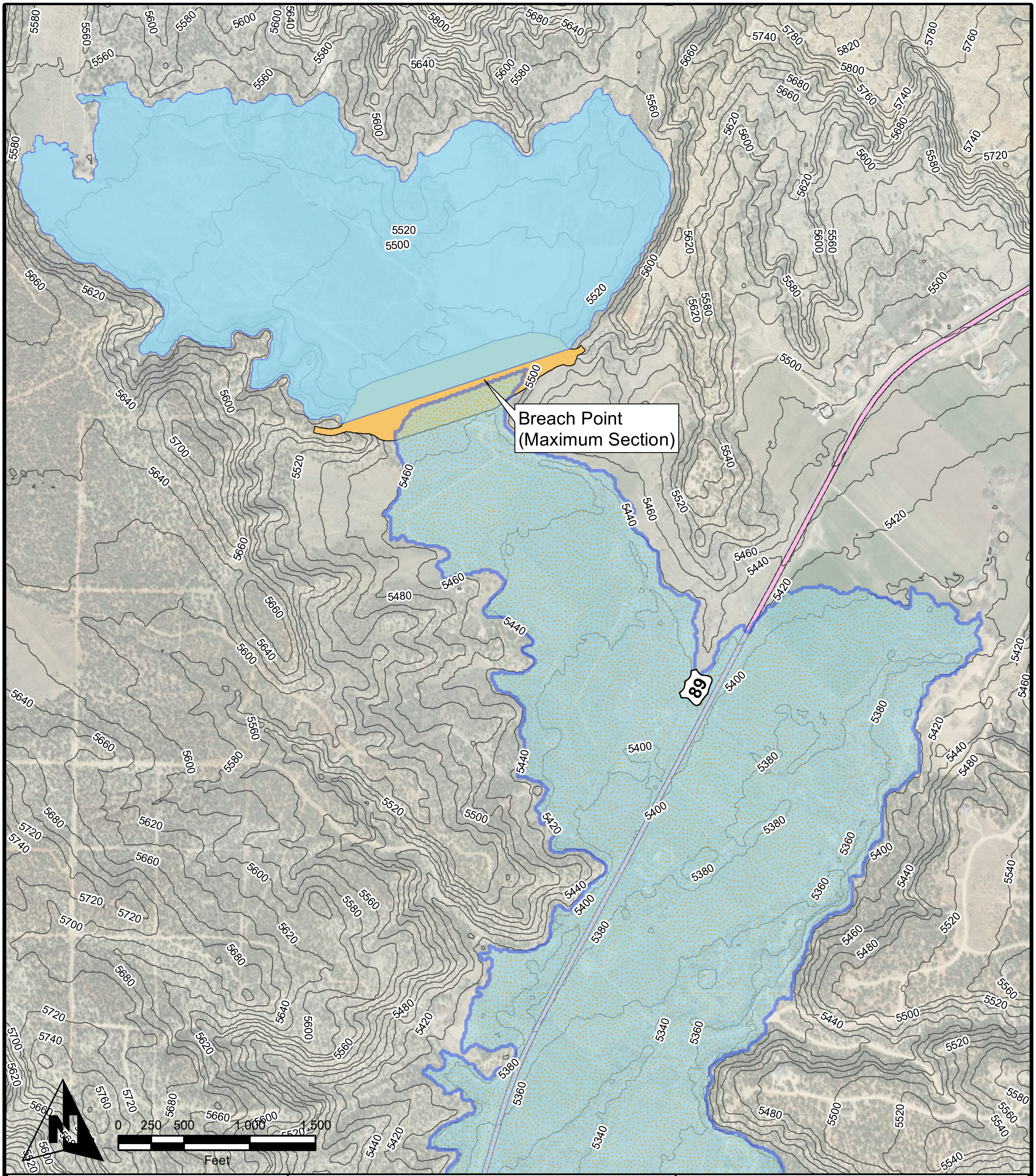
- 🟦 Reservoir
- 🟧 Cove Dam Structure
- ▨ Inundation Boundary - Breach Point 1
- — Contours (20' Interval)

Sunny Day Breach Inundation Map

Exhibit 7 - Cove Reservoir

Spatial Reference:	UT83-SF
Drawn By:	JRH
Scale:	1 inch = 1,000 feet
Date:	August 16, 2018

P:\357-21 KCWCD Cove Reservoir Environmental and Design\Drawings\GIS\357-21 Inundation Boundary Sunny Day.mxd, 8/16/2018 8:02:14 AM jmadsen



- 🟦 Reservoir
- 🟧 Cove Dam Structure
- ▨ Inundation Boundary - Breach Point 2
- — Contours (20' Interval)

Rainy Day Breach Inundation Map

Exhibit 8 - Cove Reservoir

Spatial Reference:	UT83-SF
Drawn By:	JRH
Scale:	1 inch = 1,000 feet
Date:	August 16, 2018

ALPHA ENGINEERING

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P:\357-21 KCWCD Cove Reservoir Environmental and Design\Drawings\GIS\357-21 Inundation Boundary Rainy Day.mxd, 8/16/2018 8:00:57 AM jmadsen

APPENDIX E-11

SEDIMENT SUPPLEMENTAL DOCUMENTATION

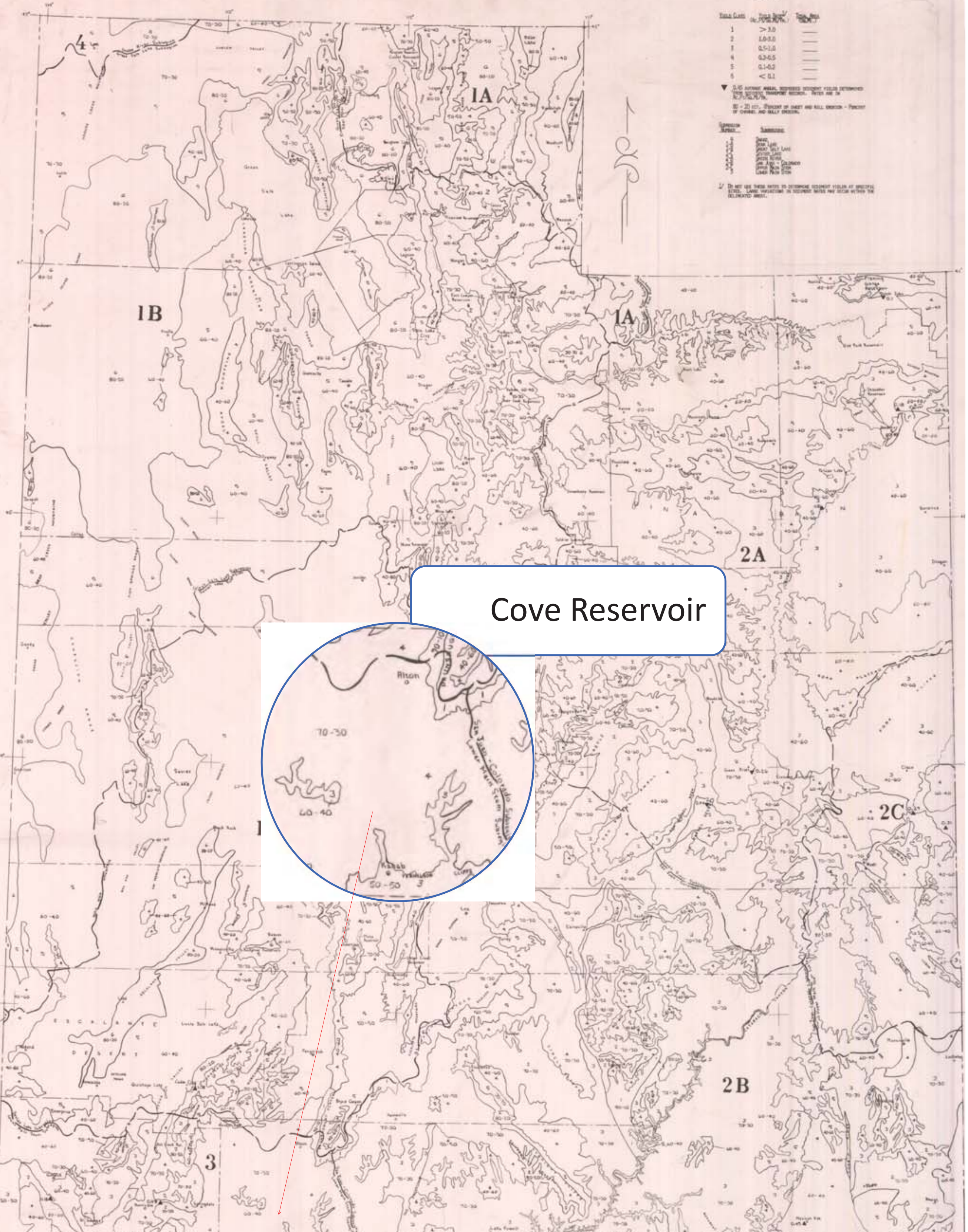
Table 2.9. List of drainage basin characteristics and possible range of numerical ratings (modified from Pacific Southwest Interagency Committee, Water Management Subcommittee, 1968)

Drainage basin characteristics	Sediment yield levels		
	High rating	Moderate rating	Low rating
Surface geology	[✓ 10:] marine shales and related mudstones and siltstones	5: rocks of medium hardness moderately weathered and fractured	0: massive hard formations
Soils	[✓ 10:] fine textured and easily dispersed or single grain salts and fine sands	5: medium textured, occasional rock fragments, or caliche crusted layers	0: frequent rock fragments, aggregated clays, or high organic content
Climate	10: frequent intense convective storms	[✓ 5:] infrequent convective storms, moderate intensity	0: humid climate with low intensity rainfall, arid climate with low intensity rainfall, or arid climate with rare convective storms
Runoff	10: high flows or volume per unit area	[✓ 5:] moderate flows or runoff volume per unit area	0: low flows or volume per unit area or rare runoff events
Topography	[✓ 20:] steep slopes (in excess of 30%), high relief, little or no flood plain development	10: moderate slopes (about 20%), moderate flood plain development	0: gentle slopes (less than 5%), extensive flood plain development
Ground cover	[✓ 10:] ground cover less than 20%, no rock or organic litter in surface soil	0: ground cover less than 40%, noticeable organic litter in surface soil	-10: area completely covered by vegetation, rock fragments, organic litter with little opportunity for rainfall to erode soil
Land use	10: more than 50% cultivated, sparse vegetation, and no rock in surface soil	0: less than 25% cultivated, less than 50% intensively grazed	[✓ -10:] no cultivation, no recent logging, and only low intensity grazing, if any
Upland erosion	25: rill, gully, or landslide erosion over more than 50% of the area	[✓ 10:] rill, gully, or landslide erosion over about 25% of area	0: no apparent signs of erosion
Channel erosion	25: continuous or frequent bank erosion, or active headcuts and degradation in tributary channels	[✓ 10:] occasional channel erosion of bed or banks	0: wide shallow channels with mild gradients, channels in massive rock, large boulders, or dense vegetation or artificially protected channels

TOTAL = 70

Table 2.10. Drainage basin sediment yield classification (Randle, 1996)

Drainage basin classification number	Total rating	Annual sediment yield (ac-ft/mi^2)
1	> 100	> 3
2	75 to 100	1.0 to 3.0
→ 3	50 to 75	0.5 to 1.0 ←
4	25 to 50	0.2 to 0.5
5	0 to 25	<0.2



- EXPLANATION -

YIELD CLASS	YIELD RATE 1/ (Ac.Ft./Sq.Mi./Yr.)	[illegible]
1	> 3.0	
2	1.0-3.0	
3	0.5-1.0	
4	0.2-0.5	
5	0.1-0.2	
6	< 0.1	

▼ 0.45 Average annual suspended sediment yields determined from sediment transport records. Rates are in Ac.Ft./Sq.Mi./Yr.

80 - 20 etc. (Percent of sheet and rill erosion - Percent of channel and gully erosion.

Subregion Number	Subregions
[illegible]	Snake
[illegible]	Bear Lake
[illegible]	Great Salt Lake
[illegible]	Sevier Lake
[illegible]	Green River
[illegible]	[illegible] - Colorado
[illegible]	Upper Main Stem
[illegible]	Lower Main Stem

1/ Do not use these rates to determine sediment yields at specific sites. Large variations in sediment rates may occur within the delineated areas.

SOURCES OF INFORMATION

1. Great Basin, Upper Colorado and Lower Colorado Regions, Comprehensive Framework Study, Appendices VIII, Watershed Management, June 1971. Pacific Southwest Inter-Agency Committee/Water Resources Council.
2. Utah State Soils Map and soils descriptions.
3. Reservoir surveys by SCS & USBR.
4. Suspended load measurements by USGS, USBR & SCS.
5. Watershed studies by SCS.
6. General knowledge of the state from regular SCS program work.

ESTIMATED SEDIMENT YIELD RATES
FOR THE
STATE OF UTAH

EROSION & SEDIMENTATION -TO
WESTERN U.S. WATER PLAN
AUGUST 1973
(SUBJECT TO REVISION)
prepared by
U.S.D.A., Soil Conservation Service
Geologist, Bob L. Bridges

10 5 0 5 10 15
scale in miles

APPENDIX E-12

PRELIMINARY DESIGN REPORT

Preliminary Design Report

Cove Reservoir

Kane County

Water Conservancy District

PRELIMINARY

August 2020

ALPHA ENGINEERING

RB&G ENGINEERING, INC.

Table of Contents

Part I. Introduction

The Kane County Water Conservancy District (KCWCD) is proposing to install a new reservoir known as Cove Reservoir with associated facilities to be located near Orderville, Utah. The reservoir is a joint venture between KCWCD and the Washington County Water Conservancy District (WCWCD). The system will store water rights from local irrigation companies for use throughout the year.

The engineering design is being performed by Alpha Engineering Company (Alpha) out of St. George, Utah, and RB&G Engineering, Inc., (RB&G) out of Provo, Utah. Alpha is responsible for providing hydraulic analyses and spillway and water conveyance facility design, and RB&G is responsible for providing geologic investigations and dam structure design.

The project includes the construction of an off-stream reservoir less than one mile off the main drainage course, East Fork Virgin River (see **Figure 1** below). The reservoir is designed to hold approximately 6,000 acre-feet of water. The dam will be an earthen structure with primary and emergency spillways adjacent to the left abutment. To convey flows to and from the reservoir, new piping will be installed to tie into existing water transmission facilities. Due to immediately downstream homes, this dam is classified as High Hazard.

This report is being prepared as a comprehensive analysis of the design elements associated with the construction and operation of Cove Reservoir. The project location is shown below and overall exhibits of the project components—which include the dam structure, primary and auxiliary spillways, outlet works, an access road around the reservoir and a water conveyance system that ties the reservoir into the existing water system—are shown in **Appendix A, Exhibits 1 and 2**.

Figure 1 Cove Reservoir Location

This study references the following sources in the analysis of the hydrologic conditions at the Cove Reservoir:

- Technical Release 210-60 (TR-60), USDA 2019
- Technical Release 55 (TR-55), USDA 1986
- Technical Release 56 (TR-56), USDA 2014
- Utah Administrative Code Rule R655-11 (UAC), utah.gov 2020
- Hydrometeorological Report 49 (HMR-49), USACE 1984
- PMP Studies by Donald T. Jensen (Jensen), USU 1995 and 2003
- National Engineering Handbook, Section 4 (NEH-4), Mockus 1965 and 1972
- NOAA Atlas 14 (NWS), NWS 2018
- National Land Cover Database (NLCD), MRLC 2011
- Web Soil Survey (WSS), NRCS 2018
- National Engineering Handbook Part 630 (NEH), USDA 2019
- Flood Hydrology Manual (USBR), USBR 1989

The following software programs were used in modeling the hydrologic/hydraulic conditions and breach analysis:

- HEC-1 version 4.1 (HEC-1), USACE 1998
- USDA Water Resource Site Analysis version 2005.1.8 (SITES), USDA 2005
- HEC-RAS version 5.0.5 (HEC-RAS), USACE 2016
- Bentley FlowMaster version V8i (FlowMaster), Bentley 2009

Part II. Hydrology Analysis

A. Site Location and Existing Conditions

The Cove Reservoir dam is located 0.6 miles west of Highway 89 along Cove Road due southwest of the town of Orderville, Utah, or 37.269° North Latitude and 112.661° West Longitude. The reservoir surface area generated with the construction of the dam is approximately 186 acres and is comprised of undisturbed shrub ground cover, natural drainage channels, dirt roads and a section of ranch land used for grazing.

An aerial drone survey was performed across the anticipated footprint of the reservoir and was used to generate a 3D model of the existing surface with an approximate one-foot vertical accuracy and six inch horizontal accuracy. This surface model was used in designing the different components of the project and are shown at 10-foot contour intervals on **Appendix A, Exhibit 2**.

Using available USGS DEM data, the area upstream of the proposed reservoir was delineated to determine the drainage area tributary to the reservoir. The drainage basin tributary to the Cove Reservoir site is 3,034 acres, or 4.7 square miles, and is generally comprised of undeveloped shrub and evergreen forest ground cover. The centroidal location of the tributary drainage basin is 37.305° North Latitude and 112.662° West Longitude. The mean basin elevation is 6271'. The average annual temperature for the area is 51.2°F (NWS, Climate Monitoring) with an average annual precipitation of 15.6 inches (USGS, StreamStats). The Climatic Index calculates to 0.6 (NEH 630, Equation 21-1). An exhibit of the Cove Reservoir and its tributary drainage basin is shown in **Appendix A, Exhibit 3**. This exhibit also shows delineated subbasins of the overall tributary drainage basin as will be discussed later in this report.

B. Design Criteria

The hydrographs analyzed in this study, as required by NRCS and Utah Dam Safety, are summarized in **Table 1**. The NRCS requires hydrograph analyses for the Principal Spillway, Auxiliary Spillway and Freeboard (TR-60, Part 2). The Utah State Engineers Office requires hydrograph analyses for probable maximum flood events (general and local storms) and for 100-year events with saturated soil conditions (UAC, Section 11-4A). As directed by the NRCS, additional hydrographs with varying return frequencies are being analyzed for informational purposes.

Hydrograph	Frequency	Duration	Precipitation
NRCS Required Hydrographs			
Principal Spillway Hydrograph	100-year	10-day	TR-60, Fig 2-1 (NWS)
Auxiliary Spillway Hydrographs	Maximum	6- & 24-hour	TR-60, Fig 2-2
Freeboard Hydrographs	Maximum	6- & 24-hour	TR-60, Fig 2-2
Varying Frequency Hydrographs	2-, 5-, 10-, 25-, 50-, 100- & 500-year	24-hour	NWS
Utah State Required Hydrographs			
SEP Hydrographs	Maximum	6- & 72-hour	Jensen
100-year (AMC III) Hydrographs	100-year	6- & 72-hour	NWS

Table 1 Summary of Design Hydrographs

Each of the above hydrographs is included in this analysis as separate Storm Events. For purposes of this analysis, **Table 2** assigns numbers to each Storm Event.

	Storm Event	Duration	Frequency	AMC
01	2-year 24-hour	24-hour	2-year	II
02	5-year 24-hour	24-hour	5-year	II
03	10-year 24-hour	24-hour	10-year	II
04	25-year 24-hour	24-hour	25-year	II
05	50-year 24-hour	24-hour	50-year	II
06	100-year 24-hour	24-hour	100-year	II
07	500-year, 24-hour	24-hour	500-year	II
08	100-year 6-hour AMC III	6-hour	100-year	III
09	100-year 24-hour AMC III	24-hour	100-year	III
10	Local SEP Hydrograph (SEP-L)	6-hour	Maximum	II
11	General SEP Hydrograph (SEP-G)	72-hour	Maximum	II
12	Principal Spillway Hydrograph (PSH)	10-day	100-year	-[1]
13	Local Auxiliary Spillway Hydrograph (ASH-L)	6-hour	Maximum	II
14	General Auxiliary Spillway Hydrograph (ASH-G)	24-hour	Maximum	II
15	Local Freeboard Hydrograph (FBH-L)	6-hour	Maximum	II
16	General Freeboard Hydrograph (FBH-G)	24-hour	Maximum	II

Table 2 Summary of Storm Events

The Principal Spillway Hydrograph (Storm Event 12) will be used in designing the Principal spillway. The most critical of the Auxiliary Spillway, Freeboard and SEP Hydrographs (Storm Events 10, 11, 13, 14, 15 and 16) will be used in designing the auxiliary spillway and establishing the top-of-dam elevation. The Local Auxiliary Spillway Hydrograph (Storm Event 13) is used to check the stability of auxiliary spillway.

---

[1] As directed in NEH 630.2102(a)(1), Curve Numbers reflected in NEH 630.2102, Table 21-2, are used for the PSH because the precipitation value exceeds 6 inches.

C. Precipitation Values

The precipitation values for the 2- to 500-year, 24-hour and the 100-year, 10-day storm events (Storm Events 01 through 09 and 12) are taken from NWS. For the PSH (Storm Event 12), see also TR-60, Figure 2-1. Fourteen evenly spaced points throughout the drainage basin were taken and averaged out to calculate a single overall precipitation value for each storm frequency. An exhibit reflecting these points is included in **Appendix A, Exhibit 4**, and calculations are included in **Appendix B**.

The precipitation values for the SEP storms (Storm Events 10 and 11) are taken from HMR-49 and Jensen. It is noted that HMR-49 outlines the method used in calculating the Probable Maximum Precipitation (PMP) values for this drainage basin. Jensen has been accepted by the Utah State Engineer's Office and further updates the PMP values. PMP values that have been updated by Jensen are referred to as Spillway Evaluation Precipitation (SEP) values and are used in lieu of the PMP values. Calculations for the SEP values are included in **Appendix B**.

The precipitation value for the ASH and FBH storm events (Storm Events 13 through 16) are taken from TR-60, Figure 2-2. The precipitation values are calculated using the NWS 100-year and Jensen SEP precipitation values. Calculations for the ASH and FBH values are included in **Appendix B**.

The precipitation values for each storm event are summarized in **Table 3**.

	Storm Event	Precipitation Value
01	2-year 24-hour	1.61 in
02	5-year 24-hour	2.01 in
03	10-year 24-hour	2.34 in
04	25-year 24-hour	2.79 in
05	50-year 24-hour	3.14 in
06	100-year 24-hour	3.51 in
07	500-year, 24-hour	4.69 in
08	100-year 6-hour AMC III	2.75 in
09	100-year 24-hour AMC III	3.51 in
10	Local SEP Hydrograph (SEP-L)[2]	7.67 in
11	General SEP Hydrograph (SEP-G)	12.50 in
12	Principal Spillway Hydrograph (PSH)	6.83 in
13	Local Auxiliary Spillway Hydrograph (ASH-L)	4.03 in
14	General Auxiliary Spillway Hydrograph (ASH-G)	5.85 in
15	Local Freeboard Hydrograph (FBH-L)	7.67 in
16	General Freeboard Hydrograph (FBH-G)	10.20 in

Table 3 Storm Event and Precipitation Values

---

[2] As allowed by UAC, SEP values are used in this analysis and are updated values (Jensen) to PMP values calculated in HMR-49. For comparison purposes, the Local PMP Precipitation Value is 9.46 inches and the General PMP Precipitation Value is 12.50 inches.

D. Drainage Basin Parameters

The 4.7-square mile tributary drainage basin for the Cove Reservoir was divided into 12 smaller subbasins, ranging in size from 0.13 square miles to 1.01 square miles, to facilitate calculations of the overall basin and account for the varying land cover conditions across each subbasin. The subbasin characteristics are summarized in **Table 4** and discussed in following sections.

Sub-basin	Area (sq mi)	CN, AMC II/III	Flow Length (ft)	Ave Slope (%)	Lag Time, AMC II/III (hr)	Time of Conc, AMC II/III (hr)	Initial Abst, AMC II/III (in)
1	0.503	72.8/86.0	7,814	44.5	0.30/0.20	0.51/0.34	0.75/0.32
2	0.436	72.5/85.8	7,709	42.1	0.31/0.21	0.52/0.34	0.76/0.33
3	0.279	71.0/84.9	5,069	42.6	0.23/0.15	0.39/0.25	0.82/0.36
4	0.453	73.3/86.3	7,181	42.1	0.29/0.19	0.48/0.32	0.73/0.32
5	0.805	74.1/86.8	10,349	42.7	0.38/0.25	0.63/0.42	0.70/0.30
6	0.150	84.3/92.5	3,221	36.9	0.12/0.08	0.19/0.14	0.37/0.16
7	0.327	75.7/87.8	7,022	39.6	0.27/0.18	0.46/0.31	0.64/0.28
8	1.012	84.0/92.4	11,194	23.1	0.40/0.29	0.67/0.48	0.38/0.17
9	0.242	85.5/93.1	4,699	34.4	0.16/0.11	0.26/0.19	0.34/0.15
10	0.129	86.7/93.7	3,010	33.3	0.11/0.08	0.18/0.14	0.31/0.13
11	0.279	84.8/92.8	6,019	24.0	0.23/0.17	0.39/0.28	0.36/0.16
12	0.127	81.2/90.9	3,485	12.0	0.24/0.17	0.40/0.28	0.46/0.20
Total[3]	**4.742**	**77.8/88.9**	**33,591**	**35.4**	**0.95/0.65**	**1.58/1.09**	**0.57/0.25**

Table 4 Drainage Subbasin Parameters

i. Land Use

Land use and soil data were obtained from NLCD and WSS. The majority of the basin is comprised of *42-Evergreen Forest*, with portions of *52-Shrub/Scrub* and smaller portions of *41-Deciduous Forest*, *21/22-Developed Open Space/Low Intensity* and *31-Barren Land*. An exhibit of the land use is included in **Appendix A, Exhibit 5**. The soil data for the site classifies the basin to have a relatively even mixture of all four hydrologic soil groups. An exhibit of the hydrologic soil groups is included in **Appendix A, Exhibit 6**.

Each subbasin is assigned a Soil Conservation Service Curve Number (CN) that associates the land use with the soil data. As different types of soil cover exist throughout a subbasin, CNs have been prorated on an area-weighted basis. CNs for each subbasin are taken from NEH, Tables 9-2 and 9-5. Because NLCD land use designations do not directly correspond to NEH land cover descriptions, **Table 5** demonstrates how each correspond for this analysis.

NLCD Land Use Designation	NEH Land Cover Designation
21/22-Developed Open Space/Low Intensity	Open Space, Poor (Table 9-5)
31-Barren Land	Desert Shrub, Fair (Table 9-2)

---

[3] While the Area for the Overall basin is a sum of each of the subbasins, the flow length is derived from portions of Subbasins B1, B2, B4, B6 and B8, which comprise the longest path through the Overall basin and is used to calculate the lag time and time of concentration. The average slope, curve number and initial abstraction were calculated based on the Overall basin.

41-Deciduous Forest	Pinyon-Juniper, Fair (Table 9-2)
42-Evergreen Forest	Pinyon-Juniper, Poor (Table 9-2)
52-Shrub/Scrub	Desert Shrub, Good (Table 9-2)

Table 5 NLCD Land Use to NEH Land Cover Designations

CNs for the individual subbasins are summarized in **Table 4** and range between 71.0 and 86.7 for AMC II and between 84.9 and 93.7 for AMC III. CNs used for the PSH (Storm Event 12) are modified per NEH 630.2102, Table 21-2, and range between 53.0 and 75.4. The overall basin CN is 77.8 for AMC II and 88.9 for AMC III. NLCD Land Use descriptions and curve number calculations are included in **Appendix B**.

ii. Lag Times

Lag times and times of concentration for the subbasins were calculated using methodology outlined in NEH Chapter 15, which estimates the lag time, TLAG, and time of concentration, T_c, for large drainage basins as:

$$TLAG = \frac{l^{0.8}\left(\left(\frac{1000}{CN} - 10\right) + 1\right)^{0.7}}{1,900Y^{0.5}}$$

$$T_c = \frac{TLAG}{0.6}$$

Paths for the basin lengths (l) are shown in **Appendix A, Exhibit 3**. Criteria and calculated lag times and times of concentration for the individual subbasins are summarized in **Table 4**. The overall time of concentration for the entire tributary basin—having a basin length of 33,591 feet, an average CN of 77.8/88.9 (AMC II/III), and an average watershed land slope of 35.4%–are 1.58 hours for AMC II and 1.09 hours for AMC III. For the PSH (Storm Event 12), which uses a CN based on NEH 630.2102, Table 21-2, the average CN is 71.8 and the overall time of concentration is 1.88 hours.

iii. Initial Abstraction

Initial abstraction depths for the subbasins were calculated using methodology outlined in TR-55, which estimates the initial abstraction depth, I_a, as:

$$I_a = 0.2 \times \left(\frac{1000}{CN} - 10\right)$$

Initial abstraction depth for the individual subbasins are summarized in **Table 4**. The overall basin initial abstraction depth equates to 0.57 inches for AMC II and 0.25 inches for AMC III. For the PSH (Storm Event 12), which uses a CN based on NEH 630.2102, Table 21-2, the initial abstraction for the overall basin is 0.79 inches.

iv. Reach Parameters

In developing the hydrologic models of the drainage basin, accumulating flows were routed along reach paths as shown in **Appendix A, Exhibit 3**. The geometry and characteristics of these reaches were based on field observations and engineering judgment. A trapezoidal channel was assumed along the reaches in conformance with field measurements having an increasing flow width, ranging from 20 to 40 feet wide, and a roughness coefficient of 0.30.

E. Storm Hydrographs

For the PSH, ASH and FBH (Storm Events 12-16), the hydrographs were developed using NEH 630.2102 and 2103. For all other storm events (Storm Events 01-11), a dimensionless design storm distribution (NEH 630.2103, Figure 21-9) was applied and modeled using HEC-1 software. The dimensionless storm distribution and calculated storm hydrographs are shown in tabular form with calculations in **Appendix B**.

F. Results

As mentioned, Storm Events 01 through 10 were modeled using HEC-1 software to determine the hydrographs. Each of the storm events were setup as separate models, and model output for the models is included in **Appendix C**. Storm Events 12-16 were developed using NEH 630.2103 and 2103 but were also modeled using HEC-1 software for comparison purposes, the calculations for which can also be found in **Appendix C**. The most conservative value between the NEH 630 results and HEC-1 model was used for these storm events. The peak inflows into the reservoir and total inflow volumes for each storm event are summarized in **Table 6**.

	Storm Event	Peak Inflow	Volume
01	2-year 24-hour	89 cfs	77 af
02	5-year 24-hour	175 cfs	130 af
03	10-year 24-hour	261 cfs	178 af
04	25-year 24-hour	396 cfs	254 af
05	50-year 24-hour	506 cfs	317 af
06	100-year 24-hour	632 cfs	387 af
07	500-year, 24-hour	1,064 cfs	624 af
08	100-year 6-hour AMC III	2,280 cfs	425 af
09	100-year 24-hour AMC III	1,031 cfs	601 af
10	Local SEP Hydrograph (SEP-L)	6,395 cfs	1,286 af
11	General SEP Hydrograph (SEP-G)	1,587 cfs	2,439 af
12	Principal Spillway Hydrograph (PSH)	850 cfs	749 af
13	Local Auxiliary Spillway Hydrograph (ASH-L)	2,180 cfs	498 af
14	General Auxiliary Spillway Hydrograph (ASH-G)	1,766 cfs	868 af
15	Local Freeboard Hydrograph (FBH-L)	6,395 cfs	1,286 af
16	General Freeboard Hydrograph (FBH-G)	3,524 cfs	1,880 af

Table 6 Peak Flows by Storm Event

Part III. Hydraulic Analysis

A. Spillway Analysis

The principal spillway (PS)—which will be an inlet and pipe carrying the flows away from the dam structure—is sized based on TR-60, Section 2-1 and Part 6. The auxiliary spillway (AS)—which will be a broad-crested weir discharging into a trapezoidal open channel—is sized based on TR-60, Section 2-2 and Part 7. The hydrographs analyzed in designing the spillway configuration are the Principal Spillway Hydrograph (PSH), Auxiliary Spillway Hydrographs (ASH) and the Freeboard Hydrographs (FBH) (Storm Events 12-16). The remaining storm events are being analyzed for comparison purposes and to ensure they are routed adequately through the principal and auxiliary spillways configuration.

SITES was used to model the PSH, ASH and FBH (Storm Events 12-16). Iteratively designed primary and auxiliary spillways were used in the model to accurately reflect conditions. A conservative auxiliary spillway crest elevation was used and each of the storm events were attenuated accordingly through the reservoir using HEC-1 modeling. A summary of the maximum water surface elevations produced in the HEC-1 models is shown in **Table 7**.

	Storm Event	Maximum Water Elevation
01	2-year 24-hour	5546.0’
02	5-year 24-hour	5546.4’
03	10-year 24-hour	5546.7’
04	25-year 24-hour	5547.3’
05	50-year 24-hour	5547.7’
06	100-year 24-hour	5548.1’
07	500-year, 24-hour	5548.9’
08	100-year 6-hour AMC III	5548.3
09	100-year 24-hour AMC III	5548.8’
10	Local SEP Hydrograph (SEP-L)	5551.0’
11	General SEP Hydrograph (SEP-G)	5551.6’
12	Principal Spillway Hydrograph (PSH)	5548.2’
13	Local Auxiliary Spillway Hydrograph (ASH-L)	5548.6’
14	General Auxiliary Spillway Hydrograph (ASH-G)	5549.6’
15	Local Freeboard Hydrograph (FBH-L)	5551.0’
16	General Freeboard Hydrograph (FBH-G)	5551.8’

Table 7 Maximum Water Surface Elevation by Storm Event

The worst-case scenario storm event is the General Freeboard Hydrograph (Storm Event 16). This storm event is also referred to as the Inflow Design Flood (IDF).

A comparative analysis was performed to see the changes in hydrologic flows during the higher frequency storm events with construction of the proposed reservoir, a summary of which is included in **Table 8**.

	Storm Event	Peak Flow *before* Proposed Reservoir	Peak Flow *after* Proposed Reservoir
01	2-year 24-hour	89 cfs	16 cfs
02	5-year 24-hour	175 cfs	22 cfs
03	10-year 24-hour	261 cfs	26 cfs
04	25-year 24-hour	396 cfs	31 cfs
05	50-year 24-hour	506 cfs	35 cfs
06	100-year 24-hour	632 cfs	38 cfs
07	500-year, 24-hour	1,064 cfs	43 cfs

Table 8 Peak Flows Before and After the Proposed Reservoir

B. Spillway Parameters

Models were setup in SITES based on the governing storm events for the PSH, ASH and FBH (Storm Events 12-16). The inflow hydrographs produced in the Hydrology Analysis section was input into the model. Output for the model is included in **Appendix C**. The results from the SITES model, which incorporate the principal and auxiliary spillway parameters at an AS width of 30 feet, include the following:

- Peak Inflow (ASH-L): 2,180 cfs
- Peak Inflow (FBH-G): 6,395 cfs
- Primary Spillway Crest Elevation: 5545.5’
- Auxiliary Spillway Crest Elevation: 5548.5’
- Maximum Water Surface (ASH-L): 5548.7’
- Maximum Water Surface (FBH-G): 5552.3’
- Peak reservoir outflow (FBH-G): 648 cfs (PS: 127 cfs, AS: 521 cfs)
- Maximum depth above AS crest: 3.8 feet

Additional constraints are considered in the design of the primary and auxiliary spillways. A riser is proposed to be installed at the inlet to the primary spillway. The riser shall have a larger cross-sectional area to reduce excessive surging, noise, vibration and vortex action. Per TR-60, Section 6-2, this cross-sectional area shall be a minimum of 2.5’ x 7.5’ (L x W). A trash rack shall be incorporated into the riser structure to avoid clogging, and an anti-vortex device (i.e. anti-vortex baffle plate) shall also be incorporated to prevent a vortex condition as water spills into the riser. An air vent is also added to the inlet to remove air and improve hydraulic performance.

It is noted that the SITES model maximum water surface elevation of 5552.3’. A more conservative auxiliary spillway crest elevation was chosen at elevation 5549.2’. All storm event hydrographs were modeled in HEC-1 using this elevation. Based on the HEC-1 model results and the site and code constraints, the following spillway parameters were selected:

- Primary Spillway (Pipe)
    - Crest Elevation: 5545.5’
    - Pipe Material: Ductile Iron Encased in Concrete
    - Pipe Diameter: 30 inches
- Auxiliary Spillway (Trapezoidal Channel)
    - Crest Elevation: 5549. 2’
    - Material: Earthen
    - Base Width: 30 feet
    - Bank Slopes: 2:1 (H:V)

The HEC-1 results are summarized as follows:

- Peak Inflow: 3,524 cfs
- Peak Outflow: 404 cfs
- Maximum Water Surface: 5551.8’
- Maximum depth above AS crest: 2.6 feet
- Time to Maximum Water Surface: 19.2 hours (0.8 days)
- Time to first flow in auxiliary spillway: 10.2 hours (0.4 days)
- Time to zero flow in auxiliary spillway: 105.8 hours (5.4 days)

C. Emergency Drain and Outlet Works

The emergency drain pipeline is required in order to drain the water supply storage in case of emergency. According to Utah State Code R655-11-7A, the pipeline is required to drain 90% of the storage volume within 30 days neglecting reservoir inflows.

Due to geographical constraints, the proposed drain is approximately 675 feet in length. The water discharges approximately 300 feet from the base of the dam into an existing ephemeral drainage channel. The maximum water surface elevation is 5545.5 feet (principal spillway crest elevation providing for 6,055 acre-feet of storage), and the outlet works discharge elevation is 5497.5 feet, which provides for 600 acre-feet of storage. A minimum 24-inch pipeline is required to drain the Cove Reservoir within the required amount of time.

A 24-inch ductile iron (DI) pipeline encased in concrete has been selected to be installed through the dam section in order to withstand bearing pressures and minimize thermal expansion. A riser is proposed to be installed at the inlet to the emergency drain pipeline with a control valve to allow use as needed. The riser shall have a larger cross-sectional area to reduce excessive surging, noise, vibration and vortex action. A trash rack shall be incorporated into the riser structure to avoid clogging, and an anti-vortex device (i.e. anti-vortex baffle plate) shall also be incorporated to prevent a vortex condition as water spills into the riser. An air vent is also added to the inlet to remove air and improve hydraulic performance. Once the emergency drain pipeline exits through the dam section, a pipeline will be upsized to 30 inches to allow the reservoir to drain in the appropriate amount of time. An energy dissipation structure and trash rack will be installed at the outlet of the pipe as it discharges into the existing channel.

Different configurations of the riser, valve and pipe inlet were evaluated, including:

1. A sloping structure constructed on the upstream face of the dam that extends to the dam crest with a stem-operated gate.

2. A shorter vertical structure with one slide gate. This structure would be partially submerged under normal reservoir operation and would not extend to the dam crest.

Of the two configurations considered, it was decided that the first configuration consisting of a sloping structure and stem operated gate would best meet the needs of the project. The second configuration was not used due to cost considerations and functionality of the valve. A stem for the gate will extend up along the face of the dam and will be supported on concrete blocks spaced every 10 feet. The blocks will have adjustable stem guides to allow for re-alignment, as required.

Reservoir discharge data has been determined by combining the amount of head in the reservoir combined with losses from the entrance, pipe friction, and other minor losses. Calculations are included in **Appendix A**. **Table 9** summarizes the discharge data:

Water Surface Elevation (ft)	Water Storage (ac-ft)	Discharge Time (days)
5545.5	6055	0.0
5530	3542	10.1
5514	1737	18.1
5797	587	23.9

Table 9 Emergency Drain Discharge Rating

The emergency drain pipeline will be also used as the feed into the reservoir. The pipeline will tie into the existing irrigation system. A new pump station will be installed on the existing irrigation system that will pump flows from the East Fork Virgin River into the reservoir. Valving will be installed to allow pressurized flows to fill the reservoir while stopping flows from discharging into the existing channel. During emergencies, pumping will stop and the valving will be opened to allow flows to discharge into the existing channel and drain the reservoir.

Part IV. Freeboard Analysis

A. Storm and Wind Events

The Administrative Rules for Dam Safety and TR-60, Part 5, state that the freeboard above the principal spillway crest elevation must exceed the values produced by the scenarios given below. In analyzing a permeable and an impermeable dam, a range of freeboard is given for the first and second condition. The dam is considered to be semi-permeable, and therefore, the actual freeboard requirement is adjusted within this range.

1. 100-year, 24-hour storm (AMC III) in conjunction with a 50-mph wind.
2. 100-mph wind without any significant rainstorm.
3. IDF (or FBH-G) without any significant windstorm.
4. ASH with Wave Action (TR-60)

B. Maximum Wave Runup

Historic data for the design wind for the Cove Reservoir area is not available. As required, wind speeds of 50 mph and 100 mph were analyzed. For these two wind speeds, the wind setup, wave height, and total wave runup was calculated as summarized in **Table 10**. Calculations are included in **Appendix B**.

Wind Velocity	Wave Runup	Wind Setup	Wave Freeboard
50 mph	2.8 ft	0.1 ft	2.9 ft
100 mph	5.8 ft	0.1 ft	5.9 ft

Table 10 Wave Runup by Wind Speed

Wave Action was further calculated using procedures outlined in TR-56. The maximum overwater wind velocity calculated to 87 mph and produced a significant wave height 1.8 ft. Calculations are included in **Appendix B**.

C. Results

The total required freeboard for each storm and wind event is summarized in **Table 11**. The Storm Freeboard is taken from the difference between the primary spillway crest elevation and the maximum water surface elevation produced by the respective storm events. The Total Freeboard is the sum of the Storm Freeboard plus the Wave Freeboard.

Scenario	Wave Freeboard	Storm Freeboard	Total Freeboard
1	2.9 ft	3.3 ft	6.2 ft
2	5.9 ft	0.0 ft	5.9 ft
3	0.0 ft	6.3 ft	6.3 ft
4	1.8 ft	4.1 ft	5.9 ft

Table 11 Total Freeboard Requirements

The governing total freeboard requirement is 6.3 feet as taken from Scenario 3. With a primary spillway crest elevation of 5545.5', the minimum top of dam elevation allowing for adequate freeboard is 5551.8'. The proposed top of dam elevation is 5552.0'.

Part V. Breach Analysis

A. Criteria

Breach simulations were completed for “Sunny Day” and “Rainy Day” scenarios. Both scenarios assume the water level is at the auxiliary spillway crest elevation (5549’) at the start of the model. The “Sunny Day” scenario breaches immediately with no storm event attenuating through the reservoir. The “Rainy Day” scenario attenuates the worst-case storm event and breaches as the water surface elevation approaches the top of the dam.

A sensitivity analysis was performed to determine the most extreme breach within NRCS parameters. Per TR-60, the minimum peak discharge of the breach hydrograph is:

$$Q_{max} = 1{,}100\left(\frac{V_s H_w}{A}\right)^{1.35} = 1{,}100\left(\frac{(7{,}245)(85.5)}{20{,}400}\right)^{1.35} = 110{,}305\ cfs$$

But not less than:

$$Q_{max} = 3.2H_w^{2.5} = 3.2(85.5^{2.5}) = 216{,}304\ cfs$$

Nor more than:

$$Q_{max} = 65H_w^{1.85} = 65(85.5^{1.85}) = 243{,}810\ cfs$$

As a result of the analysis, the most extreme breach occurred under the following breach parameter

- Storm Event: Local Freeboard Hydrograph (Storm Event 15)
- Depth of water at breach: 85.5’
- Water surface elevation: 5551.5’
- Bottom width: 427.5’ (water depth multiplied by 5)
- Side slope: 1:1 (H:V)
- Time to develop: 0.95 hours
- Storm event for “Rainy Day” scenario
    - Peak inflow: 6,395 cfs
    - Inflow volume: 1,286 af
- Manning’s ‘n’: 0.05
- Width of the downstream valley: approx. 1,100’
- Breach location at maximum section of dam
- Cross-sectional area of dam embankment at breach location: approx. 20,400 sf
- Reservoir storage at breach: 7,245 af

B. Methodology

Separate HEC-RAS models were setup for the "Sunny Day" and "Rainy Day" scenarios. Constraints were input based on the Hydrology, Hydraulic and Freeboard Analyses of this report. The terrain downstream of the dam structure was imported into the HEC-RAS geometry editor using USGS DEM files to simulate a 2D breach for each scenario.

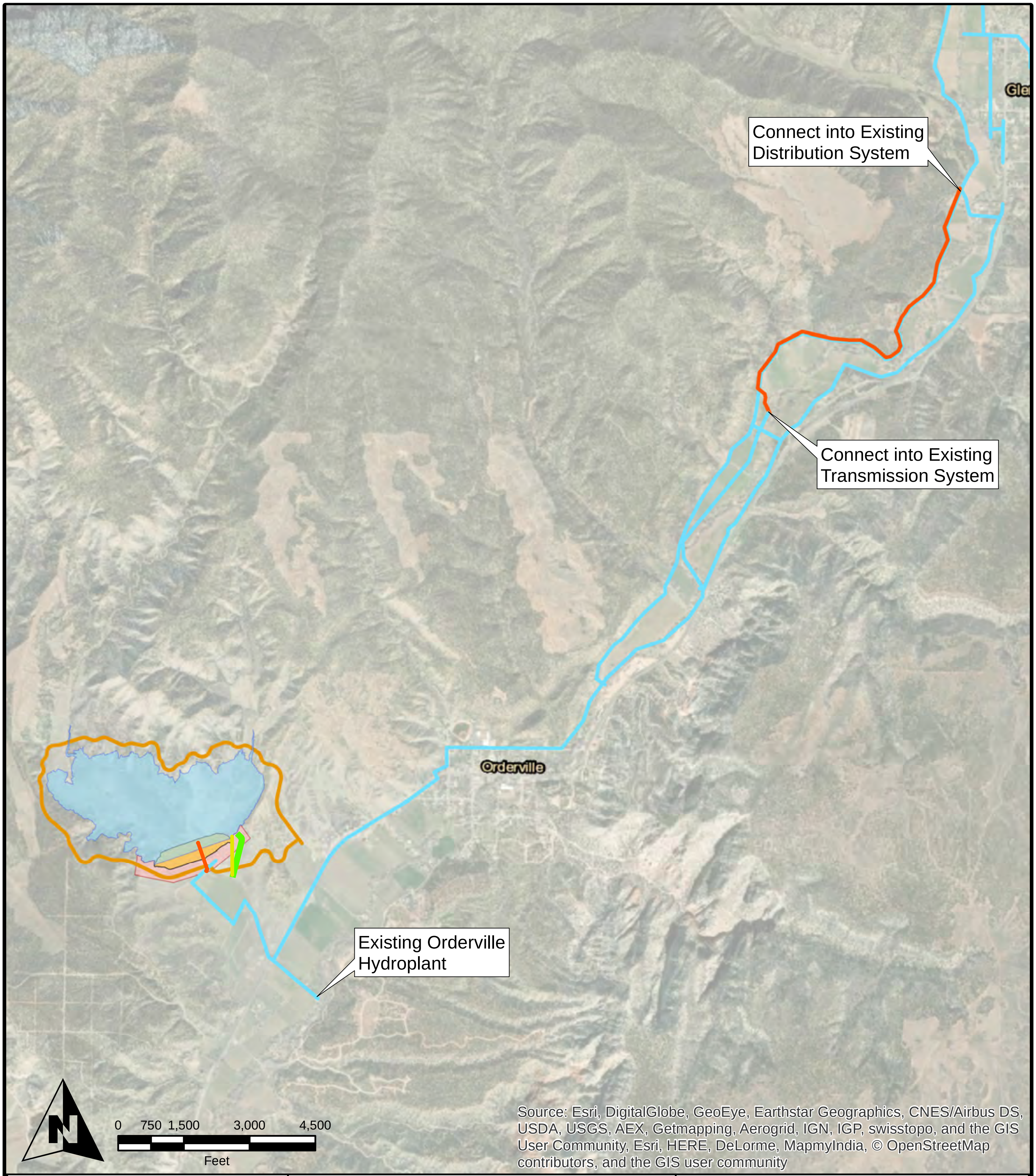
C. Results

Inundation maps have been prepared based on the results of the HEC-RAS models, as shown in **Appendix A, Exhibits 7 and 8**. Model output from the HEC-RAS models are included in **Appendix D**. The results of the models are summarized below.

- Sunny Day
    - Maximum outflow: 205,567 cfs
- Rainy Day
    - Maximum outflow: 243,575 cfs

Appendix A. Exhibits

P:\357-21 KCWCD Cove Reservoir Environmental and Design\Drawings\GIS\357-21 Design Report Exhibit 1 Overall Project Components.mxd, 9/17/2019 11:20:04 AM jmadsen



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

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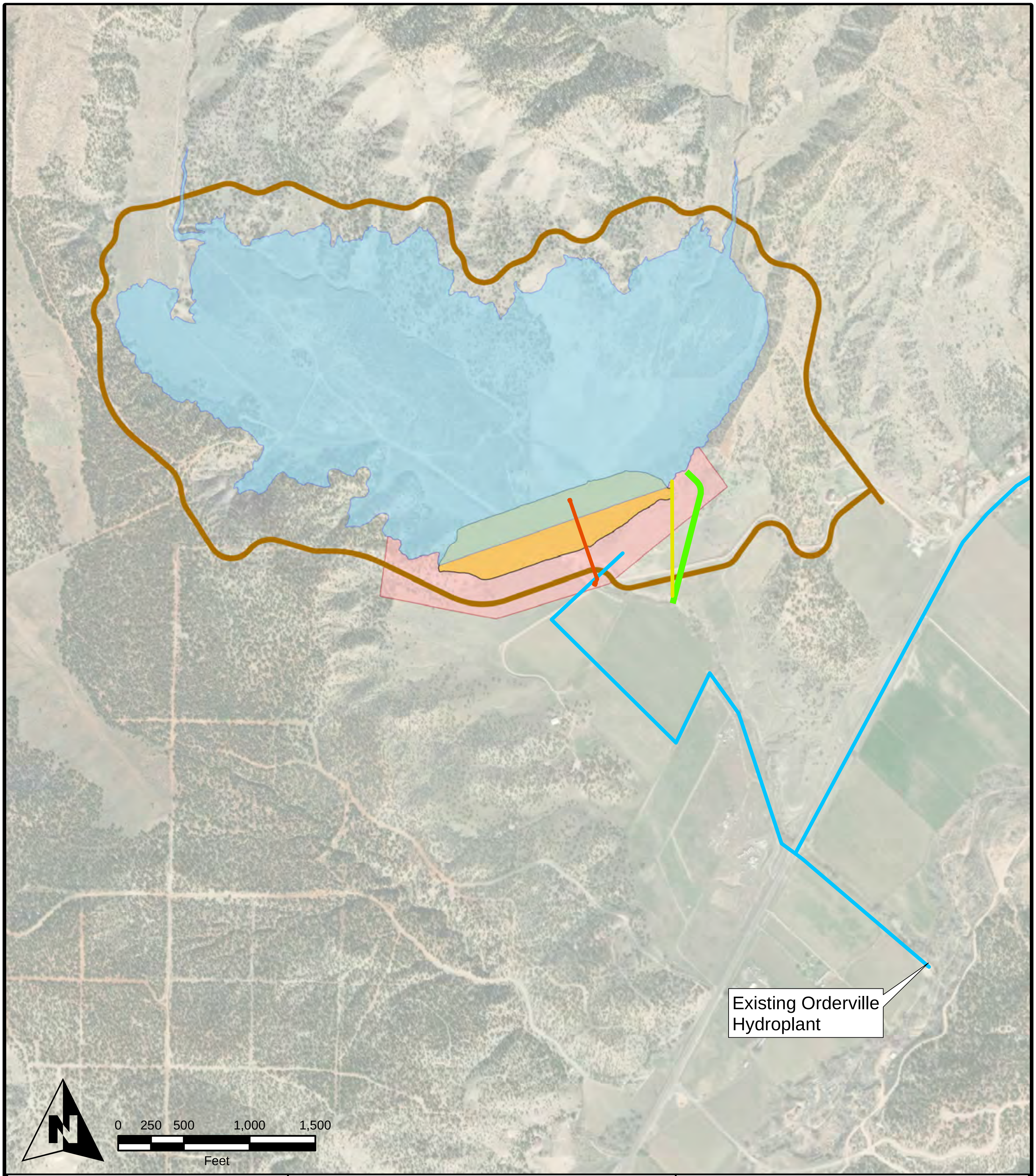
RB&G ENGINEERING, INC.

🟦 Cove Reservoir
🟧 Cove Dam Structure
🟥 Construction/Instrumentation Buffer Area
— Existing Transmission Pipeline
— New Transmission Pipeline

Overall Project Components

Exhibit 1 - Cove Reservoir

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1 inch = 3,000 feet
Date:	September 17, 2019



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RB&G ENGINEERING, INC.

🟦 Cove Reservoir
🟧 Cove Dam Structure
🟥 Construction/Instrumentation Buffer Area
— Existing Transmission Pipeline
— OutletWorks
— Principal Spillway
— Auxiliary Spillway
— Access Road

Reservoir Project Components

Exhibit 2 - Cove Reservoir

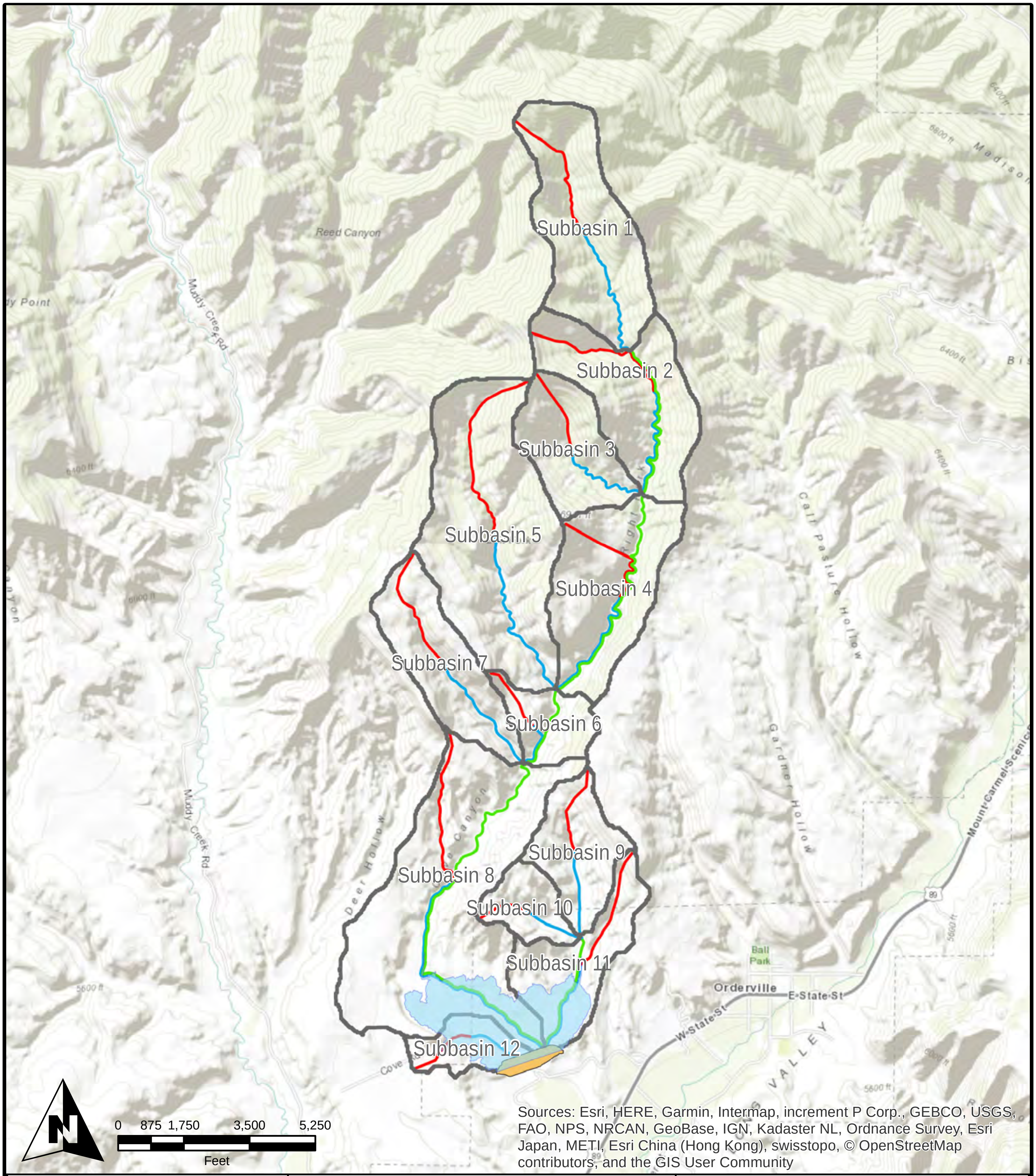
Spatial Reference: UT83-SF

Drawn By: JTM

Scale: 1 inch = 1,000 feet

Date: September 17, 2019

P:\357-21 KCWCD Cove Reservoir Environmental and Design\Drawings\GIS\357-21 Design Report Exhibit 2 Reservoir Project Components.mxd, 9/17/2019 11:13:46 AM jmadsen



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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- 🟦 Cove Reservoir
- ▭ Drainage Subbasins
- — Centroidal Water Course
- — Maximum Water Course
- — Routed Flow (Modeling)

Reservoir Drainage Basin

Exhibit 3 - Cove Reservoir

Spatial Reference: UT83-SF

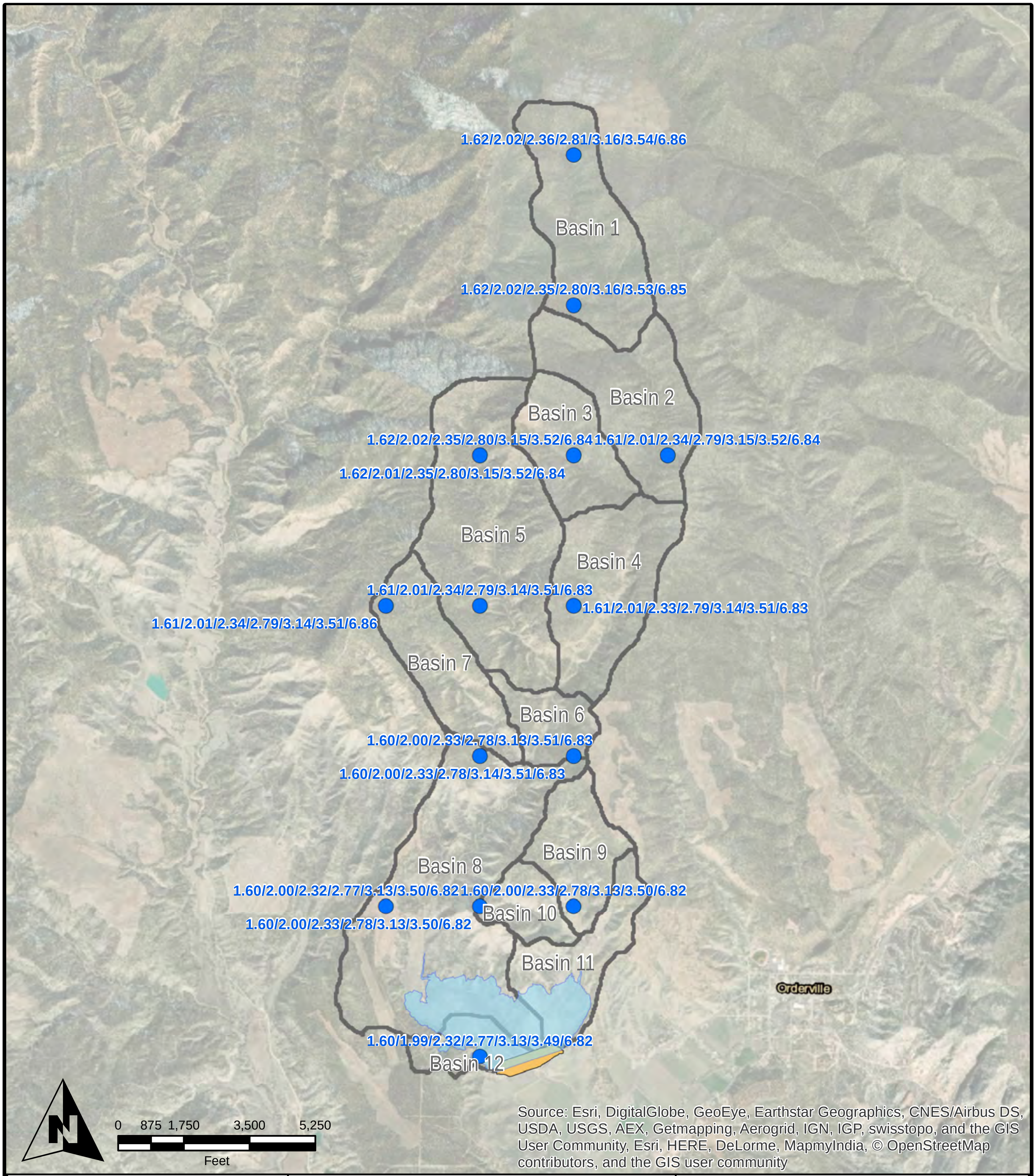
Drawn By: JTM

Scale: 1 inch = 3,500 feet

Date: September 17, 2019

P:\357-21 KCWCD Cove Reservoir Environmental and Design\Drawings\GIS\357-21 Design Report Exhibit 3 Reservoir Drainage Basin.mxd, 9/17/2019 11:22:44 AM jmadsen

P:\357-21 KCWCD Cove Reservoir Environmental and Design\Drawings\GIS\357-21 Design Report Exhibit 4 NOAA Precipitation.mxd, 9/17/2019 11:42:42 AM jmadsen



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

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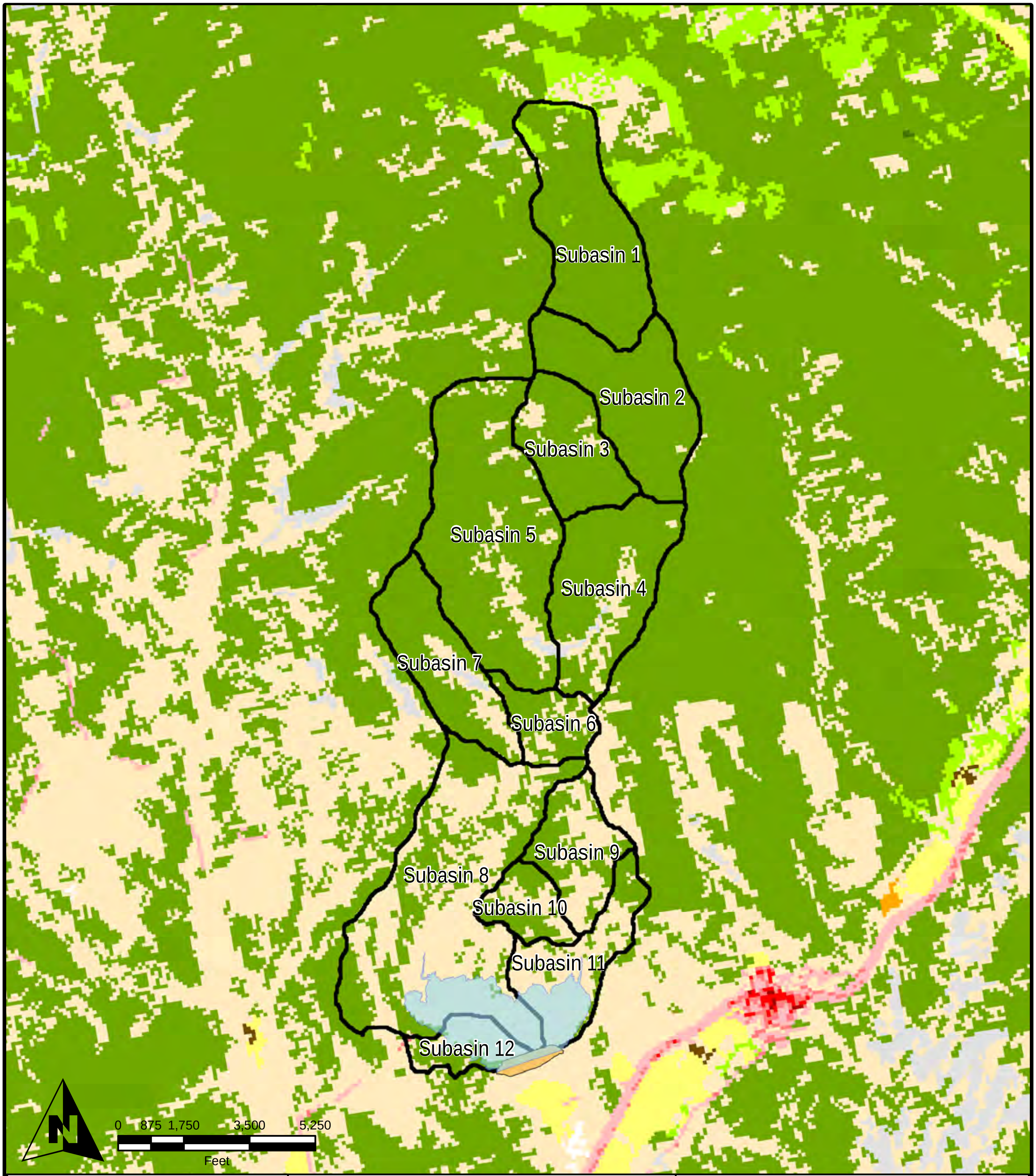
▭	Cove Reservoir
▭	Drainage Subbasins
●	NOAA Precipitation Values 2-yr / 5-yr / 10-yr / 25-yr / 50-yr / 100-yr / 100-yr (10-day)

NOAA Precipitation Points

Exhibit 4 - Cove Reservoir

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1 inch = 3,500 feet
Date:	September 17, 2019

P:\357-21 KCWCD Cove Reservoir Environmental and Design\Drawings\GIS\357-21 Design Report Exhibit 5 NLCD Soil Data.mxd, 9/17/2019 11:44:54 AM jmadsen



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- 🟦 Cove Reservoir
- ▭ Drainage Subbasins

NLCD Land Cover

- ▨ 21 - Developed, Open Space
- ▨ 22 - Developed, Low Intensity
- 🟥 23 - Developed, Medium Intensity
- ▨ 24 - Developed, High Intensity
- ▨ 31 - Barren Land (Rock/Sand/Clay)
- 🟩 41 - Deciduous Forest
- 🟩 42 - Evergreen Forest
- 🟩 43 - Mixed Forest
- ▨ 52 - Shrub/Scrub
- 🟨 81 - Pasture/Hay
- 🟧 82 - Cultivated Crops
- 🟫 90 - Woodly Wetlands

NLCD Soil Data

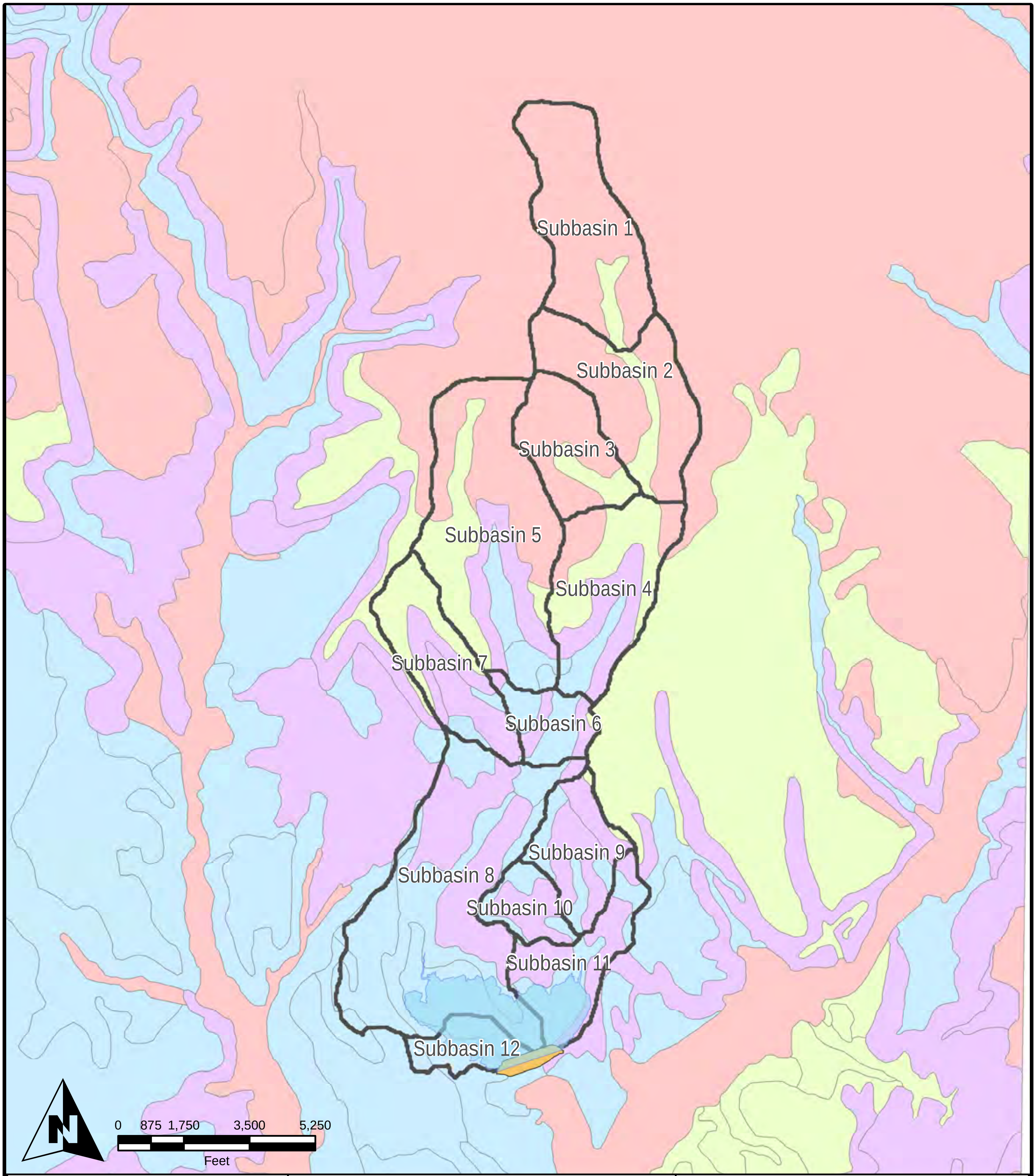
Exhibit 5 - Cove Reservoir

Spatial Reference: UT83-SF

Drawn By: JTM

Scale: 1 inch = 3,500 feet

Date: September 17, 2019



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🟦 Cove Reservoir
▭ Drainage Subbasins
Hydrologic Soil Group
🟩 A
🟥 B
🟦 C
🟪 D

Hydrologic Soil Groups
Exhibit 6 - Cove Reservoir

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1 inch = 3,500 feet
Date:	September 17, 2019

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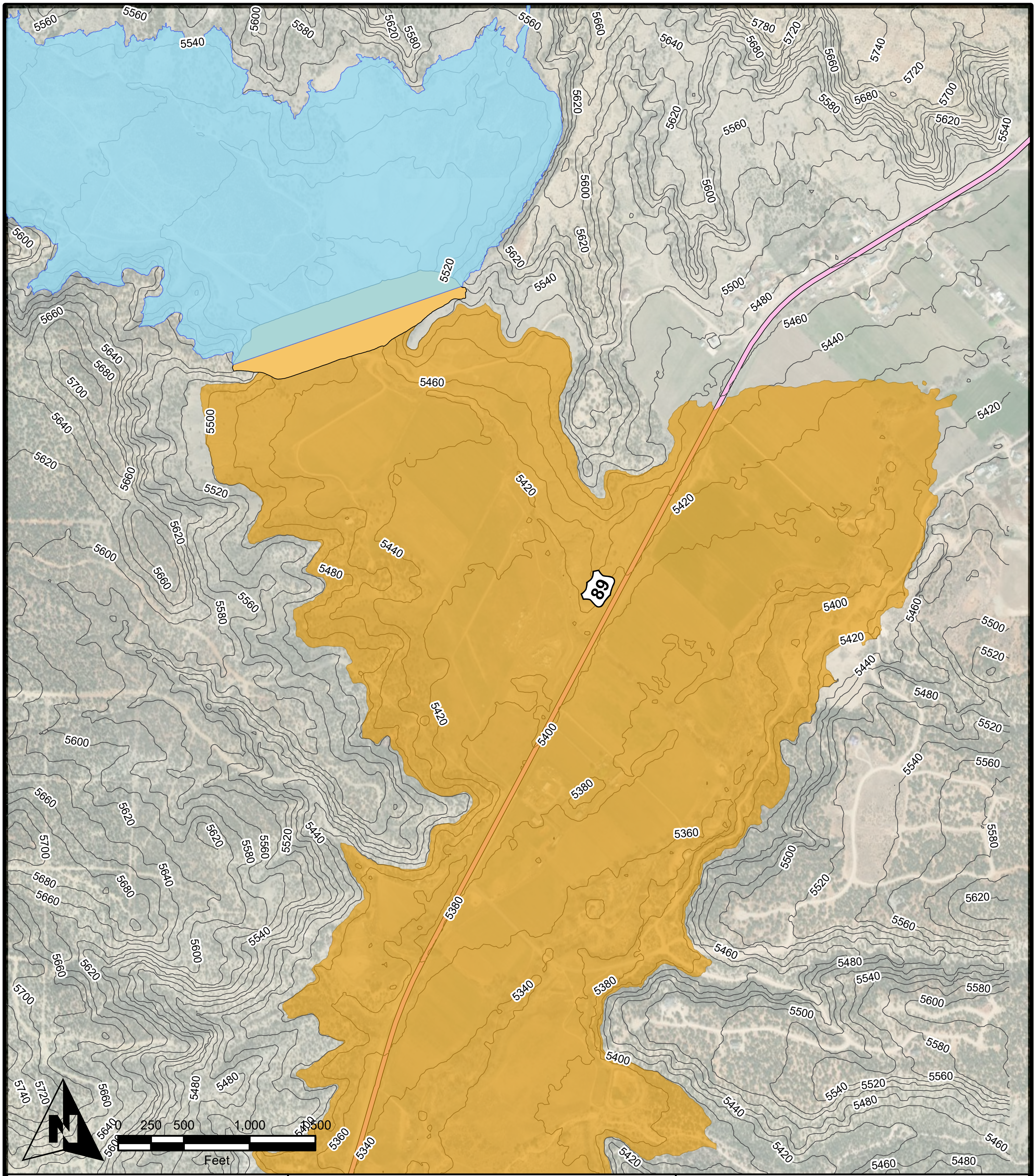

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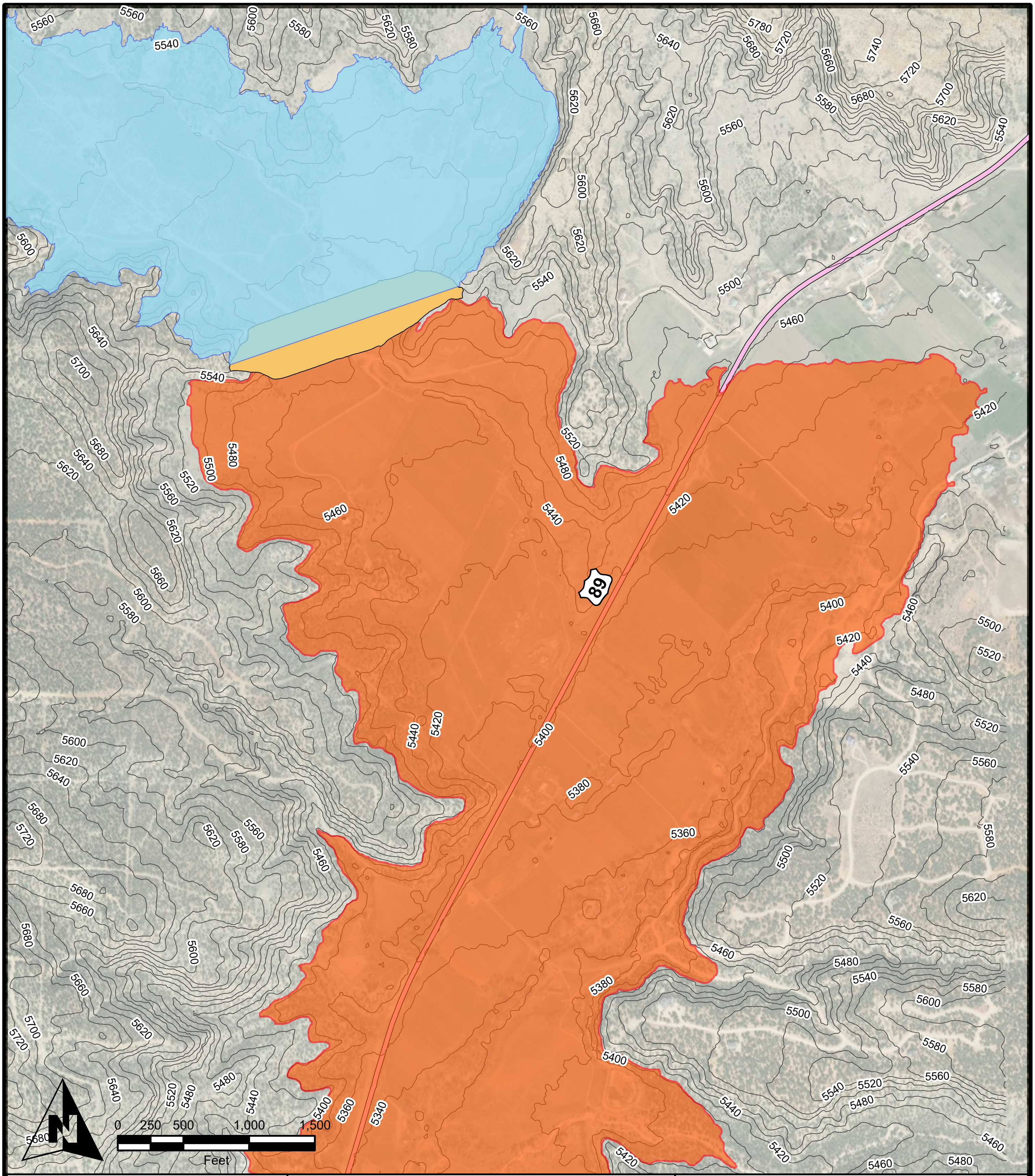
🟦 Reservoir
🟧 Cove Dam Structure
🟧 Inundation Boundary (Sunny Day)
— Contours (20' Interval)

Sunny Day Breach Inundation Map

Exhibit 7 - Cove Reservoir

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1:12,000
Date:	August 19, 2020



- 🟦 Reservoir
- 🟨 Cove Dam Structure
- 🟧 Inundation Boundary (Rainy Day)
- — Contours (20' Interval)

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Rainy Day Breach Inundation Map

Exhibit 8 - Cove Reservoir

Spatial Reference:	UT83-SF
Drawn By:	JTM
Scale:	1:12,000
Date:	August 19, 2020

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Appendix B. Calculations

Section 1. Soil Data and Curve Numbers

Section 2. Storm Distributions

Section 3. Precipitation Values

Section 4. Wave Runup

Section 5. Emergency Drain

Section 1. Soil Data and Curve Numbers

```
**********************************************************************
* Program written in ANSI-C by J. Heward                             *
* June 21 2018                                                       *
* Alpha Engineering                                                  *
* 43 S. 100 E.                                                       *
* St. George, Utah 84770                                             *
* 435-628-6500                                                       *
*                                                                    *
* Calculates curve number within basin                               *
* based on NLCD Data & Soil Data                                     *
*                                                                    *
* The following curve numbers are assumed for each                   *
* NLCD Landcover Class and Hydrologic Soil Group:                    *
*  NLCD  Group_A   Group_B   Group_C  Group_D                        *
*    11     98.0     98.0     98.0     98.0                          *
*    12     98.0     98.0     98.0     98.0                          *
*    21     68.0     79.0     86.0     89.0                          *
*    22     68.0     79.0     86.0     89.0                          *
*    23     61.0     75.0     83.0     87.0                          *
*    24     89.0     92.0     94.0     95.0                          *
*    31     55.0     72.0     81.0     86.0                          *
*    41     36.0     58.0     73.0     80.0                          *
*    42     58.0     75.0     85.0     89.0                          *
*    43     36.0     60.0     73.0     79.0                          *
*    51     35.0     56.0     70.0     77.0                          *
*    52     49.0     68.0     79.0     89.0                          *
*    71     39.0     61.0     74.0     80.0                          *
*    72     39.0     61.0     74.0     80.0                          *
*    73     39.0     61.0     74.0     80.0                          *
*    74     39.0     61.0     74.0     80.0                          *
*    81     49.0     69.0     79.0     84.0                          *
*    82     61.0     70.0     77.0     80.0                          *
*    90     30.0     55.0     70.0     77.0                          *
*    95     30.0     55.0     70.0     77.0                          *
**********************************************************************

<<Basin 1>>
       NLCD,  Soil_Group,  %_Watershed,    CN,  Weighted_CN
         41,           B,          4.5,  58.0,          2.6
         42,           A,          8.0,  58.0,          4.7
         42,           B,         85.9,  75.0,         64.4
         52,           B,          1.6,  68.0,          1.1
                                      Composite CN = **72.8**

<<Basin 2>>
       NLCD,  Soil_Group,  %_Watershed,    CN,  Weighted_CN
         42,           A,         14.5,  58.0,          8.4
         42,           B,         85.1,  75.0,         63.8
         52,           B,          0.4,  68.0,          0.3
                                      Composite CN = **72.5**

<<Basin 3>>
       NLCD,  Soil_Group,  %_Watershed,    CN,  Weighted_CN
         42,           A,         19.6,  58.0,         11.4
         42,           B,         71.4,  75.0,         53.6
         52,           B,          9.0,  68.0,          6.1
                                      Composite CN = **71.0**

<<Basin 4>>
```

```
       NLCD,  Soil_Group,  %_Watershed,    CN,  Weighted_CN
         31,           C,          0.0,  81.0,          0.0
         31,           D,          1.8,  86.0,          1.6
         42,           A,         38.7,  58.0,         22.5
         42,           B,         19.0,  75.0,         14.2
         42,           C,          7.9,  85.0,          6.7
         42,           D,         18.2,  89.0,         16.2
         52,           A,          0.3,  49.0,          0.2
         52,           B,          0.4,  68.0,          0.3
         52,           C,          4.5,  79.0,          3.6
         52,           D,          9.2,  89.0,          8.2
                                      Composite CN = **73.3**

<<Basin 5>>
       NLCD,  Soil_Group,  %_Watershed,    CN,  Weighted_CN
         31,           C,          0.0,  81.0,          0.0
         31,           D,          0.9,  86.0,          0.8
         42,           A,         25.5,  58.0,         14.8
         42,           B,         38.5,  75.0,         28.8
         42,           C,         10.3,  85.0,          8.8
         42,           D,         12.9,  89.0,         11.5
         52,           A,          0.0,  49.0,          0.0
         52,           B,          4.1,  68.0,          2.8
         52,           C,          3.1,  79.0,          2.4
         52,           D,          4.7,  89.0,          4.2
                                      Composite CN = **74.1**

<<Basin 6>>
       NLCD,  Soil_Group,  %_Watershed,    CN,  Weighted_CN
         42,           A,          0.5,  58.0,          0.3
         42,           C,         49.2,  85.0,         41.8
         42,           D,         23.0,  89.0,         20.4
         52,           A,          3.0,  49.0,          1.5
         52,           C,         13.9,  79.0,         11.0
         52,           D,         10.3,  89.0,          9.2
                                      Composite CN = **84.3**

<<Basin 7>>
       NLCD,  Soil_Group,  %_Watershed,    CN,  Weighted_CN
         31,           C,          0.0,  81.0,          0.0
         31,           D,          2.6,  86.0,          2.3
         42,           A,         41.1,  58.0,         23.8
         42,           C,          7.4,  85.0,          6.3
         42,           D,         29.4,  89.0,         26.2
         52,           A,          0.0,  49.0,          0.0
         52,           C,          1.7,  79.0,          1.4
         52,           D,         17.7,  89.0,         15.7
                                      Composite CN = **75.7**

<<Basin 8>>
       NLCD,  Soil_Group,  %_Watershed,    CN,  Weighted_CN
         21,           C,          0.0,  86.0,          0.0
         42,           A,          0.0,  58.0,          0.0
         42,           C,         26.9,  85.0,         22.9
         42,           D,         10.5,  89.0,          9.3
         52,           A,          0.0,  49.0,          0.0
         52,           C,         39.4,  79.0,         31.1
         52,           D,         23.2,  89.0,         20.6
                                      Composite CN = **84.0**
```

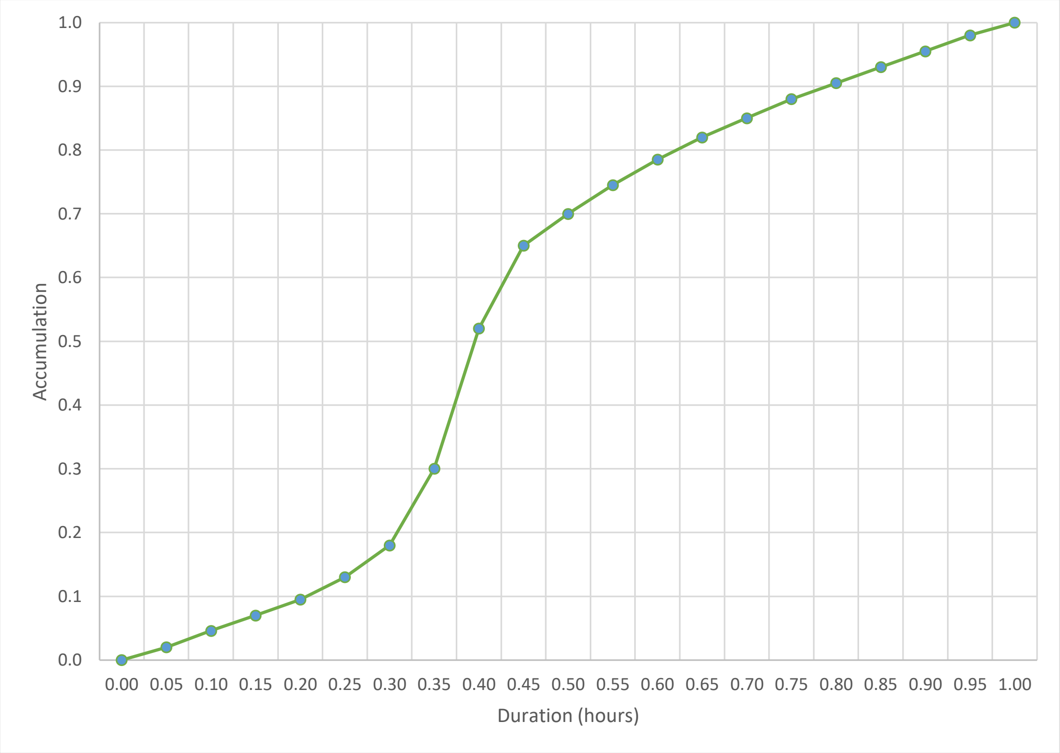
```
<<Basin 9>>
       NLCD,  Soil_Group,  %_Watershed,    CN,  Weighted_CN
         42,            A,          0.6,  58.0,          0.3
         42,            C,         20.7,  85.0,         17.6
         42,            D,         27.7,  89.0,         24.7
         52,            A,          3.7,  49.0,          1.8
         52,            C,         10.4,  79.0,          8.2
         52,            D,         36.9,  89.0,         32.8
                                      Composite CN = **85.5**

<<Basin 10>>
       NLCD,  Soil_Group,  %_Watershed,    CN,  Weighted_CN
         42,            C,         27.5,  85.0,         23.4
         42,            D,         32.1,  89.0,         28.5
         52,            C,         12.4,  79.0,          9.8
         52,            D,         28.1,  89.0,         25.0
                                      Composite CN = **86.7**

<<Basin 11>>
       NLCD,  Soil_Group,  %_Watershed,    CN,  Weighted_CN
         42,            A,          0.2,  58.0,          0.1
         42,            C,          9.1,  85.0,          7.7
         42,            D,         18.0,  89.0,         16.0
         52,            A,          0.0,  49.0,          0.0
         52,            C,         37.4,  79.0,         29.5
         52,            D,         35.3,  89.0,         31.4
                                      Composite CN = **84.8**

<<Basin 12>>
       NLCD,  Soil_Group,  %_Watershed,    CN,  Weighted_CN
         21,            C,          0.1,  86.0,          0.0
         22,            C,          0.4,  86.0,          0.4
         42,            C,         35.0,  85.0,         29.7
         52,            C,         64.0,  79.0,         50.6
         52,            D,          0.5,  89.0,          0.5
                                      Composite CN = **81.2**
```

Section 2. Storm Distributions

Dimensionless Hydrograph

Hours	Accumulation
0.00	0.000
0.05	0.020
0.10	0.046
0.15	0.070
0.20	0.095
0.25	0.130
0.30	0.180
0.35	0.300
0.40	0.520
0.45	0.650
0.50	0.700
0.55	0.745
0.60	0.785
0.65	0.820
0.70	0.850
0.75	0.880
0.80	0.905
0.85	0.930
0.90	0.955
0.95	0.980
1.00	1.000

(NEH 630, Chapter 21, Figure 21-9)



PSH Hydrograph

Characteristics

Drainage Area	4.742	sq mi
Time of Concentration	1.88	hr
Ave. Annual Precipitation	15.6	in
Ave. Annual Temperature	51.2	°F
Curve Number	71.8	
100-yr, 24-hr Precipitation	3.51	in
100-yr, 10-day Precipitation	6.83	in
Structure Hazard Classification	High	
Climatic Index	0.6	

Principal Spillway Mass Curve

Adjusted Areal Rainfall

Not Applicable (<10 sq mi)

Adjusted 10-day Curve Numbers (Table 21-2)

$CN_{1\text{-day}}$	77.8	
$CN_{10\text{-day}}$	71.8	

Direct Runoff (NEH, Appendix 10A)

$Q_{1\text{-day}}$	1.49	in
$Q_{10\text{-day}}$	3.66	in

Net Runoff (Table 21-4)

Channel Loss Reduction Factor	0.84	
$Q_{1\text{-day net}}$	1.25	in
$Q_{10\text{-day net}}$	3.08	in

Mass Curve (Equation 21-2)

a	0.3903
Qd (1-hour)	0.3625

Time (days)	Qd (inches)	Inc. Volumes (inches)	Rank	Inc. Volume Ranked	Inc. Arrangement	Time (hrs)	Inc. Volumes Rearrange	PSMC	Dimensionless PSMC
0.0000	0.0000	-	-	-	-	0	-	0.0000	0.0000
0.0417	0.3624	0.3624	1	0.3624	239	1	0.0050	0.0050	0.0016
0.0833	0.4749	0.1126	2	0.1126	237	2	0.0051	0.0101	0.0033
0.1250	0.5564	0.0814	3	0.0814	235	3	0.0051	0.0152	0.0049
0.1667	0.6225	0.0661	4	0.0661	233	4	0.0051	0.0203	0.0066
0.2083	0.6792	0.0567	5	0.0567	231	5	0.0051	0.0254	0.0082
0.2500	0.7293	0.0501	6	0.0501	229	6	0.0052	0.0305	0.0099
0.2917	0.7745	0.0452	7	0.0452	227	7	0.0052	0.0357	0.0116
0.3333	0.8159	0.0414	8	0.0414	225	8	0.0052	0.0409	0.0133
0.3750	0.8543	0.0384	9	0.0384	223	9	0.0052	0.0462	0.0150
0.4167	0.8902	0.0359	10	0.0359	221	10	0.0053	0.0515	0.0167
0.4583	0.9239	0.0337	11	0.0337	219	11	0.0053	0.0568	0.0184
0.5000	0.9558	0.0319	12	0.0319	217	12	0.0053	0.0621	0.0202
0.5417	0.9862	0.0303	13	0.0303	215	13	0.0054	0.0674	0.0219
0.5833	1.0151	0.0289	14	0.0289	213	14	0.0054	0.0728	0.0237
0.6250	1.0428	0.0277	15	0.0277	211	15	0.0054	0.0783	0.0254

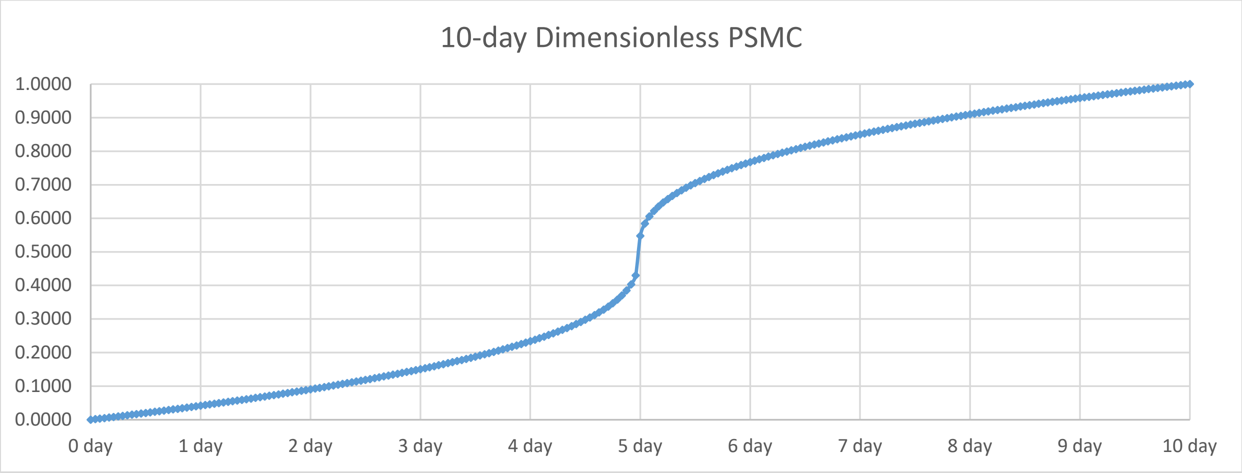
0.6667	1.0694	0.0266	16	0.0266	209	16	0.0055	0.0837	0.0272
0.7083	1.0950	0.0256	17	0.0256	207	17	0.0055	0.0892	0.0290
0.7500	1.1197	0.0247	18	0.0247	205	18	0.0055	0.0947	0.0308
0.7917	1.1436	0.0239	19	0.0239	203	19	0.0056	0.1003	0.0326
0.8333	1.1667	0.0231	20	0.0231	201	20	0.0056	0.1059	0.0344
0.8750	1.1892	0.0224	21	0.0224	199	21	0.0056	0.1115	0.0362
0.9167	1.2110	0.0218	22	0.0218	197	22	0.0057	0.1171	0.0381
0.9583	1.2322	0.0212	23	0.0212	195	23	0.0057	0.1228	0.0399
1.0000	1.2528	0.0206	24	0.0206	193	24	0.0057	0.1285	0.0418
1.0417	1.2729	0.0201	25	0.0201	191	25	0.0058	0.1343	0.0436
1.0833	1.2926	0.0196	26	0.0196	189	26	0.0058	0.1401	0.0455
1.1250	1.3117	0.0192	27	0.0192	187	27	0.0058	0.1459	0.0474
1.1667	1.3305	0.0188	28	0.0188	185	28	0.0059	0.1518	0.0493
1.2083	1.3488	0.0183	29	0.0183	183	29	0.0059	0.1577	0.0513
1.2500	1.3668	0.0180	30	0.0180	181	30	0.0060	0.1637	0.0532
1.2917	1.3844	0.0176	31	0.0176	179	31	0.0060	0.1697	0.0551
1.3333	1.4017	0.0173	32	0.0173	177	32	0.0060	0.1757	0.0571
1.3750	1.4186	0.0169	33	0.0169	175	33	0.0061	0.1818	0.0591
1.4167	1.4352	0.0166	34	0.0166	173	34	0.0061	0.1879	0.0611
1.4583	1.4516	0.0163	35	0.0163	171	35	0.0062	0.1941	0.0631
1.5000	1.4676	0.0160	36	0.0160	169	36	0.0062	0.2003	0.0651
1.5417	1.4834	0.0158	37	0.0158	167	37	0.0063	0.2065	0.0671
1.5833	1.4989	0.0155	38	0.0155	165	38	0.0063	0.2129	0.0692
1.6250	1.5142	0.0153	39	0.0153	163	39	0.0063	0.2192	0.0712
1.6667	1.5292	0.0150	40	0.0150	161	40	0.0064	0.2256	0.0733
1.7083	1.5441	0.0148	41	0.0148	159	41	0.0064	0.2320	0.0754
1.7500	1.5586	0.0146	42	0.0146	157	42	0.0065	0.2385	0.0775
1.7917	1.5730	0.0144	43	0.0144	155	43	0.0065	0.2451	0.0796
1.8333	1.5872	0.0142	44	0.0142	153	44	0.0066	0.2517	0.0818
1.8750	1.6012	0.0140	45	0.0140	151	45	0.0067	0.2583	0.0839
1.9167	1.6150	0.0138	46	0.0138	149	46	0.0067	0.2650	0.0861
1.9583	1.6286	0.0136	47	0.0136	147	47	0.0068	0.2718	0.0883
2.0000	1.6420	0.0134	48	0.0134	145	48	0.0068	0.2786	0.0905
2.0417	1.6553	0.0133	49	0.0133	143	49	0.0069	0.2855	0.0928
2.0833	1.6684	0.0131	50	0.0131	141	50	0.0069	0.2924	0.0950
2.1250	1.6814	0.0129	51	0.0129	139	51	0.0070	0.2994	0.0973
2.1667	1.6942	0.0128	52	0.0128	137	52	0.0071	0.3065	0.0996
2.2083	1.7068	0.0126	53	0.0126	135	53	0.0071	0.3136	0.1019
2.2500	1.7193	0.0125	54	0.0125	133	54	0.0072	0.3208	0.1042
2.2917	1.7317	0.0124	55	0.0124	131	55	0.0073	0.3281	0.1066
2.3333	1.7439	0.0122	56	0.0122	129	56	0.0073	0.3354	0.1090
2.3750	1.7560	0.0121	57	0.0121	127	57	0.0074	0.3428	0.1114
2.4167	1.7679	0.0120	58	0.0120	125	58	0.0075	0.3503	0.1138
2.4583	1.7798	0.0118	59	0.0118	123	59	0.0075	0.3578	0.1163
2.5000	1.7915	0.0117	60	0.0117	121	60	0.0076	0.3654	0.1187
2.5417	1.8031	0.0116	61	0.0116	119	61	0.0077	0.3731	0.1212
2.5833	1.8145	0.0115	62	0.0115	117	62	0.0078	0.3809	0.1238
2.6250	1.8259	0.0114	63	0.0114	115	63	0.0079	0.3888	0.1263
2.6667	1.8372	0.0113	64	0.0113	113	64	0.0079	0.3967	0.1289
2.7083	1.8483	0.0112	65	0.0112	111	65	0.0080	0.4047	0.1315
2.7500	1.8594	0.0110	66	0.0110	109	66	0.0081	0.4129	0.1341
2.7917	1.8703	0.0109	67	0.0109	107	67	0.0082	0.4211	0.1368
2.8333	1.8812	0.0108	68	0.0108	105	68	0.0083	0.4294	0.1395
2.8750	1.8919	0.0108	69	0.0108	103	69	0.0084	0.4378	0.1422
2.9167	1.9026	0.0107	70	0.0107	101	70	0.0085	0.4463	0.1450

2.9583	1.9131	0.0106	71	0.0106	99	71	0.0086	0.4549	0.1478
3.0000	1.9236	0.0105	72	0.0105	97	72	0.0087	0.4636	0.1506
3.0417	1.9340	0.0104	73	0.0104	95	73	0.0088	0.4725	0.1535
3.0833	1.9443	0.0103	74	0.0103	93	74	0.0090	0.4814	0.1564
3.1250	1.9545	0.0102	75	0.0102	91	75	0.0091	0.4905	0.1594
3.1667	1.9646	0.0101	76	0.0101	89	76	0.0092	0.4997	0.1624
3.2083	1.9747	0.0101	77	0.0101	87	77	0.0093	0.5090	0.1654
3.2500	1.9847	0.0100	78	0.0100	85	78	0.0095	0.5185	0.1685
3.2917	1.9946	0.0099	79	0.0099	83	79	0.0096	0.5281	0.1716
3.3333	2.0044	0.0098	80	0.0098	81	80	0.0097	0.5378	0.1747
3.3750	2.0141	0.0097	81	0.0097	79	81	0.0099	0.5477	0.1780
3.4167	2.0238	0.0097	82	0.0097	77	82	0.0101	0.5578	0.1812
3.4583	2.0334	0.0096	83	0.0096	75	83	0.0102	0.5680	0.1845
3.5000	2.0429	0.0095	84	0.0095	73	84	0.0104	0.5784	0.1879
3.5417	2.0524	0.0095	85	0.0095	71	85	0.0106	0.5889	0.1914
3.5833	2.0618	0.0094	86	0.0094	69	86	0.0108	0.5997	0.1948
3.6250	2.0711	0.0093	87	0.0093	67	87	0.0109	0.6106	0.1984
3.6667	2.0803	0.0093	88	0.0093	65	88	0.0112	0.6218	0.2020
3.7083	2.0895	0.0092	89	0.0092	63	89	0.0114	0.6331	0.2057
3.7500	2.0987	0.0091	90	0.0091	61	90	0.0116	0.6447	0.2095
3.7917	2.1077	0.0091	91	0.0091	59	91	0.0118	0.6566	0.2133
3.8333	2.1168	0.0090	92	0.0090	57	92	0.0121	0.6687	0.2173
3.8750	2.1257	0.0090	93	0.0090	55	93	0.0124	0.6810	0.2213
3.9167	2.1346	0.0089	94	0.0089	53	94	0.0126	0.6937	0.2254
3.9583	2.1434	0.0088	95	0.0088	51	95	0.0129	0.7066	0.2296
4.0000	2.1522	0.0088	96	0.0088	49	96	0.0133	0.7199	0.2339
4.0417	2.1609	0.0087	97	0.0087	47	97	0.0136	0.7335	0.2383
4.0833	2.1696	0.0087	98	0.0087	45	98	0.0140	0.7475	0.2429
4.1250	2.1782	0.0086	99	0.0086	43	99	0.0144	0.7618	0.2475
4.1667	2.1868	0.0086	100	0.0086	41	100	0.0148	0.7767	0.2524
4.2083	2.1953	0.0085	101	0.0085	39	101	0.0153	0.7919	0.2573
4.2500	2.2037	0.0085	102	0.0085	37	102	0.0158	0.8077	0.2624
4.2917	2.2122	0.0084	103	0.0084	35	103	0.0163	0.8240	0.2678
4.3333	2.2205	0.0084	104	0.0084	33	104	0.0169	0.8410	0.2733
4.3750	2.2288	0.0083	105	0.0083	31	105	0.0176	0.8586	0.2790
4.4167	2.2371	0.0083	106	0.0083	29	106	0.0183	0.8769	0.2849
4.4583	2.2453	0.0082	107	0.0082	27	107	0.0192	0.8961	0.2912
4.5000	2.2535	0.0082	108	0.0082	25	108	0.0201	0.9162	0.2977
4.5417	2.2616	0.0081	109	0.0081	23	109	0.0212	0.9374	0.3046
4.5833	2.2697	0.0081	110	0.0081	21	110	0.0224	0.9599	0.3119
4.6250	2.2777	0.0080	111	0.0080	19	111	0.0239	0.9838	0.3196
4.6667	2.2857	0.0080	112	0.0080	17	112	0.0256	1.0094	0.3280
4.7083	2.2936	0.0079	113	0.0079	15	113	0.0277	1.0371	0.3370
4.7500	2.3015	0.0079	114	0.0079	13	114	0.0303	1.0674	0.3468
4.7917	2.3094	0.0079	115	0.0079	11	115	0.0337	1.1011	0.3578
4.8333	2.3172	0.0078	116	0.0078	9	116	0.0384	1.1395	0.3703
4.8750	2.3250	0.0078	117	0.0078	7	117	0.0452	1.1848	0.3850
4.9167	2.3327	0.0077	118	0.0077	5	118	0.0567	1.2414	0.4034
4.9583	2.3404	0.0077	119	0.0077	3	119	0.0814	1.3229	0.4298
5.0000	2.3481	0.0077	120	0.0077	1	120	**0.3624**	1.6852	0.5476
5.0417	2.3557	0.0076	121	0.0076	2	121	0.1126	1.7978	0.5842
5.0833	2.3633	0.0076	122	0.0076	4	122	0.0661	1.8639	0.6056
5.1250	2.3708	0.0075	123	0.0075	6	123	0.0501	1.9140	0.6219
5.1667	2.3783	0.0075	124	0.0075	8	124	0.0414	1.9555	0.6354
5.2083	2.3858	0.0075	125	0.0075	10	125	0.0359	1.9913	0.6470

5.2500	2.3932	0.0074	126	0.0074	12	126	0.0319	2.0232	0.6574
5.2917	2.4006	0.0074	127	0.0074	14	127	0.0289	2.0522	0.6668
5.3333	2.4080	0.0074	128	0.0074	16	128	0.0266	2.0788	0.6755
5.3750	2.4153	0.0073	129	0.0073	18	129	0.0247	2.1035	0.6835
5.4167	2.4226	0.0073	130	0.0073	20	130	0.0231	2.1266	0.6910
5.4583	2.4298	0.0073	131	0.0073	22	131	0.0218	2.1484	0.6981
5.5000	2.4371	0.0072	132	0.0072	24	132	0.0206	2.1690	0.7048
5.5417	2.4443	0.0072	133	0.0072	26	133	0.0196	2.1887	0.7112
5.5833	2.4514	0.0072	134	0.0072	28	134	0.0188	2.2074	0.7173
5.6250	2.4585	0.0071	135	0.0071	30	135	0.0180	2.2254	0.7231
5.6667	2.4656	0.0071	136	0.0071	32	136	0.0173	2.2427	0.7287
5.7083	2.4727	0.0071	137	0.0071	34	137	0.0166	2.2593	0.7341
5.7500	2.4797	0.0070	138	0.0070	36	138	0.0160	2.2753	0.7393
5.7917	2.4867	0.0070	139	0.0070	38	139	0.0155	2.2909	0.7444
5.8333	2.4937	0.0070	140	0.0070	40	140	0.0150	2.3059	0.7493
5.8750	2.5006	0.0069	141	0.0069	42	141	0.0146	2.3205	0.7540
5.9167	2.5075	0.0069	142	0.0069	44	142	0.0142	2.3347	0.7586
5.9583	2.5144	0.0069	143	0.0069	46	143	0.0138	2.3485	0.7631
6.0000	2.5213	0.0068	144	0.0068	48	144	0.0134	2.3619	0.7675
6.0417	2.5281	0.0068	145	0.0068	50	145	0.0131	2.3750	0.7717
6.0833	2.5349	0.0068	146	0.0068	52	146	0.0128	2.3878	0.7759
6.1250	2.5416	0.0068	147	0.0068	54	147	0.0125	2.4003	0.7799
6.1667	2.5484	0.0067	148	0.0067	56	148	0.0122	2.4125	0.7839
6.2083	2.5551	0.0067	149	0.0067	58	149	0.0120	2.4245	0.7878
6.2500	2.5618	0.0067	150	0.0067	60	150	0.0117	2.4362	0.7916
6.2917	2.5684	0.0067	151	0.0067	62	151	0.0115	2.4477	0.7953
6.3333	2.5750	0.0066	152	0.0066	64	152	0.0113	2.4589	0.7990
6.3750	2.5816	0.0066	153	0.0066	66	153	0.0110	2.4700	0.8026
6.4167	2.5882	0.0066	154	0.0066	68	154	0.0108	2.4808	0.8061
6.4583	2.5948	0.0065	155	0.0065	70	155	0.0107	2.4915	0.8096
6.5000	2.6013	0.0065	156	0.0065	72	156	0.0105	2.5020	0.8130
6.5417	2.6078	0.0065	157	0.0065	74	157	0.0103	2.5123	0.8163
6.5833	2.6142	0.0065	158	0.0065	76	158	0.0101	2.5224	0.8196
6.6250	2.6207	0.0064	159	0.0064	78	159	0.0100	2.5324	0.8228
6.6667	2.6271	0.0064	160	0.0064	80	160	0.0098	2.5422	0.8260
6.7083	2.6335	0.0064	161	0.0064	82	161	0.0097	2.5519	0.8292
6.7500	2.6399	0.0064	162	0.0064	84	162	0.0095	2.5614	0.8323
6.7917	2.6462	0.0063	163	0.0063	86	163	0.0094	2.5708	0.8353
6.8333	2.6526	0.0063	164	0.0063	88	164	0.0093	2.5800	0.8383
6.8750	2.6589	0.0063	165	0.0063	90	165	0.0091	2.5892	0.8413
6.9167	2.6651	0.0063	166	0.0063	92	166	0.0090	2.5982	0.8442
6.9583	2.6714	0.0063	167	0.0063	94	167	0.0089	2.6071	0.8471
7.0000	2.6776	0.0062	168	0.0062	96	168	0.0088	2.6158	0.8500
7.0417	2.6838	0.0062	169	0.0062	98	169	0.0087	2.6245	0.8528
7.0833	2.6900	0.0062	170	0.0062	100	170	0.0086	2.6331	0.8556
7.1250	2.6962	0.0062	171	0.0062	102	171	0.0085	2.6415	0.8583
7.1667	2.7023	0.0061	172	0.0061	104	172	0.0084	2.6499	0.8610
7.2083	2.7085	0.0061	173	0.0061	106	173	0.0083	2.6582	0.8637
7.2500	2.7146	0.0061	174	0.0061	108	174	0.0082	2.6663	0.8664
7.2917	2.7206	0.0061	175	0.0061	110	175	0.0081	2.6744	0.8690
7.3333	2.7267	0.0061	176	0.0061	112	176	0.0080	2.6824	0.8716
7.3750	2.7327	0.0060	177	0.0060	114	177	0.0079	2.6903	0.8741
7.4167	2.7387	0.0060	178	0.0060	116	178	0.0078	2.6981	0.8767
7.4583	2.7447	0.0060	179	0.0060	118	179	0.0077	2.7058	0.8792
7.5000	2.7507	0.0060	180	0.0060	120	180	0.0077	2.7135	0.8817

7.5417	2.7567	0.0060	181	0.0060	122	181	0.0076	2.7211	0.8842
7.5833	2.7626	0.0059	182	0.0059	124	182	0.0075	2.7286	0.8866
7.6250	2.7685	0.0059	183	0.0059	126	183	0.0074	2.7360	0.8890
7.6667	2.7744	0.0059	184	0.0059	128	184	0.0074	2.7434	0.8914
7.7083	2.7803	0.0059	185	0.0059	130	185	0.0073	2.7507	0.8938
7.7500	2.7861	0.0059	186	0.0059	132	186	0.0072	2.7579	0.8961
7.7917	2.7920	0.0058	187	0.0058	134	187	0.0072	2.7650	0.8984
7.8333	2.7978	0.0058	188	0.0058	136	188	0.0071	2.7721	0.9007
7.8750	2.8036	0.0058	189	0.0058	138	189	0.0070	2.7792	0.9030
7.9167	2.8094	0.0058	190	0.0058	140	190	0.0070	2.7861	0.9053
7.9583	2.8151	0.0058	191	0.0058	142	191	0.0069	2.7930	0.9075
8.0000	2.8209	0.0057	192	0.0057	144	192	0.0068	2.7999	0.9098
8.0417	2.8266	0.0057	193	0.0057	146	193	0.0068	2.8067	0.9120
8.0833	2.8323	0.0057	194	0.0057	148	194	0.0067	2.8134	0.9142
8.1250	2.8380	0.0057	195	0.0057	150	195	0.0067	2.8201	0.9163
8.1667	2.8437	0.0057	196	0.0057	152	196	0.0066	2.8267	0.9185
8.2083	2.8493	0.0057	197	0.0057	154	197	0.0066	2.8333	0.9206
8.2500	2.8550	0.0056	198	0.0056	156	198	0.0065	2.8398	0.9227
8.2917	2.8606	0.0056	199	0.0056	158	199	0.0065	2.8463	0.9248
8.3333	2.8662	0.0056	200	0.0056	160	200	0.0064	2.8527	0.9269
8.3750	2.8718	0.0056	201	0.0056	162	201	0.0064	2.8591	0.9290
8.4167	2.8774	0.0056	202	0.0056	164	202	0.0063	2.8654	0.9311
8.4583	2.8829	0.0056	203	0.0056	166	203	0.0063	2.8717	0.9331
8.5000	2.8884	0.0055	204	0.0055	168	204	0.0062	2.8779	0.9351
8.5417	2.8940	0.0055	205	0.0055	170	205	0.0062	2.8841	0.9371
8.5833	2.8995	0.0055	206	0.0055	172	206	0.0061	2.8903	0.9391
8.6250	2.9049	0.0055	207	0.0055	174	207	0.0061	2.8964	0.9411
8.6667	2.9104	0.0055	208	0.0055	176	208	0.0061	2.9024	0.9431
8.7083	2.9159	0.0055	209	0.0055	178	209	0.0060	2.9084	0.9450
8.7500	2.9213	0.0054	210	0.0054	180	210	0.0060	2.9144	0.9470
8.7917	2.9267	0.0054	211	0.0054	182	211	0.0059	2.9203	0.9489
8.8333	2.9321	0.0054	212	0.0054	184	212	0.0059	2.9262	0.9508
8.8750	2.9375	0.0054	213	0.0054	186	213	0.0059	2.9321	0.9527
8.9167	2.9429	0.0054	214	0.0054	188	214	0.0058	2.9379	0.9546
8.9583	2.9483	0.0054	215	0.0054	190	215	0.0058	2.9437	0.9565
9.0000	2.9536	0.0053	216	0.0053	192	216	0.0057	2.9494	0.9584
9.0417	2.9589	0.0053	217	0.0053	194	217	0.0057	2.9551	0.9602
9.0833	2.9642	0.0053	218	0.0053	196	218	0.0057	2.9608	0.9620
9.1250	2.9695	0.0053	219	0.0053	198	219	0.0056	2.9664	0.9639
9.1667	2.9748	0.0053	220	0.0053	200	220	0.0056	2.9720	0.9657
9.2083	2.9801	0.0053	221	0.0053	202	221	0.0056	2.9776	0.9675
9.2500	2.9854	0.0053	222	0.0053	204	222	0.0055	2.9832	0.9693
9.2917	2.9906	0.0052	223	0.0052	206	223	0.0055	2.9887	0.9711
9.3333	2.9958	0.0052	224	0.0052	208	224	0.0055	2.9941	0.9729
9.3750	3.0010	0.0052	225	0.0052	210	225	0.0054	2.9996	0.9746
9.4167	3.0062	0.0052	226	0.0052	212	226	0.0054	3.0050	0.9764
9.4583	3.0114	0.0052	227	0.0052	214	227	0.0054	3.0103	0.9781
9.5000	3.0166	0.0052	228	0.0052	216	228	0.0053	3.0157	0.9799
9.5417	3.0218	0.0052	229	0.0052	218	229	0.0053	3.0210	0.9816
9.5833	3.0269	0.0051	230	0.0051	220	230	0.0053	3.0263	0.9833
9.6250	3.0320	0.0051	231	0.0051	222	231	0.0053	3.0315	0.9850
9.6667	3.0371	0.0051	232	0.0051	224	232	0.0052	3.0368	0.9867
9.7083	3.0423	0.0051	233	0.0051	226	233	0.0052	3.0420	0.9884
9.7500	3.0473	0.0051	234	0.0051	228	234	0.0052	3.0471	0.9901
9.7917	3.0524	0.0051	235	0.0051	230	235	0.0051	3.0523	0.9918

9.8333	3.0575	0.0051	236	0.0051	232	236	0.0051	3.0574	0.9934
9.8750	3.0625	0.0051	237	0.0051	234	237	0.0051	3.0625	0.9951
9.9167	3.0676	0.0050	238	0.0050	236	238	0.0051	3.0676	0.9967
9.9583	3.0726	0.0050	239	0.0050	238	239	0.0050	3.0726	0.9984
10.0000	3.0776	0.0050	240	0.0050	240	240	0.0050	3.0776	1.0000



Unit Hydrograph

Unit Storm Duration
ΔD 0.25 hr << 0.2-hr time increments are used

Time to Peak
Tp 1.25 hr << rounded to 1.0 hr

Unit Hydrograph Peak Discharge
qp 2295 cfs

Time Ratio	Discharge Ratio	Time (hr)	q (cfs)
0.0	0.000	0.000	0
0.1	0.030	0.100	69
0.2	0.100	0.200	230
0.3	0.190	0.300	436
0.4	0.310	0.400	711
0.5	0.470	0.500	1079
0.6	0.660	0.600	1515
0.7	0.820	0.700	1882
0.8	0.930	0.800	2134
0.9	0.990	0.900	2272
1.0	1.000	1.000	2295
1.1	0.990	1.100	2272
1.2	0.930	1.200	2134
1.3	0.860	1.300	1974
1.4	0.780	1.400	1790
1.5	0.680	1.500	1561
1.6	0.560	1.600	1285
1.7	0.460	1.700	1056
1.8	0.390	1.800	895

Time (hr)	q (cfs)
0	**0**
0.30	230
0.60	711
0.90	1515
1.20	2134
1.50	**2295**
1.80	2134
2.10	1790
2.40	1285
2.70	895
3.00	**643**
3.30	475
3.60	337
3.90	246
4.20	177
4.50	**126**
4.80	92
5.10	67
5.40	48

1.9	0.330	1.900	757
2.0	0.280	2.000	643
2.2	0.207	2.200	475
2.4	0.147	2.400	337
2.6	0.107	2.600	246
2.8	0.077	2.800	177
3.0	0.055	3.000	126
3.2	0.040	3.200	92
3.4	0.029	3.400	67
3.6	0.021	3.600	48
3.8	0.015	3.800	34
4.0	0.011	4.000	25
4.5	0.005	4.500	11
5.0	0.000	5.000	0

5.70	34
6.00	**25**
6.30	19
6.60	14
6.90	9
7.20	5
7.50	**0**
7.80	0
8.10	0
8.40	0
8.70	0
9.00	**0**
9.30	0
9.60	0

Sum 4592 cfs-h

Check

Unit Hydrograph (per 1 in. Unit Runoff) 3060.2 cfs-h

Variance -50.05%

Principal Spillway Hydrograph

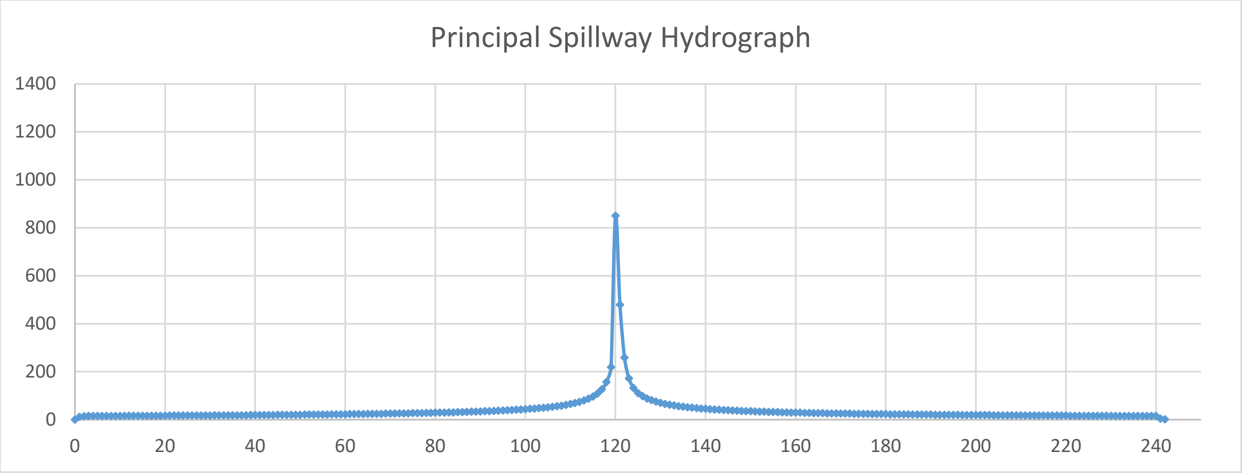
Time (hrs)	Inc. Volumes Rearranged	q (cfs)	Composite PSH (cfs)
0.0	0.0000	0	0
1.0	0.0050	2186	11
2.0	0.0051	612	14
3.0	0.0051	120	15
4.0	0.0051	24	15
5.0	0.0051	0	15
6.0	0.0052		15
7.0	0.0052		15
8.0	0.0052		15
9.0	0.0052		15
10.0	0.0053		15
11.0	0.0053		16
12.0	0.0053		16
13.0	0.0054		16
14.0	0.0054		16
15.0	0.0054		16
16.0	0.0055		16
17.0	0.0055		16
18.0	0.0055		16
19.0	0.0056		16
20.0	0.0056		16
21.0	0.0056		17
22.0	0.0057		17
23.0	0.0057		17
24.0	0.0057		17
25.0	0.0058		17
26.0	0.0058		17
27.0	0.0058		17
28.0	0.0059		17
29.0	0.0059		17

30.0	0.0060		17
31.0	0.0060		18
32.0	0.0060		18
33.0	0.0061		18
34.0	0.0061		18
35.0	0.0062		18
36.0	0.0062		18
37.0	0.0063		18
38.0	0.0063		18
39.0	0.0063		19
40.0	0.0064		19
41.0	0.0064		19
42.0	0.0065		19
43.0	0.0065		19
44.0	0.0066		19
45.0	0.0067		20
46.0	0.0067		20
47.0	0.0068		20
48.0	0.0068		20
49.0	0.0069		20
50.0	0.0069		20
51.0	0.0070		21
52.0	0.0071		21
53.0	0.0071		21
54.0	0.0072		21
55.0	0.0073		21
56.0	0.0073		21
57.0	0.0074		22
58.0	0.0075		22
59.0	0.0075		22
60.0	0.0076		22
61.0	0.0077		23
62.0	0.0078		23
63.0	0.0079		23
64.0	0.0079		23
65.0	0.0080		24
66.0	0.0081		24
67.0	0.0082		24
68.0	0.0083		24
69.0	0.0084		25
70.0	0.0085		25
71.0	0.0086		25
72.0	0.0087		26
73.0	0.0088		26
74.0	0.0090		26
75.0	0.0091		27
76.0	0.0092		27
77.0	0.0093		27
78.0	0.0095		28
79.0	0.0096		28
80.0	0.0097		29
81.0	0.0099		29
82.0	0.0101		29
83.0	0.0102		30
84.0	0.0104		30

85.0	0.0106		31
86.0	0.0108		31
87.0	0.0109		32
88.0	0.0112		33
89.0	0.0114		33
90.0	0.0116		34
91.0	0.0118		35
92.0	0.0121		35
93.0	0.0124		36
94.0	0.0126		37
95.0	0.0129		38
96.0	0.0133		39
97.0	0.0136		40
98.0	0.0140		41
99.0	0.0144		42
100.0	0.0148		43
101.0	0.0153		45
102.0	0.0158		46
103.0	0.0163		48
104.0	0.0169		49
105.0	0.0176		51
106.0	0.0183		53
107.0	0.0192		56
108.0	0.0201		58
109.0	0.0212		61
110.0	0.0224		65
111.0	0.0239		69
112.0	0.0256		74
113.0	0.0277		80
114.0	0.0303		87
115.0	0.0337		96
116.0	0.0384		109
117.0	0.0452		127
118.0	0.0567		157
119.0	0.0814		219
120.0	0.3624		850
121.0	0.1126		479
122.0	0.0661		259
123.0	0.0501		172
124.0	0.0414		132
125.0	0.0359		111
126.0	0.0319		98
127.0	0.0289		88
128.0	0.0266		81
129.0	0.0247		75
130.0	0.0231		70
131.0	0.0218		65
132.0	0.0206		62
133.0	0.0196		59
134.0	0.0188		56
135.0	0.0180		54
136.0	0.0173		51
137.0	0.0166		50
138.0	0.0160		48
139.0	0.0155		46

140.0	0.0150		45
141.0	0.0146		43
142.0	0.0142		42
143.0	0.0138		41
144.0	0.0134		40
145.0	0.0131		39
146.0	0.0128		38
147.0	0.0125		37
148.0	0.0122		36
149.0	0.0120		35
150.0	0.0117		35
151.0	0.0115		34
152.0	0.0113		33
153.0	0.0110		33
154.0	0.0108		32
155.0	0.0107		32
156.0	0.0105		31
157.0	0.0103		30
158.0	0.0101		30
159.0	0.0100		29
160.0	0.0098		29
161.0	0.0097		29
162.0	0.0095		28
163.0	0.0094		28
164.0	0.0093		27
165.0	0.0091		27
166.0	0.0090		27
167.0	0.0089		26
168.0	0.0088		26
169.0	0.0087		26
170.0	0.0086		25
171.0	0.0085		25
172.0	0.0084		25
173.0	0.0083		24
174.0	0.0082		24
175.0	0.0081		24
176.0	0.0080		24
177.0	0.0079		23
178.0	0.0078		23
179.0	0.0077		23
180.0	0.0077		23
181.0	0.0076		22
182.0	0.0075		22
183.0	0.0074		22
184.0	0.0074		22
185.0	0.0073		22
186.0	0.0072		21
187.0	0.0072		21
188.0	0.0071		21
189.0	0.0070		21
190.0	0.0070		21
191.0	0.0069		20
192.0	0.0068		20
193.0	0.0068		20
194.0	0.0067		20

195.0	0.0067		20
196.0	0.0066		20
197.0	0.0066		19
198.0	0.0065		19
199.0	0.0065		19
200.0	0.0064		19
201.0	0.0064		19
202.0	0.0063		19
203.0	0.0063		19
204.0	0.0062		18
205.0	0.0062		18
206.0	0.0061		18
207.0	0.0061		18
208.0	0.0061		18
209.0	0.0060		18
210.0	0.0060		18
211.0	0.0059		17
212.0	0.0059		17
213.0	0.0059		17
214.0	0.0058		17
215.0	0.0058		17
216.0	0.0057		17
217.0	0.0057		17
218.0	0.0057		17
219.0	0.0056		17
220.0	0.0056		17
221.0	0.0056		16
222.0	0.0055		16
223.0	0.0055		16
224.0	0.0055		16
225.0	0.0054		16
226.0	0.0054		16
227.0	0.0054		16
228.0	0.0053		16
229.0	0.0053		16
230.0	0.0053		16
231.0	0.0053		15
232.0	0.0052		15
233.0	0.0052		15
234.0	0.0052		15
235.0	0.0051		15
236.0	0.0051		15
237.0	0.0051		15
238.0	0.0051		15
239.0	0.0050		15
240.0	0.0050		15
241.0	0.0000		4
242.0	0.0000		1



Results

Peak Hydrograph Flow	850 cfs
Total Volume	749 ac-ft

ASH-L Hydrograph

Characteristics

Drainage Area	4.742	sq mi
Time of Concentration	1.58	hr
Curve Number	77.8	
Structure Hazard Classification	High	
Initial Abstraction	0.57	in
Maximum Potential Retention	2.85	in
Precipitation	4.03	in
ΔD	0.05	hr

5-Point Rainfall Distribution

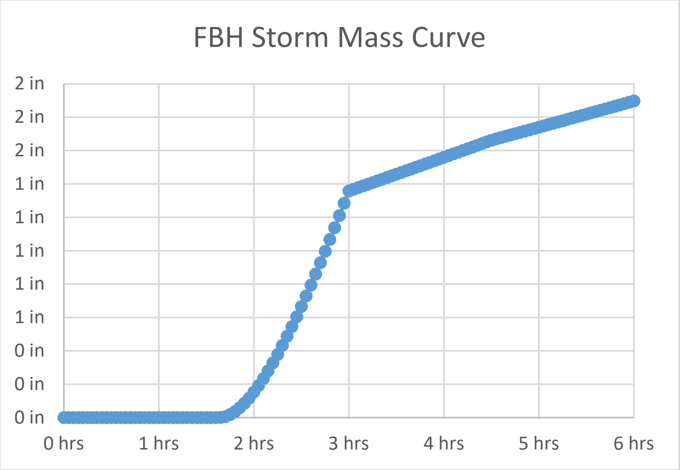
Time Increment	Incremental Rainfall		Rainfall Fractions for Each Time Increment		5 Point Rainfall Distribution	
0 to 1.5	0.299	in	0.074		0.074	
1.5 to 3	3.032	in	0.752		0.827	
2 to 4.5	0.400	in	0.099		0.926	
4.5 to 6	0.299	in	0.074		1.000	

Time (hr)	Rainfall Distribution	Time (hr)	Rainfall Distribution	Time (hr)	Rainfall Distribution	Time (hr)	Rainfall Distribution
0.00	0.000	1.50	0.074	3.00	0.827	4.50	0.926
0.05	0.002	1.55	0.099	3.05	0.830	4.55	0.928
0.10	0.005	1.60	0.124	3.10	0.833	4.60	0.931
0.15	0.007	1.65	0.149	3.15	0.836	4.65	0.933
0.20	0.010	1.70	0.175	3.20	0.840	4.70	0.936
0.25	0.012	1.75	0.200	3.25	0.843	4.75	0.938
0.30	0.015	1.80	0.225	3.30	0.846	4.80	0.941
0.35	0.017	1.85	0.250	3.35	0.850	4.85	0.943
0.40	0.020	1.90	0.275	3.40	0.853	4.90	0.946
0.45	0.022	1.95	0.300	3.45	0.856	4.95	0.948
0.50	0.025	2.00	0.325	3.50	0.860	5.00	0.951
0.55	0.027	2.05	0.350	3.55	0.863	5.05	0.953
0.60	0.030	2.10	0.375	3.60	0.866	5.10	0.955
0.65	0.032	2.15	0.400	3.65	0.870	5.15	0.958
0.70	0.035	2.20	0.425	3.70	0.873	5.20	0.960
0.75	0.037	2.25	0.450	3.75	0.876	5.25	0.963
0.80	0.040	2.30	0.475	3.80	0.879	5.30	0.965
0.85	0.042	2.35	0.501	3.85	0.883	5.35	0.968
0.90	0.045	2.40	0.526	3.90	0.886	5.40	0.970
0.95	0.047	2.45	0.551	3.95	0.889	5.45	0.973
1.00	0.049	2.50	0.576	4.00	0.893	5.50	0.975
1.05	0.052	2.55	0.601	4.05	0.896	5.55	0.978
1.10	0.054	2.60	0.626	4.10	0.899	5.60	0.980
1.15	0.057	2.65	0.651	4.15	0.903	5.65	0.983
1.20	0.059	2.70	0.676	4.20	0.906	5.70	0.985
1.25	0.062	2.75	0.701	4.25	0.909	5.75	0.988
1.30	0.064	2.80	0.726	4.30	0.913	5.80	0.990
1.35	0.067	2.85	0.751	4.35	0.916	5.85	0.993
1.40	0.069	2.90	0.776	4.40	0.919	5.90	0.995
1.45	0.072	2.95	0.801	4.45	0.922	5.95	0.998
						6.00	1.000

Time (hr)	Rainfall Distribution	Total Rainfall (in)	Acc. Mass Curve of Runoff (in)	Inc. Mass Curve of Runoff (in)
0.00	0.000	0.000	0.000	0.000
0.05	0.002	0.010	0.000	0.000
0.10	0.005	0.020	0.000	0.000
0.15	0.007	0.030	0.000	0.000
0.20	0.010	0.040	0.000	0.000
0.25	0.012	0.050	0.000	0.000
0.30	0.015	0.060	0.000	0.000
0.35	0.017	0.070	0.000	0.000
0.40	0.020	0.080	0.000	0.000
0.45	0.022	0.090	0.000	0.000
0.50	0.025	0.100	0.000	0.000
0.55	0.027	0.110	0.000	0.000
0.60	0.030	0.120	0.000	0.000
0.65	0.032	0.130	0.000	0.000
0.70	0.035	0.140	0.000	0.000
0.75	0.037	0.150	0.000	0.000
0.80	0.040	0.159	0.000	0.000
0.85	0.042	0.169	0.000	0.000
0.90	0.045	0.179	0.000	0.000
0.95	0.047	0.189	0.000	0.000
1.00	0.049	0.199	0.000	0.000
1.05	0.052	0.209	0.000	0.000
1.10	0.054	0.219	0.000	0.000
1.15	0.057	0.229	0.000	0.000
1.20	0.059	0.239	0.000	0.000
1.25	0.062	0.249	0.000	0.000
1.30	0.064	0.259	0.000	0.000
1.35	0.067	0.269	0.000	0.000
1.40	0.069	0.279	0.000	0.000
1.45	0.072	0.289	0.000	0.000
1.50	0.074	0.299	0.000	0.000
1.55	0.099	0.400	0.000	0.000
1.60	0.124	0.501	0.000	0.000
1.65	0.149	0.602	0.000	0.000
1.70	0.175	0.703	0.006	0.006
1.75	0.200	0.804	0.018	0.012
1.80	0.225	0.905	0.035	0.018
1.85	0.250	1.006	0.058	0.023
1.90	0.275	1.108	0.085	0.027
1.95	0.300	1.209	0.117	0.032
2.00	0.325	1.310	0.152	0.036
2.05	0.350	1.411	0.192	0.039
2.10	0.375	1.512	0.234	0.042
2.15	0.400	1.613	0.279	0.045
2.20	0.425	1.714	0.328	0.048
2.25	0.450	1.815	0.379	0.051
2.30	0.475	1.916	0.432	0.053
2.35	0.501	2.017	0.487	0.056

2.40	0.526	2.118	0.545	0.058
2.45	0.551	2.219	0.605	0.060
2.50	0.576	2.320	0.666	0.061
2.55	0.601	2.421	0.729	0.063
2.60	0.626	2.522	0.794	0.065
2.65	0.651	2.624	0.860	0.066
2.70	0.676	2.725	0.928	0.068
2.75	0.701	2.826	0.997	0.069
2.80	0.726	2.927	1.067	0.070
2.85	0.751	3.028	1.138	0.071
2.90	0.776	3.129	1.211	0.072
2.95	0.801	3.230	1.284	0.074
3.00	0.827	3.331	1.359	0.075
3.05	0.830	3.344	1.369	0.010
3.10	0.833	3.358	1.378	0.010
3.15	0.836	3.371	1.388	0.010
3.20	0.840	3.384	1.398	0.010
3.25	0.843	3.398	1.408	0.010
3.30	0.846	3.411	1.418	0.010
3.35	0.850	3.424	1.428	0.010
3.40	0.853	3.438	1.438	0.010
3.45	0.856	3.451	1.448	0.010
3.50	0.860	3.464	1.458	0.010
3.55	0.863	3.478	1.468	0.010
3.60	0.866	3.491	1.478	0.010
3.65	0.870	3.504	1.489	0.010
3.70	0.873	3.518	1.499	0.010
3.75	0.876	3.531	1.509	0.010
3.80	0.879	3.544	1.519	0.010
3.85	0.883	3.558	1.529	0.010
3.90	0.886	3.571	1.539	0.010
3.95	0.889	3.584	1.549	0.010
4.00	0.893	3.598	1.560	0.010
4.05	0.896	3.611	1.570	0.010
4.10	0.899	3.624	1.580	0.010
4.15	0.903	3.638	1.590	0.010
4.20	0.906	3.651	1.600	0.010
4.25	0.909	3.664	1.611	0.010
4.30	0.913	3.678	1.621	0.010
4.35	0.916	3.691	1.631	0.010
4.40	0.919	3.704	1.642	0.010
4.45	0.922	3.718	1.652	0.010
4.50	0.926	3.731	1.662	0.010
4.55	0.928	3.741	1.670	0.008
4.60	0.931	3.751	1.678	0.008
4.65	0.933	3.761	1.685	0.008
4.70	0.936	3.771	1.693	0.008
4.75	0.938	3.781	1.701	0.008
4.80	0.941	3.791	1.709	0.008
4.85	0.943	3.801	1.717	0.008
4.90	0.946	3.811	1.724	0.008
4.95	0.948	3.821	1.732	0.008
5.00	0.951	3.831	1.740	0.008
5.05	0.953	3.841	1.748	0.008
5.10	0.955	3.851	1.756	0.008

5.15	0.958	3.861	1.763	0.008
5.20	0.960	3.871	1.771	0.008
5.25	0.963	3.881	1.779	0.008
5.30	0.965	3.890	1.787	0.008
5.35	0.968	3.900	1.795	0.008
5.40	0.970	3.910	1.803	0.008
5.45	0.973	3.920	1.810	0.008
5.50	0.975	3.930	1.818	0.008
5.55	0.978	3.940	1.826	0.008
5.60	0.980	3.950	1.834	0.008
5.65	0.983	3.960	1.842	0.008
5.70	0.985	3.970	1.850	0.008
5.75	0.988	3.980	1.858	0.008
5.80	0.990	3.990	1.866	0.008
5.85	0.993	4.000	1.873	0.008
5.90	0.995	4.010	1.881	0.008
5.95	0.998	4.020	1.889	0.008
6.00	1.000	4.030	1.897	0.008



Unit Hydrograph

Unit Storm Duration

ΔD 0.05

Time to Peak

Tp 0.99 << rounded to 1.0 hr

Unit Hydrograph Peak Discharge

qp 2295

Time Ratio	Discharge Ratio	Time (hr)	q (cfs)
0.0	0.000	0.000	0
0.1	0.030	0.100	69
0.2	0.100	0.200	230
0.3	0.190	0.300	436
0.4	0.310	0.400	711
0.5	0.470	0.500	1079
0.6	0.660	0.600	1515

Time (hr)	q (cfs)
0	**0**
0.05	230
0.10	711
0.15	1515
0.20	2134
0.25	**2295**
0.30	2134

0.7	0.820	0.700	1882
0.8	0.930	0.800	2134
0.9	0.990	0.900	2272
1.0	1.000	1.000	2295
1.1	0.990	1.100	2272
1.2	0.930	1.200	2134
1.3	0.860	1.300	1974
1.4	0.780	1.400	1790
1.5	0.680	1.500	1561
1.6	0.560	1.600	1285
1.7	0.460	1.700	1056
1.8	0.390	1.800	895
1.9	0.330	1.900	757
2.0	0.280	2.000	643
2.2	0.207	2.200	475
2.4	0.147	2.400	337
2.6	0.107	2.600	246
2.8	0.077	2.800	177
3.0	0.055	3.000	126
3.2	0.040	3.200	92
3.4	0.029	3.400	67
3.6	0.021	3.600	48
3.8	0.015	3.800	34
4.0	0.011	4.000	25
4.5	0.005	4.500	11
5.0	0.000	5.000	0

0.35	1790
0.40	1285
0.45	895
0.50	**643**
0.55	475
0.60	337
0.65	246
0.70	177
0.75	**126**
0.80	92
0.85	67
0.90	48
0.95	34
1.00	**25**
1.05	19
1.10	14
1.15	9
1.20	5
1.25	**0**
1.30	0
1.35	0
1.40	0
1.45	0
1.50	**0**
1.55	0
1.60	0

Sum	1531	cfs-h

Check

Unit Hydrograph (per 1 in. Unit Runoff)	3060.2
Variance	49.98%

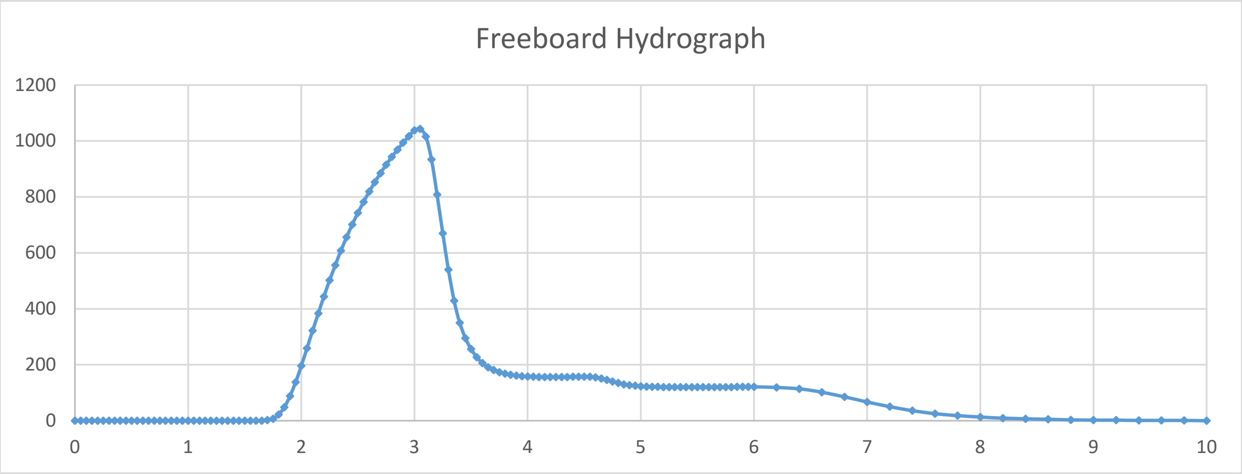
Freeboard Hydrograph

Time (hrs)	Inc. Runoff	q (cfs)	Composite FBH (cfs)
0.0	0.0000	0	0
0.1	0.0000	230	0
0.1	0.0000	711	0
0.2	0.0000	1515	0
0.2	0.0000	2134	0
0.3	0.0000	2295	0
0.3	0.0000	2134	0
0.4	0.0000	1790	0
0.4	0.0000	1285	0
0.5	0.0000	895	0
0.5	0.0000	643	0
0.6	0.0000	475	0
0.6	0.0000	337	0

0.7	0.0000	246	0
0.7	0.0000	177	0
0.8	0.0000	126	0
0.8	0.0000	92	0
0.9	0.0000	67	0
0.9	0.0000	48	0
1.0	0.0000	34	0
1.0	0.0000	25	0
1.1	0.0000	19	0
1.1	0.0000	14	0
1.2	0.0000	9	0
1.2	0.0000	5	0
1.3	0.0000	0	0
1.3	0.0000		0
1.4	0.0000		0
1.4	0.0000		0
1.5	0.0000		0
1.5	0.0000		0
1.6	0.0000		0
1.6	0.0000		0
1.7	0.0004		0
1.7	0.0056		2
1.8	0.0119		7
1.8	0.0175		22
1.9	0.0227		48
1.9	0.0273		88
2.0	0.0316		138
2.0	0.0355		196
2.1	0.0391		259
2.1	0.0424		322
2.2	0.0455		384
2.2	0.0483		444
2.3	0.0509		502
2.3	0.0533		556
2.4	0.0555		608
2.4	0.0576		656
2.5	0.0596		701
2.5	0.0614		743
2.6	0.0631		782
2.6	0.0647		819
2.7	0.0662		853
2.7	0.0676		885
2.8	0.0689		915
2.8	0.0702		943
2.9	0.0714		969
2.9	0.0725		994
3.0	0.0735		1017
3.0	0.0745		1038
3.1	0.0099		1043
3.1	0.0099		1016
3.2	0.0099		934
3.2	0.0099		808
3.3	0.0100		670
3.3	0.0100		540
3.4	0.0100		429

3.4	0.0100		350
3.5	0.0100		295
3.5	0.0100		256
3.6	0.0101		227
3.6	0.0101		206
3.7	0.0101		191
3.7	0.0101		181
3.7	0.0101		173
3.8	0.0101		168
3.8	0.0101		164
3.9	0.0102		161
3.9	0.0102		159
4.0	0.0102		158
4.0	0.0102		157
4.1	0.0102		156
4.1	0.0102		156
4.2	0.0102		156
4.2	0.0103		156
4.3	0.0103		156
4.3	0.0103		156
4.4	0.0103		157
4.4	0.0103		157
4.5	0.0103		157
4.5	0.0077		157
4.6	0.0077		155
4.6	0.0077		151
4.7	0.0078		146
4.7	0.0078		140
4.8	0.0078		135
4.8	0.0078		130
4.9	0.0078		127
4.9	0.0078		125
5.0	0.0078		123
5.0	0.0078		122
5.1	0.0078		121
5.1	0.0078		121
5.2	0.0078		120
5.2	0.0078		120
5.3	0.0078		120
5.3	0.0078		120
5.4	0.0079		120
5.4	0.0079		120
5.5	0.0079		120
5.5	0.0079		120
5.6	0.0079		120
5.6	0.0079		120
5.7	0.0079		120
5.7	0.0079		120
5.8	0.0079		120
5.8	0.0079		121
5.9	0.0079		121
5.9	0.0079		121
6.0	0.0079		121
6.2			119
6.4			114

6.6			102
6.8			85
7.0			67
7.2			50
7.4			36
7.6			25
7.8			18
8.0			13
8.2			9
8.4			7
8.6			5
8.8			3
9.0			2
9.2			2
9.4			1
9.6			1
9.8			1
10.0			0
10.2			0
10.4			0



Results

Peak Hydrograph Flow	1043 cfs
Total Volume	480 ac-ft

ASH-G Hydrograph

Characteristics

Drainage Area	4.742	sq mi	
Time of Concentration	1.58	hr	
Curve Number	77.8		
Structure Hazard Classification	High		
Initial Abstraction	0.57	in	
Maximum Potential Retention	2.85	in	
Precipitation	5.85	in	
ΔD	0.21	hr	<< 0.2-hr time increments are used

5-Point Rainfall Distribution

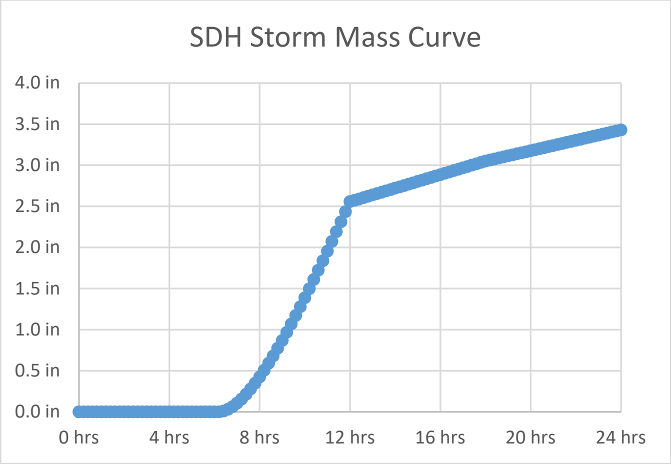
Time Increment	Incremental Rainfall		Rainfall Fractions for Each Time Increment		5 Point Rainfall Distribution	
0 to 6	0.436	in	0.075		0.075	
6 to 12	4.399	in	0.752		0.826	
12 to 18	0.580	in	0.099		0.926	
18 to 24	0.435	in	0.074		1.000	

Time (hr)	Rainfall Distribution	Time (hr)	Rainfall Distribution	Time (hr)	Rainfall Distribution	Time (hr)	Rainfall Distribution
0.00	0.000	6.00	0.075	12.00	0.826	18.00	0.926
0.20	0.002	6.20	0.100	12.20	0.830	18.20	0.928
0.40	0.005	6.40	0.125	12.40	0.833	18.40	0.931
0.60	0.007	6.60	0.150	12.60	0.836	18.60	0.933
0.80	0.010	6.80	0.175	12.80	0.840	18.80	0.936
1.00	0.012	7.00	0.200	13.00	0.843	19.00	0.938
1.20	0.015	7.20	0.225	13.20	0.846	19.20	0.941
1.40	0.017	7.40	0.250	13.40	0.850	19.40	0.943
1.60	0.020	7.60	0.275	13.60	0.853	19.60	0.945
1.80	0.022	7.80	0.300	13.80	0.856	19.80	0.948
2.00	0.025	8.00	0.325	14.00	0.860	20.00	0.950
2.20	0.027	8.20	0.350	14.20	0.863	20.20	0.953
2.40	0.030	8.40	0.375	14.40	0.866	20.40	0.955
2.60	0.032	8.60	0.400	14.60	0.869	20.60	0.958
2.80	0.035	8.80	0.425	14.80	0.873	20.80	0.960
3.00	0.037	9.00	0.451	15.00	0.876	21.00	0.963
3.20	0.040	9.20	0.476	15.20	0.879	21.20	0.965
3.40	0.042	9.40	0.501	15.40	0.883	21.40	0.968
3.60	0.045	9.60	0.526	15.60	0.886	21.60	0.970
3.80	0.047	9.80	0.551	15.80	0.889	21.80	0.973
4.00	0.050	10.00	0.576	16.00	0.893	22.00	0.975
4.20	0.052	10.20	0.601	16.20	0.896	22.20	0.978
4.40	0.055	10.40	0.626	16.40	0.899	22.40	0.980
4.60	0.057	10.60	0.651	16.60	0.903	22.60	0.983
4.80	0.060	10.80	0.676	16.80	0.906	22.80	0.985
5.00	0.062	11.00	0.701	17.00	0.909	23.00	0.988
5.20	0.065	11.20	0.726	17.20	0.912	23.20	0.990
5.40	0.067	11.40	0.751	17.40	0.916	23.40	0.993
5.60	0.070	11.60	0.776	17.60	0.919	23.60	0.995
5.80	0.072	11.80	0.801	17.80	0.922	23.80	0.998
						24.00	1.000

Time (hr)	Rainfall Distribution	Total Rainfall (in)	Acc. Mass Curve of Runoff (in)	Inc. Mass Curve of Runoff (in)
0.00	0.000	0.000	0.000	0.000
0.20	0.002	0.015	0.000	0.000
0.40	0.005	0.029	0.000	0.000
0.60	0.007	0.044	0.000	0.000
0.80	0.010	0.058	0.000	0.000
1.00	0.012	0.073	0.000	0.000
1.20	0.015	0.087	0.000	0.000
1.40	0.017	0.102	0.000	0.000
1.60	0.020	0.116	0.000	0.000
1.80	0.022	0.131	0.000	0.000
2.00	0.025	0.145	0.000	0.000
2.20	0.027	0.160	0.000	0.000
2.40	0.030	0.174	0.000	0.000
2.60	0.032	0.189	0.000	0.000
2.80	0.035	0.203	0.000	0.000
3.00	0.037	0.218	0.000	0.000
3.20	0.040	0.233	0.000	0.000
3.40	0.042	0.247	0.000	0.000
3.60	0.045	0.262	0.000	0.000
3.80	0.047	0.276	0.000	0.000
4.00	0.050	0.291	0.000	0.000
4.20	0.052	0.305	0.000	0.000
4.40	0.055	0.320	0.000	0.000
4.60	0.057	0.334	0.000	0.000
4.80	0.060	0.349	0.000	0.000
5.00	0.062	0.363	0.000	0.000
5.20	0.065	0.378	0.000	0.000
5.40	0.067	0.392	0.000	0.000
5.60	0.070	0.407	0.000	0.000
5.80	0.072	0.421	0.000	0.000
6.00	0.075	0.436	0.000	0.000
6.20	0.100	0.583	0.000	0.000
6.40	0.125	0.729	0.008	0.008
6.60	0.150	0.876	0.030	0.021
6.80	0.175	1.023	0.062	0.032
7.00	0.200	1.169	0.104	0.042
7.20	0.225	1.316	0.155	0.051
7.40	0.250	1.462	0.213	0.058
7.60	0.275	1.609	0.278	0.065
7.80	0.300	1.756	0.348	0.071
8.00	0.325	1.902	0.424	0.076
8.20	0.350	2.049	0.505	0.081
8.40	0.375	2.196	0.590	0.085
8.60	0.400	2.342	0.680	0.089
8.80	0.425	2.489	0.772	0.093
9.00	0.451	2.636	0.868	0.096
9.20	0.476	2.782	0.967	0.099
9.40	0.501	2.929	1.068	0.101
9.60	0.526	3.075	1.172	0.104
9.80	0.551	3.222	1.278	0.106
10.00	0.576	3.369	1.387	0.108

10.20	0.601	3.515	1.497	0.110
10.40	0.626	3.662	1.609	0.112
10.60	0.651	3.809	1.723	0.114
10.80	0.676	3.955	1.838	0.115
11.00	0.701	4.102	1.955	0.117
11.20	0.726	4.248	2.073	0.118
11.40	0.751	4.395	2.192	0.119
11.60	0.776	4.542	2.312	0.120
11.80	0.801	4.688	2.434	0.122
12.00	0.826	4.835	2.557	0.123
12.20	0.830	4.854	2.573	0.016
12.40	0.833	4.874	2.589	0.016
12.60	0.836	4.893	2.605	0.016
12.80	0.840	4.912	2.622	0.016
13.00	0.843	4.932	2.638	0.016
13.20	0.846	4.951	2.654	0.016
13.40	0.850	4.970	2.671	0.016
13.60	0.853	4.990	2.687	0.016
13.80	0.856	5.009	2.703	0.016
14.00	0.860	5.028	2.720	0.016
14.20	0.863	5.048	2.736	0.016
14.40	0.866	5.067	2.753	0.016
14.60	0.869	5.086	2.769	0.016
14.80	0.873	5.106	2.785	0.016
15.00	0.876	5.125	2.802	0.016
15.20	0.879	5.144	2.818	0.016
15.40	0.883	5.164	2.835	0.016
15.60	0.886	5.183	2.851	0.017
15.80	0.889	5.202	2.868	0.017
16.00	0.893	5.222	2.884	0.017
16.20	0.896	5.241	2.901	0.017
16.40	0.899	5.260	2.918	0.017
16.60	0.903	5.280	2.934	0.017
16.80	0.906	5.299	2.951	0.017
17.00	0.909	5.318	2.967	0.017
17.20	0.912	5.338	2.984	0.017
17.40	0.916	5.357	3.001	0.017
17.60	0.919	5.376	3.017	0.017
17.80	0.922	5.396	3.034	0.017
18.00	0.926	5.415	3.051	0.017
18.20	0.928	5.430	3.063	0.013
18.40	0.931	5.444	3.076	0.013
18.60	0.933	5.459	3.088	0.013
18.80	0.936	5.473	3.101	0.013
19.00	0.938	5.488	3.113	0.013
19.20	0.941	5.502	3.126	0.013
19.40	0.943	5.517	3.138	0.013
19.60	0.945	5.531	3.151	0.013
19.80	0.948	5.546	3.163	0.013
20.00	0.950	5.560	3.176	0.013
20.20	0.953	5.575	3.189	0.013
20.40	0.955	5.589	3.201	0.013
20.60	0.958	5.604	3.214	0.013
20.80	0.960	5.618	3.226	0.013
21.00	0.963	5.633	3.239	0.013
21.20	0.965	5.647	3.252	0.013

21.40	0.968	5.662	3.264	0.013
21.60	0.970	5.676	3.277	0.013
21.80	0.973	5.691	3.290	0.013
22.00	0.975	5.705	3.302	0.013
22.20	0.978	5.720	3.315	0.013
22.40	0.980	5.734	3.328	0.013
22.60	0.983	5.749	3.340	0.013
22.80	0.985	5.763	3.353	0.013
23.00	0.988	5.778	3.366	0.013
23.20	0.990	5.792	3.378	0.013
23.40	0.993	5.807	3.391	0.013
23.60	0.995	5.821	3.404	0.013
23.80	0.998	5.836	3.416	0.013
24.00	1.000	5.850	3.429	0.013



Unit Hydrograph

Unit Storm Duration

ΔD 0.21 << 0.2-hr time increments are used

Time to Peak

Tp 1.05 << rounded to 1.0 hr

Unit Hydrograph Peak Discharge

qp 2295

Time Ratio	Discharge Ratio	Time (hr)	q (cfs)
0.0	0.000	0.000	0
0.1	0.030	0.100	69
0.2	0.100	0.200	230
0.3	0.190	0.300	436
0.4	0.310	0.400	711
0.5	0.470	0.500	1079
0.6	0.660	0.600	1515
0.7	0.820	0.700	1882
0.8	0.930	0.800	2134
0.9	0.990	0.900	2272
1.0	1.000	1.000	2295
1.1	0.990	1.100	2272

Time (hr)	q (cfs)
0	**0**
0.20	230
0.40	711
0.60	1515
0.80	2134
1.00	**2295**
1.20	2134
1.40	1790
1.60	1285
1.80	895
2.00	**643**
2.20	475

1.2	0.930	1.200	2134
1.3	0.860	1.300	1974
1.4	0.780	1.400	1790
1.5	0.680	1.500	1561
1.6	0.560	1.600	1285
1.7	0.460	1.700	1056
1.8	0.390	1.800	895
1.9	0.330	1.900	757
2.0	0.280	2.000	643
2.2	0.207	2.200	475
2.4	0.147	2.400	337
2.6	0.107	2.600	246
2.8	0.077	2.800	177
3.0	0.055	3.000	126
3.2	0.040	3.200	92
3.4	0.029	3.400	67
3.6	0.021	3.600	48
3.8	0.015	3.800	34
4.0	0.011	4.000	25
4.5	0.005	4.500	11
5.0	0.000	5.000	0

2.40	337
2.60	246
2.80	177
3.00	**126**
3.20	92
3.40	67
3.60	48
3.80	34
4.00	**25**
4.20	19
4.40	14
4.60	9
4.80	5
5.00	**0**
5.20	0
5.40	0
5.60	0
5.80	0
6.00	**0**
6.20	0
6.40	0

Sum	3061	cfs-h

Check

Unit Hydrograph (per 1 in. Unit Runoff) 3060.2

Variance -0.04%

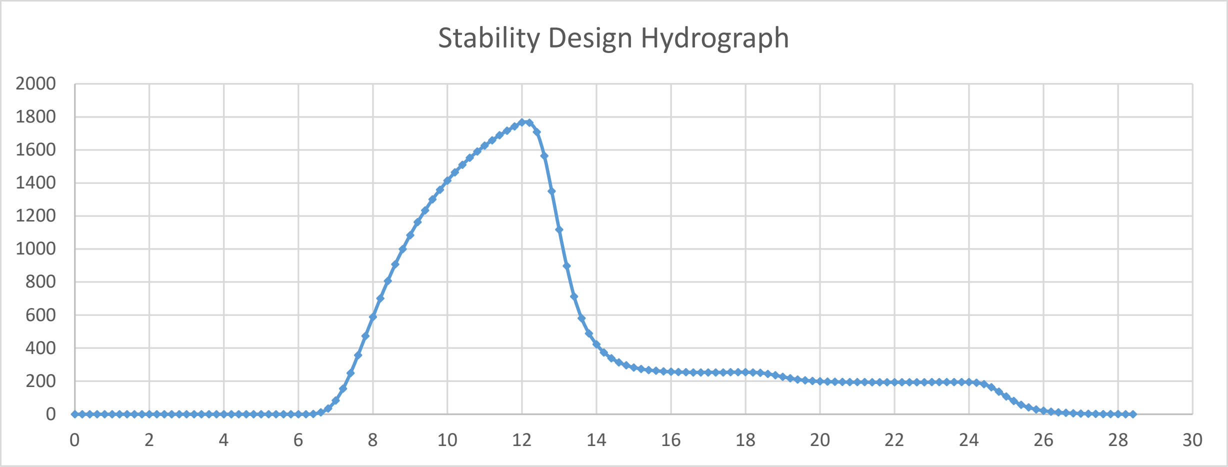
Stability Design Hydrograph

Time (hrs)	Inc. Runoff	q (cfs)	Composite SDH (cfs)
0.0	0.0000	0	0
0.2	0.0000	230	0
0.4	0.0000	711	0
0.6	0.0000	1515	0
0.8	0.0000	2134	0
1.0	0.0000	2295	0
1.2	0.0000	2134	0
1.4	0.0000	1790	0
1.6	0.0000	1285	0
1.8	0.0000	895	0
2.0	0.0000	643	0
2.2	0.0000	475	0
2.4	0.0000	337	0
2.6	0.0000	246	0
2.8	0.0000	177	0
3.0	0.0000	126	0
3.2	0.0000	92	0
3.4	0.0000	67	0
3.6	0.0000	48	0
3.8	0.0000	34	0
4.0	0.0000	25	0
4.2	0.0000	19	0
4.4	0.0000	14	0
4.6	0.0000	9	0

4.8	0.0000	5	0
5.0	0.0000	0	0
5.2	0.0000		0
5.4	0.0000		0
5.6	0.0000		0
5.8	0.0000		0
6.0	0.0000		0
6.2	0.0001		0
6.4	0.0084		2
6.6	0.0212		11
6.8	0.0324		35
7.0	0.0421		83
7.2	0.0506		155
7.4	0.0581		249
7.6	0.0648		357
7.8	0.0707		473
8.0	0.0761		589
8.2	0.0808		701
8.4	0.0852		807
8.6	0.0891		907
8.8	0.0926		999
9.0	0.0958		1084
9.2	0.0988		1163
9.4	0.1015		1234
9.6	0.1039		1300
9.8	0.1062		1359
10.0	0.1083		1414
10.2	0.1103		1464
10.4	0.1120		1510
10.6	0.1137		1552
10.8	0.1153		1590
11.0	0.1167		1626
11.2	0.1180		1658
11.4	0.1193		1689
11.6	0.1205		1716
11.8	0.1216		1742
12.0	0.1226		1766
12.2	0.0162		1764
12.4	0.0163		1708
12.6	0.0163		1564
12.8	0.0163		1350
13.0	0.0163		1117
13.2	0.0163		898
13.4	0.0163		713
13.6	0.0164		581
13.8	0.0164		489
14.0	0.0164		423
14.2	0.0164		374
14.4	0.0164		339
14.6	0.0164		314
14.8	0.0164		296
15.0	0.0165		283
15.2	0.0165		274
15.4	0.0165		267
15.6	0.0165		263
15.8	0.0165		259

16.0	0.0165		257
16.2	0.0166		255
16.4	0.0166		254
16.6	0.0166		253
16.8	0.0166		253
17.0	0.0166		253
17.2	0.0166		253
17.4	0.0166		253
17.6	0.0166		254
17.8	0.0167		254
18.0	0.0167		254
18.2	0.0125		253
18.4	0.0125		251
18.6	0.0125		244
18.8	0.0125		236
19.0	0.0125		226
19.2	0.0126		218
19.4	0.0126		210
19.6	0.0126		205
19.8	0.0126		201
20.0	0.0126		199
20.2	0.0126		197
20.4	0.0126		196
20.6	0.0126		195
20.8	0.0126		194
21.0	0.0126		194
21.2	0.0126		194
21.4	0.0126		193
21.6	0.0126		193
21.8	0.0126		193
22.0	0.0126		193
22.2	0.0127		193
22.4	0.0127		193
22.6	0.0127		193
22.8	0.0127		193
23.0	0.0127		194
23.2	0.0127		194
23.4	0.0127		194
23.6	0.0127		194
23.8	0.0127		194
24.0	0.0127		194
24.2			191
24.4			182
24.6			163
24.8			136
25.0			107
25.2			80
25.4			57
25.6			41
25.8			29
26.0			21
26.2			15
26.4			11
26.6			8
26.8			6
27.0			4

27.2			3
27.4			2
27.6			1
27.8			1
28.0			1
28.2			0
28.4			0



Results

Peak Hydrograph Flow	1766 cfs
Total Volume	868 ac-ft

FBH-L Hydrograph

Characteristics

Drainage Area	4.742 sq mi
Time of Concentration	1.58 hr
Curve Number	77.8
Structure Hazard Classification	High
Initial Abstraction	0.57 in
Maximum Potential Retention	2.85 in
$PMP_{6\text{-}hr}$	7.67 in
$PMP_{12\text{-}hr}$	8.68 in
$PMP_{24\text{-}hr}$	10.2 in
$PMP_{72\text{-}hr}$	12.5 in
ΔD	0.05 hr

5-Point Rainfall Distribution

Time Increment	Incremental Rainfall	Rainfall Fractions for Each Time Increment	5 Point Rainfall Distribution
0 to 1.5	0.57 in	0.074	0.074
1.5 to 3	5.77 in	0.752	0.827
2 to 4.5	0.76 in	0.099	0.926
4.5 to 6	0.57 in	0.074	1.000

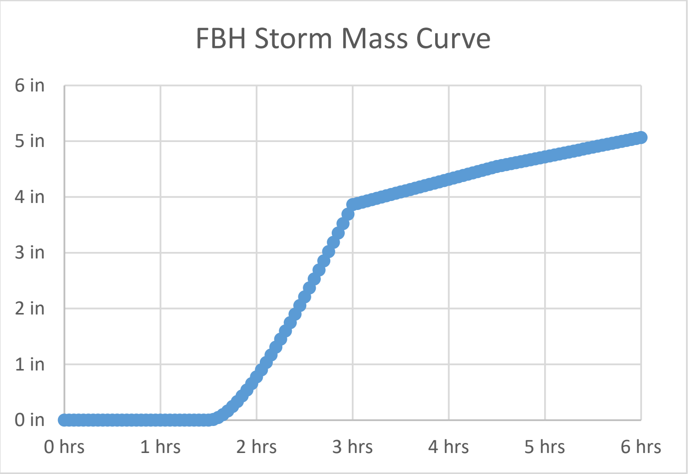
Time (hr)	Rainfall Distribution	Time (hr)	Rainfall Distribution	Time (hr)	Rainfall Distribution	Time (hr)	Rainfall Distribution
0.00	0.000	1.50	0.074	3.00	0.827	4.50	0.926
0.05	0.002	1.55	0.099	3.05	0.830	4.55	0.928
0.10	0.005	1.60	0.124	3.10	0.833	4.60	0.931
0.15	0.007	1.65	0.150	3.15	0.837	4.65	0.933
0.20	0.010	1.70	0.175	3.20	0.840	4.70	0.936
0.25	0.012	1.75	0.200	3.25	0.843	4.75	0.938
0.30	0.015	1.80	0.225	3.30	0.846	4.80	0.941
0.35	0.017	1.85	0.250	3.35	0.850	4.85	0.943
0.40	0.020	1.90	0.275	3.40	0.853	4.90	0.946
0.45	0.022	1.95	0.300	3.45	0.856	4.95	0.948
0.50	0.025	2.00	0.325	3.50	0.860	5.00	0.950
0.55	0.027	2.05	0.350	3.55	0.863	5.05	0.953
0.60	0.030	2.10	0.375	3.60	0.866	5.10	0.955
0.65	0.032	2.15	0.400	3.65	0.870	5.15	0.958
0.70	0.035	2.20	0.425	3.70	0.873	5.20	0.960
0.75	0.037	2.25	0.450	3.75	0.876	5.25	0.963
0.80	0.040	2.30	0.476	3.80	0.879	5.30	0.965
0.85	0.042	2.35	0.501	3.85	0.883	5.35	0.968
0.90	0.045	2.40	0.526	3.90	0.886	5.40	0.970
0.95	0.047	2.45	0.551	3.95	0.889	5.45	0.973
1.00	0.050	2.50	0.576	4.00	0.893	5.50	0.975
1.05	0.052	2.55	0.601	4.05	0.896	5.55	0.978
1.10	0.054	2.60	0.626	4.10	0.899	5.60	0.980
1.15	0.057	2.65	0.651	4.15	0.903	5.65	0.983
1.20	0.059	2.70	0.676	4.20	0.906	5.70	0.985
1.25	0.062	2.75	0.701	4.25	0.909	5.75	0.988
1.30	0.064	2.80	0.726	4.30	0.912	5.80	0.990

1.35	0.067	2.85	0.751	4.35	0.916	5.85	0.993
1.40	0.069	2.90	0.776	4.40	0.919	5.90	0.995
1.45	0.072	2.95	0.802	4.45	0.922	5.95	0.998
						6.00	1.000

Time (hr)	Rainfall Distribution	Total Rainfall (in)	Acc. Mass Curve of Runoff (in)	Inc. Mass Curve of Runoff (in)
0.00	0.000	0.000	0.000	0.000
0.05	0.002	0.019	0.000	0.000
0.10	0.005	0.038	0.000	0.000
0.15	0.007	0.057	0.000	0.000
0.20	0.010	0.076	0.000	0.000
0.25	0.012	0.095	0.000	0.000
0.30	0.015	0.114	0.000	0.000
0.35	0.017	0.133	0.000	0.000
0.40	0.020	0.152	0.000	0.000
0.45	0.022	0.171	0.000	0.000
0.50	0.025	0.190	0.000	0.000
0.55	0.027	0.209	0.000	0.000
0.60	0.030	0.228	0.000	0.000
0.65	0.032	0.247	0.000	0.000
0.70	0.035	0.266	0.000	0.000
0.75	0.037	0.285	0.000	0.000
0.80	0.040	0.304	0.000	0.000
0.85	0.042	0.323	0.000	0.000
0.90	0.045	0.342	0.000	0.000
0.95	0.047	0.361	0.000	0.000
1.00	0.050	0.380	0.000	0.000
1.05	0.052	0.399	0.000	0.000
1.10	0.054	0.418	0.000	0.000
1.15	0.057	0.437	0.000	0.000
1.20	0.059	0.456	0.000	0.000
1.25	0.062	0.475	0.000	0.000
1.30	0.064	0.494	0.000	0.000
1.35	0.067	0.513	0.000	0.000
1.40	0.069	0.532	0.000	0.000
1.45	0.072	0.551	0.000	0.000
1.50	0.074	0.570	0.000	0.000
1.55	0.099	0.762	0.012	0.012
1.60	0.124	0.955	0.046	0.034
1.65	0.150	1.147	0.097	0.051
1.70	0.175	1.339	0.164	0.066
1.75	0.200	1.532	0.243	0.079
1.80	0.225	1.724	0.333	0.090
1.85	0.250	1.916	0.432	0.099
1.90	0.275	2.109	0.539	0.108
1.95	0.300	2.301	0.654	0.115
2.00	0.325	2.493	0.775	0.121
2.05	0.350	2.686	0.901	0.126
2.10	0.375	2.878	1.033	0.131
2.15	0.400	3.070	1.168	0.136
2.20	0.425	3.263	1.308	0.140
2.25	0.450	3.455	1.451	0.143
2.30	0.476	3.647	1.598	0.146
2.35	0.501	3.840	1.747	0.149

2.40	0.526	4.032	1.899	0.152
2.45	0.551	4.224	2.053	0.154
2.50	0.576	4.417	2.210	0.156
2.55	0.601	4.609	2.368	0.158
2.60	0.626	4.801	2.528	0.160
2.65	0.651	4.994	2.690	0.162
2.70	0.676	5.186	2.854	0.164
2.75	0.701	5.378	3.019	0.165
2.80	0.726	5.571	3.185	0.166
2.85	0.751	5.763	3.353	0.168
2.90	0.776	5.955	3.522	0.169
2.95	0.802	6.148	3.691	0.170
3.00	0.827	6.340	3.862	0.171
3.05	0.830	6.365	3.885	0.023
3.10	0.833	6.391	3.907	0.023
3.15	0.837	6.416	3.930	0.023
3.20	0.840	6.441	3.953	0.023
3.25	0.843	6.467	3.975	0.023
3.30	0.846	6.492	3.998	0.023
3.35	0.850	6.517	4.021	0.023
3.40	0.853	6.543	4.043	0.023
3.45	0.856	6.568	4.066	0.023
3.50	0.860	6.593	4.089	0.023
3.55	0.863	6.619	4.111	0.023
3.60	0.866	6.644	4.134	0.023
3.65	0.870	6.669	4.157	0.023
3.70	0.873	6.695	4.180	0.023
3.75	0.876	6.720	4.203	0.023
3.80	0.879	6.745	4.225	0.023
3.85	0.883	6.771	4.248	0.023
3.90	0.886	6.796	4.271	0.023
3.95	0.889	6.821	4.294	0.023
4.00	0.893	6.847	4.317	0.023
4.05	0.896	6.872	4.340	0.023
4.10	0.899	6.897	4.362	0.023
4.15	0.903	6.923	4.385	0.023
4.20	0.906	6.948	4.408	0.023
4.25	0.909	6.973	4.431	0.023
4.30	0.912	6.999	4.454	0.023
4.35	0.916	7.024	4.477	0.023
4.40	0.919	7.049	4.500	0.023
4.45	0.922	7.075	4.523	0.023
4.50	0.926	7.100	4.546	0.023
4.55	0.928	7.119	4.563	0.017
4.60	0.931	7.138	4.580	0.017
4.65	0.933	7.157	4.598	0.017
4.70	0.936	7.176	4.615	0.017
4.75	0.938	7.195	4.632	0.017
4.80	0.941	7.214	4.650	0.017
4.85	0.943	7.233	4.667	0.017
4.90	0.946	7.252	4.684	0.017
4.95	0.948	7.271	4.701	0.017
5.00	0.950	7.290	4.719	0.017
5.05	0.953	7.309	4.736	0.017
5.10	0.955	7.328	4.753	0.017

5.15	0.958	7.347	4.771	0.017
5.20	0.960	7.366	4.788	0.017
5.25	0.963	7.385	4.805	0.017
5.30	0.965	7.404	4.823	0.017
5.35	0.968	7.423	4.840	0.017
5.40	0.970	7.442	4.857	0.017
5.45	0.973	7.461	4.875	0.017
5.50	0.975	7.480	4.892	0.017
5.55	0.978	7.499	4.910	0.017
5.60	0.980	7.518	4.927	0.017
5.65	0.983	7.537	4.944	0.017
5.70	0.985	7.556	4.962	0.017
5.75	0.988	7.575	4.979	0.017
5.80	0.990	7.594	4.997	0.017
5.85	0.993	7.613	5.014	0.017
5.90	0.995	7.632	5.031	0.017
5.95	0.998	7.651	5.049	0.017
6.00	1.000	7.670	5.066	0.017



Unit Hydrograph

Unit Storm Duration

ΔD 0.05

Time to Peak

Tp 0.99 << rounded to 1.0 hr

Unit Hydrograph Peak Discharge

qp 2295

Time Ratio	Discharge Ratio	Time (hr)	q (cfs)
0.0	0.000	0.000	0
0.1	0.030	0.100	69
0.2	0.100	0.200	230
0.3	0.190	0.300	436
0.4	0.310	0.400	711
0.5	0.470	0.500	1079
0.6	0.660	0.600	1515
0.7	0.820	0.700	1882
0.8	0.930	0.800	2134
0.9	0.990	0.900	2272
1.0	1.000	1.000	2295
1.1	0.990	1.100	2272
1.2	0.930	1.200	2134
1.3	0.860	1.300	1974
1.4	0.780	1.400	1790
1.5	0.680	1.500	1561
1.6	0.560	1.600	1285
1.7	0.460	1.700	1056
1.8	0.390	1.800	895
1.9	0.330	1.900	757
2.0	0.280	2.000	643
2.2	0.207	2.200	475
2.4	0.147	2.400	337
2.6	0.107	2.600	246
2.8	0.077	2.800	177
3.0	0.055	3.000	126
3.2	0.040	3.200	92
3.4	0.029	3.400	67
3.6	0.021	3.600	48
3.8	0.015	3.800	34
4.0	0.011	4.000	25
4.5	0.005	4.500	11
5.0	0.000	5.000	0

Time (hr)	q (cfs)
0	**0**
0.05	230
0.10	711
0.15	1515
0.20	2134
0.25	**2295**
0.30	2134
0.35	1790
0.40	1285
0.45	895
0.50	**643**
0.55	475
0.60	337
0.65	246
0.70	177
0.75	**126**
0.80	92
0.85	67
0.90	48
0.95	34
1.00	**25**
1.05	19
1.10	14
1.15	9
1.20	5
1.25	**0**
1.30	0
1.35	0
1.40	0
1.45	0
1.50	**0**
1.55	0
1.60	0

Sum 1531 cfs-h

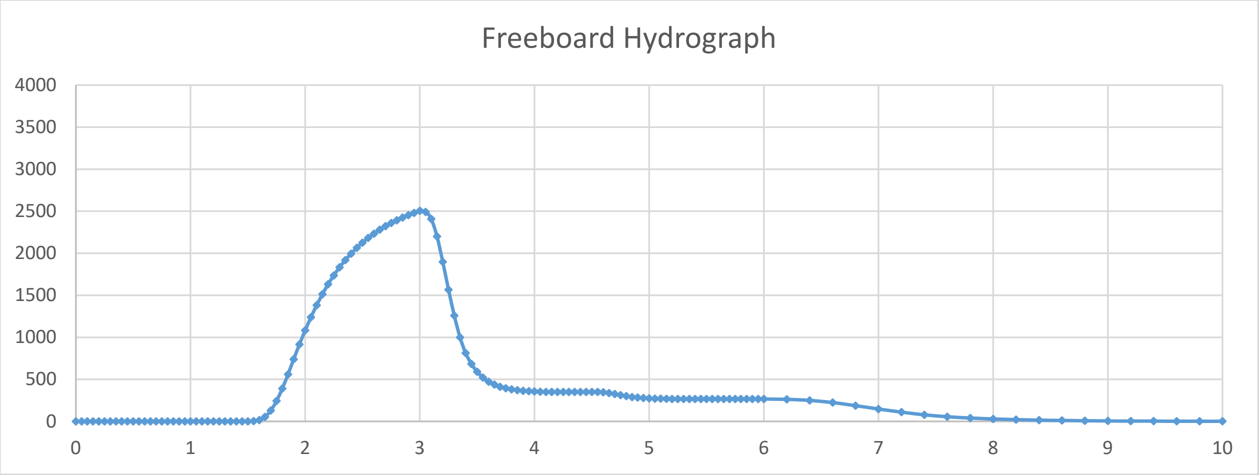
Check	
Unit Hydrograph (per 1 in. Unit Runoff)	3060.2
Variance	49.98%

Freeboard Hydrograph

Time (hrs)	Inc. Runoff	q (cfs)	Composite FBH (cfs)
0.0	0.0000	0	0
0.1	0.0000	230	0
0.1	0.0000	711	0
0.2	0.0000	1515	0
0.2	0.0000	2134	0
0.3	0.0000	2295	0
0.3	0.0000	2134	0
0.4	0.0000	1790	0
0.4	0.0000	1285	0
0.5	0.0000	895	0
0.5	0.0000	643	0
0.6	0.0000	475	0
0.6	0.0000	337	0
0.7	0.0000	246	0
0.7	0.0000	177	0
0.8	0.0000	126	0
0.8	0.0000	92	0
0.9	0.0000	67	0
0.9	0.0000	48	0
1.0	0.0000	34	0
1.0	0.0000	25	0
1.1	0.0000	19	0
1.1	0.0000	14	0
1.2	0.0000	9	0
1.2	0.0000	5	0
1.3	0.0000	0	0
1.3	0.0000		0
1.4	0.0000		0
1.4	0.0000		0
1.5	0.0000		0
1.5	0.0000		0
1.6	0.0122		3
1.6	0.0336		16
1.7	0.0514		54
1.7	0.0664		129
1.8	0.0791		243
1.8	0.0900		390
1.9	0.0994		560
1.9	0.1075		738
2.0	0.1146		915
2.0	0.1209		1082
2.1	0.1264		1238
2.1	0.1313		1382
2.2	0.1357		1512
2.2	0.1397		1630
2.3	0.1432		1736
2.3	0.1464		1832

2.4	0.1493		1918
2.4	0.1519		1995
2.5	0.1543		2064
2.5	0.1565		2126
2.6	0.1585		2182
2.6	0.1603		2233
2.7	0.1620		2279
2.7	0.1636		2321
2.8	0.1650		2359
2.8	0.1663		2393
2.9	0.1676		2425
2.9	0.1687		2453
3.0	0.1698		2480
3.0	0.1708		2504
3.1	0.0226		2492
3.1	0.0226		2407
3.2	0.0226		2199
3.2	0.0226		1897
3.3	0.0226		1567
3.3	0.0227		1258
3.4	0.0227		999
3.4	0.0227		812
3.5	0.0227		683
3.5	0.0227		590
3.6	0.0227		521
3.6	0.0227		472
3.7	0.0228		437
3.7	0.0228		411
3.7	0.0228		393
3.8	0.0228		380
3.8	0.0228		371
3.9	0.0228		364
3.9	0.0228		359
4.0	0.0229		356
4.0	0.0229		353
4.1	0.0229		351
4.1	0.0229		350
4.2	0.0229		350
4.2	0.0229		350
4.3	0.0229		350
4.3	0.0229		350

4.4	0.0230		350
4.4	0.0230		351
4.5	0.0230		351
4.5	0.0172		350
4.6	0.0173		346
4.6	0.0173		337
4.7	0.0173		325
4.7	0.0173		312
4.8	0.0173		300
4.8	0.0173		290
4.9	0.0173		283
4.9	0.0173		278
5.0	0.0173		274
5.0	0.0173		271
5.1	0.0173		270
5.1	0.0173		268
5.2	0.0173		267
5.2	0.0173		267
5.3	0.0174		266
5.3	0.0174		266
5.4	0.0174		266
5.4	0.0174		266
5.5	0.0174		266
5.5	0.0174		266
5.6	0.0174		266
5.6	0.0174		266
5.7	0.0174		266
5.7	0.0174		266
5.8	0.0174		266
5.8	0.0174		266
5.9	0.0174		266
5.9	0.0174		266
6.0	0.0174		266
6.2			262
6.4			250
6.6			224
6.8			187
7.0			147
7.2			110
7.4			78
7.6			56
7.8			40
8.0			29
8.2			21
8.4			15
8.6			11
8.8			8
9.0			5
9.2			4
9.4			3
9.6			2
9.8			1
10.0			1
10.2			0
10.4			0



Results

Peak Hydrograph Flow	2504 cfs
Total Volume	1282 ac-ft

FBH-G Hydrograph

Characteristics

Drainage Area	4.742 sq mi	
Time of Concentration	1.58 hr	
Curve Number	77.8	
Structure Hazard Classification	High	
Initial Abstraction	0.57 in	
Maximum Potential Retention	2.85 in	
$\text{PMP}_{6\text{-hr}}$	7.67 in	
$\text{PMP}_{12\text{-hr}}$	8.68 in	
$\text{PMP}_{24\text{-hr}}$	10.2 in	
$\text{PMP}_{72\text{-hr}}$	12.5 in	
ΔD	0.21 hr	<< 0.2-hr time increments are used

5-Point Rainfall Distribution

Time Increment	Incremental Rainfall	Rainfall Fractions for Each Time Increment		5 Point Rainfall Distribution	
0 to 6	0.76 in	0.075		0.075	
6 to 12	7.67 in	0.752		0.826	
12 to 18	1.01 in	0.099		0.925	
18 to 24	0.76 in	0.075		1.000	

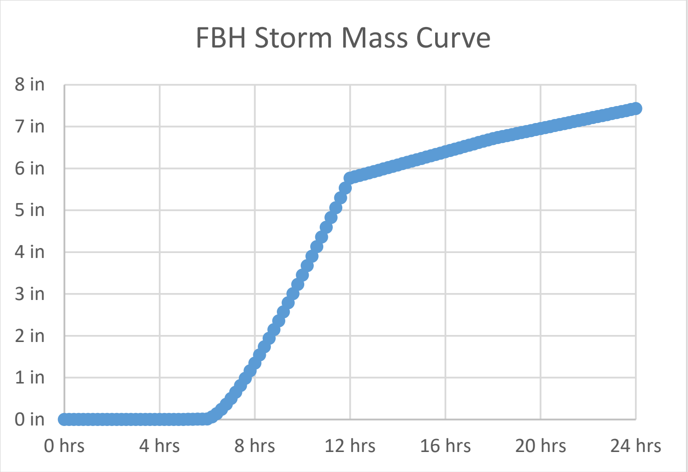
Time (hr)	Rainfall Distribution	Time (hr)	Rainfall Distribution	Time (hr)	Rainfall Distribution	Time (hr)	Rainfall Distribution
0.00	0.000	6.00	0.075	12.00	0.826	18.00	0.925
0.20	0.002	6.20	0.100	12.20	0.830	18.20	0.928
0.40	0.005	6.40	0.125	12.40	0.833	18.40	0.930
0.60	0.007	6.60	0.150	12.60	0.836	18.60	0.933
0.80	0.010	6.80	0.175	12.80	0.840	18.80	0.935
1.00	0.012	7.00	0.200	13.00	0.843	19.00	0.938
1.20	0.015	7.20	0.225	13.20	0.846	19.20	0.940
1.40	0.017	7.40	0.250	13.40	0.850	19.40	0.943
1.60	0.020	7.60	0.275	13.60	0.853	19.60	0.945
1.80	0.022	7.80	0.300	13.80	0.856	19.80	0.948
2.00	0.025	8.00	0.325	14.00	0.859	20.00	0.950
2.20	0.027	8.20	0.350	14.20	0.863	20.20	0.953
2.40	0.030	8.40	0.375	14.40	0.866	20.40	0.955
2.60	0.032	8.60	0.400	14.60	0.869	20.60	0.958
2.80	0.035	8.80	0.425	14.80	0.873	20.80	0.960
3.00	0.037	9.00	0.450	15.00	0.876	21.00	0.963
3.20	0.040	9.20	0.476	15.20	0.879	21.20	0.965
3.40	0.042	9.40	0.501	15.40	0.883	21.40	0.968
3.60	0.045	9.60	0.526	15.60	0.886	21.60	0.970
3.80	0.047	9.80	0.551	15.80	0.889	21.80	0.973
4.00	0.050	10.00	0.576	16.00	0.892	22.00	0.975
4.20	0.052	10.20	0.601	16.20	0.896	22.20	0.978
4.40	0.055	10.40	0.626	16.40	0.899	22.40	0.980
4.60	0.057	10.60	0.651	16.60	0.902	22.60	0.983
4.80	0.060	10.80	0.676	16.80	0.906	22.80	0.985
5.00	0.062	11.00	0.701	17.00	0.909	23.00	0.988
5.20	0.065	11.20	0.726	17.20	0.912	23.20	0.990

5.40	0.067	11.40	0.751	17.40	0.916	23.40	0.993
5.60	0.070	11.60	0.776	17.60	0.919	23.60	0.995
5.80	0.072	11.80	0.801	17.80	0.922	23.80	0.998
						24.00	1.000

Time (hr)	Rainfall Distribution	Total Rainfall (in)	Acc. Mass Curve of Runoff (in)	Inc. Mass Curve of Runoff (in)
0.00	0.000	0.000	0.000	0.000
0.20	0.002	0.025	0.000	0.000
0.40	0.005	0.051	0.000	0.000
0.60	0.007	0.076	0.000	0.000
0.80	0.010	0.101	0.000	0.000
1.00	0.012	0.127	0.000	0.000
1.20	0.015	0.152	0.000	0.000
1.40	0.017	0.177	0.000	0.000
1.60	0.020	0.203	0.000	0.000
1.80	0.022	0.228	0.000	0.000
2.00	0.025	0.253	0.000	0.000
2.20	0.027	0.279	0.000	0.000
2.40	0.030	0.304	0.000	0.000
2.60	0.032	0.329	0.000	0.000
2.80	0.035	0.355	0.000	0.000
3.00	0.037	0.380	0.000	0.000
3.20	0.040	0.405	0.000	0.000
3.40	0.042	0.431	0.000	0.000
3.60	0.045	0.456	0.000	0.000
3.80	0.047	0.481	0.000	0.000
4.00	0.050	0.507	0.000	0.000
4.20	0.052	0.532	0.000	0.000
4.40	0.055	0.557	0.000	0.000
4.60	0.057	0.583	0.000	0.000
4.80	0.060	0.608	0.001	0.000
5.00	0.062	0.633	0.001	0.001
5.20	0.065	0.659	0.003	0.001
5.40	0.067	0.684	0.004	0.002
5.60	0.070	0.709	0.006	0.002
5.80	0.072	0.735	0.009	0.003
6.00	0.075	0.760	0.012	0.003
6.20	0.100	1.016	0.060	0.048
6.40	0.125	1.271	0.139	0.078
6.60	0.150	1.527	0.241	0.102
6.80	0.175	1.783	0.362	0.121
7.00	0.200	2.038	0.499	0.137
7.20	0.225	2.294	0.650	0.151
7.40	0.250	2.550	0.811	0.162
7.60	0.275	2.805	0.983	0.171
7.80	0.300	3.061	1.162	0.179
8.00	0.325	3.317	1.348	0.186
8.20	0.350	3.572	1.540	0.192
8.40	0.375	3.828	1.738	0.198
8.60	0.400	4.084	1.940	0.202

8.80	0.425	4.339	2.146	0.206
9.00	0.450	4.595	2.356	0.210
9.20	0.476	4.851	2.570	0.213
9.40	0.501	5.106	2.786	0.216
9.60	0.526	5.362	3.005	0.219
9.80	0.551	5.618	3.226	0.221
10.00	0.576	5.873	3.450	0.223
10.20	0.601	6.129	3.675	0.225
10.40	0.626	6.385	3.902	0.227
10.60	0.651	6.640	4.131	0.229
10.80	0.676	6.896	4.361	0.230
11.00	0.701	7.152	4.593	0.232
11.20	0.726	7.407	4.826	0.233
11.40	0.751	7.663	5.060	0.234
11.60	0.776	7.919	5.295	0.235
11.80	0.801	8.174	5.531	0.236
12.00	0.826	8.430	5.768	0.237
12.20	0.830	8.464	5.800	0.031
12.40	0.833	8.497	5.831	0.031
12.60	0.836	8.531	5.862	0.031
12.80	0.840	8.565	5.894	0.031
13.00	0.843	8.598	5.925	0.031
13.20	0.846	8.632	5.956	0.031
13.40	0.850	8.666	5.988	0.031
13.60	0.853	8.699	6.019	0.031
13.80	0.856	8.733	6.051	0.031
14.00	0.859	8.767	6.082	0.031
14.20	0.863	8.800	6.113	0.031
14.40	0.866	8.834	6.145	0.031
14.60	0.869	8.868	6.176	0.031
14.80	0.873	8.901	6.208	0.031
15.00	0.876	8.935	6.239	0.031
15.20	0.879	8.969	6.271	0.031
15.40	0.883	9.002	6.302	0.032
15.60	0.886	9.036	6.334	0.032
15.80	0.889	9.070	6.365	0.032
16.00	0.892	9.103	6.397	0.032
16.20	0.896	9.137	6.428	0.032
16.40	0.899	9.171	6.460	0.032
16.60	0.902	9.204	6.492	0.032
16.80	0.906	9.238	6.523	0.032
17.00	0.909	9.272	6.555	0.032
17.20	0.912	9.305	6.586	0.032
17.40	0.916	9.339	6.618	0.032
17.60	0.919	9.373	6.650	0.032
17.80	0.922	9.406	6.681	0.032
18.00	0.925	9.440	6.713	0.032
18.20	0.928	9.465	6.737	0.024
18.40	0.930	9.491	6.761	0.024
18.60	0.933	9.516	6.785	0.024
18.80	0.935	9.541	6.808	0.024
19.00	0.938	9.567	6.832	0.024
19.20	0.940	9.592	6.856	0.024
19.40	0.943	9.617	6.880	0.024
19.60	0.945	9.643	6.904	0.024

19.80	0.948	9.668	6.928	0.024
20.00	0.950	9.693	6.952	0.024
20.20	0.953	9.719	6.976	0.024
20.40	0.955	9.744	7.000	0.024
20.60	0.958	9.769	7.023	0.024
20.80	0.960	9.795	7.047	0.024
21.00	0.963	9.820	7.071	0.024
21.20	0.965	9.845	7.095	0.024
21.40	0.968	9.871	7.119	0.024
21.60	0.970	9.896	7.143	0.024
21.80	0.973	9.921	7.167	0.024
22.00	0.975	9.947	7.191	0.024
22.20	0.978	9.972	7.215	0.024
22.40	0.980	9.997	7.239	0.024
22.60	0.983	10.023	7.263	0.024
22.80	0.985	10.048	7.287	0.024
23.00	0.988	10.073	7.311	0.024
23.20	0.990	10.099	7.335	0.024
23.40	0.993	10.124	7.359	0.024
23.60	0.995	10.149	7.383	0.024
23.80	0.998	10.175	7.407	0.024
24.00	1.000	10.200	7.431	0.024



Unit Hydrograph

Unit Storm Duration

ΔD 0.21 << 0.2-hr time increments are used

Time to Peak

Tp 1.05 << rounded to 1.0 hr

Unit Hydrograph Peak Discharge

qp 2295

Time Ratio	Discharge Ratio	Time (hr)	q (cfs)
0.0	0.000	0.000	0
0.1	0.030	0.100	69
0.2	0.100	0.200	230

Time (hr)	q (cfs)
0	**0**
0.20	230
0.40	711

0.3	0.190	0.300	436
0.4	0.310	0.400	711
0.5	0.470	0.500	1079
0.6	0.660	0.600	1515
0.7	0.820	0.700	1882
0.8	0.930	0.800	2134
0.9	0.990	0.900	2272
1.0	1.000	1.000	2295
1.1	0.990	1.100	2272
1.2	0.930	1.200	2134
1.3	0.860	1.300	1974
1.4	0.780	1.400	1790
1.5	0.680	1.500	1561
1.6	0.560	1.600	1285
1.7	0.460	1.700	1056
1.8	0.390	1.800	895
1.9	0.330	1.900	757
2.0	0.280	2.000	643
2.2	0.207	2.200	475
2.4	0.147	2.400	337
2.6	0.107	2.600	246
2.8	0.077	2.800	177
3.0	0.055	3.000	126
3.2	0.040	3.200	92
3.4	0.029	3.400	67
3.6	0.021	3.600	48
3.8	0.015	3.800	34
4.0	0.011	4.000	25
4.5	0.005	4.500	11
5.0	0.000	5.000	0

0.60	1515
0.80	2134
1.00	**2295**
1.20	2134
1.40	1790
1.60	1285
1.80	895
2.00	**643**
2.20	475
2.40	337
2.60	246
2.80	177
3.00	**126**
3.20	92
3.40	67
3.60	48
3.80	34
4.00	**25**
4.20	19
4.40	14
4.60	9
4.80	5
5.00	**0**
5.20	0
5.40	0
5.60	0
5.80	0
6.00	**0**
6.20	0
6.40	0

Sum	3061	cfs-h

Check

Unit Hydrograph (per 1 in. Unit Runoff)	3060.2
Variance	-0.04%

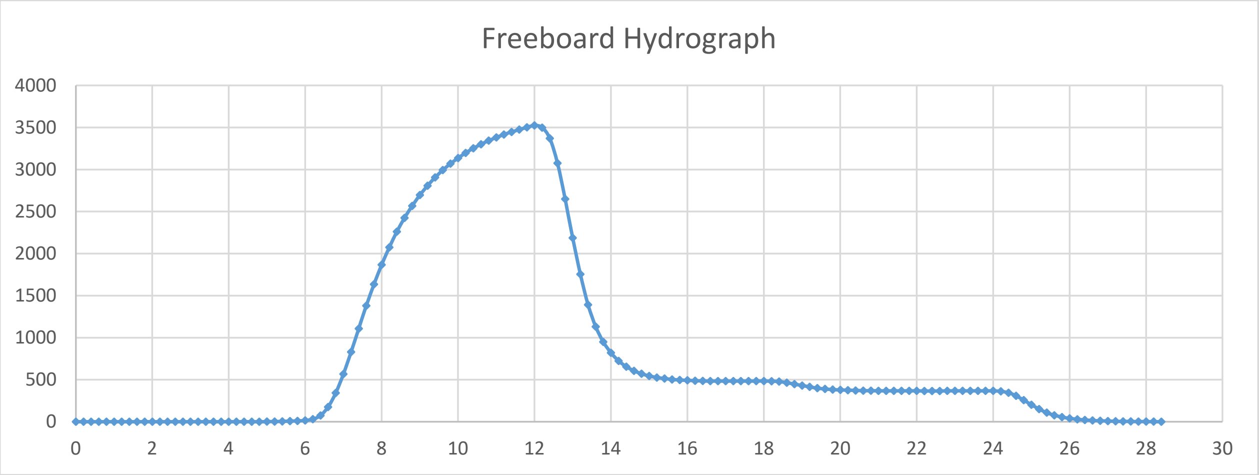
Freeboard Hydrograph

Time (hrs)	Inc. Runoff	q (cfs)	Composite FBH (cfs)
0.0	0.0000	0	0
0.2	0.0000	230	0
0.4	0.0000	711	0
0.6	0.0000	1515	0
0.8	0.0000	2134	0
1.0	0.0000	2295	0
1.2	0.0000	2134	0
1.4	0.0000	1790	0
1.6	0.0000	1285	0
1.8	0.0000	895	0
2.0	0.0000	643	0
2.2	0.0000	475	0
2.4	0.0000	337	0
2.6	0.0000	246	0

2.8	0.0000	177	0
3.0	0.0000	126	0
3.2	0.0000	92	0
3.4	0.0000	67	0
3.6	0.0000	48	0
3.8	0.0000	34	0
4.0	0.0000	25	0
4.2	0.0000	19	0
4.4	0.0000	14	0
4.6	0.0001	9	0
4.8	0.0004	5	0
5.0	0.0009	0	1
5.2	0.0013		2
5.4	0.0017		4
5.6	0.0021		7
5.8	0.0025		10
6.0	0.0029		15
6.2	0.0484		30
6.4	0.0782		74
6.6	0.1021		175
6.8	0.1214		342
7.0	0.1373		567
7.2	0.1505		829
7.4	0.1617		1108
7.6	0.1711		1380
7.8	0.1792		1634
8.0	0.1862		1866
8.2	0.1923		2074
8.4	0.1976		2260
8.6	0.2022		2424
8.8	0.2064		2568
9.0	0.2100		2696
9.2	0.2133		2807
9.4	0.2162		2906
9.6	0.2189		2993
9.8	0.2213		3069
10.0	0.2234		3137
10.2	0.2254		3198
10.4	0.2272		3252
10.6	0.2288		3300
10.8	0.2303		3343
11.0	0.2317		3381
11.2	0.2329		3416
11.4	0.2341		3447
11.6	0.2352		3475
11.8	0.2362		3501
12.0	0.2371		3524
12.2	0.0313		3498
12.4	0.0313		3371
12.6	0.0313		3075
12.8	0.0313		2649
13.0	0.0313		2187
13.2	0.0314		1755
13.4	0.0314		1392
13.6	0.0314		1131

13.8	0.0314		950
14.0	0.0314		820
14.2	0.0314		724
14.4	0.0314		655
14.6	0.0315		606
14.8	0.0315		570
15.0	0.0315		545
15.2	0.0315		526
15.4	0.0315		513
15.6	0.0315		503
15.8	0.0315		496
16.0	0.0316		492
16.2	0.0316		488
16.4	0.0316		485
16.6	0.0316		483
16.8	0.0316		483
17.0	0.0316		483
17.2	0.0316		483
17.4	0.0316		483
17.6	0.0316		483
17.8	0.0317		484
18.0	0.0317		484
18.2	0.0238		482
18.4	0.0238		477
18.6	0.0239		465
18.8	0.0239		448
19.0	0.0239		431
19.2	0.0239		414
19.4	0.0239		400
19.6	0.0239		390
19.8	0.0239		383
20.0	0.0239		378
20.2	0.0239		375
20.4	0.0239		372
20.6	0.0239		370
20.8	0.0239		369
21.0	0.0239		368
21.2	0.0239		368
21.4	0.0239		367
21.6	0.0239		367
21.8	0.0239		367
22.0	0.0240		367
22.2	0.0240		366
22.4	0.0240		366
22.6	0.0240		366
22.8	0.0240		367
23.0	0.0240		367
23.2	0.0240		367
23.4	0.0240		367
23.6	0.0240		367
23.8	0.0240		367
24.0	0.0240		367
24.2			362
24.4			345
24.6			308

24.8			257
25.0			202
25.2			151
25.4			108
25.6			77
25.8			56
26.0			40
26.2			29
26.4			21
26.6			15
26.8			11
27.0			8
27.2			5
27.4			4
27.6			3
27.8			2
28.0			1
28.2			1
28.4			0



Results

Peak Hydrograph Flow	3524 cfs
Total Volume	1880 ac-ft

Section 3. Precipitation Values

Precipitation Value - Limited Frequency Hydrographs (Storm Events 01-09 and 12)

Description: The NOAA Precipitation Value is taken from the NOAA Precipitation Frequency Data Server (PFDS). As outlined in NOAA Atlas 2 and Atlas 14, an average precipitation value for entire the basin area is calculated by deriving the values on a grid throughout the drainage basin and taking the average of these values. The exhibit on the following page, *NOAA Atlas 14 Precipitation Grid Exhibit* , shows the grid points where the point precipitation values were taken and averaged out.

NOAA Point Precipitation Value:

	6-hour	24-hour							10-day
	100-yr	**2-yr**	**5-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**	**500-yr**	**100-yr**
	3.71	1.62	2.02	2.36	2.81	3.16	3.54	4.73	6.86
	3.69	1.62	2.02	2.35	2.80	3.16	3.53	4.72	6.85
	3.68	1.61	2.01	2.34	2.79	3.15	3.52	4.70	6.84
	3.67	1.61	2.01	2.33	2.79	3.14	3.51	4.69	6.83
	3.67	1.60	2.00	2.33	2.78	3.14	3.51	4.69	6.83
	3.66	1.60	2.00	2.33	2.78	3.13	3.50	4.68	6.82
	3.66	1.60	2.00	2.33	2.78	3.13	3.50	4.68	6.82
	3.65	1.60	1.99	2.32	2.77	3.13	3.49	4.66	6.82
	3.66	1.60	2.00	2.32	2.77	3.13	3.50	4.68	6.82
	3.67	1.60	2.00	2.33	2.78	3.13	3.51	4.69	6.83
	3.67	1.61	2.01	2.34	2.79	3.14	3.51	4.69	6.83
	3.67	1.61	2.01	2.34	2.79	3.14	3.51	4.69	6.83
	3.69	1.62	2.02	2.35	2.80	3.15	3.53	4.72	6.85
	3.69	1.62	2.01	2.35	2.80	3.15	3.53	4.72	6.85
Average >>	**3.68**	**1.61**	**2.01**	**2.34**	**2.79**	**3.14**	**3.51**	**4.69**	**6.83**

(*NOAA Atlas 14*)

Precipitation Value - Local SEP Hydrograph (Storm Event 10)

Description: The Local SEP Value is the Probable Maximum Precipitation to occur ever for a period of 6 hours. It involves evaluation of the average PMP and the areal distribution of the PMP within the drainage area using methods outlined in HMR 49. Donald T. Jensen with Utah State University was commissioned to provide an update to HMR 49 resulting in the *Probable Maximum Precipitation Estimates for Short-Duration, Small-Area Storms in Utah* . The study uses the 1-hour Point PMP Value for 1 mi^2, taken from HMR 49, and applies updated reduction factors for elevation, duration, and area to adjust the value to match the characteristics of the drainage basin.

Local SEP

Initial Precipitation Value (1-hr, 1-mi^2):

9.5 in (Fig. 4.5. *HMR 49* , 1984)

Elevation Variation:

Mean Elevation: 6271'

93.6% (Section 4.3.2, *HMR 49* , 1984)

Adjusted Value 8.90 in

Duration and Areal Variation:

Duration: 6 hrs

Area: 5 sq mi

86.15% (Table 15. *Probable Maximum Precipitation for Short-Duration, Short-Area Storms in Utah* , Jensen. 1995, 2002)

Adjusted Value 7.67 in

Total Local SEP 7.67 in

Precipitation Value - General SEP Hydrograph (Storm Event 11)

Description

The General SEP Value is the Probable Maximum Precipitation to occur ever for a period of 72 hours. It involves evaluation of the Convergance PMP (precipitation resulting from atmospheric processes not affected by terrain) and the Orographic PMP (precipitation resulting from atmospheric processes affected by terrain) using methods outlined in HMR 49. Convergance and orographic precipitation can occur simultaneously. Donald T. Jensen with Utah State University was commissioned to provide an update to HMR 49 resulting in the *2002 Update for Probable Maximum Precipitation, Utah, 72-Hour Estimates, Areas to 5,000 mi*^{2}. The study updates the 72-hour Point PMP Value for 10 mi^2, as shown in Figure 1 of the said study, from which the SEP value is calculated. This point value includes adjustments from barrier and elevation variations and the orographic component. An area reduction factor is applied to adjust the value to match the size of the drainage basin.

General SEP

Point PMP 72-hr Precipitation Value:

12.5 in (Fig. 1. *2002 Update for Probably Maximum Precipitation, Utah, 72-Hour Estimates, Areas to 5,000 mi*^{2}, Jensen. 2003)

Total General PMP 12.50 in

Areal Variation:

Area: 5 sq mi

100.00% (Table 1. *2002 Update for Probably Maximum Precipitation, Utah, 72-Hour Estimates, Areas to 5,000 mi*^{2}, Jensen. 2003)

Total General SEP **12.50 in**

Total General SEP Used 12.50 in

Precipitation Value - Auxiliary Spillway Hydrographs (Storm Events 13 and 14)

Description	The ASH Storm Events are the maximum precipitation events used to design the auxiliary spillway and top of dam elevation as determined by the equations set forth in TR-60, Table Figure 2-2, using the PMP precipitation value and the 100-year precipitation value.				
Local ASH	P100:	2.75	in	< 100-yr, 6-hr NWS	(TR-60, Figure 2-2)
	PMP:	7.67	in	< Local SEP	
	ASH-L Precipitation Value			**4.03 in**	
General ASH	P100:	3.51	in	< 100-yr, 24-hr NWS	(TR-60, Figure 2-2)
	PMP:	12.50	in	< General SEP	
	ASH-G Precipitation Value			**5.85 in**	

Precipitation Value - Freeboard Hydrographs (Storm Events 15 and 16)

Description The FBH Storm Events are the maximum precipitation events used to design the spillway and top of dam elevation as determined by the equations set forth in TR-60, Table Figure 2-2, using the PMP precipitation value (and applying a duration reduction factor for the 24-hour General FBH).

Local FBH

PMP: 7.67 in < Local (6-hr) SEP (TR-60, Figure 2-2)

FBH-L Precipitation Value	**7.67 in**

General FBH

PMP: 12.50 in < Local (72-hr) SEP (TR-60, Figure 2-2)

24-hour Duration Reduction Factor:
81.6%

FBH-G Precipitation Value	**10.20 in**

Section 4. Wave Runup

Wave Runup - 50 mph Wind

Design Wind

Fastest Mile Wind:
50 mph

Maximum 1-hr wind
45 mph (Fig. 6, McCartney)

Fetch (F) Length:
0.42 miles (see attached *Fetch Length Exhibit*)

Water-Land Velocity Ratio:
1.07 (Page 11, McCartney)

Note: 120-minute velocity is calculated by multiplying the 60-minute velocity by 0.95.

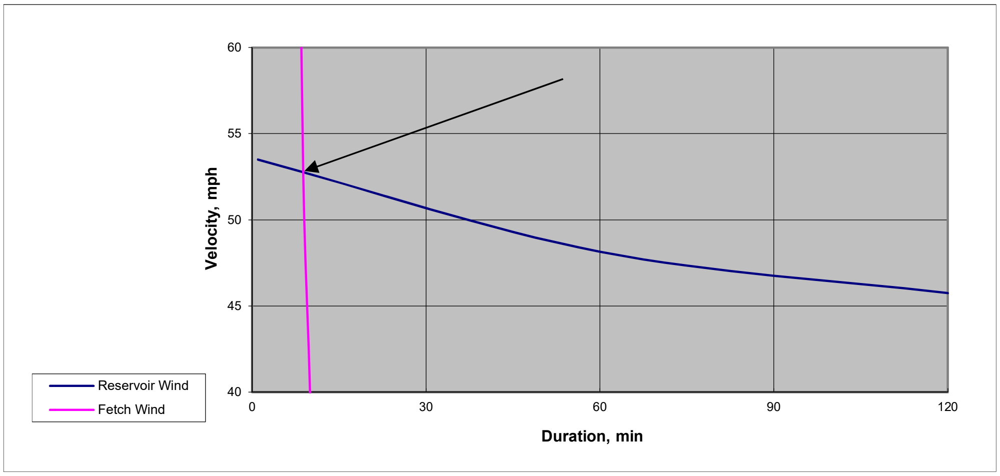
Reservoir Wind:

Duration	Velocity (Land)	Velocity (Water)
min	mph	mph
1	50	53.5
60	45	48.2
120	43	45.7

0.42-mi. Fetch Wind:

Duration	Velocity (Land)	Velocity (Water)
min	mph	mph
10	-	40
9	-	50
8.5	-	60

Note: Duration taken from Fig. 11, McCartney.



The Design Wind is taken from the intersection of the curves in the above chart:

U = 52.8 mph for 8.8 min.

Design Wave

Using a Design Wind of 52.8 mph for 8.8 minutes, the Design Wave is:

H_s = 1.40 ft (Fig. 11, McCartney)

Design Wave Significant Time Period

Using a Design Wind of 52.8 mph over a 0.42-mi. fetch, the Design Wave Significant Period is:

T_s = 2.2 sec (Fig. 12, McCartney)

Wave Runup - 50 mph Wind (cont.)

Wave Runup

Wave Runup, **R_s**, is calculated using the following equation:

$$\boxed{\frac{R_s}{H_s} = \frac{1}{0.4 + \left(\frac{H_s}{L_o}\right)^{1/2} \cot\theta}}$$

where:

H_s = 1.40 ft

L_o = $5.12(T_s)^2$ = 24.8 ft

$\cot\theta$ = 1.5

Therefore:

R_s = 1.85 ft

Maximum Wave Runup, **R_{max}**, is calculated using the following equation:

$$\boxed{R_{\max} = R_s \times 1.5}$$

Therefore:

R_{max} = 2.78 ft

Wind Setup

Wind Setup, **S**, is calculated using the following equation:

$$\boxed{S = \frac{2U^2F}{1400D}}$$

where:

U = 52.8 mph

F = 0.42 mi

D (ave. water depth) = 50 ft

Therefore:

S = 0.03 ft

Required Freeboard

The required amount of freeboard is the sum of the maximum wave runup and the wind setup.

Required Freeboard = 2.81 ft

Wave Runup - 100 mph Wind

Design Wind

Fastest Mile Wind:
100 mph

Maximum 1-hr wind
45 mph (Fig. 6, McCartney)

Fetch (F) Length:
0.42 miles (see attached *Fetch Length Exhibit*)

Water-Land Velocity Ratio:
1.07 (Page 11, McCartney)

Note: 120-minute velocity is calculated by multiplying the 60-minute velocity by 0.95.

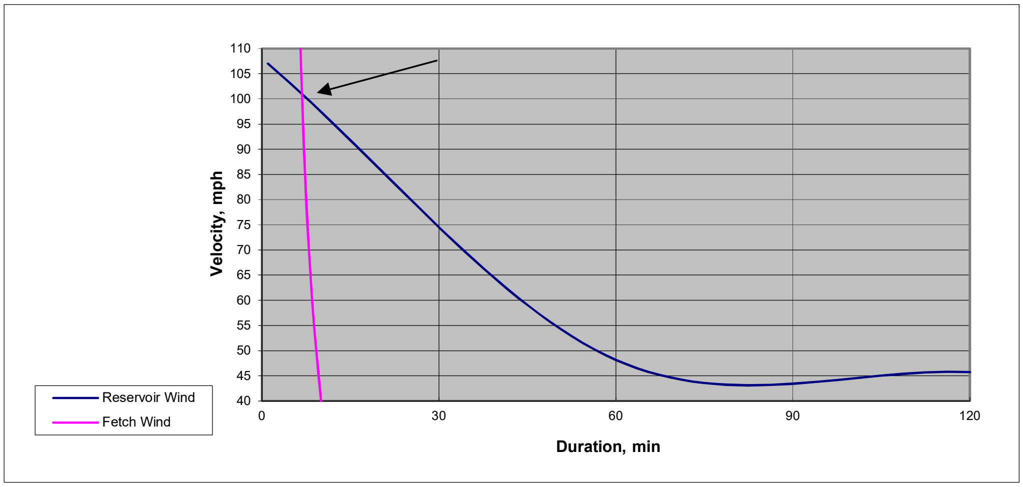
Reservoir Wind:

Duration	Velocity (Land)	Velocity (Water)
min	mph	mph
1	100	107.0
60	45	48.2
120	43	45.7

0.42-mi. Fetch Wind:

Duration	Velocity (Land)	Velocity (Water)
min	mph	mph
10	-	40
8.5	-	60
7.5	-	80
6.8	-	100
6.3	-	120

Note: Duration taken from Fig. 11, McCartney.



The Design Wind is taken from the intersection of the curves in the above chart:

U = 101 mph for 7.0 min.

Design Wave

Using a Design Wind of 101 mph for 7.0 minutes, the Design Wave is:

H_s = 3.10 ft (Fig. 11, McCartney)

Design Wave Significant Time Period

Using a Design Wind of 101 mph over a 0.42-mi. fetch, the Design Wave Significant Period is:

T_s = 2.9 sec (Fig. 12, McCartney)

Wave Runup - 100 mph Wind (cont.)

Wave Runup

Wave Runup, **R_s**, is calculated using the following equation:

$$\boxed{\frac{R_s}{H_s} = \frac{1}{0.4 + \left(\frac{H_s}{L_o}\right)^{1/2} \cot\theta}}$$

where:

H_s = 3.10 ft

L_o = $5.12(T_s)^2$ = 43.1 ft

cotθ = 1.5

Therefore:

R_s = 3.86 ft

Maximum Wave Runup, **R_{max}**, is calculated using the following equation:

$$\boxed{R_{\max} = R_s \times 1.5}$$

Therefore:

R_{max} = 5.79 ft

Wind Setup

Wind Setup, **S**, is calculated using the following equation:

$$\boxed{S = \frac{2U^2F}{1400D}}$$

where:

U = 101 mph

F = 0.42 mi

D (ave. water depth) = 50 ft

Therefore:

S = 0.12 ft

Required Freeboard

The required amount of freeboard is the sum of the maximum wave runup and the wind setup.

Required Freeboard = 5.92 ft

Wave Action

Wave Action

Fetch (F) Length:	0.42 miles	(see attached *Fetch Length Exhibit*)
Maximum Land Wind Velocity:	81 mph	(TR-56, Figure 4)
Water-Land Velocity Ratio:	1.07	(TR-56, Figure 5)
Overwater Wind Velocity	87 mph	(TR-56, Equation 2)
Significant Wave Height	1.75 ft	(TR-56, Equation 3)

Section 5. Emergency Drain

Emergency Drain Pipeline Design

OUTLET WORKS	
24" DI Pipe Inner Diameter (in)	24
Pipe Cross-Section Area (sf)	3.1
Pipe Circumference (ft)	6.3.
Pipe Length (ft)	375
Trash Loss Coefficient, K_t	1.23
Trash Rack Gross-Net Area Ratio	0.3
Trash Rack Area (sf)	100
Entrance Loss Coefficient, K_e	0.5
Friction Loss Coefficient, K_f	4.05
Manning's Coefficient	0.012

EMERGENCY DRAIN	
30" DI Pipe Inner Diameter (in)	30
Pipe Cross-Section Area (sf)	5.7
Pipe Circumference (ft)	8.5
Pipe Length (ft)	300
Bend Loss Coefficient, K_b	0.7
45° Bend Loss Coefficient	0.7
Friction Loss Coefficient, Kf	2.38
Manning's Coefficient	0.012
Discharge Loss Coefficient, Kd	1
Pipe Discharge Elevation (ft)	5450

Water Surface Elev (ft)	Water Storage (ac-ft)	Discharge Volume (ac-ft)	Cum. Discharge Vol. (ac-ft)	Height (ft)	Velocity (fps)	Discharge (cfs)	Discharge (ac-ft/day)	Discharge Time (days)	Cum. Discharge Time (days)
5546									
5545.5	6055		0	95.8	26.7	131.0	259.9		
5545	5916	139	139	95.3	26.7	130.7	259.2	0.536	0.5
5544	5777	139	278	94.5	26.6	130.2	258.2	0.538	1.1
5542	5419	179	636	92.5	26.3	128.8	255.5	0.701	2.5
5540	5074	173	981	90.5	26.0	127.4	252.7	0.685	3.8
5538	4742	166	1313	88.5	25.7	126.0	249.9	0.664	5.2
5536	4423	160	1632	86.5	25.4	124.5	247.0	0.648	6.4
5534	4116	154	1939	84.5	25.1	123.1	244.2	0.631	7.7
5532	3823	147	2232	82.5	24.8	121.6	241.3	0.609	8.9
5530	3542	141	2513	80.5	24.5	120.1	238.3	0.592	10.1
5528	3274	134	2781	78.5	24.2	118.6	235.3	0.569	11.2
5526	3018	128	3037	76.5	23.9	117.1	232.3	0.551	12.3
5524	2773	123	3282	74.5	23.6	115.6	229.3	0.537	13.4
5522	2542	116	3513	72.5	23.3	114.0	226.2	0.513	14.4
5520	2323	110	3732	70.5	22.9	112.4	223.0	0.493	15.4
5518	2117	103	3938	68.5	22.6	110.8	219.8	0.469	16.3
5516	1922	98	4133	66.5	22.3	109.2	216.6	0.452	17.2
5514	1737	93	4318	64.5	21.9	107.5	213.3	0.436	18.1
5512	1563	87	4492	62.5	21.6	105.9	210.0	0.414	18.9
5508	1248	76	4807	58.5	20.9	102.4	203.2	0.374	20.4
5506	1106	71	4949	56.5	20.5	100.7	199.7	0.356	21.1
5504	973	67	5082	54.5	20.2	98.9	196.1	0.342	21.8
5502	851	61	5204	52.5	19.8	97.0	192.5	0.317	22.4
5500	738	57	5317	50.5	19.4	95.2	188.8	0.302	23.0
5498	634	52	5421	48.5	19.0	93.3	185.0	0.281	23.6
5497	587	47	5468	47.5	18.8	92.3	183.1	0.257	23.9
5496	539	48	5516	46.5	18.6	91.3	181.1	0.265	24.1

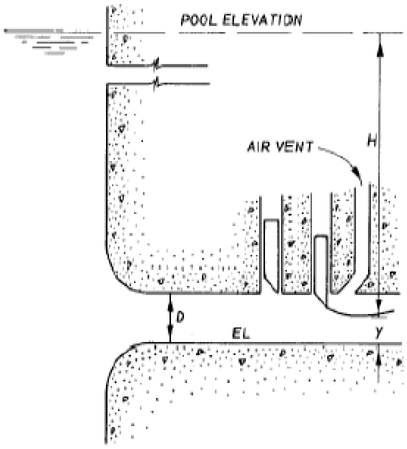
RESULTS	
Water Surface Elevation @ 24 Days	5497
Vol. Drained @ 24 Days (ac-ft)	5468
% Drained @ 24 Days	90%
Vol. Remaining @ 24 Days (ac-ft)	587
Average Flow Rate (cfs)	117

Air Vent Design

This program is to aid in the design of air vents for low level outlet works of medium size dams. The design assumption is that 80 percent gate opening the maximum air requirement will occur. Also, the maximum air velocity is not to exceed 150 fps. Although both parameters can be defined by the user. The method used below was developed by the U.S. Army Corps of Engineers in 1946.

User Defined Parameters

Gravity (ft/s)	32.2
Elev. Sluice Invert at Gate (ft)	5493.00
Design Pool Elevation (ft)	5517.00
Diameter (ft)	2.50
Discharge Coefficient	0.60
Gate Opening (%)	80%
Maximum Air Velocity (ft/s)	150.00



Slope of Outlet	0.007
Pipe Length (ft)	675
Cu	1.486
Manning’s n	0.012

Calculated Parameters

Depth of Water at Vena Contracta (y) in (ft) = 1.200

y = Discharge Coefficient x Gate Opening x Diameter (D)

a (radians) =1.531 $\quad a = a\cos\left(1-\frac{Y}{R}\right)$

Area at Vena Contracta (ft^2) = 2.329 $\quad A_{vc} = R^2 \cdot (\alpha - \cos\alpha \cdot \sin\alpha)$

Effective Head (H) in (ft) = 22.800

H = Design Pool Elev.- Elev. Sluice Invert at Gate – Depth of Water at Vena Contracta (y)

Water Discharge (Q_W) in (ft^3/s) = 89.260 $\quad Q = A_{vc}\sqrt{2 \cdot g \cdot H}$

Water Velocity (V_W) in (ft/s) = 38.319 $\quad V_w = \frac{Q_w}{A_{vc}}$

Froude Number at Vena Contracta = 6.164 $\quad F_r = \frac{V_w}{\sqrt{g \cdot y}}$

β = 0.171 $\quad \beta = 0.03(F_r - 1)^{1.06}$

Air Discharge (Q_a) in (ft^3/s) = 15.261 $\quad Q_a = \beta \cdot Q_w$

Area of Air Vent Required (ft^2) = 0.102 $$A_v = \frac{Q_a}{Maximum\_Air\_Velocity}$$

Diameter for Circular Vent (ft) = 0.360 $$D_v = \sqrt{\frac{A_v \cdot 4}{\pi}}$$

Normal Depth (Y_n) in (ft) = Full Pipe

Vent Ring Design

Air Vent Diameter (in) = 6.0
Air Vent Area (in^2) = 28.27

Combined Req'd Area of Vent Ring Holes (in^2) = 56.55

Vent Ring Hole Diameter (in) = 1
Vent Ring Hole Area (in^2) = 0.79

Req'd Number of Vent Rings Holes = 36.0

Appendix C. Model Output

Storm Event 1. ***2-year, 24-hour [HEC-1]***

Storm Event 2. ***5-year, 24-hour [HEC-1]***

Storm Event 3. ***10-year, 24-hour [HEC-1]***

Storm Event 4. ***25-year, 24-hour [HEC-1]***

Storm Event 5. ***50-year, 24-hour [HEC-1]***

Storm Event 6. ***100-year, 24-hour [HEC-1]***

Storm Event 7. ***500-year, 24-hour [HEC-1]***

Storm Event 8. ***100-year, 6-hour AMC III [HEC-1]***

Storm Event 9. ***100-year, 24-hour AMC III [HEC-1]***

Storm Event 10. ***Local SEP Hydrograph [HEC-1]***

Storm Event 11. ***General SEP Hydrograph [HEC-1]***

Storm Event 12. ***Principal Spillway Hydrograph [HEC-1]***

Storm Event 13. ***Local Auxiliary Spillway Hydrograph [HEC-1]***

Storm Event 14. ***General Auxiliary Spillway Hydrograph [HEC-1]***

Storm Event 15. ***Local Freeboard Hydrograph [HEC-1]***

Storm Event 16. ***General Freeboard Hydrograph [HEC-1]***

Spillway Analysis [SITES]

Breach Analysis [HEC-RAS]

Storm Event 1. 2-year, 24-hour

```
1****************************************                                                   ***************************************
 *                                       *                                                  *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                  *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998               *                                                  *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1                 *                                                  *          609 SECOND STREET          *
 *                                       *                                                  *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:50:18   *                                                  *           (916) 756-1104            *
 *                                       *                                                  *                                     *
 *****************************************                                                  ***************************************




                                                 X     X  XXXXXXX   XXXXX           X
                                                 X     X  X        X     X         XX
                                                 X     X  X        X                X
                                                 XXXXXXX  XXXX     X       XXXXX    X
                                                 X     X  X        X                X
                                                 X     X  X        X     X          X
                                                 X     X  XXXXXXX   XXXXX          XXX




            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                                       HEC-1 INPUT                                                     PAGE  1

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              1           ID   HYDROLOGY STUDY for COVE RESERVOIR
              2           ID   Located in KANE COUNTY, UTAH
              3           ID
              4           ID   AUG 2020
              5           ID
              6           ID   PREPARED BY ALPHA ENGINEERING
              7           ID   43 SOUTH 100 EAST, SUITE 100
              8           ID   ST. GEORGE, UTAH  84770
              9           ID   TEL: (435) 628-6500
             10           ID   FAX: (435) 628-6553
             11           ID
             12           ID   2-YR, 24-HR, AMC II
             13           ID
                          *Diagram
             14           JR    PREC     1.0
             15           IT      72       0       0      50
             16           IO       0
             17           IN      72
                          *

             18           KK   B1
             19           KM   Runoff from Basin 1
             20           BA   0.503
             21           PB    1.61
             22           PC       0   0.020   0.046   0.070   0.095   0.130   0.180   0.300   0.520   0.650
             23           PC   0.700   0.745   0.785   0.820   0.850   0.880   0.905   0.930   0.955   0.980
             24           PC   1.000
             25           LS       0    72.8
             26           UD    0.51
                          *

             27           KK   RB1
             28           KM   Route B1
             29           RD    4928    .045    .050            TRAP      20      20
                          *

             30           KK   B2
             31           KM   Runoff from Basin 2
             32           BA   0.436
             33           LS       0    72.5
             34           UD    0.52
                          *

             35           KK   B3
             36           KM   Runoff from Basin 3
             37           BA   0.279
             38           LS       0    71.0
             39           UD    0.39
                          *
1                                                       HEC-1 INPUT                                                     PAGE  2

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10
```

```
             40           KK   C1
             41           KM   Combine RB1, B2, B3
             42           HC       3
                          *

             43           KK   RC1
             44           KM   Route RC1
             45           RD    7255    .060    .030            TRAP      20      20
                          *

             46           KK   B4
             47           KM   Runoff from Basin 4
             48           BA   0.453
             49           LS       0    73.3
             50           UD    0.48
                          *

             51           KK   B5
             52           KM   Runoff from Basin 5
             53           BA   0.805
             54           LS       0    74.1
             55           UD    0.63
                          *

             56           KK   C2
             57           KM   Combine RC1, B4, B5
             58           HC       3
                          *

             59           KK   RC2
             60           KM   Route C2
             61           RD    2380    .039    .030            TRAP      40       2
                          *

             62           KK   B6
             63           KM   Runoff from Basin 6
             64           BA   0.150
             65           LS       0    84.3
             66           UD    0.19
                          *

             67           KK   B7
             68           KM   Runoff from Basin 7
             69           BA   0.327
             70           LS       0    75.7
             71           UD    0.46
                          *

             72           KK   C3
             73           KM   Combine RC2, B6, B7
             74           HC       3
                          *
1                                                       HEC-1 INPUT                                             PAGE  3

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


             75           KK   RC3
             76           KM   Route C3
             77           RD   11323    .023    .030            TRAP      40      20
                          *

             78           KK   B8
             79           KM   Runoff from Basin 8
             80           BA   1.012
             81           LS       0    84.0
             82           UD    0.67
                          *

             83           KK   B9
             84           KM   Runoff from Basin 9
             85           BA   0.242
             86           LS       0    85.5
             87           UD    0.26
                          *

             88           KK   B10
             89           KM   Runoff from Basin 10
             90           BA   0.129
             91           LS       0    86.7
             92           UD    0.18
                          *

             93           KK   C4
             94           KM   Combine B9, B10
             95           HC       2
                          *

             96           KK   RC4
             97           KM   Route C4
             98           RD    3380    .037    .030            TRAP      40      20
                          *
```

```
             99           KK   B11
            100           KM   Runoff from Basin 11
            101           BA   0.279
            102           LS       0    84.8
            103           UD    0.39
                          *

            104           KK   C5
            105           KM   Combine RC3, B8, RC4, B11
            106           HC       4
                          *

            107           KK   B12
            108           KM   Runoff from Basin 12
            109           BA   0.127
            110           LS       0    81.2
            111           UD    0.40
                          *
1                                                       HEC-1 INPUT                                             PAGE  4

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


            112           KK   Call
            113           KM   Combine C5, B12
            114           HC       2
                          *

            115           KK   Cove Reservoir
            116           KM   Routing through Res'v
            117           RS       1    ELEV  5545.5
            118           SV       0      19      95     240     453     738    1105    1563    2217    2773
            119           SV    3542    4423    5419    6149    7347    8000
            120           SE    5470    5476    5482    5488    5494    5500    5506    5512    5518    5524
            121           SE    5530    5536    5542    5548    5552    5558
            122           SL  5545.5   4.909     0.6     0.5
            123           SS  5549.2      30    2.67     1.5
            124           ST  5552.0    1892     2.9     1.5
                          *
            125           ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW

    18       B1
                 V
                 V
    27       RB1
                 .
                 .
    30           .       B2
                 .           .
                 .           .
    35           .           .       B3
                 .           .           .
                 .           .           .
    40       C1   ........................
                 V
                 V
    43       RC1
                 .
                 .
    46           .       B4
                 .           .
                 .           .
    51           .           .       B5
                 .           .           .
                 .           .           .
    56       C2   ........................
                 V
                 V
    59       RC2
                 .
                 .
    62           .       B6
                 .           .
                 .           .
    67           .           .       B7
                 .           .           .
                 .           .           .
    72       C3   ........................
                 V
                 V
    75       RC3
                 .
                 .
    78           .       B8
                 .           .
```

```
                 .           .
    83           .           .       B9
                 .           .           .
                 .           .           .
    88           .           .           .       B10
                 .           .           .           .
                 .           .           .           .
    93           .           .       C4   ............
                 .           .           V
                 .           .           V
    96           .           .       RC4
                 .           .           .
                 .           .           .
    99           .           .           .       B11
                 .           .           .           .
                 .           .           .           .
   104       C5   ....................................
                 .
                 .
   107           .       B12
                 .           .
                 .           .
   112       Call ............
                 V
                 V
   115       Cove

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                                  ***************************************
 *                                       *                                                  *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                  *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998               *                                                  *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1                 *                                                  *          609 SECOND STREET          *
 *                                       *                                                  *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:50:18   *                                                  *           (916) 756-1104            *
 *                                       *                                                  *                                     *
 *****************************************                                                  ***************************************




                            HYDROLOGY STUDY for COVE RESERVOIR
                            Located in KANE COUNTY, UTAH

                            AUG 2020

                            PREPARED BY ALPHA ENGINEERING
                            43 SOUTH 100 EAST, SUITE 100
                            ST. GEORGE, UTAH  84770
                            TEL: (435) 628-6500
                            FAX: (435) 628-6553

                            2-YR, 24-HR, AMC II


   16 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           0  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN          72  MINUTES IN COMPUTATION INTERVAL
                        IDATE      1    0  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ          50  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE      3    0  ENDING DATE
                       NDTIME        1048  ENDING TIME
                       ICENT           19  CENTURY MARK

                    COMPUTATION INTERVAL    1.20 HOURS
                         TOTAL TIME BASE   58.80 HOURS

          ENGLISH UNITS
               DRAINAGE AREA         SQUARE MILES
               PRECIPITATION DEPTH   INCHES
               LENGTH, ELEVATION     FEET
               FLOW                  CUBIC FEET PER SECOND
               STORAGE VOLUME        ACRE-FEET
               SURFACE AREA          ACRES
               TEMPERATURE           DEGREES FAHRENHEIT

      JP          MULTI-PLAN OPTION
                        NPLAN           1  NUMBER OF PLANS

      JR          MULTI-RATIO OPTION
                      RATIOS OF PRECIPITATION
                     1.00


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
```

```
 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
  112 KK     *     Call   *
             *            *
             **************
                            Combine C5, B12

  114 HC          HYDROGRAPH COMBINATION
                        ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                 ***

 ***********************************************************************************************************************************

                                                   HYDROGRAPH AT STATION    Call
                                                        SUM OF  2 HYDROGRAPHS
                                                       PLAN 1,   RATIO =  1.00

 ***********************************************************************************************************************************
                                 *                                *                                *
    DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW
                                 *                                *                                *
     1     0000    1        0.   *    1     1536   14       56.   *    2     0712   27        0.   *    2     2248   40        0.
     1     0112    2        0.   *    1     1648   15       52.   *    2     0824   28        0.   *    3     0000   41        0.
     1     0224    3        0.   *    1     1800   16       50.   *    2     0936   29        0.   *    3     0112   42        0.
     1     0336    4        0.   *    1     1912   17       47.   *    2     1048   30        0.   *    3     0224   43        0.
     1     0448    5        0.   *    1     2024   18       45.   *    2     1200   31        0.   *    3     0336   44        0.
     1     0600    6        0.   *    1     2136   19       45.   *    2     1312   32        0.   *    3     0448   45        0.
     1     0712    7        0.   *    1     2248   20       46.   *    2     1424   33        0.   *    3     0600   46        0.
     1     0824    8        4.   *    2     0000   21       43.   *    2     1536   34        0.   *    3     0712   47        0.
     1     0936    9       59.   *    2     0112   22       25.   *    2     1648   35        0.   *    3     0824   48        0.
     1     1048   10       89.   *    2     0224   23       10.   *    2     1800   36        0.   *    3     0936   49        0.
     1     1200   11       78.   *    2     0336   24        5.   *    2     1912   37        0.   *    3     1048   50        0.
     1     1312   12       65.   *    2     0448   25        2.   *    2     2024   38        0.   *
     1     1424   13       60.   *    2     0600   26        1.   *    2     2136   39        0.   *
                                 *                                *                                *
 ***********************************************************************************************************************************

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     58.80-HR
+   (CFS)       (HR)
                           (CFS)
+      89.     10.80                   70.         39.         16.          16.
                        (INCHES)      .137        .306        .306         .306
                         (AC-FT)       35.         77.         77.          77.

                         CUMULATIVE AREA =    4.74 SQ MI




 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
  115 KK     *     Cove   *     Reservoir
             *            *
             **************
                            Routing through Res'v

                HYDROGRAPH ROUTING DATA

  117 RS          STORAGE ROUTING
                        NSTPS           1  NUMBER OF SUBREACHES
                         ITYP        ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC     5545.50  INITIAL CONDITION
                            X         .00 WORKING R AND D COEFFICIENT

  118 SV            STORAGE          .0      19.0      95.0     240.0     453.0     738.0    1105.0    1563.0    2217.0    2773.0
                                 3542.0    4423.0    5419.0    6149.0    7347.0    8000.0

  120 SE          ELEVATION     5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00
                                5530.00   5536.00   5542.00   5548.00   5552.00   5558.00

  122 SL          LOW-LEVEL OUTLET
                        ELEVL     5545.50  ELEVATION AT CENTER OF OUTLET
                        CAREA        4.91  CROSS-SECTIONAL AREA
                         COQL         .60  COEFFICIENT
                         EXPL         .50  EXPONENT OF HEAD

  123 SS          SPILLWAY
                         CREL     5549.20  SPILLWAY CREST ELEVATION
                        SPWID       30.00  SPILLWAY WIDTH
                         COQW        2.67  WEIR COEFFICIENT
                         EXPW        1.50  EXPONENT OF HEAD

  124 ST          TOP OF DAM
```

```
                        TOPEL     5552.00  ELEVATION AT TOP OF DAM
                       DAMWID     1892.00  DAM WIDTH
                         COQD        2.90  WEIR COEFFICIENT
                         EXPD        1.50  EXPONENT OF HEAD

                                                                  ***

                                                    COMPUTED OUTFLOW-ELEVATION DATA

                                                      (EXCLUDING FLOW OVER DAM)

             OUTFLOW        .00        .00      25.78      27.48      29.42      31.65      34.25      37.31      40.98      45.44
           ELEVATION    5470.00    5545.50    5546.69    5546.85    5547.05    5547.30    5547.60    5548.00    5548.51    5549.20

             OUTFLOW      49.37      68.29     113.97     198.20     332.85     529.64     800.37    1156.85    1610.93    2174.46
           ELEVATION    5549.32    5549.60    5550.06    5550.68    5551.48    5552.44    5553.58    5554.88    5556.36    5558.00


                                                COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

                                                      (INCLUDING FLOW OVER DAM)

             STORAGE        .00      19.00      95.00     240.00     453.00     738.00    1105.00    1563.00    2217.00    2773.00
             OUTFLOW        .00        .00        .00        .00        .00        .00        .00        .00        .00        .00
           ELEVATION    5470.00    5476.00    5482.00    5488.00    5494.00    5500.00    5506.00    5512.00    5518.00    5524.00

             STORAGE    3542.00    4423.00    5419.00    5844.83    5989.79    6009.51    6033.57    6063.27    6100.64    6148.41
             OUTFLOW        .00        .00        .00        .00      25.78      27.48      29.42      31.65      34.25      37.31
           ELEVATION    5530.00    5536.00    5542.00    5545.50    5546.69    5546.85    5547.05    5547.30    5547.60    5548.00

             STORAGE    6301.53    6508.46    6543.56    6628.96    6765.11    6952.15    7190.23    7347.00    7395.04    7518.54
             OUTFLOW      40.98      45.44      49.37      68.29     113.97     198.20     332.85     435.48    2138.72   11657.74
           ELEVATION    5548.51    5549.20    5549.32    5549.60    5550.06    5550.68    5551.48    5552.00    5552.44    5553.58

             STORAGE    7660.53    7821.02    8000.00
             OUTFLOW   27985.71   51484.63   82813.63
           ELEVATION    5554.88    5556.36    5558.00

 *******************************************************************************************************************************

                                                     HYDROGRAPH AT STATION    Cove
                                                         PLAN 1,   RATIO =  1.00

 *******************************************************************************************************************************
                                             *                                            *
  DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE
                                             *                                            *
   1     0000   1      0.   5844.8  5545.5 *  1     2024  18      15.   5892.4  5545.9 *  2     1648  35      14.   5886.3  5545.8
   1     0112   2      0.   5844.8  5545.5 *  1     2136  19      15.   5895.4  5545.9 *  2     1800  36      14.   5884.9  5545.8
   1     0224   3      0.   5844.8  5545.5 *  1     2248  20      16.   5898.4  5545.9 *  2     1912  37      13.   5883.6  5545.8
   1     0336   4      0.   5844.8  5545.5 *  2     0000  21      16.   5901.2  5546.0 *  2     2024  38      13.   5882.3  5545.8
   1     0448   5      0.   5844.8  5545.5 *  2     0112  22      16.   5902.9  5546.0 *  2     2136  39      13.   5881.0  5545.8
   1     0600   6      0.   5844.8  5545.5 *  2     0224  23      16.   5903.0  5546.0 *  2     2248  40      13.   5879.8  5545.8
   1     0712   7      0.   5844.8  5545.5 *  2     0336  24      16.   5902.1  5546.0 *  3     0000  41      12.   5878.5  5545.8
   1     0824   8      1.   5845.0  5545.5 *  2     0448  25      16.   5900.9  5546.0 *  3     0112  42      12.   5877.3  5545.8
   1     0936   9      4.   5847.9  5545.5 *  2     0600  26      16.   5899.4  5545.9 *  3     0224  43      12.   5876.1  5545.8
   1     1048  10      7.   5854.8  5545.6 *  2     0712  27      16.   5897.9  5545.9 *  3     0336  44      12.   5874.9  5545.7
   1     1200  11      9.   5862.2  5545.6 *  2     0824  28      15.   5896.4  5545.9 *  3     0448  45      12.   5873.8  5545.7
   1     1312  12     10.   5868.4  5545.7 *  2     0936  29      15.   5894.9  5545.9 *  3     0600  46      11.   5872.6  5545.7
   1     1424  13     11.   5873.5  5545.7 *  2     1048  30      15.   5893.4  5545.9 *  3     0712  47      11.   5871.5  5545.7
   1     1536  14     12.   5878.0  5545.8 *  2     1200  31      15.   5891.9  5545.9 *  3     0824  48      11.   5870.4  5545.7
   1     1648  15     13.   5882.1  5545.8 *  2     1312  32      14.   5890.5  5545.9 *  3     0936  49      11.   5869.4  5545.7
   1     1800  16     14.   5885.9  5545.8 *  2     1424  33      14.   5889.1  5545.9 *  3     1048  50      10.   5868.3  5545.7
   1     1912  17     14.   5889.3  5545.9 *  2     1536  34      14.   5887.7  5545.9 *
                                             *                                            *
 *******************************************************************************************************************************

 PEAK OUTFLOW IS       16. AT TIME  26.40 HOURS


  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR     58.80-HR
+   (CFS)       (HR)
                         (CFS)
+      16.     26.40                 16.         15.         11.          11.
                       (INCHES)      .032        .119        .214         .214
                        (AC-FT)        8.         30.         54.          54.

 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                    6-HR       24-HR       72-HR     58.80-HR
+  (AC-FT)      (HR)
     5903.     26.40               5902.       5895.       5878.        5878.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                    6-HR       24-HR       72-HR     58.80-HR
+   (FEET)      (HR)
   5545.98     26.40             5545.97     5545.91     5545.77      5545.77

                        CUMULATIVE AREA =    4.74 SQ MI

1
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                PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                  FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                  TIME TO PEAK IN HOURS


                                                           RATIOS APPLIED TO PRECIPITATION
 OPERATION       STATION     AREA    PLAN           RATIO 1
                                                        1.00

 HYDROGRAPH AT
+                  B1          .50     1   FLOW           4.
                                           TIME       10.80

 ROUTED TO
+                  RB1         .50     1   FLOW           4.
                                           TIME       12.00

 HYDROGRAPH AT
+                  B2          .44     1   FLOW           3.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B3          .28     1   FLOW           2.
                                           TIME       22.80

  3 COMBINED AT
+                  C1         1.22     1   FLOW           9.
                                           TIME       14.40

 ROUTED TO
+                  RC1        1.22     1   FLOW           9.
                                           TIME       14.40

 HYDROGRAPH AT
+                  B4          .45     1   FLOW           4.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B5          .81     1   FLOW           9.
                                           TIME       10.80

  3 COMBINED AT
+                  C2         2.48     1   FLOW          19.
                                           TIME       14.40

 ROUTED TO
+                  RC2        2.48     1   FLOW          19.
                                           TIME       14.40

 HYDROGRAPH AT
+                  B6          .15     1   FLOW           7.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B7          .33     1   FLOW           5.
                                           TIME       10.80

  3 COMBINED AT
+                  C3         2.95     1   FLOW          27.
                                           TIME       10.80

 ROUTED TO
+                  RC3        2.95     1   FLOW          27.
                                           TIME       12.00

 HYDROGRAPH AT
+                  B8         1.01     1   FLOW          43.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B9          .24     1   FLOW          12.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B10         .13     1   FLOW           7.
                                           TIME       10.80

  2 COMBINED AT
+                  C4          .37     1   FLOW          19.
                                           TIME       10.80

 ROUTED TO
+                  RC4         .37     1   FLOW          19.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B11         .28     1   FLOW          13.
                                           TIME       10.80

  4 COMBINED AT
+                  C5         4.61     1   FLOW          85.
                                           TIME       10.80
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 HYDROGRAPH AT
+                  B12         .13     1   FLOW           4.
                                           TIME        10.80

  2 COMBINED AT
+                  Call       4.74     1   FLOW          89.
                                           TIME        10.80

 ROUTED TO
+                  Cove       4.74     1   FLOW          16.
                                           TIME        26.40

                                       ** PEAK STAGES IN FEET **
                                       1   STAGE     5545.98
                                           TIME        26.40
1
                                           SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                                               (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                                   INTERPOLATED TO
                                                                                COMPUTATION INTERVAL
            ISTAQ    ELEMENT      DT       PEAK    TIME TO     VOLUME      DT       PEAK    TIME TO     VOLUME
                                                     PEAK                                     PEAK

                                 (MIN)     (CFS)      (MIN)     (IN)     (MIN)     (CFS)     (MIN)       (IN)

           FOR PLAN = 1  RATIO=  .00
              RB1    MANE         7.20      4.28    691.20       .16     72.00      3.95    720.00         .16


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .4342E+01 EXCESS= .0000E+00 OUTFLOW= .4342E+01 BASIN STORAGE= .3500E-02 PERCENT ERROR=   -.1


           FOR PLAN = 1  RATIO=  .00
              RC1    MANE        14.40      8.59    763.20       .15     72.00      8.52    864.00         .15


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .9892E+01 EXCESS= .0000E+00 OUTFLOW= .9895E+01 BASIN STORAGE= .3327E-02 PERCENT ERROR=   -.1


           FOR PLAN = 1  RATIO=  .00
              RC2    MANE        10.57     19.01    856.25       .17     72.00     19.01    864.00         .17


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .2218E+02 EXCESS= .0000E+00 OUTFLOW= .2218E+02 BASIN STORAGE= .2800E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC3    MANE        10.80     27.32    702.00       .19     72.00     26.74    720.00         .19


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .3011E+02 EXCESS= .0000E+00 OUTFLOW= .3013E+02 BASIN STORAGE= .8425E-02 PERCENT ERROR=   -.1


           FOR PLAN = 1  RATIO=  .00
              RC4    MANE        10.80     18.94    658.80       .56     72.00     18.68    648.00         .57


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1115E+02 EXCESS= .0000E+00 OUTFLOW= .1115E+02 BASIN STORAGE= .2705E-02 PERCENT ERROR=    .0


1                                  SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION    Cove
                              (PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED  DURING BREACH FORMATION)


      PLAN  1 ..............                   INITIAL VALUE     SPILLWAY CREST     TOP OF DAM
                                 ELEVATION        5545.50            5549.20          5552.00
                                 STORAGE            5845.              6508.            7347.
                                 OUTFLOW               0.                45.             435.


                      RATIO     MAXIMUM      MAXIMUM    MAXIMUM    MAXIMUM    DURATION     TIME OF     TIME OF
                        OF     RESERVOIR      DEPTH     STORAGE    OUTFLOW    OVER TOP   MAX OUTFLOW   FAILURE
                       PMF      W.S.ELEV    OVER DAM     AC-FT       CFS        HOURS       HOURS       HOURS

                      1.00      5545.98         .00       5903.        16.       .00        26.40         .00


 *** NORMAL END OF HEC-1 ***
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Storm Event 2. 5-year, 24-hour

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1*****************************************                                                 ***************************************
 *                                       *                                                 *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                 *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998               *                                                 *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1                 *                                                 *          609 SECOND STREET          *
 *                                       *                                                 *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:51:41   *                                                 *           (916) 756-1104            *
 *                                       *                                                 *                                     *
 *****************************************                                                 ***************************************




                                                 X     X  XXXXXXX   XXXXX           X
                                                 X     X  X        X     X         XX
                                                 X     X  X        X                X
                                                 XXXXXXX  XXXX     X        XXXXX   X
                                                 X     X  X        X                X
                                                 X     X  X        X     X          X
                                                 X     X  XXXXXXX   XXXXX          XXX




            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                                       HEC-1 INPUT                                            PAGE  1

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              1           ID   HYDROLOGY STUDY for COVE RESERVOIR
              2           ID   Located in KANE COUNTY, UTAH
              3           ID
              4           ID   AUG 2020
              5           ID
              6           ID   PREPARED BY ALPHA ENGINEERING
              7           ID   43 SOUTH 100 EAST, SUITE 100
              8           ID   ST. GEORGE, UTAH  84770
              9           ID   TEL: (435) 628-6500
             10           ID   FAX: (435) 628-6553
             11           ID
             12           ID   5-YR, 24-HR, AMC II
             13           ID
                          *Diagram
             14           JR    PREC     1.0
             15           IT      72       0       0      50
             16           IO       0
             17           IN      72
                          *

             18           KK   B1
             19           KM   Runoff from Basin 1
             20           BA   0.503
             21           PB    2.01
             22           PC       0   0.020   0.046   0.070   0.095   0.130   0.180   0.300   0.520   0.650
             23           PC   0.700   0.745   0.785   0.820   0.850   0.880   0.905   0.930   0.955   0.980
             24           PC   1.000
             25           LS       0    72.8
             26           UD    0.51
                          *

             27           KK   RB1
             28           KM   Route B1
             29           RD    4928    .045    .050            TRAP      20      20
                          *

             30           KK   B2
             31           KM   Runoff from Basin 2
             32           BA   0.436
             33           LS       0    72.5
             34           UD    0.52
                          *

             35           KK   B3
             36           KM   Runoff from Basin 3
             37           BA   0.279
             38           LS       0    71.0
             39           UD    0.39
                          *
1                                                       HEC-1 INPUT                                            PAGE  2

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10
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```
             40            KK   C1
             41            KM   Combine RB1, B2, B3
             42            HC       3
                           *

             43            KK   RC1
             44            KM   Route RC1
             45            RD    7255    .060    .030            TRAP      20      20
                           *

             46            KK   B4
             47            KM   Runoff from Basin 4
             48            BA   0.453
             49            LS       0    73.3
             50            UD    0.48
                           *

             51            KK   B5
             52            KM   Runoff from Basin 5
             53            BA   0.805
             54            LS       0    74.1
             55            UD    0.63
                           *

             56            KK   C2
             57            KM   Combine RC1, B4, B5
             58            HC       3
                           *

             59            KK   RC2
             60            KM   Route C2
             61            RD    2380    .039    .030            TRAP      40       2
                           *

             62            KK   B6
             63            KM   Runoff from Basin 6
             64            BA   0.150
             65            LS       0    84.3
             66            UD    0.19
                           *

             67            KK   B7
             68            KM   Runoff from Basin 7
             69            BA   0.327
             70            LS       0    75.7
             71            UD    0.46
                           *

             72            KK   C3
             73            KM   Combine RC2, B6, B7
             74            HC       3
                           *
1                                                       HEC-1 INPUT                                             PAGE  3

           LINE            ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


             75            KK   RC3
             76            KM   Route C3
             77            RD   11323    .023    .030            TRAP      40      20
                           *

             78            KK   B8
             79            KM   Runoff from Basin 8
             80            BA   1.012
             81            LS       0    84.0
             82            UD    0.67
                           *

             83            KK   B9
             84            KM   Runoff from Basin 9
             85            BA   0.242
             86            LS       0    85.5
             87            UD    0.26
                           *

             88            KK   B10
             89            KM   Runoff from Basin 10
             90            BA   0.129
             91            LS       0    86.7
             92            UD    0.18
                           *

             93            KK   C4
             94            KM   Combine B9, B10
             95            HC       2
                           *

             96            KK   RC4
             97            KM   Route C4
             98            RD    3380    .037    .030            TRAP      40      20
                           *
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```
             99           KK   B11
            100           KM   Runoff from Basin 11
            101           BA   0.279
            102           LS       0    84.8
            103           UD    0.39
                          *

            104           KK   C5
            105           KM   Combine RC3, B8, RC4, B11
            106           HC       4
                          *

            107           KK   B12
            108           KM   Runoff from Basin 12
            109           BA   0.127
            110           LS       0    81.2
            111           UD    0.40
                          *
1                                                       HEC-1 INPUT                                            PAGE  4

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


            112           KK   Call
            113           KM   Combine C5, B12
            114           HC       2
                          *

            115           KK   Cove Reservoir
            116           KM   Routing through Res'v
            117           RS       1    ELEV  5545.5
            118           SV       0      19      95     240     453     738    1105    1563    2217    2773
            119           SV    3542    4423    5419    6149    7347    8000
            120           SE    5470    5476    5482    5488    5494    5500    5506    5512    5518    5524
            121           SE    5530    5536    5542    5548    5552    5558
            122           SL  5545.5   4.909     0.6     0.5
            123           SS  5549.2      30    2.67     1.5
            124           ST  5552.0    1892     2.9     1.5
                          *
            125           ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW

    18       B1
                 V
                 V
    27       RB1
                 .
                 .
    30           .       B2
                 .          .
                 .          .
    35           .          .       B3
                 .          .          .
                 .          .          .
    40       C1   ........................
                 V
                 V
    43       RC1
                 .
                 .
    46           .       B4
                 .          .
                 .          .
    51           .          .       B5
                 .          .          .
                 .          .          .
    56       C2   ........................
                 V
                 V
    59       RC2
                 .
                 .
    62           .       B6
                 .          .
                 .          .
    67           .          .       B7
                 .          .          .
                 .          .          .
    72       C3   ........................
                 V
                 V
    75       RC3
                 .
                 .
    78           .       B8
                 .          .
```

```
                 .           .
    83           .           .       B9
                 .           .           .
                 .           .           .
    88           .           .           .       B10
                 .           .           .           .
                 .           .           .           .
    93           .           .       C4   ............
                 .           .           V
                 .           .           V
    96           .           .       RC4
                 .           .           .
                 .           .           .
    99           .           .           .       B11
                 .           .           .           .
                 .           .           .           .
   104       C5   ....................................
                 .
                 .
   107           .       B12
                 .           .
                 .           .
   112       Call ............
                 V
                 V
   115       Cove

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                                    ***************************************
 *                                       *                                                    *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                    *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998               *                                                    *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1                 *                                                    *          609 SECOND STREET          *
 *                                       *                                                    *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:51:41   *                                                    *           (916) 756-1104            *
 *                                       *                                                    *                                     *
 *****************************************                                                    ***************************************




                            HYDROLOGY STUDY for COVE RESERVOIR
                            Located in KANE COUNTY, UTAH

                            AUG 2020

                            PREPARED BY ALPHA ENGINEERING
                            43 SOUTH 100 EAST, SUITE 100
                            ST. GEORGE, UTAH  84770
                            TEL: (435) 628-6500
                            FAX: (435) 628-6553

                            5-YR, 24-HR, AMC II


   16 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           0  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN          72  MINUTES IN COMPUTATION INTERVAL
                        IDATE      1    0  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ          50  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE      3    0  ENDING DATE
                       NDTIME        1048  ENDING TIME
                       ICENT           19  CENTURY MARK

                    COMPUTATION INTERVAL    1.20 HOURS
                         TOTAL TIME BASE   58.80 HOURS

           ENGLISH UNITS
                DRAINAGE AREA         SQUARE MILES
                PRECIPITATION DEPTH   INCHES
                LENGTH, ELEVATION     FEET
                FLOW                  CUBIC FEET PER SECOND
                STORAGE VOLUME        ACRE-FEET
                SURFACE AREA          ACRES
                TEMPERATURE           DEGREES FAHRENHEIT

      JP          MULTI-PLAN OPTION
                        NPLAN           1  NUMBER OF PLANS

      JR          MULTI-RATIO OPTION
                      RATIOS OF PRECIPITATION
                     1.00


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
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```
*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
 112 KK     *     Call   *
            *            *
            **************
                          Combine C5, B12

 114 HC          HYDROGRAPH COMBINATION
                       ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                ***

*********************************************************************************************************************************

                                                  HYDROGRAPH AT STATION    Call
                                                       SUM OF  2 HYDROGRAPHS
                                                      PLAN 1,   RATIO =  1.00

*********************************************************************************************************************************
                                *                                *                                *
   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW
                                *                                *                                *
    1     0000    1        0.   *    1     1536   14       90.   *    2     0712   27        0.   *    2     2248   40        0.
    1     0112    2        0.   *    1     1648   15       81.   *    2     0824   28        0.   *    3     0000   41        0.
    1     0224    3        0.   *    1     1800   16       78.   *    2     0936   29        0.   *    3     0112   42        0.
    1     0336    4        0.   *    1     1912   17       72.   *    2     1048   30        0.   *    3     0224   43        0.
    1     0448    5        0.   *    1     2024   18       69.   *    2     1200   31        0.   *    3     0336   44        0.
    1     0600    6        0.   *    1     2136   19       68.   *    2     1312   32        0.   *    3     0448   45        0.
    1     0712    7        0.   *    1     2248   20       69.   *    2     1424   33        0.   *    3     0600   46        0.
    1     0824    8       17.   *    2     0000   21       64.   *    2     1536   34        0.   *    3     0712   47        0.
    1     0936    9      110.   *    2     0112   22       36.   *    2     1648   35        0.   *    3     0824   48        0.
    1     1048   10      175.   *    2     0224   23       15.   *    2     1800   36        0.   *    3     0936   49        0.
    1     1200   11      141.   *    2     0336   24        6.   *    2     1912   37        0.   *    3     1048   50        0.
    1     1312   12      113.   *    2     0448   25        3.   *    2     2024   38        0.   *
    1     1424   13       99.   *    2     0600   26        1.   *    2     2136   39        0.   *
                                *                                *                                *
*********************************************************************************************************************************

 PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                               6-HR       24-HR       72-HR     58.80-HR
+   (CFS)       (HR)
                          (CFS)
+     175.     10.80               125.         65.         27.          27.
                         (INCHES)      .246        .512        .512         .512
                          (AC-FT)       62.        130.        130.         130.

                          CUMULATIVE AREA =    4.74 SQ MI




*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
 115 KK     *     Cove   *     Reservoir
            *            *
            **************
                          Routing through Res'v

               HYDROGRAPH ROUTING DATA

 117 RS          STORAGE ROUTING
                       NSTPS           1  NUMBER OF SUBREACHES
                        ITYP        ELEV  TYPE OF INITIAL CONDITION
                      RSVRIC     5545.50  INITIAL CONDITION
                           X         .00 WORKING R AND D COEFFICIENT

 118 SV            STORAGE          .0      19.0      95.0     240.0     453.0     738.0    1105.0    1563.0    2217.0    2773.0
                              3542.0    4423.0    5419.0    6149.0    7347.0    8000.0

 120 SE          ELEVATION     5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00
                               5530.00   5536.00   5542.00   5548.00   5552.00   5558.00

 122 SL          LOW-LEVEL OUTLET
                       ELEVL     5545.50  ELEVATION AT CENTER OF OUTLET
                       CAREA        4.91  CROSS-SECTIONAL AREA
                        COQL         .60  COEFFICIENT
                        EXPL         .50  EXPONENT OF HEAD

 123 SS          SPILLWAY
                        CREL     5549.20  SPILLWAY CREST ELEVATION
                       SPWID       30.00  SPILLWAY WIDTH
                        COQW        2.67  WEIR COEFFICIENT
                        EXPW        1.50  EXPONENT OF HEAD

 124 ST          TOP OF DAM
```

```
                    TOPEL     5552.00  ELEVATION AT TOP OF DAM
                   DAMWID     1892.00  DAM WIDTH
                     COQD        2.90  WEIR COEFFICIENT
                     EXPD        1.50  EXPONENT OF HEAD

                                                            ***

                                          COMPUTED OUTFLOW-ELEVATION DATA

                                            (EXCLUDING FLOW OVER DAM)

             OUTFLOW        .00       .00     25.78     27.48     29.42     31.65     34.25     37.31     40.98     45.44
           ELEVATION    5470.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00   5548.51   5549.20

             OUTFLOW      49.37     68.29    113.97    198.20    332.85    529.64    800.37   1156.85   1610.93   2174.46
           ELEVATION    5549.32   5549.60   5550.06   5550.68   5551.48   5552.44   5553.58   5554.88   5556.36   5558.00


                                      COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

                                            (INCLUDING FLOW OVER DAM)

             STORAGE        .00     19.00     95.00    240.00    453.00    738.00   1105.00   1563.00   2217.00   2773.00
             OUTFLOW        .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
           ELEVATION    5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00

             STORAGE    3542.00   4423.00   5419.00   5844.83   5989.79   6009.51   6033.57   6063.27   6100.64   6148.41
             OUTFLOW        .00       .00       .00       .00     25.78     27.48     29.42     31.65     34.25     37.31
           ELEVATION    5530.00   5536.00   5542.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00

             STORAGE    6301.53   6508.46   6543.56   6628.96   6765.11   6952.15   7190.23   7347.00   7395.04   7518.54
             OUTFLOW      40.98     45.44     49.37     68.29    113.97    198.20    332.85    435.48   2138.72  11657.74
           ELEVATION    5548.51   5549.20   5549.32   5549.60   5550.06   5550.68   5551.48   5552.00   5552.44   5553.58

             STORAGE    7660.53   7821.02   8000.00
             OUTFLOW   27985.71  51484.63  82813.63
           ELEVATION    5554.88   5556.36   5558.00

 ******************************************************************************************************************************

                                           HYDROGRAPH AT STATION    Cove
                                               PLAN 1,   RATIO =  1.00

 ******************************************************************************************************************************
                                           *                                            *
  DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE
                                           *                                            *
   1     0000   1       0.   5844.8  5545.5 *  1     2024  18      20.   5931.0  5546.2 *  2     1648  35      19.   5925.4  5546.2
   1     0112   2       0.   5844.8  5545.5 *  1     2136  19      20.   5935.8  5546.2 *  2     1800  36      19.   5923.5  5546.1
   1     0224   3       0.   5844.8  5545.5 *  1     2248  20      21.   5940.6  5546.3 *  2     1912  37      19.   5921.6  5546.1
   1     0336   4       0.   5844.8  5545.5 *  2     0000  21      21.   5945.1  5546.3 *  2     2024  38      19.   5919.8  5546.1
   1     0448   5       0.   5844.8  5545.5 *  2     0112  22      22.   5947.9  5546.3 *  2     2136  39      18.   5918.0  5546.1
   1     0600   6       0.   5844.8  5545.5 *  2     0224  23      22.   5948.3  5546.4 *  2     2248  40      18.   5916.2  5546.1
   1     0712   7       0.   5844.8  5545.5 *  2     0336  24      22.   5947.1  5546.3 *  3     0000  41      18.   5914.4  5546.1
   1     0824   8       2.   5845.6  5545.5 *  2     0448  25      21.   5945.4  5546.3 *  3     0112  42      18.   5912.6  5546.1
   1     0936   9       6.   5851.5  5545.6 *  2     0600  26      21.   5943.4  5546.3 *  3     0224  43      17.   5910.9  5546.0
   1     1048  10      10.   5864.9  5545.7 *  2     0712  27      21.   5941.4  5546.3 *  3     0336  44      17.   5909.2  5546.0
   1     1200  11      13.   5879.5  5545.8 *  2     0824  28      21.   5939.4  5546.3 *  3     0448  45      17.   5907.4  5546.0
   1     1312  12      15.   5890.8  5545.9 *  2     0936  29      21.   5937.3  5546.3 *  3     0600  46      17.   5905.8  5546.0
   1     1424  13      16.   5899.8  5546.0 *  2     1048  30      20.   5935.3  5546.2 *  3     0712  47      16.   5904.1  5546.0
   1     1536  14      17.   5907.5  5546.0 *  2     1200  31      20.   5933.2  5546.2 *  3     0824  48      16.   5902.5  5546.0
   1     1648  15      18.   5914.3  5546.1 *  2     1312  32      20.   5931.3  5546.2 *  3     0936  49      16.   5900.9  5546.0
   1     1800  16      19.   5920.4  5546.1 *  2     1424  33      20.   5929.3  5546.2 *  3     1048  50      16.   5899.3  5545.9
   1     1912  17      19.   5926.0  5546.2 *  2     1536  34      19.   5927.4  5546.2 *
                                           *                                            *
 ******************************************************************************************************************************

 PEAK OUTFLOW IS       22. AT TIME  26.40 HOURS


  PEAK FLOW     TIME                      MAXIMUM AVERAGE FLOW
                                  6-HR       24-HR       72-HR     58.80-HR
+   (CFS)       (HR)
                          (CFS)
+      22.     26.40               22.         20.         15.          15.
                       (INCHES)      .042        .161        .297         .297
                        (AC-FT)       11.         41.         75.          75.

 PEAK STORAGE   TIME                     MAXIMUM AVERAGE STORAGE
                                  6-HR       24-HR       72-HR     58.80-HR
+  (AC-FT)      (HR)
     5948.     26.40               5947.       5937.       5908.        5908.

  PEAK STAGE    TIME                      MAXIMUM AVERAGE STAGE
                                  6-HR       24-HR       72-HR     58.80-HR
+   (FEET)      (HR)
   5546.35     26.40             5546.33     5546.25     5546.02      5546.02

                        CUMULATIVE AREA =    4.74 SQ MI

1
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                PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                  FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                TIME TO PEAK IN HOURS


                                                         RATIOS APPLIED TO PRECIPITATION
 OPERATION       STATION     AREA    PLAN           RATIO 1
                                                       1.00

 HYDROGRAPH AT
+                  B1          .50     1   FLOW         11.
                                           TIME       10.80

 ROUTED TO
+                  RB1         .50     1   FLOW         10.
                                           TIME       12.00

 HYDROGRAPH AT
+                  B2          .44     1   FLOW         10.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B3          .28     1   FLOW          5.
                                           TIME       10.80

  3 COMBINED AT
+                  C1         1.22     1   FLOW         23.
                                           TIME       10.80

 ROUTED TO
+                  RC1        1.22     1   FLOW         21.
                                           TIME       12.00

 HYDROGRAPH AT
+                  B4          .45     1   FLOW         11.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B5          .81     1   FLOW         21.
                                           TIME       10.80

  3 COMBINED AT
+                  C2         2.48     1   FLOW         50.
                                           TIME       10.80

 ROUTED TO
+                  RC2        2.48     1   FLOW         48.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B6          .15     1   FLOW         11.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B7          .33     1   FLOW         11.
                                           TIME       10.80

  3 COMBINED AT
+                  C3         2.95     1   FLOW         69.
                                           TIME       10.80

 ROUTED TO
+                  RC3        2.95     1   FLOW         63.
                                           TIME       12.00

 HYDROGRAPH AT
+                  B8         1.01     1   FLOW         70.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B9          .24     1   FLOW         19.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B10         .13     1   FLOW         11.
                                           TIME       10.80

  2 COMBINED AT
+                  C4          .37     1   FLOW         30.
                                           TIME       10.80

 ROUTED TO
+                  RC4         .37     1   FLOW         29.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B11         .28     1   FLOW         21.
                                           TIME       10.80

  4 COMBINED AT
+                  C5         4.61     1   FLOW        168.
                                           TIME       10.80
```

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 HYDROGRAPH AT
+                  B12         .13     1   FLOW            7.
                                           TIME        10.80

  2 COMBINED AT
+                  Call       4.74     1   FLOW          175.
                                           TIME        10.80

 ROUTED TO
+                  Cove       4.74     1   FLOW           22.
                                           TIME        26.40

                                       ** PEAK STAGES IN FEET **
                                       1   STAGE     5546.35
                                           TIME        26.40
1
                                           SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                                               (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                                   INTERPOLATED TO
                                                                                COMPUTATION INTERVAL
            ISTAQ    ELEMENT      DT       PEAK    TIME TO     VOLUME      DT       PEAK    TIME TO     VOLUME
                                                     PEAK                                     PEAK

                                 (MIN)     (CFS)      (MIN)     (IN)     (MIN)     (CFS)     (MIN)       (IN)

           FOR PLAN = 1  RATIO=  .00
              RB1    MANE         7.20     11.31    676.80       .32     72.00      9.54    720.00         .32


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .8557E+01 EXCESS= .0000E+00 OUTFLOW= .8560E+01 BASIN STORAGE= .3508E-02 PERCENT ERROR=   -.1


           FOR PLAN = 1  RATIO=  .00
              RC1    MANE         7.20     23.21    676.80       .30     72.00     21.22    720.00         .31


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1977E+02 EXCESS= .0000E+00 OUTFLOW= .1977E+02 BASIN STORAGE= .3640E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC2    MANE         7.20     50.33    655.20       .33     72.00     47.70    648.00         .33


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .4326E+02 EXCESS= .0000E+00 OUTFLOW= .4326E+02 BASIN STORAGE= .2914E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC3    MANE        10.80     69.04    691.20       .36     72.00     63.27    720.00         .36


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .5668E+02 EXCESS= .0000E+00 OUTFLOW= .5670E+02 BASIN STORAGE= .9084E-02 PERCENT ERROR=   -.1


           FOR PLAN = 1  RATIO=  .00
              RC4    MANE        14.08     29.35    633.76       .85     72.00     29.23    648.00         .86


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1687E+02 EXCESS= .0000E+00 OUTFLOW= .1688E+02 BASIN STORAGE= .2335E-02 PERCENT ERROR=    .0

1                                  SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION    Cove
                              (PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED  DURING BREACH FORMATION)


      PLAN  1 ..............                 INITIAL VALUE     SPILLWAY CREST     TOP OF DAM
                                 ELEVATION        5545.50           5549.20          5552.00
                                 STORAGE           5845.             6508.            7347.
                                 OUTFLOW              0.               45.             435.


                      RATIO     MAXIMUM      MAXIMUM    MAXIMUM    MAXIMUM    DURATION     TIME OF     TIME OF
                        OF     RESERVOIR      DEPTH     STORAGE    OUTFLOW    OVER TOP   MAX OUTFLOW   FAILURE
                       PMF      W.S.ELEV    OVER DAM     AC-FT       CFS       HOURS        HOURS       HOURS

                      1.00      5546.35         .00       5948.        22.       .00        26.40         .00


 *** NORMAL END OF HEC-1 ***
```

Storm Event 3. 10-year, 24-hour

```
1*****************************************                                                   ***************************************
 *                                       *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
 *               JUN   1998              *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
 *            VERSION 4.1                *                                                   *          609 SECOND STREET          *
 *                                       *                                                   *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:52:08   *                                                   *           (916) 756-1104            *
 *                                       *                                                   *                                     *
 *****************************************                                                   ***************************************




                                                 X     X  XXXXXXX   XXXXX           X
                                                 X     X  X        X     X         XX
                                                 X     X  X        X                X
                                                 XXXXXXX  XXXX     X        XXXXX   X
                                                 X     X  X        X                X
                                                 X     X  X        X     X          X
                                                 X     X  XXXXXXX   XXXXX          XXX




            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                                       HEC-1 INPUT                                                     PAGE  1

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              1           ID   HYDROLOGY STUDY for COVE RESERVOIR
              2           ID   Located in KANE COUNTY, UTAH
              3           ID
              4           ID   AUG 2020
              5           ID
              6           ID   PREPARED BY ALPHA ENGINEERING
              7           ID   43 SOUTH 100 EAST, SUITE 100
              8           ID   ST. GEORGE, UTAH  84770
              9           ID   TEL: (435) 628-6500
             10           ID   FAX: (435) 628-6553
             11           ID
             12           ID   10-YR, 24-HR, AMC II
             13           ID
                          *Diagram
             14           JR    PREC     1.0
             15           IT      72       0       0      50
             16           IO       0
             17           IN      72
                          *

             18           KK   B1
             19           KM   Runoff from Basin 1
             20           BA   0.503
             21           PB    2.34
             22           PC       0   0.020   0.046   0.070   0.095   0.130   0.180   0.300   0.520   0.650
             23           PC   0.700   0.745   0.785   0.820   0.850   0.880   0.905   0.930   0.955   0.980
             24           PC   1.000
             25           LS       0    72.8
             26           UD    0.51
                          *

             27           KK   RB1
             28           KM   Route B1
             29           RD    4928    .045    .050            TRAP      20      20
                          *

             30           KK   B2
             31           KM   Runoff from Basin 2
             32           BA   0.436
             33           LS       0    72.5
             34           UD    0.52
                          *

             35           KK   B3
             36           KM   Runoff from Basin 3
             37           BA   0.279
             38           LS       0    71.0
             39           UD    0.39
                          *
1                                                       HEC-1 INPUT                                                     PAGE  2

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10
```

```
             40           KK   C1
             41           KM   Combine RB1, B2, B3
             42           HC       3
                          *

             43           KK   RC1
             44           KM   Route RC1
             45           RD    7255    .060    .030            TRAP      20      20
                          *

             46           KK   B4
             47           KM   Runoff from Basin 4
             48           BA   0.453
             49           LS       0    73.3
             50           UD    0.48
                          *

             51           KK   B5
             52           KM   Runoff from Basin 5
             53           BA   0.805
             54           LS       0    74.1
             55           UD    0.63
                          *

             56           KK   C2
             57           KM   Combine RC1, B4, B5
             58           HC       3
                          *

             59           KK   RC2
             60           KM   Route C2
             61           RD    2380    .039    .030            TRAP      40       2
                          *

             62           KK   B6
             63           KM   Runoff from Basin 6
             64           BA   0.150
             65           LS       0    84.3
             66           UD    0.19
                          *

             67           KK   B7
             68           KM   Runoff from Basin 7
             69           BA   0.327
             70           LS       0    75.7
             71           UD    0.46
                          *

             72           KK   C3
             73           KM   Combine RC2, B6, B7
             74           HC       3
                          *
1                                                       HEC-1 INPUT                                             PAGE  3

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


             75           KK   RC3
             76           KM   Route C3
             77           RD   11323    .023    .030            TRAP      40      20
                          *

             78           KK   B8
             79           KM   Runoff from Basin 8
             80           BA   1.012
             81           LS       0    84.0
             82           UD    0.67
                          *

             83           KK   B9
             84           KM   Runoff from Basin 9
             85           BA   0.242
             86           LS       0    85.5
             87           UD    0.26
                          *

             88           KK   B10
             89           KM   Runoff from Basin 10
             90           BA   0.129
             91           LS       0    86.7
             92           UD    0.18
                          *

             93           KK   C4
             94           KM   Combine B9, B10
             95           HC       2
                          *

             96           KK   RC4
             97           KM   Route C4
             98           RD    3380    .037    .030            TRAP      40      20
                          *
```

```
             99           KK   B11
            100           KM   Runoff from Basin 11
            101           BA   0.279
            102           LS       0    84.8
            103           UD    0.39
                          *

            104           KK   C5
            105           KM   Combine RC3, B8, RC4, B11
            106           HC       4
                          *

            107           KK   B12
            108           KM   Runoff from Basin 12
            109           BA   0.127
            110           LS       0    81.2
            111           UD    0.40
                          *
1                                                       HEC-1 INPUT                                             PAGE  4

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


            112           KK   Call
            113           KM   Combine C5, B12
            114           HC       2
                          *

            115           KK   Cove Reservoir
            116           KM   Routing through Res'v
            117           RS       1    ELEV  5545.5
            118           SV       0      19      95     240     453     738    1105    1563    2217    2773
            119           SV    3542    4423    5419    6149    7347    8000
            120           SE    5470    5476    5482    5488    5494    5500    5506    5512    5518    5524
            121           SE    5530    5536    5542    5548    5552    5558
            122           SL  5545.5   4.909     0.6     0.5
            123           SS  5549.2      30    2.67     1.5
            124           ST  5552.0    1892     2.9     1.5
                          *
            125           ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    18       B1
                 V
                 V
    27       RB1
                 .
                 .
    30           .       B2
                 .           .
                 .           .
    35           .           .       B3
                 .           .           .
                 .           .           .
    40       C1   ........................
                 V
                 V
    43       RC1
                 .
                 .
    46           .       B4
                 .           .
                 .           .
    51           .           .       B5
                 .           .           .
                 .           .           .
    56       C2   ........................
                 V
                 V
    59       RC2
                 .
                 .
    62           .       B6
                 .           .
                 .           .
    67           .           .       B7
                 .           .           .
                 .           .           .
    72       C3   ........................
                 V
                 V
    75       RC3
                 .
                 .
    78           .       B8
                 .           .
```

```
                 .           .
    83           .           .       B9
                 .           .           .
                 .           .           .
    88           .           .           .       B10
                 .           .           .           .
                 .           .           .           .
    93           .           .       C4   ............
                 .           .           V
                 .           .           V
    96           .           .       RC4
                 .           .           .
                 .           .           .
    99           .           .           .       B11
                 .           .           .           .
                 .           .           .           .
   104       C5   ....................................
                 .
                 .
   107           .       B12
                 .           .
                 .           .
   112       Call ............
                 V
                 V
   115       Cove

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                                   ****************************************
 *                                       *                                                   *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS      *
 *               JUN   1998              *                                                   *    HYDROLOGIC ENGINEERING CENTER     *
 *            VERSION 4.1                *                                                   *          609 SECOND STREET          *
 *                                       *                                                   *       DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   06AUG20  TIME  02:52:08   *                                                   *           (916) 756-1104             *
 *                                       *                                                   *                                      *
 *****************************************                                                   ****************************************




                            HYDROLOGY STUDY for COVE RESERVOIR
                            Located in KANE COUNTY, UTAH

                            AUG 2020

                            PREPARED BY ALPHA ENGINEERING
                            43 SOUTH 100 EAST, SUITE 100
                            ST. GEORGE, UTAH  84770
                            TEL: (435) 628-6500
                            FAX: (435) 628-6553

                            10-YR, 24-HR, AMC II


   16 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           0  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN          72  MINUTES IN COMPUTATION INTERVAL
                        IDATE      1    0  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ          50  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE      3    0  ENDING DATE
                       NDTIME        1048  ENDING TIME
                       ICENT           19  CENTURY MARK

                    COMPUTATION INTERVAL    1.20 HOURS
                         TOTAL TIME BASE   58.80 HOURS

           ENGLISH UNITS
                DRAINAGE AREA         SQUARE MILES
                PRECIPITATION DEPTH   INCHES
                LENGTH, ELEVATION     FEET
                FLOW                  CUBIC FEET PER SECOND
                STORAGE VOLUME        ACRE-FEET
                SURFACE AREA          ACRES
                TEMPERATURE           DEGREES FAHRENHEIT

      JP          MULTI-PLAN OPTION
                        NPLAN           1  NUMBER OF PLANS

      JR          MULTI-RATIO OPTION
                      RATIOS OF PRECIPITATION
                     1.00


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
```

```
*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


           **************
           *            *
 112 KK    *     Call   *
           *            *
           **************
                          Combine C5, B12

 114 HC          HYDROGRAPH COMBINATION
                       ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                            ***

*********************************************************************************************************************************

                                                 HYDROGRAPH AT STATION    Call
                                                      SUM OF  2 HYDROGRAPHS
                                                     PLAN 1,   RATIO =  1.00

*********************************************************************************************************************************
                                 *                                *                                *
   DA MON HRMN  ORD      FLOW    *   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW
                                 *                                *                                *
    1     0000    1        0.    *    1     1536   14      120.   *    2     0712   27        0.   *    2     2248   40        0.
    1     0112    2        0.    *    1     1648   15      107.   *    2     0824   28        0.   *    3     0000   41        0.
    1     0224    3        0.    *    1     1800   16      102.   *    2     0936   29        0.   *    3     0112   42        0.
    1     0336    4        0.    *    1     1912   17       94.   *    2     1048   30        0.   *    3     0224   43        0.
    1     0448    5        0.    *    1     2024   18       89.   *    2     1200   31        0.   *    3     0336   44        0.
    1     0600    6        0.    *    1     2136   19       89.   *    2     1312   32        0.   *    3     0448   45        0.
    1     0712    7        1.    *    1     2248   20       89.   *    2     1424   33        0.   *    3     0600   46        0.
    1     0824    8       32.    *    2     0000   21       82.   *    2     1536   34        0.   *    3     0712   47        0.
    1     0936    9      165.    *    2     0112   22       46.   *    2     1648   35        0.   *    3     0824   48        0.
    1     1048   10      261.    *    2     0224   23       18.   *    2     1800   36        0.   *    3     0936   49        0.
    1     1200   11      201.    *    2     0336   24        7.   *    2     1912   37        0.   *    3     1048   50        0.
    1     1312   12      155.    *    2     0448   25        2.   *    2     2024   38        0.   *
    1     1424   13      133.    *    2     0600   26        1.   *    2     2136   39        0.   *
                                 *                                *                                *
*********************************************************************************************************************************

 PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                    6-HR       24-HR       72-HR     58.80-HR
+   (CFS)       (HR)
                            (CFS)
+     261.     10.80                179.         90.         37.         37.
                          (INCHES)      .350        .704        .705        .705
                           (AC-FT)       89.        178.        178.        178.

                           CUMULATIVE AREA =    4.74 SQ MI



*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


           **************
           *            *
 115 KK    *     Cove   *     Reservoir
           *            *
           **************
                          Routing through Res'v

              HYDROGRAPH ROUTING DATA

 117 RS          STORAGE ROUTING
                       NSTPS           1  NUMBER OF SUBREACHES
                        ITYP        ELEV  TYPE OF INITIAL CONDITION
                      RSVRIC     5545.50  INITIAL CONDITION
                           X         .00 WORKING R AND D COEFFICIENT

 118 SV            STORAGE          .0      19.0      95.0     240.0     453.0     738.0    1105.0    1563.0    2217.0    2773.0
                                3542.0    4423.0    5419.0    6149.0    7347.0    8000.0

 120 SE          ELEVATION     5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00
                               5530.00   5536.00   5542.00   5548.00   5552.00   5558.00

 122 SL          LOW-LEVEL OUTLET
                       ELEVL     5545.50  ELEVATION AT CENTER OF OUTLET
                       CAREA        4.91  CROSS-SECTIONAL AREA
                        COQL         .60  COEFFICIENT
                        EXPL         .50  EXPONENT OF HEAD

 123 SS          SPILLWAY
                        CREL     5549.20  SPILLWAY CREST ELEVATION
                       SPWID       30.00  SPILLWAY WIDTH
                        COQW        2.67  WEIR COEFFICIENT
                        EXPW        1.50  EXPONENT OF HEAD

 124 ST          TOP OF DAM
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                     TOPEL     5552.00  ELEVATION AT TOP OF DAM
                    DAMWID     1892.00  DAM WIDTH
                      COQD        2.90  WEIR COEFFICIENT
                      EXPD        1.50  EXPONENT OF HEAD

                                                                ***

                                                     COMPUTED OUTFLOW-ELEVATION DATA

                                                       (EXCLUDING FLOW OVER DAM)

            OUTFLOW        .00       .00     25.78     27.48     29.42     31.65     34.25     37.31     40.98     45.44
          ELEVATION    5470.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00   5548.51   5549.20

            OUTFLOW      49.37     68.29    113.97    198.20    332.85    529.64    800.37   1156.85   1610.93   2174.46
          ELEVATION    5549.32   5549.60   5550.06   5550.68   5551.48   5552.44   5553.58   5554.88   5556.36   5558.00


                                                 COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

                                                       (INCLUDING FLOW OVER DAM)

            STORAGE        .00     19.00     95.00    240.00    453.00    738.00   1105.00   1563.00   2217.00   2773.00
            OUTFLOW        .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
          ELEVATION    5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00

            STORAGE    3542.00   4423.00   5419.00   5844.83   5989.79   6009.51   6033.57   6063.27   6100.64   6148.41
            OUTFLOW        .00       .00       .00       .00     25.78     27.48     29.42     31.65     34.25     37.31
          ELEVATION    5530.00   5536.00   5542.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00

            STORAGE    6301.53   6508.46   6543.56   6628.96   6765.11   6952.15   7190.23   7347.00   7395.04   7518.54
            OUTFLOW      40.98     45.44     49.37     68.29    113.97    198.20    332.85    435.48   2138.72  11657.74
          ELEVATION    5548.51   5549.20   5549.32   5549.60   5550.06   5550.68   5551.48   5552.00   5552.44   5553.58

            STORAGE    7660.53   7821.02   8000.00
            OUTFLOW   27985.71  51484.63  82813.63
          ELEVATION    5554.88   5556.36   5558.00

 *********************************************************************************************************************************

                                                      HYDROGRAPH AT STATION    Cove
                                                          PLAN 1,   RATIO =  1.00

 *********************************************************************************************************************************
                                                *                                            *
  DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE
                                                *                                            *
   1     0000   1      0.   5844.8  5545.5 *  1     2024  18      24.   5968.3  5546.5 *  2     1648  35      23.   5964.1  5546.5
   1     0112   2      0.   5844.8  5545.5 *  1     2136  19      24.   5974.8  5546.6 *  2     1800  36      23.   5961.7  5546.5
   1     0224   3      0.   5844.8  5545.5 *  1     2248  20      25.   5981.1  5546.6 *  2     1912  37      23.   5959.5  5546.4
   1     0336   4      0.   5844.8  5545.5 *  2     0000  21      26.   5987.1  5546.7 *  2     2024  38      23.   5957.2  5546.4
   1     0448   5      0.   5844.8  5545.5 *  2     0112  22      26.   5990.9  5546.7 *  2     2136  39      22.   5955.0  5546.4
   1     0600   6      0.   5844.8  5545.5 *  2     0224  23      26.   5991.5  5546.7 *  2     2248  40      22.   5952.8  5546.4
   1     0712   7      1.   5844.9  5545.5 *  2     0336  24      26.   5990.2  5546.7 *  3     0000  41      22.   5950.6  5546.4
   1     0824   8      3.   5846.4  5545.5 *  2     0448  25      26.   5988.1  5546.7 *  3     0112  42      22.   5948.4  5546.4
   1     0936   9      7.   5855.7  5545.6 *  2     0600  26      25.   5985.7  5546.7 *  3     0224  43      22.   5946.2  5546.3
   1     1048  10     12.   5876.0  5545.8 *  2     0712  27      25.   5983.3  5546.6 *  3     0336  44      21.   5944.1  5546.3
   1     1200  11     16.   5897.5  5545.9 *  2     0824  28      25.   5980.8  5546.6 *  3     0448  45      21.   5942.0  5546.3
   1     1312  12     18.   5913.6  5546.1 *  2     0936  29      25.   5978.4  5546.6 *  3     0600  46      21.   5939.9  5546.3
   1     1424  13     19.   5926.0  5546.2 *  2     1048  30      25.   5975.9  5546.6 *  3     0712  47      21.   5937.9  5546.3
   1     1536  14     21.   5936.6  5546.3 *  2     1200  31      24.   5973.5  5546.6 *  3     0824  48      20.   5935.8  5546.2
   1     1648  15     22.   5945.8  5546.3 *  2     1312  32      24.   5971.1  5546.5 *  3     0936  49      20.   5933.8  5546.2
   1     1800  16     22.   5954.1  5546.4 *  2     1424  33      24.   5968.8  5546.5 *  3     1048  50      20.   5931.8  5546.2
   1     1912  17     23.   5961.6  5546.5 *  2     1536  34      24.   5966.4  5546.5 *
                                                *                                            *
 *********************************************************************************************************************************

 PEAK OUTFLOW IS       26. AT TIME  26.40 HOURS


  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     58.80-HR
+   (CFS)       (HR)
                          (CFS)
+      26.     26.40                  26.         25.         19.          19.
                       (INCHES)      .050        .193        .362         .362
                        (AC-FT)       13.         49.         91.          91.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR     58.80-HR
+  (AC-FT)      (HR)
     5992.     26.40                5989.       5977.       5938.        5938.

  PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR     58.80-HR
+   (FEET)      (HR)
   5546.71     26.40             5546.69     5546.59     5546.27      5546.27

                        CUMULATIVE AREA =    4.74 SQ MI

1
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                PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                  FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                  TIME TO PEAK IN HOURS


                                                           RATIOS APPLIED TO PRECIPITATION
 OPERATION       STATION     AREA    PLAN           RATIO 1
                                                        1.00

 HYDROGRAPH AT
+                  B1          .50     1   FLOW          19.
                                           TIME        10.80

 ROUTED TO
+                  RB1         .50     1   FLOW          16.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B2          .44     1   FLOW          16.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B3          .28     1   FLOW           9.
                                           TIME        10.80

  3 COMBINED AT
+                  C1         1.22     1   FLOW          41.
                                           TIME        10.80

 ROUTED TO
+                  RC1        1.22     1   FLOW          35.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B4          .45     1   FLOW          18.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B5          .81     1   FLOW          34.
                                           TIME        10.80

  3 COMBINED AT
+                  C2         2.48     1   FLOW          88.
                                           TIME        10.80

 ROUTED TO
+                  RC2        2.48     1   FLOW          84.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B6          .15     1   FLOW          14.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B7          .33     1   FLOW          16.
                                           TIME        10.80

  3 COMBINED AT
+                  C3         2.95     1   FLOW         115.
                                           TIME        10.80

 ROUTED TO
+                  RC3        2.95     1   FLOW          99.
                                           TIME        12.00

 HYDROGRAPH AT
+                  B8         1.01     1   FLOW          94.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B9          .24     1   FLOW          25.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B10         .13     1   FLOW          14.
                                           TIME         9.60

  2 COMBINED AT
+                  C4          .37     1   FLOW          39.
                                           TIME        10.80

 ROUTED TO
+                  RC4         .37     1   FLOW          39.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B11         .28     1   FLOW          27.
                                           TIME        10.80

  4 COMBINED AT
+                  C5         4.61     1   FLOW         251.
                                           TIME        10.80
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 HYDROGRAPH AT
+                  B12         .13     1   FLOW          10.
                                           TIME        10.80

  2 COMBINED AT
+                  Call       4.74     1   FLOW         261.
                                           TIME        10.80

 ROUTED TO
+                  Cove       4.74     1   FLOW          26.
                                           TIME        26.40

                                       ** PEAK STAGES IN FEET **
                                       1   STAGE     5546.71
                                           TIME        26.40
1
                                           SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                                               (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                                   INTERPOLATED TO
                                                                                COMPUTATION INTERVAL
            ISTAQ    ELEMENT      DT       PEAK    TIME TO     VOLUME      DT       PEAK    TIME TO     VOLUME
                                                     PEAK                                     PEAK

                                 (MIN)     (CFS)      (MIN)     (IN)     (MIN)     (CFS)     (MIN)       (IN)

           FOR PLAN = 1  RATIO=  .00
              RB1    MANE         7.20     18.90    676.80       .48     72.00     16.14    648.00         .48


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1277E+02 EXCESS= .0000E+00 OUTFLOW= .1278E+02 BASIN STORAGE= .3345E-02 PERCENT ERROR=   -.1


           FOR PLAN = 1  RATIO=  .00
              RC1    MANE         7.20     40.76    669.60       .46     72.00     35.00    648.00         .46


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .2976E+02 EXCESS= .0000E+00 OUTFLOW= .2977E+02 BASIN STORAGE= .3635E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC2    MANE         6.10     86.70    652.57       .49     72.00     84.43    648.00         .49


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .6439E+02 EXCESS= .0000E+00 OUTFLOW= .6439E+02 BASIN STORAGE= .3086E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC3    MANE        14.40    113.78    691.20       .53     72.00     99.11    720.00         .52


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .8293E+02 EXCESS= .0000E+00 OUTFLOW= .8298E+02 BASIN STORAGE= .8804E-02 PERCENT ERROR=   -.1


           FOR PLAN = 1  RATIO=  .00
              RC4    MANE        13.06     39.45    600.61      1.11     72.00     38.67    648.00        1.11


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .2195E+02 EXCESS= .0000E+00 OUTFLOW= .2195E+02 BASIN STORAGE= .2242E-02 PERCENT ERROR=    .0


1                                  SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION    Cove
                              (PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED  DURING BREACH FORMATION)


      PLAN  1 ..............                 INITIAL VALUE     SPILLWAY CREST     TOP OF DAM
                                 ELEVATION        5545.50            5549.20          5552.00
                                 STORAGE            5845.              6508.            7347.
                                 OUTFLOW               0.                45.             435.


                      RATIO     MAXIMUM      MAXIMUM    MAXIMUM    MAXIMUM    DURATION     TIME OF     TIME OF
                        OF     RESERVOIR      DEPTH     STORAGE    OUTFLOW    OVER TOP   MAX OUTFLOW   FAILURE
                       PMF      W.S.ELEV    OVER DAM     AC-FT       CFS       HOURS        HOURS       HOURS

                      1.00      5546.71         .00       5992.        26.       .00        26.40         .00


 *** NORMAL END OF HEC-1 ***
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Storm Event 4. 25-year, 24-hour

```
1*****************************************                                                   ***************************************
 *                                       *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998               *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1                 *                                                   *          609 SECOND STREET          *
 *                                       *                                                   *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:52:36   *                                                   *           (916) 756-1104            *
 *                                       *                                                   *                                     *
 *****************************************                                                   ***************************************




                                                 X     X  XXXXXXX   XXXXX           X
                                                 X     X  X         X     X        XX
                                                 X     X  X         X               X
                                                 XXXXXXX  XXXX      X        XXXXX  X
                                                 X     X  X         X               X
                                                 X     X  X         X     X         X
                                                 X     X  XXXXXXX   XXXXX          XXX




            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                                      HEC-1 INPUT                                             PAGE  1

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              1           ID   HYDROLOGY STUDY for COVE RESERVOIR
              2           ID   Located in KANE COUNTY, UTAH
              3           ID
              4           ID   AUG 2020
              5           ID
              6           ID   PREPARED BY ALPHA ENGINEERING
              7           ID   43 SOUTH 100 EAST, SUITE 100
              8           ID   ST. GEORGE, UTAH  84770
              9           ID   TEL: (435) 628-6500
             10           ID   FAX: (435) 628-6553
             11           ID
             12           ID   25-YR, 24-HR, AMC II
             13           ID
                          *Diagram
             14           JR    PREC     1.0
             15           IT      72       0       0      50
             16           IO       0
             17           IN      72
                          *

             18           KK   B1
             19           KM   Runoff from Basin 1
             20           BA   0.503
             21           PB    2.79
             22           PC       0   0.020   0.046   0.070   0.095   0.130   0.180   0.300   0.520   0.650
             23           PC   0.700   0.745   0.785   0.820   0.850   0.880   0.905   0.930   0.955   0.980
             24           PC   1.000
             25           LS       0    72.8
             26           UD    0.51
                          *

             27           KK   RB1
             28           KM   Route B1
             29           RD    4928    .045    .050            TRAP      20      20
                          *

             30           KK   B2
             31           KM   Runoff from Basin 2
             32           BA   0.436
             33           LS       0    72.5
             34           UD    0.52
                          *

             35           KK   B3
             36           KM   Runoff from Basin 3
             37           BA   0.279
             38           LS       0    71.0
             39           UD    0.39
                          *
1                                                      HEC-1 INPUT                                             PAGE  2

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10
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```
             40           KK   C1
             41           KM   Combine RB1, B2, B3
             42           HC       3
                          *

             43           KK   RC1
             44           KM   Route RC1
             45           RD    7255    .060    .030            TRAP      20      20
                          *

             46           KK   B4
             47           KM   Runoff from Basin 4
             48           BA   0.453
             49           LS       0    73.3
             50           UD    0.48
                          *

             51           KK   B5
             52           KM   Runoff from Basin 5
             53           BA   0.805
             54           LS       0    74.1
             55           UD    0.63
                          *

             56           KK   C2
             57           KM   Combine RC1, B4, B5
             58           HC       3
                          *

             59           KK   RC2
             60           KM   Route C2
             61           RD    2380    .039    .030            TRAP      40       2
                          *

             62           KK   B6
             63           KM   Runoff from Basin 6
             64           BA   0.150
             65           LS       0    84.3
             66           UD    0.19
                          *

             67           KK   B7
             68           KM   Runoff from Basin 7
             69           BA   0.327
             70           LS       0    75.7
             71           UD    0.46
                          *

             72           KK   C3
             73           KM   Combine RC2, B6, B7
             74           HC       3
                          *
1                                                      HEC-1 INPUT                                             PAGE  3

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


             75           KK   RC3
             76           KM   Route C3
             77           RD   11323    .023    .030            TRAP      40      20
                          *

             78           KK   B8
             79           KM   Runoff from Basin 8
             80           BA   1.012
             81           LS       0    84.0
             82           UD    0.67
                          *

             83           KK   B9
             84           KM   Runoff from Basin 9
             85           BA   0.242
             86           LS       0    85.5
             87           UD    0.26
                          *

             88           KK   B10
             89           KM   Runoff from Basin 10
             90           BA   0.129
             91           LS       0    86.7
             92           UD    0.18
                          *

             93           KK   C4
             94           KM   Combine B9, B10
             95           HC       2
                          *

             96           KK   RC4
             97           KM   Route C4
             98           RD    3380    .037    .030            TRAP      40      20
                          *
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             99           KK   B11
            100           KM   Runoff from Basin 11
            101           BA   0.279
            102           LS       0    84.8
            103           UD    0.39
                          *

            104           KK   C5
            105           KM   Combine RC3, B8, RC4, B11
            106           HC       4
                          *

            107           KK   B12
            108           KM   Runoff from Basin 12
            109           BA   0.127
            110           LS       0    81.2
            111           UD    0.40
                          *
1                                                       HEC-1 INPUT                                             PAGE  4

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


            112           KK   Call
            113           KM   Combine C5, B12
            114           HC       2
                          *

            115           KK   Cove Reservoir
            116           KM   Routing through Res'v
            117           RS       1    ELEV  5545.5
            118           SV       0      19      95     240     453     738    1105    1563    2217    2773
            119           SV    3542    4423    5419    6149    7347    8000
            120           SE    5470    5476    5482    5488    5494    5500    5506    5512    5518    5524
            121           SE    5530    5536    5542    5548    5552    5558
            122           SL  5545.5   4.909     0.6     0.5
            123           SS  5549.2      30    2.67     1.5
            124           ST  5552.0    1892     2.9     1.5
                          *
            125           ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW

    18       B1
                 V
                 V
    27       RB1
                 .
                 .
    30           .       B2
                 .           .
                 .           .
    35           .           .       B3
                 .           .           .
                 .           .           .
    40       C1   ........................
                 V
                 V
    43       RC1
                 .
                 .
    46           .       B4
                 .           .
                 .           .
    51           .           .       B5
                 .           .           .
                 .           .           .
    56       C2   ........................
                 V
                 V
    59       RC2
                 .
                 .
    62           .       B6
                 .           .
                 .           .
    67           .           .       B7
                 .           .           .
                 .           .           .
    72       C3   ........................
                 V
                 V
    75       RC3
                 .
                 .
    78           .       B8
                 .           .
```

```
                 .           .
    83           .           .       B9
                 .           .           .
                 .           .           .
    88           .           .           .       B10
                 .           .           .           .
                 .           .           .           .
    93           .           .       C4   ............
                 .           .           V
                 .           .           V
    96           .           .       RC4
                 .           .           .
                 .           .           .
    99           .           .           .       B11
                 .           .           .           .
                 .           .           .           .
   104       C5   ....................................
                 .
                 .
   107           .       B12
                 .           .
                 .           .
   112       Call ............
                 V
                 V
   115       Cove

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                                   ***************************************
 *                                        *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998                *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1                  *                                                   *          609 SECOND STREET          *
 *                                        *                                                   *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:52:36    *                                                   *           (916) 756-1104            *
 *                                        *                                                   *                                     *
 ******************************************                                                   ***************************************




                            HYDROLOGY STUDY for COVE RESERVOIR
                            Located in KANE COUNTY, UTAH

                            AUG 2020

                            PREPARED BY ALPHA ENGINEERING
                            43 SOUTH 100 EAST, SUITE 100
                            ST. GEORGE, UTAH  84770
                            TEL: (435) 628-6500
                            FAX: (435) 628-6553

                            25-YR, 24-HR, AMC II


   16 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           0  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN          72  MINUTES IN COMPUTATION INTERVAL
                        IDATE      1    0  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ          50  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE      3    0  ENDING DATE
                       NDTIME        1048  ENDING TIME
                       ICENT           19  CENTURY MARK

                    COMPUTATION INTERVAL    1.20 HOURS
                         TOTAL TIME BASE   58.80 HOURS

           ENGLISH UNITS
                DRAINAGE AREA         SQUARE MILES
                PRECIPITATION DEPTH   INCHES
                LENGTH, ELEVATION     FEET
                FLOW                  CUBIC FEET PER SECOND
                STORAGE VOLUME        ACRE-FEET
                SURFACE AREA          ACRES
                TEMPERATURE           DEGREES FAHRENHEIT

      JP          MULTI-PLAN OPTION
                        NPLAN           1  NUMBER OF PLANS

      JR          MULTI-RATIO OPTION
                      RATIOS OF PRECIPITATION
                     1.00


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
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 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** 


            **************
            *            *
  112 KK    *     Call   *
            *            *
            **************
                           Combine C5, B12

  114 HC          HYDROGRAPH COMBINATION
                        ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                ***

 *********************************************************************************************************************************

                                                     HYDROGRAPH AT STATION    Call
                                                          SUM OF  2 HYDROGRAPHS
                                                         PLAN 1,   RATIO =  1.00

 *********************************************************************************************************************************
                                 *                                *                                *
    DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW
                                 *                                *                                *
     1     0000    1        0.   *    1     1536   14      162.   *    2     0712   27        0.   *    2     2248   40        0.
     1     0112    2        0.   *    1     1648   15      144.   *    2     0824   28        0.   *    3     0000   41        0.
     1     0224    3        0.   *    1     1800   16      137.   *    2     0936   29        0.   *    3     0112   42        0.
     1     0336    4        0.   *    1     1912   17      125.   *    2     1048   30        0.   *    3     0224   43        0.
     1     0448    5        0.   *    1     2024   18      119.   *    2     1200   31        0.   *    3     0336   44        0.
     1     0600    6        0.   *    1     2136   19      117.   *    2     1312   32        0.   *    3     0448   45        0.
     1     0712    7        6.   *    1     2248   20      118.   *    2     1424   33        0.   *    3     0600   46        0.
     1     0824    8       59.   *    2     0000   21      108.   *    2     1536   34        0.   *    3     0712   47        0.
     1     0936    9      288.   *    2     0112   22       59.   *    2     1648   35        0.   *    3     0824   48        0.
     1     1048   10      396.   *    2     0224   23       23.   *    2     1800   36        0.   *    3     0936   49        0.
     1     1200   11      290.   *    2     0336   24        9.   *    2     1912   37        0.   *    3     1048   50        0.
     1     1312   12      216.   *    2     0448   25        3.   *    2     2024   38        0.   *
     1     1424   13      183.   *    2     0600   26        1.   *    2     2136   39        0.   *
                                 *                                *                                *
 *********************************************************************************************************************************

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     58.80-HR
+   (CFS)       (HR)
                          (CFS)
+     396.     10.80                 262.        128.         52.          52.
                        (INCHES)      .514       1.005       1.005        1.005
                         (AC-FT)      130.        254.        254.         254.

                         CUMULATIVE AREA =    4.74 SQ MI



 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** 


            **************
            *            *
  115 KK    *     Cove   *     Reservoir
            *            *
            **************
                           Routing through Res'v

               HYDROGRAPH ROUTING DATA

  117 RS          STORAGE ROUTING
                        NSTPS           1  NUMBER OF SUBREACHES
                         ITYP        ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC     5545.50  INITIAL CONDITION
                            X         .00 WORKING R AND D COEFFICIENT

  118 SV            STORAGE          .0      19.0      95.0     240.0     453.0     738.0    1105.0    1563.0    2217.0    2773.0
                              3542.0    4423.0    5419.0    6149.0    7347.0    8000.0

  120 SE          ELEVATION     5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00
                             5530.00   5536.00   5542.00   5548.00   5552.00   5558.00

  122 SL          LOW-LEVEL OUTLET
                        ELEVL     5545.50  ELEVATION AT CENTER OF OUTLET
                        CAREA        4.91  CROSS-SECTIONAL AREA
                         COQL         .60  COEFFICIENT
                         EXPL         .50  EXPONENT OF HEAD

  123 SS          SPILLWAY
                         CREL     5549.20  SPILLWAY CREST ELEVATION
                        SPWID       30.00  SPILLWAY WIDTH
                         COQW        2.67  WEIR COEFFICIENT
                         EXPW        1.50  EXPONENT OF HEAD

  124 ST          TOP OF DAM
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                        TOPEL     5552.00  ELEVATION AT TOP OF DAM
                       DAMWID     1892.00  DAM WIDTH
                         COQD        2.90  WEIR COEFFICIENT
                         EXPD        1.50  EXPONENT OF HEAD

                                                                 ***

                                                  COMPUTED OUTFLOW-ELEVATION DATA

                                                    (EXCLUDING FLOW OVER DAM)

             OUTFLOW        .00       .00     25.78     27.48     29.42     31.65     34.25     37.31     40.98     45.44
           ELEVATION    5470.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00   5548.51   5549.20

             OUTFLOW      49.37     68.29    113.97    198.20    332.85    529.64    800.37   1156.85   1610.93   2174.46
           ELEVATION    5549.32   5549.60   5550.06   5550.68   5551.48   5552.44   5553.58   5554.88   5556.36   5558.00


                                              COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

                                                    (INCLUDING FLOW OVER DAM)

             STORAGE        .00     19.00     95.00    240.00    453.00    738.00   1105.00   1563.00   2217.00   2773.00
             OUTFLOW        .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
           ELEVATION    5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00

             STORAGE    3542.00   4423.00   5419.00   5844.83   5989.79   6009.51   6033.57   6063.27   6100.64   6148.41
             OUTFLOW        .00       .00       .00       .00     25.78     27.48     29.42     31.65     34.25     37.31
           ELEVATION    5530.00   5536.00   5542.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00

             STORAGE    6301.53   6508.46   6543.56   6628.96   6765.11   6952.15   7190.23   7347.00   7395.04   7518.54
             OUTFLOW      40.98     45.44     49.37     68.29    113.97    198.20    332.85    435.48   2138.72  11657.74
           ELEVATION    5548.51   5549.20   5549.32   5549.60   5550.06   5550.68   5551.48   5552.00   5552.44   5553.58

             STORAGE    7660.53   7821.02   8000.00
             OUTFLOW   27985.71  51484.63  82813.63
           ELEVATION    5554.88   5556.36   5558.00

 ***********************************************************************************************************************************

                                                   HYDROGRAPH AT STATION    Cove
                                                       PLAN 1,   RATIO =  1.00

 ***********************************************************************************************************************************
                                            *                                           *
  DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE
                                            *                                           *
   1     0000   1       0.   5844.8  5545.5 *  1     2024  18      29.   6028.3  5547.0 *  2     1648  35      29.   6026.4  5547.0
   1     0112   2       0.   5844.8  5545.5 *  1     2136  19      30.   6037.1  5547.1 *  2     1800  36      29.   6023.5  5547.0
   1     0224   3       0.   5844.8  5545.5 *  1     2248  20      30.   6045.7  5547.2 *  2     1912  37      28.   6020.7  5546.9
   1     0336   4       0.   5844.8  5545.5 *  2     0000  21      31.   6053.9  5547.2 *  2     2024  38      28.   6017.9  5546.9
   1     0448   5       0.   5844.8  5545.5 *  2     0112  22      31.   6059.1  5547.3 *  2     2136  39      28.   6015.1  5546.9
   1     0600   6       0.   5844.8  5545.5 *  2     0224  23      31.   6060.1  5547.3 *  2     2248  40      28.   6012.4  5546.9
   1     0712   7       1.   5845.1  5545.5 *  2     0336  24      31.   6058.5  5547.3 *  3     0000  41      27.   6009.6  5546.9
   1     0824   8       4.   5848.0  5545.5 *  2     0448  25      31.   6056.0  5547.2 *  3     0112  42      27.   6006.9  5546.8
   1     0936   9      10.   5864.6  5545.7 *  2     0600  26      31.   6053.1  5547.2 *  3     0224  43      27.   6004.2  5546.8
   1     1048  10      16.   5897.3  5545.9 *  2     0712  27      31.   6050.0  5547.2 *  3     0336  44      27.   6001.6  5546.8
   1     1200  11      20.   5929.6  5546.2 *  2     0824  28      30.   6047.0  5547.2 *  3     0448  45      27.   5998.9  5546.8
   1     1312  12      22.   5952.7  5546.4 *  2     0936  29      30.   6044.0  5547.1 *  3     0600  46      26.   5996.3  5546.7
   1     1424  13      24.   5970.2  5546.5 *  2     1048  30      30.   6041.0  5547.1 *  3     0712  47      26.   5993.6  5546.7
   1     1536  14      25.   5984.9  5546.7 *  2     1200  31      30.   6038.0  5547.1 *  3     0824  48      26.   5991.1  5546.7
   1     1648  15      26.   5997.5  5546.8 *  2     1312  32      30.   6035.1  5547.1 *  3     0936  49      26.   5988.5  5546.7
   1     1800  16      27.   6008.8  5546.8 *  2     1424  33      29.   6032.1  5547.0 *  3     1048  50      25.   5986.0  5546.7
   1     1912  17      28.   6019.0  5546.9 *  2     1536  34      29.   6029.2  5547.0 *
                                            *                                           *
 ***********************************************************************************************************************************

 PEAK OUTFLOW IS       31. AT TIME  26.40 HOURS


  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     58.80-HR
+   (CFS)       (HR)
                           (CFS)
+      31.     26.40                   31.         30.         23.          23.
                        (INCHES)      .061        .236        .447         .447
                         (AC-FT)       15.         60.        113.         113.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     58.80-HR
+  (AC-FT)      (HR)
     6060.     26.40                 6057.       6042.       5986.        5986.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     58.80-HR
+   (FEET)      (HR)
   5547.27     26.40               5547.25     5547.12     5546.66      5546.66

                         CUMULATIVE AREA =    4.74 SQ MI

1
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               PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                 FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                TIME TO PEAK IN HOURS


                                                          RATIOS APPLIED TO PRECIPITATION
 OPERATION       STATION     AREA    PLAN           RATIO 1
                                                       1.00

 HYDROGRAPH AT
+                  B1          .50     1   FLOW          31.
                                           TIME       10.80

 ROUTED TO
+                  RB1         .50     1   FLOW          29.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B2          .44     1   FLOW          27.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B3          .28     1   FLOW          15.
                                           TIME       10.80

  3 COMBINED AT
+                  C1         1.22     1   FLOW          70.
                                           TIME       10.80

 ROUTED TO
+                  RC1        1.22     1   FLOW          64.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B4          .45     1   FLOW          29.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B5          .81     1   FLOW          55.
                                           TIME       10.80

  3 COMBINED AT
+                  C2         2.48     1   FLOW         148.
                                           TIME       10.80

 ROUTED TO
+                  RC2        2.48     1   FLOW         145.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B6          .15     1   FLOW          20.
                                           TIME        9.60

 HYDROGRAPH AT
+                  B7          .33     1   FLOW          25.
                                           TIME       10.80

  3 COMBINED AT
+                  C3         2.95     1   FLOW         190.
                                           TIME       10.80

 ROUTED TO
+                  RC3        2.95     1   FLOW         166.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B8         1.01     1   FLOW         128.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B9          .24     1   FLOW          34.
                                           TIME        9.60

 HYDROGRAPH AT
+                  B10         .13     1   FLOW          20.
                                           TIME        9.60

  2 COMBINED AT
+                  C4          .37     1   FLOW          54.
                                           TIME        9.60

 ROUTED TO
+                  RC4         .37     1   FLOW          52.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B11         .28     1   FLOW          38.
                                           TIME        9.60

  4 COMBINED AT
+                  C5         4.61     1   FLOW         383.
                                           TIME       10.80
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 HYDROGRAPH AT
+                  B12         .13     1   FLOW          14.
                                           TIME        10.80

  2 COMBINED AT
+                  Call       4.74     1   FLOW         396.
                                           TIME        10.80

 ROUTED TO
+                  Cove       4.74     1   FLOW          31.
                                           TIME        26.40

                                       ** PEAK STAGES IN FEET **
                                       1   STAGE     5547.27
                                           TIME        26.40
1
                                           SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                                               (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                                   INTERPOLATED TO
                                                                                COMPUTATION INTERVAL
            ISTAQ    ELEMENT      DT       PEAK    TIME TO     VOLUME      DT       PEAK    TIME TO     VOLUME
                                                     PEAK                                     PEAK

                                 (MIN)     (CFS)      (MIN)     (IN)     (MIN)     (CFS)     (MIN)       (IN)

           FOR PLAN = 1  RATIO=  .00
              RB1    MANE        10.80     30.91    669.60       .72     72.00     28.63    648.00         .73


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1937E+02 EXCESS= .0000E+00 OUTFLOW= .1938E+02 BASIN STORAGE= .4507E-02 PERCENT ERROR=   -.1


           FOR PLAN = 1  RATIO=  .00
              RC1    MANE        10.80     69.48    669.60       .70     72.00     64.10    648.00         .71


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .4557E+02 EXCESS= .0000E+00 OUTFLOW= .4558E+02 BASIN STORAGE= .4033E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC2    MANE         5.04    146.95    655.56       .74     72.00    145.12    648.00         .74


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .9743E+02 EXCESS= .0000E+00 OUTFLOW= .9744E+02 BASIN STORAGE= .3141E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC3    MANE        14.40    187.14    676.80       .79     72.00    165.61    648.00         .78


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1237E+03 EXCESS= .0000E+00 OUTFLOW= .1237E+03 BASIN STORAGE= .1170E-01 PERCENT ERROR=   -.1


           FOR PLAN = 1  RATIO=  .00
              RC4    MANE        11.89     54.51    594.33      1.48     72.00     52.02    648.00        1.48


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .2925E+02 EXCESS= .0000E+00 OUTFLOW= .2926E+02 BASIN STORAGE= .2520E-02 PERCENT ERROR=    .0


1                                  SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION    Cove
                              (PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED  DURING BREACH FORMATION)


      PLAN  1 ...............                  INITIAL VALUE     SPILLWAY CREST     TOP OF DAM
                                 ELEVATION        5545.50            5549.20          5552.00
                                 STORAGE            5845.              6508.            7347.
                                 OUTFLOW               0.                45.             435.


                      RATIO     MAXIMUM      MAXIMUM    MAXIMUM    MAXIMUM    DURATION     TIME OF     TIME OF
                        OF     RESERVOIR      DEPTH     STORAGE    OUTFLOW    OVER TOP   MAX OUTFLOW   FAILURE
                       PMF      W.S.ELEV    OVER DAM     AC-FT       CFS      HOURS          HOURS       HOURS

                      1.00      5547.27         .00       6060.        31.       .00        26.40         .00


 *** NORMAL END OF HEC-1 ***
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Storm Event 5. 50-year, 24-hour

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1***************************************                                                  ***************************************
 *                                      *                                                 *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                                 *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998              *                                                 *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1                *                                                 *          609 SECOND STREET          *
 *                                      *                                                 *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:53:04  *                                                 *           (916) 756-1104            *
 *                                      *                                                 *                                     *
 ***************************************                                                  ***************************************



                                                             X     X  XXXXXXX   XXXXX           X
                                                             X     X  X        X     X         XX
                                                             X     X  X        X                X
                                                             XXXXXXX  XXXX     X       XXXXX    X
                                                             X     X  X        X                X
                                                             X     X  X        X     X          X
                                                             X     X  XXXXXXX   XXXXX          XXX



            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                                      HEC-1 INPUT                                            PAGE  1

           LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              1          ID   HYDROLOGY STUDY for COVE RESERVOIR
              2          ID   Located in KANE COUNTY, UTAH
              3          ID
              4          ID   AUG 2020
              5          ID
              6          ID   PREPARED BY ALPHA ENGINEERING
              7          ID   43 SOUTH 100 EAST, SUITE 100
              8          ID   ST. GEORGE, UTAH  84770
              9          ID   TEL: (435) 628-6500
             10          ID   FAX: (435) 628-6553
             11          ID
             12          ID   50-YR, 24-HR, AMC II
             13          ID
                         *Diagram
             14          JR    PREC     1.0
             15          IT      72       0       0      50
             16          IO       0
             17          IN      72
                         *

             18          KK   B1
             19          KM   Runoff from Basin 1
             20          BA   0.503
             21          PB    3.14
             22          PC       0   0.020   0.046   0.070   0.095   0.130   0.180   0.300   0.520   0.650
             23          PC   0.700   0.745   0.785   0.820   0.850   0.880   0.905   0.930   0.955   0.980
             24          PC   1.000
             25          LS       0    72.8
             26          UD    0.51
                         *

             27          KK   RB1
             28          KM   Route B1
             29          RD    4928    .045    .050            TRAP      20      20
                         *

             30          KK   B2
             31          KM   Runoff from Basin 2
             32          BA   0.436
             33          LS       0    72.5
             34          UD    0.52
                         *

             35          KK   B3
             36          KM   Runoff from Basin 3
             37          BA   0.279
             38          LS       0    71.0
             39          UD    0.39
                         *
1                                                      HEC-1 INPUT                                            PAGE  2

           LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10
```

```
             40           KK   C1
             41           KM   Combine RB1, B2, B3
             42           HC       3
                          *

             43           KK   RC1
             44           KM   Route RC1
             45           RD    7255    .060    .030            TRAP      20      20
                          *

             46           KK   B4
             47           KM   Runoff from Basin 4
             48           BA   0.453
             49           LS       0    73.3
             50           UD    0.48
                          *

             51           KK   B5
             52           KM   Runoff from Basin 5
             53           BA   0.805
             54           LS       0    74.1
             55           UD    0.63
                          *

             56           KK   C2
             57           KM   Combine RC1, B4, B5
             58           HC       3
                          *

             59           KK   RC2
             60           KM   Route C2
             61           RD    2380    .039    .030            TRAP      40       2
                          *

             62           KK   B6
             63           KM   Runoff from Basin 6
             64           BA   0.150
             65           LS       0    84.3
             66           UD    0.19
                          *

             67           KK   B7
             68           KM   Runoff from Basin 7
             69           BA   0.327
             70           LS       0    75.7
             71           UD    0.46
                          *

             72           KK   C3
             73           KM   Combine RC2, B6, B7
             74           HC       3
                          *
1                                                       HEC-1 INPUT                                             PAGE  3

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


             75           KK   RC3
             76           KM   Route C3
             77           RD   11323    .023    .030            TRAP      40      20
                          *

             78           KK   B8
             79           KM   Runoff from Basin 8
             80           BA   1.012
             81           LS       0    84.0
             82           UD    0.67
                          *

             83           KK   B9
             84           KM   Runoff from Basin 9
             85           BA   0.242
             86           LS       0    85.5
             87           UD    0.26
                          *

             88           KK   B10
             89           KM   Runoff from Basin 10
             90           BA   0.129
             91           LS       0    86.7
             92           UD    0.18
                          *

             93           KK   C4
             94           KM   Combine B9, B10
             95           HC       2
                          *

             96           KK   RC4
             97           KM   Route C4
             98           RD    3380    .037    .030            TRAP      40      20
                          *
```

```
             99           KK   B11
            100           KM   Runoff from Basin 11
            101           BA   0.279
            102           LS       0    84.8
            103           UD    0.39
                          *

            104           KK   C5
            105           KM   Combine RC3, B8, RC4, B11
            106           HC       4
                          *

            107           KK   B12
            108           KM   Runoff from Basin 12
            109           BA   0.127
            110           LS       0    81.2
            111           UD    0.40
                          *
1                                                      HEC-1 INPUT                                            PAGE  4

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


            112           KK   Call
            113           KM   Combine C5, B12
            114           HC       2
                          *

            115           KK   Cove Reservoir
            116           KM   Routing through Res'v
            117           RS       1    ELEV  5545.5
            118           SV       0      19      95     240     453     738    1105    1563    2217    2773
            119           SV    3542    4423    5419    6149    7347    8000
            120           SE    5470    5476    5482    5488    5494    5500    5506    5512    5518    5524
            121           SE    5530    5536    5542    5548    5552    5558
            122           SL  5545.5   4.909     0.6     0.5
            123           SS  5549.2      30    2.67     1.5
            124           ST  5552.0    1892     2.9     1.5
                          *
            125           ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW

    18       B1
                 V
                 V
    27       RB1
                 .
                 .
    30           .       B2
                 .           .
                 .           .
    35           .           .       B3
                 .           .           .
                 .           .           .
    40       C1   ........................
                 V
                 V
    43       RC1
                 .
                 .
    46           .       B4
                 .           .
                 .           .
    51           .           .       B5
                 .           .           .
                 .           .           .
    56       C2   ........................
                 V
                 V
    59       RC2
                 .
                 .
    62           .       B6
                 .           .
                 .           .
    67           .           .       B7
                 .           .           .
                 .           .           .
    72       C3   ........................
                 V
                 V
    75       RC3
                 .
                 .
    78           .       B8
                 .           .
```

```
                 .           .
    83           .           .       B9
                 .           .           .
                 .           .           .
    88           .           .           .       B10
                 .           .           .           .
                 .           .           .           .
    93           .           .       C4   ...........
                 .           .           V
                 .           .           V
    96           .           .       RC4
                 .           .           .
                 .           .           .
    99           .           .           .       B11
                 .           .           .           .
                 .           .           .           .
   104       C5   ...................................
                 .
                 .
   107           .       B12
                 .           .
                 .           .
   112       Call ............
                 V
                 V
   115       Cove

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                                   ***************************************
 *                                       *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998               *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1                 *                                                   *          609 SECOND STREET          *
 *                                       *                                                   *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:53:04   *                                                   *           (916) 756-1104            *
 *                                       *                                                   *                                     *
 *****************************************                                                   ***************************************




                            HYDROLOGY STUDY for COVE RESERVOIR
                            Located in KANE COUNTY, UTAH

                            AUG 2020

                            PREPARED BY ALPHA ENGINEERING
                            43 SOUTH 100 EAST, SUITE 100
                            ST. GEORGE, UTAH  84770
                            TEL: (435) 628-6500
                            FAX: (435) 628-6553

                            50-YR, 24-HR, AMC II


   16 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           0  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN          72  MINUTES IN COMPUTATION INTERVAL
                        IDATE      1    0  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ          50  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE      3    0  ENDING DATE
                       NDTIME        1048  ENDING TIME
                       ICENT           19  CENTURY MARK

                    COMPUTATION INTERVAL    1.20 HOURS
                         TOTAL TIME BASE   58.80 HOURS

           ENGLISH UNITS
                DRAINAGE AREA         SQUARE MILES
                PRECIPITATION DEPTH   INCHES
                LENGTH, ELEVATION     FEET
                FLOW                  CUBIC FEET PER SECOND
                STORAGE VOLUME        ACRE-FEET
                SURFACE AREA          ACRES
                TEMPERATURE           DEGREES FAHRENHEIT

      JP          MULTI-PLAN OPTION
                        NPLAN           1  NUMBER OF PLANS

      JR          MULTI-RATIO OPTION
                      RATIOS OF PRECIPITATION
                     1.00


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
```

```
 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
  112 KK     *     Call   *
             *            *
             **************
                            Combine C5, B12

  114 HC          HYDROGRAPH COMBINATION
                        ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                 ***

 ***********************************************************************************************************************************

                                                   HYDROGRAPH AT STATION    Call
                                                        SUM OF  2 HYDROGRAPHS
                                                       PLAN 1,   RATIO =  1.00

 ***********************************************************************************************************************************
                                 *                                *                                *
    DA MON HRMN  ORD      FLOW   *    DA MON HRMN  ORD      FLOW  *    DA MON HRMN  ORD      FLOW  *    DA MON HRMN  ORD      FLOW
                                 *                                *                                *
     1     0000    1        0.   *    1     1536   14      196.   *    2     0712   27        0.   *    2     2248   40        0.
     1     0112    2        0.   *    1     1648   15      174.   *    2     0824   28        0.   *    3     0000   41        0.
     1     0224    3        0.   *    1     1800   16      165.   *    2     0936   29        0.   *    3     0112   42        0.
     1     0336    4        0.   *    1     1912   17      150.   *    2     1048   30        0.   *    3     0224   43        0.
     1     0448    5        0.   *    1     2024   18      142.   *    2     1200   31        0.   *    3     0336   44        0.
     1     0600    6        1.   *    1     2136   19      140.   *    2     1312   32        0.   *    3     0448   45        0.
     1     0712    7       12.   *    1     2248   20      141.   *    2     1424   33        0.   *    3     0600   46        0.
     1     0824    8       85.   *    2     0000   21      129.   *    2     1536   34        0.   *    3     0712   47        0.
     1     0936    9      398.   *    2     0112   22       69.   *    2     1648   35        0.   *    3     0824   48        0.
     1     1048   10      506.   *    2     0224   23       28.   *    2     1800   36        0.   *    3     0936   49        0.
     1     1200   11      362.   *    2     0336   24        9.   *    2     1912   37        0.   *    3     1048   50        0.
     1     1312   12      268.   *    2     0448   25        3.   *    2     2024   38        0.   *
     1     1424   13      223.   *    2     0600   26        1.   *    2     2136   39        0.   *
                                 *                                *                                *
 ***********************************************************************************************************************************

  PEAK FLOW     TIME                            MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     58.80-HR
+   (CFS)       (HR)
                           (CFS)
+     506.     10.80                  338.        160.         65.          65.
                        (INCHES)      .662       1.254       1.255        1.255
                         (AC-FT)      167.        317.        317.         317.

                         CUMULATIVE AREA =    4.74 SQ MI



 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
  115 KK     *     Cove   *     Reservoir
             *            *
             **************
                            Routing through Res'v

                HYDROGRAPH ROUTING DATA

  117 RS          STORAGE ROUTING
                        NSTPS           1  NUMBER OF SUBREACHES
                         ITYP        ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC     5545.50  INITIAL CONDITION
                            X         .00 WORKING R AND D COEFFICIENT

  118 SV            STORAGE          .0      19.0      95.0     240.0     453.0     738.0    1105.0    1563.0    2217.0    2773.0
                                 3542.0    4423.0    5419.0    6149.0    7347.0    8000.0

  120 SE          ELEVATION     5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00
                                5530.00   5536.00   5542.00   5548.00   5552.00   5558.00

  122 SL          LOW-LEVEL OUTLET
                        ELEVL     5545.50  ELEVATION AT CENTER OF OUTLET
                        CAREA        4.91  CROSS-SECTIONAL AREA
                         COQL         .60  COEFFICIENT
                         EXPL         .50  EXPONENT OF HEAD

  123 SS          SPILLWAY
                         CREL     5549.20  SPILLWAY CREST ELEVATION
                        SPWID       30.00  SPILLWAY WIDTH
                         COQW        2.67  WEIR COEFFICIENT
                         EXPW        1.50  EXPONENT OF HEAD

  124 ST          TOP OF DAM
```

```
                        TOPEL     5552.00  ELEVATION AT TOP OF DAM
                       DAMWID     1892.00  DAM WIDTH
                         COQD        2.90  WEIR COEFFICIENT
                         EXPD        1.50  EXPONENT OF HEAD

                                                                 ***

                                                  COMPUTED OUTFLOW-ELEVATION DATA

                                                    (EXCLUDING FLOW OVER DAM)

             OUTFLOW       .00       .00     25.78     27.48     29.42     31.65     34.25     37.31     40.98     45.44
           ELEVATION   5470.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00   5548.51   5549.20

             OUTFLOW     49.37     68.29    113.97    198.20    332.85    529.64    800.37   1156.85   1610.93   2174.46
           ELEVATION   5549.32   5549.60   5550.06   5550.68   5551.48   5552.44   5553.58   5554.88   5556.36   5558.00


                                              COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

                                                    (INCLUDING FLOW OVER DAM)

             STORAGE       .00     19.00     95.00    240.00    453.00    738.00   1105.00   1563.00   2217.00   2773.00
             OUTFLOW       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
           ELEVATION   5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00

             STORAGE   3542.00   4423.00   5419.00   5844.83   5989.79   6009.51   6033.57   6063.27   6100.64   6148.41
             OUTFLOW       .00       .00       .00       .00     25.78     27.48     29.42     31.65     34.25     37.31
           ELEVATION   5530.00   5536.00   5542.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00

             STORAGE   6301.53   6508.46   6543.56   6628.96   6765.11   6952.15   7190.23   7347.00   7395.04   7518.54
             OUTFLOW     40.98     45.44     49.37     68.29    113.97    198.20    332.85    435.48   2138.72  11657.74
           ELEVATION   5548.51   5549.20   5549.32   5549.60   5550.06   5550.68   5551.48   5552.00   5552.44   5553.58

             STORAGE   7660.53   7821.02   8000.00
             OUTFLOW  27985.71  51484.63  82813.63
           ELEVATION   5554.88   5556.36   5558.00

 ***********************************************************************************************************************************

                                                   HYDROGRAPH AT STATION    Cove
                                                       PLAN 1,   RATIO =  1.00

 ***********************************************************************************************************************************
                                            *                                           *
  DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE
                                            *                                           *
   1     0000   1       0.   5844.8  5545.5 *  1     2024  18      33.   6079.1  5547.4 *  2     1648  35      33.   6079.8  5547.4
   1     0112   2       0.   5844.8  5545.5 *  1     2136  19      34.   6089.8  5547.5 *  2     1800  36      33.   6076.5  5547.4
   1     0224   3       0.   5844.8  5545.5 *  1     2248  20      34.   6100.3  5547.6 *  2     1912  37      32.   6073.3  5547.4
   1     0336   4       0.   5844.8  5545.5 *  2     0000  21      35.   6110.3  5547.7 *  2     2024  38      32.   6070.1  5547.4
   1     0448   5       0.   5844.8  5545.5 *  2     0112  22      35.   6116.6  5547.7 *  2     2136  39      32.   6067.0  5547.3
   1     0600   6       0.   5844.8  5545.5 *  2     0224  23      35.   6117.8  5547.7 *  2     2248  40      32.   6063.8  5547.3
   1     0712   7       2.   5845.4  5545.5 *  2     0336  24      35.   6116.1  5547.7 *  3     0000  41      31.   6060.7  5547.3
   1     0824   8       5.   5849.9  5545.5 *  2     0448  25      35.   6113.2  5547.7 *  3     0112  42      31.   6057.6  5547.2
   1     0936   9      11.   5873.1  5545.7 *  2     0600  26      35.   6109.9  5547.7 *  3     0224  43      31.   6054.5  5547.2
   1     1048  10      18.   5916.5  5546.1 *  2     0712  27      35.   6106.5  5547.7 *  3     0336  44      31.   6051.4  5547.2
   1     1200  11      23.   5957.5  5546.4 *  2     0824  28      34.   6103.1  5547.6 *  3     0448  45      31.   6048.4  5547.2
   1     1312  12      25.   5986.4  5546.7 *  2     0936  29      34.   6099.8  5547.6 *  3     0600  46      30.   6045.3  5547.1
   1     1424  13      27.   6008.1  5546.8 *  2     1048  30      34.   6096.4  5547.6 *  3     0712  47      30.   6042.4  5547.1
   1     1536  14      29.   6026.1  5547.0 *  2     1200  31      34.   6093.0  5547.5 *  3     0824  48      30.   6039.4  5547.1
   1     1648  15      30.   6041.5  5547.1 *  2     1312  32      34.   6089.7  5547.5 *  3     0936  49      30.   6036.4  5547.1
   1     1800  16      31.   6055.3  5547.2 *  2     1424  33      33.   6086.3  5547.5 *  3     1048  50      29.   6033.5  5547.1
   1     1912  17      32.   6067.8  5547.3 *  2     1536  34      33.   6083.1  5547.5 *
                                            *                                           *
 ***********************************************************************************************************************************

 PEAK OUTFLOW IS       35. AT TIME  26.40 HOURS


  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     58.80-HR
+   (CFS)       (HR)
                           (CFS)
+      35.     26.40                   35.         34.         27.          27.
                        (INCHES)      .069        .267        .509         .509
                         (AC-FT)       17.         67.        129.         129.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     58.80-HR
+  (AC-FT)      (HR)
     6118.     26.40                 6115.       6097.       6028.        6028.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     58.80-HR
+   (FEET)      (HR)
   5547.74     26.40               5547.72     5547.57     5547.00      5547.00

                         CUMULATIVE AREA =    4.74 SQ MI

1
```

```
               PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                 FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                TIME TO PEAK IN HOURS


                                                         RATIOS APPLIED TO PRECIPITATION
 OPERATION       STATION     AREA    PLAN           RATIO 1
                                                       1.00

 HYDROGRAPH AT
+                  B1          .50     1   FLOW          42.
                                           TIME       10.80

 ROUTED TO
+                  RB1         .50     1   FLOW          39.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B2          .44     1   FLOW          36.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B3          .28     1   FLOW          20.
                                           TIME       10.80

  3 COMBINED AT
+                  C1         1.22     1   FLOW          95.
                                           TIME       10.80

 ROUTED TO
+                  RC1        1.22     1   FLOW          89.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B4          .45     1   FLOW          39.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B5          .81     1   FLOW          73.
                                           TIME       10.80

  3 COMBINED AT
+                  C2         2.48     1   FLOW         201.
                                           TIME       10.80

 ROUTED TO
+                  RC2        2.48     1   FLOW         198.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B6          .15     1   FLOW          24.
                                           TIME        9.60

 HYDROGRAPH AT
+                  B7          .33     1   FLOW          33.
                                           TIME       10.80

  3 COMBINED AT
+                  C3         2.95     1   FLOW         254.
                                           TIME       10.80

 ROUTED TO
+                  RC3        2.95     1   FLOW         226.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B8         1.01     1   FLOW         156.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B9          .24     1   FLOW          43.
                                           TIME        9.60

 HYDROGRAPH AT
+                  B10         .13     1   FLOW          24.
                                           TIME        9.60

  2 COMBINED AT
+                  C4          .37     1   FLOW          67.
                                           TIME        9.60

 ROUTED TO
+                  RC4         .37     1   FLOW          63.
                                           TIME       10.80

 HYDROGRAPH AT
+                  B11         .28     1   FLOW          47.
                                           TIME        9.60

  4 COMBINED AT
+                  C5         4.61     1   FLOW         489.
                                           TIME       10.80
```

```
 HYDROGRAPH AT
+                  B12          .13    1   FLOW           17.
                                           TIME         10.80

  2 COMBINED AT
+                  Call        4.74    1   FLOW          506.
                                           TIME         10.80

 ROUTED TO
+                  Cove        4.74    1   FLOW           35.
                                           TIME         26.40

                                       ** PEAK STAGES IN FEET **
                                       1   STAGE      5547.74
                                           TIME         26.40
1
                                           SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                                               (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                                   INTERPOLATED TO
                                                                                COMPUTATION INTERVAL
            ISTAQ    ELEMENT      DT       PEAK    TIME TO     VOLUME      DT       PEAK    TIME TO     VOLUME
                                                     PEAK                                     PEAK

                                 (MIN)     (CFS)      (MIN)     (IN)     (MIN)     (CFS)     (MIN)       (IN)

           FOR PLAN = 1  RATIO=  .00
              RB1    MANE        10.80     41.28    669.60       .93     72.00     39.32    648.00         .94


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .2506E+02 EXCESS= .0000E+00 OUTFLOW= .2507E+02 BASIN STORAGE= .3252E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC1    MANE        10.80     93.85    669.60       .91     72.00     89.39    648.00         .92


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .5909E+02 EXCESS= .0000E+00 OUTFLOW= .5910E+02 BASIN STORAGE= .3497E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC2    MANE         4.52    199.61    651.21       .95     72.00    197.63    648.00         .95


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1257E+03 EXCESS= .0000E+00 OUTFLOW= .1257E+03 BASIN STORAGE= .3088E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC3    MANE        18.00    247.22    666.00      1.01     72.00    225.83    648.00        1.01


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1584E+03 EXCESS= .0000E+00 OUTFLOW= .1585E+03 BASIN STORAGE= .1185E-01 PERCENT ERROR=   -.1


           FOR PLAN = 1  RATIO=  .00
              RC4    MANE        11.21     66.99    594.15      1.78     72.00     62.77    648.00        1.78


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .3515E+02 EXCESS= .0000E+00 OUTFLOW= .3516E+02 BASIN STORAGE= .2436E-02 PERCENT ERROR=    .0


1                                  SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION    Cove
                              (PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED  DURING BREACH FORMATION)


      PLAN  1 ..............                 INITIAL VALUE     SPILLWAY CREST     TOP OF DAM
                                 ELEVATION        5545.50           5549.20         5552.00
                                 STORAGE           5845.             6508.           7347.
                                 OUTFLOW              0.               45.            435.


                      RATIO     MAXIMUM      MAXIMUM    MAXIMUM    MAXIMUM    DURATION     TIME OF     TIME OF
                        OF     RESERVOIR      DEPTH     STORAGE    OUTFLOW    OVER TOP   MAX OUTFLOW   FAILURE
                       PMF      W.S.ELEV    OVER DAM     AC-FT       CFS       HOURS        HOURS       HOURS

                      1.00      5547.74         .00       6118.        35.       .00        26.40         .00


 *** NORMAL END OF HEC-1 ***
```

Storm Event 6. 100-year, 24-hour

```
1*****************************************                                                   ***************************************
 *                                       *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
 *               JUN   1998              *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
 *            VERSION 4.1                *                                                   *          609 SECOND STREET          *
 *                                       *                                                   *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:53:31   *                                                   *           (916) 756-1104            *
 *                                       *                                                   *                                     *
 *****************************************                                                   ***************************************




                                                 X     X  XXXXXXX   XXXXX           X
                                                 X     X  X        X     X         XX
                                                 X     X  X        X                X
                                                 XXXXXXX  XXXX     X        XXXXX   X
                                                 X     X  X        X                X
                                                 X     X  X        X     X          X
                                                 X     X  XXXXXXX   XXXXX          XXX




            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                                       HEC-1 INPUT                                                     PAGE  1

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              1           ID   HYDROLOGY STUDY for COVE RESERVOIR
              2           ID   Located in KANE COUNTY, UTAH
              3           ID
              4           ID   AUG 2020
              5           ID
              6           ID   PREPARED BY ALPHA ENGINEERING
              7           ID   43 SOUTH 100 EAST, SUITE 100
              8           ID   ST. GEORGE, UTAH  84770
              9           ID   TEL: (435) 628-6500
             10           ID   FAX: (435) 628-6553
             11           ID
             12           ID   100-YR, 24-HR, AMC II
             13           ID
                          *Diagram
             14           JR    PREC     1.0
             15           IT      72       0       0      50
             16           IO       0
             17           IN      72
                          *

             18           KK   B1
             19           KM   Runoff from Basin 1
             20           BA   0.503
             21           PB    3.51
             22           PC       0   0.020   0.046   0.070   0.095   0.130   0.180   0.300   0.520   0.650
             23           PC   0.700   0.745   0.785   0.820   0.850   0.880   0.905   0.930   0.955   0.980
             24           PC   1.000
             25           LS       0    72.8
             26           UD    0.51
                          *

             27           KK   RB1
             28           KM   Route B1
             29           RD    4928    .045    .050            TRAP      20      20
                          *

             30           KK   B2
             31           KM   Runoff from Basin 2
             32           BA   0.436
             33           LS       0    72.5
             34           UD    0.52
                          *

             35           KK   B3
             36           KM   Runoff from Basin 3
             37           BA   0.279
             38           LS       0    71.0
             39           UD    0.39
                          *
1                                                       HEC-1 INPUT                                                     PAGE  2

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10
```

```
             40           KK   C1
             41           KM   Combine RB1, B2, B3
             42           HC       3
                          *

             43           KK   RC1
             44           KM   Route RC1
             45           RD    7255    .060    .030            TRAP      20      20
                          *

             46           KK   B4
             47           KM   Runoff from Basin 4
             48           BA   0.453
             49           LS       0    73.3
             50           UD    0.48
                          *

             51           KK   B5
             52           KM   Runoff from Basin 5
             53           BA   0.805
             54           LS       0    74.1
             55           UD    0.63
                          *

             56           KK   C2
             57           KM   Combine RC1, B4, B5
             58           HC       3
                          *

             59           KK   RC2
             60           KM   Route C2
             61           RD    2380    .039    .030            TRAP      40       2
                          *

             62           KK   B6
             63           KM   Runoff from Basin 6
             64           BA   0.150
             65           LS       0    84.3
             66           UD    0.19
                          *

             67           KK   B7
             68           KM   Runoff from Basin 7
             69           BA   0.327
             70           LS       0    75.7
             71           UD    0.46
                          *

             72           KK   C3
             73           KM   Combine RC2, B6, B7
             74           HC       3
                          *
1                                                      HEC-1 INPUT                                             PAGE  3

           LINE           ID......1.......2.......3.......4.......5.......6.......7.......8.......9......10


             75           KK   RC3
             76           KM   Route C3
             77           RD   11323    .023    .030            TRAP      40      20
                          *

             78           KK   B8
             79           KM   Runoff from Basin 8
             80           BA   1.012
             81           LS       0    84.0
             82           UD    0.67
                          *

             83           KK   B9
             84           KM   Runoff from Basin 9
             85           BA   0.242
             86           LS       0    85.5
             87           UD    0.26
                          *

             88           KK   B10
             89           KM   Runoff from Basin 10
             90           BA   0.129
             91           LS       0    86.7
             92           UD    0.18
                          *

             93           KK   C4
             94           KM   Combine B9, B10
             95           HC       2
                          *

             96           KK   RC4
             97           KM   Route C4
             98           RD    3380    .037    .030            TRAP      40      20
                          *
```

```
             99           KK   B11
            100           KM   Runoff from Basin 11
            101           BA   0.279
            102           LS       0    84.8
            103           UD    0.39
                          *

            104           KK   C5
            105           KM   Combine RC3, B8, RC4, B11
            106           HC       4
                          *

            107           KK   B12
            108           KM   Runoff from Basin 12
            109           BA   0.127
            110           LS       0    81.2
            111           UD    0.40
                          *
1                                                       HEC-1 INPUT                                             PAGE  4

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


            112           KK   Call
            113           KM   Combine C5, B12
            114           HC       2
                          *

            115           KK   Cove Reservoir
            116           KM   Routing through Res'v
            117           RS       1    ELEV  5545.5
            118           SV       0      19      95     240     453     738    1105    1563    2217    2773
            119           SV    3542    4423    5419    6149    7347    8000
            120           SE    5470    5476    5482    5488    5494    5500    5506    5512    5518    5524
            121           SE    5530    5536    5542    5548    5552    5558
            122           SL  5545.5   4.909     0.6     0.5
            123           SS  5549.2      30    2.67     1.5
            124           ST  5552.0    1892     2.9     1.5
                          *
            125           ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW

    18       B1
                 V
                 V
    27       RB1
                 .
                 .
    30           .       B2
                 .           .
                 .           .
    35           .           .       B3
                 .           .           .
                 .           .           .
    40       C1   ........................
                 V
                 V
    43       RC1
                 .
                 .
    46           .       B4
                 .           .
                 .           .
    51           .           .       B5
                 .           .           .
                 .           .           .
    56       C2   ........................
                 V
                 V
    59       RC2
                 .
                 .
    62           .       B6
                 .           .
                 .           .
    67           .           .       B7
                 .           .           .
                 .           .           .
    72       C3   ........................
                 V
                 V
    75       RC3
                 .
                 .
    78           .       B8
                 .           .
```

```
                 .           .
    83           .           .       B9
                 .           .           .
                 .           .           .
    88           .           .           .       B10
                 .           .           .           .
                 .           .           .           .
    93           .           .       C4   ............
                 .           .           V
                 .           .           V
    96           .           .       RC4
                 .           .           .
                 .           .           .
    99           .           .           .       B11
                 .           .           .           .
                 .           .           .           .
   104       C5   ....................................
                 .
                 .
   107           .       B12
                 .           .
                 .           .
   112       Call ............
                 V
                 V
   115       Cove

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                                   ***************************************
 *                                       *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
 *               JUN   1998              *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
 *            VERSION 4.1                *                                                   *          609 SECOND STREET          *
 *                                       *                                                   *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:53:31   *                                                   *           (916) 756-1104            *
 *                                       *                                                   *                                     *
 *****************************************                                                   ***************************************




                            HYDROLOGY STUDY for COVE RESERVOIR
                            Located in KANE COUNTY, UTAH

                            AUG 2020

                            PREPARED BY ALPHA ENGINEERING
                            43 SOUTH 100 EAST, SUITE 100
                            ST. GEORGE, UTAH  84770
                            TEL: (435) 628-6500
                            FAX: (435) 628-6553

                            100-YR, 24-HR, AMC II


   16 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           0  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN          72  MINUTES IN COMPUTATION INTERVAL
                        IDATE      1    0  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ          50  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE      3    0  ENDING DATE
                       NDTIME        1048  ENDING TIME
                       ICENT           19  CENTURY MARK

                    COMPUTATION INTERVAL    1.20 HOURS
                         TOTAL TIME BASE   58.80 HOURS

           ENGLISH UNITS
                DRAINAGE AREA         SQUARE MILES
                PRECIPITATION DEPTH   INCHES
                LENGTH, ELEVATION     FEET
                FLOW                  CUBIC FEET PER SECOND
                STORAGE VOLUME        ACRE-FEET
                SURFACE AREA          ACRES
                TEMPERATURE           DEGREES FAHRENHEIT

      JP          MULTI-PLAN OPTION
                        NPLAN           1  NUMBER OF PLANS

      JR          MULTI-RATIO OPTION
                      RATIOS OF PRECIPITATION
                     1.00


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
```

```
*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
 112 KK     *     Call   *
            *            *
            **************
                          Combine C5, B12

 114 HC          HYDROGRAPH COMBINATION
                       ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                ***

***********************************************************************************************************************************

                                                  HYDROGRAPH AT STATION    Call
                                                       SUM OF  2 HYDROGRAPHS
                                                      PLAN 1,   RATIO =  1.00

***********************************************************************************************************************************
                                *                                 *                                 *
   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW    *   DA MON HRMN  ORD      FLOW    *   DA MON HRMN  ORD      FLOW
                                *                                 *                                 *
    1     0000    1        0.   *    1     1536   14      233.    *    2     0712   27        0.    *    2     2248   40        0.
    1     0112    2        0.   *    1     1648   15      206.    *    2     0824   28        0.    *    3     0000   41        0.
    1     0224    3        0.   *    1     1800   16      194.    *    2     0936   29        0.    *    3     0112   42        0.
    1     0336    4        0.   *    1     1912   17      177.    *    2     1048   30        0.    *    3     0224   43        0.
    1     0448    5        0.   *    1     2024   18      167.    *    2     1200   31        0.    *    3     0336   44        0.
    1     0600    6        3.   *    1     2136   19      165.    *    2     1312   32        0.    *    3     0448   45        0.
    1     0712    7       20.   *    1     2248   20      165.    *    2     1424   33        0.    *    3     0600   46        0.
    1     0824    8      116.   *    2     0000   21      150.    *    2     1536   34        0.    *    3     0712   47        0.
    1     0936    9      519.   *    2     0112   22       79.    *    2     1648   35        0.    *    3     0824   48        0.
    1     1048   10      632.   *    2     0224   23       32.    *    2     1800   36        0.    *    3     0936   49        0.
    1     1200   11      442.   *    2     0336   24       11.    *    2     1912   37        0.    *    3     1048   50        0.
    1     1312   12      321.   *    2     0448   25        3.    *    2     2024   38        0.    *
    1     1424   13      265.   *    2     0600   26        1.    *    2     2136   39        0.    *
                                *                                 *                                 *
***********************************************************************************************************************************

 PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     58.80-HR
+   (CFS)       (HR)
                          (CFS)
+     632.     10.80                 421.        195.         80.          80.
                        (INCHES)      .826       1.529       1.530        1.530
                         (AC-FT)      209.        387.        387.         387.

                         CUMULATIVE AREA =    4.74 SQ MI



*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
 115 KK     *     Cove   *     Reservoir
            *            *
            **************
                          Routing through Res'v

               HYDROGRAPH ROUTING DATA

 117 RS          STORAGE ROUTING
                       NSTPS           1  NUMBER OF SUBREACHES
                        ITYP        ELEV  TYPE OF INITIAL CONDITION
                      RSVRIC     5545.50  INITIAL CONDITION
                           X         .00 WORKING R AND D COEFFICIENT

 118 SV            STORAGE          .0      19.0      95.0     240.0     453.0     738.0    1105.0    1563.0    2217.0    2773.0
                              3542.0    4423.0    5419.0    6149.0    7347.0    8000.0

 120 SE          ELEVATION     5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00
                             5530.00   5536.00   5542.00   5548.00   5552.00   5558.00

 122 SL          LOW-LEVEL OUTLET
                       ELEVL     5545.50  ELEVATION AT CENTER OF OUTLET
                       CAREA        4.91  CROSS-SECTIONAL AREA
                        COQL         .60  COEFFICIENT
                        EXPL         .50  EXPONENT OF HEAD

 123 SS          SPILLWAY
                        CREL     5549.20  SPILLWAY CREST ELEVATION
                       SPWID       30.00  SPILLWAY WIDTH
                        COQW        2.67  WEIR COEFFICIENT
                        EXPW        1.50  EXPONENT OF HEAD

 124 ST          TOP OF DAM
```

```
                        TOPEL     5552.00  ELEVATION AT TOP OF DAM
                       DAMWID     1892.00  DAM WIDTH
                         COQD        2.90  WEIR COEFFICIENT
                         EXPD        1.50  EXPONENT OF HEAD

                                                                 ***

                                                  COMPUTED OUTFLOW-ELEVATION DATA

                                                    (EXCLUDING FLOW OVER DAM)

             OUTFLOW        .00       .00     25.78     27.48     29.42     31.65     34.25     37.31     40.98     45.44
           ELEVATION    5470.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00   5548.51   5549.20

             OUTFLOW      49.37     68.29    113.97    198.20    332.85    529.64    800.37   1156.85   1610.93   2174.46
           ELEVATION    5549.32   5549.60   5550.06   5550.68   5551.48   5552.44   5553.58   5554.88   5556.36   5558.00


                                              COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

                                                    (INCLUDING FLOW OVER DAM)

             STORAGE        .00     19.00     95.00    240.00    453.00    738.00   1105.00   1563.00   2217.00   2773.00
             OUTFLOW        .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
           ELEVATION    5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00

             STORAGE    3542.00   4423.00   5419.00   5844.83   5989.79   6009.51   6033.57   6063.27   6100.64   6148.41
             OUTFLOW        .00       .00       .00       .00     25.78     27.48     29.42     31.65     34.25     37.31
           ELEVATION    5530.00   5536.00   5542.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00

             STORAGE    6301.53   6508.46   6543.56   6628.96   6765.11   6952.15   7190.23   7347.00   7395.04   7518.54
             OUTFLOW      40.98     45.44     49.37     68.29    113.97    198.20    332.85    435.48   2138.72  11657.74
           ELEVATION    5548.51   5549.20   5549.32   5549.60   5550.06   5550.68   5551.48   5552.00   5552.44   5553.58

             STORAGE    7660.53   7821.02   8000.00
             OUTFLOW   27985.71  51484.63  82813.63
           ELEVATION    5554.88   5556.36   5558.00

 ***********************************************************************************************************************************

                                                   HYDROGRAPH AT STATION    Cove
                                                       PLAN 1,   RATIO =  1.00

 ***********************************************************************************************************************************
                                            *                                           *
  DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE
                                            *                                           *
   1     0000   1       0.   5844.8  5545.5 *  1     2024  18      36.   6135.3  5547.9 *  2     1648  35      37.   6140.0  5547.9
   1     0112   2       0.   5844.8  5545.5 *  1     2136  19      37.   6148.0  5548.0 *  2     1800  36      37.   6136.3  5547.9
   1     0224   3       0.   5844.8  5545.5 *  1     2248  20      38.   6160.7  5548.0 *  2     1912  37      36.   6132.7  5547.9
   1     0336   4       0.   5844.8  5545.5 *  2     0000  21      38.   6172.5  5548.1 *  2     2024  38      36.   6129.2  5547.8
   1     0448   5       0.   5844.8  5545.5 *  2     0112  22      38.   6180.1  5548.1 *  2     2136  39      36.   6125.6  5547.8
   1     0600   6       1.   5845.0  5545.5 *  2     0224  23      38.   6181.9  5548.1 *  2     2248  40      36.   6122.0  5547.8
   1     0712   7       2.   5846.0  5545.5 *  2     0336  24      38.   6180.1  5548.1 *  3     0000  41      35.   6118.5  5547.7
   1     0824   8       6.   5852.3  5545.6 *  2     0448  25      38.   6177.1  5548.1 *  3     0112  42      35.   6115.0  5547.7
   1     0936   9      13.   5882.9  5545.8 *  2     0600  26      38.   6173.4  5548.1 *  3     0224  43      35.   6111.5  5547.7
   1     1048  10      21.   5938.3  5546.3 *  2     0712  27      38.   6169.8  5548.1 *  3     0336  44      35.   6108.1  5547.7
   1     1200  11      26.   5989.3  5546.7 *  2     0824  28      38.   6166.0  5548.1 *  3     0448  45      35.   6104.6  5547.6
   1     1312  12      29.   6024.4  5547.0 *  2     0936  29      38.   6162.2  5548.0 *  3     0600  46      34.   6101.2  5547.6
   1     1424  13      31.   6050.6  5547.2 *  2     1048  30      38.   6158.4  5548.0 *  3     0712  47      34.   6097.9  5547.6
   1     1536  14      32.   6072.1  5547.4 *  2     1200  31      37.   6154.7  5548.0 *  3     0824  48      34.   6094.5  5547.6
   1     1648  15      34.   6090.6  5547.5 *  2     1312  32      37.   6151.0  5548.0 *  3     0936  49      34.   6091.1  5547.5
   1     1800  16      35.   6107.0  5547.7 *  2     1424  33      37.   6147.3  5548.0 *  3     1048  50      33.   6087.8  5547.5
   1     1912  17      36.   6121.9  5547.8 *  2     1536  34      37.   6143.7  5548.0 *
                                            *                                           *
 ***********************************************************************************************************************************

 PEAK OUTFLOW IS       38. AT TIME  26.40 HOURS


  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     58.80-HR
+   (CFS)       (HR)
                           (CFS)
+      38.     26.40                   38.         37.         30.          30.
                        (INCHES)      .075        .294        .568         .568
                         (AC-FT)       19.         74.        144.         144.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     58.80-HR
+  (AC-FT)      (HR)
     6182.     26.40                 6178.       6158.       6075.        6075.

  PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     58.80-HR
+   (FEET)      (HR)
   5548.11     26.40               5548.10     5548.02     5547.36      5547.36

                         CUMULATIVE AREA =    4.74 SQ MI

1
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                PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                  FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                  TIME TO PEAK IN HOURS


                                                           RATIOS APPLIED TO PRECIPITATION
 OPERATION       STATION     AREA    PLAN            RATIO 1
                                                        1.00

 HYDROGRAPH AT
+                  B1          .50     1   FLOW          54.
                                           TIME        10.80

 ROUTED TO
+                  RB1         .50     1   FLOW          51.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B2          .44     1   FLOW          46.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B3          .28     1   FLOW          27.
                                           TIME        10.80

  3 COMBINED AT
+                  C1         1.22     1   FLOW         124.
                                           TIME        10.80

 ROUTED TO
+                  RC1        1.22     1   FLOW         118.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B4          .45     1   FLOW          50.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B5          .81     1   FLOW          92.
                                           TIME        10.80

  3 COMBINED AT
+                  C2         2.48     1   FLOW         260.
                                           TIME        10.80

 ROUTED TO
+                  RC2        2.48     1   FLOW         257.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B6          .15     1   FLOW          30.
                                           TIME         9.60

 HYDROGRAPH AT
+                  B7          .33     1   FLOW          41.
                                           TIME        10.80

  3 COMBINED AT
+                  C3         2.95     1   FLOW         326.
                                           TIME        10.80

 ROUTED TO
+                  RC3        2.95     1   FLOW         298.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B8         1.01     1   FLOW         190.
                                           TIME         9.60

 HYDROGRAPH AT
+                  B9          .24     1   FLOW          51.
                                           TIME         9.60

 HYDROGRAPH AT
+                  B10         .13     1   FLOW          29.
                                           TIME         9.60

  2 COMBINED AT
+                  C4          .37     1   FLOW          81.
                                           TIME         9.60

 ROUTED TO
+                  RC4         .37     1   FLOW          74.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B11         .28     1   FLOW          57.
                                           TIME         9.60

  4 COMBINED AT
+                  C5         4.61     1   FLOW         611.
                                           TIME        10.80
```

```
 HYDROGRAPH AT
+                  B12         .13     1   FLOW          21.
                                           TIME         9.60

  2 COMBINED AT
+                  Call       4.74     1   FLOW         632.
                                           TIME        10.80

 ROUTED TO
+                  Cove       4.74     1   FLOW          38.
                                           TIME        26.40

                                       ** PEAK STAGES IN FEET **
                                       1   STAGE     5548.11
                                           TIME        26.40
1
                                           SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                                               (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                                   INTERPOLATED TO
                                                                                COMPUTATION INTERVAL
            ISTAQ    ELEMENT      DT       PEAK    TIME TO     VOLUME      DT       PEAK    TIME TO     VOLUME
                                                     PEAK                                     PEAK

                                 (MIN)     (CFS)      (MIN)     (IN)     (MIN)     (CFS)     (MIN)       (IN)

           FOR PLAN = 1  RATIO=  .00
              RB1    MANE        10.80     52.87    669.60      1.17     72.00     51.47    648.00        1.18


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .3151E+02 EXCESS= .0000E+00 OUTFLOW= .3152E+02 BASIN STORAGE= .3618E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC1    MANE        10.80    122.15    658.80      1.15     72.00    118.32    648.00        1.15


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .7446E+02 EXCESS= .0000E+00 OUTFLOW= .7448E+02 BASIN STORAGE= .3965E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC2    MANE         4.12    258.94    650.80      1.19     72.00    257.20    648.00        1.20


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1578E+03 EXCESS= .0000E+00 OUTFLOW= .1578E+03 BASIN STORAGE= .3030E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC3    MANE        18.00    321.28    666.00      1.25     72.00    298.28    648.00        1.26


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1975E+03 EXCESS= .0000E+00 OUTFLOW= .1976E+03 BASIN STORAGE= .8525E-02 PERCENT ERROR=   -.1


           FOR PLAN = 1  RATIO=  .00
              RC4    MANE        10.64     80.58    595.79      2.10     72.00     74.24    648.00        2.11


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .4157E+02 EXCESS= .0000E+00 OUTFLOW= .4158E+02 BASIN STORAGE= .3047E-02 PERCENT ERROR=    .0


1                                  SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION    Cove
                              (PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED  DURING BREACH FORMATION)


      PLAN  1 ..............                   INITIAL VALUE     SPILLWAY CREST     TOP OF DAM
                                 ELEVATION        5545.50           5549.20          5552.00
                                 STORAGE           5845.             6508.            7347.
                                 OUTFLOW              0.                45.             435.


                      RATIO     MAXIMUM      MAXIMUM    MAXIMUM    MAXIMUM    DURATION     TIME OF     TIME OF
                        OF     RESERVOIR      DEPTH     STORAGE    OUTFLOW    OVER TOP   MAX OUTFLOW   FAILURE
                       PMF      W.S.ELEV    OVER DAM     AC-FT       CFS       HOURS        HOURS       HOURS

                      1.00      5548.11         .00       6182.        38.       .00        26.40         .00


 *** NORMAL END OF HEC-1 ***
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Storm Event 7. 500-year, 24-hour

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1****************************************                                                   ***************************************
 *                                      *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998              *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1                *                                                   *          609 SECOND STREET          *
 *                                      *                                                   *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:53:56   *                                                   *           (916) 756-1104            *
 *                                      *                                                   *                                     *
 ****************************************                                                   ***************************************




                                                  X     X  XXXXXXX   XXXXX           X
                                                  X     X  X        X     X         XX
                                                  X     X  X        X                X
                                                  XXXXXXX  XXXX     X        XXXXX   X
                                                  X     X  X        X                X
                                                  X     X  X        X     X          X
                                                  X     X  XXXXXXX   XXXXX          XXX




            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                                       HEC-1 INPUT                                          PAGE  1

           LINE          ID......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              1          ID   HYDROLOGY STUDY for COVE RESERVOIR
              2          ID   Located in KANE COUNTY, UTAH
              3          ID
              4          ID   AUG 2020
              5          ID
              6          ID   PREPARED BY ALPHA ENGINEERING
              7          ID   43 SOUTH 100 EAST, SUITE 100
              8          ID   ST. GEORGE, UTAH  84770
              9          ID   TEL: (435) 628-6500
             10          ID   FAX: (435) 628-6553
             11          ID
             12          ID   500-YR, 24-HR, AMC II
             13          ID
                         *Diagram
             14          JR    PREC     1.0
             15          IT      72       0       0      50
             16          IO       0
             17          IN      72
                         *

             18          KK   B1
             19          KM   Runoff from Basin 1
             20          BA   0.503
             21          PB    4.69
             22          PC       0   0.020   0.046   0.070   0.095   0.130   0.180   0.300   0.520   0.650
             23          PC   0.700   0.745   0.785   0.820   0.850   0.880   0.905   0.930   0.955   0.980
             24          PC   1.000
             25          LS       0    72.8
             26          UD    0.51
                         *

             27          KK   RB1
             28          KM   Route B1
             29          RD    4928    .045    .050            TRAP      20      20
                         *

             30          KK   B2
             31          KM   Runoff from Basin 2
             32          BA   0.436
             33          LS       0    72.5
             34          UD    0.52
                         *

             35          KK   B3
             36          KM   Runoff from Basin 3
             37          BA   0.279
             38          LS       0    71.0
             39          UD    0.39
                         *
1                                                       HEC-1 INPUT                                          PAGE  2

           LINE          ID......1.......2.......3.......4.......5.......6.......7.......8.......9......10
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```
             40          KK   C1
             41          KM   Combine RB1, B2, B3
             42          HC       3
                         *

             43          KK   RC1
             44          KM   Route RC1
             45          RD    7255    .060    .030            TRAP      20      20
                         *

             46          KK   B4
             47          KM   Runoff from Basin 4
             48          BA   0.453
             49          LS       0    73.3
             50          UD    0.48
                         *

             51          KK   B5
             52          KM   Runoff from Basin 5
             53          BA   0.805
             54          LS       0    74.1
             55          UD    0.63
                         *

             56          KK   C2
             57          KM   Combine RC1, B4, B5
             58          HC       3
                         *

             59          KK   RC2
             60          KM   Route C2
             61          RD    2380    .039    .030            TRAP      40       2
                         *

             62          KK   B6
             63          KM   Runoff from Basin 6
             64          BA   0.150
             65          LS       0    84.3
             66          UD    0.19
                         *

             67          KK   B7
             68          KM   Runoff from Basin 7
             69          BA   0.327
             70          LS       0    75.7
             71          UD    0.46
                         *

             72          KK   C3
             73          KM   Combine RC2, B6, B7
             74          HC       3
                         *
1                                                       HEC-1 INPUT                                             PAGE  3

           LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


             75          KK   RC3
             76          KM   Route C3
             77          RD   11323    .023    .030            TRAP      40      20
                         *

             78          KK   B8
             79          KM   Runoff from Basin 8
             80          BA   1.012
             81          LS       0    84.0
             82          UD    0.67
                         *

             83          KK   B9
             84          KM   Runoff from Basin 9
             85          BA   0.242
             86          LS       0    85.5
             87          UD    0.26
                         *

             88          KK   B10
             89          KM   Runoff from Basin 10
             90          BA   0.129
             91          LS       0    86.7
             92          UD    0.18
                         *

             93          KK   C4
             94          KM   Combine B9, B10
             95          HC       2
                         *

             96          KK   RC4
             97          KM   Route C4
             98          RD    3380    .037    .030            TRAP      40      20
                         *
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```
              99           KK   B11
             100           KM   Runoff from Basin 11
             101           BA   0.279
             102           LS       0    84.8
             103           UD    0.39
                           *

             104           KK   C5
             105           KM   Combine RC3, B8, RC4, B11
             106           HC       4
                           *

             107           KK   B12
             108           KM   Runoff from Basin 12
             109           BA   0.127
             110           LS       0    81.2
             111           UD    0.40
                           *
1                                                       HEC-1 INPUT                                            PAGE  4

           LINE            ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


             112           KK   Call
             113           KM   Combine C5, B12
             114           HC       2
                           *

             115           KK   Cove Reservoir
             116           KM   Routing through Res'v
             117           RS       1    ELEV  5545.5
             118           SV       0      19      95     240     453     738    1105    1563    2217    2773
             119           SV    3542    4423    5419    6149    7347    8000
             120           SE    5470    5476    5482    5488    5494    5500    5506    5512    5518    5524
             121           SE    5530    5536    5542    5548    5552    5558
             122           SL  5545.5   4.909     0.6     0.5
             123           SS  5549.2      30    2.67     1.5
             124           ST  5552.0    1892     2.9     1.5
                           *
             125           ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW

    18       B1
                 V
                 V
    27       RB1
                 .
                 .
    30           .       B2
                 .           .
                 .           .
    35           .           .       B3
                 .           .           .
                 .           .           .
    40       C1   ........................
                 V
                 V
    43       RC1
                 .
                 .
    46           .       B4
                 .           .
                 .           .
    51           .           .       B5
                 .           .           .
                 .           .           .
    56       C2   ........................
                 V
                 V
    59       RC2
                 .
                 .
    62           .       B6
                 .           .
                 .           .
    67           .           .       B7
                 .           .           .
                 .           .           .
    72       C3   ........................
                 V
                 V
    75       RC3
                 .
                 .
    78           .       B8
                 .           .
```

```
                 .           .
    83           .           .       B9
                 .           .           .
                 .           .           .
    88           .           .           .       B10
                 .           .           .           .
                 .           .           .           .
    93           .           .       C4   ............
                 .           .           V
                 .           .           V
    96           .           .       RC4
                 .           .           .
                 .           .           .
    99           .           .           .       B11
                 .           .           .           .
                 .           .           .           .
   104       C5   ....................................
                 .
                 .
   107           .       B12
                 .           .
                 .           .
   112       Call ............
                 V
                 V
   115       Cove

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                                   ****************************************
 *                                       *                                                   *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS      *
 *              JUN   1998               *                                                   *    HYDROLOGIC ENGINEERING CENTER     *
 *            VERSION 4.1                *                                                   *          609 SECOND STREET           *
 *                                       *                                                   *       DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   06AUG20  TIME  02:53:56   *                                                   *           (916) 756-1104             *
 *                                       *                                                   *                                      *
 *****************************************                                                   ****************************************




                            HYDROLOGY STUDY for COVE RESERVOIR
                            Located in KANE COUNTY, UTAH

                            AUG 2020

                            PREPARED BY ALPHA ENGINEERING
                            43 SOUTH 100 EAST, SUITE 100
                            ST. GEORGE, UTAH  84770
                            TEL: (435) 628-6500
                            FAX: (435) 628-6553

                            500-YR, 24-HR, AMC II


   16 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           0  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN          72  MINUTES IN COMPUTATION INTERVAL
                        IDATE      1    0  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ          50  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE      3    0  ENDING DATE
                       NDTIME        1048  ENDING TIME
                       ICENT           19  CENTURY MARK

                    COMPUTATION INTERVAL    1.20 HOURS
                         TOTAL TIME BASE   58.80 HOURS

           ENGLISH UNITS
                DRAINAGE AREA         SQUARE MILES
                PRECIPITATION DEPTH   INCHES
                LENGTH, ELEVATION     FEET
                FLOW                  CUBIC FEET PER SECOND
                STORAGE VOLUME        ACRE-FEET
                SURFACE AREA          ACRES
                TEMPERATURE           DEGREES FAHRENHEIT

      JP          MULTI-PLAN OPTION
                        NPLAN           1  NUMBER OF PLANS

      JR          MULTI-RATIO OPTION
                      RATIOS OF PRECIPITATION
                     1.00


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
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```
 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
  112 KK     *     Call   *
             *            *
             **************
                            Combine C5, B12

  114 HC          HYDROGRAPH COMBINATION
                        ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                 ***

 ***********************************************************************************************************************************

                                                   HYDROGRAPH AT STATION    Call
                                                        SUM OF  2 HYDROGRAPHS
                                                       PLAN 1,   RATIO =  1.00

 ***********************************************************************************************************************************
                                 *                                *                                *
    DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW
                                 *                                *                                *
     1     0000    1        0.   *    1     1536   14      352.   *    2     0712   27        0.   *    2     2248   40        0.
     1     0112    2        0.   *    1     1648   15      309.   *    2     0824   28        0.   *    3     0000   41        0.
     1     0224    3        0.   *    1     1800   16      291.   *    2     0936   29        0.   *    3     0112   42        0.
     1     0336    4        0.   *    1     1912   17      263.   *    2     1048   30        0.   *    3     0224   43        0.
     1     0448    5        2.   *    1     2024   18      247.   *    2     1200   31        0.   *    3     0336   44        0.
     1     0600    6       17.   *    1     2136   19      244.   *    2     1312   32        0.   *    3     0448   45        0.
     1     0712    7       55.   *    1     2248   20      244.   *    2     1424   33        0.   *    3     0600   46        0.
     1     0824    8      257.   *    2     0000   21      221.   *    2     1536   34        0.   *    3     0712   47        0.
     1     0936    9      937.   *    2     0112   22      114.   *    2     1648   35        0.   *    3     0824   48        0.
     1     1048   10     1064.   *    2     0224   23       43.   *    2     1800   36        0.   *    3     0936   49        0.
     1     1200   11      711.   *    2     0336   24       13.   *    2     1912   37        0.   *    3     1048   50        0.
     1     1312   12      497.   *    2     0448   25        3.   *    2     2024   38        0.   *
     1     1424   13      404.   *    2     0600   26        1.   *    2     2136   39        0.   *
                                 *                                *                                *
 ***********************************************************************************************************************************

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     58.80-HR
+   (CFS)       (HR)
                           (CFS)
+    1064.     10.80                  708.        314.        128.         128.
                        (INCHES)     1.388       2.465       2.466        2.466
                         (AC-FT)      351.        623.        624.         624.

                         CUMULATIVE AREA =    4.74 SQ MI



 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
  115 KK     *     Cove   *     Reservoir
             *            *
             **************
                            Routing through Res'v

                HYDROGRAPH ROUTING DATA

  117 RS          STORAGE ROUTING
                        NSTPS           1  NUMBER OF SUBREACHES
                         ITYP        ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC     5545.50  INITIAL CONDITION
                            X         .00 WORKING R AND D COEFFICIENT

  118 SV            STORAGE          .0      19.0      95.0     240.0     453.0     738.0    1105.0    1563.0    2217.0    2773.0
                                 3542.0    4423.0    5419.0    6149.0    7347.0    8000.0

  120 SE          ELEVATION     5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00
                                5530.00   5536.00   5542.00   5548.00   5552.00   5558.00

  122 SL          LOW-LEVEL OUTLET
                        ELEVL     5545.50  ELEVATION AT CENTER OF OUTLET
                        CAREA        4.91  CROSS-SECTIONAL AREA
                         COQL         .60  COEFFICIENT
                         EXPL         .50  EXPONENT OF HEAD

  123 SS          SPILLWAY
                         CREL     5549.20  SPILLWAY CREST ELEVATION
                        SPWID       30.00  SPILLWAY WIDTH
                         COQW        2.67  WEIR COEFFICIENT
                         EXPW        1.50  EXPONENT OF HEAD

  124 ST          TOP OF DAM
```

```
                     TOPEL     5552.00  ELEVATION AT TOP OF DAM
                    DAMWID     1892.00  DAM WIDTH
                      COQD        2.90  WEIR COEFFICIENT
                      EXPD        1.50  EXPONENT OF HEAD

                                                            ***

                                          COMPUTED OUTFLOW-ELEVATION DATA

                                            (EXCLUDING FLOW OVER DAM)

             OUTFLOW        .00       .00     25.78     27.48     29.42     31.65     34.25     37.31     40.98     45.44
           ELEVATION    5470.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00   5548.51   5549.20

             OUTFLOW      49.37     68.29    113.97    198.20    332.85    529.64    800.37   1156.85   1610.93   2174.46
           ELEVATION    5549.32   5549.60   5550.06   5550.68   5551.48   5552.44   5553.58   5554.88   5556.36   5558.00


                                      COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

                                            (INCLUDING FLOW OVER DAM)

             STORAGE        .00     19.00     95.00    240.00    453.00    738.00   1105.00   1563.00   2217.00   2773.00
             OUTFLOW        .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
           ELEVATION    5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00

             STORAGE    3542.00   4423.00   5419.00   5844.83   5989.79   6009.51   6033.57   6063.27   6100.64   6148.41
             OUTFLOW        .00       .00       .00       .00     25.78     27.48     29.42     31.65     34.25     37.31
           ELEVATION    5530.00   5536.00   5542.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00

             STORAGE    6301.53   6508.46   6543.56   6628.96   6765.11   6952.15   7190.23   7347.00   7395.04   7518.54
             OUTFLOW      40.98     45.44     49.37     68.29    113.97    198.20    332.85    435.48   2138.72  11657.74
           ELEVATION    5548.51   5549.20   5549.32   5549.60   5550.06   5550.68   5551.48   5552.00   5552.44   5553.58

             STORAGE    7660.53   7821.02   8000.00
             OUTFLOW   27985.71  51484.63  82813.63
           ELEVATION    5554.88   5556.36   5558.00

 *********************************************************************************************************************************

                                                 HYDROGRAPH AT STATION    Cove
                                                     PLAN 1,   RATIO =  1.00

 *********************************************************************************************************************************
                                             *                                            *
  DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE
                                             *                                            *
   1     0000   1       0.   5844.8  5545.5 *  1     2024  18      42.   6333.4  5548.6 *  2     1648  35      42.   6361.0  5548.7
   1     0112   2       0.   5844.8  5545.5 *  1     2136  19      42.   6353.6  5548.7 *  2     1800  36      42.   6356.8  5548.7
   1     0224   3       0.   5844.8  5545.5 *  1     2248  20      43.   6373.6  5548.8 *  2     1912  37      42.   6352.6  5548.7
   1     0336   4       0.   5844.8  5545.5 *  2     0000  21      43.   6392.5  5548.8 *  2     2024  38      42.   6348.3  5548.7
   1     0448   5       1.   5845.0  5545.5 *  2     0112  22      43.   6404.8  5548.9 *  2     2136  39      42.   6344.2  5548.7
   1     0600   6       2.   5845.8  5545.5 *  2     0224  23      43.   6408.3  5548.9 *  2     2248  40      42.   6340.1  5548.6
   1     0712   7       4.   5849.1  5545.5 *  2     0336  24      43.   6406.8  5548.9 *  3     0000  41      42.   6336.0  5548.6
   1     0824   8       9.   5863.8  5545.7 *  2     0448  25      43.   6403.3  5548.8 *  3     0112  42      42.   6331.9  5548.6
   1     0936   9      19.   5921.6  5546.1 *  2     0600  26      43.   6399.2  5548.8 *  3     0224  43      42.   6327.9  5548.6
   1     1048  10      28.   6018.5  5546.9 *  2     0712  27      43.   6395.0  5548.8 *  3     0336  44      41.   6323.8  5548.6
   1     1200  11      34.   6103.4  5547.6 *  2     0824  28      43.   6390.7  5548.8 *  3     0448  45      41.   6319.7  5548.6
   1     1312  12      38.   6159.7  5548.0 *  2     0936  29      43.   6386.5  5548.8 *  3     0600  46      41.   6315.6  5548.6
   1     1424  13      39.   6200.6  5548.2 *  2     1048  30      43.   6382.3  5548.8 *  3     0712  47      41.   6311.5  5548.5
   1     1536  14      39.   6234.3  5548.3 *  2     1200  31      43.   6378.0  5548.8 *  3     0824  48      41.   6307.4  5548.5
   1     1648  15      40.   6263.1  5548.4 *  2     1312  32      43.   6373.8  5548.8 *  3     0936  49      41.   6303.3  5548.5
   1     1800  16      41.   6288.8  5548.5 *  2     1424  33      42.   6369.5  5548.7 *  3     1048  50      41.   6299.2  5548.5
   1     1912  17      41.   6312.2  5548.5 *  2     1536  34      42.   6365.3  5548.7 *
                                             *                                            *
 *********************************************************************************************************************************

 PEAK OUTFLOW IS       43. AT TIME  26.40 HOURS


  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     58.80-HR
+   (CFS)       (HR)
                          (CFS)
+      43.     26.40                   43.         43.         35.          35.
                       (INCHES)       .085        .335        .670         .670
                        (AC-FT)        21.         85.        169.         169.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     58.80-HR
+  (AC-FT)      (HR)
     6408.     26.40                 6404.       6380.       6245.        6245.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     58.80-HR
+   (FEET)      (HR)
   5548.87     26.40               5548.85     5548.77     5548.06      5548.06

                        CUMULATIVE AREA =    4.74 SQ MI

1
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```
                PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                  FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                  TIME TO PEAK IN HOURS


                                                           RATIOS APPLIED TO PRECIPITATION
 OPERATION       STATION     AREA    PLAN            RATIO 1
                                                        1.00

 HYDROGRAPH AT
+                  B1          .50     1   FLOW          95.
                                           TIME        10.80

 ROUTED TO
+                  RB1         .50     1   FLOW          96.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B2          .44     1   FLOW          82.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B3          .28     1   FLOW          49.
                                           TIME        10.80

  3 COMBINED AT
+                  C1         1.22     1   FLOW         227.
                                           TIME        10.80

 ROUTED TO
+                  RC1        1.22     1   FLOW         221.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B4          .45     1   FLOW          88.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B5          .81     1   FLOW         161.
                                           TIME        10.80

  3 COMBINED AT
+                  C2         2.48     1   FLOW         469.
                                           TIME        10.80

 ROUTED TO
+                  RC2        2.48     1   FLOW         467.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B6          .15     1   FLOW          48.
                                           TIME         9.60

 HYDROGRAPH AT
+                  B7          .33     1   FLOW          70.
                                           TIME         9.60

  3 COMBINED AT
+                  C3         2.95     1   FLOW         579.
                                           TIME        10.80

 ROUTED TO
+                  RC3        2.95     1   FLOW         555.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B8         1.01     1   FLOW         307.
                                           TIME         9.60

 HYDROGRAPH AT
+                  B9          .24     1   FLOW          81.
                                           TIME         9.60

 HYDROGRAPH AT
+                  B10         .13     1   FLOW          45.
                                           TIME         9.60

  2 COMBINED AT
+                  C4          .37     1   FLOW         126.
                                           TIME         9.60

 ROUTED TO
+                  RC4         .37     1   FLOW         117.
                                           TIME         9.60

 HYDROGRAPH AT
+                  B11         .28     1   FLOW          91.
                                           TIME         9.60

  4 COMBINED AT
+                  C5         4.61     1   FLOW        1031.
                                           TIME        10.80
```

```
 HYDROGRAPH AT
+                  B12         .13     1   FLOW          36.
                                           TIME         9.60

  2 COMBINED AT
+                  Call       4.74     1   FLOW        1064.
                                           TIME        10.80

 ROUTED TO
+                  Cove       4.74     1   FLOW          43.
                                           TIME        26.40

                                       ** PEAK STAGES IN FEET **
                                       1   STAGE     5548.87
                                           TIME        26.40
1
                                           SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                                               (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                                   INTERPOLATED TO
                                                                                COMPUTATION INTERVAL
            ISTAQ    ELEMENT      DT       PEAK    TIME TO     VOLUME      DT       PEAK    TIME TO     VOLUME
                                                     PEAK                                     PEAK

                                 (MIN)     (CFS)      (MIN)     (IN)     (MIN)     (CFS)     (MIN)       (IN)

           FOR PLAN = 1  RATIO=  .00
              RB1    MANE        14.40     95.90    648.00      2.02     72.00     95.90    648.00        2.04


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .5431E+02 EXCESS= .0000E+00 OUTFLOW= .5432E+02 BASIN STORAGE= .4285E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC1    MANE        13.43    223.85    658.04      1.99     72.00    220.85    648.00        2.00


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1292E+03 EXCESS= .0000E+00 OUTFLOW= .1293E+03 BASIN STORAGE= .3778E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC2    MANE         3.33    467.63    649.64      2.05     72.00    466.77    648.00        2.06


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .2710E+03 EXCESS= .0000E+00 OUTFLOW= .2710E+03 BASIN STORAGE= .3014E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC3    MANE        21.60    572.39    669.60      2.13     72.00    554.87    648.00        2.13


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .3352E+03 EXCESS= .0000E+00 OUTFLOW= .3354E+03 BASIN STORAGE= .1060E-01 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC4    MANE         9.39    125.40    591.38      3.17     72.00    117.08    576.00        3.18


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .6274E+02 EXCESS= .0000E+00 OUTFLOW= .6274E+02 BASIN STORAGE= .2980E-02 PERCENT ERROR=    .0


1                                  SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION    Cove
                              (PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED  DURING BREACH FORMATION)


      PLAN  1 ...............                  INITIAL VALUE     SPILLWAY CREST     TOP OF DAM
                                 ELEVATION        5545.50            5549.20          5552.00
                                 STORAGE            5845.              6508.            7347.
                                 OUTFLOW               0.                45.             435.


                      RATIO     MAXIMUM      MAXIMUM    MAXIMUM    MAXIMUM    DURATION     TIME OF     TIME OF
                        OF     RESERVOIR      DEPTH     STORAGE    OUTFLOW    OVER TOP   MAX OUTFLOW   FAILURE
                       PMF      W.S.ELEV    OVER DAM     AC-FT       CFS       HOURS        HOURS       HOURS

                      1.00      5548.87         .00       6408.        43.       .00        26.40         .00


 *** NORMAL END OF HEC-1 ***
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Storm Event 8. 100-year, 6-hour AMC III

```
1*****************************************                                                   ***************************************
 *                                       *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
 *               JUN   1998              *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
 *            VERSION 4.1                *                                                   *          609 SECOND STREET          *
 *                                       *                                                   *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:54:27   *                                                   *           (916) 756-1104            *
 *                                       *                                                   *                                     *
 *****************************************                                                   ***************************************




                                                 X     X  XXXXXXX   XXXXX           X
                                                 X     X  X        X     X         XX
                                                 X     X  X        X                X
                                                 XXXXXXX  XXXX     X       XXXXX    X
                                                 X     X  X        X                X
                                                 X     X  X        X     X          X
                                                 X     X  XXXXXXX   XXXXX          XXX




            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                                       HEC-1 INPUT                                             PAGE  1

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              1           ID   HYDROLOGY STUDY for COVE RESERVOIR
              2           ID   Located in KANE COUNTY, UTAH
              3           ID
              4           ID   AUG 2020
              5           ID
              6           ID   PREPARED BY ALPHA ENGINEERING
              7           ID   43 SOUTH 100 EAST, SUITE 100
              8           ID   ST. GEORGE, UTAH  84770
              9           ID   TEL: (435) 628-6500
             10           ID   FAX: (435) 628-6553
             11           ID
             12           ID   100-YR, 6-HR, AMC III
             13           ID
                          *Diagram
             14           JR    PREC     1.0
             15           IT      18       0       0      50
             16           IO       0
             17           IN      18
                          *

             18           KK   B1
             19           KM   Runoff from Basin 1
             20           BA   0.503
             21           PB    2.75
             22           PC       0   0.020   0.046   0.070   0.095   0.130   0.180   0.300   0.520   0.650
             23           PC   0.700   0.745   0.785   0.820   0.850   0.880   0.905   0.930   0.955   0.980
             24           PC   1.000
             25           LS       0    86.0
             26           UD    0.34
                          *

             27           KK   RB1
             28           KM   Route B1
             29           RD    4928    .045    .050            TRAP      20      20
                          *

             30           KK   B2
             31           KM   Runoff from Basin 2
             32           BA   0.436
             33           LS       0    85.8
             34           UD    0.34
                          *

             35           KK   B3
             36           KM   Runoff from Basin 3
             37           BA   0.279
             38           LS       0    84.9
             39           UD    0.25
                          *
1                                                       HEC-1 INPUT                                             PAGE  2

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10
```

```
             40           KK   C1
             41           KM   Combine RB1, B2, B3
             42           HC       3
                          *

             43           KK   RC1
             44           KM   Route RC1
             45           RD    7255    .060    .030            TRAP      20      20
                          *

             46           KK   B4
             47           KM   Runoff from Basin 4
             48           BA   0.453
             49           LS       0    86.3
             50           UD    0.32
                          *

             51           KK   B5
             52           KM   Runoff from Basin 5
             53           BA   0.805
             54           LS       0    86.8
             55           UD    0.42
                          *

             56           KK   C2
             57           KM   Combine RC1, B4, B5
             58           HC       3
                          *

             59           KK   RC2
             60           KM   Route C2
             61           RD    2380    .039    .030            TRAP      40       2
                          *

             62           KK   B6
             63           KM   Runoff from Basin 6
             64           BA   0.150
             65           LS       0    92.5
             66           UD    0.14
                          *

             67           KK   B7
             68           KM   Runoff from Basin 7
             69           BA   0.327
             70           LS       0    87.8
             71           UD    0.31
                          *

             72           KK   C3
             73           KM   Combine RC2, B6, B7
             74           HC       3
                          *
1                                                       HEC-1 INPUT                                             PAGE  3

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


             75           KK   RC3
             76           KM   Route C3
             77           RD   11323    .023    .030            TRAP      40      20
                          *

             78           KK   B8
             79           KM   Runoff from Basin 8
             80           BA   1.012
             81           LS       0    92.4
             82           UD    0.48
                          *

             83           KK   B9
             84           KM   Runoff from Basin 9
             85           BA   0.242
             86           LS       0    93.1
             87           UD    0.19
                          *

             88           KK   B10
             89           KM   Runoff from Basin 10
             90           BA   0.129
             91           LS       0    93.7
             92           UD    0.14
                          *

             93           KK   C4
             94           KM   Combine B9, B10
             95           HC       2
                          *

             96           KK   RC4
             97           KM   Route C4
             98           RD    3380    .037    .030            TRAP      40      20
                          *
```

```
             99           KK   B11
            100           KM   Runoff from Basin 11
            101           BA   0.279
            102           LS       0    92.8
            103           UD    0.28
                          *

            104           KK   C5
            105           KM   Combine RC3, B8, RC4, B11
            106           HC       4
                          *

            107           KK   B12
            108           KM   Runoff from Basin 12
            109           BA   0.127
            110           LS       0    90.9
            111           UD    0.28
                          *
1                                                       HEC-1 INPUT                                             PAGE  4

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


            112           KK   Call
            113           KM   Combine C5, B12
            114           HC       2
                          *

            115           KK   Cove Reservoir
            116           KM   Routing through Res'v
            117           RS       1    ELEV  5545.5
            118           SV       0      19      95     240     453     738    1105    1563    2217    2773
            119           SV    3542    4423    5419    6149    7347    8000
            120           SE    5470    5476    5482    5488    5494    5500    5506    5512    5518    5524
            121           SE    5530    5536    5542    5548    5552    5558
            122           SL  5545.5   4.909     0.6     0.5
            123           SS  5549.2      30    2.67     1.5
            124           ST  5552.0    1892     2.9     1.5
                          *
            125           ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW

    18       B1
                 V
                 V
    27       RB1
                 .
                 .
    30           .       B2
                 .           .
                 .           .
    35           .           .       B3
                 .           .           .
                 .           .           .
    40       C1   ........................
                 V
                 V
    43       RC1
                 .
                 .
    46           .       B4
                 .           .
                 .           .
    51           .           .       B5
                 .           .           .
                 .           .           .
    56       C2   ........................
                 V
                 V
    59       RC2
                 .
                 .
    62           .       B6
                 .           .
                 .           .
    67           .           .       B7
                 .           .           .
                 .           .           .
    72       C3   ........................
                 V
                 V
    75       RC3
                 .
                 .
    78           .       B8
                 .           .
```

```
                 .           .
    83           .           .       B9
                 .           .           .
                 .           .           .
    88           .           .           .       B10
                 .           .           .           .
                 .           .           .           .
    93           .           .       C4   ............
                 .           .           V
                 .           .           V
    96           .           .       RC4
                 .           .           .
                 .           .           .
    99           .           .           .       B11
                 .           .           .           .
                 .           .           .           .
   104       C5   ....................................
                 .
                 .
   107           .       B12
                 .           .
                 .           .
   112       Call ............
                 V
                 V
   115       Cove

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                                   ****************************************
 *                                       *                                                   *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
 *               JUN   1998              *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
 *            VERSION 4.1                *                                                   *          609 SECOND STREET          *
 *                                       *                                                   *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:54:27   *                                                   *           (916) 756-1104            *
 *                                       *                                                   *                                      *
 *****************************************                                                   ****************************************





                            HYDROLOGY STUDY for COVE RESERVOIR
                            Located in KANE COUNTY, UTAH

                            AUG 2020

                            PREPARED BY ALPHA ENGINEERING
                            43 SOUTH 100 EAST, SUITE 100
                            ST. GEORGE, UTAH  84770
                            TEL: (435) 628-6500
                            FAX: (435) 628-6553

                            100-YR, 6-HR, AMC III


   16 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           0  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN          18  MINUTES IN COMPUTATION INTERVAL
                        IDATE      1    0  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ          50  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE      1    0  ENDING DATE
                       NDTIME        1442  ENDING TIME
                       ICENT           19  CENTURY MARK

                    COMPUTATION INTERVAL     .30 HOURS
                         TOTAL TIME BASE   14.70 HOURS

           ENGLISH UNITS
                DRAINAGE AREA         SQUARE MILES
                PRECIPITATION DEPTH   INCHES
                LENGTH, ELEVATION     FEET
                FLOW                  CUBIC FEET PER SECOND
                STORAGE VOLUME        ACRE-FEET
                SURFACE AREA          ACRES
                TEMPERATURE           DEGREES FAHRENHEIT

      JP          MULTI-PLAN OPTION
                        NPLAN           1  NUMBER OF PLANS

      JR          MULTI-RATIO OPTION
                      RATIOS OF PRECIPITATION
                     1.00



 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
```

```
 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
  112 KK    *     Call   *
            *            *
            **************
                         Combine C5, B12

  114 HC          HYDROGRAPH COMBINATION
                        ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                          ***

 *****************************************************************************************************************************

                                                     HYDROGRAPH AT STATION    Call
                                                          SUM OF  2 HYDROGRAPHS
                                                         PLAN 1,   RATIO =  1.00

 *****************************************************************************************************************************
                                  *                                 *                                 *
    DA MON HRMN  ORD      FLOW    *   DA MON HRMN  ORD      FLOW    *   DA MON HRMN  ORD      FLOW    *   DA MON HRMN  ORD      FLOW
                                  *                                 *                                 *
     1     0000   1        0.     *    1     0354   14     1248.    *    1     0748   27       53.    *    1     1142   40        0.
     1     0018   2        0.     *    1     0412   15     1032.    *    1     0806   28       30.    *    1     1200   41        0.
     1     0036   3        0.     *    1     0430   16      892.    *    1     0824   29       15.    *    1     1218   42        0.
     1     0054   4        1.     *    1     0448   17      796.    *    1     0842   30        8.    *    1     1236   43        0.
     1     0112   5       10.     *    1     0506   18      719.    *    1     0900   31        4.    *    1     1254   44        0.
     1     0130   6       39.     *    1     0524   19      668.    *    1     0918   32        2.    *    1     1312   45        0.
     1     0148   7      106.     *    1     0542   20      638.    *    1     0936   33        1.    *    1     1330   46        0.
     1     0206   8      321.     *    1     0600   21      611.    *    1     0954   34        0.    *    1     1348   47        0.
     1     0224   9      883.     *    1     0618   22      529.    *    1     1012   35        0.    *    1     1406   48        0.
     1     0242  10     1826.     *    1     0636   23      386.    *    1     1030   36        0.    *    1     1424   49        0.
     1     0300  11     2280.     *    1     0654   24      254.    *    1     1048   37        0.    *    1     1442   50        0.
     1     0318  12     1978.     *    1     0712   25      156.    *    1     1106   38        0.    *
     1     0336  13     1550.     *    1     0730   26       95.    *    1     1124   39        0.    *
                                  *                                 *                                 *
 *****************************************************************************************************************************

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     14.70-HR
+   (CFS)       (HR)
                           (CFS)
+    2280.      3.00                 847.        350.        350.         350.
                        (INCHES)    1.661       1.679       1.679        1.679
                         (AC-FT)     420.        425.        425.         425.

                         CUMULATIVE AREA =    4.74 SQ MI



 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
  115 KK    *     Cove   *     Reservoir
            *            *
            **************
                         Routing through Res'v

               HYDROGRAPH ROUTING DATA

  117 RS          STORAGE ROUTING
                        NSTPS           1  NUMBER OF SUBREACHES
                         ITYP        ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC     5545.50  INITIAL CONDITION
                            X         .00 WORKING R AND D COEFFICIENT

  118 SV            STORAGE           .0      19.0      95.0     240.0     453.0     738.0    1105.0    1563.0    2217.0    2773.0
                                3542.0    4423.0    5419.0    6149.0    7347.0    8000.0

  120 SE          ELEVATION     5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00
                                5530.00   5536.00   5542.00   5548.00   5552.00   5558.00

  122 SL          LOW-LEVEL OUTLET
                        ELEVL     5545.50  ELEVATION AT CENTER OF OUTLET
                        CAREA        4.91  CROSS-SECTIONAL AREA
                         COQL         .60  COEFFICIENT
                         EXPL         .50  EXPONENT OF HEAD

  123 SS          SPILLWAY
                         CREL     5549.20  SPILLWAY CREST ELEVATION
                        SPWID       30.00  SPILLWAY WIDTH
                         COQW        2.67  WEIR COEFFICIENT
                         EXPW        1.50  EXPONENT OF HEAD

  124 ST          TOP OF DAM
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                        TOPEL     5552.00  ELEVATION AT TOP OF DAM
                       DAMWID     1892.00  DAM WIDTH
                         COQD        2.90  WEIR COEFFICIENT
                         EXPD        1.50  EXPONENT OF HEAD

                                                                 ***

                                                  COMPUTED OUTFLOW-ELEVATION DATA

                                                    (EXCLUDING FLOW OVER DAM)

             OUTFLOW        .00       .00     25.78     27.48     29.42     31.65     34.25     37.31     40.98     45.44
           ELEVATION    5470.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00   5548.51   5549.20

             OUTFLOW      49.37     68.29    113.97    198.20    332.85    529.64    800.37   1156.85   1610.93   2174.46
           ELEVATION    5549.32   5549.60   5550.06   5550.68   5551.48   5552.44   5553.58   5554.88   5556.36   5558.00


                                              COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

                                                    (INCLUDING FLOW OVER DAM)

             STORAGE        .00     19.00     95.00    240.00    453.00    738.00   1105.00   1563.00   2217.00   2773.00
             OUTFLOW        .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
           ELEVATION    5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00

             STORAGE    3542.00   4423.00   5419.00   5844.83   5989.79   6009.51   6033.57   6063.27   6100.64   6148.41
             OUTFLOW        .00       .00       .00       .00     25.78     27.48     29.42     31.65     34.25     37.31
           ELEVATION    5530.00   5536.00   5542.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00

             STORAGE    6301.53   6508.46   6543.56   6628.96   6765.11   6952.15   7190.23   7347.00   7395.04   7518.54
             OUTFLOW      40.98     45.44     49.37     68.29    113.97    198.20    332.85    435.48   2138.72  11657.74
           ELEVATION    5548.51   5549.20   5549.32   5549.60   5550.06   5550.68   5551.48   5552.00   5552.44   5553.58

             STORAGE    7660.53   7821.02   8000.00
             OUTFLOW   27985.71  51484.63  82813.63
           ELEVATION    5554.88   5556.36   5558.00

 ***********************************************************************************************************************************

                                                   HYDROGRAPH AT STATION    Cove
                                                       PLAN 1,   RATIO =  1.00

 ***********************************************************************************************************************************
                                            *                                           *
  DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE
                                            *                                           *
   1     0000   1       0.   5844.8  5545.5 *  1     0506  18      38.   6168.2  5548.1 *  1     1012  35      40.   6245.8  5548.3
   1     0018   2       0.   5844.8  5545.5 *  1     0524  19      38.   6184.4  5548.1 *  1     1030  36      40.   6244.8  5548.3
   1     0036   3       0.   5844.8  5545.5 *  1     0542  20      39.   6199.6  5548.2 *  1     1048  37      40.   6243.8  5548.3
   1     0054   4       0.   5844.8  5545.5 *  1     0600  21      39.   6214.1  5548.2 *  1     1106  38      40.   6242.7  5548.3
   1     0112   5       1.   5845.0  5545.5 *  1     0618  22      39.   6227.2  5548.3 *  1     1124  39      40.   6241.7  5548.3
   1     0130   6       2.   5845.5  5545.5 *  1     0636  23      39.   6237.6  5548.3 *  1     1142  40      40.   6240.7  5548.3
   1     0148   7       3.   5847.3  5545.5 *  1     0654  24      40.   6244.6  5548.3 *  1     1200  41      40.   6239.7  5548.3
   1     0206   8       6.   5852.4  5545.6 *  1     0712  25      40.   6248.7  5548.3 *  1     1218  42      40.   6238.6  5548.3
   1     0224   9      10.   5867.2  5545.7 *  1     0730  26      40.   6250.9  5548.3 *  1     1236  43      39.   6237.6  5548.3
   1     0242  10      16.   5900.4  5546.0 *  1     0748  27      40.   6251.8  5548.3 *  1     1254  44      39.   6236.6  5548.3
   1     0300  11      22.   5950.9  5546.4 *  1     0806  28      40.   6251.8  5548.3 *  1     1312  45      39.   6235.6  5548.3
   1     0318  12      27.   6003.0  5546.8 *  1     0824  29      40.   6251.4  5548.3 *  1     1330  46      39.   6234.6  5548.3
   1     0336  13      30.   6046.0  5547.2 *  1     0842  30      40.   6250.6  5548.3 *  1     1348  47      39.   6233.5  5548.3
   1     0354  14      33.   6080.0  5547.4 *  1     0900  31      40.   6249.8  5548.3 *  1     1406  48      39.   6232.5  5548.3
   1     0412  15      35.   6107.4  5547.7 *  1     0918  32      40.   6248.9  5548.3 *  1     1424  49      39.   6231.5  5548.3
   1     0430  16      36.   6130.3  5547.8 *  1     0936  33      40.   6247.9  5548.3 *  1     1442  50      39.   6230.5  5548.3
   1     0448  17      37.   6150.3  5548.0 *  1     0954  34      40.   6246.8  5548.3 *
                                            *                                           *
 ***********************************************************************************************************************************

 PEAK OUTFLOW IS       40. AT TIME   7.80 HOURS


  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     14.70-HR
+   (CFS)       (HR)
                           (CFS)
+      40.      7.80                   40.         31.         31.          31.
                        (INCHES)      .078        .151        .151         .151
                         (AC-FT)       20.         38.         38.          38.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     14.70-HR
+  (AC-FT)      (HR)
     6252.      7.80                 6246.       6138.       6138.        6138.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     14.70-HR
+   (FEET)      (HR)
   5548.34      7.80               5548.32     5547.63     5547.63      5547.63

                         CUMULATIVE AREA =    4.74 SQ MI

1
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                PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                  FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                  TIME TO PEAK IN HOURS


                                                           RATIOS APPLIED TO PRECIPITATION
 OPERATION       STATION     AREA    PLAN           RATIO 1
                                                        1.00

 HYDROGRAPH AT
+                  B1          .50     1   FLOW         252.
                                           TIME         2.70

 ROUTED TO
+                  RB1         .50     1   FLOW         245.
                                           TIME         3.00

 HYDROGRAPH AT
+                  B2          .44     1   FLOW         216.
                                           TIME         2.70

 HYDROGRAPH AT
+                  B3          .28     1   FLOW         142.
                                           TIME         2.70

  3 COMBINED AT
+                  C1         1.22     1   FLOW         542.
                                           TIME         2.70

 ROUTED TO
+                  RC1        1.22     1   FLOW         538.
                                           TIME         3.00

 HYDROGRAPH AT
+                  B4          .45     1   FLOW         237.
                                           TIME         2.70

 HYDROGRAPH AT
+                  B5          .81     1   FLOW         376.
                                           TIME         2.70

  3 COMBINED AT
+                  C2         2.48     1   FLOW        1100.
                                           TIME         3.00

 ROUTED TO
+                  RC2        2.48     1   FLOW        1090.
                                           TIME         3.00

 HYDROGRAPH AT
+                  B6          .15     1   FLOW         128.
                                           TIME         2.40

 HYDROGRAPH AT
+                  B7          .33     1   FLOW         188.
                                           TIME         2.70

  3 COMBINED AT
+                  C3         2.95     1   FLOW        1294.
                                           TIME         3.00

 ROUTED TO
+                  RC3        2.95     1   FLOW        1250.
                                           TIME         3.30

 HYDROGRAPH AT
+                  B8         1.01     1   FLOW         620.
                                           TIME         3.00

 HYDROGRAPH AT
+                  B9          .24     1   FLOW         196.
                                           TIME         2.40

 HYDROGRAPH AT
+                  B10         .13     1   FLOW         118.
                                           TIME         2.40

  2 COMBINED AT
+                  C4          .37     1   FLOW         314.
                                           TIME         2.40

 ROUTED TO
+                  RC4         .37     1   FLOW         290.
                                           TIME         2.70

 HYDROGRAPH AT
+                  B11         .28     1   FLOW         212.
                                           TIME         2.70

  4 COMBINED AT
+                  C5         4.61     1   FLOW        2218.
                                           TIME         3.00
```

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 HYDROGRAPH AT
+                  B12         .13     1   FLOW          88.
                                           TIME         2.70

  2 COMBINED AT
+                  Call       4.74     1   FLOW        2280.
                                           TIME         3.00

 ROUTED TO
+                  Cove       4.74     1   FLOW          40.
                                           TIME         7.80

                                       ** PEAK STAGES IN FEET **
                                       1   STAGE     5548.34
                                           TIME         7.80
1
                                           SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                                               (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                                   INTERPOLATED TO
                                                                                COMPUTATION INTERVAL
            ISTAQ    ELEMENT      DT       PEAK    TIME TO     VOLUME      DT       PEAK    TIME TO     VOLUME
                                                     PEAK                                     PEAK

                                 (MIN)     (CFS)      (MIN)     (IN)     (MIN)     (CFS)     (MIN)       (IN)

           FOR PLAN = 1  RATIO=  .00
              RB1    MANE         4.50    251.41    175.50      1.45     18.00    245.28    180.00        1.45


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .3891E+02 EXCESS= .0000E+00 OUTFLOW= .3894E+02 BASIN STORAGE= .4659E-02 PERCENT ERROR=   -.1


           FOR PLAN = 1  RATIO=  .00
              RC1    MANE         4.50    551.33    175.50      1.43     18.00    538.17    180.00        1.42


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .9271E+02 EXCESS= .0000E+00 OUTFLOW= .9275E+02 BASIN STORAGE= .3503E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC2    MANE         2.45   1093.25    181.44      1.46     18.00   1089.58    180.00        1.46


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1924E+03 EXCESS= .0000E+00 OUTFLOW= .1925E+03 BASIN STORAGE= .2883E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC3    MANE         7.20   1313.52    187.20      1.50     18.00   1250.30    198.00        1.50


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .2363E+03 EXCESS= .0000E+00 OUTFLOW= .2366E+03 BASIN STORAGE= .1038E-01 PERCENT ERROR=   -.1


           FOR PLAN = 1  RATIO=  .00
              RC4    MANE         5.40    310.06    156.60      2.04     18.00    289.52    162.00        2.04


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .4045E+02 EXCESS= .0000E+00 OUTFLOW= .4046E+02 BASIN STORAGE= .2901E-02 PERCENT ERROR=    .0


1                                  SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION    Cove
                              (PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED  DURING BREACH FORMATION)


      PLAN  1 ...............                  INITIAL VALUE     SPILLWAY CREST     TOP OF DAM
                                 ELEVATION        5545.50            5549.20          5552.00
                                 STORAGE            5845.              6508.            7347.
                                 OUTFLOW               0.                45.             435.


                      RATIO     MAXIMUM      MAXIMUM    MAXIMUM    MAXIMUM    DURATION     TIME OF     TIME OF
                        OF     RESERVOIR      DEPTH     STORAGE    OUTFLOW    OVER TOP   MAX OUTFLOW   FAILURE
                       PMF      W.S.ELEV    OVER DAM     AC-FT       CFS       HOURS       HOURS       HOURS

                      1.00      5548.34         .00       6252.        40.       .00         7.80         .00


 *** NORMAL END OF HEC-1 ***
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Storm Event 9. 100-year, 24-hour AMC III

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1****************************************                                                   ***************************************
 *                                       *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998               *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1                 *                                                   *          609 SECOND STREET          *
 *                                       *                                                   *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:55:10   *                                                   *           (916) 756-1104            *
 *                                       *                                                   *                                     *
 ****************************************                                                   ***************************************




                                                 X     X  XXXXXXX   XXXXX           X
                                                 X     X  X        X     X         XX
                                                 X     X  X        X                X
                                                 XXXXXXX  XXXX     X        XXXXX   X
                                                 X     X  X        X                X
                                                 X     X  X        X     X          X
                                                 X     X  XXXXXXX   XXXXX          XXX




            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                                       HEC-1 INPUT                                                    PAGE  1

           LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              1          ID   HYDROLOGY STUDY for COVE RESERVOIR
              2          ID   Located in KANE COUNTY, UTAH
              3          ID
              4          ID   AUG 2020
              5          ID
              6          ID   PREPARED BY ALPHA ENGINEERING
              7          ID   43 SOUTH 100 EAST, SUITE 100
              8          ID   ST. GEORGE, UTAH  84770
              9          ID   TEL: (435) 628-6500
             10          ID   FAX: (435) 628-6553
             11          ID
             12          ID   100-YR, 24-HR, AMC III
             13          ID
                         *Diagram
             14          JR    PREC     1.0
             15          IT      72       0       0      50
             16          IO       0
             17          IN      72
                         *

             18          KK   B1
             19          KM   Runoff from Basin 1
             20          BA   0.503
             21          PB    3.51
             22          PC       0   0.020   0.046   0.070   0.095   0.130   0.180   0.300   0.520   0.650
             23          PC   0.700   0.745   0.785   0.820   0.850   0.880   0.905   0.930   0.955   0.980
             24          PC   1.000
             25          LS       0    86.0
             26          UD    0.34
                         *

             27          KK   RB1
             28          KM   Route B1
             29          RD    4928    .045    .050            TRAP      20      20
                         *

             30          KK   B2
             31          KM   Runoff from Basin 2
             32          BA   0.436
             33          LS       0    85.8
             34          UD    0.34
                         *

             35          KK   B3
             36          KM   Runoff from Basin 3
             37          BA   0.279
             38          LS       0    84.9
             39          UD    0.25
                         *
1                                                       HEC-1 INPUT                                                    PAGE  2

           LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10
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```
             40           KK   C1
             41           KM   Combine RB1, B2, B3
             42           HC       3
                          *

             43           KK   RC1
             44           KM   Route RC1
             45           RD    7255    .060    .030            TRAP      20      20
                          *

             46           KK   B4
             47           KM   Runoff from Basin 4
             48           BA   0.453
             49           LS       0    86.3
             50           UD    0.32
                          *

             51           KK   B5
             52           KM   Runoff from Basin 5
             53           BA   0.805
             54           LS       0    86.8
             55           UD    0.42
                          *

             56           KK   C2
             57           KM   Combine RC1, B4, B5
             58           HC       3
                          *

             59           KK   RC2
             60           KM   Route C2
             61           RD    2380    .039    .030            TRAP      40       2
                          *

             62           KK   B6
             63           KM   Runoff from Basin 6
             64           BA   0.150
             65           LS       0    92.5
             66           UD    0.14
                          *

             67           KK   B7
             68           KM   Runoff from Basin 7
             69           BA   0.327
             70           LS       0    87.8
             71           UD    0.31
                          *

             72           KK   C3
             73           KM   Combine RC2, B6, B7
             74           HC       3
                          *
1                                                       HEC-1 INPUT                                             PAGE  3

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


             75           KK   RC3
             76           KM   Route C3
             77           RD   11323    .023    .030            TRAP      40      20
                          *

             78           KK   B8
             79           KM   Runoff from Basin 8
             80           BA   1.012
             81           LS       0    92.4
             82           UD    0.48
                          *

             83           KK   B9
             84           KM   Runoff from Basin 9
             85           BA   0.242
             86           LS       0    93.1
             87           UD    0.19
                          *

             88           KK   B10
             89           KM   Runoff from Basin 10
             90           BA   0.129
             91           LS       0    93.7
             92           UD    0.14
                          *

             93           KK   C4
             94           KM   Combine B9, B10
             95           HC       2
                          *

             96           KK   RC4
             97           KM   Route C4
             98           RD    3380    .037    .030            TRAP      40      20
                          *
```

```
             99           KK   B11
            100           KM   Runoff from Basin 11
            101           BA   0.279
            102           LS       0    92.8
            103           UD    0.28
                          *

            104           KK   C5
            105           KM   Combine RC3, B8, RC4, B11
            106           HC       4
                          *

            107           KK   B12
            108           KM   Runoff from Basin 12
            109           BA   0.127
            110           LS       0    90.9
            111           UD    0.28
                          *
1                                                       HEC-1 INPUT                                             PAGE  4

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


            112           KK   Call
            113           KM   Combine C5, B12
            114           HC       2
                          *

            115           KK   Cove Reservoir
            116           KM   Routing through Res'v
            117           RS       1    ELEV  5545.5
            118           SV       0      19      95     240     453     738    1105    1563    2217    2773
            119           SV    3542    4423    5419    6149    7347    8000
            120           SE    5470    5476    5482    5488    5494    5500    5506    5512    5518    5524
            121           SE    5530    5536    5542    5548    5552    5558
            122           SL  5545.5   4.909     0.6     0.5
            123           SS  5549.2      30    2.67     1.5
            124           ST  5552.0    1892     2.9     1.5
                          *
            125           ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW

    18       B1
                 V
                 V
    27       RB1
                 .
                 .
    30           .       B2
                 .           .
                 .           .
    35           .           .       B3
                 .           .           .
                 .           .           .
    40       C1   ........................
                 V
                 V
    43       RC1
                 .
                 .
    46           .       B4
                 .           .
                 .           .
    51           .           .       B5
                 .           .           .
                 .           .           .
    56       C2   ........................
                 V
                 V
    59       RC2
                 .
                 .
    62           .       B6
                 .           .
                 .           .
    67           .           .       B7
                 .           .           .
                 .           .           .
    72       C3   ........................
                 V
                 V
    75       RC3
                 .
                 .
    78           .       B8
                 .           .
```

```
                 .           .
    83           .           .       B9
                 .           .           .
                 .           .           .
    88           .           .           .       B10
                 .           .           .           .
                 .           .           .           .
    93           .           .       C4   ............
                 .           .           V
                 .           .           V
    96           .           .       RC4
                 .           .           .
                 .           .           .
    99           .           .           .       B11
                 .           .           .           .
                 .           .           .           .
   104       C5   ....................................
                 .
                 .
   107           .       B12
                 .           .
                 .           .
   112       Call ............
                 V
                 V
   115       Cove

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                                   ***************************************
 *                                       *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
 *               JUN   1998              *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
 *            VERSION 4.1                *                                                   *          609 SECOND STREET         *
 *                                       *                                                   *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:55:10   *                                                   *           (916) 756-1104            *
 *                                       *                                                   *                                     *
 *****************************************                                                   ***************************************





                            HYDROLOGY STUDY for COVE RESERVOIR
                            Located in KANE COUNTY, UTAH

                            AUG 2020

                            PREPARED BY ALPHA ENGINEERING
                            43 SOUTH 100 EAST, SUITE 100
                            ST. GEORGE, UTAH  84770
                            TEL: (435) 628-6500
                            FAX: (435) 628-6553

                            100-YR, 24-HR, AMC III


   16 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           0  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN          72  MINUTES IN COMPUTATION INTERVAL
                        IDATE      1    0  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ          50  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE      3    0  ENDING DATE
                       NDTIME        1048  ENDING TIME
                       ICENT           19  CENTURY MARK

                    COMPUTATION INTERVAL    1.20 HOURS
                         TOTAL TIME BASE   58.80 HOURS

           ENGLISH UNITS
                DRAINAGE AREA         SQUARE MILES
                PRECIPITATION DEPTH   INCHES
                LENGTH, ELEVATION     FEET
                FLOW                  CUBIC FEET PER SECOND
                STORAGE VOLUME        ACRE-FEET
                SURFACE AREA          ACRES
                TEMPERATURE           DEGREES FAHRENHEIT

      JP          MULTI-PLAN OPTION
                        NPLAN           1  NUMBER OF PLANS

      JR          MULTI-RATIO OPTION
                      RATIOS OF PRECIPITATION
                     1.00



 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
```

```
 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
  112 KK     *     Call   *
             *            *
             **************
                            Combine C5, B12

  114 HC          HYDROGRAPH COMBINATION
                        ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                 ***

 ***********************************************************************************************************************************

                                                   HYDROGRAPH AT STATION    Call
                                                        SUM OF  2 HYDROGRAPHS
                                                       PLAN 1,   RATIO =  1.00

 ***********************************************************************************************************************************
                                 *                                *                                *
    DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW
                                 *                                *                                *
     1     0000    1        0.   *    1     1536   14      305.   *    2     0712   27        0.   *    2     2248   40        0.
     1     0112    2        0.   *    1     1648   15      266.   *    2     0824   28        0.   *    3     0000   41        0.
     1     0224    3        0.   *    1     1800   16      248.   *    2     0936   29        0.   *    3     0112   42        0.
     1     0336    4        6.   *    1     1912   17      223.   *    2     1048   30        0.   *    3     0224   43        0.
     1     0448    5       18.   *    1     2024   18      209.   *    2     1200   31        0.   *    3     0336   44        0.
     1     0600    6       44.   *    1     2136   19      205.   *    2     1312   32        0.   *    3     0448   45        0.
     1     0712    7      101.   *    1     2248   20      204.   *    2     1424   33        0.   *    3     0600   46        0.
     1     0824    8      371.   *    2     0000   21      185.   *    2     1536   34        0.   *    3     0712   47        0.
     1     0936    9     1026.   *    2     0112   22       96.   *    2     1648   35        0.   *    3     0824   48        0.
     1     1048   10     1031.   *    2     0224   23       37.   *    2     1800   36        0.   *    3     0936   49        0.
     1     1200   11      662.   *    2     0336   24       12.   *    2     1912   37        0.   *    3     1048   50        0.
     1     1312   12      453.   *    2     0448   25        3.   *    2     2024   38        0.   *
     1     1424   13      356.   *    2     0600   26        1.   *    2     2136   39        0.   *
                                 *                                *                                *
 ***********************************************************************************************************************************

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     58.80-HR
+   (CFS)       (HR)
                           (CFS)
+    1031.     10.80                  707.        302.        124.         124.
                        (INCHES)     1.386       2.372       2.377        2.377
                         (AC-FT)      351.        600.        601.         601.

                         CUMULATIVE AREA =    4.74 SQ MI



 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
  115 KK     *     Cove   *     Reservoir
             *            *
             **************
                            Routing through Res'v

                HYDROGRAPH ROUTING DATA

  117 RS          STORAGE ROUTING
                        NSTPS           1  NUMBER OF SUBREACHES
                         ITYP        ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC     5545.50  INITIAL CONDITION
                            X         .00 WORKING R AND D COEFFICIENT

  118 SV            STORAGE          .0      19.0      95.0     240.0     453.0     738.0    1105.0    1563.0    2217.0    2773.0
                                 3542.0    4423.0    5419.0    6149.0    7347.0    8000.0

  120 SE          ELEVATION     5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00
                                5530.00   5536.00   5542.00   5548.00   5552.00   5558.00

  122 SL          LOW-LEVEL OUTLET
                        ELEVL     5545.50  ELEVATION AT CENTER OF OUTLET
                        CAREA        4.91  CROSS-SECTIONAL AREA
                         COQL         .60  COEFFICIENT
                         EXPL         .50  EXPONENT OF HEAD

  123 SS          SPILLWAY
                         CREL     5549.20  SPILLWAY CREST ELEVATION
                        SPWID       30.00  SPILLWAY WIDTH
                         COQW        2.67  WEIR COEFFICIENT
                         EXPW        1.50  EXPONENT OF HEAD

  124 ST          TOP OF DAM
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                        TOPEL     5552.00  ELEVATION AT TOP OF DAM
                       DAMWID     1892.00  DAM WIDTH
                         COQD        2.90  WEIR COEFFICIENT
                         EXPD        1.50  EXPONENT OF HEAD

                                                                 ***

                                                  COMPUTED OUTFLOW-ELEVATION DATA

                                                    (EXCLUDING FLOW OVER DAM)

             OUTFLOW       .00       .00     25.78     27.48     29.42     31.65     34.25     37.31     40.98     45.44
           ELEVATION   5470.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00   5548.51   5549.20

             OUTFLOW     49.37     68.29    113.97    198.20    332.85    529.64    800.37   1156.85   1610.93   2174.46
           ELEVATION   5549.32   5549.60   5550.06   5550.68   5551.48   5552.44   5553.58   5554.88   5556.36   5558.00


                                              COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

                                                    (INCLUDING FLOW OVER DAM)

             STORAGE       .00     19.00     95.00    240.00    453.00    738.00   1105.00   1563.00   2217.00   2773.00
             OUTFLOW       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
           ELEVATION   5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00

             STORAGE   3542.00   4423.00   5419.00   5844.83   5989.79   6009.51   6033.57   6063.27   6100.64   6148.41
             OUTFLOW       .00       .00       .00       .00     25.78     27.48     29.42     31.65     34.25     37.31
           ELEVATION   5530.00   5536.00   5542.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00

             STORAGE   6301.53   6508.46   6543.56   6628.96   6765.11   6952.15   7190.23   7347.00   7395.04   7518.54
             OUTFLOW     40.98     45.44     49.37     68.29    113.97    198.20    332.85    435.48   2138.72  11657.74
           ELEVATION   5548.51   5549.20   5549.32   5549.60   5550.06   5550.68   5551.48   5552.00   5552.44   5553.58

             STORAGE   7660.53   7821.02   8000.00
             OUTFLOW  27985.71  51484.63  82813.63
           ELEVATION   5554.88   5556.36   5558.00

 ***********************************************************************************************************************************

                                                   HYDROGRAPH AT STATION    Cove
                                                       PLAN 1,   RATIO =  1.00

 ***********************************************************************************************************************************
                                            *                                           *
  DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE
                                            *                                           *
   1     0000   1       0.   5844.8  5545.5 *  1     2024  18      42.   6325.1  5548.6 *  2     1648  35      42.   6337.5  5548.6
   1     0112   2       0.   5844.8  5545.5 *  1     2136  19      42.   6341.5  5548.6 *  2     1800  36      42.   6333.4  5548.6
   1     0224   3       0.   5844.8  5545.5 *  1     2248  20      42.   6357.5  5548.7 *  2     1912  37      42.   6329.3  5548.6
   1     0336   4       1.   5845.1  5545.5 *  2     0000  21      43.   6372.6  5548.7 *  2     2024  38      42.   6325.2  5548.6
   1     0448   5       2.   5846.1  5545.5 *  2     0112  22      43.   6382.3  5548.8 *  2     2136  39      41.   6321.1  5548.6
   1     0600   6       4.   5848.8  5545.5 *  2     0224  23      43.   6384.6  5548.8 *  2     2248  40      41.   6317.0  5548.6
   1     0712   7       7.   5855.4  5545.6 *  2     0336  24      43.   6382.8  5548.8 *  3     0000  41      41.   6312.9  5548.5
   1     0824   8      12.   5877.9  5545.8 *  2     0448  25      43.   6379.3  5548.8 *  3     0112  42      41.   6308.8  5548.5
   1     0936   9      21.   5945.5  5546.3 *  2     0600  26      43.   6375.2  5548.8 *  3     0224  43      41.   6304.7  5548.5
   1     1048  10      30.   6044.9  5547.1 *  2     0712  27      43.   6371.0  5548.7 *  3     0336  44      41.   6300.7  5548.5
   1     1200  11      36.   6125.6  5547.8 *  2     0824  28      42.   6366.8  5548.7 *  3     0448  45      41.   6296.6  5548.5
   1     1312  12      38.   6177.2  5548.1 *  2     0936  29      42.   6362.5  5548.7 *  3     0600  46      41.   6292.5  5548.5
   1     1424  13      39.   6213.5  5548.2 *  2     1048  30      42.   6358.3  5548.7 *  3     0712  47      41.   6288.4  5548.5
   1     1536  14      40.   6242.4  5548.3 *  2     1200  31      42.   6354.0  5548.7 *  3     0824  48      41.   6284.3  5548.5
   1     1648  15      40.   6266.9  5548.4 *  2     1312  32      42.   6349.8  5548.7 *  3     0936  49      40.   6280.3  5548.4
   1     1800  16      41.   6288.4  5548.5 *  2     1424  33      42.   6345.7  5548.7 *  3     1048  50      40.   6276.4  5548.4
   1     1912  17      41.   6307.7  5548.5 *  2     1536  34      42.   6341.6  5548.6 *
                                            *                                           *
 ***********************************************************************************************************************************

 PEAK OUTFLOW IS       43. AT TIME  26.40 HOURS


  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     58.80-HR
+   (CFS)       (HR)
                           (CFS)
+      43.     26.40                   43.         42.         35.          35.
                        (INCHES)      .084        .331        .671         .671
                         (AC-FT)       21.         84.        170.         170.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     58.80-HR
+  (AC-FT)      (HR)
     6385.     26.40                 6381.       6358.       6233.        6233.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     58.80-HR
+   (FEET)      (HR)
   5548.79     26.40               5548.77     5548.70     5548.03      5548.03

                         CUMULATIVE AREA =    4.74 SQ MI

1
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                PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                  FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                  TIME TO PEAK IN HOURS


                                                           RATIOS APPLIED TO PRECIPITATION
 OPERATION       STATION     AREA    PLAN            RATIO 1
                                                        1.00

 HYDROGRAPH AT
+                  B1          .50     1   FLOW         110.
                                           TIME         9.60

 ROUTED TO
+                  RB1         .50     1   FLOW         102.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B2          .44     1   FLOW          94.
                                           TIME         9.60

 HYDROGRAPH AT
+                  B3          .28     1   FLOW          57.
                                           TIME         9.60

  3 COMBINED AT
+                  C1         1.22     1   FLOW         245.
                                           TIME         9.60

 ROUTED TO
+                  RC1        1.22     1   FLOW         241.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B4          .45     1   FLOW         100.
                                           TIME         9.60

 HYDROGRAPH AT
+                  B5          .81     1   FLOW         183.
                                           TIME         9.60

  3 COMBINED AT
+                  C2         2.48     1   FLOW         502.
                                           TIME         9.60

 ROUTED TO
+                  RC2        2.48     1   FLOW         496.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B6          .15     1   FLOW          44.
                                           TIME         9.60

 HYDROGRAPH AT
+                  B7          .33     1   FLOW          78.
                                           TIME         9.60

  3 COMBINED AT
+                  C3         2.95     1   FLOW         612.
                                           TIME         9.60

 ROUTED TO
+                  RC3        2.95     1   FLOW         589.
                                           TIME        10.80

 HYDROGRAPH AT
+                  B8         1.01     1   FLOW         298.
                                           TIME         9.60

 HYDROGRAPH AT
+                  B9          .24     1   FLOW          73.
                                           TIME         9.60

 HYDROGRAPH AT
+                  B10         .13     1   FLOW          40.
                                           TIME         9.60

  2 COMBINED AT
+                  C4          .37     1   FLOW         113.
                                           TIME         9.60

 ROUTED TO
+                  RC4         .37     1   FLOW         106.
                                           TIME         9.60

 HYDROGRAPH AT
+                  B11         .28     1   FLOW          83.
                                           TIME         9.60

  4 COMBINED AT
+                  C5         4.61     1   FLOW        1001.
                                           TIME        10.80
```

```
 HYDROGRAPH AT
+                  B12         .13     1   FLOW          35.
                                           TIME         9.60

  2 COMBINED AT
+                  Call       4.74     1   FLOW        1031.
                                           TIME        10.80

 ROUTED TO
+                  Cove       4.74     1   FLOW          43.
                                           TIME        26.40

                                       ** PEAK STAGES IN FEET **
                                       1   STAGE     5548.79
                                           TIME        26.40
1
                                           SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                                               (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                       INTERPOLATED TO
                                                                    COMPUTATION INTERVAL
            ISTAQ    ELEMENT      DT       PEAK    TIME TO     VOLUME      DT       PEAK    TIME TO     VOLUME
                                                     PEAK                                    PEAK

                                (MIN)     (CFS)      (MIN)     (IN)     (MIN)     (CFS)     (MIN)       (IN)

           FOR PLAN = 1  RATIO=  .00
              RB1    MANE        17.89    109.66    608.15      2.11     72.00    102.14    648.00        2.12


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .5653E+02 EXCESS= .0000E+00 OUTFLOW= .5654E+02 BASIN STORAGE= .5474E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC1    MANE        13.16    246.58    605.26      2.08     72.00    240.71    648.00        2.09


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1354E+03 EXCESS= .0000E+00 OUTFLOW= .1354E+03 BASIN STORAGE= .3020E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC2    MANE         3.25    503.11    582.29      2.13     72.00    496.18    648.00        2.13


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .2808E+03 EXCESS= .0000E+00 OUTFLOW= .2808E+03 BASIN STORAGE= .2726E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC3    MANE        23.97    630.14    623.12      2.17     72.00    588.94    648.00        2.18


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .3423E+03 EXCESS= .0000E+00 OUTFLOW= .3424E+03 BASIN STORAGE= .1070E-01 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC4    MANE         9.67    112.23    590.06      2.78     72.00    105.70    576.00        2.78


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .5492E+02 EXCESS= .0000E+00 OUTFLOW= .5492E+02 BASIN STORAGE= .2119E-02 PERCENT ERROR=    .0


1                                  SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION    Cove
                              (PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED  DURING BREACH FORMATION)


      PLAN  1 ..............                 INITIAL VALUE     SPILLWAY CREST     TOP OF DAM
                                ELEVATION        5545.50          5549.20         5552.00
                                STORAGE            5845.             6508.           7347.
                                OUTFLOW               0.               45.            435.


                    RATIO     MAXIMUM      MAXIMUM    MAXIMUM    MAXIMUM    DURATION     TIME OF     TIME OF
                      OF     RESERVOIR      DEPTH     STORAGE    OUTFLOW    OVER TOP   MAX OUTFLOW   FAILURE
                     PMF      W.S.ELEV    OVER DAM     AC-FT       CFS       HOURS       HOURS       HOURS

                    1.00      5548.79         .00       6385.        43.       .00        26.40         .00


 *** NORMAL END OF HEC-1 ***
```

Storm Event 10. Local SEP Hydrograph

```
1*****************************************                                              ***************************************
 *                                        *                                             *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *                                             *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998                *                                             *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1                  *                                             *          609 SECOND STREET          *
 *                                        *                                             *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:56:10    *                                             *           (916) 756-1104            *
 *                                        *                                             *                                     *
 *****************************************                                              ***************************************




                                                 X     X  XXXXXXX   XXXXX           X
                                                 X     X  X        X     X         XX
                                                 X     X  X        X                X
                                                 XXXXXXX  XXXX     X        XXXXX   X
                                                 X     X  X        X                X
                                                 X     X  X        X     X          X
                                                 X     X  XXXXXXX   XXXXX          XXX




            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                                       HEC-1 INPUT                                             PAGE  1

           LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              1          ID   HYDROLOGY STUDY for COVE RESERVOIR
              2          ID   Located in KANE COUNTY, UTAH
              3          ID
              4          ID   AUG 2020
              5          ID
              6          ID   PREPARED BY ALPHA ENGINEERING
              7          ID   43 SOUTH 100 EAST, SUITE 100
              8          ID   ST. GEORGE, UTAH  84770
              9          ID   TEL: (435) 628-6500
             10          ID   FAX: (435) 628-6553
             11          ID
             12          ID   Local SEP
             13          ID
                         *Diagram
             14          JR    PREC     1.0
             15          IT      18       0       0      50
             16          IO       0
             17          IN      18
                         *

             18          KK   B1
             19          KM   Runoff from Basin 1
             20          BA   0.503
             21          PB    7.67
             22          PC       0   0.020   0.046   0.070   0.095   0.130   0.180   0.300   0.520   0.650
             23          PC   0.700   0.745   0.785   0.820   0.850   0.880   0.905   0.930   0.955   0.980
             24          PC   1.000
             25          LS       0    72.8
             26          UD    0.51
                         *

             27          KK   RB1
             28          KM   Route B1
             29          RD    4928    .045    .050            TRAP      20      20
                         *

             30          KK   B2
             31          KM   Runoff from Basin 2
             32          BA   0.436
             33          LS       0    72.5
             34          UD    0.52
                         *

             35          KK   B3
             36          KM   Runoff from Basin 3
             37          BA   0.279
             38          LS       0    71.0
             39          UD    0.39
                         *
1                                                       HEC-1 INPUT                                             PAGE  2

           LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10
```

```
             40           KK   C1
             41           KM   Combine RB1, B2, B3
             42           HC       3
                          *

             43           KK   RC1
             44           KM   Route RC1
             45           RD    7255    .060    .030            TRAP      20      20
                          *

             46           KK   B4
             47           KM   Runoff from Basin 4
             48           BA   0.453
             49           LS       0    73.3
             50           UD    0.48
                          *

             51           KK   B5
             52           KM   Runoff from Basin 5
             53           BA   0.805
             54           LS       0    74.1
             55           UD    0.63
                          *

             56           KK   C2
             57           KM   Combine RC1, B4, B5
             58           HC       3
                          *

             59           KK   RC2
             60           KM   Route C2
             61           RD    2380    .039    .030            TRAP      40       2
                          *

             62           KK   B6
             63           KM   Runoff from Basin 6
             64           BA   0.150
             65           LS       0    84.3
             66           UD    0.19
                          *

             67           KK   B7
             68           KM   Runoff from Basin 7
             69           BA   0.327
             70           LS       0    75.7
             71           UD    0.46
                          *

             72           KK   C3
             73           KM   Combine RC2, B6, B7
             74           HC       3
                          *
1                                                       HEC-1 INPUT                                             PAGE  3

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


             75           KK   RC3
             76           KM   Route C3
             77           RD   11323    .023    .030            TRAP      40      20
                          *

             78           KK   B8
             79           KM   Runoff from Basin 8
             80           BA   1.012
             81           LS       0    84.0
             82           UD    0.67
                          *

             83           KK   B9
             84           KM   Runoff from Basin 9
             85           BA   0.242
             86           LS       0    85.5
             87           UD    0.26
                          *

             88           KK   B10
             89           KM   Runoff from Basin 10
             90           BA   0.129
             91           LS       0    86.7
             92           UD    0.18
                          *

             93           KK   C4
             94           KM   Combine B9, B10
             95           HC       2
                          *

             96           KK   RC4
             97           KM   Route C4
             98           RD    3380    .037    .030            TRAP      40      20
                          *
```

```
             99          KK   B11
            100          KM   Runoff from Basin 11
            101          BA   0.279
            102          LS       0    84.8
            103          UD    0.39
                         *

            104          KK   C5
            105          KM   Combine RC3, B8, RC4, B11
            106          HC       4
                         *

            107          KK   B12
            108          KM   Runoff from Basin 12
            109          BA   0.127
            110          LS       0    81.2
            111          UD    0.40
                         *
1                                                      HEC-1 INPUT                                            PAGE  4

           LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


            112          KK   Call
            113          KM   Combine C5, B12
            114          HC       2
                         *

            115          KK   Cove Reservoir
            116          KM   Routing through Res'v
            117          RS       1    ELEV  5545.5
            118          SV       0      19      95     240     453     738    1105    1563    2217    2773
            119          SV    3542    4423    5419    6149    7347    8000
            120          SE    5470    5476    5482    5488    5494    5500    5506    5512    5518    5524
            121          SE    5530    5536    5542    5548    5552    5558
            122          SL  5545.5   4.909     0.6     0.5
            123          SS  5549.2      30    2.67     1.5
            124          ST  5552.0    1892     2.9     1.5
                         *
            125          ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW

    18      B1
                V
                V
    27      RB1
                .
                .
    30          .       B2
                .           .
                .           .
    35          .           .       B3
                .           .           .
                .           .           .
    40      C1   ........................
                V
                V
    43      RC1
                .
                .
    46          .       B4
                .           .
                .           .
    51          .           .       B5
                .           .           .
                .           .           .
    56      C2   ........................
                V
                V
    59      RC2
                .
                .
    62          .       B6
                .           .
                .           .
    67          .           .       B7
                .           .           .
                .           .           .
    72      C3   ........................
                V
                V
    75      RC3
                .
                .
    78          .       B8
                .           .
```

```
                 .           .
    83           .           .       B9
                 .           .           .
                 .           .           .
    88           .           .           .       B10
                 .           .           .           .
                 .           .           .           .
    93           .           .       C4   ............
                 .           .           V
                 .           .           V
    96           .           .       RC4
                 .           .           .
                 .           .           .
    99           .           .           .       B11
                 .           .           .           .
                 .           .           .           .
   104       C5   ....................................
                 .
                 .
   107           .       B12
                 .           .
                 .           .
   112       Call ............
                 V
                 V
   115       Cove

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                                   ***************************************
 *                                       *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
 *               JUN   1998              *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
 *            VERSION 4.1                *                                                   *          609 SECOND STREET          *
 *                                       *                                                   *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:56:10   *                                                   *           (916) 756-1104            *
 *                                       *                                                   *                                     *
 *****************************************                                                   ***************************************




                            HYDROLOGY STUDY for COVE RESERVOIR
                            Located in KANE COUNTY, UTAH

                            AUG 2020

                            PREPARED BY ALPHA ENGINEERING
                            43 SOUTH 100 EAST, SUITE 100
                            ST. GEORGE, UTAH  84770
                            TEL: (435) 628-6500
                            FAX: (435) 628-6553

                            Local SEP


   16 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           0  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN          18  MINUTES IN COMPUTATION INTERVAL
                        IDATE      1    0  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ          50  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE      1    0  ENDING DATE
                       NDTIME        1442  ENDING TIME
                       ICENT           19  CENTURY MARK

                    COMPUTATION INTERVAL     .30 HOURS
                         TOTAL TIME BASE   14.70 HOURS

           ENGLISH UNITS
                DRAINAGE AREA         SQUARE MILES
                PRECIPITATION DEPTH   INCHES
                LENGTH, ELEVATION     FEET
                FLOW                  CUBIC FEET PER SECOND
                STORAGE VOLUME        ACRE-FEET
                SURFACE AREA          ACRES
                TEMPERATURE           DEGREES FAHRENHEIT

      JP          MULTI-PLAN OPTION
                        NPLAN           1  NUMBER OF PLANS

      JR          MULTI-RATIO OPTION
                      RATIOS OF PRECIPITATION
                     1.00


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
```

```
 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
  112 KK     *     Call   *
             *            *
             **************
                            Combine C5, B12

  114 HC          HYDROGRAPH COMBINATION
                        ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                 ***

 ***********************************************************************************************************************************

                                                   HYDROGRAPH AT STATION    Call
                                                        SUM OF  2 HYDROGRAPHS
                                                       PLAN 1,   RATIO =  1.00

 ***********************************************************************************************************************************
                                 *                                *                                *
    DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW
                                 *                                *                                *
     1     0000    1        0.   *    1     0354   14     4063.   *    1     0748   27      201.   *    1     1142   40        0.
     1     0018    2        0.   *    1     0412   15     3364.   *    1     0806   28      113.   *    1     1200   41        0.
     1     0036    3        0.   *    1     0430   16     2855.   *    1     0824   29       62.   *    1     1218   42        0.
     1     0054    4        8.   *    1     0448   17     2500.   *    1     0842   30       34.   *    1     1236   43        0.
     1     0112    5       43.   *    1     0506   18     2228.   *    1     0900   31       18.   *    1     1254   44        0.
     1     0130    6      129.   *    1     0524   19     2039.   *    1     0918   32        9.   *    1     1312   45        0.
     1     0148    7      306.   *    1     0542   20     1913.   *    1     0936   33        5.   *    1     1330   46        0.
     1     0206    8      824.   *    1     0600   21     1819.   *    1     0954   34        2.   *    1     1348   47        0.
     1     0224    9     2325.   *    1     0618   22     1614.   *    1     1012   35        1.   *    1     1406   48        0.
     1     0242   10     4867.   *    1     0636   23     1240.   *    1     1030   36        0.   *    1     1424   49        0.
     1     0300   11     6395.   *    1     0654   24      851.   *    1     1048   37        0.   *    1     1442   50        0.
     1     0318   12     6123.   *    1     0712   25      540.   *    1     1106   38        0.   *
     1     0336   13     5053.   *    1     0730   26      332.   *    1     1124   39        0.   *
                                 *                                *                                *
 ***********************************************************************************************************************************

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     14.70-HR
+   (CFS)       (HR)
                           (CFS)
+    6395.      3.00                 2560.       1059.       1059.        1059.
                        (INCHES)     5.019       5.085       5.085        5.085
                         (AC-FT)     1269.       1286.       1286.        1286.

                         CUMULATIVE AREA =    4.74 SQ MI




 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
  115 KK     *     Cove   *     Reservoir
             *            *
             **************
                            Routing through Res'v

                HYDROGRAPH ROUTING DATA

  117 RS          STORAGE ROUTING
                        NSTPS           1  NUMBER OF SUBREACHES
                         ITYP        ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC     5545.50  INITIAL CONDITION
                            X         .00 WORKING R AND D COEFFICIENT

  118 SV            STORAGE           .0      19.0      95.0     240.0     453.0     738.0    1105.0    1563.0    2217.0    2773.0
                                  3542.0    4423.0    5419.0    6149.0    7347.0    8000.0

  120 SE          ELEVATION      5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00
                                 5530.00   5536.00   5542.00   5548.00   5552.00   5558.00

  122 SL          LOW-LEVEL OUTLET
                        ELEVL     5545.50  ELEVATION AT CENTER OF OUTLET
                        CAREA        4.91  CROSS-SECTIONAL AREA
                         COQL         .60  COEFFICIENT
                         EXPL         .50  EXPONENT OF HEAD

  123 SS          SPILLWAY
                         CREL     5549.20  SPILLWAY CREST ELEVATION
                        SPWID       30.00  SPILLWAY WIDTH
                         COQW        2.67  WEIR COEFFICIENT
                         EXPW        1.50  EXPONENT OF HEAD

  124 ST          TOP OF DAM
```

```
                        TOPEL     5552.00  ELEVATION AT TOP OF DAM
                       DAMWID     1892.00  DAM WIDTH
                         COQD        2.90  WEIR COEFFICIENT
                         EXPD        1.50  EXPONENT OF HEAD

                                                                 ***

                                                  COMPUTED OUTFLOW-ELEVATION DATA

                                                    (EXCLUDING FLOW OVER DAM)

             OUTFLOW       .00       .00     25.78     27.48     29.42     31.65     34.25     37.31     40.98     45.44
           ELEVATION   5470.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00   5548.51   5549.20

             OUTFLOW     49.37     68.29    113.97    198.20    332.85    529.64    800.37   1156.85   1610.93   2174.46
           ELEVATION   5549.32   5549.60   5550.06   5550.68   5551.48   5552.44   5553.58   5554.88   5556.36   5558.00


                                              COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

                                                    (INCLUDING FLOW OVER DAM)

             STORAGE       .00     19.00     95.00    240.00    453.00    738.00   1105.00   1563.00   2217.00   2773.00
             OUTFLOW       .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
           ELEVATION   5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00

             STORAGE   3542.00   4423.00   5419.00   5844.83   5989.79   6009.51   6033.57   6063.27   6100.64   6148.41
             OUTFLOW       .00       .00       .00       .00     25.78     27.48     29.42     31.65     34.25     37.31
           ELEVATION   5530.00   5536.00   5542.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00

             STORAGE   6301.53   6508.46   6543.56   6628.96   6765.11   6952.15   7190.23   7347.00   7395.04   7518.54
             OUTFLOW     40.98     45.44     49.37     68.29    113.97    198.20    332.85    435.48   2138.72  11657.74
           ELEVATION   5548.51   5549.20   5549.32   5549.60   5550.06   5550.68   5551.48   5552.00   5552.44   5553.58

             STORAGE   7660.53   7821.02   8000.00
             OUTFLOW  27985.71  51484.63  82813.63
           ELEVATION   5554.88   5556.36   5558.00

 ***********************************************************************************************************************************

                                                   HYDROGRAPH AT STATION    Cove
                                                       PLAN 1,   RATIO =  1.00

 ***********************************************************************************************************************************
                                            *                                           *
  DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE
                                            *                                           *
   1     0000   1       0.   5844.8  5545.5 *  1     0506  18     137.   6821.4  5550.2 *  1     1012  35     233.   7019.3  5550.9
   1     0018   2       0.   5844.8  5545.5 *  1     0524  19     159.   6870.7  5550.4 *  1     1030  36     230.   7013.6  5550.9
   1     0036   3       0.   5844.8  5545.5 *  1     0542  20     180.   6915.4  5550.6 *  1     1048  37     227.   7007.9  5550.9
   1     0054   4       1.   5845.0  5545.5 *  1     0600  21     201.   6957.0  5550.7 *  1     1106  38     224.   7002.3  5550.8
   1     0112   5       2.   5845.5  5545.5 *  1     0618  22     220.   6994.3  5550.8 *  1     1124  39     221.   6996.8  5550.8
   1     0130   6       4.   5847.6  5545.5 *  1     0636  23     236.   7024.0  5550.9 *  1     1142  40     218.   6991.3  5550.8
   1     0148   7       6.   5852.9  5545.6 *  1     0654  24     247.   7043.8  5551.0 *  1     1200  41     216.   6985.9  5550.8
   1     0206   8      10.   5866.8  5545.7 *  1     0712  25     253.   7054.8  5551.0 *  1     1218  42     213.   6980.7  5550.8
   1     0224   9      17.   5905.5  5546.0 *  1     0730  26     255.   7059.3  5551.0 *  1     1236  43     210.   6975.4  5550.8
   1     0242  10      26.   5994.1  5546.7 *  1     0748  27     256.   7059.6  5551.0 *  1     1254  44     207.   6970.3  5550.7
   1     0300  11      36.   6133.0  5547.9 *  1     0806  28     254.   7057.2  5551.0 *  1     1312  45     205.   6965.2  5550.7
   1     0318  12      41.   6287.2  5548.5 *  1     0824  29     252.   7053.1  5551.0 *  1     1330  46     202.   6960.0  5550.7
   1     0336  13      44.   6424.7  5548.9 *  1     0842  30     249.   7048.1  5551.0 *  1     1348  47     200.   6955.1  5550.7
   1     0354  14      48.   6536.5  5549.3 *  1     0900  31     246.   7042.5  5551.0 *  1     1406  48     197.   6950.1  5550.7
   1     0412  15      68.   6627.1  5549.6 *  1     0918  32     243.   7036.8  5551.0 *  1     1424  49     195.   6945.3  5550.7
   1     0430  16      91.   6702.2  5549.8 *  1     0936  33     240.   7031.0  5550.9 *  1     1442  50     192.   6940.5  5550.6
   1     0448  17     114.   6766.0  5550.1 *  1     0954  34     237.   7025.1  5550.9 *
                                            *                                           *
 ***********************************************************************************************************************************

 PEAK OUTFLOW IS      256. AT TIME   7.80 HOURS


  PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     14.70-HR
+   (CFS)       (HR)
                           (CFS)
+     256.      7.80                  238.        156.        156.         156.
                        (INCHES)      .466        .752        .752         .752
                         (AC-FT)      118.        190.        190.         190.

 PEAK STORAGE   TIME                       MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     14.70-HR
+  (AC-FT)      (HR)
     7060.      7.80                 7027.       6705.       6705.        6705.

  PEAK STAGE    TIME                        MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     14.70-HR
+   (FEET)      (HR)
   5551.04      7.80               5550.93     5549.59     5549.59      5549.59

                         CUMULATIVE AREA =    4.74 SQ MI

1
```

```
                PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                  FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                TIME TO PEAK IN HOURS


                                                         RATIOS APPLIED TO PRECIPITATION
 OPERATION       STATION     AREA    PLAN           RATIO 1
                                                       1.00

 HYDROGRAPH AT
+                  B1          .50     1   FLOW         689.
                                           TIME         3.00

 ROUTED TO
+                  RB1         .50     1   FLOW         657.
                                           TIME         3.00

 HYDROGRAPH AT
+                  B2          .44     1   FLOW         589.
                                           TIME         3.00

 HYDROGRAPH AT
+                  B3          .28     1   FLOW         393.
                                           TIME         2.70

  3 COMBINED AT
+                  C1         1.22     1   FLOW        1608.
                                           TIME         3.00

 ROUTED TO
+                  RC1        1.22     1   FLOW        1507.
                                           TIME         3.00

 HYDROGRAPH AT
+                  B4          .45     1   FLOW         636.
                                           TIME         3.00

 HYDROGRAPH AT
+                  B5          .81     1   FLOW        1050.
                                           TIME         3.00

  3 COMBINED AT
+                  C2         2.48     1   FLOW        3194.
                                           TIME         3.00

 ROUTED TO
+                  RC2        2.48     1   FLOW        3137.
                                           TIME         3.00

 HYDROGRAPH AT
+                  B6          .15     1   FLOW         351.
                                           TIME         2.40

 HYDROGRAPH AT
+                  B7          .33     1   FLOW         490.
                                           TIME         3.00

  3 COMBINED AT
+                  C3         2.95     1   FLOW        3813.
                                           TIME         3.00

 ROUTED TO
+                  RC3        2.95     1   FLOW        3723.
                                           TIME         3.30

 HYDROGRAPH AT
+                  B8         1.01     1   FLOW        1656.
                                           TIME         3.00

 HYDROGRAPH AT
+                  B9          .24     1   FLOW         547.
                                           TIME         2.70

 HYDROGRAPH AT
+                  B10         .13     1   FLOW         326.
                                           TIME         2.40

  2 COMBINED AT
+                  C4          .37     1   FLOW         835.
                                           TIME         2.70

 ROUTED TO
+                  RC4         .37     1   FLOW         819.
                                           TIME         2.70

 HYDROGRAPH AT
+                  B11         .28     1   FLOW         575.
                                           TIME         2.70

  4 COMBINED AT
+                  C5         4.61     1   FLOW        6184.
                                           TIME         3.00
```

```
 HYDROGRAPH AT
+                  B12         .13     1   FLOW         238.
                                           TIME         2.70

  2 COMBINED AT
+                  Call       4.74     1   FLOW        6395.
                                           TIME         3.00

 ROUTED TO
+                  Cove       4.74     1   FLOW         256.
                                           TIME         7.80

                                       ** PEAK STAGES IN FEET **
                                       1   STAGE     5551.04
                                           TIME         7.80
1
                                           SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                                               (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                                   INTERPOLATED TO
                                                                                COMPUTATION INTERVAL
            ISTAQ    ELEMENT      DT       PEAK    TIME TO     VOLUME      DT       PEAK    TIME TO     VOLUME
                                                     PEAK                                     PEAK

                                 (MIN)     (CFS)      (MIN)     (IN)     (MIN)     (CFS)     (MIN)       (IN)

           FOR PLAN = 1  RATIO=  .00
             RB1    MANE         5.40    673.41    189.00      4.50     18.00    657.41    180.00        4.48


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1206E+03 EXCESS= .0000E+00 OUTFLOW= .1207E+03 BASIN STORAGE= .3686E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
             RC1    MANE         5.40   1594.30    189.00      4.43     18.00   1507.33    180.00        4.43


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .2880E+03 EXCESS= .0000E+00 OUTFLOW= .2881E+03 BASIN STORAGE= .3547E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
             RC2    MANE         1.67   3186.21    182.05      4.52     18.00   3137.38    180.00        4.53


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .5970E+03 EXCESS= .0000E+00 OUTFLOW= .5970E+03 BASIN STORAGE= .3099E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
             RC3    MANE         7.20   3778.09    194.40      4.63     18.00   3723.23    198.00        4.64


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .7287E+03 EXCESS= .0000E+00 OUTFLOW= .7291E+03 BASIN STORAGE= .1048E-01 PERCENT ERROR=   -.1


           FOR PLAN = 1  RATIO=  .00
             RC4    MANE         5.53    841.55    154.72      6.01     18.00    818.78    162.00        6.02


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1188E+03 EXCESS= .0000E+00 OUTFLOW= .1189E+03 BASIN STORAGE= .2808E-02 PERCENT ERROR=    .0


1                                  SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION    Cove
                              (PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED  DURING BREACH FORMATION)


      PLAN  1 ..............                 INITIAL VALUE     SPILLWAY CREST     TOP OF DAM
                                 ELEVATION        5545.50           5549.20         5552.00
                                 STORAGE            5845.             6508.           7347.
                                 OUTFLOW               0.               45.            435.


                      RATIO     MAXIMUM      MAXIMUM    MAXIMUM    MAXIMUM    DURATION     TIME OF     TIME OF
                        OF     RESERVOIR      DEPTH     STORAGE    OUTFLOW    OVER TOP   MAX OUTFLOW   FAILURE
                       PMF      W.S.ELEV    OVER DAM     AC-FT       CFS       HOURS        HOURS       HOURS

                      1.00      5551.04         .00       7060.       256.       .00         7.80         .00


 *** NORMAL END OF HEC-1 ***
```

Storm Event 11. General SEP Hydrograph

```
1*****************************************                                                    ***************************************
 *                                       *                                                    *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                    *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998               *                                                    *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1                 *                                                    *          609 SECOND STREET          *
 *                                       *                                                    *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:56:37   *                                                    *           (916) 756-1104            *
 *                                       *                                                    *                                     *
 *****************************************                                                    ***************************************



                                        X     X  XXXXXXX   XXXXX           X
                                        X     X  X        X     X         XX
                                        X     X  X        X                X
                                        XXXXXXX  XXXX     X       XXXXX    X
                                        X     X  X        X                X
                                        X     X  X        X     X          X
                                        X     X  XXXXXXX   XXXXX          XXX




            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                                 HEC-1 INPUT                                             PAGE  1

           LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              1          ID   HYDROLOGY STUDY for COVE RESERVOIR
              2          ID   Located in KANE COUNTY, UTAH
              3          ID
              4          ID   AUG 2020
              5          ID
              6          ID   PREPARED BY ALPHA ENGINEERING
              7          ID   43 SOUTH 100 EAST, SUITE 100
              8          ID   ST. GEORGE, UTAH  84770
              9          ID   TEL: (435) 628-6500
             10          ID   FAX: (435) 628-6553
             11          ID
             12          ID   SEP General
             13          ID
                         *Diagram
             14          JR    PREC     1.0
             15          IT     216       0       0      50
             16          IO       0
             17          IN     216
                         *

             18          KK   B1
             19          KM   Runoff from Basin 1
             20          BA   0.503
             21          PB   12.50
             22          PC       0   0.020   0.046   0.070   0.095   0.130   0.180   0.300   0.520   0.650
             23          PC   0.700   0.745   0.785   0.820   0.850   0.880   0.905   0.930   0.955   0.980
             24          PC   1.000
             25          LS       0    72.8
             26          UD    0.51
                         *

             27          KK   RB1
             28          KM   Route B1
             29          RD    4928    .045    .050            TRAP      20      20
                         *

             30          KK   B2
             31          KM   Runoff from Basin 2
             32          BA   0.436
             33          LS       0    72.5
             34          UD    0.52
                         *

             35          KK   B3
             36          KM   Runoff from Basin 3
             37          BA   0.279
             38          LS       0    71.0
             39          UD    0.39
                         *
1                                                 HEC-1 INPUT                                             PAGE  2

           LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10
```

```
             40           KK   C1
             41           KM   Combine RB1, B2, B3
             42           HC       3
                          *

             43           KK   RC1
             44           KM   Route RC1
             45           RD    7255    .060    .030            TRAP      20      20
                          *

             46           KK   B4
             47           KM   Runoff from Basin 4
             48           BA   0.453
             49           LS       0    73.3
             50           UD    0.48
                          *

             51           KK   B5
             52           KM   Runoff from Basin 5
             53           BA   0.805
             54           LS       0    74.1
             55           UD    0.63
                          *

             56           KK   C2
             57           KM   Combine RC1, B4, B5
             58           HC       3
                          *

             59           KK   RC2
             60           KM   Route C2
             61           RD    2380    .039    .030            TRAP      40       2
                          *

             62           KK   B6
             63           KM   Runoff from Basin 6
             64           BA   0.150
             65           LS       0    84.3
             66           UD    0.19
                          *

             67           KK   B7
             68           KM   Runoff from Basin 7
             69           BA   0.327
             70           LS       0    75.7
             71           UD    0.46
                          *

             72           KK   C3
             73           KM   Combine RC2, B6, B7
             74           HC       3
                          *
1                                                       HEC-1 INPUT                                              PAGE  3

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


             75           KK   RC3
             76           KM   Route C3
             77           RD   11323    .023    .030            TRAP      40      20
                          *

             78           KK   B8
             79           KM   Runoff from Basin 8
             80           BA   1.012
             81           LS       0    84.0
             82           UD    0.67
                          *

             83           KK   B9
             84           KM   Runoff from Basin 9
             85           BA   0.242
             86           LS       0    85.5
             87           UD    0.26
                          *

             88           KK   B10
             89           KM   Runoff from Basin 10
             90           BA   0.129
             91           LS       0    86.7
             92           UD    0.18
                          *

             93           KK   C4
             94           KM   Combine B9, B10
             95           HC       2
                          *

             96           KK   RC4
             97           KM   Route C4
             98           RD    3380    .037    .030            TRAP      40      20
                          *
```

```
             99           KK   B11
            100           KM   Runoff from Basin 11
            101           BA   0.279
            102           LS       0    84.8
            103           UD    0.39
                          *

            104           KK   C5
            105           KM   Combine RC3, B8, RC4, B11
            106           HC       4
                          *

            107           KK   B12
            108           KM   Runoff from Basin 12
            109           BA   0.127
            110           LS       0    81.2
            111           UD    0.40
                          *
1                                                       HEC-1 INPUT                                                     PAGE  4

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


            112           KK   Call
            113           KM   Combine C5, B12
            114           HC       2
                          *

            115           KK   Cove Reservoir
            116           KM   Routing through Res'v
            117           RS       1    ELEV  5545.5
            118           SV       0      19      95     240     453     738    1105    1563    2217    2773
            119           SV    3542    4423    5419    6149    7347    8000
            120           SE    5470    5476    5482    5488    5494    5500    5506    5512    5518    5524
            121           SE    5530    5536    5542    5548    5552    5558
            122           SL  5545.5   4.909     0.6     0.5
            123           SS  5549.2      30    2.67     1.5
            124           ST  5552.0    1892     2.9     1.5
                          *
            125           ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW

    18       B1
                 V
                 V
    27       RB1
                 .
                 .
    30           .       B2
                 .           .
                 .           .
    35           .           .       B3
                 .           .           .
                 .           .           .
    40       C1   ........................
                 V
                 V
    43       RC1
                 .
                 .
    46           .       B4
                 .           .
                 .           .
    51           .           .       B5
                 .           .           .
                 .           .           .
    56       C2   ........................
                 V
                 V
    59       RC2
                 .
                 .
    62           .       B6
                 .           .
                 .           .
    67           .           .       B7
                 .           .           .
                 .           .           .
    72       C3   ........................
                 V
                 V
    75       RC3
                 .
                 .
    78           .       B8
                 .           .
```

```
                 .           .
    83           .           .       B9
                 .           .           .
                 .           .           .
    88           .           .           .       B10
                 .           .           .           .
                 .           .           .           .
    93           .           .       C4   ............
                 .           .           V
                 .           .           V
    96           .           .       RC4
                 .           .           .
                 .           .           .
    99           .           .           .       B11
                 .           .           .           .
                 .           .           .           .
   104       C5   ....................................
                 .
                 .
   107           .       B12
                 .           .
                 .           .
   112       Call ............
                 V
                 V
   115       Cove

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************                                                   ***************************************
 *                                       *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
 *               JUN   1998              *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
 *            VERSION 4.1                *                                                   *          609 SECOND STREET          *
 *                                       *                                                   *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:56:37   *                                                   *           (916) 756-1104            *
 *                                       *                                                   *                                     *
 *****************************************                                                   ***************************************




                            HYDROLOGY STUDY for COVE RESERVOIR
                            Located in KANE COUNTY, UTAH

                            AUG 2020

                            PREPARED BY ALPHA ENGINEERING
                            43 SOUTH 100 EAST, SUITE 100
                            ST. GEORGE, UTAH  84770
                            TEL: (435) 628-6500
                            FAX: (435) 628-6553

                            SEP General


   16 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           0  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN         216  MINUTES IN COMPUTATION INTERVAL
                        IDATE      1    0  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ          50  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE      8    0  ENDING DATE
                       NDTIME        0824  ENDING TIME
                       ICENT           19  CENTURY MARK

                    COMPUTATION INTERVAL    3.60 HOURS
                         TOTAL TIME BASE  176.40 HOURS

           ENGLISH UNITS
                DRAINAGE AREA         SQUARE MILES
                PRECIPITATION DEPTH   INCHES
                LENGTH, ELEVATION     FEET
                FLOW                  CUBIC FEET PER SECOND
                STORAGE VOLUME        ACRE-FEET
                SURFACE AREA          ACRES
                TEMPERATURE           DEGREES FAHRENHEIT

      JP          MULTI-PLAN OPTION
                        NPLAN           1  NUMBER OF PLANS

      JR          MULTI-RATIO OPTION
                      RATIOS OF PRECIPITATION
                     1.00


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
```

```
 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
  112 KK     *     Call   *
             *            *
             **************
                            Combine C5, B12

  114 HC          HYDROGRAPH COMBINATION
                        ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                 ***

 ***********************************************************************************************************************************

                                                   HYDROGRAPH AT STATION    Call
                                                        SUM OF  2 HYDROGRAPHS
                                                       PLAN 1,   RATIO =  1.00

 ***********************************************************************************************************************************
                                 *                                *                                *
    DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW
                                 *                                *                                *
     1     0000    1        0.   *    2     2248   14      372.   *    4     2136   27        0.   *    6     2024   40        0.
     1     0336    2        0.   *    3     0224   15      323.   *    5     0112   28        0.   *    7     0000   41        0.
     1     0712    3        5.   *    3     0600   16      307.   *    5     0448   29        0.   *    7     0336   42        0.
     1     1048    4       25.   *    3     0936   17      271.   *    5     0824   30        0.   *    7     0712   43        0.
     1     1424    5       56.   *    3     1312   18      257.   *    5     1200   31        0.   *    7     1048   44        0.
     1     1800    6      120.   *    3     1648   19      254.   *    5     1536   32        0.   *    7     1424   45        0.
     1     2136    7      235.   *    3     2024   20      254.   *    5     1912   33        0.   *    7     1800   46        0.
     2     0112    8      688.   *    4     0000   21      221.   *    5     2248   34        0.   *    7     2136   47        0.
     2     0448    9     1587.   *    4     0336   22       81.   *    6     0224   35        0.   *    8     0112   48        0.
     2     0824   10     1393.   *    4     0712   23       21.   *    6     0600   36        0.   *    8     0448   49        0.
     2     1200   11      771.   *    4     1048   24        4.   *    6     0936   37        0.   *    8     0824   50        0.
     2     1536   12      523.   *    4     1424   25        1.   *    6     1312   38        0.   *
     2     1912   13      428.   *    4     1800   26        0.   *    6     1648   39        0.   *
                                 *                                *                                *
 ***********************************************************************************************************************************

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR    176.40-HR
+   (CFS)       (HR)
                           (CFS)
+    1587.     28.80                 1490.        882.        409.         167.
                        (INCHES)     1.753       6.228       9.622        9.643
                         (AC-FT)      443.       1575.       2433.        2439.

                         CUMULATIVE AREA =    4.74 SQ MI



 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
  115 KK     *     Cove   *     Reservoir
             *            *
             **************
                            Routing through Res'v

                HYDROGRAPH ROUTING DATA

  117 RS          STORAGE ROUTING
                        NSTPS           1  NUMBER OF SUBREACHES
                         ITYP        ELEV  TYPE OF INITIAL CONDITION
                       RSVRIC     5545.50  INITIAL CONDITION
                            X         .00 WORKING R AND D COEFFICIENT

  118 SV            STORAGE          .0      19.0      95.0     240.0     453.0     738.0    1105.0    1563.0    2217.0    2773.0
                                 3542.0    4423.0    5419.0    6149.0    7347.0    8000.0

  120 SE          ELEVATION     5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00
                                5530.00   5536.00   5542.00   5548.00   5552.00   5558.00

  122 SL          LOW-LEVEL OUTLET
                        ELEVL     5545.50  ELEVATION AT CENTER OF OUTLET
                        CAREA        4.91  CROSS-SECTIONAL AREA
                         COQL         .60  COEFFICIENT
                         EXPL         .50  EXPONENT OF HEAD

  123 SS          SPILLWAY
                         CREL     5549.20  SPILLWAY CREST ELEVATION
                        SPWID       30.00  SPILLWAY WIDTH
                         COQW        2.67  WEIR COEFFICIENT
                         EXPW        1.50  EXPONENT OF HEAD

  124 ST          TOP OF DAM
```

```
                      TOPEL     5552.00  ELEVATION AT TOP OF DAM
                     DAMWID     1892.00  DAM WIDTH
                       COQD        2.90  WEIR COEFFICIENT
                       EXPD        1.50  EXPONENT OF HEAD

                                                     ***

                                          COMPUTED OUTFLOW-ELEVATION DATA

                                            (EXCLUDING FLOW OVER DAM)

           OUTFLOW        .00       .00     25.78     27.48     29.42     31.65     34.25     37.31     40.98     45.44
         ELEVATION    5470.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00   5548.51   5549.20

           OUTFLOW      49.37     68.29    113.97    198.20    332.85    529.64    800.37   1156.85   1610.93   2174.46
         ELEVATION    5549.32   5549.60   5550.06   5550.68   5551.48   5552.44   5553.58   5554.88   5556.36   5558.00


                                      COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

                                            (INCLUDING FLOW OVER DAM)

           STORAGE        .00     19.00     95.00    240.00    453.00    738.00   1105.00   1563.00   2217.00   2773.00
           OUTFLOW        .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
         ELEVATION    5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00

           STORAGE    3542.00   4423.00   5419.00   5844.83   5989.79   6009.51   6033.57   6063.27   6100.64   6148.41
           OUTFLOW        .00       .00       .00       .00     25.78     27.48     29.42     31.65     34.25     37.31
         ELEVATION    5530.00   5536.00   5542.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00

           STORAGE    6301.53   6508.46   6543.56   6628.96   6765.11   6952.15   7190.23   7347.00   7395.04   7518.54
           OUTFLOW      40.98     45.44     49.37     68.29    113.97    198.20    332.85    435.48   2138.72  11657.74
         ELEVATION    5548.51   5549.20   5549.32   5549.60   5550.06   5550.68   5551.48   5552.00   5552.44   5553.58

           STORAGE    7660.53   7821.02   8000.00
           OUTFLOW   27985.71  51484.63  82813.63
         ELEVATION    5554.88   5556.36   5558.00

 *********************************************************************************************************************************

                                             HYDROGRAPH AT STATION    Cove
                                                 PLAN 1,   RATIO =  1.00

 *********************************************************************************************************************************
                                             *                                            *
  DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE
                                             *                                            *
   1     0000   1       0.   5844.8  5545.5 *  3     1312  18     326.   7179.3  5551.4 *  6     0224  35      61.   6601.8  5549.5
   1     0336   2       0.   5844.8  5545.5 *  3     1648  19     314.   7160.1  5551.4 *  6     0600  36      57.   6584.2  5549.5
   1     0712   3       2.   5845.4  5545.5 *  3     2024  20     304.   7143.7  5551.3 *  6     0936  37      54.   6567.7  5549.4
   1     1048   4       4.   5849.0  5545.5 *  4     0000  21     294.   7125.6  5551.3 *  6     1312  38      51.   6552.2  5549.3
   1     1424   5       8.   5859.3  5545.6 *  4     0336  22     271.   7086.7  5551.1 *  6     1648  39      48.   6537.4  5549.3
   1     1800   6      13.   5882.4  5545.8 *  4     0712  23     237.   7026.1  5550.9 *  6     2024  40      47.   6523.2  5549.2
   1     2136   7      20.   5930.4  5546.2 *  4     1048  24     204.   6964.1  5550.7 *  7     0000  41      45.   6509.5  5549.2
   2     0112   8      31.   6060.0  5547.3 *  4     1424  25     177.   6908.3  5550.5 *  7     0336  42      45.   6496.0  5549.2
   2     0448   9      43.   6386.9  5548.8 *  4     1800  26     154.   6859.3  5550.4 *  7     0712  43      45.   6482.6  5549.1
   2     0824  10     130.   6804.4  5550.2 *  4     2136  27     135.   6816.4  5550.2 *  7     1048  44      45.   6469.3  5549.1
   2     1200  11     261.   7069.4  5551.1 *  5     0112  28     119.   6778.6  5550.1 *  7     1424  45      44.   6456.0  5549.0
   2     1536  12     323.   7174.9  5551.4 *  5     0448  29     106.   6745.1  5550.0 *  7     1800  46      44.   6442.9  5549.0
   2     1912  13     349.   7216.3  5551.6 *  5     0824  30      95.   6715.1  5549.9 *  7     2136  47      44.   6429.9  5548.9
   2     2248  14     358.   7230.0  5551.6 *  5     1200  31      86.   6688.0  5549.8 *  8     0112  48      44.   6417.1  5548.9
   3     0224  15     356.   7227.2  5551.6 *  5     1536  32      78.   6663.6  5549.7 *  8     0448  49      43.   6404.2  5548.9
   3     0600  16     349.   7216.0  5551.6 *  5     1912  33      72.   6641.2  5549.6 *  8     0824  50      43.   6391.5  5548.8
   3     0936  17     339.   7199.7  5551.5 *  5     2248  34      66.   6620.8  5549.6 *
                                             *                                            *
 *********************************************************************************************************************************

 PEAK OUTFLOW IS      358. AT TIME  46.80 HOURS


  PEAK FLOW     TIME                       MAXIMUM AVERAGE FLOW
                                    6-HR        24-HR       72-HR    176.40-HR
+   (CFS)       (HR)
                         (CFS)
+     358.     46.80                357.         346.        254.         130.
                      (INCHES)      .420        2.442       5.987        7.487
                       (AC-FT)      106.         618.       1514.        1894.

 PEAK STORAGE   TIME                      MAXIMUM AVERAGE STORAGE
                                    6-HR        24-HR       72-HR    176.40-HR
+  (AC-FT)      (HR)
     7230.     46.80               7229.        7211.       7044.        6643.

  PEAK STAGE    TIME                       MAXIMUM AVERAGE STAGE
                                    6-HR        24-HR       72-HR    176.40-HR
+   (FEET)      (HR)
   5551.61     46.80             5551.60      5551.55     5550.99      5549.46

                       CUMULATIVE AREA =    4.74 SQ MI

1
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                PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                  FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                  TIME TO PEAK IN HOURS


                                                           RATIOS APPLIED TO PRECIPITATION
 OPERATION       STATION     AREA    PLAN           RATIO 1
                                                        1.00

 HYDROGRAPH AT
+                  B1           .50     1   FLOW         162.
                                            TIME        28.80

 ROUTED TO
+                  RB1          .50     1   FLOW         156.
                                            TIME        28.80

 HYDROGRAPH AT
+                  B2           .44     1   FLOW         140.
                                            TIME        28.80

 HYDROGRAPH AT
+                  B3           .28     1   FLOW          87.
                                            TIME        28.80

  3 COMBINED AT
+                  C1          1.22     1   FLOW         382.
                                            TIME        28.80

 ROUTED TO
+                  RC1         1.22     1   FLOW         371.
                                            TIME        28.80

 HYDROGRAPH AT
+                  B4           .45     1   FLOW         147.
                                            TIME        28.80

 HYDROGRAPH AT
+                  B5           .81     1   FLOW         266.
                                            TIME        28.80

  3 COMBINED AT
+                  C2          2.48     1   FLOW         785.
                                            TIME        28.80

 ROUTED TO
+                  RC2         2.48     1   FLOW         780.
                                            TIME        28.80

 HYDROGRAPH AT
+                  B6           .15     1   FLOW          58.
                                            TIME        28.80

 HYDROGRAPH AT
+                  B7           .33     1   FLOW         111.
                                            TIME        28.80

  3 COMBINED AT
+                  C3          2.95     1   FLOW         949.
                                            TIME        28.80

 ROUTED TO
+                  RC3         2.95     1   FLOW         900.
                                            TIME        28.80

 HYDROGRAPH AT
+                  B8          1.01     1   FLOW         389.
                                            TIME        28.80

 HYDROGRAPH AT
+                  B9           .24     1   FLOW          95.
                                            TIME        28.80

 HYDROGRAPH AT
+                  B10          .13     1   FLOW          51.
                                            TIME        28.80

  2 COMBINED AT
+                  C4           .37     1   FLOW         146.
                                            TIME        28.80

 ROUTED TO
+                  RC4          .37     1   FLOW         143.
                                            TIME        28.80

 HYDROGRAPH AT
+                  B11          .28     1   FLOW         108.
                                            TIME        28.80

  4 COMBINED AT
+                  C5          4.61     1   FLOW        1540.
                                            TIME        28.80
```

```
 HYDROGRAPH AT
+                  B12         .13     1   FLOW          47.
                                           TIME        28.80

  2 COMBINED AT
+                  Call       4.74     1   FLOW        1587.
                                           TIME        28.80

 ROUTED TO
+                  Cove       4.74     1   FLOW         358.
                                           TIME        46.80

                                       ** PEAK STAGES IN FEET **
                                       1   STAGE     5551.61
                                           TIME        46.80
1
                                           SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                                               (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                                   INTERPOLATED TO
                                                                                COMPUTATION INTERVAL
            ISTAQ    ELEMENT      DT       PEAK    TIME TO     VOLUME      DT       PEAK    TIME TO     VOLUME
                                                     PEAK                                     PEAK

                                 (MIN)     (CFS)      (MIN)     (IN)     (MIN)     (CFS)     (MIN)       (IN)

           FOR PLAN = 1  RATIO=  .00
              RB1    MANE        16.14    161.33   1758.92      8.92    216.00    155.93   1728.00        8.94


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .2392E+03 EXCESS= .0000E+00 OUTFLOW= .2392E+03 BASIN STORAGE= .3928E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC1    MANE        11.70    381.73   1743.12      8.85    216.00    371.42   1728.00        8.87


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .5750E+03 EXCESS= .0000E+00 OUTFLOW= .5750E+03 BASIN STORAGE= .2955E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC2    MANE         2.77    784.17   1730.55      8.97    216.00    779.86   1728.00        8.97


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1184E+04 EXCESS= .0000E+00 OUTFLOW= .1184E+04 BASIN STORAGE= .2978E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC3    MANE        21.20    945.64   1759.24      9.09    216.00    900.19   1728.00        9.11


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1431E+04 EXCESS= .0000E+00 OUTFLOW= .1431E+04 BASIN STORAGE= .1049E-01 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC4    MANE         9.01    145.33   1739.46     10.73    216.00    142.95   1728.00       10.74


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .2123E+03 EXCESS= .0000E+00 OUTFLOW= .2123E+03 BASIN STORAGE= .2832E-02 PERCENT ERROR=    .0

1                                  SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION    Cove
                              (PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED  DURING BREACH FORMATION)


      PLAN  1 ..............                    INITIAL VALUE     SPILLWAY CREST     TOP OF DAM
                                 ELEVATION        5545.50            5549.20          5552.00
                                 STORAGE            5845.              6508.            7347.
                                 OUTFLOW               0.                45.             435.


                      RATIO     MAXIMUM      MAXIMUM    MAXIMUM    MAXIMUM    DURATION     TIME OF     TIME OF
                        OF     RESERVOIR      DEPTH     STORAGE    OUTFLOW    OVER TOP   MAX OUTFLOW   FAILURE
                       PMF      W.S.ELEV    OVER DAM     AC-FT       CFS       HOURS        HOURS       HOURS

                      1.00      5551.61         .00       7230.       358.       .00        46.80         .00


 *** NORMAL END OF HEC-1 ***
```

Storm Event 12. Principal Spillway Hydrograph

```
1****************************************                                                   ***************************************
 *                                       *                                                  *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                  *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998               *                                                  *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1                 *                                                  *          609 SECOND STREET          *
 *                                       *                                                  *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  03:15:56   *                                                  *           (916) 756-1104            *
 *                                       *                                                  *                                     *
 ****************************************                                                   ***************************************




                                              X     X  XXXXXXX   XXXXX          X
                                              X     X  X        X     X        XX
                                              X     X  X        X               X
                                              XXXXXXX  XXXX     X       XXXXX   X
                                              X     X  X        X               X
                                              X     X  X        X     X         X
                                              X     X  XXXXXXX   XXXXX         XXX




            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                                   HEC-1 INPUT                                         PAGE  1

           LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              1          ID   HYDROLOGY STUDY for COVE RESERVOIR
              2          ID   Located in KANE COUNTY, UTAH
              3          ID
              4          ID   AUG 2020
              5          ID
              6          ID   PREPARED BY ALPHA ENGINEERING
              7          ID   43 SOUTH 100 EAST, SUITE 100
              8          ID   ST. GEORGE, UTAH  84770
              9          ID   TEL: (435) 628-6500
             10          ID   FAX: (435) 628-6553
             11          ID
             12          ID   PSH (NEH)
             13          ID
                         *Diagram
             14          JR    PREC     1.0
             15          IT      60       0       0     350
             16          IO       0
             17          IN      60
                         *
             18          QI       0      11      14      15      15      15      15      15      15      15
             19          QI      15      16      16      16      16      16      16      16      16      16
             20          QI      16      17      17      17      17      17      17      17      17      17
             21          QI      17      18      18      18      18      18      18      18      18      19
             22          QI      19      19      19      19      19      20      20      20      20      20
             23          QI      20      21      21      21      21      21      21      22      22      22
             24          QI      22      23      23      23      23      24      24      24      24      25
             25          QI      25      25      26      26      26      27      27      27      28      28
             26          QI      29      29      29      30      30      31      31      32      33      33
             27          QI      34      35      35      36      37      38      39      40      41      42
             28          QI      43      45      46      48      49      51      53      56      58      61
             29          QI      65      69      74      80      87      96     109     127     157     219
             30          QI     850     479     259     172     132     111      98      88      81      75
             31          QI      70      65      62      59      56      54      51      50      48      46
             32          QI      45      43      42      41      40      39      38      37      36      35
             33          QI      35      34      33      33      32      32      31      30      30      29
             34          QI      29      29      28      28      27      27      27      26      26      26
             35          QI      25      25      25      24      24      24      24      23      23      23
             36          QI      23      22      22      22      22      22      21      21      21      21
             37          QI      21      20      20      20      20      20      20      19      19      19
             38          QI      19      19      19      19      18      18      18      18      18      18
             39          QI      18      17      17      17      17      17      17      17      17      17
             40          QI      17      16      16      16      16      16      16      16      16      16
             41          QI      16      15      15      15      15      15      15      15      15      15
             42          QI      15       4       1
                         *

             43          KK   Cove Reservoir
             44          KM   Routing through Res'v
             45          RS       1    ELEV  5545.5
             46          SV       0      19      95     240     453     738    1105    1563    2217    2773
             47          SV    3542    4423    5419    6149    7347    8000
             48          SE    5470    5476    5482    5488    5494    5500    5506    5512    5518    5524
             49          SE    5530    5536    5542    5548    5552    5558
             50          SL  5545.5   4.909     0.6     0.5
```

```
             51          SS  5549.2      30    2.67     1.5
1                                                       HEC-1 INPUT                                            PAGE  2

           LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

             52          ST  5552.0    1892     2.9     1.5
                          *
             53          ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW

 *** HEC1 ERROR 4 *** NO HYDROGRAPHS AVAILABLE TO ROUTE
                 V
                 V
    43       Cove

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION

         1 ERRORS IN STREAM SYSTEM
1*****************************************                                                   ***************************************
 *                                       *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
 *               JUN   1998              *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
 *            VERSION 4.1                *                                                   *          609 SECOND STREET          *
 *                                       *                                                   *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  03:15:56   *                                                   *           (916) 756-1104            *
 *                                       *                                                   *                                     *
 *****************************************                                                   ***************************************




                            HYDROLOGY STUDY for COVE RESERVOIR
                            Located in KANE COUNTY, UTAH

                            AUG 2020

                            PREPARED BY ALPHA ENGINEERING
                            43 SOUTH 100 EAST, SUITE 100
                            ST. GEORGE, UTAH  84770
                            TEL: (435) 628-6500
                            FAX: (435) 628-6553

                            PSH (NEH)


   16 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           0  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN          60  MINUTES IN COMPUTATION INTERVAL
                        IDATE      1    0  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ         350  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE     15    0  ENDING DATE
                       NDTIME        1300  ENDING TIME
                       ICENT           19  CENTURY MARK

                    COMPUTATION INTERVAL    1.00 HOURS
                         TOTAL TIME BASE  349.00 HOURS

           ENGLISH UNITS
                DRAINAGE AREA         SQUARE MILES
                PRECIPITATION DEPTH   INCHES
                LENGTH, ELEVATION     FEET
                FLOW                  CUBIC FEET PER SECOND
                STORAGE VOLUME        ACRE-FEET
                SURFACE AREA          ACRES
                TEMPERATURE           DEGREES FAHRENHEIT

      JP          MULTI-PLAN OPTION
                        NPLAN           1  NUMBER OF PLANS

      JR          MULTI-RATIO OPTION
                      RATIOS OF PRECIPITATION
                     1.00

   17 IN          TIME DATA FOR INPUT TIME SERIES
                        JXMIN          60  TIME INTERVAL IN MINUTES
                       JXDATE      1    0  STARTING DATE
                       JXTIME           0  STARTING TIME

                SUBBASIN RUNOFF DATA

    0 BA          SUBBASIN CHARACTERISTICS
```

```
                    TAREA         .00  SUBBASIN AREA

                                                          ***

************************************************************************************************************************

                                                HYDROGRAPH AT STATION    Cove

************************************************************************************************************************
                                  *                              *                              *
   DA MON HRMN  ORD      FLOW     *  DA MON HRMN  ORD      FLOW  *  DA MON HRMN  ORD      FLOW  *  DA MON HRMN  ORD      FLOW
                                  *                              *                              *
    1     0000    1         0.    *   4     1600   89       33.  *   8     0800  177       24.  *  12     0000  265        1.
    1     0100    2        11.    *   4     1700   90       33.  *   8     0900  178       23.  *  12     0100  266        1.
    1     0200    3        14.    *   4     1800   91       34.  *   8     1000  179       23.  *  12     0200  267        1.
    1     0300    4        15.    *   4     1900   92       35.  *   8     1100  180       23.  *  12     0300  268        1.
    1     0400    5        15.    *   4     2000   93       35.  *   8     1200  181       23.  *  12     0400  269        1.
    1     0500    6        15.    *   4     2100   94       36.  *   8     1300  182       22.  *  12     0500  270        1.
    1     0600    7        15.    *   4     2200   95       37.  *   8     1400  183       22.  *  12     0600  271        1.
    1     0700    8        15.    *   4     2300   96       38.  *   8     1500  184       22.  *  12     0700  272        1.
    1     0800    9        15.    *   5     0000   97       39.  *   8     1600  185       22.  *  12     0800  273        1.
    1     0900   10        15.    *   5     0100   98       40.  *   8     1700  186       22.  *  12     0900  274        1.
    1     1000   11        15.    *   5     0200   99       41.  *   8     1800  187       21.  *  12     1000  275        1.
    1     1100   12        16.    *   5     0300  100       42.  *   8     1900  188       21.  *  12     1100  276        1.
    1     1200   13        16.    *   5     0400  101       43.  *   8     2000  189       21.  *  12     1200  277        1.
    1     1300   14        16.    *   5     0500  102       45.  *   8     2100  190       21.  *  12     1300  278        1.
    1     1400   15        16.    *   5     0600  103       46.  *   8     2200  191       21.  *  12     1400  279        1.
    1     1500   16        16.    *   5     0700  104       48.  *   8     2300  192       20.  *  12     1500  280        1.
    1     1600   17        16.    *   5     0800  105       49.  *   9     0000  193       20.  *  12     1600  281        1.
    1     1700   18        16.    *   5     0900  106       51.  *   9     0100  194       20.  *  12     1700  282        1.
    1     1800   19        16.    *   5     1000  107       53.  *   9     0200  195       20.  *  12     1800  283        1.
    1     1900   20        16.    *   5     1100  108       56.  *   9     0300  196       20.  *  12     1900  284        1.
    1     2000   21        16.    *   5     1200  109       58.  *   9     0400  197       20.  *  12     2000  285        1.
    1     2100   22        17.    *   5     1300  110       61.  *   9     0500  198       19.  *  12     2100  286        1.
    1     2200   23        17.    *   5     1400  111       65.  *   9     0600  199       19.  *  12     2200  287        1.
    1     2300   24        17.    *   5     1500  112       69.  *   9     0700  200       19.  *  12     2300  288        1.
    2     0000   25        17.    *   5     1600  113       74.  *   9     0800  201       19.  *  13     0000  289        1.
    2     0100   26        17.    *   5     1700  114       80.  *   9     0900  202       19.  *  13     0100  290        1.
    2     0200   27        17.    *   5     1800  115       87.  *   9     1000  203       19.  *  13     0200  291        1.
    2     0300   28        17.    *   5     1900  116       96.  *   9     1100  204       19.  *  13     0300  292        1.
    2     0400   29        17.    *   5     2000  117      109.  *   9     1200  205       18.  *  13     0400  293        1.
    2     0500   30        17.    *   5     2100  118      127.  *   9     1300  206       18.  *  13     0500  294        1.
    2     0600   31        17.    *   5     2200  119      157.  *   9     1400  207       18.  *  13     0600  295        1.
    2     0700   32        18.    *   5     2300  120      219.  *   9     1500  208       18.  *  13     0700  296        1.
    2     0800   33        18.    *   6     0000  121      850.  *   9     1600  209       18.  *  13     0800  297        1.
    2     0900   34        18.    *   6     0100  122      479.  *   9     1700  210       18.  *  13     0900  298        1.
    2     1000   35        18.    *   6     0200  123      259.  *   9     1800  211       18.  *  13     1000  299        1.
    2     1100   36        18.    *   6     0300  124      172.  *   9     1900  212       17.  *  13     1100  300        1.
    2     1200   37        18.    *   6     0400  125      132.  *   9     2000  213       17.  *  13     1200  301        1.
    2     1300   38        18.    *   6     0500  126      111.  *   9     2100  214       17.  *  13     1300  302        1.
    2     1400   39        18.    *   6     0600  127       98.  *   9     2200  215       17.  *  13     1400  303        1.
    2     1500   40        19.    *   6     0700  128       88.  *   9     2300  216       17.  *  13     1500  304        1.
    2     1600   41        19.    *   6     0800  129       81.  *  10     0000  217       17.  *  13     1600  305        1.
    2     1700   42        19.    *   6     0900  130       75.  *  10     0100  218       17.  *  13     1700  306        1.
    2     1800   43        19.    *   6     1000  131       70.  *  10     0200  219       17.  *  13     1800  307        1.
    2     1900   44        19.    *   6     1100  132       65.  *  10     0300  220       17.  *  13     1900  308        1.
    2     2000   45        19.    *   6     1200  133       62.  *  10     0400  221       17.  *  13     2000  309        1.
    2     2100   46        20.    *   6     1300  134       59.  *  10     0500  222       16.  *  13     2100  310        1.
    2     2200   47        20.    *   6     1400  135       56.  *  10     0600  223       16.  *  13     2200  311        1.
    2     2300   48        20.    *   6     1500  136       54.  *  10     0700  224       16.  *  13     2300  312        1.
    3     0000   49        20.    *   6     1600  137       51.  *  10     0800  225       16.  *  14     0000  313        1.
    3     0100   50        20.    *   6     1700  138       50.  *  10     0900  226       16.  *  14     0100  314        1.
    3     0200   51        20.    *   6     1800  139       48.  *  10     1000  227       16.  *  14     0200  315        1.
    3     0300   52        21.    *   6     1900  140       46.  *  10     1100  228       16.  *  14     0300  316        1.
    3     0400   53        21.    *   6     2000  141       45.  *  10     1200  229       16.  *  14     0400  317        1.
    3     0500   54        21.    *   6     2100  142       43.  *  10     1300  230       16.  *  14     0500  318        1.
    3     0600   55        21.    *   6     2200  143       42.  *  10     1400  231       16.  *  14     0600  319        1.
    3     0700   56        21.    *   6     2300  144       41.  *  10     1500  232       15.  *  14     0700  320        1.
    3     0800   57        21.    *   7     0000  145       40.  *  10     1600  233       15.  *  14     0800  321        1.
    3     0900   58        22.    *   7     0100  146       39.  *  10     1700  234       15.  *  14     0900  322        1.
    3     1000   59        22.    *   7     0200  147       38.  *  10     1800  235       15.  *  14     1000  323        1.
    3     1100   60        22.    *   7     0300  148       37.  *  10     1900  236       15.  *  14     1100  324        1.
    3     1200   61        22.    *   7     0400  149       36.  *  10     2000  237       15.  *  14     1200  325        1.
    3     1300   62        23.    *   7     0500  150       35.  *  10     2100  238       15.  *  14     1300  326        1.
    3     1400   63        23.    *   7     0600  151       35.  *  10     2200  239       15.  *  14     1400  327        1.
    3     1500   64        23.    *   7     0700  152       34.  *  10     2300  240       15.  *  14     1500  328        1.
    3     1600   65        23.    *   7     0800  153       33.  *  11     0000  241       15.  *  14     1600  329        1.
    3     1700   66        24.    *   7     0900  154       33.  *  11     0100  242        4.  *  14     1700  330        1.
    3     1800   67        24.    *   7     1000  155       32.  *  11     0200  243        1.  *  14     1800  331        1.
    3     1900   68        24.    *   7     1100  156       32.  *  11     0300  244        1.  *  14     1900  332        1.
    3     2000   69        24.    *   7     1200  157       31.  *  11     0400  245        1.  *  14     2000  333        1.
    3     2100   70        25.    *   7     1300  158       30.  *  11     0500  246        1.  *  14     2100  334        1.
    3     2200   71        25.    *   7     1400  159       30.  *  11     0600  247        1.  *  14     2200  335        1.
    3     2300   72        25.    *   7     1500  160       29.  *  11     0700  248        1.  *  14     2300  336        1.
    4     0000   73        26.    *   7     1600  161       29.  *  11     0800  249        1.  *  15     0000  337        1.
    4     0100   74        26.    *   7     1700  162       29.  *  11     0900  250        1.  *  15     0100  338        1.
    4     0200   75        26.    *   7     1800  163       28.  *  11     1000  251        1.  *  15     0200  339        1.
    4     0300   76        27.    *   7     1900  164       28.  *  11     1100  252        1.  *  15     0300  340        1.
    4     0400   77        27.    *   7     2000  165       27.  *  11     1200  253        1.  *  15     0400  341        1.
    4     0500   78        27.    *   7     2100  166       27.  *  11     1300  254        1.  *  15     0500  342        1.
    4     0600   79        28.    *   7     2200  167       27.  *  11     1400  255        1.  *  15     0600  343        1.
    4     0700   80        28.    *   7     2300  168       26.  *  11     1500  256        1.  *  15     0700  344        1.
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     4     0800   81       29.   *    8     0000  169       26.   *   11     1600  257        1.   *   15     0800  345        1.
     4     0900   82       29.   *    8     0100  170       26.   *   11     1700  258        1.   *   15     0900  346        1.
     4     1000   83       29.   *    8     0200  171       25.   *   11     1800  259        1.   *   15     1000  347        1.
     4     1100   84       30.   *    8     0300  172       25.   *   11     1900  260        1.   *   15     1100  348        1.
     4     1200   85       30.   *    8     0400  173       25.   *   11     2000  261        1.   *   15     1200  349        1.
     4     1300   86       31.   *    8     0500  174       24.   *   11     2100  262        1.   *   15     1300  350        1.
     4     1400   87       31.   *    8     0600  175       24.   *   11     2200  263        1.   *
     4     1500   88       32.   *    8     0700  176       24.   *   11     2300  264        1.   *
                                 *                                *                                *
 ***********************************************************************************************************************************

   PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR    349.00-HR

+   (CFS)       (HR)
                           (CFS)
+     850.   120.00                   354.        154.         79.          26.
                        (INCHES)      .000        .000        .000         .000
                         (AC-FT)      175.        305.        468.         757.

                         CUMULATIVE AREA =     .00 SQ MI


 ***********************************************************************************************************************************

                                                   HYDROGRAPH AT STATION    Cove
                                                       PLAN 1,   RATIO =  1.00

 ***********************************************************************************************************************************
                                 *                                *                                *
    DA MON HRMN  ORD      FLOW   *  DA MON HRMN  ORD      FLOW    *  DA MON HRMN  ORD      FLOW    *  DA MON HRMN  ORD      FLOW
                                 *                                *                                *
     1     0000    1        0.   *    4     1600   89       33.   *    8     0800  177       24.   *   12     0000  265        1.
     1     0100    2       11.   *    4     1700   90       33.   *    8     0900  178       23.   *   12     0100  266        1.
     1     0200    3       14.   *    4     1800   91       34.   *    8     1000  179       23.   *   12     0200  267        1.
     1     0300    4       15.   *    4     1900   92       35.   *    8     1100  180       23.   *   12     0300  268        1.
     1     0400    5       15.   *    4     2000   93       35.   *    8     1200  181       23.   *   12     0400  269        1.
     1     0500    6       15.   *    4     2100   94       36.   *    8     1300  182       22.   *   12     0500  270        1.
     1     0600    7       15.   *    4     2200   95       37.   *    8     1400  183       22.   *   12     0600  271        1.
     1     0700    8       15.   *    4     2300   96       38.   *    8     1500  184       22.   *   12     0700  272        1.
     1     0800    9       15.   *    5     0000   97       39.   *    8     1600  185       22.   *   12     0800  273        1.
     1     0900   10       15.   *    5     0100   98       40.   *    8     1700  186       22.   *   12     0900  274        1.
     1     1000   11       15.   *    5     0200   99       41.   *    8     1800  187       21.   *   12     1000  275        1.
     1     1100   12       16.   *    5     0300  100       42.   *    8     1900  188       21.   *   12     1100  276        1.
     1     1200   13       16.   *    5     0400  101       43.   *    8     2000  189       21.   *   12     1200  277        1.
     1     1300   14       16.   *    5     0500  102       45.   *    8     2100  190       21.   *   12     1300  278        1.
     1     1400   15       16.   *    5     0600  103       46.   *    8     2200  191       21.   *   12     1400  279        1.
     1     1500   16       16.   *    5     0700  104       48.   *    8     2300  192       20.   *   12     1500  280        1.
     1     1600   17       16.   *    5     0800  105       49.   *    9     0000  193       20.   *   12     1600  281        1.
     1     1700   18       16.   *    5     0900  106       51.   *    9     0100  194       20.   *   12     1700  282        1.
     1     1800   19       16.   *    5     1000  107       53.   *    9     0200  195       20.   *   12     1800  283        1.
     1     1900   20       16.   *    5     1100  108       56.   *    9     0300  196       20.   *   12     1900  284        1.
     1     2000   21       16.   *    5     1200  109       58.   *    9     0400  197       20.   *   12     2000  285        1.
     1     2100   22       17.   *    5     1300  110       61.   *    9     0500  198       19.   *   12     2100  286        1.
     1     2200   23       17.   *    5     1400  111       65.   *    9     0600  199       19.   *   12     2200  287        1.
     1     2300   24       17.   *    5     1500  112       69.   *    9     0700  200       19.   *   12     2300  288        1.
     2     0000   25       17.   *    5     1600  113       74.   *    9     0800  201       19.   *   13     0000  289        1.
     2     0100   26       17.   *    5     1700  114       80.   *    9     0900  202       19.   *   13     0100  290        1.
     2     0200   27       17.   *    5     1800  115       87.   *    9     1000  203       19.   *   13     0200  291        1.
     2     0300   28       17.   *    5     1900  116       96.   *    9     1100  204       19.   *   13     0300  292        1.
     2     0400   29       17.   *    5     2000  117      109.   *    9     1200  205       18.   *   13     0400  293        1.
     2     0500   30       17.   *    5     2100  118      127.   *    9     1300  206       18.   *   13     0500  294        1.
     2     0600   31       17.   *    5     2200  119      157.   *    9     1400  207       18.   *   13     0600  295        1.
     2     0700   32       18.   *    5     2300  120      219.   *    9     1500  208       18.   *   13     0700  296        1.
     2     0800   33       18.   *    6     0000  121      850.   *    9     1600  209       18.   *   13     0800  297        1.
     2     0900   34       18.   *    6     0100  122      479.   *    9     1700  210       18.   *   13     0900  298        1.
     2     1000   35       18.   *    6     0200  123      259.   *    9     1800  211       18.   *   13     1000  299        1.
     2     1100   36       18.   *    6     0300  124      172.   *    9     1900  212       17.   *   13     1100  300        1.
     2     1200   37       18.   *    6     0400  125      132.   *    9     2000  213       17.   *   13     1200  301        1.
     2     1300   38       18.   *    6     0500  126      111.   *    9     2100  214       17.   *   13     1300  302        1.
     2     1400   39       18.   *    6     0600  127       98.   *    9     2200  215       17.   *   13     1400  303        1.
     2     1500   40       19.   *    6     0700  128       88.   *    9     2300  216       17.   *   13     1500  304        1.
     2     1600   41       19.   *    6     0800  129       81.   *   10     0000  217       17.   *   13     1600  305        1.
     2     1700   42       19.   *    6     0900  130       75.   *   10     0100  218       17.   *   13     1700  306        1.
     2     1800   43       19.   *    6     1000  131       70.   *   10     0200  219       17.   *   13     1800  307        1.
     2     1900   44       19.   *    6     1100  132       65.   *   10     0300  220       17.   *   13     1900  308        1.
     2     2000   45       19.   *    6     1200  133       62.   *   10     0400  221       17.   *   13     2000  309        1.
     2     2100   46       20.   *    6     1300  134       59.   *   10     0500  222       16.   *   13     2100  310        1.
     2     2200   47       20.   *    6     1400  135       56.   *   10     0600  223       16.   *   13     2200  311        1.
     2     2300   48       20.   *    6     1500  136       54.   *   10     0700  224       16.   *   13     2300  312        1.
     3     0000   49       20.   *    6     1600  137       51.   *   10     0800  225       16.   *   14     0000  313        1.
     3     0100   50       20.   *    6     1700  138       50.   *   10     0900  226       16.   *   14     0100  314        1.
     3     0200   51       20.   *    6     1800  139       48.   *   10     1000  227       16.   *   14     0200  315        1.
     3     0300   52       21.   *    6     1900  140       46.   *   10     1100  228       16.   *   14     0300  316        1.
     3     0400   53       21.   *    6     2000  141       45.   *   10     1200  229       16.   *   14     0400  317        1.
     3     0500   54       21.   *    6     2100  142       43.   *   10     1300  230       16.   *   14     0500  318        1.
     3     0600   55       21.   *    6     2200  143       42.   *   10     1400  231       16.   *   14     0600  319        1.
     3     0700   56       21.   *    6     2300  144       41.   *   10     1500  232       15.   *   14     0700  320        1.
     3     0800   57       21.   *    7     0000  145       40.   *   10     1600  233       15.   *   14     0800  321        1.
     3     0900   58       22.   *    7     0100  146       39.   *   10     1700  234       15.   *   14     0900  322        1.
     3     1000   59       22.   *    7     0200  147       38.   *   10     1800  235       15.   *   14     1000  323        1.
     3     1100   60       22.   *    7     0300  148       37.   *   10     1900  236       15.   *   14     1100  324        1.
     3     1200   61       22.   *    7     0400  149       36.   *   10     2000  237       15.   *   14     1200  325        1.
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     3     1300   62       23.   *    7     0500  150       35.   *   10     2100  238       15.   *   14     1300  326        1.
     3     1400   63       23.   *    7     0600  151       35.   *   10     2200  239       15.   *   14     1400  327        1.
     3     1500   64       23.   *    7     0700  152       34.   *   10     2300  240       15.   *   14     1500  328        1.
     3     1600   65       23.   *    7     0800  153       33.   *   11     0000  241       15.   *   14     1600  329        1.
     3     1700   66       24.   *    7     0900  154       33.   *   11     0100  242        4.   *   14     1700  330        1.
     3     1800   67       24.   *    7     1000  155       32.   *   11     0200  243        1.   *   14     1800  331        1.
     3     1900   68       24.   *    7     1100  156       32.   *   11     0300  244        1.   *   14     1900  332        1.
     3     2000   69       24.   *    7     1200  157       31.   *   11     0400  245        1.   *   14     2000  333        1.
     3     2100   70       25.   *    7     1300  158       30.   *   11     0500  246        1.   *   14     2100  334        1.
     3     2200   71       25.   *    7     1400  159       30.   *   11     0600  247        1.   *   14     2200  335        1.
     3     2300   72       25.   *    7     1500  160       29.   *   11     0700  248        1.   *   14     2300  336        1.
     4     0000   73       26.   *    7     1600  161       29.   *   11     0800  249        1.   *   15     0000  337        1.
     4     0100   74       26.   *    7     1700  162       29.   *   11     0900  250        1.   *   15     0100  338        1.
     4     0200   75       26.   *    7     1800  163       28.   *   11     1000  251        1.   *   15     0200  339        1.
     4     0300   76       27.   *    7     1900  164       28.   *   11     1100  252        1.   *   15     0300  340        1.
     4     0400   77       27.   *    7     2000  165       27.   *   11     1200  253        1.   *   15     0400  341        1.
     4     0500   78       27.   *    7     2100  166       27.   *   11     1300  254        1.   *   15     0500  342        1.
     4     0600   79       28.   *    7     2200  167       27.   *   11     1400  255        1.   *   15     0600  343        1.
     4     0700   80       28.   *    7     2300  168       26.   *   11     1500  256        1.   *   15     0700  344        1.
     4     0800   81       29.   *    8     0000  169       26.   *   11     1600  257        1.   *   15     0800  345        1.
     4     0900   82       29.   *    8     0100  170       26.   *   11     1700  258        1.   *   15     0900  346        1.
     4     1000   83       29.   *    8     0200  171       25.   *   11     1800  259        1.   *   15     1000  347        1.
     4     1100   84       30.   *    8     0300  172       25.   *   11     1900  260        1.   *   15     1100  348        1.
     4     1200   85       30.   *    8     0400  173       25.   *   11     2000  261        1.   *   15     1200  349        1.
     4     1300   86       31.   *    8     0500  174       24.   *   11     2100  262        1.   *   15     1300  350        1.
     4     1400   87       31.   *    8     0600  175       24.   *   11     2200  263        1.   *
     4     1500   88       32.   *    8     0700  176       24.   *   11     2300  264        1.   *
                                 *                                *                                *
*********************************************************************************************************************************

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR    349.00-HR
+   (CFS)       (HR)
                          (CFS)
+     850.    120.00                  354.        154.         79.          26.
                       (INCHES)      .000        .000        .000         .000
                        (AC-FT)      175.        305.        468.         757.

                        CUMULATIVE AREA =     .00 SQ MI




 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
   43 KK    *     Cove   *     Reservoir
            *            *
            **************
                         Routing through Res'v

               HYDROGRAPH ROUTING DATA

   45 RS         STORAGE ROUTING
                       NSTPS           1  NUMBER OF SUBREACHES
                        ITYP        ELEV  TYPE OF INITIAL CONDITION
                      RSVRIC     5545.50  INITIAL CONDITION
                           X         .00 WORKING R AND D COEFFICIENT

   46 SV           STORAGE          .0      19.0      95.0     240.0     453.0     738.0    1105.0    1563.0    2217.0    2773.0
                             3542.0    4423.0    5419.0    6149.0    7347.0    8000.0

   48 SE         ELEVATION    5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00
                              5530.00   5536.00   5542.00   5548.00   5552.00   5558.00

   50 SL         LOW-LEVEL OUTLET
                       ELEVL     5545.50  ELEVATION AT CENTER OF OUTLET
                       CAREA        4.91  CROSS-SECTIONAL AREA
                        COQL         .60  COEFFICIENT
                        EXPL         .50  EXPONENT OF HEAD

   51 SS         SPILLWAY
                        CREL     5549.20  SPILLWAY CREST ELEVATION
                       SPWID       30.00  SPILLWAY WIDTH
                        COQW        2.67  WEIR COEFFICIENT
                        EXPW        1.50  EXPONENT OF HEAD

   52 ST         TOP OF DAM
                       TOPEL     5552.00  ELEVATION AT TOP OF DAM
                      DAMWID     1892.00  DAM WIDTH
                        COQD        2.90  WEIR COEFFICIENT
                        EXPD        1.50  EXPONENT OF HEAD

                                                                 ***

                                                 COMPUTED OUTFLOW-ELEVATION DATA

                                                   (EXCLUDING FLOW OVER DAM)

            OUTFLOW        .00       .00     25.78     27.48     29.42     31.65     34.25     37.31     40.98     45.44
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          ELEVATION    5470.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00   5548.51   5549.20

            OUTFLOW      49.37     68.29    113.97    198.20    332.85    529.64    800.37   1156.85   1610.93   2174.46
          ELEVATION    5549.32   5549.60   5550.06   5550.68   5551.48   5552.44   5553.58   5554.88   5556.36   5558.00


                                             COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

                                                   (INCLUDING FLOW OVER DAM)

            STORAGE        .00     19.00     95.00    240.00    453.00    738.00   1105.00   1563.00   2217.00   2773.00
            OUTFLOW        .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
          ELEVATION    5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00

            STORAGE    3542.00   4423.00   5419.00   5844.83   5989.79   6009.51   6033.57   6063.27   6100.64   6148.41
            OUTFLOW        .00       .00       .00       .00     25.78     27.48     29.42     31.65     34.25     37.31
          ELEVATION    5530.00   5536.00   5542.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00

            STORAGE    6301.53   6508.46   6543.56   6628.96   6765.11   6952.15   7190.23   7347.00   7395.04   7518.54
            OUTFLOW      40.98     45.44     49.37     68.29    113.97    198.20    332.85    435.48   2138.72  11657.74
          ELEVATION    5548.51   5549.20   5549.32   5549.60   5550.06   5550.68   5551.48   5552.00   5552.44   5553.58

            STORAGE    7660.53   7821.02   8000.00
            OUTFLOW   27985.71  51484.63  82813.63
          ELEVATION    5554.88   5556.36   5558.00

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                                                  HYDROGRAPH AT STATION    Cove
                                                      PLAN 1,   RATIO =  1.00

***********************************************************************************************************************************
                                           *                                           *
 DA MON HRMN ORD  OUTFLOW  STORAGE    STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE    STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE    STAGE
                                           *                                           *
  1     0000   1       0.   5844.8  5545.5 *  5     2100 118      26.   5992.5  5546.7 * 10     1800 235      34.   6094.7  5547.6
  1     0100   2       1.   5845.2  5545.5 *  5     2200 119      27.   6002.1  5546.8 * 10     1900 236      34.   6093.2  5547.5
  1     0200   3       2.   5846.1  5545.5 *  5     2300 120      28.   6015.3  5546.9 * 10     2000 237      34.   6091.6  5547.5
  1     0300   4       3.   5847.1  5545.5 *  6     0000 121      31.   6057.0  5547.2 * 10     2100 238      34.   6090.1  5547.5
  1     0400   5       4.   5848.0  5545.5 *  6     0100 122      35.   6109.3  5547.7 * 10     2200 239      33.   6088.5  5547.5
  1     0500   6       4.   5848.9  5545.5 *  6     0200 123      37.   6136.7  5547.9 * 10     2300 240      33.   6087.0  5547.5
  1     0600   7       5.   5849.8  5545.5 *  6     0300 124      37.   6151.5  5548.0 * 11     0000 241      33.   6085.6  5547.5
  1     0700   8       5.   5850.7  5545.5 *  6     0400 125      38.   6161.0  5548.0 * 11     0100 242      33.   6083.6  5547.5
  1     0800   9       6.   5851.5  5545.6 *  6     0500 126      38.   6167.9  5548.1 * 11     0200 243      33.   6081.1  5547.4
  1     0900  10       6.   5852.3  5545.6 *  6     0600 127      38.   6173.4  5548.1 * 11     0300 244      33.   6078.5  5547.4
  1     1000  11       6.   5853.0  5545.6 *  6     0700 128      38.   6178.0  5548.1 * 11     0400 245      33.   6075.9  5547.4
  1     1100  12       6.   5853.8  5545.6 *  6     0800 129      38.   6181.8  5548.1 * 11     0500 246      32.   6073.3  5547.4
  1     1200  13       7.   5854.6  5545.6 *  6     0900 130      38.   6185.0  5548.1 * 11     0600 247      32.   6070.6  5547.4
  1     1300  14       7.   5855.3  5545.6 *  6     1000 131      38.   6187.8  5548.1 * 11     0700 248      32.   6068.1  5547.3
  1     1400  15       7.   5856.1  5545.6 *  6     1100 132      38.   6190.1  5548.1 * 11     0800 249      32.   6065.5  5547.3
  1     1500  16       7.   5856.8  5545.6 *  6     1200 133      38.   6192.1  5548.1 * 11     0900 250      32.   6063.0  5547.3
  1     1600  17       8.   5857.5  5545.6 *  6     1300 134      38.   6193.9  5548.1 * 11     1000 251      31.   6060.5  5547.3
  1     1700  18       8.   5858.3  5545.6 *  6     1400 135      38.   6195.5  5548.2 * 11     1100 252      31.   6058.0  5547.3
  1     1800  19       8.   5858.9  5545.6 *  6     1500 136      39.   6196.8  5548.2 * 11     1200 253      31.   6055.5  5547.2
  1     1900  20       8.   5859.6  5545.6 *  6     1600 137      39.   6198.0  5548.2 * 11     1300 254      31.   6053.0  5547.2
  1     2000  21       8.   5860.2  5545.6 *  6     1700 138      39.   6199.0  5548.2 * 11     1400 255      31.   6050.6  5547.2
  1     2100  22       9.   5860.9  5545.6 *  6     1800 139      39.   6199.9  5548.2 * 11     1500 256      31.   6048.1  5547.2
  1     2200  23       9.   5861.6  5545.6 *  6     1900 140      39.   6200.6  5548.2 * 11     1600 257      30.   6045.7  5547.2
  1     2300  24       9.   5862.2  5545.6 *  6     2000 141      39.   6201.2  5548.2 * 11     1700 258      30.   6043.3  5547.1
  2     0000  25       9.   5862.9  5545.6 *  6     2100 142      39.   6201.6  5548.2 * 11     1800 259      30.   6040.9  5547.1
  2     0100  26       9.   5863.5  5545.7 *  6     2200 143      39.   6201.9  5548.2 * 11     1900 260      30.   6038.5  5547.1
  2     0200  27       9.   5864.2  5545.7 *  6     2300 144      39.   6202.2  5548.2 * 11     2000 261      30.   6036.1  5547.1
  2     0300  28      10.   5864.8  5545.7 *  7     0000 145      39.   6202.4  5548.2 * 11     2100 262      29.   6033.7  5547.1
  2     0400  29      10.   5865.4  5545.7 *  7     0100 146      39.   6202.4  5548.2 * 11     2200 263      29.   6031.4  5547.0
  2     0500  30      10.   5866.0  5545.7 *  7     0200 147      39.   6202.4  5548.2 * 11     2300 264      29.   6029.1  5547.0
  2     0600  31      10.   5866.6  5545.7 *  7     0300 148      39.   6202.2  5548.2 * 12     0000 265      29.   6026.8  5547.0
  2     0700  32      10.   5867.2  5545.7 *  7     0400 149      39.   6202.1  5548.2 * 12     0100 266      29.   6024.5  5547.0
  2     0800  33      10.   5867.8  5545.7 *  7     0500 150      39.   6201.8  5548.2 * 12     0200 267      29.   6022.2  5547.0
  2     0900  34      10.   5868.5  5545.7 *  7     0600 151      39.   6201.5  5548.2 * 12     0300 268      28.   6020.0  5546.9
  2     1000  35      11.   5869.1  5545.7 *  7     0700 152      39.   6201.2  5548.2 * 12     0400 269      28.   6017.7  5546.9
  2     1100  36      11.   5869.7  5545.7 *  7     0800 153      39.   6200.8  5548.2 * 12     0500 270      28.   6015.5  5546.9
  2     1200  37      11.   5870.3  5545.7 *  7     0900 154      39.   6200.3  5548.2 * 12     0600 271      28.   6013.3  5546.9
  2     1300  38      11.   5870.9  5545.7 *  7     1000 155      39.   6199.9  5548.2 * 12     0700 272      28.   6011.1  5546.9
  2     1400  39      11.   5871.4  5545.7 *  7     1100 156      39.   6199.3  5548.2 * 12     0800 273      27.   6008.9  5546.8
  2     1500  40      11.   5872.0  5545.7 *  7     1200 157      39.   6198.7  5548.2 * 12     0900 274      27.   6006.7  5546.8
  2     1600  41      11.   5872.7  5545.7 *  7     1300 158      39.   6198.0  5548.2 * 12     1000 275      27.   6004.5  5546.8
  2     1700  42      11.   5873.3  5545.7 *  7     1400 159      39.   6197.3  5548.2 * 12     1100 276      27.   6002.4  5546.8
  2     1800  43      12.   5873.9  5545.7 *  7     1500 160      39.   6196.5  5548.2 * 12     1200 277      27.   6000.2  5546.8
  2     1900  44      12.   5874.5  5545.7 *  7     1600 161      38.   6195.8  5548.2 * 12     1300 278      27.   5998.1  5546.8
  2     2000  45      12.   5875.1  5545.7 *  7     1700 162      38.   6195.1  5548.2 * 12     1400 279      26.   5996.0  5546.7
  2     2100  46      12.   5875.8  5545.8 *  7     1800 163      38.   6194.2  5548.2 * 12     1500 280      26.   5993.9  5546.7
  2     2200  47      12.   5876.4  5545.8 *  7     1900 164      38.   6193.3  5548.1 * 12     1600 281      26.   5991.9  5546.7
  2     2300  48      12.   5877.1  5545.8 *  7     2000 165      38.   6192.4  5548.1 * 12     1700 282      26.   5989.8  5546.7
  3     0000  49      12.   5877.7  5545.8 *  7     2100 166      38.   6191.6  5548.1 * 12     1800 283      26.   5987.8  5546.7
  3     0100  50      12.   5878.4  5545.8 *  7     2200 167      38.   6190.7  5548.1 * 12     1900 284      25.   5985.7  5546.7
  3     0200  51      13.   5879.1  5545.8 *  7     2300 168      38.   6189.7  5548.1 * 12     2000 285      25.   5983.7  5546.6
  3     0300  52      13.   5879.7  5545.8 *  8     0000 169      38.   6188.6  5548.1 * 12     2100 286      25.   5981.7  5546.6
  3     0400  53      13.   5880.4  5545.8 *  8     0100 170      38.   6187.6  5548.1 * 12     2200 287      25.   5979.7  5546.6
  3     0500  54      13.   5881.1  5545.8 *  8     0200 171      38.   6186.6  5548.1 * 12     2300 288      25.   5977.8  5546.6
  3     0600  55      13.   5881.7  5545.8 *  8     0300 172      38.   6185.6  5548.1 * 13     0000 289      25.   5975.8  5546.6
  3     0700  56      13.   5882.4  5545.8 *  8     0400 173      38.   6184.5  5548.1 * 13     0100 290      24.   5973.9  5546.6
  3     0800  57      13.   5883.0  5545.8 *  8     0500 174      38.   6183.4  5548.1 * 13     0200 291      24.   5972.0  5546.5
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   3     0900  58      13.   5883.7  5545.8 *  8     0600 175      38.   6182.2  5548.1 * 13     0300 292      24.   5970.1  5546.5
   3     1000  59      13.   5884.4  5545.8 *  8     0700 176      38.   6181.0  5548.1 * 13     0400 293      24.   5968.2  5546.5
   3     1100  60      14.   5885.1  5545.8 *  8     0800 177      38.   6179.9  5548.1 * 13     0500 294      24.   5966.3  5546.5
   3     1200  61      14.   5885.8  5545.8 *  8     0900 178      38.   6178.7  5548.1 * 13     0600 295      23.   5964.4  5546.5
   3     1300  62      14.   5886.5  5545.8 *  8     1000 179      38.   6177.4  5548.1 * 13     0700 296      23.   5962.6  5546.5
   3     1400  63      14.   5887.3  5545.8 *  8     1100 180      38.   6176.2  5548.1 * 13     0800 297      23.   5960.7  5546.5
   3     1500  64      14.   5888.1  5545.9 *  8     1200 181      38.   6175.0  5548.1 * 13     0900 298      23.   5958.9  5546.4
   3     1600  65      14.   5888.8  5545.9 *  8     1300 182      38.   6173.7  5548.1 * 13     1000 299      23.   5957.1  5546.4
   3     1700  66      14.   5889.6  5545.9 *  8     1400 183      38.   6172.4  5548.1 * 13     1100 300      23.   5955.3  5546.4
   3     1800  67      14.   5890.3  5545.9 *  8     1500 184      38.   6171.1  5548.1 * 13     1200 301      22.   5953.5  5546.4
   3     1900  68      15.   5891.1  5545.9 *  8     1600 185      38.   6169.8  5548.1 * 13     1300 302      22.   5951.8  5546.4
   3     2000  69      15.   5891.9  5545.9 *  8     1700 186      38.   6168.5  5548.1 * 13     1400 303      22.   5950.0  5546.4
   3     2100  70      15.   5892.7  5545.9 *  8     1800 187      38.   6167.1  5548.1 * 13     1500 304      22.   5948.3  5546.4
   3     2200  71      15.   5893.5  5545.9 *  8     1900 188      38.   6165.8  5548.1 * 13     1600 305      22.   5946.6  5546.3
   3     2300  72      15.   5894.4  5545.9 *  8     2000 189      38.   6164.5  5548.1 * 13     1700 306      21.   5944.9  5546.3
   4     0000  73      15.   5895.2  5545.9 *  8     2100 190      38.   6163.2  5548.0 * 13     1800 307      21.   5943.2  5546.3
   4     0100  74      15.   5896.1  5545.9 *  8     2200 191      38.   6161.9  5548.0 * 13     1900 308      21.   5941.5  5546.3
   4     0200  75      15.   5897.0  5545.9 *  8     2300 192      38.   6160.4  5548.0 * 13     2000 309      21.   5939.9  5546.3
   4     0300  76      16.   5897.9  5545.9 *  9     0000 193      38.   6158.9  5548.0 * 13     2100 310      21.   5938.2  5546.3
   4     0400  77      16.   5898.8  5545.9 *  9     0100 194      38.   6157.5  5548.0 * 13     2200 311      21.   5936.6  5546.3
   4     0500  78      16.   5899.8  5546.0 *  9     0200 195      38.   6156.0  5548.0 * 13     2300 312      20.   5935.0  5546.2
   4     0600  79      16.   5900.7  5546.0 *  9     0300 196      37.   6154.6  5548.0 * 14     0000 313      20.   5933.4  5546.2
   4     0700  80      16.   5901.7  5546.0 *  9     0400 197      37.   6153.1  5548.0 * 14     0100 314      20.   5931.8  5546.2
   4     0800  81      16.   5902.8  5546.0 *  9     0500 198      37.   6151.6  5548.0 * 14     0200 315      20.   5930.3  5546.2
   4     0900  82      16.   5903.8  5546.0 *  9     0600 199      37.   6150.2  5548.0 * 14     0300 316      20.   5928.7  5546.2
   4     1000  83      17.   5904.8  5546.0 *  9     0700 200      37.   6148.6  5548.0 * 14     0400 317      19.   5927.2  5546.2
   4     1100  84      17.   5905.9  5546.0 *  9     0800 201      37.   6147.2  5548.0 * 14     0500 318      19.   5925.6  5546.2
   4     1200  85      17.   5907.0  5546.0 *  9     0900 202      37.   6145.7  5548.0 * 14     0600 319      19.   5924.1  5546.2
   4     1300  86      17.   5908.1  5546.0 *  9     1000 203      37.   6144.2  5548.0 * 14     0700 320      19.   5922.7  5546.1
   4     1400  87      17.   5909.2  5546.0 *  9     1100 204      37.   6142.7  5547.9 * 14     0800 321      19.   5921.2  5546.1
   4     1500  88      17.   5910.4  5546.0 *  9     1200 205      37.   6141.2  5547.9 * 14     0900 322      19.   5919.7  5546.1
   4     1600  89      18.   5911.7  5546.0 *  9     1300 206      37.   6139.6  5547.9 * 14     1000 323      18.   5918.3  5546.1
   4     1700  90      18.   5912.9  5546.1 *  9     1400 207      37.   6138.1  5547.9 * 14     1100 324      18.   5916.8  5546.1
   4     1800  91      18.   5914.2  5546.1 *  9     1500 208      37.   6136.5  5547.9 * 14     1200 325      18.   5915.4  5546.1
   4     1900  92      18.   5915.6  5546.1 *  9     1600 209      36.   6135.0  5547.9 * 14     1300 326      18.   5914.0  5546.1
   4     2000  93      18.   5917.0  5546.1 *  9     1700 210      36.   6133.4  5547.9 * 14     1400 327      18.   5912.6  5546.1
   4     2100  94      18.   5918.4  5546.1 *  9     1800 211      36.   6131.9  5547.9 * 14     1500 328      17.   5911.3  5546.0
   4     2200  95      19.   5919.9  5546.1 *  9     1900 212      36.   6130.3  5547.8 * 14     1600 329      17.   5909.9  5546.0
   4     2300  96      19.   5921.5  5546.1 *  9     2000 213      36.   6128.7  5547.8 * 14     1700 330      17.   5908.5  5546.0
   5     0000  97      19.   5923.1  5546.1 *  9     2100 214      36.   6127.2  5547.8 * 14     1800 331      17.   5907.2  5546.0
   5     0100  98      19.   5924.7  5546.2 *  9     2200 215      36.   6125.7  5547.8 * 14     1900 332      17.   5905.9  5546.0
   5     0200  99      19.   5926.5  5546.2 *  9     2300 216      36.   6124.1  5547.8 * 14     2000 333      17.   5904.6  5546.0
   5     0300 100      20.   5928.4  5546.2 * 10     0000 217      36.   6122.6  5547.8 * 14     2100 334      16.   5903.3  5546.0
   5     0400 101      20.   5930.3  5546.2 * 10     0100 218      36.   6121.0  5547.8 * 14     2200 335      16.   5902.0  5546.0
   5     0500 102      20.   5932.3  5546.2 * 10     0200 219      35.   6119.5  5547.8 * 14     2300 336      16.   5900.8  5546.0
   5     0600 103      20.   5934.4  5546.2 * 10     0300 220      35.   6117.9  5547.7 * 15     0000 337      16.   5899.5  5545.9
   5     0700 104      21.   5936.6  5546.3 * 10     0400 221      35.   6116.4  5547.7 * 15     0100 338      16.   5898.3  5545.9
   5     0800 105      21.   5938.9  5546.3 * 10     0500 222      35.   6114.8  5547.7 * 15     0200 339      15.   5897.1  5545.9
   5     0900 106      21.   5941.3  5546.3 * 10     0600 223      35.   6113.2  5547.7 * 15     0300 340      15.   5895.9  5545.9
   5     1000 107      21.   5943.9  5546.3 * 10     0700 224      35.   6111.7  5547.7 * 15     0400 341      15.   5894.7  5545.9
   5     1100 108      22.   5946.6  5546.3 * 10     0800 225      35.   6110.1  5547.7 * 15     0500 342      15.   5893.5  5545.9
   5     1200 109      22.   5949.5  5546.4 * 10     0900 226      35.   6108.6  5547.7 * 15     0600 343      15.   5892.4  5545.9
   5     1300 110      22.   5952.6  5546.4 * 10     1000 227      35.   6107.1  5547.7 * 15     0700 344      15.   5891.3  5545.9
   5     1400 111      23.   5956.0  5546.4 * 10     1100 228      35.   6105.5  5547.6 * 15     0800 345      14.   5890.2  5545.9
   5     1500 112      23.   5959.7  5546.4 * 10     1200 229      34.   6104.0  5547.6 * 15     0900 346      14.   5889.0  5545.9
   5     1600 113      23.   5963.6  5546.5 * 10     1300 230      34.   6102.4  5547.6 * 15     1000 347      14.   5888.0  5545.9
   5     1700 114      24.   5968.0  5546.5 * 10     1400 231      34.   6100.9  5547.6 * 15     1100 348      14.   5886.9  5545.8
   5     1800 115      24.   5973.0  5546.6 * 10     1500 232      34.   6099.4  5547.6 * 15     1200 349      14.   5885.8  5545.8
   5     1900 116      25.   5978.5  5546.6 * 10     1600 233      34.   6097.8  5547.6 * 15     1300 350      14.   5884.8  5545.8
   5     2000 117      25.   5984.9  5546.7 * 10     1700 234      34.   6096.2  5547.6 *
                                           *                                            *
 *******************************************************************************************************************************

 PEAK OUTFLOW IS       39. AT TIME 144.00 HOURS


  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    349.00-HR
+   (CFS)       (HR)
                          (CFS)
+      39.    144.00                  39.         39.         38.          25.
                       (INCHES)      .000        .000        .000         .000
                        (AC-FT)       19.         77.        228.         718.

 PEAK STORAGE   TIME                        MAXIMUM AVERAGE STORAGE
                                     6-HR       24-HR       72-HR    349.00-HR
+  (AC-FT)      (HR)
     6202.    144.00                6202.       6200.       6186.        6010.

  PEAK STAGE    TIME                         MAXIMUM AVERAGE STAGE
                                     6-HR       24-HR       72-HR    349.00-HR
+   (FEET)      (HR)
   5548.18    144.00              5548.18     5548.17     5548.13      5546.82

                        CUMULATIVE AREA =     .00 SQ MI

1

                PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                  FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                  TIME TO PEAK IN HOURS
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                                                          RATIOS APPLIED TO PRECIPITATION
 OPERATION       STATION     AREA    PLAN            RATIO 1
                                                        1.00

 HYDROGRAPH AT
+                  Cove        .00     1   FLOW         850.
                                           TIME       120.00

 ROUTED TO
+                  Cove        .00     1   FLOW          39.
                                           TIME       144.00

                                       ** PEAK STAGES IN FEET **
                                       1   STAGE     5548.18
                                           TIME       144.00
1                                  SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION    Cove
                              (PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED  DURING BREACH FORMATION)


      PLAN  1 ..............                 INITIAL VALUE     SPILLWAY CREST     TOP OF DAM
                                 ELEVATION        5545.50           5549.20          5552.00
                                 STORAGE            5845.             6508.            7347.
                                 OUTFLOW              0.               45.              435.


                     RATIO     MAXIMUM      MAXIMUM    MAXIMUM    MAXIMUM    DURATION     TIME OF     TIME OF
                       OF      RESERVOIR      DEPTH     STORAGE    OUTFLOW    OVER TOP   MAX OUTFLOW   FAILURE
                      PMF      W.S.ELEV    OVER DAM     AC-FT       CFS       HOURS        HOURS       HOURS

                     1.00      5548.18         .00       6202.        39.       .00       144.00         .00


 *** NORMAL END OF HEC-1 ***
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Storm Event 13. Local Auxiliary Spillway Hydrograph

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1*****************************************                                                    ***************************************
 *                                       *                                                    *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                    *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998               *                                                    *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1                 *                                                    *          609 SECOND STREET          *
 *                                       *                                                    *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:58:03   *                                                    *           (916) 756-1104            *
 *                                       *                                                    *                                     *
 *****************************************                                                    ***************************************




                                                  X     X  XXXXXXX   XXXXX           X
                                                  X     X  X        X     X         XX
                                                  X     X  X        X                X
                                                  XXXXXXX  XXXX     X       XXXXX    X
                                                  X     X  X        X                X
                                                  X     X  X        X     X          X
                                                  X     X  XXXXXXX   XXXXX          XXX




            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                                       HEC-1 INPUT                                             PAGE  1

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              1           ID   HYDROLOGY STUDY for COVE RESERVOIR
              2           ID   Located in KANE COUNTY, UTAH
              3           ID
              4           ID   AUG 2020
              5           ID
              6           ID   PREPARED BY ALPHA ENGINEERING
              7           ID   43 SOUTH 100 EAST, SUITE 100
              8           ID   ST. GEORGE, UTAH  84770
              9           ID   TEL: (435) 628-6500
             10           ID   FAX: (435) 628-6553
             11           ID
             12           ID   Local ASH
             13           ID
                          *
             14           JR    PREC     1.0
             15           IT      18       0       0     100
             16           IO       0
             17           IN      18
                          *

             18           KK   B1
             19           KM   Runoff from Basin 1
             20           BA   0.503
             21           PB    4.09
             22           PC       0   0.020   0.046   0.070   0.095   0.130   0.180   0.300   0.520   0.650
             23           PC   0.700   0.745   0.785   0.820   0.850   0.880   0.905   0.930   0.955   0.980
             24           PC   1.000
             25           LS       0    72.8
             26           UD    0.51
                          *

             27           KK   RB1
             28           KM   Route B1
             29           RD    4928    .045    .050            TRAP      20      20
                          *

             30           KK   B2
             31           KM   Runoff from Basin 2
             32           BA   0.436
             33           LS       0    72.5
             34           UD    0.52
                          *

             35           KK   B3
             36           KM   Runoff from Basin 3
             37           BA   0.279
             38           LS       0    71.0
             39           UD    0.39
                          *
1                                                       HEC-1 INPUT                                             PAGE  2

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10
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```
             40           KK   C1
             41           KM   Combine RB1, B2, B3
             42           HC       3
                          *

             43           KK   RC1
             44           KM   Route RC1
             45           RD    7255    .060    .030            TRAP      20      20
                          *

             46           KK   B4
             47           KM   Runoff from Basin 4
             48           BA   0.453
             49           LS       0    73.3
             50           UD    0.48
                          *

             51           KK   B5
             52           KM   Runoff from Basin 5
             53           BA   0.805
             54           LS       0    74.1
             55           UD    0.63
                          *

             56           KK   C2
             57           KM   Combine RC1, B4, B5
             58           HC       3
                          *

             59           KK   RC2
             60           KM   Route C2
             61           RD    2380    .039    .030            TRAP      40       2
                          *

             62           KK   B6
             63           KM   Runoff from Basin 6
             64           BA   0.150
             65           LS       0    84.3
             66           UD    0.19
                          *

             67           KK   B7
             68           KM   Runoff from Basin 7
             69           BA   0.327
             70           LS       0    75.7
             71           UD    0.46
                          *

             72           KK   C3
             73           KM   Combine RC2, B6, B7
             74           HC       3
                          *
1                                                       HEC-1 INPUT                                             PAGE  3

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


             75           KK   RC3
             76           KM   Route C3
             77           RD   11323    .023    .030            TRAP      40      20
                          *

             78           KK   B8
             79           KM   Runoff from Basin 8
             80           BA   1.012
             81           LS       0    84.0
             82           UD    0.67
                          *

             83           KK   B9
             84           KM   Runoff from Basin 9
             85           BA   0.242
             86           LS       0    85.5
             87           UD    0.26
                          *

             88           KK   B10
             89           KM   Runoff from Basin 10
             90           BA   0.129
             91           LS       0    86.7
             92           UD    0.18
                          *

             93           KK   C4
             94           KM   Combine B9, B10
             95           HC       2
                          *

             96           KK   RC4
             97           KM   Route C4
             98           RD    3380    .037    .030            TRAP      40      20
                          *
```

```
             99           KK   B11
            100           KM   Runoff from Basin 11
            101           BA   0.279
            102           LS       0    84.8
            103           UD    0.39
                          *

            104           KK   C5
            105           KM   Combine RC3, B8, RC4, B11
            106           HC       4
                          *

            107           KK   B12
            108           KM   Runoff from Basin 12
            109           BA   0.127
            110           LS       0    81.2
            111           UD    0.40
                          *
1                                                       HEC-1 INPUT                                                     PAGE  4

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


            112           KK   Call
            113           KM   Combine C5, B12
            114           HC       2
                          *

            115           KK   Cove Reservoir
            116           KM   Routing through Res'v
            117           RS       1    ELEV  5545.5
            118           SV       0      19      95     240     453     738    1105    1563    2217    2773
            119           SV    3542    4423    5419    6149    7347    8000
            120           SE    5470    5476    5482    5488    5494    5500    5506    5512    5518    5524
            121           SE    5530    5536    5542    5548    5552    5558
            122           SL  5545.5   4.909     0.6     0.5
            123           SS  5549.2      30    2.67     1.5
            124           ST  5552.0    1892     2.9     1.5
                          *
            125           ZZ
1*****************************************                                                   ***************************************
 *                                       *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998               *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
 *            VERSION 4.1                *                                                   *          609 SECOND STREET          *
 *                                       *                                                   *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:58:03   *                                                   *           (916) 756-1104            *
 *                                       *                                                   *                                     *
 *****************************************                                                   ***************************************




                            HYDROLOGY STUDY for COVE RESERVOIR
                            Located in KANE COUNTY, UTAH

                            AUG 2020

                            PREPARED BY ALPHA ENGINEERING
                            43 SOUTH 100 EAST, SUITE 100
                            ST. GEORGE, UTAH  84770
                            TEL: (435) 628-6500
                            FAX: (435) 628-6553

                            Local ASH


   16 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           0  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN          18  MINUTES IN COMPUTATION INTERVAL
                        IDATE      1    0  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ         100  NUMBER OF HYDROGRAPH ORDINATES
                       NDATE      2    0  ENDING DATE
                       NDTIME        0542  ENDING TIME
                       ICENT           19  CENTURY MARK

                    COMPUTATION INTERVAL     .30 HOURS
                         TOTAL TIME BASE   29.70 HOURS

           ENGLISH UNITS
                DRAINAGE AREA         SQUARE MILES
                PRECIPITATION DEPTH   INCHES
                LENGTH, ELEVATION     FEET
                FLOW                  CUBIC FEET PER SECOND
                STORAGE VOLUME        ACRE-FEET
```

```
                SURFACE AREA          ACRES
                TEMPERATURE           DEGREES FAHRENHEIT

      JP          MULTI-PLAN OPTION
                        NPLAN           1  NUMBER OF PLANS

      JR          MULTI-RATIO OPTION
                      RATIOS OF PRECIPITATION
                     1.00


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
  112 KK     *     Call   *
             *            *
             **************
                            Combine C5, B12

  114 HC          HYDROGRAPH COMBINATION
                        ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                 ***

 ***********************************************************************************************************************************

                                                   HYDROGRAPH AT STATION    Call
                                                        SUM OF  2 HYDROGRAPHS
                                                       PLAN 1,   RATIO =  1.00

 ***********************************************************************************************************************************
                                 *                                *                                *
    DA MON HRMN  ORD       FLOW  *   DA MON HRMN  ORD       FLOW  *   DA MON HRMN  ORD       FLOW  *   DA MON HRMN  ORD       FLOW
                                 *                                *                                *
     1     0000    1         0.  *    1     0730   26       180.  *    1     1500   51         0.  *    1     2230   76         0.
     1     0018    2         0.  *    1     0748   27       112.  *    1     1518   52         0.  *    1     2248   77         0.
     1     0036    3         0.  *    1     0806   28        73.  *    1     1536   53         0.  *    1     2306   78         0.
     1     0054    4         0.  *    1     0824   29        47.  *    1     1554   54         0.  *    1     2324   79         0.
     1     0112    5         0.  *    1     0842   30        28.  *    1     1612   55         0.  *    1     2342   80         0.
     1     0130    6         6.  *    1     0900   31        16.  *    1     1630   56         0.  *    2     0000   81         0.
     1     0148    7        39.  *    1     0918   32         9.  *    1     1648   57         0.  *    2     0018   82         0.
     1     0206    8       194.  *    1     0936   33         5.  *    1     1706   58         0.  *    2     0036   83         0.
     1     0224    9       687.  *    1     0954   34         3.  *    1     1724   59         0.  *    2     0054   84         0.
     1     0242   10      1365.  *    1     1012   35         1.  *    1     1742   60         0.  *    2     0112   85         0.
     1     0300   11      2027.  *    1     1030   36         1.  *    1     1800   61         0.  *    2     0130   86         0.
     1     0318   12      2180.  *    1     1048   37         0.  *    1     1818   62         0.  *    2     0148   87         0.
     1     0336   13      1955.  *    1     1106   38         0.  *    1     1836   63         0.  *    2     0206   88         0.
     1     0354   14      1683.  *    1     1124   39         0.  *    1     1854   64         0.  *    2     0224   89         0.
     1     0412   15      1441.  *    1     1142   40         0.  *    1     1912   65         0.  *    2     0242   90         0.
     1     0430   16      1248.  *    1     1200   41         0.  *    1     1930   66         0.  *    2     0300   91         0.
     1     0448   17      1107.  *    1     1218   42         0.  *    1     1948   67         0.  *    2     0318   92         0.
     1     0506   18      1001.  *    1     1236   43         0.  *    1     2006   68         0.  *    2     0336   93         0.
     1     0524   19       924.  *    1     1254   44         0.  *    1     2024   69         0.  *    2     0354   94         0.
     1     0542   20       874.  *    1     1312   45         0.  *    1     2042   70         0.  *    2     0412   95         0.
     1     0600   21       833.  *    1     1330   46         0.  *    1     2100   71         0.  *    2     0430   96         0.
     1     0618   22       748.  *    1     1348   47         0.  *    1     2118   72         0.  *    2     0448   97         0.
     1     0636   23       589.  *    1     1406   48         0.  *    1     2136   73         0.  *    2     0506   98         0.
     1     0654   24       423.  *    1     1424   49         0.  *    1     2154   74         0.  *    2     0524   99         0.
     1     0712   25       283.  *    1     1442   50         0.  *    1     2212   75         0.  *    2     0542  100         0.
                                 *                                *                                *
 ***********************************************************************************************************************************

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     29.70-HR
+   (CFS)       (HR)
                           (CFS)
+    2180.      3.30                  991.        251.        203.         203.
                        (INCHES)     1.943       1.969       1.969        1.969
                         (AC-FT)      491.        498.        498.         498.

                         CUMULATIVE AREA =    4.74 SQ MI



 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
  115 KK     *     Cove   *     Reservoir
             *            *
             **************
                            Routing through Res'v

                HYDROGRAPH ROUTING DATA
```

```
 117 RS          STORAGE ROUTING
                       NSTPS           1  NUMBER OF SUBREACHES
                        ITYP        ELEV  TYPE OF INITIAL CONDITION
                      RSVRIC     5545.50  INITIAL CONDITION
                           X         .00 WORKING R AND D COEFFICIENT

 118 SV            STORAGE          .0      19.0      95.0     240.0     453.0     738.0    1105.0    1563.0    2217.0    2773.0
                                3542.0    4423.0    5419.0    6149.0    7347.0    8000.0

 120 SE          ELEVATION     5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00
                               5530.00   5536.00   5542.00   5548.00   5552.00   5558.00

 122 SL          LOW-LEVEL OUTLET
                       ELEVL     5545.50  ELEVATION AT CENTER OF OUTLET
                       CAREA        4.91  CROSS-SECTIONAL AREA
                        COQL         .60  COEFFICIENT
                        EXPL         .50  EXPONENT OF HEAD

 123 SS          SPILLWAY
                        CREL     5549.20  SPILLWAY CREST ELEVATION
                       SPWID       30.00  SPILLWAY WIDTH
                        COQW        2.67  WEIR COEFFICIENT
                        EXPW        1.50  EXPONENT OF HEAD

 124 ST          TOP OF DAM
                       TOPEL     5552.00  ELEVATION AT TOP OF DAM
                      DAMWID     1892.00  DAM WIDTH
                        COQD        2.90  WEIR COEFFICIENT
                        EXPD        1.50  EXPONENT OF HEAD

                                                                ***

                                                 COMPUTED OUTFLOW-ELEVATION DATA

                                                   (EXCLUDING FLOW OVER DAM)

            OUTFLOW        .00       .00     25.78     27.48     29.42     31.65     34.25     37.31     40.98     45.44
          ELEVATION    5470.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00   5548.51   5549.20

            OUTFLOW      49.37     68.29    113.97    198.20    332.85    529.64    800.37   1156.85   1610.93   2174.46
          ELEVATION    5549.32   5549.60   5550.06   5550.68   5551.48   5552.44   5553.58   5554.88   5556.36   5558.00


                                             COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

                                                   (INCLUDING FLOW OVER DAM)

            STORAGE        .00     19.00     95.00    240.00    453.00    738.00   1105.00   1563.00   2217.00   2773.00
            OUTFLOW        .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
          ELEVATION    5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00

            STORAGE    3542.00   4423.00   5419.00   5844.83   5989.79   6009.51   6033.57   6063.27   6100.64   6148.41
            OUTFLOW        .00       .00       .00       .00     25.78     27.48     29.42     31.65     34.25     37.31
          ELEVATION    5530.00   5536.00   5542.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00

            STORAGE    6301.53   6508.46   6543.56   6628.96   6765.11   6952.15   7190.23   7347.00   7395.04   7518.54
            OUTFLOW      40.98     45.44     49.37     68.29    113.97    198.20    332.85    435.48   2138.72  11657.74
          ELEVATION    5548.51   5549.20   5549.32   5549.60   5550.06   5550.68   5551.48   5552.00   5552.44   5553.58

            STORAGE    7660.53   7821.02   8000.00
            OUTFLOW   27985.71  51484.63  82813.63
          ELEVATION    5554.88   5556.36   5558.00

***********************************************************************************************************************************

                                                  HYDROGRAPH AT STATION    Cove
                                                      PLAN 1,   RATIO =  1.00

***********************************************************************************************************************************
                                           *                                           *
 DA MON HRMN ORD  OUTFLOW  STORAGE    STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE    STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE    STAGE
                                           *                                           *
  1     0000   1       0.   5844.8  5545.5 *  1     1012  35      41.   6318.9  5548.6 *  1     2024  69      41.   6284.1  5548.5
  1     0018   2       0.   5844.8  5545.5 *  1     1030  36      41.   6317.9  5548.6 *  1     2042  70      41.   6283.1  5548.4
  1     0036   3       0.   5844.8  5545.5 *  1     1048  37      41.   6316.9  5548.6 *  1     2100  71      41.   6282.1  5548.4
  1     0054   4       0.   5844.8  5545.5 *  1     1106  38      41.   6315.9  5548.6 *  1     2118  72      41.   6281.1  5548.4
  1     0112   5       0.   5844.8  5545.5 *  1     1124  39      41.   6314.8  5548.6 *  1     2136  73      40.   6280.0  5548.4
  1     0130   6       1.   5844.9  5545.5 *  1     1142  40      41.   6313.8  5548.6 *  1     2154  74      40.   6279.0  5548.4
  1     0148   7       2.   5845.4  5545.5 *  1     1200  41      41.   6312.8  5548.5 *  1     2212  75      40.   6278.0  5548.4
  1     0206   8       4.   5848.3  5545.5 *  1     1218  42      41.   6311.8  5548.5 *  1     2230  76      40.   6277.0  5548.4
  1     0224   9       8.   5859.1  5545.6 *  1     1236  43      41.   6310.7  5548.5 *  1     2248  77      40.   6275.9  5548.4
  1     0242  10      13.   5884.3  5545.8 *  1     1254  44      41.   6309.7  5548.5 *  1     2306  78      40.   6274.9  5548.4
  1     0300  11      19.   5925.9  5546.2 *  1     1312  45      41.   6308.7  5548.5 *  1     2324  79      40.   6273.9  5548.4
  1     0318  12      25.   5977.5  5546.6 *  1     1330  46      41.   6307.7  5548.5 *  1     2342  80      40.   6272.9  5548.4
  1     0336  13      29.   6028.2  5547.0 *  1     1348  47      41.   6306.6  5548.5 *  2     0000  81      40.   6271.8  5548.4
  1     0354  14      32.   6072.5  5547.4 *  1     1406  48      41.   6305.6  5548.5 *  2     0018  82      40.   6270.8  5548.4
  1     0412  15      35.   6110.4  5547.7 *  1     1424  49      41.   6304.6  5548.5 *  2     0036  83      40.   6269.8  5548.4
  1     0430  16      37.   6142.7  5547.9 *  1     1442  50      41.   6303.6  5548.5 *  2     0054  84      40.   6268.8  5548.4
  1     0448  17      38.   6170.9  5548.1 *  1     1500  51      41.   6302.6  5548.5 *  2     0112  85      40.   6267.7  5548.4
  1     0506  18      39.   6196.1  5548.2 *  1     1518  52      41.   6301.5  5548.5 *  2     0130  86      40.   6266.7  5548.4
  1     0524  19      39.   6219.0  5548.2 *  1     1536  53      41.   6300.5  5548.5 *  2     0148  87      40.   6265.7  5548.4
  1     0542  20      40.   6240.4  5548.3 *  1     1554  54      41.   6299.5  5548.5 *  2     0206  88      40.   6264.7  5548.4
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   1     0600  21      40.   6260.6  5548.4 *  1     1612  55      41.   6298.5  5548.5 *  2     0224  89      40.   6263.7  5548.4
   1     0618  22      40.   6279.2  5548.4 *  1     1630  56      41.   6297.4  5548.5 *  2     0242  90      40.   6262.6  5548.4
   1     0636  23      41.   6294.7  5548.5 *  1     1648  57      41.   6296.4  5548.5 *  2     0300  91      40.   6261.6  5548.4
   1     0654  24      41.   6306.2  5548.5 *  1     1706  58      41.   6295.4  5548.5 *  2     0318  92      40.   6260.6  5548.4
   1     0712  25      41.   6314.0  5548.6 *  1     1724  59      41.   6294.4  5548.5 *  2     0336  93      40.   6259.6  5548.4
   1     0730  26      41.   6318.6  5548.6 *  1     1742  60      41.   6293.3  5548.5 *  2     0354  94      40.   6258.5  5548.4
   1     0748  27      41.   6321.3  5548.6 *  1     1800  61      41.   6292.3  5548.5 *  2     0412  95      40.   6257.5  5548.4
   1     0806  28      41.   6322.6  5548.6 *  1     1818  62      41.   6291.3  5548.5 *  2     0430  96      40.   6256.5  5548.4
   1     0824  29      41.   6323.0  5548.6 *  1     1836  63      41.   6290.3  5548.5 *  2     0448  97      40.   6255.5  5548.4
   1     0842  30      41.   6322.9  5548.6 *  1     1854  64      41.   6289.2  5548.5 *  2     0506  98      40.   6254.4  5548.4
   1     0900  31      41.   6322.4  5548.6 *  1     1912  65      41.   6288.2  5548.5 *  2     0524  99      40.   6253.4  5548.3
   1     0918  32      41.   6321.7  5548.6 *  1     1930  66      41.   6287.2  5548.5 *  2     0542 100      40.   6252.4  5548.3
   1     0936  33      41.   6320.8  5548.6 *  1     1948  67      41.   6286.2  5548.5 *
   1     0954  34      41.   6320.0  5548.6 *  1     2006  68      41.   6285.1  5548.5 *
                                            *                                          *
 *******************************************************************************************************************************

 PEAK OUTFLOW IS       41. AT TIME   8.40 HOURS


  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     29.70-HR
+   (CFS)       (HR)
                           (CFS)
+      41.      8.40                   41.         41.         36.          36.
                        (INCHES)      .081        .319        .353         .353
                         (AC-FT)       20.         81.         89.          89.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     29.70-HR
+  (AC-FT)      (HR)
     6323.      8.40                 6317.       6290.       6230.        6230.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     29.70-HR
+   (FEET)      (HR)
   5548.58      8.40               5548.56     5548.47     5548.10      5548.10

                         CUMULATIVE AREA =    4.74 SQ MI

1

               PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                 FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                TIME TO PEAK IN HOURS


                                                         RATIOS APPLIED TO PRECIPITATION
 OPERATION       STATION     AREA    PLAN           RATIO 1
                                                       1.00


 HYDROGRAPH AT
+                  B1          .50     1   FLOW         221.
                                           TIME         3.00

 ROUTED TO
+                  RB1         .50     1   FLOW         215.
                                           TIME         3.30

 HYDROGRAPH AT
+                  B2          .44     1   FLOW         187.
                                           TIME         3.00

 HYDROGRAPH AT
+                  B3          .28     1   FLOW         116.
                                           TIME         3.00

  3 COMBINED AT
+                  C1         1.22     1   FLOW         493.
                                           TIME         3.00

 ROUTED TO
+                  RC1        1.22     1   FLOW         478.
                                           TIME         3.30

 HYDROGRAPH AT
+                  B4          .45     1   FLOW         209.
                                           TIME         3.00

 HYDROGRAPH AT
+                  B5          .81     1   FLOW         334.
                                           TIME         3.00

  3 COMBINED AT
+                  C2         2.48     1   FLOW         983.
                                           TIME         3.30

 ROUTED TO
+                  RC2        2.48     1   FLOW         977.
                                           TIME         3.30

 HYDROGRAPH AT
```

```
+                  B6          .15     1   FLOW         141.
                                           TIME         2.70

 HYDROGRAPH AT
+                  B7          .33     1   FLOW         172.
                                           TIME         3.00

  3 COMBINED AT
+                  C3         2.95     1   FLOW        1173.
                                           TIME         3.30

 ROUTED TO
+                  RC3        2.95     1   FLOW        1135.
                                           TIME         3.30

 HYDROGRAPH AT
+                  B8         1.01     1   FLOW         669.
                                           TIME         3.00

 HYDROGRAPH AT
+                  B9          .24     1   FLOW         237.
                                           TIME         2.70

 HYDROGRAPH AT
+                  B10         .13     1   FLOW         138.
                                           TIME         2.40

  2 COMBINED AT
+                  C4          .37     1   FLOW         368.
                                           TIME         2.70

 ROUTED TO
+                  RC4         .37     1   FLOW         354.
                                           TIME         2.70

 HYDROGRAPH AT
+                  B11         .28     1   FLOW         237.
                                           TIME         2.70

  4 COMBINED AT
+                  C5         4.61     1   FLOW        2118.
                                           TIME         3.30

 HYDROGRAPH AT
+                  B12         .13     1   FLOW          90.
                                           TIME         2.70

  2 COMBINED AT
+                  Call       4.74     1   FLOW        2180.
                                           TIME         3.30

 ROUTED TO
+                  Cove       4.74     1   FLOW          41.
                                           TIME         8.40

                                       ** PEAK STAGES IN FEET **
                                       1   STAGE     5548.58
                                           TIME         8.40
1
                                           SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                                               (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                              INTERPOLATED TO
                                                                           COMPUTATION INTERVAL
            ISTAQ    ELEMENT      DT       PEAK    TIME TO     VOLUME      DT       PEAK    TIME TO     VOLUME
                                                     PEAK                                     PEAK

                                (MIN)     (CFS)      (MIN)     (IN)     (MIN)     (CFS)     (MIN)       (IN)

           FOR PLAN = 1  RATIO=  .00
              RB1    MANE         3.60    218.47    194.40      1.58     18.00    214.54    198.00        1.58


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .4234E+02 EXCESS= .0000E+00 OUTFLOW= .4236E+02 BASIN STORAGE= .4004E-02 PERCENT ERROR=   -.1


           FOR PLAN = 1  RATIO=  .00
              RC1    MANE         3.60    494.09    190.80      1.54     18.00    478.26    198.00        1.53


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1002E+03 EXCESS= .0000E+00 OUTFLOW= .1002E+03 BASIN STORAGE= .2965E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC2    MANE         2.55    978.48    199.17      1.59     18.00    977.20    198.00        1.60


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .2103E+03 EXCESS= .0000E+00 OUTFLOW= .2103E+03 BASIN STORAGE= .2799E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC3    MANE         7.20   1186.64    208.80      1.66     18.00   1135.13    198.00        1.66
```

```
 CONTINUITY SUMMARY (AC-FT) - INFLOW= .2617E+03 EXCESS= .0000E+00 OUTFLOW= .2619E+03 BASIN STORAGE= .9925E-02 PERCENT ERROR=   -.1


          FOR PLAN = 1  RATIO=  .00
             RC4    MANE         5.40    361.92    167.40      2.62     18.00    354.00    162.00        2.62


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .5187E+02 EXCESS= .0000E+00 OUTFLOW= .5189E+02 BASIN STORAGE= .2315E-02 PERCENT ERROR=    .0


1                                  SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION    Cove
                              (PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED  DURING BREACH FORMATION)


      PLAN  1 ...............                 INITIAL VALUE     SPILLWAY CREST     TOP OF DAM
                                 ELEVATION        5545.50           5549.20          5552.00
                                 STORAGE            5845.              6508.            7347.
                                 OUTFLOW               0.                45.             435.


                      RATIO     MAXIMUM      MAXIMUM    MAXIMUM    MAXIMUM    DURATION     TIME OF     TIME OF
                       OF      RESERVOIR      DEPTH     STORAGE    OUTFLOW    OVER TOP   MAX OUTFLOW   FAILURE
                       PMF      W.S.ELEV    OVER DAM     AC-FT       CFS       HOURS        HOURS       HOURS

                      1.00      5548.58         .00       6323.        41.       .00         8.40         .00


 *** NORMAL END OF HEC-1 ***
```

Storm Event 14. General Auxiliary Spillway Hydrograph

```
1*****************************************                                                   ***************************************
 *                                       *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
 *             JUN   1998                *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1                 *                                                   *          609 SECOND STREET          *
 *                                       *                                                   *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  03:33:46   *                                                   *           (916) 756-1104            *
 *                                       *                                                   *                                     *
 *****************************************                                                   ***************************************




                                                 X     X  XXXXXXX   XXXXX           X
                                                 X     X  X        X     X         XX
                                                 X     X  X        X                X
                                                 XXXXXXX  XXXX     X       XXXXX    X
                                                 X     X  X        X                X
                                                 X     X  X        X     X          X
                                                 X     X  XXXXXXX   XXXXX          XXX




            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                                    HEC-1 INPUT                                           PAGE  1

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              1           ID   HYDROLOGY STUDY for COVE RESERVOIR
              2           ID   Located in KANE COUNTY, UTAH
              3           ID
              4           ID   AUG 2020
              5           ID
              6           ID   PREPARED BY ALPHA ENGINEERING
              7           ID   43 SOUTH 100 EAST, SUITE 100
              8           ID   ST. GEORGE, UTAH  84770
              9           ID   TEL: (435) 628-6500
             10           ID   FAX: (435) 628-6553
             11           ID
             12           ID   General ASH (NEH)
             13           ID
                          *
             14           JR    PREC     1.0
             15           IT      12       0       0     200
             16           IO       0
             17           IN      12
                          *
             18           QI       0       0       0       0       0       0       0       0       0       0
             19           QI       0       0       0       0       0       0       0       0       0       0
             20           QI       0       0       0       0       0       0       0       0       0       0
             21           QI       0       0       2      11      35      83     155     249     357     473
             22           QI     589     701     807     907     999    1084    1163    1234    1300    1359
             23           QI    1414    1464    1510    1552    1590    1626    1658    1689    1716    1742
             24           QI    1766    1764    1708    1564    1350    1117     898     713     581     489
             25           QI     423     374     339     314     296     283     274     267     263     259
             26           QI     257     255     254     253     253     253     253     253     254     254
             27           QI     254     253     251     244     236     226     218     210     205     201
             28           QI     199     197     196     195     194     194     194     193     193     193
             29           QI     193     193     193     193     193     194     194     194     194     194
             30           QI     194     191     182     163     136     107      80      57      41      29
             31           QI      21      15      11       8       6       4       3       2       1       1
             32           QI       1
                          *

             33           KK   Cove Reservoir
             34           KM   Routing through Res'v
             35           RS       1    ELEV  5545.5
             36           SV       0      19      95     240     453     738    1105    1563    2217    2773
             37           SV    3542    4423    5419    6149    7347    8000
             38           SE    5470    5476    5482    5488    5494    5500    5506    5512    5518    5524
             39           SE    5530    5536    5542    5548    5552    5558
             40           SL  5545.5   4.909     0.6     0.5
             41           SS  5549.2      30    2.67     1.5
             42           ST  5552.0    1892     2.9     1.5
                          *
             43           ZZ
1*****************************************                                                   ***************************************
 *                                       *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
 *             JUN   1998                *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1                 *                                                   *          609 SECOND STREET          *
 *                                       *                                                   *       DAVIS, CALIFORNIA 95616       *
```

```
*  RUN DATE   06AUG20  TIME  03:33:46   *                                                   *           (916) 756-1104           *
*                                       *                                                   *                                      *
*****************************************                                                   ****************************************




                           HYDROLOGY STUDY for COVE RESERVOIR
                           Located in KANE COUNTY, UTAH

                           AUG 2020

                           PREPARED BY ALPHA ENGINEERING
                           43 SOUTH 100 EAST, SUITE 100
                           ST. GEORGE, UTAH  84770
                           TEL: (435) 628-6500
                           FAX: (435) 628-6553

                           General ASH (NEH)


  16 IO          OUTPUT CONTROL VARIABLES
                       IPRNT           0  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

     IT          HYDROGRAPH TIME DATA
                        NMIN          12  MINUTES IN COMPUTATION INTERVAL
                       IDATE      1    0  STARTING DATE
                       ITIME        0000  STARTING TIME
                          NQ         200  NUMBER OF HYDROGRAPH ORDINATES
                      NDDATE      2    0  ENDING DATE
                      NDTIME        1548  ENDING TIME
                      ICENT           19  CENTURY MARK

                   COMPUTATION INTERVAL     .20 HOURS
                        TOTAL TIME BASE   39.80 HOURS

          ENGLISH UNITS
               DRAINAGE AREA         SQUARE MILES
               PRECIPITATION DEPTH   INCHES
               LENGTH, ELEVATION     FEET
               FLOW                  CUBIC FEET PER SECOND
               STORAGE VOLUME        ACRE-FEET
               SURFACE AREA          ACRES
               TEMPERATURE           DEGREES FAHRENHEIT

     JP          MULTI-PLAN OPTION
                       NPLAN           1  NUMBER OF PLANS

     JR          MULTI-RATIO OPTION
                     RATIOS OF PRECIPITATION
                    1.00

  17 IN          TIME DATA FOR INPUT TIME SERIES
                       JXMIN          12  TIME INTERVAL IN MINUTES
                      JXDATE      1    0  STARTING DATE
                      JXTIME           0  STARTING TIME

               SUBBASIN RUNOFF DATA

   0 BA          SUBBASIN CHARACTERISTICS
                       TAREA         .00  SUBBASIN AREA

                                                                ***

***********************************************************************************************************************************

                                                  HYDROGRAPH AT STATION    Cove

***********************************************************************************************************************************
                                 *                                *                                *
   DA MON HRMN  ORD      FLOW    *  DA MON HRMN  ORD      FLOW    *  DA MON HRMN  ORD      FLOW    *  DA MON HRMN  ORD      FLOW
                                 *                                *                                *
    1     0000    1        0.    *    1     1000   51     1414.    *    1     2000  101      199.    *    2     0600  151        1.
    1     0012    2        0.    *    1     1012   52     1464.    *    1     2012  102      197.    *    2     0612  152        1.
    1     0024    3        0.    *    1     1024   53     1510.    *    1     2024  103      196.    *    2     0624  153        1.
    1     0036    4        0.    *    1     1036   54     1552.    *    1     2036  104      195.    *    2     0636  154        1.
    1     0048    5        0.    *    1     1048   55     1590.    *    1     2048  105      194.    *    2     0648  155        1.
    1     0100    6        0.    *    1     1100   56     1626.    *    1     2100  106      194.    *    2     0700  156        1.
    1     0112    7        0.    *    1     1112   57     1658.    *    1     2112  107      194.    *    2     0712  157        1.
    1     0124    8        0.    *    1     1124   58     1689.    *    1     2124  108      193.    *    2     0724  158        1.
    1     0136    9        0.    *    1     1136   59     1716.    *    1     2136  109      193.    *    2     0736  159        1.
    1     0148   10        0.    *    1     1148   60     1742.    *    1     2148  110      193.    *    2     0748  160        1.
    1     0200   11        0.    *    1     1200   61     1766.    *    1     2200  111      193.    *    2     0800  161        1.
    1     0212   12        0.    *    1     1212   62     1764.    *    1     2212  112      193.    *    2     0812  162        1.
    1     0224   13        0.    *    1     1224   63     1708.    *    1     2224  113      193.    *    2     0824  163        1.
    1     0236   14        0.    *    1     1236   64     1564.    *    1     2236  114      193.    *    2     0836  164        1.
    1     0248   15        0.    *    1     1248   65     1350.    *    1     2248  115      193.    *    2     0848  165        1.
    1     0300   16        0.    *    1     1300   66     1117.    *    1     2300  116      194.    *    2     0900  166        1.
    1     0312   17        0.    *    1     1312   67      898.    *    1     2312  117      194.    *    2     0912  167        1.
```

```
      1     0324   18        0.   *    1     1324   68      713.   *    1     2324  118      194.   *    2     0924  168        1.
      1     0336   19        0.   *    1     1336   69      581.   *    1     2336  119      194.   *    2     0936  169        1.
      1     0348   20        0.   *    1     1348   70      489.   *    1     2348  120      194.   *    2     0948  170        1.
      1     0400   21        0.   *    1     1400   71      423.   *    2     0000  121      194.   *    2     1000  171        1.
      1     0412   22        0.   *    1     1412   72      374.   *    2     0012  122      191.   *    2     1012  172        1.
      1     0424   23        0.   *    1     1424   73      339.   *    2     0024  123      182.   *    2     1024  173        1.
      1     0436   24        0.   *    1     1436   74      314.   *    2     0036  124      163.   *    2     1036  174        1.
      1     0448   25        0.   *    1     1448   75      296.   *    2     0048  125      136.   *    2     1048  175        1.
      1     0500   26        0.   *    1     1500   76      283.   *    2     0100  126      107.   *    2     1100  176        1.
      1     0512   27        0.   *    1     1512   77      274.   *    2     0112  127       80.   *    2     1112  177        1.
      1     0524   28        0.   *    1     1524   78      267.   *    2     0124  128       57.   *    2     1124  178        1.
      1     0536   29        0.   *    1     1536   79      263.   *    2     0136  129       41.   *    2     1136  179        1.
      1     0548   30        0.   *    1     1548   80      259.   *    2     0148  130       29.   *    2     1148  180        1.
      1     0600   31        0.   *    1     1600   81      257.   *    2     0200  131       21.   *    2     1200  181        1.
      1     0612   32        0.   *    1     1612   82      255.   *    2     0212  132       15.   *    2     1212  182        1.
      1     0624   33        2.   *    1     1624   83      254.   *    2     0224  133       11.   *    2     1224  183        1.
      1     0636   34       11.   *    1     1636   84      253.   *    2     0236  134        8.   *    2     1236  184        1.
      1     0648   35       35.   *    1     1648   85      253.   *    2     0248  135        6.   *    2     1248  185        1.
      1     0700   36       83.   *    1     1700   86      253.   *    2     0300  136        4.   *    2     1300  186        1.
      1     0712   37      155.   *    1     1712   87      253.   *    2     0312  137        3.   *    2     1312  187        1.
      1     0724   38      249.   *    1     1724   88      253.   *    2     0324  138        2.   *    2     1324  188        1.
      1     0736   39      357.   *    1     1736   89      254.   *    2     0336  139        1.   *    2     1336  189        1.
      1     0748   40      473.   *    1     1748   90      254.   *    2     0348  140        1.   *    2     1348  190        1.
      1     0800   41      589.   *    1     1800   91      254.   *    2     0400  141        1.   *    2     1400  191        1.
      1     0812   42      701.   *    1     1812   92      253.   *    2     0412  142        1.   *    2     1412  192        1.
      1     0824   43      807.   *    1     1824   93      251.   *    2     0424  143        1.   *    2     1424  193        1.
      1     0836   44      907.   *    1     1836   94      244.   *    2     0436  144        1.   *    2     1436  194        1.
      1     0848   45      999.   *    1     1848   95      236.   *    2     0448  145        1.   *    2     1448  195        1.
      1     0900   46     1084.   *    1     1900   96      226.   *    2     0500  146        1.   *    2     1500  196        1.
      1     0912   47     1163.   *    1     1912   97      218.   *    2     0512  147        1.   *    2     1512  197        1.
      1     0924   48     1234.   *    1     1924   98      210.   *    2     0524  148        1.   *    2     1524  198        1.
      1     0936   49     1300.   *    1     1936   99      205.   *    2     0536  149        1.   *    2     1536  199        1.
      1     0948   50     1359.   *    1     1948  100      201.   *    2     0548  150        1.   *    2     1548  200        1.
                                  *                                 *                                 *
 ***************************************************************************************************************************

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                        6-HR       24-HR       72-HR     39.80-HR
+   (CFS)       (HR)
                                (CFS)
+    1766.     12.00                   1268.        437.        264.         264.
                              (INCHES)      .000        .000        .000         .000
                               (AC-FT)      629.        868.        868.         868.

                               CUMULATIVE AREA =     .00 SQ MI


 ***************************************************************************************************************************

                                                   HYDROGRAPH AT STATION    Cove
                                                       PLAN 1,   RATIO =  1.00

 ***************************************************************************************************************************
                                  *                                 *                                 *
    DA MON HRMN  ORD      FLOW    *  DA MON HRMN  ORD      FLOW     *  DA MON HRMN  ORD      FLOW     *  DA MON HRMN  ORD      FLOW
                                  *                                 *                                 *
      1     0000    1        0.   *    1     1000   51     1414.   *    1     2000  101      199.   *    2     0600  151        1.
      1     0012    2        0.   *    1     1012   52     1464.   *    1     2012  102      197.   *    2     0612  152        1.
      1     0024    3        0.   *    1     1024   53     1510.   *    1     2024  103      196.   *    2     0624  153        1.
      1     0036    4        0.   *    1     1036   54     1552.   *    1     2036  104      195.   *    2     0636  154        1.
      1     0048    5        0.   *    1     1048   55     1590.   *    1     2048  105      194.   *    2     0648  155        1.
      1     0100    6        0.   *    1     1100   56     1626.   *    1     2100  106      194.   *    2     0700  156        1.
      1     0112    7        0.   *    1     1112   57     1658.   *    1     2112  107      194.   *    2     0712  157        1.
      1     0124    8        0.   *    1     1124   58     1689.   *    1     2124  108      193.   *    2     0724  158        1.
      1     0136    9        0.   *    1     1136   59     1716.   *    1     2136  109      193.   *    2     0736  159        1.
      1     0148   10        0.   *    1     1148   60     1742.   *    1     2148  110      193.   *    2     0748  160        1.
      1     0200   11        0.   *    1     1200   61     1766.   *    1     2200  111      193.   *    2     0800  161        1.
      1     0212   12        0.   *    1     1212   62     1764.   *    1     2212  112      193.   *    2     0812  162        1.
      1     0224   13        0.   *    1     1224   63     1708.   *    1     2224  113      193.   *    2     0824  163        1.
      1     0236   14        0.   *    1     1236   64     1564.   *    1     2236  114      193.   *    2     0836  164        1.
      1     0248   15        0.   *    1     1248   65     1350.   *    1     2248  115      193.   *    2     0848  165        1.
      1     0300   16        0.   *    1     1300   66     1117.   *    1     2300  116      194.   *    2     0900  166        1.
      1     0312   17        0.   *    1     1312   67      898.   *    1     2312  117      194.   *    2     0912  167        1.
      1     0324   18        0.   *    1     1324   68      713.   *    1     2324  118      194.   *    2     0924  168        1.
      1     0336   19        0.   *    1     1336   69      581.   *    1     2336  119      194.   *    2     0936  169        1.
      1     0348   20        0.   *    1     1348   70      489.   *    1     2348  120      194.   *    2     0948  170        1.
      1     0400   21        0.   *    1     1400   71      423.   *    2     0000  121      194.   *    2     1000  171        1.
      1     0412   22        0.   *    1     1412   72      374.   *    2     0012  122      191.   *    2     1012  172        1.
      1     0424   23        0.   *    1     1424   73      339.   *    2     0024  123      182.   *    2     1024  173        1.
      1     0436   24        0.   *    1     1436   74      314.   *    2     0036  124      163.   *    2     1036  174        1.
      1     0448   25        0.   *    1     1448   75      296.   *    2     0048  125      136.   *    2     1048  175        1.
      1     0500   26        0.   *    1     1500   76      283.   *    2     0100  126      107.   *    2     1100  176        1.
      1     0512   27        0.   *    1     1512   77      274.   *    2     0112  127       80.   *    2     1112  177        1.
      1     0524   28        0.   *    1     1524   78      267.   *    2     0124  128       57.   *    2     1124  178        1.
      1     0536   29        0.   *    1     1536   79      263.   *    2     0136  129       41.   *    2     1136  179        1.
      1     0548   30        0.   *    1     1548   80      259.   *    2     0148  130       29.   *    2     1148  180        1.
      1     0600   31        0.   *    1     1600   81      257.   *    2     0200  131       21.   *    2     1200  181        1.
      1     0612   32        0.   *    1     1612   82      255.   *    2     0212  132       15.   *    2     1212  182        1.
      1     0624   33        2.   *    1     1624   83      254.   *    2     0224  133       11.   *    2     1224  183        1.
      1     0636   34       11.   *    1     1636   84      253.   *    2     0236  134        8.   *    2     1236  184        1.
      1     0648   35       35.   *    1     1648   85      253.   *    2     0248  135        6.   *    2     1248  185        1.
      1     0700   36       83.   *    1     1700   86      253.   *    2     0300  136        4.   *    2     1300  186        1.
```

```
    1    0712   37      155.   *    1     1712   87      253.   *    2     0312  137        3.   *    2     1312  187        1.
    1    0724   38      249.   *    1     1724   88      253.   *    2     0324  138        2.   *    2     1324  188        1.
    1    0736   39      357.   *    1     1736   89      254.   *    2     0336  139        1.   *    2     1336  189        1.
    1    0748   40      473.   *    1     1748   90      254.   *    2     0348  140        1.   *    2     1348  190        1.
    1    0800   41      589.   *    1     1800   91      254.   *    2     0400  141        1.   *    2     1400  191        1.
    1    0812   42      701.   *    1     1812   92      253.   *    2     0412  142        1.   *    2     1412  192        1.
    1    0824   43      807.   *    1     1824   93      251.   *    2     0424  143        1.   *    2     1424  193        1.
    1    0836   44      907.   *    1     1836   94      244.   *    2     0436  144        1.   *    2     1436  194        1.
    1    0848   45      999.   *    1     1848   95      236.   *    2     0448  145        1.   *    2     1448  195        1.
    1    0900   46     1084.   *    1     1900   96      226.   *    2     0500  146        1.   *    2     1500  196        1.
    1    0912   47     1163.   *    1     1912   97      218.   *    2     0512  147        1.   *    2     1512  197        1.
    1    0924   48     1234.   *    1     1924   98      210.   *    2     0524  148        1.   *    2     1524  198        1.
    1    0936   49     1300.   *    1     1936   99      205.   *    2     0536  149        1.   *    2     1536  199        1.
    1    0948   50     1359.   *    1     1948  100      201.   *    2     0548  150        1.   *    2     1548  200        1.
                               *                                *                                *
*******************************************************************************************************************************

  PEAK FLOW     TIME                         MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR     39.80-HR

+   (CFS)       (HR)
                          (CFS)
+    1766.     12.00                1268.        437.        264.         264.
                       (INCHES)      .000        .000        .000         .000
                        (AC-FT)      629.        868.        868.         868.

                        CUMULATIVE AREA =     .00 SQ MI




*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
  33 KK     *     Cove   *     Reservoir
            *            *
            **************
                           Routing through Res'v

               HYDROGRAPH ROUTING DATA

  35 RS          STORAGE ROUTING
                       NSTPS           1  NUMBER OF SUBREACHES
                        ITYP        ELEV  TYPE OF INITIAL CONDITION
                      RSVRIC     5545.50  INITIAL CONDITION
                           X         .00 WORKING R AND D COEFFICIENT

  36 SV            STORAGE          .0      19.0      95.0     240.0     453.0     738.0    1105.0    1563.0    2217.0    2773.0
                             3542.0    4423.0    5419.0    6149.0    7347.0    8000.0

  38 SE          ELEVATION     5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00
                               5530.00   5536.00   5542.00   5548.00   5552.00   5558.00

  40 SL          LOW-LEVEL OUTLET
                       ELEVL     5545.50  ELEVATION AT CENTER OF OUTLET
                       CAREA        4.91  CROSS-SECTIONAL AREA
                        COQL         .60  COEFFICIENT
                        EXPL         .50  EXPONENT OF HEAD

  41 SS          SPILLWAY
                        CREL     5549.20  SPILLWAY CREST ELEVATION
                       SPWID       30.00  SPILLWAY WIDTH
                        COQW        2.67  WEIR COEFFICIENT
                        EXPW        1.50  EXPONENT OF HEAD

  42 ST          TOP OF DAM
                       TOPEL     5552.00  ELEVATION AT TOP OF DAM
                      DAMWID     1892.00  DAM WIDTH
                        COQD        2.90  WEIR COEFFICIENT
                        EXPD        1.50  EXPONENT OF HEAD
                                                                   ***

                                                     COMPUTED OUTFLOW-ELEVATION DATA

                                                       (EXCLUDING FLOW OVER DAM)

            OUTFLOW        .00       .00     25.78     27.48     29.42     31.65     34.25     37.31     40.98     45.44
          ELEVATION    5470.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00   5548.51   5549.20

            OUTFLOW      49.37     68.29    113.97    198.20    332.85    529.64    800.37   1156.85   1610.93   2174.46
          ELEVATION    5549.32   5549.60   5550.06   5550.68   5551.48   5552.44   5553.58   5554.88   5556.36   5558.00


                                                 COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

                                                       (INCLUDING FLOW OVER DAM)

            STORAGE        .00     19.00     95.00    240.00    453.00    738.00   1105.00   1563.00   2217.00   2773.00
            OUTFLOW        .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
          ELEVATION    5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00
```

```
             STORAGE    3542.00   4423.00   5419.00   5844.83   5989.79   6009.51   6033.57   6063.27   6100.64   6148.41
             OUTFLOW        .00       .00       .00       .00     25.78     27.48     29.42     31.65     34.25     37.31
           ELEVATION    5530.00   5536.00   5542.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00

             STORAGE    6301.53   6508.46   6543.56   6628.96   6765.11   6952.15   7190.23   7347.00   7395.04   7518.54
             OUTFLOW      40.98     45.44     49.37     68.29    113.97    198.20    332.85    435.48   2138.72  11657.74
           ELEVATION    5548.51   5549.20   5549.32   5549.60   5550.06   5550.68   5551.48   5552.00   5552.44   5553.58

             STORAGE    7660.53   7821.02   8000.00
             OUTFLOW   27985.71  51484.63  82813.63
           ELEVATION    5554.88   5556.36   5558.00

*********************************************************************************************************************************

                                                  HYDROGRAPH AT STATION    Cove
                                                      PLAN 1,   RATIO =  1.00

*********************************************************************************************************************************
                                           *                                            *
 DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE
                                           *                                            *
  1     0000   1       0.   5844.8  5545.5 *  1     1324  68      44.   6457.6  5549.0 *  2     0248 135      69.   6632.9  5549.6
  1     0012   2       0.   5844.8  5545.5 *  1     1336  69      45.   6467.5  5549.1 *  2     0300 136      69.   6631.9  5549.6
  1     0024   3       0.   5844.8  5545.5 *  1     1348  70      45.   6475.6  5549.1 *  2     0312 137      69.   6630.9  5549.6
  1     0036   4       0.   5844.8  5545.5 *  1     1400  71      45.   6482.3  5549.1 *  2     0324 138      69.   6629.8  5549.6
  1     0048   5       0.   5844.8  5545.5 *  1     1412  72      45.   6488.1  5549.1 *  2     0336 139      68.   6628.7  5549.6
  1     0100   6       0.   5844.8  5545.5 *  1     1424  73      45.   6493.2  5549.1 *  2     0348 140      68.   6627.5  5549.6
  1     0112   7       0.   5844.8  5545.5 *  1     1436  74      45.   6497.9  5549.2 *  2     0400 141      68.   6626.3  5549.6
  1     0124   8       0.   5844.8  5545.5 *  1     1448  75      45.   6502.2  5549.2 *  2     0412 142      67.   6625.2  5549.6
  1     0136   9       0.   5844.8  5545.5 *  1     1500  76      45.   6506.3  5549.2 *  2     0424 143      67.   6624.1  5549.6
  1     0148  10       0.   5844.8  5545.5 *  1     1512  77      46.   6510.1  5549.2 *  2     0436 144      67.   6623.1  5549.6
  1     0200  11       0.   5844.8  5545.5 *  1     1524  78      46.   6513.7  5549.2 *  2     0448 145      66.   6622.1  5549.6
  1     0212  12       0.   5844.8  5545.5 *  1     1536  79      46.   6517.4  5549.2 *  2     0500 146      66.   6621.1  5549.6
  1     0224  13       0.   5844.8  5545.5 *  1     1548  80      46.   6520.9  5549.2 *  2     0512 147      66.   6620.0  5549.6
  1     0236  14       0.   5844.8  5545.5 *  1     1600  81      47.   6524.4  5549.3 *  2     0524 148      66.   6619.0  5549.6
  1     0248  15       0.   5844.8  5545.5 *  1     1612  82      47.   6527.9  5549.3 *  2     0536 149      65.   6618.0  5549.6
  1     0300  16       0.   5844.8  5545.5 *  1     1624  83      48.   6531.3  5549.3 *  2     0548 150      65.   6617.0  5549.6
  1     0312  17       0.   5844.8  5545.5 *  1     1636  84      48.   6534.6  5549.3 *  2     0600 151      65.   6615.9  5549.6
  1     0324  18       0.   5844.8  5545.5 *  1     1648  85      49.   6538.0  5549.3 *  2     0612 152      65.   6614.9  5549.6
  1     0336  19       0.   5844.8  5545.5 *  1     1700  86      49.   6541.4  5549.3 *  2     0624 153      64.   6613.9  5549.6
  1     0348  20       0.   5844.8  5545.5 *  1     1712  87      50.   6544.7  5549.3 *  2     0636 154      64.   6612.9  5549.5
  1     0400  21       0.   5844.8  5545.5 *  1     1724  88      50.   6548.1  5549.3 *  2     0648 155      64.   6611.9  5549.5
  1     0412  22       0.   5844.8  5545.5 *  1     1736  89      51.   6551.5  5549.3 *  2     0700 156      63.   6610.8  5549.5
  1     0424  23       0.   5844.8  5545.5 *  1     1748  90      51.   6554.8  5549.4 *  2     0712 157      63.   6609.8  5549.5
  1     0436  24       0.   5844.8  5545.5 *  1     1800  91      52.   6558.2  5549.4 *  2     0724 158      63.   6608.8  5549.5
  1     0448  25       0.   5844.8  5545.5 *  1     1812  92      52.   6561.5  5549.4 *  2     0736 159      63.   6607.8  5549.5
  1     0500  26       0.   5844.8  5545.5 *  1     1824  93      53.   6564.9  5549.4 *  2     0748 160      62.   6606.7  5549.5
  1     0512  27       0.   5844.8  5545.5 *  1     1836  94      54.   6568.1  5549.4 *  2     0800 161      62.   6605.7  5549.5
  1     0524  28       0.   5844.8  5545.5 *  1     1848  95      54.   6571.2  5549.4 *  2     0812 162      62.   6604.7  5549.5
  1     0536  29       0.   5844.8  5545.5 *  1     1900  96      55.   6574.1  5549.4 *  2     0824 163      62.   6603.7  5549.5
  1     0548  30       0.   5844.8  5545.5 *  1     1912  97      56.   6576.9  5549.4 *  2     0836 164      61.   6602.6  5549.5
  1     0600  31       0.   5844.8  5545.5 *  1     1924  98      56.   6579.5  5549.4 *  2     0848 165      61.   6601.6  5549.5
  1     0612  32       0.   5844.8  5545.5 *  1     1936  99      57.   6582.0  5549.4 *  2     0900 166      61.   6600.6  5549.5
  1     0624  33       0.   5844.8  5545.5 *  1     1948 100      57.   6584.5  5549.5 *  2     0912 167      61.   6599.6  5549.5
  1     0636  34       1.   5845.0  5545.5 *  1     2000 101      58.   6586.8  5549.5 *  2     0924 168      60.   6598.5  5549.5
  1     0648  35       1.   5845.3  5545.5 *  1     2012 102      58.   6589.2  5549.5 *  2     0936 169      60.   6597.5  5549.5
  1     0700  36       3.   5846.3  5545.5 *  1     2024 103      59.   6591.5  5549.5 *  2     0948 170      60.   6596.5  5549.5
  1     0712  37       4.   5848.2  5545.5 *  1     2036 104      59.   6593.7  5549.5 *  2     1000 171      60.   6595.5  5549.5
  1     0724  38       5.   5851.4  5545.6 *  1     2048 105      60.   6595.9  5549.5 *  2     1012 172      59.   6594.4  5549.5
  1     0736  39       7.   5856.4  5545.6 *  1     2100 106      60.   6598.1  5549.5 *  2     1024 173      59.   6593.4  5549.5
  1     0748  40       9.   5863.1  5545.6 *  1     2112 107      61.   6600.3  5549.5 *  2     1036 174      59.   6592.4  5549.5
  1     0800  41      11.   5871.7  5545.7 *  1     2124 108      61.   6602.5  5549.5 *  2     1048 175      59.   6591.4  5549.5
  1     0812  42      13.   5882.1  5545.8 *  1     2136 109      62.   6604.7  5549.5 *  2     1100 176      59.   6590.4  5549.5
  1     0824  43      15.   5894.4  5545.9 *  1     2148 110      63.   6606.9  5549.5 *  2     1112 177      58.   6589.5  5549.5
  1     0836  44      17.   5908.3  5546.0 *  1     2200 111      63.   6609.1  5549.5 *  2     1124 178      58.   6588.6  5549.5
  1     0848  45      19.   5923.7  5546.1 *  1     2212 112      64.   6611.3  5549.5 *  2     1136 179      58.   6587.7  5549.5
  1     0900  46      21.   5940.6  5546.3 *  1     2224 113      64.   6613.5  5549.6 *  2     1148 180      58.   6586.8  5549.5
  1     0912  47      23.   5958.8  5546.4 *  1     2236 114      65.   6615.7  5549.6 *  2     1200 181      58.   6586.0  5549.5
  1     0924  48      25.   5978.3  5546.6 *  1     2248 115      65.   6617.7  5549.6 *  2     1212 182      57.   6585.1  5549.5
  1     0936  49      27.   5998.8  5546.8 *  1     2300 116      66.   6619.7  5549.6 *  2     1224 183      57.   6584.2  5549.5
  1     0948  50      28.   6020.3  5546.9 *  1     2312 117      66.   6621.8  5549.6 *  2     1236 184      57.   6583.3  5549.5
  1     1000  51      30.   6042.7  5547.1 *  1     2324 118      67.   6623.8  5549.6 *  2     1248 185      57.   6582.5  5549.4
  1     1012  52      32.   6066.0  5547.3 *  1     2336 119      67.   6625.9  5549.6 *  2     1300 186      57.   6581.6  5549.4
  1     1024  53      34.   6090.1  5547.5 *  1     2348 120      68.   6627.9  5549.6 *  2     1312 187      56.   6580.7  5549.4
  1     1036  54      35.   6114.7  5547.7 *  2     0000 121      69.   6630.0  5549.6 *  2     1324 188      56.   6579.8  5549.4
  1     1048  55      37.   6140.0  5547.9 *  2     0012 122      69.   6632.0  5549.6 *  2     1336 189      56.   6578.9  5549.4
  1     1100  56      38.   6166.0  5548.1 *  2     0024 123      70.   6633.9  5549.6 *  2     1348 190      56.   6578.1  5549.4
  1     1112  57      38.   6192.4  5548.1 *  2     0036 124      70.   6635.7  5549.6 *  2     1400 191      56.   6577.2  5549.4
  1     1124  58      39.   6219.5  5548.2 *  2     0048 125      71.   6637.0  5549.6 *  2     1412 192      55.   6576.3  5549.4
  1     1136  59      40.   6247.0  5548.3 *  2     0100 126      71.   6637.9  5549.6 *  2     1424 193      55.   6575.4  5549.4
  1     1148  60      40.   6274.9  5548.4 *  2     0112 127      71.   6638.3  5549.6 *  2     1436 194      55.   6574.6  5549.4
  1     1200  61      41.   6303.3  5548.5 *  2     0124 128      71.   6638.3  5549.6 *  2     1448 195      55.   6573.7  5549.4
  1     1212  62      42.   6331.8  5548.6 *  2     0136 129      71.   6638.0  5549.6 *  2     1500 196      55.   6572.8  5549.4
  1     1224  63      42.   6359.7  5548.7 *  2     0148 130      71.   6637.4  5549.6 *  2     1512 197      55.   6571.9  5549.4
  1     1236  64      43.   6386.1  5548.8 *  2     0200 131      70.   6636.7  5549.6 *  2     1524 198      54.   6571.0  5549.4
  1     1248  65      43.   6409.5  5548.9 *  2     0212 132      70.   6635.8  5549.6 *  2     1536 199      54.   6570.2  5549.4
  1     1300  66      44.   6429.0  5548.9 *  2     0224 133      70.   6635.0  5549.6 *  2     1548 200      54.   6569.3  5549.4
  1     1312  67      44.   6445.0  5549.0 *  2     0236 134      70.   6633.9  5549.6 *
                                           *                                            *
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```
 PEAK OUTFLOW IS       71. AT TIME  25.20 HOURS


  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     39.80-HR
+   (CFS)       (HR)
                              (CFS)
+      71.     25.20                   69.         61.         44.          44.
                           (INCHES)      .000        .000        .000         .000
                            (AC-FT)       34.        121.        145.         145.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     39.80-HR
+  (AC-FT)      (HR)
     6638.     25.20                 6631.       6598.       6379.        6379.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     39.80-HR
+   (FEET)      (HR)
   5549.63     25.20               5549.61     5549.50     5548.41      5548.41

                         CUMULATIVE AREA =     .00 SQ MI

1

               PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                 FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                TIME TO PEAK IN HOURS


                                                         RATIOS APPLIED TO PRECIPITATION
 OPERATION       STATION     AREA    PLAN            RATIO 1
                                                        1.00

 HYDROGRAPH AT
+                  Cove        .00     1   FLOW        1766.
                                           TIME        12.00

 ROUTED TO
+                  Cove        .00     1   FLOW          71.
                                           TIME        25.20

                                       ** PEAK STAGES IN FEET **
                                       1   STAGE     5549.63
                                           TIME        25.20
1                                  SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION    Cove
                              (PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED  DURING BREACH FORMATION)


      PLAN  1 ..............                  INITIAL VALUE     SPILLWAY CREST     TOP OF DAM
                                 ELEVATION        5545.50           5549.20          5552.00
                                 STORAGE            5845.             6508.            7347.
                                 OUTFLOW               0.               45.             435.


                      RATIO     MAXIMUM      MAXIMUM    MAXIMUM    MAXIMUM    DURATION     TIME OF     TIME OF
                        OF     RESERVOIR      DEPTH     STORAGE    OUTFLOW    OVER TOP   MAX OUTFLOW   FAILURE
                       PMF      W.S.ELEV    OVER DAM     AC-FT       CFS       HOURS        HOURS       HOURS

                      1.00      5549.63         .00       6638.        71.       .00        25.20         .00


 *** NORMAL END OF HEC-1 ***
```

Storm Event 15. Local Freeboard Hydrograph

```
1****************************************                                                   ***************************************
 *                                      *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
 *               JUN   1998             *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
 *            VERSION 4.1               *                                                   *          609 SECOND STREET          *
 *                                      *                                                   *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:59:11  *                                                   *           (916) 756-1104            *
 *                                      *                                                   *                                     *
 ****************************************                                                   ***************************************




                                                X     X  XXXXXXX   XXXXX           X
                                                X     X  X        X     X         XX
                                                X     X  X        X               X
                                                XXXXXXX  XXXX     X       XXXXX   X
                                                X     X  X        X               X
                                                X     X  X        X     X          X
                                                X     X  XXXXXXX   XXXXX          XXX




            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                                      HEC-1 INPUT                                            PAGE  1

           LINE           ID......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              1           ID   HYDROLOGY STUDY for COVE RESERVOIR
              2           ID   Located in KANE COUNTY, UTAH
              3           ID
              4           ID   AUG 2020
              5           ID
              6           ID   PREPARED BY ALPHA ENGINEERING
              7           ID   43 SOUTH 100 EAST, SUITE 100
              8           ID   ST. GEORGE, UTAH  84770
              9           ID   TEL: (435) 628-6500
             10           ID   FAX: (435) 628-6553
             11           ID
             12           ID   Local FBH
             13           ID
                          *
             14           JR    PREC     1.0
             15           IT      18       0       0     100
             16           IO       0
             17           IN      18
                          *

             18           KK   B1
             19           KM   Runoff from Basin 1
             20           BA   0.503
             21           PB    7.67
             22           PC       0   0.020   0.046   0.070   0.095   0.130   0.180   0.300   0.520   0.650
             23           PC   0.700   0.745   0.785   0.820   0.850   0.880   0.905   0.930   0.955   0.980
             24           PC   1.000
             25           LS       0    72.8
             26           UD    0.51
                          *

             27           KK   RB1
             28           KM   Route B1
             29           RD    4928    .045    .050            TRAP      20      20
                          *

             30           KK   B2
             31           KM   Runoff from Basin 2
             32           BA   0.436
             33           LS       0    72.5
             34           UD    0.52
                          *

             35           KK   B3
             36           KM   Runoff from Basin 3
             37           BA   0.279
             38           LS       0    71.0
             39           UD    0.39
                          *
1                                                      HEC-1 INPUT                                            PAGE  2

           LINE           ID......1.......2.......3.......4.......5.......6.......7.......8.......9......10
```

```
             40           KK   C1
             41           KM   Combine RB1, B2, B3
             42           HC      3
                          *

             43           KK   RC1
             44           KM   Route RC1
             45           RD   7255    .060    .030            TRAP      20      20
                          *

             46           KK   B4
             47           KM   Runoff from Basin 4
             48           BA   0.453
             49           LS      0    73.3
             50           UD   0.48
                          *

             51           KK   B5
             52           KM   Runoff from Basin 5
             53           BA   0.805
             54           LS      0    74.1
             55           UD   0.63
                          *

             56           KK   C2
             57           KM   Combine RC1, B4, B5
             58           HC      3
                          *

             59           KK   RC2
             60           KM   Route C2
             61           RD   2380    .039    .030            TRAP      40       2
                          *

             62           KK   B6
             63           KM   Runoff from Basin 6
             64           BA   0.150
             65           LS      0    84.3
             66           UD   0.19
                          *

             67           KK   B7
             68           KM   Runoff from Basin 7
             69           BA   0.327
             70           LS      0    75.7
             71           UD   0.46
                          *

             72           KK   C3
             73           KM   Combine RC2, B6, B7
             74           HC      3
                          *
1                                                       HEC-1 INPUT                                             PAGE  3

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


             75           KK   RC3
             76           KM   Route C3
             77           RD   11323    .023    .030            TRAP      40      20
                          *

             78           KK   B8
             79           KM   Runoff from Basin 8
             80           BA   1.012
             81           LS      0    84.0
             82           UD   0.67
                          *

             83           KK   B9
             84           KM   Runoff from Basin 9
             85           BA   0.242
             86           LS      0    85.5
             87           UD   0.26
                          *

             88           KK   B10
             89           KM   Runoff from Basin 10
             90           BA   0.129
             91           LS      0    86.7
             92           UD   0.18
                          *

             93           KK   C4
             94           KM   Combine B9, B10
             95           HC      2
                          *

             96           KK   RC4
             97           KM   Route C4
             98           RD   3380    .037    .030            TRAP      40      20
                          *
```

```
             99           KK   B11
            100           KM   Runoff from Basin 11
            101           BA   0.279
            102           LS       0    84.8
            103           UD    0.39
                          *

            104           KK   C5
            105           KM   Combine RC3, B8, RC4, B11
            106           HC       4
                          *

            107           KK   B12
            108           KM   Runoff from Basin 12
            109           BA   0.127
            110           LS       0    81.2
            111           UD    0.40
                          *
1                                                       HEC-1 INPUT                                             PAGE  4

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10


            112           KK   Call
            113           KM   Combine C5, B12
            114           HC       2
                          *

            115           KK   Cove Reservoir
            116           KM   Routing through Res'v
            117           RS       1    ELEV  5545.5
            118           SV       0      19      95     240     453     738    1105    1563    2217    2773
            119           SV    3542    4423    5419    6149    7347    8000
            120           SE    5470    5476    5482    5488    5494    5500    5506    5512    5518    5524
            121           SE    5530    5536    5542    5548    5552    5558
            122           SL  5545.5   4.909     0.6     0.5
            123           SS  5549.2      30    2.67     1.5
            124           ST  5552.0    1892     2.9     1.5
                          *
            125           ZZ
1*****************************************                                                   ***************************************
 *                                       *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS     *
 *              JUN   1998               *                                                   *    HYDROLOGIC ENGINEERING CENTER    *
 *           VERSION 4.1                 *                                                   *          609 SECOND STREET          *
 *                                       *                                                   *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06AUG20  TIME  02:59:11   *                                                   *           (916) 756-1104            *
 *                                       *                                                   *                                     *
 *****************************************                                                   ***************************************





                            HYDROLOGY STUDY for COVE RESERVOIR
                            Located in KANE COUNTY, UTAH

                            AUG 2020

                            PREPARED BY ALPHA ENGINEERING
                            43 SOUTH 100 EAST, SUITE 100
                            ST. GEORGE, UTAH  84770
                            TEL: (435) 628-6500
                            FAX: (435) 628-6553

                            Local FBH


   16 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           0  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL          0.  HYDROGRAPH PLOT SCALE

      IT          HYDROGRAPH TIME DATA
                         NMIN          18  MINUTES IN COMPUTATION INTERVAL
                        IDATE      1    0  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ         100  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE      2    0  ENDING DATE
                       NDTIME        0542  ENDING TIME
                       ICENT           19  CENTURY MARK

                    COMPUTATION INTERVAL     .30 HOURS
                         TOTAL TIME BASE   29.70 HOURS

           ENGLISH UNITS
                DRAINAGE AREA         SQUARE MILES
                PRECIPITATION DEPTH   INCHES
                LENGTH, ELEVATION     FEET
                FLOW                  CUBIC FEET PER SECOND
                STORAGE VOLUME        ACRE-FEET
```

```
                SURFACE AREA          ACRES
                TEMPERATURE           DEGREES FAHRENHEIT

      JP          MULTI-PLAN OPTION
                        NPLAN           1  NUMBER OF PLANS

      JR          MULTI-RATIO OPTION
                      RATIOS OF PRECIPITATION
                     1.00


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
  112 KK     *     Call   *
             *            *
             **************
                            Combine C5, B12

  114 HC          HYDROGRAPH COMBINATION
                        ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                                 ***

 ***********************************************************************************************************************************

                                                   HYDROGRAPH AT STATION    Call
                                                        SUM OF  2 HYDROGRAPHS
                                                       PLAN 1,   RATIO =  1.00

 ***********************************************************************************************************************************
                                 *                                *                                *
    DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW
                                 *                                *                                *
     1     0000    1        0.   *    1     0730   26      332.   *    1     1500   51        0.   *    1     2230   76        0.
     1     0018    2        0.   *    1     0748   27      201.   *    1     1518   52        0.   *    1     2248   77        0.
     1     0036    3        0.   *    1     0806   28      113.   *    1     1536   53        0.   *    1     2306   78        0.
     1     0054    4        8.   *    1     0824   29       62.   *    1     1554   54        0.   *    1     2324   79        0.
     1     0112    5       43.   *    1     0842   30       34.   *    1     1612   55        0.   *    1     2342   80        0.
     1     0130    6      129.   *    1     0900   31       18.   *    1     1630   56        0.   *    2     0000   81        0.
     1     0148    7      306.   *    1     0918   32        9.   *    1     1648   57        0.   *    2     0018   82        0.
     1     0206    8      824.   *    1     0936   33        5.   *    1     1706   58        0.   *    2     0036   83        0.
     1     0224    9     2325.   *    1     0954   34        2.   *    1     1724   59        0.   *    2     0054   84        0.
     1     0242   10     4867.   *    1     1012   35        1.   *    1     1742   60        0.   *    2     0112   85        0.
     1     0300   11     6395.   *    1     1030   36        0.   *    1     1800   61        0.   *    2     0130   86        0.
     1     0318   12     6123.   *    1     1048   37        0.   *    1     1818   62        0.   *    2     0148   87        0.
     1     0336   13     5053.   *    1     1106   38        0.   *    1     1836   63        0.   *    2     0206   88        0.
     1     0354   14     4063.   *    1     1124   39        0.   *    1     1854   64        0.   *    2     0224   89        0.
     1     0412   15     3364.   *    1     1142   40        0.   *    1     1912   65        0.   *    2     0242   90        0.
     1     0430   16     2855.   *    1     1200   41        0.   *    1     1930   66        0.   *    2     0300   91        0.
     1     0448   17     2500.   *    1     1218   42        0.   *    1     1948   67        0.   *    2     0318   92        0.
     1     0506   18     2228.   *    1     1236   43        0.   *    1     2006   68        0.   *    2     0336   93        0.
     1     0524   19     2039.   *    1     1254   44        0.   *    1     2024   69        0.   *    2     0354   94        0.
     1     0542   20     1913.   *    1     1312   45        0.   *    1     2042   70        0.   *    2     0412   95        0.
     1     0600   21     1819.   *    1     1330   46        0.   *    1     2100   71        0.   *    2     0430   96        0.
     1     0618   22     1614.   *    1     1348   47        0.   *    1     2118   72        0.   *    2     0448   97        0.
     1     0636   23     1240.   *    1     1406   48        0.   *    1     2136   73        0.   *    2     0506   98        0.
     1     0654   24      851.   *    1     1424   49        0.   *    1     2154   74        0.   *    2     0524   99        0.
     1     0712   25      540.   *    1     1442   50        0.   *    1     2212   75        0.   *    2     0542  100        0.
                                 *                                *                                *
 ***********************************************************************************************************************************

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     29.70-HR
+   (CFS)       (HR)
                           (CFS)
+    6395.      3.00                2560.        648.        524.         524.
                        (INCHES)     5.019       5.085       5.085        5.085
                         (AC-FT)     1269.       1286.       1286.        1286.

                         CUMULATIVE AREA =    4.74 SQ MI



 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


             **************
             *            *
  115 KK     *     Cove   *     Reservoir
             *            *
             **************
                            Routing through Res'v

                HYDROGRAPH ROUTING DATA
```

```
 117 RS         STORAGE ROUTING
                       NSTPS           1  NUMBER OF SUBREACHES
                        ITYP        ELEV  TYPE OF INITIAL CONDITION
                      RSVRIC     5545.50  INITIAL CONDITION
                           X         .00 WORKING R AND D COEFFICIENT

 118 SV           STORAGE          .0      19.0      95.0     240.0     453.0     738.0    1105.0    1563.0    2217.0    2773.0
                                3542.0    4423.0    5419.0    6149.0    7347.0    8000.0

 120 SE         ELEVATION     5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00
                              5530.00   5536.00   5542.00   5548.00   5552.00   5558.00

 122 SL         LOW-LEVEL OUTLET
                       ELEVL     5545.50  ELEVATION AT CENTER OF OUTLET
                       CAREA        4.91  CROSS-SECTIONAL AREA
                        COQL         .60  COEFFICIENT
                        EXPL         .50  EXPONENT OF HEAD

 123 SS         SPILLWAY
                        CREL     5549.20  SPILLWAY CREST ELEVATION
                       SPWID       30.00  SPILLWAY WIDTH
                        COQW        2.67  WEIR COEFFICIENT
                        EXPW        1.50  EXPONENT OF HEAD

 124 ST         TOP OF DAM
                       TOPEL     5552.00  ELEVATION AT TOP OF DAM
                      DAMWID     1892.00  DAM WIDTH
                        COQD        2.90  WEIR COEFFICIENT
                        EXPD        1.50  EXPONENT OF HEAD

                                                                ***

                                                 COMPUTED OUTFLOW-ELEVATION DATA

                                                   (EXCLUDING FLOW OVER DAM)

            OUTFLOW        .00       .00     25.78     27.48     29.42     31.65     34.25     37.31     40.98     45.44
          ELEVATION    5470.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00   5548.51   5549.20

            OUTFLOW      49.37     68.29    113.97    198.20    332.85    529.64    800.37   1156.85   1610.93   2174.46
          ELEVATION    5549.32   5549.60   5550.06   5550.68   5551.48   5552.44   5553.58   5554.88   5556.36   5558.00


                                             COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

                                                   (INCLUDING FLOW OVER DAM)

            STORAGE        .00     19.00     95.00    240.00    453.00    738.00   1105.00   1563.00   2217.00   2773.00
            OUTFLOW        .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
          ELEVATION    5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00

            STORAGE    3542.00   4423.00   5419.00   5844.83   5989.79   6009.51   6033.57   6063.27   6100.64   6148.41
            OUTFLOW        .00       .00       .00       .00     25.78     27.48     29.42     31.65     34.25     37.31
          ELEVATION    5530.00   5536.00   5542.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00

            STORAGE    6301.53   6508.46   6543.56   6628.96   6765.11   6952.15   7190.23   7347.00   7395.04   7518.54
            OUTFLOW      40.98     45.44     49.37     68.29    113.97    198.20    332.85    435.48   2138.72  11657.74
          ELEVATION    5548.51   5549.20   5549.32   5549.60   5550.06   5550.68   5551.48   5552.00   5552.44   5553.58

            STORAGE    7660.53   7821.02   8000.00
            OUTFLOW   27985.71  51484.63  82813.63
          ELEVATION    5554.88   5556.36   5558.00

***********************************************************************************************************************************

                                                  HYDROGRAPH AT STATION    Cove
                                                      PLAN 1,   RATIO =  1.00

***********************************************************************************************************************************
                                           *                                           *
 DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE
                                           *                                           *
  1     0000   1       0.   5844.8  5545.5 *  1     1012  35     233.   7019.3  5550.9 *  1     2024  69     154.   6859.6  5550.4
  1     0018   2       0.   5844.8  5545.5 *  1     1030  36     230.   7013.6  5550.9 *  1     2042  70     152.   6855.8  5550.4
  1     0036   3       0.   5844.8  5545.5 *  1     1048  37     227.   7007.9  5550.9 *  1     2100  71     150.   6852.0  5550.3
  1     0054   4       1.   5845.0  5545.5 *  1     1106  38     224.   7002.3  5550.8 *  1     2118  72     149.   6848.3  5550.3
  1     0112   5       2.   5845.5  5545.5 *  1     1124  39     221.   6996.8  5550.8 *  1     2136  73     147.   6844.7  5550.3
  1     0130   6       4.   5847.6  5545.5 *  1     1142  40     218.   6991.3  5550.8 *  1     2154  74     146.   6841.0  5550.3
  1     0148   7       6.   5852.9  5545.6 *  1     1200  41     216.   6985.9  5550.8 *  1     2212  75     144.   6837.4  5550.3
  1     0206   8      10.   5866.8  5545.7 *  1     1218  42     213.   6980.7  5550.8 *  1     2230  76     142.   6833.8  5550.3
  1     0224   9      17.   5905.5  5546.0 *  1     1236  43     210.   6975.4  5550.8 *  1     2248  77     141.   6830.3  5550.3
  1     0242  10      26.   5994.1  5546.7 *  1     1254  44     207.   6970.3  5550.7 *  1     2306  78     139.   6826.8  5550.3
  1     0300  11      36.   6133.0  5547.9 *  1     1312  45     205.   6965.2  5550.7 *  1     2324  79     138.   6823.5  5550.3
  1     0318  12      41.   6287.2  5548.5 *  1     1330  46     202.   6960.0  5550.7 *  1     2342  80     136.   6820.1  5550.2
  1     0336  13      44.   6424.7  5548.9 *  1     1348  47     200.   6955.1  5550.7 *  2     0000  81     135.   6816.7  5550.2
  1     0354  14      48.   6536.5  5549.3 *  1     1406  48     197.   6950.1  5550.7 *  2     0018  82     134.   6813.4  5550.2
  1     0412  15      68.   6627.1  5549.6 *  1     1424  49     195.   6945.3  5550.7 *  2     0036  83     132.   6810.0  5550.2
  1     0430  16      91.   6702.2  5549.8 *  1     1442  50     192.   6940.5  5550.6 *  2     0054  84     131.   6806.8  5550.2
  1     0448  17     114.   6766.0  5550.1 *  1     1500  51     190.   6935.8  5550.6 *  2     0112  85     129.   6803.6  5550.2
  1     0506  18     137.   6821.4  5550.2 *  1     1518  52     188.   6931.1  5550.6 *  2     0130  86     128.   6800.4  5550.2
  1     0524  19     159.   6870.7  5550.4 *  1     1536  53     185.   6926.4  5550.6 *  2     0148  87     127.   6797.1  5550.2
  1     0542  20     180.   6915.4  5550.6 *  1     1554  54     183.   6921.9  5550.6 *  2     0206  88     126.   6794.1  5550.2
```

```
   1     0600  21     201.   6957.0  5550.7 *  1     1612  55     181.   6917.3  5550.6 *  2     0224  89     124.   6791.0  5550.1
   1     0618  22     220.   6994.3  5550.8 *  1     1630  56     179.   6913.0  5550.6 *  2     0242  90     123.   6787.9  5550.1
   1     0636  23     236.   7024.0  5550.9 *  1     1648  57     177.   6908.6  5550.5 *  2     0300  91     122.   6784.9  5550.1
   1     0654  24     247.   7043.8  5551.0 *  1     1706  58     175.   6904.2  5550.5 *  2     0318  92     121.   6781.8  5550.1
   1     0712  25     253.   7054.8  5551.0 *  1     1724  59     173.   6899.9  5550.5 *  2     0336  93     119.   6778.9  5550.1
   1     0730  26     255.   7059.3  5551.0 *  1     1742  60     171.   6895.7  5550.5 *  2     0354  94     118.   6775.9  5550.1
   1     0748  27     256.   7059.6  5551.0 *  1     1800  61     169.   6891.5  5550.5 *  2     0412  95     117.   6773.0  5550.1
   1     0806  28     254.   7057.2  5551.0 *  1     1818  62     167.   6887.4  5550.5 *  2     0430  96     116.   6770.1  5550.1
   1     0824  29     252.   7053.1  5551.0 *  1     1836  63     165.   6883.3  5550.5 *  2     0448  97     115.   6767.2  5550.1
   1     0842  30     249.   7048.1  5551.0 *  1     1854  64     163.   6879.2  5550.4 *  2     0506  98     114.   6764.4  5550.1
   1     0900  31     246.   7042.5  5551.0 *  1     1912  65     161.   6875.2  5550.4 *  2     0524  99     113.   6761.6  5550.0
   1     0918  32     243.   7036.8  5551.0 *  1     1930  66     159.   6871.3  5550.4 *  2     0542 100     112.   6758.8  5550.0
   1     0936  33     240.   7031.0  5550.9 *  1     1948  67     157.   6867.3  5550.4 *
   1     0954  34     237.   7025.1  5550.9 *  1     2006  68     156.   6863.4  5550.4 *
                                           *                                           *
 *****************************************************************************************************************************************

 PEAK OUTFLOW IS      256. AT TIME   7.80 HOURS


  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR     29.70-HR
+   (CFS)       (HR)
                           (CFS)
+     256.      7.80                  238.        178.        151.         151.
                        (INCHES)      .466       1.393       1.470        1.470
                         (AC-FT)      118.        352.        372.         372.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                      6-HR       24-HR       72-HR     29.70-HR
+  (AC-FT)      (HR)
     7060.      7.80                 7027.       6906.       6774.        6774.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                      6-HR       24-HR       72-HR     29.70-HR
+   (FEET)      (HR)
   5551.04      7.80               5550.93     5550.53     5549.96      5549.96

                         CUMULATIVE AREA =    4.74 SQ MI

1

               PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                 FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                TIME TO PEAK IN HOURS


                                                         RATIOS APPLIED TO PRECIPITATION
 OPERATION       STATION     AREA    PLAN           RATIO 1
                                                       1.00


 HYDROGRAPH AT
+                  B1          .50     1   FLOW         689.
                                           TIME         3.00

 ROUTED TO
+                  RB1         .50     1   FLOW         657.
                                           TIME         3.00

 HYDROGRAPH AT
+                  B2          .44     1   FLOW         589.
                                           TIME         3.00

 HYDROGRAPH AT
+                  B3          .28     1   FLOW         393.
                                           TIME         2.70

  3 COMBINED AT
+                  C1         1.22     1   FLOW        1608.
                                           TIME         3.00

 ROUTED TO
+                  RC1        1.22     1   FLOW        1507.
                                           TIME         3.00

 HYDROGRAPH AT
+                  B4          .45     1   FLOW         636.
                                           TIME         3.00

 HYDROGRAPH AT
+                  B5          .81     1   FLOW        1050.
                                           TIME         3.00

  3 COMBINED AT
+                  C2         2.48     1   FLOW        3194.
                                           TIME         3.00

 ROUTED TO
+                  RC2        2.48     1   FLOW        3137.
                                           TIME         3.00

 HYDROGRAPH AT
```

```
+                  B6          .15     1   FLOW         351.
                                           TIME         2.40

 HYDROGRAPH AT
+                  B7          .33     1   FLOW         490.
                                           TIME         3.00

  3 COMBINED AT
+                  C3         2.95     1   FLOW        3813.
                                           TIME         3.00

 ROUTED TO
+                  RC3        2.95     1   FLOW        3723.
                                           TIME         3.30

 HYDROGRAPH AT
+                  B8         1.01     1   FLOW        1656.
                                           TIME         3.00

 HYDROGRAPH AT
+                  B9          .24     1   FLOW         547.
                                           TIME         2.70

 HYDROGRAPH AT
+                  B10         .13     1   FLOW         326.
                                           TIME         2.40

  2 COMBINED AT
+                  C4          .37     1   FLOW         835.
                                           TIME         2.70

 ROUTED TO
+                  RC4         .37     1   FLOW         819.
                                           TIME         2.70

 HYDROGRAPH AT
+                  B11         .28     1   FLOW         575.
                                           TIME         2.70

  4 COMBINED AT
+                  C5         4.61     1   FLOW        6184.
                                           TIME         3.00

 HYDROGRAPH AT
+                  B12         .13     1   FLOW         238.
                                           TIME         2.70

  2 COMBINED AT
+                  Call       4.74     1   FLOW        6395.
                                           TIME         3.00

 ROUTED TO
+                  Cove       4.74     1   FLOW         256.
                                           TIME         7.80

                                       ** PEAK STAGES IN FEET **
                                       1   STAGE     5551.04
                                           TIME         7.80
1
                                           SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
                                               (FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)
                                                                                   INTERPOLATED TO
                                                                                COMPUTATION INTERVAL
            ISTAQ    ELEMENT      DT       PEAK    TIME TO     VOLUME      DT       PEAK    TIME TO     VOLUME
                                                     PEAK                                    PEAK

                                 (MIN)     (CFS)      (MIN)     (IN)     (MIN)     (CFS)     (MIN)       (IN)

           FOR PLAN = 1  RATIO=  .00
              RB1    MANE         5.40    673.41    189.00      4.50     18.00    657.41    180.00        4.48


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1206E+03 EXCESS= .0000E+00 OUTFLOW= .1207E+03 BASIN STORAGE= .3686E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC1    MANE         5.40   1594.30    189.00      4.43     18.00   1507.33    180.00        4.43


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .2880E+03 EXCESS= .0000E+00 OUTFLOW= .2881E+03 BASIN STORAGE= .3547E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC2    MANE         1.67   3186.21    182.05      4.52     18.00   3137.38    180.00        4.53


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .5970E+03 EXCESS= .0000E+00 OUTFLOW= .5970E+03 BASIN STORAGE= .3099E-02 PERCENT ERROR=    .0


           FOR PLAN = 1  RATIO=  .00
              RC3    MANE         7.20   3778.09    194.40      4.63     18.00   3723.23    198.00        4.64
```

```
 CONTINUITY SUMMARY (AC-FT) - INFLOW= .7287E+03 EXCESS= .0000E+00 OUTFLOW= .7291E+03 BASIN STORAGE= .1048E-01 PERCENT ERROR=   -.1


          FOR PLAN = 1  RATIO=  .00
             RC4    MANE         5.53    841.55    154.72      6.01     18.00    818.78    162.00        6.02


 CONTINUITY SUMMARY (AC-FT) - INFLOW= .1188E+03 EXCESS= .0000E+00 OUTFLOW= .1189E+03 BASIN STORAGE= .2808E-02 PERCENT ERROR=    .0


1                                   SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION    Cove
                              (PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED  DURING BREACH FORMATION)


      PLAN  1 ...............                 INITIAL VALUE     SPILLWAY CREST     TOP OF DAM
                                 ELEVATION        5545.50           5549.20          5552.00
                                 STORAGE            5845.             6508.            7347.
                                 OUTFLOW               0.               45.             435.


                      RATIO     MAXIMUM      MAXIMUM    MAXIMUM    MAXIMUM    DURATION     TIME OF     TIME OF
                        OF     RESERVOIR      DEPTH     STORAGE    OUTFLOW    OVER TOP   MAX OUTFLOW   FAILURE
                       PMF      W.S.ELEV    OVER DAM     AC-FT       CFS       HOURS        HOURS       HOURS

                      1.00      5551.04         .00       7060.       256.       .00         7.80         .00


 *** NORMAL END OF HEC-1 ***
```

Storm Event 16. General Freeboard Hydrograph

```
1*****************************************                                                   ****************************************
 *                                       *                                                   *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS      *
 *               JUN   1998              *                                                   *    HYDROLOGIC ENGINEERING CENTER     *
 *            VERSION 4.1                *                                                   *          609 SECOND STREET           *
 *                                       *                                                   *       DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   06AUG20  TIME  03:41:08   *                                                   *           (916) 756-1104             *
 *                                       *                                                   *                                      *
 *****************************************                                                   ****************************************




                                                 X     X  XXXXXXX   XXXXX           X
                                                 X     X  X        X     X         XX
                                                 X     X  X        X                X
                                                 XXXXXXX  XXXX     X        XXXXX   X
                                                 X     X  X        X                X
                                                 X     X  X        X     X          X
                                                 X     X  XXXXXXX   XXXXX          XXX




            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                                       HEC-1 INPUT                                             PAGE  1

           LINE           ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              1           ID   HYDROLOGY STUDY for COVE RESERVOIR
              2           ID   Located in KANE COUNTY, UTAH
              3           ID
              4           ID   AUG 2020
              5           ID
              6           ID   PREPARED BY ALPHA ENGINEERING
              7           ID   43 SOUTH 100 EAST, SUITE 100
              8           ID   ST. GEORGE, UTAH  84770
              9           ID   TEL: (435) 628-6500
             10           ID   FAX: (435) 628-6553
             11           ID
             12           ID   General FBH (NEH)
             13           ID
                          *
             14           JR    PREC     1.0
             15           IT      12       0       0     600
             16           IO       0
             17           IN      12
                          *
             18           QI       0       0       0       0       0       0       0       0       0       0
             19           QI       0       0       0       0       0       0       0       0       0       0
             20           QI       0       0       0       0       0       1       2       4       7      10
             21           QI      15      30      74     175     342     567     829    1108    1380    1634
             22           QI    1866    2071    2260    2424    2568    2696    2807    2906    2993    3069
             23           QI    3137    3198    3252    3300    3343    3381    3416    3447    3475    3501
             24           QI    3524    3498    3371    3075    2649    2187    1755    1392    1131     950
             25           QI     820     724     655     606     570     545     526     513     503     496
             26           QI     492     488     485     483     483     483     483     483     483     484
             27           QI     484     482     477     465     448     431     414     400     390     383
             28           QI     378     375     372     370     369     368     368     367     367     367
             29           QI     367     366     366     366     367     367     367     367     367     367
             30           QI     367     362     345     308     257     202     151     108      77      56
             31           QI      40      29      21      15      11       8       5       4       3       2
             32           QI       1       1       0
                          *

             33           KK   Cove Reservoir
             34           KM   Routing through Res'v
             35           RS       1    ELEV  5545.5
             36           SV       0      19      95     240     453     738    1105    1563    2217    2773
             37           SV    3542    4423    5419    6149    7347    8000
             38           SE    5470    5476    5482    5488    5494    5500    5506    5512    5518    5524
             39           SE    5530    5536    5542    5548    5552    5558
             40           SL  5545.5   4.909     0.6     0.5
             41           SS  5549.2      30    2.67     1.5
             42           ST  5552.0    1892     2.9     1.5
                          *
             43           ZZ
1*****************************************                                                   ****************************************
 *                                       *                                                   *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                   *    U.S. ARMY CORPS OF ENGINEERS      *
 *               JUN   1998              *                                                   *    HYDROLOGIC ENGINEERING CENTER     *
 *            VERSION 4.1                *                                                   *          609 SECOND STREET           *
 *                                       *                                                   *       DAVIS, CALIFORNIA 95616        *
```

```
*  RUN DATE   06AUG20  TIME  03:41:08   *                                                   *           (916) 756-1104             *
*                                       *                                                   *                                      *
*****************************************                                                   ****************************************




                           HYDROLOGY STUDY for COVE RESERVOIR
                           Located in KANE COUNTY, UTAH

                           AUG 2020

                           PREPARED BY ALPHA ENGINEERING
                           43 SOUTH 100 EAST, SUITE 100
                           ST. GEORGE, UTAH  84770
                           TEL: (435) 628-6500
                           FAX: (435) 628-6553

                           General FBH (NEH)


  16 IO          OUTPUT CONTROL VARIABLES
                       IPRNT           0  PRINT CONTROL
                       IPLOT           0  PLOT CONTROL
                       QSCAL          0.  HYDROGRAPH PLOT SCALE

     IT          HYDROGRAPH TIME DATA
                        NMIN          12  MINUTES IN COMPUTATION INTERVAL
                       IDATE      1    0  STARTING DATE
                       ITIME        0000  STARTING TIME
                          NQ         600  NUMBER OF HYDROGRAPH ORDINATES
                      NDDATE      5    0  ENDING DATE
                      NDTIME        2348  ENDING TIME
                      ICENT           19  CENTURY MARK

                   COMPUTATION INTERVAL     .20 HOURS
                        TOTAL TIME BASE  119.80 HOURS

          ENGLISH UNITS
               DRAINAGE AREA         SQUARE MILES
               PRECIPITATION DEPTH   INCHES
               LENGTH, ELEVATION     FEET
               FLOW                  CUBIC FEET PER SECOND
               STORAGE VOLUME        ACRE-FEET
               SURFACE AREA          ACRES
               TEMPERATURE           DEGREES FAHRENHEIT

     JP          MULTI-PLAN OPTION
                       NPLAN           1  NUMBER OF PLANS

     JR          MULTI-RATIO OPTION
                     RATIOS OF PRECIPITATION
                    1.00

  17 IN          TIME DATA FOR INPUT TIME SERIES
                       JXMIN          12  TIME INTERVAL IN MINUTES
                      JXDATE      1    0  STARTING DATE
                      JXTIME           0  STARTING TIME

               SUBBASIN RUNOFF DATA

   0 BA          SUBBASIN CHARACTERISTICS
                       TAREA         .00  SUBBASIN AREA

                                                                ***

************************************************************************************************************************************

                                                  HYDROGRAPH AT STATION    Cove

************************************************************************************************************************************
                                *                                *                                *
   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW
                                *                                *                                *
    1     0000    1        0.   *    2     0600  151        1.   *    3     1200  301        1.   *    4     1800  451        1.
    1     0012    2        0.   *    2     0612  152        1.   *    3     1212  302        1.   *    4     1812  452        1.
    1     0024    3        0.   *    2     0624  153        1.   *    3     1224  303        1.   *    4     1824  453        1.
    1     0036    4        0.   *    2     0636  154        1.   *    3     1236  304        1.   *    4     1836  454        1.
    1     0048    5        0.   *    2     0648  155        1.   *    3     1248  305        1.   *    4     1848  455        1.
    1     0100    6        0.   *    2     0700  156        1.   *    3     1300  306        1.   *    4     1900  456        1.
    1     0112    7        0.   *    2     0712  157        1.   *    3     1312  307        1.   *    4     1912  457        1.
    1     0124    8        0.   *    2     0724  158        1.   *    3     1324  308        1.   *    4     1924  458        1.
    1     0136    9        0.   *    2     0736  159        1.   *    3     1336  309        1.   *    4     1936  459        1.
    1     0148   10        0.   *    2     0748  160        1.   *    3     1348  310        1.   *    4     1948  460        1.
    1     0200   11        0.   *    2     0800  161        1.   *    3     1400  311        1.   *    4     2000  461        1.
    1     0212   12        0.   *    2     0812  162        1.   *    3     1412  312        1.   *    4     2012  462        1.
    1     0224   13        0.   *    2     0824  163        1.   *    3     1424  313        1.   *    4     2024  463        1.
    1     0236   14        0.   *    2     0836  164        1.   *    3     1436  314        1.   *    4     2036  464        1.
    1     0248   15        0.   *    2     0848  165        1.   *    3     1448  315        1.   *    4     2048  465        1.
    1     0300   16        0.   *    2     0900  166        1.   *    3     1500  316        1.   *    4     2100  466        1.
    1     0312   17        0.   *    2     0912  167        1.   *    3     1512  317        1.   *    4     2112  467        1.
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1     0324   18        0.   *    2     0924  168         1.   *    3     1524  318         1.   *    4     2124  468         1.
1     0336   19        0.   *    2     0936  169         1.   *    3     1536  319         1.   *    4     2136  469         1.
1     0348   20        0.   *    2     0948  170         1.   *    3     1548  320         1.   *    4     2148  470         1.
1     0400   21        0.   *    2     1000  171         1.   *    3     1600  321         1.   *    4     2200  471         1.
1     0412   22        0.   *    2     1012  172         1.   *    3     1612  322         1.   *    4     2212  472         1.
1     0424   23        0.   *    2     1024  173         1.   *    3     1624  323         1.   *    4     2224  473         1.
1     0436   24        0.   *    2     1036  174         1.   *    3     1636  324         1.   *    4     2236  474         1.
1     0448   25        0.   *    2     1048  175         1.   *    3     1648  325         1.   *    4     2248  475         1.
1     0500   26        1.   *    2     1100  176         1.   *    3     1700  326         1.   *    4     2300  476         1.
1     0512   27        2.   *    2     1112  177         1.   *    3     1712  327         1.   *    4     2312  477         1.
1     0524   28        4.   *    2     1124  178         1.   *    3     1724  328         1.   *    4     2324  478         1.
1     0536   29        7.   *    2     1136  179         1.   *    3     1736  329         1.   *    4     2336  479         1.
1     0548   30       10.   *    2     1148  180         1.   *    3     1748  330         1.   *    4     2348  480         1.
1     0600   31       15.   *    2     1200  181         1.   *    3     1800  331         1.   *    5     0000  481         1.
1     0612   32       30.   *    2     1212  182         1.   *    3     1812  332         1.   *    5     0012  482         1.
1     0624   33       74.   *    2     1224  183         1.   *    3     1824  333         1.   *    5     0024  483         1.
1     0636   34      175.   *    2     1236  184         1.   *    3     1836  334         1.   *    5     0036  484         1.
1     0648   35      342.   *    2     1248  185         1.   *    3     1848  335         1.   *    5     0048  485         1.
1     0700   36      567.   *    2     1300  186         1.   *    3     1900  336         1.   *    5     0100  486         1.
1     0712   37      829.   *    2     1312  187         1.   *    3     1912  337         1.   *    5     0112  487         1.
1     0724   38     1108.   *    2     1324  188         1.   *    3     1924  338         1.   *    5     0124  488         1.
1     0736   39     1380.   *    2     1336  189         1.   *    3     1936  339         1.   *    5     0136  489         1.
1     0748   40     1634.   *    2     1348  190         1.   *    3     1948  340         1.   *    5     0148  490         1.
1     0800   41     1866.   *    2     1400  191         1.   *    3     2000  341         1.   *    5     0200  491         1.
1     0812   42     2071.   *    2     1412  192         1.   *    3     2012  342         1.   *    5     0212  492         1.
1     0824   43     2260.   *    2     1424  193         1.   *    3     2024  343         1.   *    5     0224  493         1.
1     0836   44     2424.   *    2     1436  194         1.   *    3     2036  344         1.   *    5     0236  494         1.
1     0848   45     2568.   *    2     1448  195         1.   *    3     2048  345         1.   *    5     0248  495         1.
1     0900   46     2696.   *    2     1500  196         1.   *    3     2100  346         1.   *    5     0300  496         1.
1     0912   47     2807.   *    2     1512  197         1.   *    3     2112  347         1.   *    5     0312  497         1.
1     0924   48     2906.   *    2     1524  198         1.   *    3     2124  348         1.   *    5     0324  498         1.
1     0936   49     2993.   *    2     1536  199         1.   *    3     2136  349         1.   *    5     0336  499         1.
1     0948   50     3069.   *    2     1548  200         1.   *    3     2148  350         1.   *    5     0348  500         1.
1     1000   51     3137.   *    2     1600  201         1.   *    3     2200  351         1.   *    5     0400  501         1.
1     1012   52     3198.   *    2     1612  202         1.   *    3     2212  352         1.   *    5     0412  502         1.
1     1024   53     3252.   *    2     1624  203         1.   *    3     2224  353         1.   *    5     0424  503         1.
1     1036   54     3300.   *    2     1636  204         1.   *    3     2236  354         1.   *    5     0436  504         1.
1     1048   55     3343.   *    2     1648  205         1.   *    3     2248  355         1.   *    5     0448  505         1.
1     1100   56     3381.   *    2     1700  206         1.   *    3     2300  356         1.   *    5     0500  506         1.
1     1112   57     3416.   *    2     1712  207         1.   *    3     2312  357         1.   *    5     0512  507         1.
1     1124   58     3447.   *    2     1724  208         1.   *    3     2324  358         1.   *    5     0524  508         1.
1     1136   59     3475.   *    2     1736  209         1.   *    3     2336  359         1.   *    5     0536  509         1.
1     1148   60     3501.   *    2     1748  210         1.   *    3     2348  360         1.   *    5     0548  510         1.
1     1200   61     3524.   *    2     1800  211         1.   *    4     0000  361         1.   *    5     0600  511         1.
1     1212   62     3498.   *    2     1812  212         1.   *    4     0012  362         1.   *    5     0612  512         1.
1     1224   63     3371.   *    2     1824  213         1.   *    4     0024  363         1.   *    5     0624  513         1.
1     1236   64     3075.   *    2     1836  214         1.   *    4     0036  364         1.   *    5     0636  514         1.
1     1248   65     2649.   *    2     1848  215         1.   *    4     0048  365         1.   *    5     0648  515         1.
1     1300   66     2187.   *    2     1900  216         1.   *    4     0100  366         1.   *    5     0700  516         1.
1     1312   67     1755.   *    2     1912  217         1.   *    4     0112  367         1.   *    5     0712  517         1.
1     1324   68     1392.   *    2     1924  218         1.   *    4     0124  368         1.   *    5     0724  518         1.
1     1336   69     1131.   *    2     1936  219         1.   *    4     0136  369         1.   *    5     0736  519         1.
1     1348   70      950.   *    2     1948  220         1.   *    4     0148  370         1.   *    5     0748  520         1.
1     1400   71      820.   *    2     2000  221         1.   *    4     0200  371         1.   *    5     0800  521         1.
1     1412   72      724.   *    2     2012  222         1.   *    4     0212  372         1.   *    5     0812  522         1.
1     1424   73      655.   *    2     2024  223         1.   *    4     0224  373         1.   *    5     0824  523         1.
1     1436   74      606.   *    2     2036  224         1.   *    4     0236  374         1.   *    5     0836  524         1.
1     1448   75      570.   *    2     2048  225         1.   *    4     0248  375         1.   *    5     0848  525         1.
1     1500   76      545.   *    2     2100  226         1.   *    4     0300  376         1.   *    5     0900  526         1.
1     1512   77      526.   *    2     2112  227         1.   *    4     0312  377         1.   *    5     0912  527         1.
1     1524   78      513.   *    2     2124  228         1.   *    4     0324  378         1.   *    5     0924  528         1.
1     1536   79      503.   *    2     2136  229         1.   *    4     0336  379         1.   *    5     0936  529         1.
1     1548   80      496.   *    2     2148  230         1.   *    4     0348  380         1.   *    5     0948  530         1.
1     1600   81      492.   *    2     2200  231         1.   *    4     0400  381         1.   *    5     1000  531         1.
1     1612   82      488.   *    2     2212  232         1.   *    4     0412  382         1.   *    5     1012  532         1.
1     1624   83      485.   *    2     2224  233         1.   *    4     0424  383         1.   *    5     1024  533         1.
1     1636   84      483.   *    2     2236  234         1.   *    4     0436  384         1.   *    5     1036  534         1.
1     1648   85      483.   *    2     2248  235         1.   *    4     0448  385         1.   *    5     1048  535         1.
1     1700   86      483.   *    2     2300  236         1.   *    4     0500  386         1.   *    5     1100  536         1.
1     1712   87      483.   *    2     2312  237         1.   *    4     0512  387         1.   *    5     1112  537         1.
1     1724   88      483.   *    2     2324  238         1.   *    4     0524  388         1.   *    5     1124  538         1.
1     1736   89      483.   *    2     2336  239         1.   *    4     0536  389         1.   *    5     1136  539         1.
1     1748   90      484.   *    2     2348  240         1.   *    4     0548  390         1.   *    5     1148  540         1.
1     1800   91      484.   *    3     0000  241         1.   *    4     0600  391         1.   *    5     1200  541         1.
1     1812   92      482.   *    3     0012  242         1.   *    4     0612  392         1.   *    5     1212  542         1.
1     1824   93      477.   *    3     0024  243         1.   *    4     0624  393         1.   *    5     1224  543         1.
1     1836   94      465.   *    3     0036  244         1.   *    4     0636  394         1.   *    5     1236  544         1.
1     1848   95      448.   *    3     0048  245         1.   *    4     0648  395         1.   *    5     1248  545         1.
1     1900   96      431.   *    3     0100  246         1.   *    4     0700  396         1.   *    5     1300  546         1.
1     1912   97      414.   *    3     0112  247         1.   *    4     0712  397         1.   *    5     1312  547         1.
1     1924   98      400.   *    3     0124  248         1.   *    4     0724  398         1.   *    5     1324  548         1.
1     1936   99      390.   *    3     0136  249         1.   *    4     0736  399         1.   *    5     1336  549         1.
1     1948  100      383.   *    3     0148  250         1.   *    4     0748  400         1.   *    5     1348  550         1.
1     2000  101      378.   *    3     0200  251         1.   *    4     0800  401         1.   *    5     1400  551         1.
1     2012  102      375.   *    3     0212  252         1.   *    4     0812  402         1.   *    5     1412  552         1.
1     2024  103      372.   *    3     0224  253         1.   *    4     0824  403         1.   *    5     1424  553         1.
1     2036  104      370.   *    3     0236  254         1.   *    4     0836  404         1.   *    5     1436  554         1.
1     2048  105      369.   *    3     0248  255         1.   *    4     0848  405         1.   *    5     1448  555         1.
1     2100  106      368.   *    3     0300  256         1.   *    4     0900  406         1.   *    5     1500  556         1.
1     2112  107      368.   *    3     0312  257         1.   *    4     0912  407         1.   *    5     1512  557         1.
1     2124  108      367.   *    3     0324  258         1.   *    4     0924  408         1.   *    5     1524  558         1.
1     2136  109      367.   *    3     0336  259         1.   *    4     0936  409         1.   *    5     1536  559         1.
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      1     2148  110      367.  *    3     0348  260        1.  *    4     0948  410        1.  *    5     1548  560        1.
      1     2200  111      367.  *    3     0400  261        1.  *    4     1000  411        1.  *    5     1600  561        1.
      1     2212  112      366.  *    3     0412  262        1.  *    4     1012  412        1.  *    5     1612  562        1.
      1     2224  113      366.  *    3     0424  263        1.  *    4     1024  413        1.  *    5     1624  563        1.
      1     2236  114      366.  *    3     0436  264        1.  *    4     1036  414        1.  *    5     1636  564        1.
      1     2248  115      367.  *    3     0448  265        1.  *    4     1048  415        1.  *    5     1648  565        1.
      1     2300  116      367.  *    3     0500  266        1.  *    4     1100  416        1.  *    5     1700  566        1.
      1     2312  117      367.  *    3     0512  267        1.  *    4     1112  417        1.  *    5     1712  567        1.
      1     2324  118      367.  *    3     0524  268        1.  *    4     1124  418        1.  *    5     1724  568        1.
      1     2336  119      367.  *    3     0536  269        1.  *    4     1136  419        1.  *    5     1736  569        1.
      1     2348  120      367.  *    3     0548  270        1.  *    4     1148  420        1.  *    5     1748  570        1.
      2     0000  121      367.  *    3     0600  271        1.  *    4     1200  421        1.  *    5     1800  571        1.
      2     0012  122      362.  *    3     0612  272        1.  *    4     1212  422        1.  *    5     1812  572        1.
      2     0024  123      345.  *    3     0624  273        1.  *    4     1224  423        1.  *    5     1824  573        1.
      2     0036  124      308.  *    3     0636  274        1.  *    4     1236  424        1.  *    5     1836  574        1.
      2     0048  125      257.  *    3     0648  275        1.  *    4     1248  425        1.  *    5     1848  575        1.
      2     0100  126      202.  *    3     0700  276        1.  *    4     1300  426        1.  *    5     1900  576        1.
      2     0112  127      151.  *    3     0712  277        1.  *    4     1312  427        1.  *    5     1912  577        1.
      2     0124  128      108.  *    3     0724  278        1.  *    4     1324  428        1.  *    5     1924  578        1.
      2     0136  129       77.  *    3     0736  279        1.  *    4     1336  429        1.  *    5     1936  579        1.
      2     0148  130       56.  *    3     0748  280        1.  *    4     1348  430        1.  *    5     1948  580        1.
      2     0200  131       40.  *    3     0800  281        1.  *    4     1400  431        1.  *    5     2000  581        1.
      2     0212  132       29.  *    3     0812  282        1.  *    4     1412  432        1.  *    5     2012  582        1.
      2     0224  133       21.  *    3     0824  283        1.  *    4     1424  433        1.  *    5     2024  583        1.
      2     0236  134       15.  *    3     0836  284        1.  *    4     1436  434        1.  *    5     2036  584        1.
      2     0248  135       11.  *    3     0848  285        1.  *    4     1448  435        1.  *    5     2048  585        1.
      2     0300  136        8.  *    3     0900  286        1.  *    4     1500  436        1.  *    5     2100  586        1.
      2     0312  137        5.  *    3     0912  287        1.  *    4     1512  437        1.  *    5     2112  587        1.
      2     0324  138        4.  *    3     0924  288        1.  *    4     1524  438        1.  *    5     2124  588        1.
      2     0336  139        3.  *    3     0936  289        1.  *    4     1536  439        1.  *    5     2136  589        1.
      2     0348  140        2.  *    3     0948  290        1.  *    4     1548  440        1.  *    5     2148  590        1.
      2     0400  141        1.  *    3     1000  291        1.  *    4     1600  441        1.  *    5     2200  591        1.
      2     0412  142        1.  *    3     1012  292        1.  *    4     1612  442        1.  *    5     2212  592        1.
      2     0424  143        1.  *    3     1024  293        1.  *    4     1624  443        1.  *    5     2224  593        1.
      2     0436  144        1.  *    3     1036  294        1.  *    4     1636  444        1.  *    5     2236  594        1.
      2     0448  145        1.  *    3     1048  295        1.  *    4     1648  445        1.  *    5     2248  595        1.
      2     0500  146        1.  *    3     1100  296        1.  *    4     1700  446        1.  *    5     2300  596        1.
      2     0512  147        1.  *    3     1112  297        1.  *    4     1712  447        1.  *    5     2312  597        1.
      2     0524  148        1.  *    3     1124  298        1.  *    4     1724  448        1.  *    5     2324  598        1.
      2     0536  149        1.  *    3     1136  299        1.  *    4     1736  449        1.  *    5     2336  599        1.
      2     0548  150        1.  *    3     1148  300        1.  *    4     1748  450        1.  *    5     2348  600        1.
                                 *                                 *                                 *
 *****************************************************************************************************************************

   PEAK FLOW     TIME                        MAXIMUM AVERAGE FLOW
                                     6-HR       24-HR       72-HR    119.80-HR

+   (CFS)       (HR)
                            (CFS)
+    3524.     12.00                2782.        948.        317.         191.
                          (INCHES)      .000        .000        .000         .000
                           (AC-FT)     1379.       1880.       1884.        1888.

                           CUMULATIVE AREA =     .00 SQ MI


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                                                  HYDROGRAPH AT STATION    Cove
                                                      PLAN 1,   RATIO =  1.00

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                                 *                                 *                                 *
    DA MON HRMN  ORD      FLOW   *   DA MON HRMN  ORD      FLOW    *   DA MON HRMN  ORD      FLOW    *   DA MON HRMN  ORD      FLOW
                                 *                                 *                                 *
      1     0000    1        0.  *    2     0600  151        1.  *    3     1200  301        1.  *    4     1800  451        1.
      1     0012    2        0.  *    2     0612  152        1.  *    3     1212  302        1.  *    4     1812  452        1.
      1     0024    3        0.  *    2     0624  153        1.  *    3     1224  303        1.  *    4     1824  453        1.
      1     0036    4        0.  *    2     0636  154        1.  *    3     1236  304        1.  *    4     1836  454        1.
      1     0048    5        0.  *    2     0648  155        1.  *    3     1248  305        1.  *    4     1848  455        1.
      1     0100    6        0.  *    2     0700  156        1.  *    3     1300  306        1.  *    4     1900  456        1.
      1     0112    7        0.  *    2     0712  157        1.  *    3     1312  307        1.  *    4     1912  457        1.
      1     0124    8        0.  *    2     0724  158        1.  *    3     1324  308        1.  *    4     1924  458        1.
      1     0136    9        0.  *    2     0736  159        1.  *    3     1336  309        1.  *    4     1936  459        1.
      1     0148   10        0.  *    2     0748  160        1.  *    3     1348  310        1.  *    4     1948  460        1.
      1     0200   11        0.  *    2     0800  161        1.  *    3     1400  311        1.  *    4     2000  461        1.
      1     0212   12        0.  *    2     0812  162        1.  *    3     1412  312        1.  *    4     2012  462        1.
      1     0224   13        0.  *    2     0824  163        1.  *    3     1424  313        1.  *    4     2024  463        1.
      1     0236   14        0.  *    2     0836  164        1.  *    3     1436  314        1.  *    4     2036  464        1.
      1     0248   15        0.  *    2     0848  165        1.  *    3     1448  315        1.  *    4     2048  465        1.
      1     0300   16        0.  *    2     0900  166        1.  *    3     1500  316        1.  *    4     2100  466        1.
      1     0312   17        0.  *    2     0912  167        1.  *    3     1512  317        1.  *    4     2112  467        1.
      1     0324   18        0.  *    2     0924  168        1.  *    3     1524  318        1.  *    4     2124  468        1.
      1     0336   19        0.  *    2     0936  169        1.  *    3     1536  319        1.  *    4     2136  469        1.
      1     0348   20        0.  *    2     0948  170        1.  *    3     1548  320        1.  *    4     2148  470        1.
      1     0400   21        0.  *    2     1000  171        1.  *    3     1600  321        1.  *    4     2200  471        1.
      1     0412   22        0.  *    2     1012  172        1.  *    3     1612  322        1.  *    4     2212  472        1.
      1     0424   23        0.  *    2     1024  173        1.  *    3     1624  323        1.  *    4     2224  473        1.
      1     0436   24        0.  *    2     1036  174        1.  *    3     1636  324        1.  *    4     2236  474        1.
      1     0448   25        0.  *    2     1048  175        1.  *    3     1648  325        1.  *    4     2248  475        1.
      1     0500   26        1.  *    2     1100  176        1.  *    3     1700  326        1.  *    4     2300  476        1.
      1     0512   27        2.  *    2     1112  177        1.  *    3     1712  327        1.  *    4     2312  477        1.
      1     0524   28        4.  *    2     1124  178        1.  *    3     1724  328        1.  *    4     2324  478        1.
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1     0536   29        7.   *    2     1136  179        1.   *    3     1736  329        1.   *    4     2336  479        1.
1     0548   30       10.   *    2     1148  180        1.   *    3     1748  330        1.   *    4     2348  480        1.
1     0600   31       15.   *    2     1200  181        1.   *    3     1800  331        1.   *    5     0000  481        1.
1     0612   32       30.   *    2     1212  182        1.   *    3     1812  332        1.   *    5     0012  482        1.
1     0624   33       74.   *    2     1224  183        1.   *    3     1824  333        1.   *    5     0024  483        1.
1     0636   34      175.   *    2     1236  184        1.   *    3     1836  334        1.   *    5     0036  484        1.
1     0648   35      342.   *    2     1248  185        1.   *    3     1848  335        1.   *    5     0048  485        1.
1     0700   36      567.   *    2     1300  186        1.   *    3     1900  336        1.   *    5     0100  486        1.
1     0712   37      829.   *    2     1312  187        1.   *    3     1912  337        1.   *    5     0112  487        1.
1     0724   38     1108.   *    2     1324  188        1.   *    3     1924  338        1.   *    5     0124  488        1.
1     0736   39     1380.   *    2     1336  189        1.   *    3     1936  339        1.   *    5     0136  489        1.
1     0748   40     1634.   *    2     1348  190        1.   *    3     1948  340        1.   *    5     0148  490        1.
1     0800   41     1866.   *    2     1400  191        1.   *    3     2000  341        1.   *    5     0200  491        1.
1     0812   42     2071.   *    2     1412  192        1.   *    3     2012  342        1.   *    5     0212  492        1.
1     0824   43     2260.   *    2     1424  193        1.   *    3     2024  343        1.   *    5     0224  493        1.
1     0836   44     2424.   *    2     1436  194        1.   *    3     2036  344        1.   *    5     0236  494        1.
1     0848   45     2568.   *    2     1448  195        1.   *    3     2048  345        1.   *    5     0248  495        1.
1     0900   46     2696.   *    2     1500  196        1.   *    3     2100  346        1.   *    5     0300  496        1.
1     0912   47     2807.   *    2     1512  197        1.   *    3     2112  347        1.   *    5     0312  497        1.
1     0924   48     2906.   *    2     1524  198        1.   *    3     2124  348        1.   *    5     0324  498        1.
1     0936   49     2993.   *    2     1536  199        1.   *    3     2136  349        1.   *    5     0336  499        1.
1     0948   50     3069.   *    2     1548  200        1.   *    3     2148  350        1.   *    5     0348  500        1.
1     1000   51     3137.   *    2     1600  201        1.   *    3     2200  351        1.   *    5     0400  501        1.
1     1012   52     3198.   *    2     1612  202        1.   *    3     2212  352        1.   *    5     0412  502        1.
1     1024   53     3252.   *    2     1624  203        1.   *    3     2224  353        1.   *    5     0424  503        1.
1     1036   54     3300.   *    2     1636  204        1.   *    3     2236  354        1.   *    5     0436  504        1.
1     1048   55     3343.   *    2     1648  205        1.   *    3     2248  355        1.   *    5     0448  505        1.
1     1100   56     3381.   *    2     1700  206        1.   *    3     2300  356        1.   *    5     0500  506        1.
1     1112   57     3416.   *    2     1712  207        1.   *    3     2312  357        1.   *    5     0512  507        1.
1     1124   58     3447.   *    2     1724  208        1.   *    3     2324  358        1.   *    5     0524  508        1.
1     1136   59     3475.   *    2     1736  209        1.   *    3     2336  359        1.   *    5     0536  509        1.
1     1148   60     3501.   *    2     1748  210        1.   *    3     2348  360        1.   *    5     0548  510        1.
1     1200   61     3524.   *    2     1800  211        1.   *    4     0000  361        1.   *    5     0600  511        1.
1     1212   62     3498.   *    2     1812  212        1.   *    4     0012  362        1.   *    5     0612  512        1.
1     1224   63     3371.   *    2     1824  213        1.   *    4     0024  363        1.   *    5     0624  513        1.
1     1236   64     3075.   *    2     1836  214        1.   *    4     0036  364        1.   *    5     0636  514        1.
1     1248   65     2649.   *    2     1848  215        1.   *    4     0048  365        1.   *    5     0648  515        1.
1     1300   66     2187.   *    2     1900  216        1.   *    4     0100  366        1.   *    5     0700  516        1.
1     1312   67     1755.   *    2     1912  217        1.   *    4     0112  367        1.   *    5     0712  517        1.
1     1324   68     1392.   *    2     1924  218        1.   *    4     0124  368        1.   *    5     0724  518        1.
1     1336   69     1131.   *    2     1936  219        1.   *    4     0136  369        1.   *    5     0736  519        1.
1     1348   70      950.   *    2     1948  220        1.   *    4     0148  370        1.   *    5     0748  520        1.
1     1400   71      820.   *    2     2000  221        1.   *    4     0200  371        1.   *    5     0800  521        1.
1     1412   72      724.   *    2     2012  222        1.   *    4     0212  372        1.   *    5     0812  522        1.
1     1424   73      655.   *    2     2024  223        1.   *    4     0224  373        1.   *    5     0824  523        1.
1     1436   74      606.   *    2     2036  224        1.   *    4     0236  374        1.   *    5     0836  524        1.
1     1448   75      570.   *    2     2048  225        1.   *    4     0248  375        1.   *    5     0848  525        1.
1     1500   76      545.   *    2     2100  226        1.   *    4     0300  376        1.   *    5     0900  526        1.
1     1512   77      526.   *    2     2112  227        1.   *    4     0312  377        1.   *    5     0912  527        1.
1     1524   78      513.   *    2     2124  228        1.   *    4     0324  378        1.   *    5     0924  528        1.
1     1536   79      503.   *    2     2136  229        1.   *    4     0336  379        1.   *    5     0936  529        1.
1     1548   80      496.   *    2     2148  230        1.   *    4     0348  380        1.   *    5     0948  530        1.
1     1600   81      492.   *    2     2200  231        1.   *    4     0400  381        1.   *    5     1000  531        1.
1     1612   82      488.   *    2     2212  232        1.   *    4     0412  382        1.   *    5     1012  532        1.
1     1624   83      485.   *    2     2224  233        1.   *    4     0424  383        1.   *    5     1024  533        1.
1     1636   84      483.   *    2     2236  234        1.   *    4     0436  384        1.   *    5     1036  534        1.
1     1648   85      483.   *    2     2248  235        1.   *    4     0448  385        1.   *    5     1048  535        1.
1     1700   86      483.   *    2     2300  236        1.   *    4     0500  386        1.   *    5     1100  536        1.
1     1712   87      483.   *    2     2312  237        1.   *    4     0512  387        1.   *    5     1112  537        1.
1     1724   88      483.   *    2     2324  238        1.   *    4     0524  388        1.   *    5     1124  538        1.
1     1736   89      483.   *    2     2336  239        1.   *    4     0536  389        1.   *    5     1136  539        1.
1     1748   90      484.   *    2     2348  240        1.   *    4     0548  390        1.   *    5     1148  540        1.
1     1800   91      484.   *    3     0000  241        1.   *    4     0600  391        1.   *    5     1200  541        1.
1     1812   92      482.   *    3     0012  242        1.   *    4     0612  392        1.   *    5     1212  542        1.
1     1824   93      477.   *    3     0024  243        1.   *    4     0624  393        1.   *    5     1224  543        1.
1     1836   94      465.   *    3     0036  244        1.   *    4     0636  394        1.   *    5     1236  544        1.
1     1848   95      448.   *    3     0048  245        1.   *    4     0648  395        1.   *    5     1248  545        1.
1     1900   96      431.   *    3     0100  246        1.   *    4     0700  396        1.   *    5     1300  546        1.
1     1912   97      414.   *    3     0112  247        1.   *    4     0712  397        1.   *    5     1312  547        1.
1     1924   98      400.   *    3     0124  248        1.   *    4     0724  398        1.   *    5     1324  548        1.
1     1936   99      390.   *    3     0136  249        1.   *    4     0736  399        1.   *    5     1336  549        1.
1     1948  100      383.   *    3     0148  250        1.   *    4     0748  400        1.   *    5     1348  550        1.
1     2000  101      378.   *    3     0200  251        1.   *    4     0800  401        1.   *    5     1400  551        1.
1     2012  102      375.   *    3     0212  252        1.   *    4     0812  402        1.   *    5     1412  552        1.
1     2024  103      372.   *    3     0224  253        1.   *    4     0824  403        1.   *    5     1424  553        1.
1     2036  104      370.   *    3     0236  254        1.   *    4     0836  404        1.   *    5     1436  554        1.
1     2048  105      369.   *    3     0248  255        1.   *    4     0848  405        1.   *    5     1448  555        1.
1     2100  106      368.   *    3     0300  256        1.   *    4     0900  406        1.   *    5     1500  556        1.
1     2112  107      368.   *    3     0312  257        1.   *    4     0912  407        1.   *    5     1512  557        1.
1     2124  108      367.   *    3     0324  258        1.   *    4     0924  408        1.   *    5     1524  558        1.
1     2136  109      367.   *    3     0336  259        1.   *    4     0936  409        1.   *    5     1536  559        1.
1     2148  110      367.   *    3     0348  260        1.   *    4     0948  410        1.   *    5     1548  560        1.
1     2200  111      367.   *    3     0400  261        1.   *    4     1000  411        1.   *    5     1600  561        1.
1     2212  112      366.   *    3     0412  262        1.   *    4     1012  412        1.   *    5     1612  562        1.
1     2224  113      366.   *    3     0424  263        1.   *    4     1024  413        1.   *    5     1624  563        1.
1     2236  114      366.   *    3     0436  264        1.   *    4     1036  414        1.   *    5     1636  564        1.
1     2248  115      367.   *    3     0448  265        1.   *    4     1048  415        1.   *    5     1648  565        1.
1     2300  116      367.   *    3     0500  266        1.   *    4     1100  416        1.   *    5     1700  566        1.
1     2312  117      367.   *    3     0512  267        1.   *    4     1112  417        1.   *    5     1712  567        1.
1     2324  118      367.   *    3     0524  268        1.   *    4     1124  418        1.   *    5     1724  568        1.
1     2336  119      367.   *    3     0536  269        1.   *    4     1136  419        1.   *    5     1736  569        1.
1     2348  120      367.   *    3     0548  270        1.   *    4     1148  420        1.   *    5     1748  570        1.
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     2    0000  121      367.   *    3     0600  271        1.   *    4     1200  421        1.   *    5     1800  571        1.
     2    0012  122      362.   *    3     0612  272        1.   *    4     1212  422        1.   *    5     1812  572        1.
     2    0024  123      345.   *    3     0624  273        1.   *    4     1224  423        1.   *    5     1824  573        1.
     2    0036  124      308.   *    3     0636  274        1.   *    4     1236  424        1.   *    5     1836  574        1.
     2    0048  125      257.   *    3     0648  275        1.   *    4     1248  425        1.   *    5     1848  575        1.
     2    0100  126      202.   *    3     0700  276        1.   *    4     1300  426        1.   *    5     1900  576        1.
     2    0112  127      151.   *    3     0712  277        1.   *    4     1312  427        1.   *    5     1912  577        1.
     2    0124  128      108.   *    3     0724  278        1.   *    4     1324  428        1.   *    5     1924  578        1.
     2    0136  129       77.   *    3     0736  279        1.   *    4     1336  429        1.   *    5     1936  579        1.
     2    0148  130       56.   *    3     0748  280        1.   *    4     1348  430        1.   *    5     1948  580        1.
     2    0200  131       40.   *    3     0800  281        1.   *    4     1400  431        1.   *    5     2000  581        1.
     2    0212  132       29.   *    3     0812  282        1.   *    4     1412  432        1.   *    5     2012  582        1.
     2    0224  133       21.   *    3     0824  283        1.   *    4     1424  433        1.   *    5     2024  583        1.
     2    0236  134       15.   *    3     0836  284        1.   *    4     1436  434        1.   *    5     2036  584        1.
     2    0248  135       11.   *    3     0848  285        1.   *    4     1448  435        1.   *    5     2048  585        1.
     2    0300  136        8.   *    3     0900  286        1.   *    4     1500  436        1.   *    5     2100  586        1.
     2    0312  137        5.   *    3     0912  287        1.   *    4     1512  437        1.   *    5     2112  587        1.
     2    0324  138        4.   *    3     0924  288        1.   *    4     1524  438        1.   *    5     2124  588        1.
     2    0336  139        3.   *    3     0936  289        1.   *    4     1536  439        1.   *    5     2136  589        1.
     2    0348  140        2.   *    3     0948  290        1.   *    4     1548  440        1.   *    5     2148  590        1.
     2    0400  141        1.   *    3     1000  291        1.   *    4     1600  441        1.   *    5     2200  591        1.
     2    0412  142        1.   *    3     1012  292        1.   *    4     1612  442        1.   *    5     2212  592        1.
     2    0424  143        1.   *    3     1024  293        1.   *    4     1624  443        1.   *    5     2224  593        1.
     2    0436  144        1.   *    3     1036  294        1.   *    4     1636  444        1.   *    5     2236  594        1.
     2    0448  145        1.   *    3     1048  295        1.   *    4     1648  445        1.   *    5     2248  595        1.
     2    0500  146        1.   *    3     1100  296        1.   *    4     1700  446        1.   *    5     2300  596        1.
     2    0512  147        1.   *    3     1112  297        1.   *    4     1712  447        1.   *    5     2312  597        1.
     2    0524  148        1.   *    3     1124  298        1.   *    4     1724  448        1.   *    5     2324  598        1.
     2    0536  149        1.   *    3     1136  299        1.   *    4     1736  449        1.   *    5     2336  599        1.
     2    0548  150        1.   *    3     1148  300        1.   *    4     1748  450        1.   *    5     2348  600        1.
                                *                                 *                                 *
*******************************************************************************************************************************

  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                      6-HR       24-HR       72-HR    119.80-HR
+   (CFS)       (HR)
                          (CFS)
+    3524.     12.00                 2782.        948.        317.         191.
                       (INCHES)      .000        .000        .000         .000
                        (AC-FT)     1379.       1880.       1884.        1888.

                        CUMULATIVE AREA =     .00 SQ MI



*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


            **************
            *            *
   33 KK    *     Cove   *     Reservoir
            *            *
            **************
                          Routing through Res'v

               HYDROGRAPH ROUTING DATA

   35 RS         STORAGE ROUTING
                       NSTPS           1  NUMBER OF SUBREACHES
                        ITYP        ELEV  TYPE OF INITIAL CONDITION
                      RSVRIC     5545.50  INITIAL CONDITION
                           X         .00 WORKING R AND D COEFFICIENT

   36 SV           STORAGE          .0      19.0      95.0     240.0     453.0     738.0    1105.0    1563.0    2217.0    2773.0
                              3542.0    4423.0    5419.0    6149.0    7347.0    8000.0

   38 SE         ELEVATION     5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00
                              5530.00   5536.00   5542.00   5548.00   5552.00   5558.00

   40 SL         LOW-LEVEL OUTLET
                       ELEVL     5545.50  ELEVATION AT CENTER OF OUTLET
                       CAREA        4.91  CROSS-SECTIONAL AREA
                        COQL         .60  COEFFICIENT
                        EXPL         .50  EXPONENT OF HEAD

   41 SS         SPILLWAY
                        CREL     5549.20  SPILLWAY CREST ELEVATION
                       SPWID       30.00  SPILLWAY WIDTH
                        COQW        2.67  WEIR COEFFICIENT
                        EXPW        1.50  EXPONENT OF HEAD

   42 ST         TOP OF DAM
                       TOPEL     5552.00  ELEVATION AT TOP OF DAM
                      DAMWID     1892.00  DAM WIDTH
                        COQD        2.90  WEIR COEFFICIENT
                        EXPD        1.50  EXPONENT OF HEAD

                                                                ***

                                                 COMPUTED OUTFLOW-ELEVATION DATA
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                                                   (EXCLUDING FLOW OVER DAM)

            OUTFLOW        .00       .00     25.78     27.48     29.42     31.65     34.25     37.31     40.98     45.44
          ELEVATION    5470.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00   5548.51   5549.20

            OUTFLOW      49.37     68.29    113.97    198.20    332.85    529.64    800.37   1156.85   1610.93   2174.46
          ELEVATION    5549.32   5549.60   5550.06   5550.68   5551.48   5552.44   5553.58   5554.88   5556.36   5558.00


                                             COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

                                                   (INCLUDING FLOW OVER DAM)

            STORAGE        .00     19.00     95.00    240.00    453.00    738.00   1105.00   1563.00   2217.00   2773.00
            OUTFLOW        .00       .00       .00       .00       .00       .00       .00       .00       .00       .00
          ELEVATION    5470.00   5476.00   5482.00   5488.00   5494.00   5500.00   5506.00   5512.00   5518.00   5524.00

            STORAGE    3542.00   4423.00   5419.00   5844.83   5989.79   6009.51   6033.57   6063.27   6100.64   6148.41
            OUTFLOW        .00       .00       .00       .00     25.78     27.48     29.42     31.65     34.25     37.31
          ELEVATION    5530.00   5536.00   5542.00   5545.50   5546.69   5546.85   5547.05   5547.30   5547.60   5548.00

            STORAGE    6301.53   6508.46   6543.56   6628.96   6765.11   6952.15   7190.23   7347.00   7395.04   7518.54
            OUTFLOW      40.98     45.44     49.37     68.29    113.97    198.20    332.85    435.48   2138.72  11657.74
          ELEVATION    5548.51   5549.20   5549.32   5549.60   5550.06   5550.68   5551.48   5552.00   5552.44   5553.58

            STORAGE    7660.53   7821.02   8000.00
            OUTFLOW   27985.71  51484.63  82813.63
          ELEVATION    5554.88   5556.36   5558.00

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                                                  HYDROGRAPH AT STATION    Cove
                                                      PLAN 1,   RATIO =  1.00

***********************************************************************************************************************************
                                           *                                           *
 DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE * DA MON HRMN ORD  OUTFLOW  STORAGE   STAGE
                                           *                                           *
  1     0000   1       0.   5844.8  5545.5 *  2     1600 201     195.   6946.4  5550.7 *  4     0800 401      60.   6596.5  5549.5
  1     0012   2       0.   5844.8  5545.5 *  2     1612 202     194.   6943.2  5550.7 *  4     0812 402      60.   6595.5  5549.5
  1     0024   3       0.   5844.8  5545.5 *  2     1624 203     192.   6940.0  5550.6 *  4     0824 403      59.   6594.4  5549.5
  1     0036   4       0.   5844.8  5545.5 *  2     1636 204     191.   6936.8  5550.6 *  4     0836 404      59.   6593.4  5549.5
  1     0048   5       0.   5844.8  5545.5 *  2     1648 205     189.   6933.7  5550.6 *  4     0848 405      59.   6592.4  5549.5
  1     0100   6       0.   5844.8  5545.5 *  2     1700 206     187.   6930.7  5550.6 *  4     0900 406      59.   6591.4  5549.5
  1     0112   7       0.   5844.8  5545.5 *  2     1712 207     186.   6927.6  5550.6 *  4     0912 407      59.   6590.4  5549.5
  1     0124   8       0.   5844.8  5545.5 *  2     1724 208     184.   6924.5  5550.6 *  4     0924 408      58.   6589.5  5549.5
  1     0136   9       0.   5844.8  5545.5 *  2     1736 209     183.   6921.4  5550.6 *  4     0936 409      58.   6588.6  5549.5
  1     0148  10       0.   5844.8  5545.5 *  2     1748 210     182.   6918.5  5550.6 *  4     0948 410      58.   6587.7  5549.5
  1     0200  11       0.   5844.8  5545.5 *  2     1800 211     180.   6915.6  5550.6 *  4     1000 411      58.   6586.8  5549.5
  1     0212  12       0.   5844.8  5545.5 *  2     1812 212     179.   6912.7  5550.5 *  4     1012 412      58.   6586.0  5549.5
  1     0224  13       0.   5844.8  5545.5 *  2     1824 213     177.   6909.7  5550.5 *  4     1024 413      57.   6585.1  5549.5
  1     0236  14       0.   5844.8  5545.5 *  2     1836 214     176.   6906.8  5550.5 *  4     1036 414      57.   6584.2  5549.5
  1     0248  15       0.   5844.8  5545.5 *  2     1848 215     174.   6903.9  5550.5 *  4     1048 415      57.   6583.3  5549.5
  1     0300  16       0.   5844.8  5545.5 *  2     1900 216     173.   6901.0  5550.5 *  4     1100 416      57.   6582.5  5549.4
  1     0312  17       0.   5844.8  5545.5 *  2     1912 217     172.   6898.2  5550.5 *  4     1112 417      57.   6581.6  5549.4
  1     0324  18       0.   5844.8  5545.5 *  2     1924 218     170.   6895.4  5550.5 *  4     1124 418      56.   6580.7  5549.4
  1     0336  19       0.   5844.8  5545.5 *  2     1936 219     169.   6892.6  5550.5 *  4     1136 419      56.   6579.8  5549.4
  1     0348  20       0.   5844.8  5545.5 *  2     1948 220     168.   6889.9  5550.5 *  4     1148 420      56.   6578.9  5549.4
  1     0400  21       0.   5844.8  5545.5 *  2     2000 221     166.   6887.1  5550.5 *  4     1200 421      56.   6578.1  5549.4
  1     0412  22       0.   5844.8  5545.5 *  2     2012 222     165.   6884.3  5550.5 *  4     1212 422      56.   6577.2  5549.4
  1     0424  23       0.   5844.8  5545.5 *  2     2024 223     164.   6881.7  5550.4 *  4     1224 423      55.   6576.3  5549.4
  1     0436  24       0.   5844.8  5545.5 *  2     2036 224     163.   6879.0  5550.4 *  4     1236 424      55.   6575.4  5549.4
  1     0448  25       0.   5844.8  5545.5 *  2     2048 225     162.   6876.4  5550.4 *  4     1248 425      55.   6574.6  5549.4
  1     0500  26       0.   5844.8  5545.5 *  2     2100 226     160.   6873.8  5550.4 *  4     1300 426      55.   6573.7  5549.4
  1     0512  27       0.   5844.8  5545.5 *  2     2112 227     159.   6871.1  5550.4 *  4     1312 427      55.   6572.8  5549.4
  1     0524  28       1.   5844.9  5545.5 *  2     2124 228     158.   6868.5  5550.4 *  4     1324 428      55.   6571.9  5549.4
  1     0536  29       1.   5845.0  5545.5 *  2     2136 229     157.   6865.9  5550.4 *  4     1336 429      54.   6571.0  5549.4
  1     0548  30       1.   5845.1  5545.5 *  2     2148 230     155.   6863.2  5550.4 *  4     1348 430      54.   6570.2  5549.4
  1     0600  31       1.   5845.2  5545.5 *  2     2200 231     154.   6860.8  5550.4 *  4     1400 431      54.   6569.3  5549.4
  1     0612  32       2.   5845.6  5545.5 *  2     2212 232     153.   6858.3  5550.4 *  4     1412 432      54.   6568.4  5549.4
  1     0624  33       3.   5846.4  5545.5 *  2     2224 233     152.   6855.8  5550.4 *  4     1424 433      54.   6567.5  5549.4
  1     0636  34       4.   5848.5  5545.5 *  2     2236 234     151.   6853.3  5550.4 *  4     1436 434      53.   6566.7  5549.4
  1     0648  35       6.   5852.7  5545.6 *  2     2248 235     150.   6850.8  5550.3 *  4     1448 435      53.   6565.8  5549.4
  1     0700  36       8.   5860.1  5545.6 *  2     2300 236     149.   6848.3  5550.3 *  4     1500 436      53.   6564.9  5549.4
  1     0712  37      11.   5871.5  5545.7 *  2     2312 237     148.   6845.8  5550.3 *  4     1512 437      53.   6564.0  5549.4
  1     0724  38      14.   5887.3  5545.8 *  2     2324 238     147.   6843.3  5550.3 *  4     1524 438      53.   6563.2  5549.4
  1     0736  39      17.   5907.6  5546.0 *  2     2336 239     146.   6841.0  5550.3 *  4     1536 439      53.   6562.3  5549.4
  1     0748  40      20.   5932.2  5546.2 *  2     2348 240     144.   6838.7  5550.3 *  4     1548 440      52.   6561.4  5549.4
  1     0800  41      23.   5960.8  5546.5 *  3     0000 241     143.   6836.3  5550.3 *  4     1600 441      52.   6560.5  5549.4
  1     0812  42      26.   5992.9  5546.7 *  3     0012 242     142.   6834.0  5550.3 *  4     1612 442      52.   6559.6  5549.4
  1     0824  43      29.   6028.3  5547.0 *  3     0024 243     141.   6831.6  5550.3 *  4     1624 443      52.   6558.8  5549.4
  1     0836  44      32.   6066.5  5547.3 *  3     0036 244     140.   6829.3  5550.3 *  4     1636 444      52.   6557.9  5549.4
  1     0848  45      35.   6107.2  5547.7 *  3     0048 245     139.   6827.0  5550.3 *  4     1648 445      52.   6557.0  5549.4
  1     0900  46      37.   6150.0  5548.0 *  3     0100 246     138.   6824.6  5550.3 *  4     1700 446      51.   6556.1  5549.4
  1     0912  47      38.   6194.9  5548.2 *  3     0112 247     137.   6822.4  5550.2 *  4     1712 447      51.   6555.3  5549.4
  1     0924  48      40.   6241.4  5548.3 *  3     0124 248     137.   6820.2  5550.2 *  4     1724 448      51.   6554.4  5549.4
  1     0936  49      41.   6289.5  5548.5 *  3     0136 249     136.   6818.0  5550.2 *  4     1736 449      51.   6553.5  5549.4
  1     0948  50      42.   6339.0  5548.6 *  3     0148 250     135.   6815.9  5550.2 *  4     1748 450      51.   6552.6  5549.3
  1     1000  51      43.   6389.6  5548.8 *  3     0200 251     134.   6813.7  5550.2 *  4     1800 451      51.   6551.7  5549.3
  1     1012  52      44.   6441.2  5549.0 *  3     0212 252     133.   6811.5  5550.2 *  4     1812 452      51.   6550.9  5549.3
  1     1024  53      45.   6493.7  5549.2 *  3     0224 253     132.   6809.3  5550.2 *  4     1824 453      50.   6550.0  5549.3
  1     1036  54      50.   6547.1  5549.3 *  3     0236 254     131.   6807.1  5550.2 *  4     1836 454      50.   6549.1  5549.3
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1     1048  55      61.   6601.0  5549.5 *  3     0248 255     130.   6804.9  5550.2 *  4     1848 455      50.   6548.2  5549.3
1     1100  56      76.   6655.4  5549.7 *  3     0300 256     129.   6802.7  5550.2 *  4     1900 456      50.   6547.4  5549.3
1     1112  57      94.   6710.1  5549.9 *  3     0312 257     128.   6800.6  5550.2 *  4     1912 457      50.   6546.5  5549.3
1     1124  58     114.   6765.1  5550.1 *  3     0324 258     127.   6798.6  5550.2 *  4     1924 458      50.   6545.6  5549.3
1     1136  59     137.   6820.2  5550.2 *  3     0336 259     127.   6796.6  5550.2 *  4     1936 459      50.   6544.9  5549.3
1     1148  60     161.   6875.4  5550.4 *  3     0348 260     126.   6794.5  5550.2 *  4     1948 460      49.   6544.1  5549.3
1     1200  61     187.   6930.5  5550.6 *  3     0400 261     125.   6792.5  5550.1 *  4     2000 461      49.   6543.4  5549.3
1     1212  62     215.   6985.2  5550.8 *  3     0412 262     124.   6790.4  5550.1 *  4     2012 462      49.   6542.7  5549.3
1     1224  63     244.   7038.1  5551.0 *  3     0424 263     123.   6788.4  5550.1 *  4     2024 463      49.   6541.9  5549.3
1     1236  64     271.   7087.1  5551.1 *  3     0436 264     122.   6786.3  5550.1 *  4     2036 464      49.   6541.2  5549.3
1     1248  65     296.   7129.7  5551.3 *  3     0448 265     122.   6784.3  5550.1 *  4     2048 465      49.   6540.5  5549.3
1     1300  66     317.   7164.6  5551.4 *  3     0500 266     121.   6782.2  5550.1 *  4     2100 466      49.   6539.8  5549.3
1     1312  67     334.   7191.8  5551.5 *  3     0512 267     120.   6780.3  5550.1 *  4     2112 467      49.   6539.0  5549.3
1     1324  68     347.   7212.2  5551.5 *  3     0524 268     119.   6778.4  5550.1 *  4     2124 468      49.   6538.3  5549.3
1     1336  69     356.   7227.2  5551.6 *  3     0536 269     118.   6776.5  5550.1 *  4     2136 469      48.   6537.6  5549.3
1     1348  70     363.   7238.5  5551.6 *  3     0548 270     118.   6774.6  5550.1 *  4     2148 470      48.   6536.8  5549.3
1     1400  71     369.   7247.1  5551.7 *  3     0600 271     117.   6772.7  5550.1 *  4     2200 471      48.   6536.1  5549.3
1     1412  72     373.   7253.7  5551.7 *  3     0612 272     116.   6770.8  5550.1 *  4     2212 472      48.   6535.4  5549.3
1     1424  73     377.   7259.0  5551.7 *  3     0624 273     115.   6768.9  5550.1 *  4     2224 473      48.   6534.6  5549.3
1     1436  74     379.   7263.2  5551.7 *  3     0636 274     115.   6767.0  5550.1 *  4     2236 474      48.   6533.9  5549.3
1     1448  75     382.   7266.6  5551.7 *  3     0648 275     114.   6765.1  5550.1 *  4     2248 475      48.   6533.2  5549.3
1     1500  76     383.   7269.5  5551.7 *  3     0700 276     113.   6763.2  5550.1 *  4     2300 476      48.   6532.4  5549.3
1     1512  77     385.   7272.0  5551.7 *  3     0712 277     112.   6761.3  5550.0 *  4     2312 477      48.   6531.7  5549.3
1     1524  78     387.   7274.2  5551.8 *  3     0724 278     112.   6759.4  5550.0 *  4     2324 478      48.   6531.0  5549.3
1     1536  79     388.   7276.2  5551.8 *  3     0736 279     111.   6757.7  5550.0 *  4     2336 479      47.   6530.2  5549.3
1     1548  80     389.   7278.1  5551.8 *  3     0748 280     110.   6755.9  5550.0 *  4     2348 480      47.   6529.5  5549.3
1     1600  81     390.   7279.9  5551.8 *  3     0800 281     110.   6754.1  5550.0 *  5     0000 481      47.   6528.8  5549.3
1     1612  82     391.   7281.5  5551.8 *  3     0812 282     109.   6752.4  5550.0 *  5     0012 482      47.   6528.1  5549.3
1     1624  83     392.   7283.1  5551.8 *  3     0824 283     108.   6750.6  5550.0 *  5     0024 483      47.   6527.3  5549.3
1     1636  84     393.   7284.6  5551.8 *  3     0836 284     108.   6748.9  5550.0 *  5     0036 484      47.   6526.6  5549.3
1     1648  85     394.   7286.0  5551.8 *  3     0848 285     107.   6747.1  5550.0 *  5     0048 485      47.   6525.9  5549.3
1     1700  86     395.   7287.5  5551.8 *  3     0900 286     106.   6745.4  5550.0 *  5     0100 486      47.   6525.1  5549.3
1     1712  87     396.   7288.9  5551.8 *  3     0912 287     106.   6743.6  5550.0 *  5     0112 487      47.   6524.4  5549.3
1     1724  88     397.   7290.4  5551.8 *  3     0924 288     105.   6741.9  5550.0 *  5     0124 488      47.   6523.7  5549.3
1     1736  89     398.   7291.9  5551.8 *  3     0936 289     104.   6740.1  5550.0 *  5     0136 489      47.   6522.9  5549.2
1     1748  90     399.   7293.3  5551.8 *  3     0948 290     104.   6738.3  5550.0 *  5     0148 490      47.   6522.2  5549.2
1     1800  91     400.   7294.8  5551.8 *  3     1000 291     103.   6736.6  5550.0 *  5     0200 491      46.   6521.5  5549.2
1     1812  92     401.   7296.1  5551.8 *  3     1012 292     103.   6734.8  5550.0 *  5     0212 492      46.   6520.7  5549.2
1     1824  93     402.   7297.4  5551.8 *  3     1024 293     102.   6733.2  5550.0 *  5     0224 493      46.   6520.0  5549.2
1     1836  94     403.   7298.6  5551.8 *  3     1036 294     101.   6731.6  5549.9 *  5     0236 494      46.   6519.3  5549.2
1     1848  95     403.   7299.5  5551.8 *  3     1048 295     101.   6730.0  5549.9 *  5     0248 495      46.   6518.5  5549.2
1     1900  96     404.   7300.1  5551.8 *  3     1100 296     100.   6728.4  5549.9 *  5     0300 496      46.   6517.8  5549.2
1     1912  97     404.   7300.3  5551.8 *  3     1112 297     100.   6726.8  5549.9 *  5     0312 497      46.   6517.1  5549.2
1     1924  98     404.   7300.3  5551.8 *  3     1124 298      99.   6725.2  5549.9 *  5     0324 498      46.   6516.4  5549.2
1     1936  99     404.   7300.2  5551.8 *  3     1136 299      98.   6723.6  5549.9 *  5     0336 499      46.   6515.6  5549.2
1     1948 100     404.   7299.9  5551.8 *  3     1148 300      98.   6722.0  5549.9 *  5     0348 500      46.   6514.9  5549.2
1     2000 101     403.   7299.5  5551.8 *  3     1200 301      97.   6720.4  5549.9 *  5     0400 501      46.   6514.2  5549.2
1     2012 102     403.   7299.0  5551.8 *  3     1212 302      97.   6718.8  5549.9 *  5     0412 502      46.   6513.4  5549.2
1     2024 103     403.   7298.6  5551.8 *  3     1224 303      96.   6717.1  5549.9 *  5     0424 503      46.   6512.7  5549.2
1     2036 104     402.   7298.0  5551.8 *  3     1236 304      96.   6715.5  5549.9 *  5     0436 504      46.   6512.0  5549.2
1     2048 105     402.   7297.4  5551.8 *  3     1248 305      95.   6713.9  5549.9 *  5     0448 505      46.   6511.2  5549.2
1     2100 106     402.   7296.8  5551.8 *  3     1300 306      94.   6712.3  5549.9 *  5     0500 506      46.   6510.5  5549.2
1     2112 107     401.   7296.3  5551.8 *  3     1312 307      94.   6710.7  5549.9 *  5     0512 507      45.   6509.8  5549.2
1     2124 108     401.   7295.7  5551.8 *  3     1324 308      93.   6709.2  5549.9 *  5     0524 508      45.   6509.0  5549.2
1     2136 109     400.   7295.1  5551.8 *  3     1336 309      93.   6707.8  5549.9 *  5     0536 509      45.   6508.3  5549.2
1     2148 110     400.   7294.5  5551.8 *  3     1348 310      92.   6706.3  5549.9 *  5     0548 510      45.   6507.6  5549.2
1     2200 111     400.   7293.9  5551.8 *  3     1400 311      92.   6704.9  5549.9 *  5     0600 511      45.   6506.8  5549.2
1     2212 112     399.   7293.3  5551.8 *  3     1412 312      91.   6703.4  5549.9 *  5     0612 512      45.   6506.1  5549.2
1     2224 113     399.   7292.7  5551.8 *  3     1424 313      91.   6701.9  5549.8 *  5     0624 513      45.   6505.4  5549.2
1     2236 114     398.   7292.2  5551.8 *  3     1436 314      90.   6700.5  5549.8 *  5     0636 514      45.   6504.7  5549.2
1     2248 115     398.   7291.6  5551.8 *  3     1448 315      90.   6699.0  5549.8 *  5     0648 515      45.   6503.9  5549.2
1     2300 116     398.   7291.1  5551.8 *  3     1500 316      89.   6697.5  5549.8 *  5     0700 516      45.   6503.2  5549.2
1     2312 117     397.   7290.7  5551.8 *  3     1512 317      89.   6696.1  5549.8 *  5     0712 517      45.   6502.5  5549.2
1     2324 118     397.   7290.3  5551.8 *  3     1524 318      88.   6694.6  5549.8 *  5     0724 518      45.   6501.7  5549.2
1     2336 119     397.   7289.8  5551.8 *  3     1536 319      88.   6693.2  5549.8 *  5     0736 519      45.   6501.0  5549.2
1     2348 120     397.   7289.4  5551.8 *  3     1548 320      87.   6691.7  5549.8 *  5     0748 520      45.   6500.3  5549.2
2     0000 121     396.   7288.9  5551.8 *  3     1600 321      87.   6690.2  5549.8 *  5     0800 521      45.   6499.5  5549.2
2     0012 122     396.   7288.4  5551.8 *  3     1612 322      86.   6688.8  5549.8 *  5     0812 522      45.   6498.8  5549.2
2     0024 123     395.   7287.6  5551.8 *  3     1624 323      86.   6687.3  5549.8 *  5     0824 523      45.   6498.1  5549.2
2     0036 124     395.   7286.5  5551.8 *  3     1636 324      85.   6685.8  5549.8 *  5     0836 524      45.   6497.3  5549.2
2     0048 125     393.   7284.6  5551.8 *  3     1648 325      85.   6684.4  5549.8 *  5     0848 525      45.   6496.6  5549.2
2     0100 126     392.   7281.9  5551.8 *  3     1700 326      85.   6683.1  5549.8 *  5     0900 526      45.   6495.9  5549.2
2     0112 127     389.   7278.4  5551.8 *  3     1712 327      84.   6681.8  5549.8 *  5     0912 527      45.   6495.2  5549.2
2     0124 128     387.   7274.2  5551.8 *  3     1724 328      84.   6680.4  5549.8 *  5     0924 528      45.   6494.4  5549.2
2     0136 129     383.   7269.3  5551.7 *  3     1736 329      83.   6679.1  5549.8 *  5     0936 529      45.   6493.7  5549.2
2     0148 130     380.   7264.1  5551.7 *  3     1748 330      83.   6677.8  5549.8 *  5     0948 530      45.   6493.0  5549.1
2     0200 131     376.   7258.7  5551.7 *  3     1800 331      82.   6676.5  5549.8 *  5     1000 531      45.   6492.2  5549.1
2     0212 132     373.   7253.1  5551.7 *  3     1812 332      82.   6675.2  5549.8 *  5     1012 532      45.   6491.5  5549.1
2     0224 133     369.   7247.4  5551.7 *  3     1824 333      82.   6673.9  5549.8 *  5     1024 533      45.   6490.8  5549.1
2     0236 134     365.   7241.7  5551.6 *  3     1836 334      81.   6672.5  5549.7 *  5     1036 534      45.   6490.0  5549.1
2     0248 135     362.   7235.9  5551.6 *  3     1848 335      81.   6671.2  5549.7 *  5     1048 535      45.   6489.3  5549.1
2     0300 136     358.   7230.0  5551.6 *  3     1900 336      80.   6669.9  5549.7 *  5     1100 536      45.   6488.6  5549.1
2     0312 137     354.   7224.2  5551.6 *  3     1912 337      80.   6668.6  5549.7 *  5     1112 537      45.   6487.8  5549.1
2     0324 138     351.   7218.5  5551.6 *  3     1924 338      80.   6667.3  5549.7 *  5     1124 538      45.   6487.1  5549.1
2     0336 139     347.   7212.8  5551.6 *  3     1936 339      79.   6666.0  5549.7 *  5     1136 539      45.   6486.4  5549.1
2     0348 140     343.   7207.0  5551.5 *  3     1948 340      79.   6664.6  5549.7 *  5     1148 540      45.   6485.6  5549.1
2     0400 141     340.   7201.5  5551.5 *  3     2000 341      78.   6663.3  5549.7 *  5     1200 541      45.   6484.9  5549.1
2     0412 142     336.   7195.9  5551.5 *  3     2012 342      78.   6662.0  5549.7 *  5     1212 542      45.   6484.2  5549.1
2     0424 143     333.   7190.4  5551.5 *  3     2024 343      77.   6660.7  5549.7 *  5     1224 543      45.   6483.5  5549.1
2     0436 144     330.   7185.0  5551.5 *  3     2036 344      77.   6659.4  5549.7 *  5     1236 544      45.   6482.7  5549.1
2     0448 145     326.   7179.6  5551.4 *  3     2048 345      77.   6658.1  5549.7 *  5     1248 545      45.   6482.0  5549.1
2     0500 146     323.   7174.1  5551.4 *  3     2100 346      76.   6656.7  5549.7 *  5     1300 546      45.   6481.3  5549.1
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   2     0512 147     320.    7168.9  5551.4 *  3     2112 347      76.    6655.6  5549.7 *  5     1312 547      45.    6480.5  5549.1
   2     0524 148     316.    7163.6  5551.4 *  3     2124 348      76.    6654.4  5549.7 *  5     1324 548      45.    6479.8  5549.1
   2     0536 149     313.    7158.5  5551.4 *  3     2136 349      75.    6653.2  5549.7 *  5     1336 549      45.    6479.1  5549.1
   2     0548 150     310.    7153.4  5551.4 *  3     2148 350      75.    6652.1  5549.7 *  5     1348 550      45.    6478.3  5549.1
   2     0600 151     307.    7148.3  5551.3 *  3     2200 351      75.    6650.9  5549.7 *  5     1400 551      45.    6477.6  5549.1
   2     0612 152     304.    7143.3  5551.3 *  3     2212 352      74.    6649.7  5549.7 *  5     1412 552      45.    6476.9  5549.1
   2     0624 153     301.    7138.3  5551.3 *  3     2224 353      74.    6648.6  5549.7 *  5     1424 553      45.    6476.1  5549.1
   2     0636 154     298.    7133.3  5551.3 *  3     2236 354      74.    6647.4  5549.7 *  5     1436 554      45.    6475.4  5549.1
   2     0648 155     295.    7128.5  5551.3 *  3     2248 355      73.    6646.2  5549.7 *  5     1448 555      45.    6474.7  5549.1
   2     0700 156     292.    7123.7  5551.3 *  3     2300 356      73.    6645.0  5549.7 *  5     1500 556      45.    6473.9  5549.1
   2     0712 157     290.    7118.9  5551.2 *  3     2312 357      72.    6643.9  5549.7 *  5     1512 557      45.    6473.2  5549.1
   2     0724 158     287.    7114.2  5551.2 *  3     2324 358      72.    6642.7  5549.6 *  5     1524 558      45.    6472.5  5549.1
   2     0736 159     284.    7109.5  5551.2 *  3     2336 359      72.    6641.5  5549.6 *  5     1536 559      45.    6471.8  5549.1
   2     0748 160     281.    7104.8  5551.2 *  3     2348 360      71.    6640.4  5549.6 *  5     1548 560      45.    6471.0  5549.1
   2     0800 161     279.    7100.1  5551.2 *  4     0000 361      71.    6639.2  5549.6 *  5     1600 561      45.    6470.3  5549.1
   2     0812 162     276.    7095.6  5551.2 *  4     0012 362      71.    6638.0  5549.6 *  5     1612 562      45.    6469.6  5549.1
   2     0824 163     273.    7091.1  5551.1 *  4     0024 363      70.    6636.9  5549.6 *  5     1624 563      45.    6468.8  5549.1
   2     0836 164     271.    7086.5  5551.1 *  4     0036 364      70.    6635.7  5549.6 *  5     1636 564      45.    6468.1  5549.1
   2     0848 165     268.    7082.2  5551.1 *  4     0048 365      70.    6634.5  5549.6 *  5     1648 565      45.    6467.4  5549.1
   2     0900 166     266.    7077.8  5551.1 *  4     0100 366      70.    6633.3  5549.6 *  5     1700 566      45.    6466.6  5549.1
   2     0912 167     263.    7073.4  5551.1 *  4     0112 367      69.    6632.2  5549.6 *  5     1712 567      45.    6465.9  5549.1
   2     0924 168     261.    7069.0  5551.1 *  4     0124 368      69.    6631.0  5549.6 *  5     1724 568      45.    6465.2  5549.1
   2     0936 169     258.    7064.8  5551.1 *  4     0136 369      69.    6629.8  5549.6 *  5     1736 569      45.    6464.4  5549.1
   2     0948 170     256.    7060.5  5551.0 *  4     0148 370      68.    6628.7  5549.6 *  5     1748 570      45.    6463.7  5549.1
   2     1000 171     254.    7056.3  5551.0 *  4     0200 371      68.    6627.5  5549.6 *  5     1800 571      44.    6463.0  5549.0
   2     1012 172     251.    7052.2  5551.0 *  4     0212 372      68.    6626.3  5549.6 *  5     1812 572      44.    6462.2  5549.0
   2     1024 173     249.    7048.1  5551.0 *  4     0224 373      67.    6625.2  5549.6 *  5     1824 573      44.    6461.5  5549.0
   2     1036 174     247.    7044.0  5551.0 *  4     0236 374      67.    6624.1  5549.6 *  5     1836 574      44.    6460.8  5549.0
   2     1048 175     245.    7039.9  5551.0 *  4     0248 375      67.    6623.1  5549.6 *  5     1848 575      44.    6460.1  5549.0
   2     1100 176     242.    7035.9  5551.0 *  4     0300 376      66.    6622.1  5549.6 *  5     1900 576      44.    6459.3  5549.0
   2     1112 177     240.    7032.0  5550.9 *  4     0312 377      66.    6621.1  5549.6 *  5     1912 577      44.    6458.6  5549.0
   2     1124 178     238.    7028.0  5550.9 *  4     0324 378      66.    6620.0  5549.6 *  5     1924 578      44.    6457.9  5549.0
   2     1136 179     236.    7024.1  5550.9 *  4     0336 379      66.    6619.0  5549.6 *  5     1936 579      44.    6457.1  5549.0
   2     1148 180     234.    7020.3  5550.9 *  4     0348 380      65.    6618.0  5549.6 *  5     1948 580      44.    6456.4  5549.0
   2     1200 181     232.    7016.5  5550.9 *  4     0400 381      65.    6617.0  5549.6 *  5     2000 581      44.    6455.7  5549.0
   2     1212 182     230.    7012.7  5550.9 *  4     0412 382      65.    6615.9  5549.6 *  5     2012 582      44.    6454.9  5549.0
   2     1224 183     228.    7008.9  5550.9 *  4     0424 383      65.    6614.9  5549.6 *  5     2024 583      44.    6454.2  5549.0
   2     1236 184     226.    7005.1  5550.9 *  4     0436 384      64.    6613.9  5549.6 *  5     2036 584      44.    6453.5  5549.0
   2     1248 185     224.    7001.4  5550.8 *  4     0448 385      64.    6612.9  5549.5 *  5     2048 585      44.    6452.7  5549.0
   2     1300 186     222.    6997.8  5550.8 *  4     0500 386      64.    6611.9  5549.5 *  5     2100 586      44.    6452.0  5549.0
   2     1312 187     220.    6994.1  5550.8 *  4     0512 387      63.    6610.8  5549.5 *  5     2112 587      44.    6451.3  5549.0
   2     1324 188     218.    6990.5  5550.8 *  4     0524 388      63.    6609.8  5549.5 *  5     2124 588      44.    6450.5  5549.0
   2     1336 189     216.    6987.0  5550.8 *  4     0536 389      63.    6608.8  5549.5 *  5     2136 589      44.    6449.8  5549.0
   2     1348 190     214.    6983.4  5550.8 *  4     0548 390      63.    6607.8  5549.5 *  5     2148 590      44.    6449.1  5549.0
   2     1400 191     212.    6979.9  5550.8 *  4     0600 391      62.    6606.7  5549.5 *  5     2200 591      44.    6448.4  5549.0
   2     1412 192     211.    6976.4  5550.8 *  4     0612 392      62.    6605.7  5549.5 *  5     2212 592      44.    6447.6  5549.0
   2     1424 193     209.    6972.9  5550.8 *  4     0624 393      62.    6604.7  5549.5 *  5     2224 593      44.    6446.9  5549.0
   2     1436 194     207.    6969.6  5550.7 *  4     0636 394      62.    6603.7  5549.5 *  5     2236 594      44.    6446.2  5549.0
   2     1448 195     205.    6966.2  5550.7 *  4     0648 395      61.    6602.6  5549.5 *  5     2248 595      44.    6445.4  5549.0
   2     1500 196     204.    6962.8  5550.7 *  4     0700 396      61.    6601.6  5549.5 *  5     2300 596      44.    6444.7  5549.0
   2     1512 197     202.    6959.5  5550.7 *  4     0712 397      61.    6600.6  5549.5 *  5     2312 597      44.    6444.0  5549.0
   2     1524 198     200.    6956.1  5550.7 *  4     0724 398      61.    6599.6  5549.5 *  5     2324 598      44.    6443.2  5549.0
   2     1536 199     199.    6952.9  5550.7 *  4     0736 399      60.    6598.5  5549.5 *  5     2336 599      44.    6442.5  5549.0
   2     1548 200     197.    6949.7  5550.7 *  4     0748 400      60.    6597.5  5549.5 *  5     2348 600      44.    6441.8  5549.0
                                               *                                          *
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 PEAK OUTFLOW IS      404. AT TIME  19.20 HOURS


  PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
                                   6-HR       24-HR       72-HR    119.80-HR
+   (CFS)       (HR)
                         (CFS)
+     404.     19.20               401.        346.        191.         130.
                      (INCHES)      .000        .000        .000         .000
                       (AC-FT)      199.        687.       1135.        1291.

 PEAK STORAGE   TIME                         MAXIMUM AVERAGE STORAGE
                                   6-HR       24-HR       72-HR    119.80-HR
+  (AC-FT)      (HR)
     7300.     19.20              7296.       7209.       6902.        6696.

  PEAK STAGE    TIME                          MAXIMUM AVERAGE STAGE
                                   6-HR       24-HR       72-HR    119.80-HR
+   (FEET)      (HR)
   5551.84     19.20            5551.83     5551.54     5550.52      5549.72

                       CUMULATIVE AREA =     .00 SQ MI

1

               PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
                                 FLOWS IN CUBIC FEET PER SECOND,  AREA IN SQUARE MILES
                                                TIME TO PEAK IN HOURS


                                                         RATIOS APPLIED TO PRECIPITATION
 OPERATION       STATION     AREA    PLAN            RATIO 1
                                                        1.00

 HYDROGRAPH AT
```

```
+                  Cove        .00     1   FLOW        3524.
                                           TIME        12.00

 ROUTED TO
+                  Cove        .00     1   FLOW         404.
                                           TIME        19.20

                                       ** PEAK STAGES IN FEET **
                                       1   STAGE     5551.84
                                           TIME        19.20
1                                  SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION    Cove
                              (PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED  DURING BREACH FORMATION)


      PLAN  1 ..............                 INITIAL VALUE     SPILLWAY CREST     TOP OF DAM
                                 ELEVATION        5545.50           5549.20          5552.00
                                 STORAGE            5845.              6508.            7347.
                                 OUTFLOW               0.                45.             435.


                      RATIO     MAXIMUM      MAXIMUM    MAXIMUM    MAXIMUM    DURATION     TIME OF     TIME OF
                        OF     RESERVOIR      DEPTH     STORAGE    OUTFLOW    OVER TOP   MAX OUTFLOW   FAILURE
                       PMF      W.S.ELEV    OVER DAM     AC-FT       CFS       HOURS        HOURS       HOURS

                      1.00      5551.84         .00       7300.       404.       .00        19.20         .00


 *** NORMAL END OF HEC-1 ***
```

Spillway Analysis

```
*******************************************************************************
SITES XEQ 08/20/2020   WATER RESOURCE SITE ANALYSIS COMPUTER PROGRAM
     VER 2005.1.8               (USER MANUAL - DATED DECEMBER 2005)
     TIME 06:12:11

************************** 80-80 LIST OF INPUT Data ***************************

SITES     01/01/2005COVRES    COV RES                       4.74      C3
SAVMOV    0    101
SAVMOV    101  1                                                      1
STRUCTURE STR1      Cove Res
                    5470                                    0.18
                    5480                                    62.26
                    5490                                    303.40
                    5500                                    738.03
                    5510                                    1400.09
                    5520                                    2323.02
                    5530                                    3541.97
                    5540                                    5073.81
                    5545.5                                  6055.03
                    5550                                    6934.92
                    5552                                    7347.18
                    5552.5                                  7450.25
ENDTABLE
HYD       1                   Principal Spillway
                    1
                    0         11        14        15        15
                    15        15        15        15        15
                    15        16        16        16        16
                    16        16        16        16        16
                    16        17        17        17        17
                    17        17        17        17        17
                    17        18        18        18        18
                    18        18        18        18        19
                    19        19        19        19        19
                    20        20        20        20        20
                    20        21        21        21        21
                    21        21        22        22        22
                    22        23        23        23        23
                    24        24        24        24        25
                    25        25        26        26        26
                    27        27        27        28        28
                    29        29        29        30        30
                    31        31        32        33        33
                    34        35        35        36        37
                    38        39        40        41        42
                    43        45        46        48        49
                    51        53        56        58        61
                    65        69        74        80        87
                    96        109       127       157       219
                    850       479       259       172       132
                    111       98        88        81        75
                    70        65        62        59        56
                    54        51        50        48        46
                    45        43        42        41        40
                    39        38        37        36        35
                    35        34        33        33        32
                    32        31        30        30        29
                    29        29        28        28        27
                    27        27        26        26        26
                    25        25        25        24        24
                    24        24        23        23        23
                    23        22        22        22        22
                    22        21        21        21        21
                    21        20        20        20        20
                    20        20        19        19        19
                    19        19        19        19        18
                    18        18        18        18        18
                    18        17        17        17        17
                    17        17        17        17        17
                    17        16        16        16        16
                    16        16        16        16        16
                    16        15        15        15        15
                    15        15        15        15        15
                    15        4         1
ENDTABLE
HYD       3                   Auxiliary Spillway (Local)
                    0.3
                    0         0         0         0         0
                    6         39        194       687       1365
                    2027      2180      1955      1683      1441
                    1248      1107      1001      924       874
                    833       748       589       423       283
                    180       112       73        47        28
                    16        9         5         3         1
                    1         0
ENDTABLE
HYD       5                   Freeboard (General)
                    1.2
                    0         0         4         35        84
                    195       425       1352      3365      3296
                    2008      1331      1060      912       792
```

```
                     742       664       624       613       611
                     547       262       90        24        5
                     1         0
 ENDTABLE
 WSDATA    2C CR               4.74
 PDIRECT                                 9.40      16.00
 POOLDATA  ELEV                5545.5              5552      5435      SC
 PSINLET             1         3.75
 PSDATA    1         1000      30                  0.012     5450
 ASSPRFL   41
           0         5530      75        5549.2    155       5549.2
           237       5517.6    600       5481.7    1049      5453.3
           1170      5435
 ENDTABLE
 ASSURFACE 41        1170      1
           0         1170      1         0         1
 ENDTABLE
 ASDATA    41                            2                             1
 BTMWIDTH  FEET      30
 ASMATERIAL
           1         50        1         75        115       .2
 ENDTABLE
 ASCOORD    1        W.Shale   N
           0         5530      75        5550      125       5565
           200       5552      250       5520      600       5485
           1050      5460      1150      5435      1300      5432.4
 ENDTABLE
 GRAPHICS  I
 GO,DESIGN LP        TYPE2     24
 SAVMOV    2    101  1                   STR1
 ENDJOB

 *******************************************************************************

 ***** MESSAGE - DEFAULT TOPSOIL FILL MATERIAL PARAMETERS USED.

 ***** MESSAGE - AUXILIARY SPILLWAY CREST ELEVATION IS SET TO  5549.20
                 FROM THE ASSPRFL RECORDS.

 ***** MESSAGE - ASSURFACE REACH  1: ZERO ROOTING DEPTH IS DEFAULTED TO O.5 FT.


1SITES --------------------------------------------------------------------------
 XEQ 08/20/2020                   COV RES                        WSID= COVRES
 VER 2005.1.8                       Cove Res                       SUBW= CR
 TIME 06:12:11            SITE = STR1              PASS=    1     PART=   1



 **********************    MATERIAL PROPERTIES    ****************************
                            DRY                  PERCENT       DETACH.      REP.
      MATERIAL       PI   DENSITY        Kh        CLAY         RATE      DIAMETER
                         lbs/CuFt                        (Ft/H)/(lb/SqFt)  inches
     W.Shale        50.      115.      0.20       75.0          --        1.00000
     TS_FILL         0.      100.      0.05        0.0          --        0.05000
     GEN_FILL       50.      115.      0.20       75.0          --        1.00000

 ****************************    BASIC Data    *********************************
 HUMID- SUBHUMID CLIMATE AREA                     DESIGN CLASS  C

 INFLOW HYDROGRAPH(S) ENTERED

 PRECIP. - Q-PS,1-DAY    Q-PS,10-DAY       P-SD           P-FB
               0.00          0.00          9.40          16.00

 WSDATA -       CN          DA-SM          TC/L           -/H          QRF
               0.00          4.74          0.00           0.00          0.00

 SITEDATA- PERM POOL     CREST PS        FP SED        VALLEY FL         378?
               0.00       5545.50          0.00        5435.00            NO

           BASEFLOW      INITIAL EL     EXTRA VOL      SITE TYPE
               0.00          0.00          0.00         DESIGN

 PSDATA -  NO. COND        COND L         DIA/W            -/H
               1.00       1000.00         30.00           0.00

               PS N            KE         WEIR L         TW EL
              0.012          1.00          3.75        5450.00

            2ND STG         ORF H          ORF L      START AUX.
               0.00          0.00          0.00           0.00

 ASCRESTS -   AUX.1         AUX.2         AUX.3          AUX.4          AUX.5
            5549.20          0.00          0.00           0.00          0.00

 AUX.Data -  REF.NO.    RETARD. Ci   TIE STATION    INLET LENGTH
                 41          0.00        155.00              0

 AUX.Data - INLET Ci    SIDE SLOPE       EXIT Ci     EXIT SLOPE     ACTUAL AUX?
              1.000          2.00         1.000          0.385            NO
```

```
 BTM WIDTH -    BW1           BW2           BW3            BW4           BW5
   ft         30.00          0.00          0.00           0.00          0.00

 AUXILIARY SPILLWAY RATING DEVELOPED USING WSPVRT.


1SITES -------------------------------------------------------------------------
 XEQ 08/20/2020                    COV RES                        WSID= COVRES
 VER 2005.1.8                        Cove Res                       SUBW= CR
 TIME 06:12:11            SITE = STR1              PASS=    1     PART=   2

MESSAGE ---- Climatic Index changed from 0.0 to 1.0 for this run.

 CREST PS       5545.50 FT    6055.0 ACFT      0.00 AC     126.3 CFS

 SED ACCUM      5545.50 FT    6055.0 ACFT      0.00 AC     126.3 CFS

 START ELEV     5545.50 FT    6055.0 ACFT      0.00 AC       0.0 CFS

 INFLOW HYDROGRAPH PROVIDED IN LOCATION  1,  PEAK=    850.00 CFS, AT 120.00 HRS.
 TITLE = Principal Spillway


 CREST PS       5545.50 FT    6055.0 ACFT      0.00 AC     126.3 CFS

 SED ACCUM      5545.50 FT    6055.0 ACFT      0.00 AC     126.3 CFS

 START ELEV     5545.50 FT    6055.0 ACFT      0.00 AC       0.0 CFS


 NRCS-PSH  RAINFALL   1-DAY =   0.00 IN    10-DAY =   0.00 IN    DA =   4.74 SM
           RUNOFF     1-DAY =   0.00 IN    10-DAY =   0.00 IN

      CLIMATIC INDEX = 1.00    CN 10-DAY =  0.    CN 1-DAY =   0.

      PEAK =       850.0 CFS, AT  120.0 HRS.


 ROUTED RESULT - HYD TYPE      EMAX         VOL-MAX        AMAX         QMAX
                NRCS-PSH   5547.76 FT    6496.1 ACFT      0.00 AC     40.0 CFS

      PS STORAGE     441.0 ACFT,  BETWEEN AUX. CREST AND SED. ACCUM ELEVATIONS.

 DRAWDOWN (DDT) TEST       5545.84 FT    6121.2 ACFT      4.35 CFS
      CONTROL IS 0.150 DETENTION STORAGE

      TIME LIMIT REACHED = 10.00 DAYS. FLOW WAS     9.73 CFS,  ELEV =  5546.26
      (ELEVATION TO START ROUTING SDH AND/OR FBH HAS BEEN RAISED.)

      TIME TO DDT TEST DISCHARGE IS 15.79 DAYS - DRAWDOWN STOPPED.

 ***** NOTE - CREST OF AUX. RAISED TO HOLD   148.03 ACFT NOT EVACUATED IN
              DRAWDOWN TIME LIMIT.  TOTAL STORAGE REQUIRED =  6644.08 ACFT,
              NEW ELEVATION OF AUXILIARY SPILLWAY CREST    =  5548.51 FT.

 PLOT OF PRINCIPAL SPILLWAY HYDROGRAPH,  1 INCH=     200. CFS
                                                  0.      200.      400.      600.      800.      1000.     1200.     1400.
  Time    Qin  Qout   Elev    Vol   Area  ExtVel  I         I         I         I         I         I         I         I
   0.00   0.0   0.0 5545.5  6055.5   0.0          .
   1.00  11.0   0.0 5545.5  6055.5   0.0          .I
   2.00  14.0   0.1 5545.5  6056.5   0.0          .I
   3.00  15.0   0.2 5545.5  6057.7   0.0          .I
   4.00  15.0   0.3 5545.5  6058.9   0.0          .I
   5.00  15.0   0.3 5545.5  6060.1   0.0          .I
   6.00  15.0   0.4 5545.5  6061.3   0.0          .I
   7.00  15.0   0.5 5545.5  6062.5   0.0          .I
   8.00  15.0   0.6 5545.5  6063.7   0.0          .I
   9.00  15.0   0.7 5545.6  6064.9   0.0          .I
  10.00  15.0   0.7 5545.6  6066.1   0.0          .I
  11.00  16.0   0.8 5545.6  6067.3   0.0          .I
  12.00  16.0   0.9 5545.6  6068.6   0.0          .I
  13.00  16.0   1.0 5545.6  6069.8   0.0          .I
  14.00  16.0   1.1 5545.6  6071.1   0.0          .I
  15.00  16.0   1.1 5545.6  6072.3   0.0          .I
  16.00  16.0   1.2 5545.6  6073.5   0.0          .I
  17.00  16.0   1.3 5545.6  6074.7   0.0          .I
  18.00  16.0   1.4 5545.6  6076.0   0.0          .I
  19.00  16.0   1.5 5545.6  6077.2   0.0          .I
  20.00  16.0   1.5 5545.6  6078.4   0.0          .I
  21.00  17.0   1.6 5545.6  6079.6   0.0          .I
  22.00  17.0   1.7 5545.6  6080.9   0.0          .I
  23.00  17.0   1.8 5545.6  6082.1   0.0          .I
  24.00  17.0   1.9 5545.6  6083.4   0.0          .I
  25.00  17.0   1.9 5545.7  6084.6   0.0          .I
  26.00  17.0   2.0 5545.7  6085.9   0.0          .I
  27.00  17.0   2.1 5545.7  6087.1   0.0          .I
  28.00  17.0   2.2 5545.7  6088.3   0.0          .I
  29.00  17.0   2.3 5545.7  6089.5   0.0          .I
  30.00  17.0   2.3 5545.7  6090.8   0.0          .I
  31.00  18.0   2.4 5545.7  6092.0   0.0          .I
  32.00  18.0   2.5 5545.7  6093.3   0.0          .I
  33.00  18.0   2.6 5545.7  6094.6   0.0          .I
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 34.00  18.0   2.7 5545.7  6095.8   0.0          .I
 35.00  18.0   2.8 5545.7  6097.1   0.0          .I
 36.00  18.0   2.8 5545.7  6098.4   0.0          .I
 37.00  18.0   2.9 5545.7  6099.6   0.0          .I
 38.00  18.0   3.0 5545.7  6100.8   0.0          .I
 39.00  19.0   3.1 5545.7  6102.1   0.0          .I
 40.00  19.0   3.2 5545.7  6103.4   0.0          .I
 41.00  19.0   3.3 5545.8  6104.7   0.0          .I
 42.00  19.0   3.4 5545.8  6106.0   0.0          .I
 43.00  19.0   3.4 5545.8  6107.3   0.0          .I
 44.00  19.0   3.5 5545.8  6108.6   0.0          .I
 45.00  20.0   3.6 5545.8  6109.9   0.0          .I
 46.00  20.0   3.7 5545.8  6111.3   0.0          .I
 47.00  20.0   3.8 5545.8  6112.6   0.0          .I
 48.00  20.0   3.9 5545.8  6114.0   0.0          .I
 49.00  20.0   4.0 5545.8  6115.3   0.0          .I
 50.00  20.0   4.0 5545.8  6116.6   0.0          .I
 51.00  21.0   4.1 5545.8  6118.0   0.0          .I
 52.00  21.0   4.2 5545.8  6119.4   0.0          .I
 53.00  21.0   4.3 5545.8  6120.7   0.0          .I
 54.00  21.0   4.4 5545.8  6122.1   0.0          .I
 55.00  21.0   4.5 5545.9  6123.5   0.0          .I
 56.00  21.0   4.6 5545.9  6124.8   0.0          .I
 57.00  22.0   4.7 5545.9  6126.2   0.0          .I
 58.00  22.0   4.8 5545.9  6127.7   0.0          .I
 59.00  22.0   4.9 5545.9  6129.1   0.0          .I
 60.00  22.0   5.0 5545.9  6130.5   0.0          .I
 61.00  23.0   5.1 5545.9  6131.9   0.0          .I
 62.00  23.0   5.2 5545.9  6133.4   0.0          .I
 63.00  23.0   5.2 5545.9  6134.9   0.0          .I
 64.00  23.0   5.3 5545.9  6136.4   0.0          .I
 65.00  24.0   5.4 5545.9  6137.8   0.0          .I
 66.00  24.0   5.5 5545.9  6139.4   0.0          .I
 67.00  24.0   5.6 5545.9  6140.9   0.0          .I
 68.00  24.0   5.7 5545.9  6142.4   0.0          .I
 69.00  25.0   5.8 5546.0  6144.0   0.0          .I
 70.00  25.0   5.9 5546.0  6145.5   0.0          .I
 71.00  25.0   6.1 5546.0  6147.1   0.0          .I
 72.00  26.0   6.2 5546.0  6148.7   0.0          .I
 73.00  26.0   6.3 5546.0  6150.3   0.0          .I
 74.00  26.0   6.4 5546.0  6152.0   0.0          .I
 75.00  27.0   6.5 5546.0  6153.6   0.0          .I
 76.00  27.0   6.6 5546.0  6155.3   0.0          .I
 77.00  27.0   6.7 5546.0  6157.0   0.0          .I
 78.00  28.0   6.8 5546.0  6158.7   0.0          .I
 79.00  28.0   6.9 5546.0  6160.5   0.0          .I
 80.00  29.0   7.0 5546.0  6162.2   0.0          .I
 81.00  29.0   7.2 5546.1  6164.1   0.0          .I
 82.00  29.0   7.3 5546.1  6165.9   0.0          .I
 83.00  30.0   7.4 5546.1  6167.7   0.0          . I
 84.00  30.0   7.5 5546.1  6169.5   0.0          . I
 85.00  31.0   7.7 5546.1  6171.4   0.0          . I
 86.00  31.0   7.8 5546.1  6173.4   0.0          . I
 87.00  32.0   7.9 5546.1  6175.3   0.0          . I
 88.00  33.0   8.0 5546.1  6177.3   0.0          . I
 89.00  33.0   8.2 5546.1  6179.4   0.0          . I
 90.00  34.0   8.3 5546.1  6181.5   0.0          . I
 91.00  35.0   8.5 5546.2  6183.6   0.0          . I
 92.00  35.0   8.6 5546.2  6185.8   0.0          . I
 93.00  36.0   8.7 5546.2  6188.1   0.0          . I
 94.00  37.0   8.9 5546.2  6190.3   0.0          . I
 95.00  38.0   9.0 5546.2  6192.7   0.0          . I
 96.00  39.0   9.2 5546.2  6195.1   0.0          . I
 97.00  40.0   9.4 5546.2  6197.6   0.0          . I
 98.00  41.0   9.5 5546.2  6200.2   0.0          . I
 99.00  42.0   9.7 5546.3  6202.8   0.0          . I
100.00  43.0   9.9 5546.3  6205.5   0.0          . I
101.00  45.0  10.1 5546.3  6208.3   0.0          .PI
102.00  46.0  10.3 5546.3  6211.3   0.0          .PI
103.00  48.0  10.5 5546.3  6214.3   0.0          .PI
104.00  49.0  10.7 5546.3  6217.4   0.0          .PI
105.00  51.0  10.9 5546.3  6220.7   0.0          .P I
106.00  53.0  11.1 5546.4  6224.0   0.0          .P I
107.00  56.0  11.3 5546.4  6227.6   0.0          .P I
108.00  58.0  11.6 5546.4  6231.4   0.0          .P I
109.00  61.0  11.9 5546.4  6235.3   0.0          .P I
110.00  65.0  12.1 5546.4  6239.5   0.0          .P I
111.00  69.0  12.4 5546.5  6244.1   0.0          .P I
112.00  74.0  12.7 5546.5  6248.9   0.0          .P  I
113.00  80.0  13.1 5546.5  6254.2   0.0          .P  I
114.00  87.0  13.5 5546.5  6260.0   0.0          .P  I
115.00  96.0  13.9 5546.6  6266.5   0.0          .P   I
116.00 109.0  14.4 5546.6  6273.8   0.0          .P   I
117.00 127.0  14.9 5546.7  6282.3   0.0          .P    I
118.00 157.0  15.6 5546.7  6292.8   0.0          .P      I
119.00 219.0  17.3 5546.8  6307.0   0.0          .P         I
120.00 850.0  22.4 5547.0  6349.5   0.0          .P                                         X
121.00 479.0  28.7 5547.3  6402.3   0.0          .P                      I
122.00 259.0  32.1 5547.4  6430.3   0.0          . P          I
123.00 172.0  33.9 5547.5  6445.4   0.0          . P      I
124.00 132.0  35.1 5547.5  6455.1   0.0          . P    I
125.00 111.0  35.9 5547.6  6462.2   0.0          . P   I
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126.00  98.0   36.6 5547.6  6467.8   0.0          . P  I
127.00  88.0   37.2 5547.6  6472.5   0.0          . P I
128.00  81.0   37.6 5547.7  6476.4   0.0          . P I
129.00  75.0   38.0 5547.7  6479.7   0.0          . P I
130.00  70.0   38.4 5547.7  6482.5   0.0          . P I
131.00  65.0   38.7 5547.7  6484.9   0.0          . PI
132.00  62.0   38.9 5547.7  6487.0   0.0          . PI
133.00  59.0   39.1 5547.7  6488.7   0.0          . PI
134.00  56.0   39.3 5547.7  6490.2   0.0          . PI
135.00  54.0   39.4 5547.7  6491.5   0.0          . PI
136.00  51.0   39.6 5547.7  6492.6   0.0          . PI
137.00  50.0   39.7 5547.7  6493.5   0.0          . PI
138.00  48.0   39.8 5547.7  6494.3   0.0          . P
139.00  46.0   39.8 5547.7  6494.9   0.0          . P
140.00  45.0   39.9 5547.8  6495.3   0.0          . P
141.00  43.0   39.9 5547.8  6495.7   0.0          . P
142.00  42.0   40.0 5547.8  6495.9   0.0          . P
143.00  41.0   40.0 5547.8  6496.0   0.0          . P
144.00  40.0   40.0 5547.8  6496.1   0.0          . X
145.00  39.0   40.0 5547.8  6496.0   0.0          . P
146.00  38.0   40.0 5547.8  6495.9   0.0          . P
147.00  37.0   39.9 5547.8  6495.7   0.0          . P
148.00  36.0   39.9 5547.8  6495.4   0.0          . P
149.00  35.0   39.9 5547.8  6495.0   0.0          . P
150.00  35.0   39.8 5547.7  6494.6   0.0          . P
151.00  34.0   39.8 5547.7  6494.2   0.0          . P
152.00  33.0   39.7 5547.7  6493.7   0.0          . P
153.00  33.0   39.6 5547.7  6493.1   0.0          . P
154.00  32.0   39.6 5547.7  6492.6   0.0          . P
155.00  32.0   39.5 5547.7  6491.9   0.0          . P
156.00  31.0   39.4 5547.7  6491.3   0.0          . P
157.00  30.0   39.3 5547.7  6490.5   0.0          . P
158.00  30.0   39.2 5547.7  6489.8   0.0          . P
159.00  29.0   39.1 5547.7  6489.0   0.0          .IP
160.00  29.0   39.0 5547.7  6488.1   0.0          .IP
161.00  29.0   38.9 5547.7  6487.3   0.0          .IP
162.00  28.0   38.8 5547.7  6486.5   0.0          .IP
163.00  28.0   38.7 5547.7  6485.6   0.0          .IP
164.00  27.0   38.6 5547.7  6484.6   0.0          .IP
165.00  27.0   38.5 5547.7  6483.7   0.0          .IP
166.00  27.0   38.4 5547.7  6482.7   0.0          .IP
167.00  26.0   38.3 5547.7  6481.8   0.0          .IP
168.00  26.0   38.1 5547.7  6480.8   0.0          .IP
169.00  26.0   38.0 5547.7  6479.8   0.0          .IP
170.00  25.0   37.9 5547.7  6478.7   0.0          .IP
171.00  25.0   37.8 5547.7  6477.7   0.0          .IP
172.00  25.0   37.7 5547.7  6476.6   0.0          .IP
173.00  24.0   37.5 5547.7  6475.5   0.0          .IP
174.00  24.0   37.4 5547.6  6474.4   0.0          .IP
175.00  24.0   37.3 5547.6  6473.3   0.0          .IP
176.00  24.0   37.1 5547.6  6472.2   0.0          .IP
177.00  23.0   37.0 5547.6  6471.1   0.0          .IP
178.00  23.0   36.9 5547.6  6470.0   0.0          .IP
179.00  23.0   36.7 5547.6  6468.8   0.0          .IP
180.00  23.0   36.6 5547.6  6467.7   0.0          .IP
181.00  22.0   36.4 5547.6  6466.5   0.0          .IP
182.00  22.0   36.3 5547.6  6465.3   0.0          .IP
183.00  22.0   36.2 5547.6  6464.2   0.0          .IP
184.00  22.0   36.0 5547.6  6463.0   0.0          .IP
185.00  22.0   35.9 5547.6  6461.8   0.0          .IP
186.00  21.0   35.7 5547.6  6460.7   0.0          .IP
187.00  21.0   35.6 5547.6  6459.5   0.0          .IP
188.00  21.0   35.4 5547.6  6458.3   0.0          .IP
189.00  21.0   35.3 5547.6  6457.1   0.0          .IP
190.00  21.0   35.2 5547.6  6455.9   0.0          .IP
191.00  20.0   35.0 5547.5  6454.7   0.0          .IP
192.00  20.0   34.9 5547.5  6453.4   0.0          .IP
193.00  20.0   34.7 5547.5  6452.2   0.0          .IP
194.00  20.0   34.6 5547.5  6451.0   0.0          .IP
195.00  20.0   34.4 5547.5  6449.8   0.0          .IP
196.00  20.0   34.3 5547.5  6448.6   0.0          .IP
197.00  19.0   34.1 5547.5  6447.4   0.0          .IP
198.00  19.0   34.0 5547.5  6446.2   0.0          .IP
199.00  19.0   33.8 5547.5  6444.9   0.0          .IP
200.00  19.0   33.7 5547.5  6443.7   0.0          .IP
201.00  19.0   33.6 5547.5  6442.5   0.0          .IP
202.00  19.0   33.4 5547.5  6441.3   0.0          .IP
203.00  19.0   33.3 5547.5  6440.1   0.0          .IP
204.00  18.0   33.1 5547.5  6438.9   0.0          .IP
205.00  18.0   33.0 5547.5  6437.7   0.0          .IP
206.00  18.0   32.8 5547.5  6436.4   0.0          .IP
207.00  18.0   32.7 5547.4  6435.2   0.0          .IP
208.00  18.0   32.5 5547.4  6434.0   0.0          .IP
209.00  18.0   32.4 5547.4  6432.8   0.0          .IP
210.00  18.0   32.2 5547.4  6431.6   0.0          .IP
211.00  17.0   32.1 5547.4  6430.4   0.0          .IP
212.00  17.0   32.0 5547.4  6429.2   0.0          .IP
213.00  17.0   31.8 5547.4  6427.9   0.0          .IP
214.00  17.0   31.7 5547.4  6426.7   0.0          .IP
215.00  17.0   31.5 5547.4  6425.5   0.0          .IP
216.00  17.0   31.4 5547.4  6424.3   0.0          .IP
217.00  17.0   31.2 5547.4  6423.1   0.0          .IP
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 218.00  17.0  31.1 5547.4  6422.0   0.0          .IP
 219.00  17.0  30.9 5547.4  6420.8   0.0          .IP
 220.00  17.0  30.8 5547.4  6419.7   0.0          .IP
 221.00  16.0  30.7 5547.4  6418.5   0.0          .IP
 222.00  16.0  30.5 5547.4  6417.3   0.0          .IP
 223.00  16.0  30.4 5547.3  6416.1   0.0          .IP
 224.00  16.0  30.2 5547.3  6414.9   0.0          .IP
 225.00  16.0  30.1 5547.3  6413.7   0.0          .IP
 226.00  16.0  30.0 5547.3  6412.6   0.0          .P
 227.00  16.0  29.8 5547.3  6411.4   0.0          .P
 228.00  16.0  29.7 5547.3  6410.3   0.0          .P
 229.00  16.0  29.5 5547.3  6409.2   0.0          .P
 230.00  16.0  29.4 5547.3  6408.1   0.0          .P
 231.00  15.0  29.3 5547.3  6406.9   0.0          .P
 232.00  15.0  29.1 5547.3  6405.7   0.0          .P
 233.00  15.0  29.0 5547.3  6404.6   0.0          .P
 234.00  15.0  28.9 5547.3  6403.4   0.0          .P
 235.00  15.0  28.7 5547.3  6402.3   0.0          .P
 236.00  15.0  28.6 5547.3  6401.2   0.0          .P
 237.00  15.0  28.5 5547.3  6400.0   0.0          .P
 238.00  15.0  28.3 5547.3  6398.9   0.0          .P
 239.00  15.0  28.2 5547.3  6397.8   0.0          .P
  Time    Qin  Qout   Elev    Vol   Area  ExtVel  I         I         I         I         I         I         I         I
                                                  0.      200.      400.      600.      800.     1000.     1200.     1400.
         END NRCS-PSH   PLOT

 ********************************************************************************
 RATING TABLE DEVELOPED, SITE = STR1 :
  BY PROGRAM FOR PS AND AUX. SPILLWAYS
  AUX. RATING USED WSPVRT METHOD.


 RATING TABLE NUMBER  1
        ELEV.    Q-TOTAL    Q-PS     Q-AUX.    VOLUME     AREA
        FEET       CFS       CFS       CFS      AC-FT     ACRE
   1  5545.50      0.00      0.00      0.00   6055.03      0.00
   2  5546.72     15.71     15.71      0.00   6294.00      0.00
   3  5547.94     44.43     44.43      0.00   6532.97      0.00
   4  5549.17     81.62     81.62      0.00   6771.95      0.00
                                            FULL CONDUIT FLOW, ELEV = 5550.39 FT
   5  5550.39    125.65    125.65      0.00   7015.04      0.00
   6  5550.65    125.84    125.84      0.00   7069.39      0.00
   7  5550.92    126.01    126.01      0.00   7123.74      0.00
   8  5551.18    126.17    126.17      0.00   7178.09      0.00
   9  5551.44    126.34    126.34      0.00   7232.44      0.00
  10  5551.71    126.50    126.50      0.00   7286.79      0.00
  11  5551.97    126.67    126.67      0.00   7341.14      0.00
  12  5552.23    126.83    126.83      0.00   7395.49      0.00
  13  5552.50    126.99    126.99      0.00   7449.85      0.00

 INFLOW HYDROGRAPH PROVIDED IN LOCATION  3,  PEAK=   2180.00 CFS, AT   3.30 HRS.
 TITLE = Auxiliary Spillway (Local)


 INFLOW HYDROGRAPH PROVIDED IN LOCATION  5,  PEAK=   3365.00 CFS, AT   9.60 HRS.
 TITLE = Freeboard (General)



1SITES ------------------------------------------------------------------------
 XEQ 08/20/2020                    COV RES                        WSID= COVRES
 VER 2005.1.8                        Cove Res                       SUBW= CR
 TIME 06:12:11            SITE = STR1              PASS=    1     PART=   3


 AUX. CREST     5548.51 FT    6644.1 ACFT      0.00 AC      61.7 CFS

      PS STORAGE    589.1 ACFT,  BETWEEN AUX. CREST AND SED. ACCUM ELEVATIONS.

 START ELEV     5546.26 FT    6203.0 ACFT      0.00 AC       9.7 CFS

 ***** WARNING - AUXILIARY CREST LOWER THAN LOW POINT IN SITE.

 NRCS-SDH   INFLOW HYDROGRAPH INPUT, DA =    4.74 SQUARE MILES

      PEAK =      2180.0 CFS, AT    3.3 HRS.

 NRCS-FBH   INFLOW HYDROGRAPH INPUT, DA =    4.74 SQUARE MILES

      PEAK =      3365.0 CFS, AT    9.6 HRS.

 ***** WARNING - MAXIMUM AUX. SURFACE PROFILE ELEVATION ( 5549.20) AND AUXILIARY
                 CREST ( 5548.51) ELEVATION Do NOT MATCH.  MAXIMUM AUX. SURFACE
                 PROFILE ELEVATION USED IN WSPVRT PROCEDURE.


 ***** MESSAGE - INPUT(5549.14) TO INTERPOLATION ROUTINE IS BELOW
                 ARRAY LIMIT(5549.20).


 ********************************************************************************
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RATING TABLE DEVELOPED, SITE = STR1 :
 BY PROGRAM FOR PS AND AUX. SPILLWAYS
 AUX. RATING USED WSPVRT METHOD.


RATING TABLE NUMBER  2
       ELEV.    Q-TOTAL    Q-PS     Q-AUX.    VOLUME     AREA
       FEET       CFS       CFS       CFS      AC-FT      ACRE
  1  5545.50      0.00      0.00      0.00   6055.03      0.00
  2  5545.83      2.25      2.25      0.00   6120.52      0.00
  3  5546.17      6.37      6.37      0.00   6186.02      0.00
  4  5546.50     11.71     11.71      0.00   6251.52      0.00
  5  5546.84     18.03     18.03      0.00   6317.01      0.00
  6  5547.17     25.20     25.20      0.00   6382.51      0.00
  7  5547.51     33.12     33.12      0.00   6448.00      0.00
  8  5547.84     41.74     41.74      0.00   6513.50      0.00
  9  5548.18     50.99     50.99      0.00   6578.99      0.00
 10  5548.51     60.85     60.85      0.00   6644.49      0.00
 11  5549.14     80.67     80.67      0.00   6766.41      0.00
 12  5549.76    126.50    102.35     24.15   6888.71      0.00
                                           FULL CONDUIT FLOW, ELEV = 5550.39 FT
 13  5550.39    223.05    125.67     97.38   7015.14      0.00
 14  5550.49    237.89    125.75    112.14   7036.88      0.00
 15  5550.60    255.98    125.81    130.16   7058.62      0.00
 16  5550.79    290.40    125.93    164.47   7097.77      0.00
 17  5551.02    332.53    126.08    206.45   7145.68      0.00
 18  5551.44    422.70    126.34    296.36   7232.64      0.00
 19  5551.97    551.57    126.67    424.90   7341.44      0.00
 20  5552.50    697.75    126.99    570.75   7450.25      0.00
 ***************************************************************************

SUMMARY OF AUXILIARY SPILLWAY SURFACE CONDITIONS USED IN COMPUTATIONS BY REACH

REACH  FROM     TO   SLOPE  RETARDANCE  VEGETAL  MAINT. ROOTING  REACH
       STA     STA            CURVE      COVER    CODE   DEPTH  LOCATION
       (ft)    (ft)   (%)     INDEX      FACTOR     +    (ft)     *
-----  ----    ----  ------ ----------  -------  -----  ------- --------
  1      0.     75.  -25.6     1.000       **       **     **    INLET
  2     75.    155.    0.0     1.000       **       **     **    CREST
  3    155.    237.   38.5     1.000     0.00       1            EXIT !
  4    237.    600.    9.9     1.000     0.00       1            EXIT
  5    600.   1049.    6.3     1.000     0.00       1            EXIT
  6   1049.   1170.   15.1     1.000     0.00       1            EXIT

 + The minimum maintenance code value of 2 is used in INTEGRITY computations
     (the program changes values of 1 to 2 during computation).
 * Upper case indicates a reach of constructed spillway channel.
** The program does not use vegetal cover factor, maintenance code, and
     rooting depth for inlet and crest reaches in computations.
 ! Reach   3 used in computing exit channel velocities.
 ***************************************************************************

ROUTED       BTM WIDTH  MAX ELEV   VOL-MAX  AREA-MAX   AUX.-HP   VOL-AUX.
RESULTS          FT        FT        ACFT      AC         FT       ACFT
NRCS-SDH          30.0   5548.67    6675.5       0.0      0.16      31.0

          PEAK - CFS        Q-PS     Q-AUX.     Q-TOT.
          DISCHARGE  =      65.7       0.2      65.9

                        CRITICAL  CRITICAL   CRITICAL  25% OF Q
                          DEPTH   VELOCITY   SLOPE-Sc     Sc
          AUXILIARY         FT      FT/SEC     FT/FT     FT/FT
          SPILLWAY ---     0.01      0.57     0.148     0.308

          AUXILIARY SPILLWAY DURATION FLOW =        8.7 HOURS

          PLOT NRCS-SDH                  1 IN =    500. CFS                                          EXIT SLOPE = 0.385
                                                 0.      500.     1000.     1500.     2000.     2500.     3000.     3500.
 Time    Qin  Qout   Elev    Vol   Area  ExtVel  I         I         I         I         I         I         I         I
  1.50     0     8 5546.3  6203.0   0.0   0.00   .
  1.80     6     8 5546.3  6203.0   0.0   0.00   .
  2.10    39     8 5546.3  6203.4   0.0   0.00   .I
  2.40   194     8 5546.3  6206.1   0.0   0.00   .   I
  2.70   687     9 5546.3  6216.8   0.0   0.00   .             I
  3.00  1365    11 5546.5  6242.0   0.0   0.00   .                          I
  3.30  2027    15 5546.7  6283.7   0.0   0.00   .                                        I
  3.60  2180    20 5546.9  6335.4   0.0   0.00   .                                           X
  3.90  1955    26 5547.2  6386.1   0.0   0.00   .P                                     I
  4.20  1683    31 5547.4  6430.5   0.0   0.00   .P                                I
  4.50  1441    36 5547.6  6468.4   0.0   0.00   .P                           I
  4.80  1248    40 5547.8  6500.8   0.0   0.00   .P                       I
  5.10  1107    44 5547.9  6528.9   0.0   0.00   .P                    I
  5.40  1001    47 5548.1  6553.9   0.0   0.00   .P                  I
  5.70   924    51 5548.2  6576.6   0.0   0.00   .P                I
  6.00   874    54 5548.3  6597.6   0.0   0.00   .P               I
  6.30   833    57 5548.4  6617.4   0.0   0.00   .P               I
  6.60   748    60 5548.5  6635.5   0.0   0.00   .P             I
  6.90   589    62 5548.5  6650.6   0.0   0.00   .A          I
  7.20   423    64 5548.6  6661.6   0.0   0.00   .A      I
  7.50   283    65 5548.6  6668.8   0.0   0.00   .A    I
  7.80   180    65 5548.7  6672.9   0.0   0.00   .A  I
  8.10   112    66 5548.7  6674.9   0.0   0.00   .AI
```

```
  8.40    73    66 5548.7  6675.5   0.0   0.00   .X
  8.70    47    66 5548.7  6675.4   0.0   0.00   .A
  9.00    28    66 5548.7  6674.7   0.0   0.00   .A
  9.30    16    66 5548.7  6673.6   0.0   0.00   .A
  9.60     9    65 5548.7  6672.3   0.0   0.00   .A
  9.90     5    65 5548.6  6670.8   0.0   0.00   .A
 10.20     3    65 5548.6  6669.3   0.0   0.00   .A
 10.50     1    65 5548.6  6667.8   0.0   0.00   .A
 10.80     1    64 5548.6  6666.2   0.0   0.00   .A
 11.10     0    64 5548.6  6664.6   0.0   0.00   .A
 11.40     0    64 5548.6  6663.1   0.0   0.00   .A
 11.70     0    64 5548.6  6661.5   0.0   0.00   .A
 12.00     0    63 5548.6  6660.0   0.0   0.00   .A
 12.30     0    63 5548.6  6658.4   0.0   0.00   .A
 12.60     0    63 5548.6  6656.9   0.0   0.00   .A
 12.90     0    63 5548.6  6655.4   0.0   0.00   .A
 13.20     0    62 5548.6  6653.8   0.0   0.00   .A
 13.50     0    62 5548.6  6652.3   0.0   0.00   .A
 13.80     0    62 5548.5  6650.8   0.0   0.00   .A
 14.10     0    62 5548.5  6649.3   0.0   0.00   .A
 14.40     0    61 5548.5  6647.8   0.0   0.00   .A
 14.70     0    61 5548.5  6646.3   0.0   0.00   .A
 15.00     0    61 5548.5  6644.8   0.0   0.00   .A
 15.30     0    61 5548.5  6643.3   0.0   0.00   .P
 15.60     0    60 5548.5  6641.9   0.0   0.00   .P
 15.90     0    60 5548.5  6640.4   0.0   0.00   .P
 16.20     0    60 5548.5  6638.9   0.0   0.00   .P
 16.50     0    60 5548.5  6637.5   0.0   0.00   .P
 16.80     0    60 5548.5  6636.0   0.0   0.00   .P
 17.10     0    59 5548.5  6634.5   0.0   0.00   .P
 17.40     0    59 5548.5  6633.1   0.0   0.00   .P
 17.70     0    59 5548.4  6631.7   0.0   0.00   .P
 18.00     0    59 5548.4  6630.2   0.0   0.00   .P
 18.30     0    58 5548.4  6628.8   0.0   0.00   .P
 18.60     0    58 5548.4  6627.4   0.0   0.00   .P
 18.90     0    58 5548.4  6626.0   0.0   0.00   .P
 19.20     0    58 5548.4  6624.6   0.0   0.00   .P
 19.50     0    58 5548.4  6623.1   0.0   0.00   .P
 19.80     0    57 5548.4  6621.7   0.0   0.00   .P
 20.10     0    57 5548.4  6620.3   0.0   0.00   .P
 20.40     0    57 5548.4  6619.0   0.0   0.00   .P
 20.70     0    57 5548.4  6617.6   0.0   0.00   .P
 21.00     0    57 5548.4  6616.2   0.0   0.00   .P
 21.30     0    56 5548.4  6614.8   0.0   0.00   .P
 21.60     0    56 5548.4  6613.4   0.0   0.00   .P
 21.90     0    56 5548.3  6612.1   0.0   0.00   .P
 22.20     0    56 5548.3  6610.7   0.0   0.00   .P
 22.50     0    56 5548.3  6609.4   0.0   0.00   .P
 22.80     0    55 5548.3  6608.0   0.0   0.00   .P
 23.10     0    55 5548.3  6606.7   0.0   0.00   .P
 23.40     0    55 5548.3  6605.3   0.0   0.00   .P
 23.70     0    55 5548.3  6604.0   0.0   0.00   .P
 24.00     0    55 5548.3  6602.7   0.0   0.00   .P
 24.30     0    54 5548.3  6601.3   0.0   0.00   .P
 24.60     0    54 5548.3  6600.0   0.0   0.00   .P
 24.90     0    54 5548.3  6598.7   0.0   0.00   .P
 25.20     0    54 5548.3  6597.4   0.0   0.00   .P
 25.50     0    54 5548.3  6596.1   0.0   0.00   .P
 25.80     0    53 5548.3  6594.8   0.0   0.00   .P
 26.10     0    53 5548.3  6593.5   0.0   0.00   .P
 26.40     0    53 5548.2  6592.2   0.0   0.00   .P
 26.70     0    53 5548.2  6590.9   0.0   0.00   .P
 27.00     0    53 5548.2  6589.6   0.0   0.00   .P
 27.30     0    52 5548.2  6588.4   0.0   0.00   .P
 27.60     0    52 5548.2  6587.1   0.0   0.00   .P
 27.90     0    52 5548.2  6585.8   0.0   0.00   .P
 28.20     0    52 5548.2  6584.5   0.0   0.00   .P
 28.50     0    52 5548.2  6583.3   0.0   0.00   .P
 28.80     0    51 5548.2  6582.0   0.0   0.00   .P
 29.10     0    51 5548.2  6580.8   0.0   0.00   .P
 29.40     0    51 5548.2  6579.5   0.0   0.00   .P
 29.70     0    51 5548.2  6578.3   0.0   0.00   .P
 30.00     0    51 5548.2  6577.1   0.0   0.00   .P
 30.30     0    51 5548.2  6575.8   0.0   0.00   .P
 30.60     0    50 5548.2  6574.6   0.0   0.00   .P
 30.90     0    50 5548.2  6573.4   0.0   0.00   .P
 31.20     0    50 5548.1  6572.2   0.0   0.00   .P
 31.50     0    50 5548.1  6571.0   0.0   0.00   .P
 31.80     0    50 5548.1  6569.8   0.0   0.00   .P
 32.10     0    50 5548.1  6568.5   0.0   0.00   .P
 32.40     0    49 5548.1  6567.3   0.0   0.00   .P
 32.70     0    49 5548.1  6566.1   0.0   0.00   .P
 33.00     0    49 5548.1  6565.0   0.0   0.00   .P
 33.30     0    49 5548.1  6563.8   0.0   0.00   .P
 33.60     0    49 5548.1  6562.6   0.0   0.00   .P
 33.90     0    49 5548.1  6561.4   0.0   0.00   .P
 34.20     0    48 5548.1  6560.2   0.0   0.00   .P
 34.50     0    48 5548.1  6559.1   0.0   0.00   .P
 34.80     0    48 5548.1  6557.9   0.0   0.00   .P
 35.10     0    48 5548.1  6556.7   0.0   0.00   .P
 35.40     0    48 5548.1  6555.6   0.0   0.00   .P
 35.70     0    48 5548.1  6554.4   0.0   0.00   .P
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36.00     0    47 5548.0  6553.3   0.0   0.00   .P
36.30     0    47 5548.0  6552.1   0.0   0.00   .P
36.60     0    47 5548.0  6551.0   0.0   0.00   .P
36.90     0    47 5548.0  6549.8   0.0   0.00   .P
37.20     0    47 5548.0  6548.7   0.0   0.00   .P
37.50     0    47 5548.0  6547.6   0.0   0.00   .P
37.80     0    46 5548.0  6546.4   0.0   0.00   .P
38.10     0    46 5548.0  6545.3   0.0   0.00   .P
38.40     0    46 5548.0  6544.2   0.0   0.00   .P
38.70     0    46 5548.0  6543.1   0.0   0.00   .P
39.00     0    46 5548.0  6542.0   0.0   0.00   .P
39.30     0    46 5548.0  6540.9   0.0   0.00   .P
39.60     0    45 5548.0  6539.8   0.0   0.00   .P
39.90     0    45 5548.0  6538.7   0.0   0.00   .P
40.20     0    45 5548.0  6537.6   0.0   0.00   .P
40.50     0    45 5548.0  6536.5   0.0   0.00   .P
40.80     0    45 5548.0  6535.4   0.0   0.00   .P
41.10     0    45 5548.0  6534.3   0.0   0.00   .P
41.40     0    45 5547.9  6533.2   0.0   0.00   .P
41.70     0    44 5547.9  6532.1   0.0   0.00   .P
42.00     0    44 5547.9  6531.1   0.0   0.00   .P
42.30     0    44 5547.9  6530.0   0.0   0.00   .P
42.60     0    44 5547.9  6528.9   0.0   0.00   .P
42.90     0    44 5547.9  6527.9   0.0   0.00   .P
43.20     0    44 5547.9  6526.8   0.0   0.00   .P
43.50     0    43 5547.9  6525.7   0.0   0.00   .P
43.80     0    43 5547.9  6524.7   0.0   0.00   .P
44.10     0    43 5547.9  6523.6   0.0   0.00   .P
44.40     0    43 5547.9  6522.6   0.0   0.00   .P
44.70     0    43 5547.9  6521.6   0.0   0.00   .P
45.00     0    43 5547.9  6520.5   0.0   0.00   .P
45.30     0    43 5547.9  6519.5   0.0   0.00   .P
45.60     0    42 5547.9  6518.5   0.0   0.00   .P
45.90     0    42 5547.9  6517.4   0.0   0.00   .P
46.20     0    42 5547.9  6516.4   0.0   0.00   .P
46.50     0    42 5547.9  6515.4   0.0   0.00   .P
46.80     0    42 5547.8  6514.4   0.0   0.00   .P
47.10     0    42 5547.8  6513.4   0.0   0.00   .P
47.40     0    42 5547.8  6512.4   0.0   0.00   .P
47.70     0    41 5547.8  6511.4   0.0   0.00   .P
48.00     0    41 5547.8  6510.4   0.0   0.00   .P
48.30     0    41 5547.8  6509.4   0.0   0.00   .P
48.60     0    41 5547.8  6508.4   0.0   0.00   .P
48.90     0    41 5547.8  6507.4   0.0   0.00   .P
49.20     0    41 5547.8  6506.4   0.0   0.00   .P
49.50     0    41 5547.8  6505.4   0.0   0.00   .P
49.80     0    41 5547.8  6504.4   0.0   0.00   .P
50.10     0    40 5547.8  6503.4   0.0   0.00   .P
50.40     0    40 5547.8  6502.5   0.0   0.00   .P
50.70     0    40 5547.8  6501.5   0.0   0.00   .P
51.00     0    40 5547.8  6500.5   0.0   0.00   .P
51.30     0    40 5547.8  6499.6   0.0   0.00   .P
51.60     0    40 5547.8  6498.6   0.0   0.00   .P
51.90     0    40 5547.8  6497.6   0.0   0.00   .P
52.20     0    40 5547.8  6496.7   0.0   0.00   .P
52.50     0    39 5547.8  6495.7   0.0   0.00   .P
52.80     0    39 5547.7  6494.8   0.0   0.00   .P
53.10     0    39 5547.7  6493.8   0.0   0.00   .P
53.40     0    39 5547.7  6492.9   0.0   0.00   .P
53.70     0    39 5547.7  6491.9   0.0   0.00   .P
54.00     0    39 5547.7  6491.0   0.0   0.00   .P
54.30     0    39 5547.7  6490.1   0.0   0.00   .P
54.60     0    39 5547.7  6489.1   0.0   0.00   .P
54.90     0    38 5547.7  6488.2   0.0   0.00   .P
55.20     0    38 5547.7  6487.3   0.0   0.00   .P
55.50     0    38 5547.7  6486.4   0.0   0.00   .P
55.80     0    38 5547.7  6485.4   0.0   0.00   .P
56.10     0    38 5547.7  6484.5   0.0   0.00   .P
56.40     0    38 5547.7  6483.6   0.0   0.00   .P
56.70     0    38 5547.7  6482.7   0.0   0.00   .P
57.00     0    38 5547.7  6481.8   0.0   0.00   .P
57.30     0    37 5547.7  6480.9   0.0   0.00   .P
57.60     0    37 5547.7  6480.0   0.0   0.00   .P
57.90     0    37 5547.7  6479.1   0.0   0.00   .P
58.20     0    37 5547.7  6478.2   0.0   0.00   .P
58.50     0    37 5547.7  6477.3   0.0   0.00   .P
58.80     0    37 5547.7  6476.4   0.0   0.00   .P
59.10     0    37 5547.7  6475.5   0.0   0.00   .P
59.40     0    37 5547.6  6474.6   0.0   0.00   .P
59.70     0    37 5547.6  6473.7   0.0   0.00   .P
60.00     0    36 5547.6  6472.9   0.0   0.00   .P
60.30     0    36 5547.6  6472.0   0.0   0.00   .P
60.60     0    36 5547.6  6471.1   0.0   0.00   .P
60.90     0    36 5547.6  6470.2   0.0   0.00   .P
61.20     0    36 5547.6  6469.4   0.0   0.00   .P
61.50     0    36 5547.6  6468.5   0.0   0.00   .P
61.80     0    36 5547.6  6467.7   0.0   0.00   .P
62.10     0    36 5547.6  6466.8   0.0   0.00   .P
62.40     0    35 5547.6  6465.9   0.0   0.00   .P
62.70     0    35 5547.6  6465.1   0.0   0.00   .P
63.00     0    35 5547.6  6464.2   0.0   0.00   .P
63.30     0    35 5547.6  6463.4   0.0   0.00   .P
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63.60     0    35 5547.6  6462.5   0.0   0.00   .P
63.90     0    35 5547.6  6461.7   0.0   0.00   .P
64.20     0    35 5547.6  6460.9   0.0   0.00   .P
64.50     0    35 5547.6  6460.0   0.0   0.00   .P
64.80     0    35 5547.6  6459.2   0.0   0.00   .P
65.10     0    34 5547.6  6458.4   0.0   0.00   .P
65.40     0    34 5547.6  6457.5   0.0   0.00   .P
65.70     0    34 5547.6  6456.7   0.0   0.00   .P
66.00     0    34 5547.5  6455.9   0.0   0.00   .P
66.30     0    34 5547.5  6455.1   0.0   0.00   .P
66.60     0    34 5547.5  6454.2   0.0   0.00   .P
66.90     0    34 5547.5  6453.4   0.0   0.00   .P
67.20     0    34 5547.5  6452.6   0.0   0.00   .P
67.50     0    34 5547.5  6451.8   0.0   0.00   .P
67.80     0    34 5547.5  6451.0   0.0   0.00   .P
68.10     0    33 5547.5  6450.2   0.0   0.00   .P
68.40     0    33 5547.5  6449.4   0.0   0.00   .P
68.70     0    33 5547.5  6448.6   0.0   0.00   .P
69.00     0    33 5547.5  6447.8   0.0   0.00   .P
69.30     0    33 5547.5  6447.0   0.0   0.00   .P
69.60     0    33 5547.5  6446.2   0.0   0.00   .P
69.90     0    33 5547.5  6445.4   0.0   0.00   .P
70.20     0    33 5547.5  6444.6   0.0   0.00   .P
70.50     0    33 5547.5  6443.8   0.0   0.00   .P
70.80     0    33 5547.5  6443.1   0.0   0.00   .P
71.10     0    32 5547.5  6442.3   0.0   0.00   .P
71.40     0    32 5547.5  6441.5   0.0   0.00   .P
71.70     0    32 5547.5  6440.7   0.0   0.00   .P
72.00     0    32 5547.5  6439.9   0.0   0.00   .P
72.30     0    32 5547.5  6439.2   0.0   0.00   .P
72.60     0    32 5547.5  6438.4   0.0   0.00   .P
72.90     0    32 5547.5  6437.6   0.0   0.00   .P
73.20     0    32 5547.5  6436.9   0.0   0.00   .P
73.50     0    32 5547.4  6436.1   0.0   0.00   .P
73.80     0    32 5547.4  6435.4   0.0   0.00   .P
74.10     0    31 5547.4  6434.6   0.0   0.00   .P
74.40     0    31 5547.4  6433.8   0.0   0.00   .P
74.70     0    31 5547.4  6433.1   0.0   0.00   .P
75.00     0    31 5547.4  6432.3   0.0   0.00   .P
75.30     0    31 5547.4  6431.6   0.0   0.00   .P
75.60     0    31 5547.4  6430.8   0.0   0.00   .P
75.90     0    31 5547.4  6430.1   0.0   0.00   .P
76.20     0    31 5547.4  6429.4   0.0   0.00   .P
76.50     0    31 5547.4  6428.6   0.0   0.00   .P
76.80     0    31 5547.4  6427.9   0.0   0.00   .P
77.10     0    31 5547.4  6427.1   0.0   0.00   .P
77.40     0    31 5547.4  6426.4   0.0   0.00   .P
77.70     0    30 5547.4  6425.7   0.0   0.00   .P
78.00     0    30 5547.4  6425.0   0.0   0.00   .P
78.30     0    30 5547.4  6424.2   0.0   0.00   .P
78.60     0    30 5547.4  6423.5   0.0   0.00   .P
78.90     0    30 5547.4  6422.8   0.0   0.00   .P
79.20     0    30 5547.4  6422.1   0.0   0.00   .P
79.50     0    30 5547.4  6421.3   0.0   0.00   .P
79.80     0    30 5547.4  6420.6   0.0   0.00   .P
80.10     0    30 5547.4  6419.9   0.0   0.00   .P
80.40     0    30 5547.4  6419.2   0.0   0.00   .P
80.70     0    30 5547.4  6418.5   0.0   0.00   .P
81.00     0    29 5547.4  6417.8   0.0   0.00   .P
81.30     0    29 5547.4  6417.1   0.0   0.00   .P
81.60     0    29 5547.3  6416.4   0.0   0.00   .P
81.90     0    29 5547.3  6415.7   0.0   0.00   .P
82.20     0    29 5547.3  6415.0   0.0   0.00   .P
82.50     0    29 5547.3  6414.3   0.0   0.00   .P
82.80     0    29 5547.3  6413.6   0.0   0.00   .P
83.10     0    29 5547.3  6412.9   0.0   0.00   .P
83.40     0    29 5547.3  6412.2   0.0   0.00   .P
83.70     0    29 5547.3  6411.5   0.0   0.00   .P
84.00     0    29 5547.3  6410.8   0.0   0.00   .P
84.30     0    29 5547.3  6410.2   0.0   0.00   .P
84.60     0    28 5547.3  6409.5   0.0   0.00   .P
84.90     0    28 5547.3  6408.8   0.0   0.00   .P
85.20     0    28 5547.3  6408.1   0.0   0.00   .P
85.50     0    28 5547.3  6407.4   0.0   0.00   .P
85.80     0    28 5547.3  6406.8   0.0   0.00   .P
86.10     0    28 5547.3  6406.1   0.0   0.00   .P
86.40     0    28 5547.3  6405.4   0.0   0.00   .P
86.70     0    28 5547.3  6404.8   0.0   0.00   .P
87.00     0    28 5547.3  6404.1   0.0   0.00   .P
87.30     0    28 5547.3  6403.4   0.0   0.00   .P
87.60     0    28 5547.3  6402.8   0.0   0.00   .P
87.90     0    28 5547.3  6402.1   0.0   0.00   .P
88.20     0    27 5547.3  6401.4   0.0   0.00   .P
88.50     0    27 5547.3  6400.8   0.0   0.00   .P
88.80     0    27 5547.3  6400.1   0.0   0.00   .P
89.10     0    27 5547.3  6399.5   0.0   0.00   .P
89.40     0    27 5547.3  6398.8   0.0   0.00   .P
89.70     0    27 5547.3  6398.2   0.0   0.00   .P
90.00     0    27 5547.3  6397.5   0.0   0.00   .P
90.30     0    27 5547.2  6396.9   0.0   0.00   .P
90.60     0    27 5547.2  6396.3   0.0   0.00   .P
90.90     0    27 5547.2  6395.6   0.0   0.00   .P
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 91.20     0    27 5547.2  6395.0   0.0   0.00   .P
 91.50     0    27 5547.2  6394.3   0.0   0.00   .P
 91.80     0    27 5547.2  6393.7   0.0   0.00   .P
 92.10     0    26 5547.2  6393.1   0.0   0.00   .P
 92.40     0    26 5547.2  6392.4   0.0   0.00   .P
 92.70     0    26 5547.2  6391.8   0.0   0.00   .P
 93.00     0    26 5547.2  6391.2   0.0   0.00   .P
 93.30     0    26 5547.2  6390.6   0.0   0.00   .P
 93.60     0    26 5547.2  6389.9   0.0   0.00   .P
 93.90     0    26 5547.2  6389.3   0.0   0.00   .P
 94.20     0    26 5547.2  6388.7   0.0   0.00   .P
 94.50     0    26 5547.2  6388.1   0.0   0.00   .P
 94.80     0    26 5547.2  6387.5   0.0   0.00   .P
 95.10     0    26 5547.2  6386.9   0.0   0.00   .P
 95.40     0    26 5547.2  6386.2   0.0   0.00   .P
 95.70     0    26 5547.2  6385.6   0.0   0.00   .P
 96.00     0    26 5547.2  6385.0   0.0   0.00   .P
 96.30     0    25 5547.2  6384.4   0.0   0.00   .P
 96.60     0    25 5547.2  6383.8   0.0   0.00   .P
 96.90     0    25 5547.2  6383.2   0.0   0.00   .P
 97.20     0    25 5547.2  6382.6   0.0   0.00   .P
 Time    Qin  Qout   Elev    Vol   Area  ExtVel  I         I         I         I         I         I         I         I
                                                 0.      500.     1000.     1500.     2000.     2500.     3000.     3500.
        END NRCS-SDH   PLOT

ROUTED       BTM WIDTH  MAX ELEV   VOL-MAX  AREA-MAX   AUX.-HP   VOL-AUX.
RESULTS          FT        FT        ACFT      AC         FT       ACFT
NRCS-FBH          30.0   5552.32    7413.5       0.0      3.81     769.0

          PEAK - CFS        Q-PS     Q-AUX.    Q-TOT.
          DISCHARGE  =     126.9     521.5     648.3

                        CRITICAL  CRITICAL   CRITICAL  25% OF Q
                          DEPTH   VELOCITY   SLOPE-Sc      Sc
          AUXILIARY         FT      FT/SEC     FT/FT     FT/FT
          SPILLWAY ---     2.01      7.61     0.008     0.011

          INTEGRITY ANALYSIS - REACH SURFACE PERFORMANCE SUMMARY
           (The auxiliary spillway began flow at time =    9.6 hours
            and peaked at time =   20.4 hours.)


            REACH   3: FROM STATION    155. TO    237. ON   38.5% SLOPE.
               Non-vegetated conditions implied: flow concentration
                assumed with minimal flow: Time =   12.0 hours.


            REACH   4: FROM STATION    237. TO    600. ON    9.9% SLOPE.
               Non-vegetated conditions implied: flow concentration
                assumed with minimal flow: Time =   12.0 hours.


            REACH   5: FROM STATION    600. TO   1049. ON    6.3% SLOPE.
               Non-vegetated conditions implied: flow concentration
                assumed with minimal flow: Time =   12.0 hours.


            REACH   6: FROM STATION   1049. TO   1170. ON   15.1% SLOPE.
               Non-vegetated conditions implied: flow concentration
                assumed with minimal flow: Time =   12.0 hours.


          INTEGRITY ANALYSIS - HEADCUT EROSION DAMAGE SUMMARY

            The headcut BREACHED the spillway crest at
            time equal approximately    27.6 hours.
            Computations terminated at that point!

            The most upstream headcut began at station    237.
            and progressed upstream to station     75.
            The final height of the headcut was   36.2 ft.

            The deepest headcut is also the furthest upstream.

          THE HYDROGRAPH WAS NOT ADJUSTED FOR THE EFFECTS OF EROSION.

                         DURATION    ATTACK   DIST. FROM MOST U/S
                           FLOW       OE/B    HEADCUT TO U/S EDGE
          AUXILIARY         HRS     ACFT/FT     AUX. CREST, FT
          SPILLWAY----     74.4      27.8         >>>BREACH<<<
                                               Depth =   36.2 ft

          EXIT CHANNEL FLOW SUPERCRITICAL: MAX VELOCITY=  25.9 FT/SEC
                                           EXIT SLOPE  = 0.385 FT/FT
                                           FLOW DEPTH  =   0.6 FT

          PLOT NRCS-FBH                  1 IN =    500. CFS                                         EXIT SLOPE = 0.385
                                                 0.      500.     1000.     1500.     2000.     2500.     3000.     3500.
 Time    Qin  Qout   Elev    Vol   Area  ExtVel  I         I         I         I         I         I         I         I
  2.40     0     8 5546.3  6203.0   0.0   0.00   .
  3.60     4     8 5546.3  6203.0   0.0   0.00   .
  4.80    35     8 5546.3  6204.0   0.0   0.00   .I
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   6.00    84     8 5546.3  6209.1   0.0   0.00   . I
   7.20   195     9 5546.4  6222.1   0.0   0.00   .   I
   8.40   425    12 5546.5  6251.8   0.0   0.00   .        I
   9.60  1352    20 5546.9  6338.3   0.0   0.00   .                          I
  10.80  3365    50 5548.1  6568.7   0.0   0.00   .P                                                                 X
  12.00  3296   128 5549.8  6890.2   0.0   7.93   .  A                                                              I
  13.20  2008   320 5551.0  7131.1   0.0  17.72   .     A                                 I
  14.40  1331   453 5551.6  7258.3   0.0  21.69   .        A                 I
  15.60  1060   535 5551.9  7327.8   0.0  23.63   .          A         I
  16.80   912   590 5552.1  7369.8   0.0  24.78   .           A     I
  18.00   792   622 5552.2  7394.2   0.0  25.43   .           A   I
  19.20   742   641 5552.3  7407.7   0.0  25.78   .            A I
  20.40   664   648 5552.3  7413.5   0.0  25.92   .            X
  21.60   624   648 5552.3  7413.1   0.0  25.91   .           IA
  22.80   613   644 5552.3  7410.3   0.0  25.85   .           IA
  24.00   611   640 5552.3  7407.4   0.0  25.77   .           IA
  25.20   547   632 5552.3  7401.7   0.0  25.62   .          I A
  26.40   262   604 5552.2  7380.5   0.0  25.07   .    I      A
  27.60    90   551 5552.0  7340.7   0.0  23.96   . I        A
  28.80    24   496 5551.7  7294.4   0.0  22.73   .         A
  30.00     5   442 5551.5  7249.3   0.0  21.41   .        A
  31.20     1   397 5551.3  7208.0   0.0  20.18   .       A
  32.40     0   358 5551.1  7170.6   0.0  19.01   .      A
  33.60     0   325 5551.0  7136.9   0.0  17.90   .     A
  34.80     0   298 5550.8  7106.1   0.0  16.91   .     A
  36.00     0   273 5550.7  7077.9   0.0  15.92   .    A
  37.20     0   251 5550.6  7052.0   0.0  14.93   .    A
  38.40     0   232 5550.5  7028.2   0.0  14.02   .    A
  39.60     0   216 5550.3  7006.1   0.0  13.26   .   A
  40.80     0   200 5550.2  6985.5   0.0  12.56   .   A
  42.00     0   186 5550.2  6966.5   0.0  11.85   .   A
  43.20     0   172 5550.1  6948.8   0.0  11.12   .  A
  44.40     0   160 5550.0  6932.4   0.0  10.38   .  A
  45.60     0   148 5549.9  6917.2   0.0   9.61   .  A
  46.80     0   138 5549.8  6903.2   0.0   8.80   .  A
  48.00     0   128 5549.8  6890.1   0.0   7.92   .  A
  49.20     0   122 5549.7  6877.8   0.0   7.54   . A
  50.40     0   118 5549.6  6866.0   0.0   7.23   . A
  51.60     0   114 5549.6  6854.6   0.0   6.89   . A
  52.80     0   110 5549.5  6843.6   0.0   6.55   . A
  54.00     0   106 5549.5  6833.1   0.0   6.18   . A
  55.20     0   102 5549.4  6822.9   0.0   5.80   . A
  56.40     0    98 5549.4  6813.1   0.0   5.38   . A
  57.60     0    95 5549.3  6803.6   0.0   4.92   . A
  58.80     0    91 5549.3  6794.5   0.0   4.40   . A
  60.00     0    88 5549.2  6785.7   0.0   3.68   . A
  61.20     0    85 5549.2  6777.2   0.0   2.77   . A
  62.40     0    82 5549.2  6769.1   0.0   1.37   . A
  63.60     0    80 5549.1  6761.2   0.0   0.00   . A
  64.80     0    79 5549.1  6753.4   0.0   0.00   . A
  66.00     0    77 5549.0  6745.8   0.0   0.00   . A
  67.20     0    76 5549.0  6738.3   0.0   0.00   . A
  68.40     0    75 5549.0  6730.9   0.0   0.00   .A
  69.60     0    74 5548.9  6723.6   0.0   0.00   .A
  70.80     0    73 5548.9  6716.5   0.0   0.00   .A
  72.00     0    71 5548.8  6709.4   0.0   0.00   .A
  73.20     0    70 5548.8  6702.5   0.0   0.00   .A
  74.40     0    69 5548.8  6695.7   0.0   0.00   .A
  75.60     0    68 5548.7  6689.0   0.0   0.00   .A
  76.80     0    67 5548.7  6682.4   0.0   0.00   .A
  78.00     0    66 5548.7  6675.9   0.0   0.00   .A
  79.20     0    65 5548.6  6669.5   0.0   0.00   .A
  80.40     0    64 5548.6  6663.2   0.0   0.00   .A
  Time    Qin  Qout   Elev    Vol   Area  ExtVel  I         I         I         I         I         I         I         I
                                                  0.       500.      1000.     1500.     2000.     2500.     3000.     3500.
         END NRCS-FBH   PLOT
 -------------------------------------------------------------------------------

 Inflow Hyd 1 PSH-Peak =         39.99 CFS  at  143.00 hrs.,  Location Point

 Inflow Hyd 1 SDH-Peak =         65.90 CFS  at    8.10 hrs.,  Location Point

 Inflow Hyd 1 FBH-Peak =        648.34 CFS  at   19.20 hrs.,  Location Point
HYDOUT   1     STR1

1SITES....JOB NO.  1 COMPLETE.
 -------------------------------------------------------------------------------

 COVRES        COV RES

       0 SUBWATERSHED(S) ANALYZED.

       1 STRUCTURE(S) ANALYZED.

       3 HYDROGRAPHS ROUTED AT LOWEST SITE.

       0 TRIALS TO OBTAIN BOTTOM WIDTH FOR SPECIFIED STRESS OR VELOCITY.

 *******************************************************************************
```

```
 SITES.....COMPUTATIONS COMPLETE


                              SUMMARY TABLE  1          SITES VERSION 2005.1.8
                             ----------------               DATED 01/01/2005


 WATERSHED ID                       RUN DATE                           RUN TIME
 ------------                       --------                           --------
 COVRES                           08/20/2020                           06:12:11

 >>>   SITE   SUBWS   SUBWS DA   CURVE    TC   TOTAL DA   TYPE    STRUC    <<<
        ID      ID     (SQ MI)    NO.    (HRS)  (SQ MI)  DESIGN   CLASS
       -----   ----   --------   -----   ----   -------   -----   -----
       STR1     CR        4.74      0.   0.00      4.74    TR60     C

 PASS  DIA./  AUX.CREST  BTM.  MAX.    MAX.    EMB.  INTEGR.*  EXIT*    TYPE
  NO.  WIDTH    ELEV    WIDTH   HP     ELEV    VOL.   DIST.     VEL.     HYD
      (IN/FT)   (FT)     (FT)  (FT)    (FT)    (CY)   (FT)   (FT/SEC)
 ----  -----  -------  ------  ----  -------  -------  -----  ------  ---------
    1   30.0   5548.5    30.0   3.8   5552.3       0.<BREACH>   25.9  NRCS-FBH


 *  INTEGRITY DIST. AND EXIT VEL. VALUES ARE BASED ON THE ROUTED
    HYDROGRAPH SHOWN UNDER TYPE HYD.




 SITES.......SUMMARY TABLE 1 COMPLETED.


                    NRCS  SITES    VERSION 2005.1.8  ,01/01/2005
                             COVRES   FILES

INPUT  = c:\USDA\SITES\080620-PSH-ASHL-FBHG.d2c
OUTPUT = c:\USDA\SITES\080620-PSH-ASHL-FBHG.OUT
         DATED 08/20/2020 06:12:11

                         GRAPHICS FILES GENERATED

OPTION "L"  = c:\USDA\SITES\080620-PSH-ASHL-FBHG.DRG DATED 08/20/2020 06:12:11

OPTION "P"  = c:\USDA\SITES\080620-PSH-ASHL-FBHG.DHY DATED 08/20/2020 06:12:11

OPTION "E"  = c:\USDA\SITES\080620-PSH-ASHL-FBHG.DEM DATED 08/20/2020 06:12:11

AUX.GRAPHICS = c:\USDA\SITES\080620-PSH-ASHL-FBHG.DG* DATED 08/20/2020 06:12:11
```

```
********************************************************************************
SITES XEQ 08/20/2020   WATER RESOURCE SITE ANALYSIS COMPUTER PROGRAM
     VER 2005.1.8               (USER MANUAL - DATED DECEMBER 2005)
     TIME 06:12:11

************************** 80-80 LIST OF INPUT Data ***************************

SITES     01/01/2005COVRES    COV RES                       4.74      C3
SAVMOV    0    101
SAVMOV    101  1                                                      1
STRUCTURE STR1      Cove Res
                    5470                                    0.18
                    5480                                    62.26
                    5490                                    303.40
                    5500                                    738.03
                    5510                                    1400.09
                    5520                                    2323.02
                    5530                                    3541.97
                    5540                                    5073.81
                    5545.5                                  6055.03
                    5550                                    6934.92
                    5552                                    7347.18
                    5552.5                                  7450.25
ENDTABLE
HYD       1                   Principal Spillway
                    1
                    0         11        14        15        15
                    15        15        15        15        15
                    15        16        16        16        16
                    16        16        16        16        16
                    16        17        17        17        17
                    17        17        17        17        17
                    17        18        18        18        18
                    18        18        18        18        19
                    19        19        19        19        19
                    20        20        20        20        20
                    20        21        21        21        21
                    21        21        22        22        22
                    22        23        23        23        23
                    24        24        24        24        25
                    25        25        26        26        26
                    27        27        27        28        28
                    29        29        29        30        30
                    31        31        32        33        33
                    34        35        35        36        37
                    38        39        40        41        42
                    43        45        46        48        49
                    51        53        56        58        61
                    65        69        74        80        87
                    96        109       127       157       219
                    850       479       259       172       132
                    111       98        88        81        75
                    70        65        62        59        56
                    54        51        50        48        46
                    45        43        42        41        40
                    39        38        37        36        35
                    35        34        33        33        32
                    32        31        30        30        29
                    29        29        28        28        27
                    27        27        26        26        26
                    25        25        25        24        24
                    24        24        23        23        23
                    23        22        22        22        22
                    22        21        21        21        21
                    21        20        20        20        20
                    20        20        19        19        19
                    19        19        19        19        18
                    18        18        18        18        18
                    18        17        17        17        17
                    17        17        17        17        17
                    17        16        16        16        16
                    16        16        16        16        16
                    16        15        15        15        15
                    15        15        15        15        15
                    15        4         1
ENDTABLE
HYD       3                   Auxiliary Spillway (Local)
                    0.3
                    0         0         0         0         0
                    6         39        194       687       1365
                    2027      2180      1955      1683      1441
                    1248      1107      1001      924       874
                    833       748       589       423       283
                    180       112       73        47        28
                    16        9         5         3         1
                    1         0
ENDTABLE
HYD       5                   Freeboard (Local)
                    0.3
                    0         0         0         8         43
                    129       306       824       2325      4867
                    6395      6123      5053      4063      3364
```

```
                     2855      2500      2228      2039      1913
                     1819      1614      1240      851       540
                     332       201       113       62        34
                     18        9         5         2         1
                     0
 ENDTABLE
 WSDATA    2C CR               4.74
 PDIRECT                                 9.40      16.00
 POOLDATA  ELEV                5545.5              5552      5435      SC
 PSINLET             1         3.75
 PSDATA    1         1000      30                  0.012     5450
 ASSPRFL   41
           0         5530      75        5549.2    155       5549.2
           237       5517.6    600       5481.7    1049      5453.3
           1170      5435
 ENDTABLE
 ASSURFACE 41        1170      1
           0         1170      1         0         1
 ENDTABLE
 ASDATA    41                            2                             1
 BTMWIDTH  FEET      30
 ASMATERIAL
           1         50        1         75        115       .2
 ENDTABLE
 ASCOORD    1        W.Shale   N
           0         5530      75        5550      125       5565
           200       5552      250       5520      600       5485
           1050      5460      1150      5435      1300      5432.4
 ENDTABLE
 GRAPHICS  I
 GO,DESIGN LCP       TYPE2     24
 SAVMOV    2    101  1                   STR1
 ENDJOB

 *******************************************************************************

 ***** MESSAGE - DEFAULT TOPSOIL FILL MATERIAL PARAMETERS USED.

 ***** MESSAGE - AUXILIARY SPILLWAY CREST ELEVATION IS SET TO  5549.20
                 FROM THE ASSPRFL RECORDS.

 ***** MESSAGE - ASSURFACE REACH  1: ZERO ROOTING DEPTH IS DEFAULTED TO O.5 FT.


1SITES -------------------------------------------------------------------------
 XEQ 08/20/2020                    COV RES                         WSID= COVRES
 VER 2005.1.8                        Cove Res                        SUBW= CR
 TIME 06:12:11            SITE = STR1              PASS=    1     PART=   1



 **********************    MATERIAL PROPERTIES     ****************************
                            DRY                     PERCENT       DETACH.      REP.
      MATERIAL       PI   DENSITY        Kh        CLAY         RATE      DIAMETER
                         lbs/CuFt                        (Ft/H)/(lb/SqFt)  inches
     W.Shale        50.      115.      0.20        75.0          --        1.00000
     TS_FILL         0.      100.      0.05         0.0          --        0.05000
     GEN_FILL       50.      115.      0.20        75.0          --        1.00000

 ****************************    BASIC Data    *********************************
 HUMID- SUBHUMID CLIMATE AREA                     DESIGN CLASS  C

 INFLOW HYDROGRAPH(S) ENTERED

 PRECIP. - Q-PS,1-DAY    Q-PS,10-DAY       P-SD           P-FB
               0.00          0.00          9.40          16.00

 WSDATA -       CN          DA-SM          TC/L            -/H          QRF
               0.00          4.74          0.00           0.00          0.00

 SITEDATA- PERM POOL     CREST PS        FP SED        VALLEY FL         378?
               0.00       5545.50          0.00       5435.00            NO

           BASEFLOW      INITIAL EL     EXTRA VOL      SITE TYPE
               0.00          0.00          0.00         DESIGN

 PSDATA -  NO. COND        COND L         DIA/W            -/H
               1.00       1000.00         30.00           0.00

               PS N            KE         WEIR L         TW EL
              0.012          1.00          3.75       5450.00

            2ND STG         ORF H          ORF L      START AUX.
               0.00          0.00          0.00           0.00

 ASCRESTS -   AUX.1         AUX.2         AUX.3          AUX.4          AUX.5
            5549.20          0.00          0.00           0.00          0.00

 AUX.Data -  REF.NO.    RETARD. Ci   TIE STATION    INLET LENGTH
                 41          0.00       155.00              0

 AUX.Data - INLET Ci    SIDE SLOPE       EXIT Ci     EXIT SLOPE     ACTUAL AUX?
```

```
             1.000          2.00         1.000          0.385            NO

 BTM WIDTH -    BW1           BW2           BW3            BW4           BW5
   ft         30.00          0.00          0.00           0.00          0.00

 AUXILIARY SPILLWAY RATING DEVELOPED USING WSPVRT.

1*********************     DETAILED LIST OF BASIC Data     *********************
 WEIR COEF. FOR ORIFICES.......... 3.10    RATIO OF Ia TO S (CH.10,NEH4). 0.20
 WEIR COEF. FOR DROP INLET........ 3.10    TIME INCS TO PEAK OF UNIT HYD.  10.
 DISCHARGE COEF. FOR ORIFICES..... 0.60    NO. POINTS FOR DESIGN HYD. ... 5000

 HOOD, WEIR INLET COEF. .......... 0.60    DRAWDOWN TIME LIMIT - DAYS.... 10.0
 HOOD, PIPE ENTRANCE COEF. ....... 0.60    DRAWDOWN RATIO STORAGE LIMIT.. 0.15
 HOOD, SLUG FLOW COEF. ........... 0.00    OTHER DRAWDOWN RATIOS APPLY ?.   NO

 PS ACCURACY OF FULL FLOW CALC.,FT 0.01    WSP ALLOWABLE FSS VEL. CHANGE. 0.05
 FILLET SIZE FOR BOX CONDUITS..... 6.00    WSP FSS CALC. PRECISION, FT.. 0.005

 GRAVITATIONAL CONSTANT.......... 32.16    AUX. SPILLWAY MIN. CAP. COEF. 237.0
 MIN. NHCP378 PS PIPE AREA SQFT.. 0.545    AUX. SPILLWAY MIN. CAP. EXP.  0.493

 MIN. TR60 DEPTH AUX. TO TOP DAM.. 3.00    MIN. AUX. BW IN BW SOLUTION,FT 20.0
 MIN. NHCP378 DEPTH AUX.TO TOP DAM 2.00    PRECISION OF BW SOLUTION......  1.0
 MIN. NHCP378 DEPTH PS - AUX.CREST 1.00    OLD TR60 CRITERIA USED .......   NO
 MIN. NHCP378 DEPTH DESIGN Q - TOD 1.00    OLD NHCP378 CRITERIA USED ....   NO

 EMBANKMENT TEMPLATE:  TOP WIDTH = (calc.),  MAX. CROWN = 0.667 ft,
 SIDE SLOPE   WAVE BERM   MULTIPLE STABILITY BERMS    SEPARATE STABILITY BERMS
    RATIOS      WIDTH      U&D/S WIDTHS   DELTA H     WIDTHS, ft   HEIGHTS, ft
   U/S  D/S       ft             ft          ft        U/S   D/S    U/S   D/S
  2.50 2.50      10.0            0.0        0.00       0.00  0.00   0.00  0.00


 DIMENSIONLESS UNIT HYDROGRAPH
 STANDARD DIMENSIONLESS UNIT HYDROGRAPH
 PEAK FACTOR = 484.0 | TIME INC. =0.020 | NO. INC. TO PEAK =  10.
 VOLUME FACTOR =  48.3429

      0.0000     0.0300     0.1000     0.1900     0.3100
      0.4700     0.6600     0.8200     0.9300     0.9900
      1.0000     0.9900     0.9300     0.8600     0.7800
      0.6800     0.5600     0.4600     0.3900     0.3300
      0.2800     0.2410     0.2070     0.1740     0.1470
      0.1260     0.1070     0.0910     0.0770     0.0660
      0.0550     0.0470     0.0400     0.0340     0.0290
      0.0250     0.0210     0.0180     0.0150     0.0130
      0.0110     0.0090     0.0080     0.0070     0.0060
      0.0050     0.0040     0.0030     0.0020     0.0010
      0.0000

 EXISTING NATURAL SURFACE AT AUXILIARY SPILLWAY SITE - X,Y COORDINATES:

               0.     5530.00
              75.     5550.00
             125.     5565.00
             200.     5552.00
             250.     5520.00
             600.     5485.00
            1050.     5460.00
            1150.     5435.00


1NRCS DESIGN STORM RAINFALL DISTRIBUTION  (CHAPTER 21, NEH4 & TR-60).

       0.000      0.008      0.016      0.025      0.033
       0.043      0.052      0.063      0.074      0.086
       0.099      0.112      0.126      0.142      0.160
       0.180      0.205      0.255      0.345      0.437
       0.530      0.603      0.633      0.660      0.684
       0.705      0.724      0.742      0.759      0.775
       0.790      0.804      0.818      0.831      0.844
       0.856      0.868      0.879      0.890      0.900
       0.910      0.920      0.930      0.939      0.948
       0.957      0.966      0.975      0.983      0.992
       1.000


 24 HOUR TYPE II RAINFALL DISTRIBUTION
 IDENTIFICATION NAME IS TYPE2  GIVEN DURATION =  24.0 HRS

       0.000      0.001      0.002      0.003      0.004
       0.005      0.006      0.007      0.008      0.009
       0.010      0.012      0.013      0.014      0.015
       0.016      0.017      0.018      0.020      0.021
       0.022      0.023      0.024      0.026      0.027
       0.028      0.029      0.031      0.032      0.033
       0.034      0.036      0.037      0.038      0.040
       0.041      0.042      0.044      0.045      0.047
       0.048      0.049      0.051      0.052      0.054
       0.055      0.057      0.058      0.060      0.061
       0.063      0.065      0.066      0.068      0.070
```

```
       0.071      0.073      0.075      0.076      0.078
       0.080      0.082      0.084      0.085      0.087
       0.089      0.091      0.093      0.095      0.097
       0.099      0.101      0.103      0.105      0.107
       0.109      0.111      0.113      0.116      0.118
       0.120      0.122      0.125      0.127      0.130
       0.132      0.135      0.138      0.141      0.144
       0.147      0.150      0.153      0.157      0.160
       0.163      0.166      0.170      0.173      0.177
       0.181      0.185      0.189      0.194      0.199
       0.204      0.209      0.215      0.221      0.228
       0.235      0.243      0.251      0.261      0.271
       0.283      0.307      0.354      0.431      0.568
       0.663      0.682      0.699      0.713      0.725
       0.735      0.743      0.751      0.759      0.766
       0.772      0.778      0.784      0.789      0.794
       0.799      0.804      0.808      0.812      0.816
       0.820      0.824      0.827      0.831      0.834
       0.838      0.841      0.844      0.847      0.850
       0.854      0.856      0.859      0.862      0.865
       0.868      0.870      0.873      0.875      0.878
       0.880      0.882      0.885      0.887      0.889
       0.891      0.893      0.895      0.898      0.900
       0.902      0.904      0.906      0.908      0.910
       0.912      0.914      0.915      0.917      0.919
       0.921      0.923      0.925      0.926      0.928
       0.930      0.931      0.933      0.935      0.936
       0.938      0.939      0.941      0.942      0.944
       0.945      0.947      0.948      0.949      0.951
       0.952      0.953      0.955      0.956      0.957
       0.958      0.960      0.961      0.962      0.964
       0.965      0.966      0.967      0.968      0.970
       0.971      0.972      0.973      0.975      0.976
       0.977      0.978      0.979      0.981      0.982
       0.983      0.984      0.985      0.986      0.988
       0.989      0.990      0.991      0.992      0.993
       0.994      0.996      0.997      0.998      0.999
       1.000

1SITES -------------------------------------------------------------------------
 XEQ 08/20/2020                    COV RES                        WSID= COVRES
 VER 2005.1.8                        Cove Res                       SUBW= CR
 TIME 06:12:11            SITE = STR1              PASS=    1     PART=   2

MESSAGE ---- Climatic Index changed from 0.0 to 1.0 for this run.

 CREST PS       5545.50 FT    6055.0 ACFT      0.00 AC     126.3 CFS

 SED ACCUM      5545.50 FT    6055.0 ACFT      0.00 AC     126.3 CFS

 START ELEV     5545.50 FT    6055.0 ACFT      0.00 AC       0.0 CFS

 INFLOW HYDROGRAPH PROVIDED IN LOCATION  1,  PEAK=    850.00 CFS, AT 120.00 HRS.
 TITLE = Principal Spillway


 CREST PS       5545.50 FT    6055.0 ACFT      0.00 AC     126.3 CFS

 SED ACCUM      5545.50 FT    6055.0 ACFT      0.00 AC     126.3 CFS

 START ELEV     5545.50 FT    6055.0 ACFT      0.00 AC       0.0 CFS


 NRCS-PSH  RAINFALL   1-DAY =   0.00 IN    10-DAY =   0.00 IN    DA =   4.74 SM
           RUNOFF     1-DAY =   0.00 IN    10-DAY =   0.00 IN

      CLIMATIC INDEX = 1.00    CN 10-DAY =  0.    CN 1-DAY =   0.

      PEAK =       850.0 CFS, AT  120.0 HRS.


 ROUTED RESULT - HYD TYPE      EMAX         VOL-MAX        AMAX         QMAX
                NRCS-PSH   5547.76 FT    6496.1 ACFT      0.00 AC     40.0 CFS

      PS STORAGE     441.0 ACFT,  BETWEEN AUX. CREST AND SED. ACCUM ELEVATIONS.

 DRAWDOWN (DDT) TEST       5545.84 FT    6121.2 ACFT      4.35 CFS
      CONTROL IS 0.150 DETENTION STORAGE

      TIME LIMIT REACHED = 10.00 DAYS. FLOW WAS     9.73 CFS,  ELEV =  5546.26
      (ELEVATION TO START ROUTING SDH AND/OR FBH HAS BEEN RAISED.)

      TIME TO DDT TEST DISCHARGE IS 15.79 DAYS - DRAWDOWN STOPPED.

 ***** NOTE - CREST OF AUX. RAISED TO HOLD   148.03 ACFT NOT EVACUATED IN
              DRAWDOWN TIME LIMIT.  TOTAL STORAGE REQUIRED =  6644.08 ACFT,
              NEW ELEVATION OF AUXILIARY SPILLWAY CREST    =  5548.51 FT.

 PLOT OF PRINCIPAL SPILLWAY HYDROGRAPH,  1 INCH=     200. CFS
                                                 0.      200.      400.      600.      800.     1000.     1200.     1400.
  Time    Qin  Qout   Elev    Vol   Area  ExtVel  I         I         I         I         I         I         I         I
```

```
 0.00   0.0   0.0 5545.5  6055.5   0.0           .
 1.00  11.0   0.0 5545.5  6055.5   0.0           .I
 2.00  14.0   0.1 5545.5  6056.5   0.0           .I
 3.00  15.0   0.2 5545.5  6057.7   0.0           .I
 4.00  15.0   0.3 5545.5  6058.9   0.0           .I
 5.00  15.0   0.3 5545.5  6060.1   0.0           .I
 6.00  15.0   0.4 5545.5  6061.3   0.0           .I
 7.00  15.0   0.5 5545.5  6062.5   0.0           .I
 8.00  15.0   0.6 5545.5  6063.7   0.0           .I
 9.00  15.0   0.7 5545.6  6064.9   0.0           .I
10.00  15.0   0.7 5545.6  6066.1   0.0           .I
11.00  16.0   0.8 5545.6  6067.3   0.0           .I
12.00  16.0   0.9 5545.6  6068.6   0.0           .I
13.00  16.0   1.0 5545.6  6069.8   0.0           .I
14.00  16.0   1.1 5545.6  6071.1   0.0           .I
15.00  16.0   1.1 5545.6  6072.3   0.0           .I
16.00  16.0   1.2 5545.6  6073.5   0.0           .I
17.00  16.0   1.3 5545.6  6074.7   0.0           .I
18.00  16.0   1.4 5545.6  6076.0   0.0           .I
19.00  16.0   1.5 5545.6  6077.2   0.0           .I
20.00  16.0   1.5 5545.6  6078.4   0.0           .I
21.00  17.0   1.6 5545.6  6079.6   0.0           .I
22.00  17.0   1.7 5545.6  6080.9   0.0           .I
23.00  17.0   1.8 5545.6  6082.1   0.0           .I
24.00  17.0   1.9 5545.6  6083.4   0.0           .I
25.00  17.0   1.9 5545.7  6084.6   0.0           .I
26.00  17.0   2.0 5545.7  6085.9   0.0           .I
27.00  17.0   2.1 5545.7  6087.1   0.0           .I
28.00  17.0   2.2 5545.7  6088.3   0.0           .I
29.00  17.0   2.3 5545.7  6089.5   0.0           .I
30.00  17.0   2.3 5545.7  6090.8   0.0           .I
31.00  18.0   2.4 5545.7  6092.0   0.0           .I
32.00  18.0   2.5 5545.7  6093.3   0.0           .I
33.00  18.0   2.6 5545.7  6094.6   0.0           .I
34.00  18.0   2.7 5545.7  6095.8   0.0           .I
35.00  18.0   2.8 5545.7  6097.1   0.0           .I
36.00  18.0   2.8 5545.7  6098.4   0.0           .I
37.00  18.0   2.9 5545.7  6099.6   0.0           .I
38.00  18.0   3.0 5545.7  6100.8   0.0           .I
39.00  19.0   3.1 5545.7  6102.1   0.0           .I
40.00  19.0   3.2 5545.7  6103.4   0.0           .I
41.00  19.0   3.3 5545.8  6104.7   0.0           .I
42.00  19.0   3.4 5545.8  6106.0   0.0           .I
43.00  19.0   3.4 5545.8  6107.3   0.0           .I
44.00  19.0   3.5 5545.8  6108.6   0.0           .I
45.00  20.0   3.6 5545.8  6109.9   0.0           .I
46.00  20.0   3.7 5545.8  6111.3   0.0           .I
47.00  20.0   3.8 5545.8  6112.6   0.0           .I
48.00  20.0   3.9 5545.8  6114.0   0.0           .I
49.00  20.0   4.0 5545.8  6115.3   0.0           .I
50.00  20.0   4.0 5545.8  6116.6   0.0           .I
51.00  21.0   4.1 5545.8  6118.0   0.0           .I
52.00  21.0   4.2 5545.8  6119.4   0.0           .I
53.00  21.0   4.3 5545.8  6120.7   0.0           .I
54.00  21.0   4.4 5545.8  6122.1   0.0           .I
55.00  21.0   4.5 5545.9  6123.5   0.0           .I
56.00  21.0   4.6 5545.9  6124.8   0.0           .I
57.00  22.0   4.7 5545.9  6126.2   0.0           .I
58.00  22.0   4.8 5545.9  6127.7   0.0           .I
59.00  22.0   4.9 5545.9  6129.1   0.0           .I
60.00  22.0   5.0 5545.9  6130.5   0.0           .I
61.00  23.0   5.1 5545.9  6131.9   0.0           .I
62.00  23.0   5.2 5545.9  6133.4   0.0           .I
63.00  23.0   5.2 5545.9  6134.9   0.0           .I
64.00  23.0   5.3 5545.9  6136.4   0.0           .I
65.00  24.0   5.4 5545.9  6137.8   0.0           .I
66.00  24.0   5.5 5545.9  6139.4   0.0           .I
67.00  24.0   5.6 5545.9  6140.9   0.0           .I
68.00  24.0   5.7 5545.9  6142.4   0.0           .I
69.00  25.0   5.8 5546.0  6144.0   0.0           .I
70.00  25.0   5.9 5546.0  6145.5   0.0           .I
71.00  25.0   6.1 5546.0  6147.1   0.0           .I
72.00  26.0   6.2 5546.0  6148.7   0.0           .I
73.00  26.0   6.3 5546.0  6150.3   0.0           .I
74.00  26.0   6.4 5546.0  6152.0   0.0           .I
75.00  27.0   6.5 5546.0  6153.6   0.0           .I
76.00  27.0   6.6 5546.0  6155.3   0.0           .I
77.00  27.0   6.7 5546.0  6157.0   0.0           .I
78.00  28.0   6.8 5546.0  6158.7   0.0           .I
79.00  28.0   6.9 5546.0  6160.5   0.0           .I
80.00  29.0   7.0 5546.0  6162.2   0.0           .I
81.00  29.0   7.2 5546.1  6164.1   0.0           .I
82.00  29.0   7.3 5546.1  6165.9   0.0           .I
83.00  30.0   7.4 5546.1  6167.7   0.0           . I
84.00  30.0   7.5 5546.1  6169.5   0.0           . I
85.00  31.0   7.7 5546.1  6171.4   0.0           . I
86.00  31.0   7.8 5546.1  6173.4   0.0           . I
87.00  32.0   7.9 5546.1  6175.3   0.0           . I
88.00  33.0   8.0 5546.1  6177.3   0.0           . I
89.00  33.0   8.2 5546.1  6179.4   0.0           . I
90.00  34.0   8.3 5546.1  6181.5   0.0           . I
91.00  35.0   8.5 5546.2  6183.6   0.0           . I
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 92.00  35.0   8.6 5546.2  6185.8   0.0          . I
 93.00  36.0   8.7 5546.2  6188.1   0.0          . I
 94.00  37.0   8.9 5546.2  6190.3   0.0          . I
 95.00  38.0   9.0 5546.2  6192.7   0.0          . I
 96.00  39.0   9.2 5546.2  6195.1   0.0          . I
 97.00  40.0   9.4 5546.2  6197.6   0.0          . I
 98.00  41.0   9.5 5546.2  6200.2   0.0          . I
 99.00  42.0   9.7 5546.3  6202.8   0.0          . I
100.00  43.0   9.9 5546.3  6205.5   0.0          . I
101.00  45.0  10.1 5546.3  6208.3   0.0          .PI
102.00  46.0  10.3 5546.3  6211.3   0.0          .PI
103.00  48.0  10.5 5546.3  6214.3   0.0          .PI
104.00  49.0  10.7 5546.3  6217.4   0.0          .PI
105.00  51.0  10.9 5546.3  6220.7   0.0          .P I
106.00  53.0  11.1 5546.4  6224.0   0.0          .P I
107.00  56.0  11.3 5546.4  6227.6   0.0          .P I
108.00  58.0  11.6 5546.4  6231.4   0.0          .P I
109.00  61.0  11.9 5546.4  6235.3   0.0          .P I
110.00  65.0  12.1 5546.4  6239.5   0.0          .P I
111.00  69.0  12.4 5546.5  6244.1   0.0          .P I
112.00  74.0  12.7 5546.5  6248.9   0.0          .P  I
113.00  80.0  13.1 5546.5  6254.2   0.0          .P  I
114.00  87.0  13.5 5546.5  6260.0   0.0          .P  I
115.00  96.0  13.9 5546.6  6266.5   0.0          .P   I
116.00 109.0  14.4 5546.6  6273.8   0.0          .P   I
117.00 127.0  14.9 5546.7  6282.3   0.0          .P    I
118.00 157.0  15.6 5546.7  6292.8   0.0          .P      I
119.00 219.0  17.3 5546.8  6307.0   0.0          .P         I
120.00 850.0  22.4 5547.0  6349.5   0.0          .P                                         X
121.00 479.0  28.7 5547.3  6402.3   0.0          .P                      I
122.00 259.0  32.1 5547.4  6430.3   0.0          . P          I
123.00 172.0  33.9 5547.5  6445.4   0.0          . P      I
124.00 132.0  35.1 5547.5  6455.1   0.0          . P    I
125.00 111.0  35.9 5547.6  6462.2   0.0          . P   I
126.00  98.0  36.6 5547.6  6467.8   0.0          . P  I
127.00  88.0  37.2 5547.6  6472.5   0.0          . P I
128.00  81.0  37.6 5547.7  6476.4   0.0          . P I
129.00  75.0  38.0 5547.7  6479.7   0.0          . P I
130.00  70.0  38.4 5547.7  6482.5   0.0          . P I
131.00  65.0  38.7 5547.7  6484.9   0.0          . PI
132.00  62.0  38.9 5547.7  6487.0   0.0          . PI
133.00  59.0  39.1 5547.7  6488.7   0.0          . PI
134.00  56.0  39.3 5547.7  6490.2   0.0          . PI
135.00  54.0  39.4 5547.7  6491.5   0.0          . PI
136.00  51.0  39.6 5547.7  6492.6   0.0          . PI
137.00  50.0  39.7 5547.7  6493.5   0.0          . PI
138.00  48.0  39.8 5547.7  6494.3   0.0          . P
139.00  46.0  39.8 5547.7  6494.9   0.0          . P
140.00  45.0  39.9 5547.8  6495.3   0.0          . P
141.00  43.0  39.9 5547.8  6495.7   0.0          . P
142.00  42.0  40.0 5547.8  6495.9   0.0          . P
143.00  41.0  40.0 5547.8  6496.0   0.0          . P
144.00  40.0  40.0 5547.8  6496.1   0.0          . X
145.00  39.0  40.0 5547.8  6496.0   0.0          . P
146.00  38.0  40.0 5547.8  6495.9   0.0          . P
147.00  37.0  39.9 5547.8  6495.7   0.0          . P
148.00  36.0  39.9 5547.8  6495.4   0.0          . P
149.00  35.0  39.9 5547.8  6495.0   0.0          . P
150.00  35.0  39.8 5547.7  6494.6   0.0          . P
151.00  34.0  39.8 5547.7  6494.2   0.0          . P
152.00  33.0  39.7 5547.7  6493.7   0.0          . P
153.00  33.0  39.6 5547.7  6493.1   0.0          . P
154.00  32.0  39.6 5547.7  6492.6   0.0          . P
155.00  32.0  39.5 5547.7  6491.9   0.0          . P
156.00  31.0  39.4 5547.7  6491.3   0.0          . P
157.00  30.0  39.3 5547.7  6490.5   0.0          . P
158.00  30.0  39.2 5547.7  6489.8   0.0          . P
159.00  29.0  39.1 5547.7  6489.0   0.0          .IP
160.00  29.0  39.0 5547.7  6488.1   0.0          .IP
161.00  29.0  38.9 5547.7  6487.3   0.0          .IP
162.00  28.0  38.8 5547.7  6486.5   0.0          .IP
163.00  28.0  38.7 5547.7  6485.6   0.0          .IP
164.00  27.0  38.6 5547.7  6484.6   0.0          .IP
165.00  27.0  38.5 5547.7  6483.7   0.0          .IP
166.00  27.0  38.4 5547.7  6482.7   0.0          .IP
167.00  26.0  38.3 5547.7  6481.8   0.0          .IP
168.00  26.0  38.1 5547.7  6480.8   0.0          .IP
169.00  26.0  38.0 5547.7  6479.8   0.0          .IP
170.00  25.0  37.9 5547.7  6478.7   0.0          .IP
171.00  25.0  37.8 5547.7  6477.7   0.0          .IP
172.00  25.0  37.7 5547.7  6476.6   0.0          .IP
173.00  24.0  37.5 5547.7  6475.5   0.0          .IP
174.00  24.0  37.4 5547.6  6474.4   0.0          .IP
175.00  24.0  37.3 5547.6  6473.3   0.0          .IP
176.00  24.0  37.1 5547.6  6472.2   0.0          .IP
177.00  23.0  37.0 5547.6  6471.1   0.0          .IP
178.00  23.0  36.9 5547.6  6470.0   0.0          .IP
179.00  23.0  36.7 5547.6  6468.8   0.0          .IP
180.00  23.0  36.6 5547.6  6467.7   0.0          .IP
181.00  22.0  36.4 5547.6  6466.5   0.0          .IP
182.00  22.0  36.3 5547.6  6465.3   0.0          .IP
183.00  22.0  36.2 5547.6  6464.2   0.0          .IP
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184.00  22.0  36.0 5547.6  6463.0   0.0          .IP
185.00  22.0  35.9 5547.6  6461.8   0.0          .IP
186.00  21.0  35.7 5547.6  6460.7   0.0          .IP
187.00  21.0  35.6 5547.6  6459.5   0.0          .IP
188.00  21.0  35.4 5547.6  6458.3   0.0          .IP
189.00  21.0  35.3 5547.6  6457.1   0.0          .IP
190.00  21.0  35.2 5547.6  6455.9   0.0          .IP
191.00  20.0  35.0 5547.5  6454.7   0.0          .IP
192.00  20.0  34.9 5547.5  6453.4   0.0          .IP
193.00  20.0  34.7 5547.5  6452.2   0.0          .IP
194.00  20.0  34.6 5547.5  6451.0   0.0          .IP
195.00  20.0  34.4 5547.5  6449.8   0.0          .IP
196.00  20.0  34.3 5547.5  6448.6   0.0          .IP
197.00  19.0  34.1 5547.5  6447.4   0.0          .IP
198.00  19.0  34.0 5547.5  6446.2   0.0          .IP
199.00  19.0  33.8 5547.5  6444.9   0.0          .IP
200.00  19.0  33.7 5547.5  6443.7   0.0          .IP
201.00  19.0  33.6 5547.5  6442.5   0.0          .IP
202.00  19.0  33.4 5547.5  6441.3   0.0          .IP
203.00  19.0  33.3 5547.5  6440.1   0.0          .IP
204.00  18.0  33.1 5547.5  6438.9   0.0          .IP
205.00  18.0  33.0 5547.5  6437.7   0.0          .IP
206.00  18.0  32.8 5547.5  6436.4   0.0          .IP
207.00  18.0  32.7 5547.4  6435.2   0.0          .IP
208.00  18.0  32.5 5547.4  6434.0   0.0          .IP
209.00  18.0  32.4 5547.4  6432.8   0.0          .IP
210.00  18.0  32.2 5547.4  6431.6   0.0          .IP
211.00  17.0  32.1 5547.4  6430.4   0.0          .IP
212.00  17.0  32.0 5547.4  6429.2   0.0          .IP
213.00  17.0  31.8 5547.4  6427.9   0.0          .IP
214.00  17.0  31.7 5547.4  6426.7   0.0          .IP
215.00  17.0  31.5 5547.4  6425.5   0.0          .IP
216.00  17.0  31.4 5547.4  6424.3   0.0          .IP
217.00  17.0  31.2 5547.4  6423.1   0.0          .IP
218.00  17.0  31.1 5547.4  6422.0   0.0          .IP
219.00  17.0  30.9 5547.4  6420.8   0.0          .IP
220.00  17.0  30.8 5547.4  6419.7   0.0          .IP
221.00  16.0  30.7 5547.4  6418.5   0.0          .IP
222.00  16.0  30.5 5547.4  6417.3   0.0          .IP
223.00  16.0  30.4 5547.3  6416.1   0.0          .IP
224.00  16.0  30.2 5547.3  6414.9   0.0          .IP
225.00  16.0  30.1 5547.3  6413.7   0.0          .IP
226.00  16.0  30.0 5547.3  6412.6   0.0          .P
227.00  16.0  29.8 5547.3  6411.4   0.0          .P
228.00  16.0  29.7 5547.3  6410.3   0.0          .P
229.00  16.0  29.5 5547.3  6409.2   0.0          .P
230.00  16.0  29.4 5547.3  6408.1   0.0          .P
231.00  15.0  29.3 5547.3  6406.9   0.0          .P
232.00  15.0  29.1 5547.3  6405.7   0.0          .P
233.00  15.0  29.0 5547.3  6404.6   0.0          .P
234.00  15.0  28.9 5547.3  6403.4   0.0          .P
235.00  15.0  28.7 5547.3  6402.3   0.0          .P
236.00  15.0  28.6 5547.3  6401.2   0.0          .P
237.00  15.0  28.5 5547.3  6400.0   0.0          .P
238.00  15.0  28.3 5547.3  6398.9   0.0          .P
239.00  15.0  28.2 5547.3  6397.8   0.0          .P
 Time    Qin  Qout   Elev    Vol   Area  ExtVel  I         I         I         I         I         I         I         I
                                                 0.      200.      400.      600.      800.     1000.     1200.     1400.
        END NRCS-PSH   PLOT

*******************************************************************************
RATING TABLE DEVELOPED, SITE = STR1 :
 BY PROGRAM FOR PS AND AUX. SPILLWAYS
 AUX. RATING USED WSPVRT METHOD.


RATING TABLE NUMBER  1
       ELEV.    Q-TOTAL    Q-PS     Q-AUX.    VOLUME     AREA
       FEET       CFS       CFS       CFS      AC-FT     ACRE
  1  5545.50      0.00      0.00      0.00   6055.03      0.00
  2  5546.72     15.71     15.71      0.00   6294.00      0.00
  3  5547.94     44.43     44.43      0.00   6532.97      0.00
  4  5549.17     81.62     81.62      0.00   6771.95      0.00
                                           FULL CONDUIT FLOW, ELEV = 5550.39 FT
  5  5550.39    125.65    125.65      0.00   7015.04      0.00
  6  5550.65    125.84    125.84      0.00   7069.39      0.00
  7  5550.92    126.01    126.01      0.00   7123.74      0.00
  8  5551.18    126.17    126.17      0.00   7178.09      0.00
  9  5551.44    126.34    126.34      0.00   7232.44      0.00
 10  5551.71    126.50    126.50      0.00   7286.79      0.00
 11  5551.97    126.67    126.67      0.00   7341.14      0.00
 12  5552.23    126.83    126.83      0.00   7395.49      0.00
 13  5552.50    126.99    126.99      0.00   7449.85      0.00

INFLOW HYDROGRAPH PROVIDED IN LOCATION  3,  PEAK=   2180.00 CFS, AT   3.30 HRS.
TITLE = Auxiliary Spillway (Local)


INFLOW HYDROGRAPH PROVIDED IN LOCATION  5,  PEAK=   6395.00 CFS, AT   3.00 HRS.
TITLE = Freeboard (Local)
```

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1SITES ------------------------------------------------------------------------
 XEQ 08/20/2020                    COV RES                        WSID= COVRES
 VER 2005.1.8                        Cove Res                       SUBW= CR
 TIME 06:12:11            SITE = STR1              PASS=    1     PART=   3


 AUX. CREST     5548.51 FT    6644.1 ACFT      0.00 AC      61.7 CFS

      PS STORAGE    589.1 ACFT,  BETWEEN AUX. CREST AND SED. ACCUM ELEVATIONS.

 START ELEV     5546.26 FT    6203.0 ACFT      0.00 AC       9.7 CFS

 ***** WARNING - AUXILIARY CREST LOWER THAN LOW POINT IN SITE.

 NRCS-SDH   INFLOW HYDROGRAPH INPUT, DA =    4.74 SQUARE MILES

      PEAK =      2180.0 CFS, AT    3.3 HRS.

 NRCS-FBH   INFLOW HYDROGRAPH INPUT, DA =    4.74 SQUARE MILES

      PEAK =      6395.0 CFS, AT    3.0 HRS.

 ***** WARNING - MAXIMUM AUX. SURFACE PROFILE ELEVATION ( 5549.20) AND AUXILIARY
                 CREST ( 5548.51) ELEVATION Do NOT MATCH.  MAXIMUM AUX. SURFACE
                 PROFILE ELEVATION USED IN WSPVRT PROCEDURE.


 ***** MESSAGE - INPUT(5549.14) TO INTERPOLATION ROUTINE IS BELOW
                 ARRAY LIMIT(5549.20).


 ******************************************************************************
 RATING TABLE DEVELOPED, SITE = STR1 :
  BY PROGRAM FOR PS AND AUX. SPILLWAYS
  AUX. RATING USED WSPVRT METHOD.


 RATING TABLE NUMBER  2
        ELEV.    Q-TOTAL    Q-PS     Q-AUX.    VOLUME     AREA
        FEET       CFS       CFS       CFS      AC-FT     ACRE
   1  5545.50      0.00      0.00      0.00   6055.03      0.00
   2  5545.83      2.25      2.25      0.00   6120.52      0.00
   3  5546.17      6.37      6.37      0.00   6186.02      0.00
   4  5546.50     11.71     11.71      0.00   6251.52      0.00
   5  5546.84     18.03     18.03      0.00   6317.01      0.00
   6  5547.17     25.20     25.20      0.00   6382.51      0.00
   7  5547.51     33.12     33.12      0.00   6448.00      0.00
   8  5547.84     41.74     41.74      0.00   6513.50      0.00
   9  5548.18     50.99     50.99      0.00   6578.99      0.00
  10  5548.51     60.85     60.85      0.00   6644.49      0.00
  11  5549.14     80.67     80.67      0.00   6766.41      0.00
  12  5549.76    126.50    102.35     24.15   6888.71      0.00
                                             FULL CONDUIT FLOW, ELEV = 5550.39 FT
  13  5550.39    223.05    125.67     97.38   7015.14      0.00
  14  5550.49    237.89    125.75    112.14   7036.88      0.00
  15  5550.60    255.98    125.81    130.16   7058.62      0.00
  16  5550.79    290.40    125.93    164.47   7097.77      0.00
  17  5551.02    332.53    126.08    206.45   7145.68      0.00
  18  5551.44    422.70    126.34    296.36   7232.64      0.00
  19  5551.97    551.57    126.67    424.90   7341.44      0.00
  20  5552.50    697.75    126.99    570.75   7450.25      0.00
  ***************************************************************************

 SUMMARY OF AUXILIARY SPILLWAY SURFACE CONDITIONS USED IN COMPUTATIONS BY REACH

 REACH  FROM     TO   SLOPE  RETARDANCE  VEGETAL  MAINT. ROOTING  REACH
        STA     STA            CURVE      COVER    CODE   DEPTH  LOCATION
        (ft)    (ft)   (%)     INDEX      FACTOR     +    (ft)      *
 -----  ----    ----  ------ ----------  -------  -----  ------- --------
   1      0.     75.  -25.6     1.000       **       **     **    INLET
   2     75.    155.    0.0     1.000       **       **     **    CREST
   3    155.    237.   38.5     1.000     0.00       1            EXIT !
   4    237.    600.    9.9     1.000     0.00       1            EXIT
   5    600.   1049.    6.3     1.000     0.00       1            EXIT
   6   1049.   1170.   15.1     1.000     0.00       1            EXIT

  + The minimum maintenance code value of 2 is used in INTEGRITY computations
      (the program changes values of 1 to 2 during computation).
  * Upper case indicates a reach of constructed spillway channel.
 ** The program does not use vegetal cover factor, maintenance code, and
      rooting depth for inlet and crest reaches in computations.
  ! Reach   3 used in computing exit channel velocities.
  ***************************************************************************

 ROUTED       BTM WIDTH  MAX ELEV   VOL-MAX  AREA-MAX   AUX.-HP   VOL-AUX.
 RESULTS          FT        FT        ACFT      AC         FT       ACFT
 NRCS-SDH          30.0   5548.67    6675.5       0.0      0.16      31.0

           PEAK - CFS        Q-PS     Q-AUX.    Q-TOT.
           DISCHARGE  =      65.7       0.2      65.9
```

```
                       CRITICAL  CRITICAL   CRITICAL  25% OF Q
                         DEPTH   VELOCITY   SLOPE-Sc     Sc
         AUXILIARY         FT      FT/SEC     FT/FT     FT/FT
         SPILLWAY ---     0.01      0.57     0.148     0.308

         AUXILIARY SPILLWAY DURATION FLOW =        8.7 HOURS

         PLOT NRCS-SDH                 1 IN =    500. CFS                                          EXIT SLOPE = 0.385
                                                0.      500.     1000.     1500.     2000.     2500.     3000.     3500.
Time    Qin  Qout   Elev    Vol   Area  ExtVel  I         I         I         I         I         I         I         I
 1.50     0     8 5546.3  6203.0   0.0   0.00   .
 1.80     6     8 5546.3  6203.0   0.0   0.00   .
 2.10    39     8 5546.3  6203.4   0.0   0.00   .I
 2.40   194     8 5546.3  6206.1   0.0   0.00   .   I
 2.70   687     9 5546.3  6216.8   0.0   0.00   .             I
 3.00  1365    11 5546.5  6242.0   0.0   0.00   .                          I
 3.30  2027    15 5546.7  6283.7   0.0   0.00   .                                        I
 3.60  2180    20 5546.9  6335.4   0.0   0.00   .                                           X
 3.90  1955    26 5547.2  6386.1   0.0   0.00   .P                                     I
 4.20  1683    31 5547.4  6430.5   0.0   0.00   .P                                I
 4.50  1441    36 5547.6  6468.4   0.0   0.00   .P                           I
 4.80  1248    40 5547.8  6500.8   0.0   0.00   .P                       I
 5.10  1107    44 5547.9  6528.9   0.0   0.00   .P                    I
 5.40  1001    47 5548.1  6553.9   0.0   0.00   .P                  I
 5.70   924    51 5548.2  6576.6   0.0   0.00   .P                I
 6.00   874    54 5548.3  6597.6   0.0   0.00   .P               I
 6.30   833    57 5548.4  6617.4   0.0   0.00   .P               I
 6.60   748    60 5548.5  6635.5   0.0   0.00   .P             I
 6.90   589    62 5548.5  6650.6   0.0   0.00   .A          I
 7.20   423    64 5548.6  6661.6   0.0   0.00   .A      I
 7.50   283    65 5548.6  6668.8   0.0   0.00   .A    I
 7.80   180    65 5548.7  6672.9   0.0   0.00   .A  I
 8.10   112    66 5548.7  6674.9   0.0   0.00   .AI
 8.40    73    66 5548.7  6675.5   0.0   0.00   .X
 8.70    47    66 5548.7  6675.4   0.0   0.00   .A
 9.00    28    66 5548.7  6674.7   0.0   0.00   .A
 9.30    16    66 5548.7  6673.6   0.0   0.00   .A
 9.60     9    65 5548.7  6672.3   0.0   0.00   .A
 9.90     5    65 5548.6  6670.8   0.0   0.00   .A
10.20     3    65 5548.6  6669.3   0.0   0.00   .A
10.50     1    65 5548.6  6667.8   0.0   0.00   .A
10.80     1    64 5548.6  6666.2   0.0   0.00   .A
11.10     0    64 5548.6  6664.6   0.0   0.00   .A
11.40     0    64 5548.6  6663.1   0.0   0.00   .A
11.70     0    64 5548.6  6661.5   0.0   0.00   .A
12.00     0    63 5548.6  6660.0   0.0   0.00   .A
12.30     0    63 5548.6  6658.4   0.0   0.00   .A
12.60     0    63 5548.6  6656.9   0.0   0.00   .A
12.90     0    63 5548.6  6655.4   0.0   0.00   .A
13.20     0    62 5548.6  6653.8   0.0   0.00   .A
13.50     0    62 5548.6  6652.3   0.0   0.00   .A
13.80     0    62 5548.5  6650.8   0.0   0.00   .A
14.10     0    62 5548.5  6649.3   0.0   0.00   .A
14.40     0    61 5548.5  6647.8   0.0   0.00   .A
14.70     0    61 5548.5  6646.3   0.0   0.00   .A
15.00     0    61 5548.5  6644.8   0.0   0.00   .A
15.30     0    61 5548.5  6643.3   0.0   0.00   .P
15.60     0    60 5548.5  6641.9   0.0   0.00   .P
15.90     0    60 5548.5  6640.4   0.0   0.00   .P
16.20     0    60 5548.5  6638.9   0.0   0.00   .P
16.50     0    60 5548.5  6637.5   0.0   0.00   .P
16.80     0    60 5548.5  6636.0   0.0   0.00   .P
17.10     0    59 5548.5  6634.5   0.0   0.00   .P
17.40     0    59 5548.5  6633.1   0.0   0.00   .P
17.70     0    59 5548.4  6631.7   0.0   0.00   .P
18.00     0    59 5548.4  6630.2   0.0   0.00   .P
18.30     0    58 5548.4  6628.8   0.0   0.00   .P
18.60     0    58 5548.4  6627.4   0.0   0.00   .P
18.90     0    58 5548.4  6626.0   0.0   0.00   .P
19.20     0    58 5548.4  6624.6   0.0   0.00   .P
19.50     0    58 5548.4  6623.1   0.0   0.00   .P
19.80     0    57 5548.4  6621.7   0.0   0.00   .P
20.10     0    57 5548.4  6620.3   0.0   0.00   .P
20.40     0    57 5548.4  6619.0   0.0   0.00   .P
20.70     0    57 5548.4  6617.6   0.0   0.00   .P
21.00     0    57 5548.4  6616.2   0.0   0.00   .P
21.30     0    56 5548.4  6614.8   0.0   0.00   .P
21.60     0    56 5548.4  6613.4   0.0   0.00   .P
21.90     0    56 5548.3  6612.1   0.0   0.00   .P
22.20     0    56 5548.3  6610.7   0.0   0.00   .P
22.50     0    56 5548.3  6609.4   0.0   0.00   .P
22.80     0    55 5548.3  6608.0   0.0   0.00   .P
23.10     0    55 5548.3  6606.7   0.0   0.00   .P
23.40     0    55 5548.3  6605.3   0.0   0.00   .P
23.70     0    55 5548.3  6604.0   0.0   0.00   .P
24.00     0    55 5548.3  6602.7   0.0   0.00   .P
24.30     0    54 5548.3  6601.3   0.0   0.00   .P
24.60     0    54 5548.3  6600.0   0.0   0.00   .P
24.90     0    54 5548.3  6598.7   0.0   0.00   .P
25.20     0    54 5548.3  6597.4   0.0   0.00   .P
25.50     0    54 5548.3  6596.1   0.0   0.00   .P
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25.80     0    53 5548.3  6594.8   0.0   0.00   .P
26.10     0    53 5548.3  6593.5   0.0   0.00   .P
26.40     0    53 5548.2  6592.2   0.0   0.00   .P
26.70     0    53 5548.2  6590.9   0.0   0.00   .P
27.00     0    53 5548.2  6589.6   0.0   0.00   .P
27.30     0    52 5548.2  6588.4   0.0   0.00   .P
27.60     0    52 5548.2  6587.1   0.0   0.00   .P
27.90     0    52 5548.2  6585.8   0.0   0.00   .P
28.20     0    52 5548.2  6584.5   0.0   0.00   .P
28.50     0    52 5548.2  6583.3   0.0   0.00   .P
28.80     0    51 5548.2  6582.0   0.0   0.00   .P
29.10     0    51 5548.2  6580.8   0.0   0.00   .P
29.40     0    51 5548.2  6579.5   0.0   0.00   .P
29.70     0    51 5548.2  6578.3   0.0   0.00   .P
30.00     0    51 5548.2  6577.1   0.0   0.00   .P
30.30     0    51 5548.2  6575.8   0.0   0.00   .P
30.60     0    50 5548.2  6574.6   0.0   0.00   .P
30.90     0    50 5548.2  6573.4   0.0   0.00   .P
31.20     0    50 5548.1  6572.2   0.0   0.00   .P
31.50     0    50 5548.1  6571.0   0.0   0.00   .P
31.80     0    50 5548.1  6569.8   0.0   0.00   .P
32.10     0    50 5548.1  6568.5   0.0   0.00   .P
32.40     0    49 5548.1  6567.3   0.0   0.00   .P
32.70     0    49 5548.1  6566.1   0.0   0.00   .P
33.00     0    49 5548.1  6565.0   0.0   0.00   .P
33.30     0    49 5548.1  6563.8   0.0   0.00   .P
33.60     0    49 5548.1  6562.6   0.0   0.00   .P
33.90     0    49 5548.1  6561.4   0.0   0.00   .P
34.20     0    48 5548.1  6560.2   0.0   0.00   .P
34.50     0    48 5548.1  6559.1   0.0   0.00   .P
34.80     0    48 5548.1  6557.9   0.0   0.00   .P
35.10     0    48 5548.1  6556.7   0.0   0.00   .P
35.40     0    48 5548.1  6555.6   0.0   0.00   .P
35.70     0    48 5548.1  6554.4   0.0   0.00   .P
36.00     0    47 5548.0  6553.3   0.0   0.00   .P
36.30     0    47 5548.0  6552.1   0.0   0.00   .P
36.60     0    47 5548.0  6551.0   0.0   0.00   .P
36.90     0    47 5548.0  6549.8   0.0   0.00   .P
37.20     0    47 5548.0  6548.7   0.0   0.00   .P
37.50     0    47 5548.0  6547.6   0.0   0.00   .P
37.80     0    46 5548.0  6546.4   0.0   0.00   .P
38.10     0    46 5548.0  6545.3   0.0   0.00   .P
38.40     0    46 5548.0  6544.2   0.0   0.00   .P
38.70     0    46 5548.0  6543.1   0.0   0.00   .P
39.00     0    46 5548.0  6542.0   0.0   0.00   .P
39.30     0    46 5548.0  6540.9   0.0   0.00   .P
39.60     0    45 5548.0  6539.8   0.0   0.00   .P
39.90     0    45 5548.0  6538.7   0.0   0.00   .P
40.20     0    45 5548.0  6537.6   0.0   0.00   .P
40.50     0    45 5548.0  6536.5   0.0   0.00   .P
40.80     0    45 5548.0  6535.4   0.0   0.00   .P
41.10     0    45 5548.0  6534.3   0.0   0.00   .P
41.40     0    45 5547.9  6533.2   0.0   0.00   .P
41.70     0    44 5547.9  6532.1   0.0   0.00   .P
42.00     0    44 5547.9  6531.1   0.0   0.00   .P
42.30     0    44 5547.9  6530.0   0.0   0.00   .P
42.60     0    44 5547.9  6528.9   0.0   0.00   .P
42.90     0    44 5547.9  6527.9   0.0   0.00   .P
43.20     0    44 5547.9  6526.8   0.0   0.00   .P
43.50     0    43 5547.9  6525.7   0.0   0.00   .P
43.80     0    43 5547.9  6524.7   0.0   0.00   .P
44.10     0    43 5547.9  6523.6   0.0   0.00   .P
44.40     0    43 5547.9  6522.6   0.0   0.00   .P
44.70     0    43 5547.9  6521.6   0.0   0.00   .P
45.00     0    43 5547.9  6520.5   0.0   0.00   .P
45.30     0    43 5547.9  6519.5   0.0   0.00   .P
45.60     0    42 5547.9  6518.5   0.0   0.00   .P
45.90     0    42 5547.9  6517.4   0.0   0.00   .P
46.20     0    42 5547.9  6516.4   0.0   0.00   .P
46.50     0    42 5547.9  6515.4   0.0   0.00   .P
46.80     0    42 5547.8  6514.4   0.0   0.00   .P
47.10     0    42 5547.8  6513.4   0.0   0.00   .P
47.40     0    42 5547.8  6512.4   0.0   0.00   .P
47.70     0    41 5547.8  6511.4   0.0   0.00   .P
48.00     0    41 5547.8  6510.4   0.0   0.00   .P
48.30     0    41 5547.8  6509.4   0.0   0.00   .P
48.60     0    41 5547.8  6508.4   0.0   0.00   .P
48.90     0    41 5547.8  6507.4   0.0   0.00   .P
49.20     0    41 5547.8  6506.4   0.0   0.00   .P
49.50     0    41 5547.8  6505.4   0.0   0.00   .P
49.80     0    41 5547.8  6504.4   0.0   0.00   .P
50.10     0    40 5547.8  6503.4   0.0   0.00   .P
50.40     0    40 5547.8  6502.5   0.0   0.00   .P
50.70     0    40 5547.8  6501.5   0.0   0.00   .P
51.00     0    40 5547.8  6500.5   0.0   0.00   .P
51.30     0    40 5547.8  6499.6   0.0   0.00   .P
51.60     0    40 5547.8  6498.6   0.0   0.00   .P
51.90     0    40 5547.8  6497.6   0.0   0.00   .P
52.20     0    40 5547.8  6496.7   0.0   0.00   .P
52.50     0    39 5547.8  6495.7   0.0   0.00   .P
52.80     0    39 5547.7  6494.8   0.0   0.00   .P
53.10     0    39 5547.7  6493.8   0.0   0.00   .P
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53.40     0    39 5547.7  6492.9   0.0   0.00   .P
53.70     0    39 5547.7  6491.9   0.0   0.00   .P
54.00     0    39 5547.7  6491.0   0.0   0.00   .P
54.30     0    39 5547.7  6490.1   0.0   0.00   .P
54.60     0    39 5547.7  6489.1   0.0   0.00   .P
54.90     0    38 5547.7  6488.2   0.0   0.00   .P
55.20     0    38 5547.7  6487.3   0.0   0.00   .P
55.50     0    38 5547.7  6486.4   0.0   0.00   .P
55.80     0    38 5547.7  6485.4   0.0   0.00   .P
56.10     0    38 5547.7  6484.5   0.0   0.00   .P
56.40     0    38 5547.7  6483.6   0.0   0.00   .P
56.70     0    38 5547.7  6482.7   0.0   0.00   .P
57.00     0    38 5547.7  6481.8   0.0   0.00   .P
57.30     0    37 5547.7  6480.9   0.0   0.00   .P
57.60     0    37 5547.7  6480.0   0.0   0.00   .P
57.90     0    37 5547.7  6479.1   0.0   0.00   .P
58.20     0    37 5547.7  6478.2   0.0   0.00   .P
58.50     0    37 5547.7  6477.3   0.0   0.00   .P
58.80     0    37 5547.7  6476.4   0.0   0.00   .P
59.10     0    37 5547.7  6475.5   0.0   0.00   .P
59.40     0    37 5547.6  6474.6   0.0   0.00   .P
59.70     0    37 5547.6  6473.7   0.0   0.00   .P
60.00     0    36 5547.6  6472.9   0.0   0.00   .P
60.30     0    36 5547.6  6472.0   0.0   0.00   .P
60.60     0    36 5547.6  6471.1   0.0   0.00   .P
60.90     0    36 5547.6  6470.2   0.0   0.00   .P
61.20     0    36 5547.6  6469.4   0.0   0.00   .P
61.50     0    36 5547.6  6468.5   0.0   0.00   .P
61.80     0    36 5547.6  6467.7   0.0   0.00   .P
62.10     0    36 5547.6  6466.8   0.0   0.00   .P
62.40     0    35 5547.6  6465.9   0.0   0.00   .P
62.70     0    35 5547.6  6465.1   0.0   0.00   .P
63.00     0    35 5547.6  6464.2   0.0   0.00   .P
63.30     0    35 5547.6  6463.4   0.0   0.00   .P
63.60     0    35 5547.6  6462.5   0.0   0.00   .P
63.90     0    35 5547.6  6461.7   0.0   0.00   .P
64.20     0    35 5547.6  6460.9   0.0   0.00   .P
64.50     0    35 5547.6  6460.0   0.0   0.00   .P
64.80     0    35 5547.6  6459.2   0.0   0.00   .P
65.10     0    34 5547.6  6458.4   0.0   0.00   .P
65.40     0    34 5547.6  6457.5   0.0   0.00   .P
65.70     0    34 5547.6  6456.7   0.0   0.00   .P
66.00     0    34 5547.5  6455.9   0.0   0.00   .P
66.30     0    34 5547.5  6455.1   0.0   0.00   .P
66.60     0    34 5547.5  6454.2   0.0   0.00   .P
66.90     0    34 5547.5  6453.4   0.0   0.00   .P
67.20     0    34 5547.5  6452.6   0.0   0.00   .P
67.50     0    34 5547.5  6451.8   0.0   0.00   .P
67.80     0    34 5547.5  6451.0   0.0   0.00   .P
68.10     0    33 5547.5  6450.2   0.0   0.00   .P
68.40     0    33 5547.5  6449.4   0.0   0.00   .P
68.70     0    33 5547.5  6448.6   0.0   0.00   .P
69.00     0    33 5547.5  6447.8   0.0   0.00   .P
69.30     0    33 5547.5  6447.0   0.0   0.00   .P
69.60     0    33 5547.5  6446.2   0.0   0.00   .P
69.90     0    33 5547.5  6445.4   0.0   0.00   .P
70.20     0    33 5547.5  6444.6   0.0   0.00   .P
70.50     0    33 5547.5  6443.8   0.0   0.00   .P
70.80     0    33 5547.5  6443.1   0.0   0.00   .P
71.10     0    32 5547.5  6442.3   0.0   0.00   .P
71.40     0    32 5547.5  6441.5   0.0   0.00   .P
71.70     0    32 5547.5  6440.7   0.0   0.00   .P
72.00     0    32 5547.5  6439.9   0.0   0.00   .P
72.30     0    32 5547.5  6439.2   0.0   0.00   .P
72.60     0    32 5547.5  6438.4   0.0   0.00   .P
72.90     0    32 5547.5  6437.6   0.0   0.00   .P
73.20     0    32 5547.5  6436.9   0.0   0.00   .P
73.50     0    32 5547.4  6436.1   0.0   0.00   .P
73.80     0    32 5547.4  6435.4   0.0   0.00   .P
74.10     0    31 5547.4  6434.6   0.0   0.00   .P
74.40     0    31 5547.4  6433.8   0.0   0.00   .P
74.70     0    31 5547.4  6433.1   0.0   0.00   .P
75.00     0    31 5547.4  6432.3   0.0   0.00   .P
75.30     0    31 5547.4  6431.6   0.0   0.00   .P
75.60     0    31 5547.4  6430.8   0.0   0.00   .P
75.90     0    31 5547.4  6430.1   0.0   0.00   .P
76.20     0    31 5547.4  6429.4   0.0   0.00   .P
76.50     0    31 5547.4  6428.6   0.0   0.00   .P
76.80     0    31 5547.4  6427.9   0.0   0.00   .P
77.10     0    31 5547.4  6427.1   0.0   0.00   .P
77.40     0    31 5547.4  6426.4   0.0   0.00   .P
77.70     0    30 5547.4  6425.7   0.0   0.00   .P
78.00     0    30 5547.4  6425.0   0.0   0.00   .P
78.30     0    30 5547.4  6424.2   0.0   0.00   .P
78.60     0    30 5547.4  6423.5   0.0   0.00   .P
78.90     0    30 5547.4  6422.8   0.0   0.00   .P
79.20     0    30 5547.4  6422.1   0.0   0.00   .P
79.50     0    30 5547.4  6421.3   0.0   0.00   .P
79.80     0    30 5547.4  6420.6   0.0   0.00   .P
80.10     0    30 5547.4  6419.9   0.0   0.00   .P
80.40     0    30 5547.4  6419.2   0.0   0.00   .P
80.70     0    30 5547.4  6418.5   0.0   0.00   .P
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  81.00     0    29 5547.4  6417.8   0.0   0.00   .P
  81.30     0    29 5547.4  6417.1   0.0   0.00   .P
  81.60     0    29 5547.3  6416.4   0.0   0.00   .P
  81.90     0    29 5547.3  6415.7   0.0   0.00   .P
  82.20     0    29 5547.3  6415.0   0.0   0.00   .P
  82.50     0    29 5547.3  6414.3   0.0   0.00   .P
  82.80     0    29 5547.3  6413.6   0.0   0.00   .P
  83.10     0    29 5547.3  6412.9   0.0   0.00   .P
  83.40     0    29 5547.3  6412.2   0.0   0.00   .P
  83.70     0    29 5547.3  6411.5   0.0   0.00   .P
  84.00     0    29 5547.3  6410.8   0.0   0.00   .P
  84.30     0    29 5547.3  6410.2   0.0   0.00   .P
  84.60     0    28 5547.3  6409.5   0.0   0.00   .P
  84.90     0    28 5547.3  6408.8   0.0   0.00   .P
  85.20     0    28 5547.3  6408.1   0.0   0.00   .P
  85.50     0    28 5547.3  6407.4   0.0   0.00   .P
  85.80     0    28 5547.3  6406.8   0.0   0.00   .P
  86.10     0    28 5547.3  6406.1   0.0   0.00   .P
  86.40     0    28 5547.3  6405.4   0.0   0.00   .P
  86.70     0    28 5547.3  6404.8   0.0   0.00   .P
  87.00     0    28 5547.3  6404.1   0.0   0.00   .P
  87.30     0    28 5547.3  6403.4   0.0   0.00   .P
  87.60     0    28 5547.3  6402.8   0.0   0.00   .P
  87.90     0    28 5547.3  6402.1   0.0   0.00   .P
  88.20     0    27 5547.3  6401.4   0.0   0.00   .P
  88.50     0    27 5547.3  6400.8   0.0   0.00   .P
  88.80     0    27 5547.3  6400.1   0.0   0.00   .P
  89.10     0    27 5547.3  6399.5   0.0   0.00   .P
  89.40     0    27 5547.3  6398.8   0.0   0.00   .P
  89.70     0    27 5547.3  6398.2   0.0   0.00   .P
  90.00     0    27 5547.3  6397.5   0.0   0.00   .P
  90.30     0    27 5547.2  6396.9   0.0   0.00   .P
  90.60     0    27 5547.2  6396.3   0.0   0.00   .P
  90.90     0    27 5547.2  6395.6   0.0   0.00   .P
  91.20     0    27 5547.2  6395.0   0.0   0.00   .P
  91.50     0    27 5547.2  6394.3   0.0   0.00   .P
  91.80     0    27 5547.2  6393.7   0.0   0.00   .P
  92.10     0    26 5547.2  6393.1   0.0   0.00   .P
  92.40     0    26 5547.2  6392.4   0.0   0.00   .P
  92.70     0    26 5547.2  6391.8   0.0   0.00   .P
  93.00     0    26 5547.2  6391.2   0.0   0.00   .P
  93.30     0    26 5547.2  6390.6   0.0   0.00   .P
  93.60     0    26 5547.2  6389.9   0.0   0.00   .P
  93.90     0    26 5547.2  6389.3   0.0   0.00   .P
  94.20     0    26 5547.2  6388.7   0.0   0.00   .P
  94.50     0    26 5547.2  6388.1   0.0   0.00   .P
  94.80     0    26 5547.2  6387.5   0.0   0.00   .P
  95.10     0    26 5547.2  6386.9   0.0   0.00   .P
  95.40     0    26 5547.2  6386.2   0.0   0.00   .P
  95.70     0    26 5547.2  6385.6   0.0   0.00   .P
  96.00     0    26 5547.2  6385.0   0.0   0.00   .P
  96.30     0    25 5547.2  6384.4   0.0   0.00   .P
  96.60     0    25 5547.2  6383.8   0.0   0.00   .P
  96.90     0    25 5547.2  6383.2   0.0   0.00   .P
  97.20     0    25 5547.2  6382.6   0.0   0.00   .P
  Time    Qin  Qout   Elev    Vol   Area  ExtVel  I         I         I         I         I         I         I         I
                                                  0.      500.     1000.     1500.     2000.     2500.     3000.     3500.
         END NRCS-SDH   PLOT

 ROUTED       BTM WIDTH  MAX ELEV   VOL-MAX  AREA-MAX   AUX.-HP   VOL-AUX.
 RESULTS          FT        FT        ACFT      AC         FT       ACFT
 NRCS-FBH          30.0   5552.00    7347.2       0.0      3.49     702.7

           PEAK - CFS        Q-PS     Q-AUX.    Q-TOT.
           DISCHARGE  =     126.7     432.6     559.2

                         CRITICAL  CRITICAL   CRITICAL  25% OF Q
                           DEPTH   VELOCITY   SLOPE-Sc     Sc
           AUXILIARY         FT      FT/SEC     FT/FT     FT/FT
           SPILLWAY ---     1.79      7.21     0.008     0.011

           INTEGRITY ANALYSIS - REACH SURFACE PERFORMANCE SUMMARY
            (The auxiliary spillway began flow at time =    3.3 hours
             and peaked at time =    7.5 hours.)


             REACH   3: FROM STATION    155. TO    237. ON   38.5% SLOPE.
                Non-vegetated conditions implied: flow concentration
                 assumed with minimal flow: Time =    4.2 hours.


             REACH   4: FROM STATION    237. TO    600. ON    9.9% SLOPE.
                Non-vegetated conditions implied: flow concentration
                 assumed with minimal flow: Time =    4.2 hours.


             REACH   5: FROM STATION    600. TO   1049. ON    6.3% SLOPE.
                Non-vegetated conditions implied: flow concentration
                 assumed with minimal flow: Time =    4.2 hours.


             REACH   6: FROM STATION   1049. TO   1170. ON   15.1% SLOPE.
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               Non-vegetated conditions implied: flow concentration
                assumed with minimal flow: Time =    4.2 hours.


          INTEGRITY ANALYSIS - HEADCUT EROSION DAMAGE SUMMARY

            The most upstream headcut began at station    155.
            and progressed upstream to station    153.
            The final height of the headcut was    6.9 ft.

            The deepest headcut is also the furthest upstream.

          THE HYDROGRAPH WAS NOT ADJUSTED FOR THE EFFECTS OF EROSION.

                         DURATION    ATTACK   DIST. FROM MOST U/S
                           FLOW       OE/B    HEADCUT TO U/S EDGE
          AUXILIARY         HRS     ACFT/FT     AUX. CREST, FT
          SPILLWAY ---    61.5       12.1            78.

          EXIT CHANNEL FLOW SUPERCRITICAL: MAX VELOCITY=  24.1 FT/SEC
                                           EXIT SLOPE  = 0.385 FT/FT
                                           FLOW DEPTH  =   0.6 FT


>>>>> MINIMUM FLOW IN AUXILIARY SPILLWAY FROM TR60 ( 510. CFS).

ROUTED       BTM WIDTH  MAX ELEV   VOL-MAX  AREA-MAX   AUX.-HP   VOL-AUX.
RESULTS          FT        FT        ACFT      AC         FT       ACFT
MIN. AUX.         30.0   5552.28    7405.2       0.0      3.77     760.7

          PEAK - CFS        Q-PS     Q-AUX.    Q-TOT.
          DISCHARGE  =     126.9     510.4     637.3

                        CRITICAL  CRITICAL   CRITICAL  25% OF Q
                          DEPTH   VELOCITY   SLOPE-Sc     Sc
          AUXILIARY         FT      FT/SEC     FT/FT     FT/FT
          SPILLWAY ---     1.99      7.57     0.008     0.011

          PLOT NRCS-FBH                  1 IN =   1000. CFS                                          EXIT SLOPE = 0.385
                                                 0.     1000.     2000.     3000.     4000.     5000.     6000.     7000.
 Time    Qin  Qout   Elev    Vol   Area  ExtVel  I         I         I         I         I         I         I         I
  0.90     0     8 5546.3  6203.0   0.0   0.00   .
  1.20     8     8 5546.3  6203.0   0.0   0.00   .
  1.50    43     8 5546.3  6203.5   0.0   0.00   .
  1.80   129     8 5546.3  6205.4   0.0   0.00   .I
  2.10   306     8 5546.3  6210.6   0.0   0.00   .  I
  2.40   824     9 5546.4  6224.4   0.0   0.00   .       I
  2.70  2325    13 5546.6  6263.1   0.0   0.00   .                      I
  3.00  4867    22 5547.0  6351.9   0.0   0.00   .                                                I
  3.30  6395    39 5547.7  6490.7   0.0   0.00   .                                                               X
  3.60  6123    61 5548.5  6644.7   0.0   0.00   .A                                                           I
  3.90  5053    86 5549.2  6781.4   0.0   3.25   .A                                                 I
  4.20  4063   129 5549.8  6891.7   0.0   8.04   .A                                       I
  4.50  3364   196 5550.2  6979.8   0.0  12.35   . A                               I
  4.80  2855   250 5550.6  7051.3   0.0  14.90   . A                          I
  5.10  2500   302 5550.9  7110.9   0.0  17.07   .  A                     I
  5.40  2228   349 5551.1  7161.4   0.0  18.71   .  A                  I
  5.70  2039   394 5551.3  7205.1   0.0  20.09   .   A               I
  6.00  1913   436 5551.5  7243.8   0.0  21.24   .   A              I
  6.30  1819   477 5551.7  7278.8   0.0  22.29   .    A            I
  6.60  1614   513 5551.8  7309.0   0.0  23.13   .    A          I
  6.90  1240   540 5551.9  7331.4   0.0  23.72   .    A      I
  7.20   851   555 5552.0  7343.7   0.0  24.05   .     A  I
  7.50   540   559 5552.0  7347.2   0.0  24.15   .    IX
  7.80   332   555 5552.0  7344.1   0.0  24.06   .  I  A
  8.10   201   546 5552.0  7337.1   0.0  23.87   . I  A
  8.40   113   535 5551.9  7327.6   0.0  23.62   .I   A
  8.70    62   522 5551.9  7316.6   0.0  23.34   .I   A
  9.00    34   508 5551.8  7305.1   0.0  23.02   .    A
  9.30    18   495 5551.7  7293.3   0.0  22.70   .    A
  9.60     9   481 5551.7  7281.5   0.0  22.37   .    A
  9.90     5   467 5551.6  7269.9   0.0  22.03   .    A
 10.20     2   453 5551.6  7258.6   0.0  21.70   .    A
 10.50     1   440 5551.5  7247.6   0.0  21.36   .   A
 10.80     0   428 5551.5  7236.8   0.0  21.02   .   A
 11.10     0   416 5551.4  7226.4   0.0  20.71   .   A
 11.40     0   406 5551.4  7216.2   0.0  20.42   .   A
 11.70     0   395 5551.3  7206.3   0.0  20.13   .   A
 12.00     0   385 5551.3  7196.7   0.0  19.84   .   A
 12.30     0   376 5551.2  7187.3   0.0  19.55   .   A
 12.60     0   366 5551.2  7178.1   0.0  19.26   .   A
 12.90     0   357 5551.1  7169.2   0.0  18.97   .   A
 13.20     0   348 5551.1  7160.4   0.0  18.68   .  A
 13.50     0   339 5551.1  7152.0   0.0  18.39   .  A
 13.80     0   331 5551.0  7143.7   0.0  18.11   .  A
 14.10     0   324 5551.0  7135.6   0.0  17.86   .  A
 14.40     0   317 5550.9  7127.7   0.0  17.62   .  A
 14.70     0   310 5550.9  7119.9   0.0  17.37   .  A
 15.00     0   303 5550.9  7112.4   0.0  17.12   .  A
 15.30     0   297 5550.8  7104.9   0.0  16.88   .  A
 15.60     0   290 5550.8  7097.7   0.0  16.63   .  A
 15.90     0   284 5550.8  7090.6   0.0  16.38   .  A
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16.20     0   278 5550.7  7083.7   0.0  16.13   .  A
16.50     0   272 5550.7  7076.9   0.0  15.88   .  A
16.80     0   266 5550.7  7070.2   0.0  15.63   .  A
17.10     0   260 5550.6  7063.7   0.0  15.38   .  A
17.40     0   255 5550.6  7057.3   0.0  15.13   .  A
17.70     0   250 5550.6  7051.1   0.0  14.89   . A
18.00     0   245 5550.5  7045.0   0.0  14.65   . A
18.30     0   240 5550.5  7039.0   0.0  14.41   . A
18.60     0   235 5550.5  7033.2   0.0  14.20   . A
18.90     0   231 5550.4  7027.4   0.0  14.00   . A
19.20     0   228 5550.4  7021.7   0.0  13.79   . A
19.50     0   224 5550.4  7016.2   0.0  13.59   . A
19.80     0   220 5550.4  7010.7   0.0  13.41   . A
20.10     0   216 5550.3  7005.3   0.0  13.24   . A
20.40     0   212 5550.3  7000.1   0.0  13.06   . A
20.70     0   208 5550.3  6994.9   0.0  12.89   . A
21.00     0   204 5550.3  6989.8   0.0  12.71   . A
21.30     0   200 5550.2  6984.8   0.0  12.54   . A
21.60     0   196 5550.2  6979.9   0.0  12.36   . A
21.90     0   193 5550.2  6975.2   0.0  12.18   . A
22.20     0   189 5550.2  6970.5   0.0  12.01   . A
22.50     0   185 5550.1  6965.8   0.0  11.83   . A
22.80     0   182 5550.1  6961.3   0.0  11.65   . A
23.10     0   179 5550.1  6956.9   0.0  11.46   . A
23.40     0   175 5550.1  6952.5   0.0  11.28   . A
23.70     0   172 5550.1  6948.2   0.0  11.10   . A
24.00     0   169 5550.0  6944.0   0.0  10.91   . A
24.30     0   166 5550.0  6939.9   0.0  10.73   . A
24.60     0   163 5550.0  6935.9   0.0  10.54   . A
24.90     0   159 5550.0  6931.9   0.0  10.35   . A
25.20     0   157 5550.0  6928.0   0.0  10.16   . A
25.50     0   154 5549.9  6924.2   0.0   9.97   . A
25.80     0   151 5549.9  6920.4   0.0   9.78   . A
26.10     0   148 5549.9  6916.8   0.0   9.58   .A
26.40     0   145 5549.9  6913.1   0.0   9.38   .A
26.70     0   142 5549.9  6909.6   0.0   9.18   .A
27.00     0   140 5549.9  6906.1   0.0   8.98   .A
27.30     0   137 5549.8  6902.7   0.0   8.77   .A
27.60     0   135 5549.8  6899.4   0.0   8.56   .A
27.90     0   132 5549.8  6896.1   0.0   8.34   .A
28.20     0   130 5549.8  6892.9   0.0   8.12   .A
28.50     0   127 5549.8  6889.7   0.0   7.89   .A
28.80     0   126 5549.8  6886.6   0.0   7.77   .A
29.10     0   125 5549.7  6883.5   0.0   7.69   .A
29.40     0   123 5549.7  6880.5   0.0   7.61   .A
29.70     0   122 5549.7  6877.5   0.0   7.53   .A
30.00     0   121 5549.7  6874.5   0.0   7.46   .A
30.30     0   120 5549.7  6871.5   0.0   7.38   .A
30.60     0   119 5549.7  6868.6   0.0   7.30   .A
30.90     0   118 5549.6  6865.7   0.0   7.22   .A
31.20     0   117 5549.6  6862.8   0.0   7.13   .A
31.50     0   116 5549.6  6859.9   0.0   7.05   .A
31.80     0   115 5549.6  6857.1   0.0   6.97   .A
32.10     0   114 5549.6  6854.3   0.0   6.88   .A
32.40     0   113 5549.6  6851.5   0.0   6.80   .A
32.70     0   112 5549.6  6848.7   0.0   6.71   .A
33.00     0   110 5549.5  6846.0   0.0   6.62   .A
33.30     0   109 5549.5  6843.3   0.0   6.54   .A
33.60     0   108 5549.5  6840.6   0.0   6.45   .A
33.90     0   107 5549.5  6838.0   0.0   6.36   .A
34.20     0   107 5549.5  6835.4   0.0   6.27   .A
34.50     0   106 5549.5  6832.8   0.0   6.17   .A
34.80     0   105 5549.5  6830.2   0.0   6.08   .A
35.10     0   104 5549.5  6827.6   0.0   5.98   .A
35.40     0   103 5549.4  6825.1   0.0   5.88   .A
35.70     0   102 5549.4  6822.6   0.0   5.78   .A
36.00     0   101 5549.4  6820.1   0.0   5.68   .A
36.30     0   100 5549.4  6817.6   0.0   5.58   .A
36.60     0    99 5549.4  6815.2   0.0   5.47   .A
36.90     0    98 5549.4  6812.8   0.0   5.36   .A
37.20     0    97 5549.4  6810.4   0.0   5.25   .A
37.50     0    96 5549.4  6808.0   0.0   5.14   .A
37.80     0    95 5549.3  6805.7   0.0   5.02   .A
38.10     0    95 5549.3  6803.3   0.0   4.90   .A
38.40     0    94 5549.3  6801.0   0.0   4.78   .A
38.70     0    93 5549.3  6798.7   0.0   4.65   .A
39.00     0    92 5549.3  6796.5   0.0   4.52   .A
39.30     0    91 5549.3  6794.2   0.0   4.39   .A
39.60     0    90 5549.3  6792.0   0.0   4.22   .A
39.90     0    89 5549.3  6789.8   0.0   4.04   .A
40.20     0    89 5549.2  6787.6   0.0   3.85   .A
40.50     0    88 5549.2  6785.4   0.0   3.66   .A
40.80     0    87 5549.2  6783.3   0.0   3.45   .A
41.10     0    86 5549.2  6781.2   0.0   3.23   .A
41.40     0    85 5549.2  6779.1   0.0   2.99   .A
41.70     0    85 5549.2  6777.0   0.0   2.74   .A
42.00     0    84 5549.2  6774.9   0.0   2.46   .A
42.30     0    83 5549.2  6772.9   0.0   2.14   .A
42.60     0    82 5549.2  6770.9   0.0   1.77   .A
42.90     0    82 5549.2  6768.9   0.0   1.29   .A
43.20     0    81 5549.1  6766.9   0.0   0.00   .A
43.50     0    80 5549.1  6764.9   0.0   0.00   .A
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43.80     0    80 5549.1  6762.9   0.0   0.00   .A
44.10     0    80 5549.1  6761.0   0.0   0.00   .A
44.40     0    79 5549.1  6759.0   0.0   0.00   .A
44.70     0    79 5549.1  6757.1   0.0   0.00   .A
45.00     0    79 5549.1  6755.1   0.0   0.00   .A
45.30     0    79 5549.1  6753.2   0.0   0.00   .A
45.60     0    78 5549.1  6751.3   0.0   0.00   .A
45.90     0    78 5549.1  6749.4   0.0   0.00   .A
46.20     0    78 5549.0  6747.5   0.0   0.00   .A
46.50     0    77 5549.0  6745.6   0.0   0.00   .A
46.80     0    77 5549.0  6743.7   0.0   0.00   .A
47.10     0    77 5549.0  6741.8   0.0   0.00   .A
47.40     0    76 5549.0  6740.0   0.0   0.00   .A
47.70     0    76 5549.0  6738.1   0.0   0.00   .A
48.00     0    76 5549.0  6736.2   0.0   0.00   .A
48.30     0    75 5549.0  6734.4   0.0   0.00   .A
48.60     0    75 5549.0  6732.5   0.0   0.00   .A
48.90     0    75 5549.0  6730.7   0.0   0.00   .A
49.20     0    75 5548.9  6728.9   0.0   0.00   .A
49.50     0    74 5548.9  6727.1   0.0   0.00   .A
49.80     0    74 5548.9  6725.2   0.0   0.00   .A
50.10     0    74 5548.9  6723.4   0.0   0.00   .A
50.40     0    73 5548.9  6721.6   0.0   0.00   .A
50.70     0    73 5548.9  6719.8   0.0   0.00   .A
51.00     0    73 5548.9  6718.1   0.0   0.00   .A
51.30     0    73 5548.9  6716.3   0.0   0.00   .A
51.60     0    72 5548.9  6714.5   0.0   0.00   .A
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52.20     0    72 5548.9  6711.0   0.0   0.00   .A
52.50     0    71 5548.8  6709.2   0.0   0.00   .A
52.80     0    71 5548.8  6707.5   0.0   0.00   .A
53.10     0    71 5548.8  6705.8   0.0   0.00   .A
53.40     0    71 5548.8  6704.0   0.0   0.00   .A
53.70     0    70 5548.8  6702.3   0.0   0.00   .A
54.00     0    70 5548.8  6700.6   0.0   0.00   .A
54.30     0    70 5548.8  6698.9   0.0   0.00   .A
54.60     0    69 5548.8  6697.2   0.0   0.00   .A
54.90     0    69 5548.8  6695.5   0.0   0.00   .A
55.20     0    69 5548.8  6693.8   0.0   0.00   .A
55.50     0    69 5548.8  6692.1   0.0   0.00   .A
55.80     0    68 5548.8  6690.5   0.0   0.00   .A
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56.40     0    68 5548.7  6687.1   0.0   0.00   .A
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58.20     0    66 5548.7  6677.3   0.0   0.00   .A
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59.10     0    65 5548.7  6672.5   0.0   0.00   .A
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61.20     0    64 5548.6  6661.5   0.0   0.00   .A
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61.80     0    63 5548.6  6658.4   0.0   0.00   .A
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62.70     0    62 5548.6  6653.8   0.0   0.00   .A
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68.40     0    58 5548.4  6625.9   0.0   0.00   .P
68.70     0    58 5548.4  6624.5   0.0   0.00   .P
69.00     0    58 5548.4  6623.1   0.0   0.00   .P
69.30     0    57 5548.4  6621.7   0.0   0.00   .P
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69.90     0    57 5548.4  6618.9   0.0   0.00   .P
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70.50     0    57 5548.4  6616.2   0.0   0.00   .P
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71.10     0    56 5548.4  6613.4   0.0   0.00   .P
```
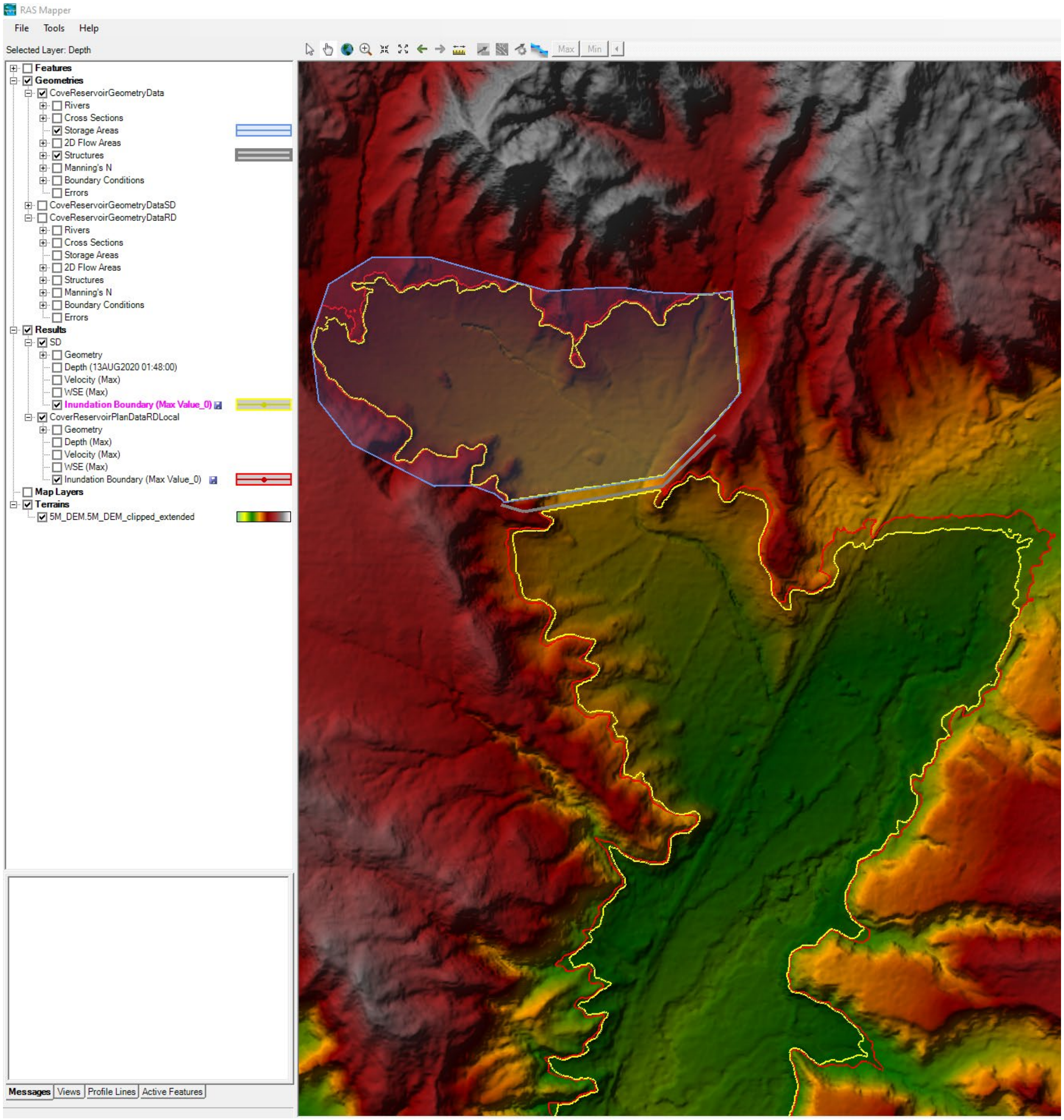

```
  71.40     0    56 5548.3  6612.1   0.0   0.00   .P
  71.70     0    56 5548.3  6610.7   0.0   0.00   .P
  Time    Qin  Qout   Elev    Vol   Area  ExtVel  I         I         I         I         I         I         I         I
                                                  0.     1000.     2000.     3000.     4000.     5000.     6000.     7000.
         END NRCS-FBH   PLOT
 --------------------------------------------------------------------------------

 Inflow Hyd 1 PSH-Peak =         39.99 CFS  at  143.00 hrs.,  Location Point

 Inflow Hyd 1 SDH-Peak =         65.90 CFS  at    8.10 hrs.,  Location Point

 Inflow Hyd 1 FBH-Peak =        559.24 CFS  at    7.20 hrs.,  Location Point
HYDOUT   1     STR1

1SITES....JOB NO.  1 COMPLETE.
 --------------------------------------------------------------------------------

 COVRES        COV RES

       0 SUBWATERSHED(S) ANALYZED.

       1 STRUCTURE(S) ANALYZED.

       3 HYDROGRAPHS ROUTED AT LOWEST SITE.

       0 TRIALS TO OBTAIN BOTTOM WIDTH FOR SPECIFIED STRESS OR VELOCITY.

 ********************************************************************************



 SITES.....COMPUTATIONS COMPLETE


                              SUMMARY TABLE  1          SITES VERSION 2005.1.8
                             ----------------                DATED 01/01/2005


 WATERSHED ID                       RUN DATE                           RUN TIME
 ------------                       --------                           --------
 COVRES                           08/20/2020                           06:12:11

 >>>   SITE   SUBWS   SUBWS DA   CURVE    TC   TOTAL DA   TYPE    STRUC    <<<
        ID      ID     (SQ MI)    NO.    (HRS)  (SQ MI)  DESIGN   CLASS
       -----   ----   --------   -----   ----   -------   -----   -----
       STR1     CR        4.74      0.   0.00      4.74    TR60     C

 PASS  DIA./  AUX.CREST  BTM.  MAX.    MAX.    EMB.  INTEGR.*  EXIT*    TYPE
  NO.  WIDTH    ELEV    WIDTH   HP     ELEV    VOL.   DIST.     VEL.     HYD
      (IN/FT)   (FT)     (FT)  (FT)    (FT)    (CY)   (FT)   (FT/SEC)
 ----  -----  -------  ------  ----  -------  -------  -----  ------  ---------
    1   30.0   5548.5    30.0   3.8   5552.3       0.    78.    24.1  MIN. AUX.


 *  INTEGRITY DIST. AND EXIT VEL. ARE BASED ON THE ROUTED HYDROGRAPH
    AND WILL NOT RELATE TO THE MAX. ELEV. (TOP OF DAM),
    WHICH IS SET BY MINIMUM DESIGN CRITERIA.




 SITES......SUMMARY TABLE 1 COMPLETED.


                    NRCS  SITES    VERSION 2005.1.8  ,01/01/2005
                             COVRES   FILES

INPUT  = c:\USDA\SITES\080620-PSH-ASHL-FBHL.d2c
OUTPUT = c:\USDA\SITES\080620-PSH-ASHL-FBHL.OUT
         DATED 08/20/2020 06:12:11

                         GRAPHICS FILES GENERATED

OPTION "L"  = c:\USDA\SITES\080620-PSH-ASHL-FBHL.DRG DATED 08/20/2020 06:12:11

OPTION "P"  = c:\USDA\SITES\080620-PSH-ASHL-FBHL.DHY DATED 08/20/2020 06:12:11

OPTION "E"  = c:\USDA\SITES\080620-PSH-ASHL-FBHL.DEM DATED 08/20/2020 06:12:11

AUX.GRAPHICS = c:\USDA\SITES\080620-PSH-ASHL-FBHL.DG* DATED 08/20/2020 06:12:11
```

Breach Analysis



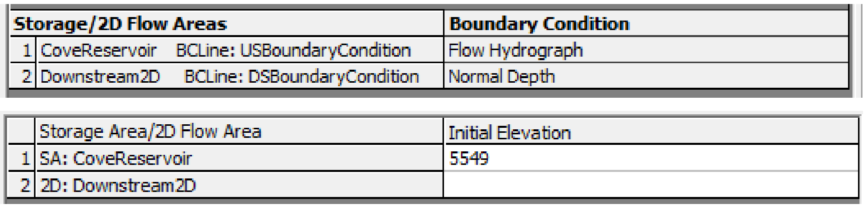
Selected Layer: Depth

- ☐ **Features**
- ☑ **Geometries**
  - ☑ CoveReservoirGeometryData
    - ☐ Rivers
    - ☐ Cross Sections
    - ☑ Storage Areas
    - ☐ 2D Flow Areas
    - ☑ Structures
    - ☐ Manning's N
    - ☐ Boundary Conditions
    - ☐ Errors
  - ☐ CoveReservoirGeometryDataSD
  - ☐ CoveReservoirGeometryDataRD
    - ☐ Rivers
    - ☐ Cross Sections
    - ☐ Storage Areas
    - ☐ 2D Flow Areas
    - ☐ Structures
    - ☐ Manning's N
    - ☐ Boundary Conditions
    - ☐ Errors
- ☑ **Results**
  - ☑ SD
    - ☐ Geometry
    - ☐ Depth (13AUG2020 01:48:00)
    - ☐ Velocity (Max)
    - ☐ WSE (Max)
    - ☑ **Inundation Boundary (Max Value_0)**
  - ☑ CoverReservoirPlanDataRDLocal
    - ☐ Geometry
    - ☐ Depth (Max)
    - ☐ Velocity (Max)
    - ☐ WSE (Max)
    - ☑ Inundation Boundary (Max Value_0)
- ☐ **Map Layers**
- ☑ **Terrains**
  - ☑ 5M_DEM.5M_DEM_clipped_extended

HEC-RAS Graphical Output with Inundation Boundaries - Sunny Day (yellow) and Rainy Day (red)

Sunny Day

Unsteady Flow Data

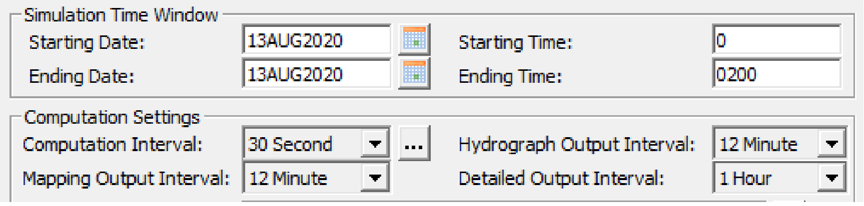


	Storage/2D Flow Areas	Boundary Condition
1	CoveReservoir BCLine: USBoundaryCondition	Flow Hydrograph
2	Downstream2D BCLine: DSBoundaryCondition	Normal Depth

	Storage Area/2D Flow Area	Initial Elevation
1	SA: CoveReservoir	5549
2	2D: Downstream2D	

Flow Hydrograph = No Storm

Unsteady Flow Analysis



Simulation Time Window

Starting Date: 13AUG2020

Ending Date: 13AUG2020

Starting Time: 0

Ending Time: 0200

Computation Settings

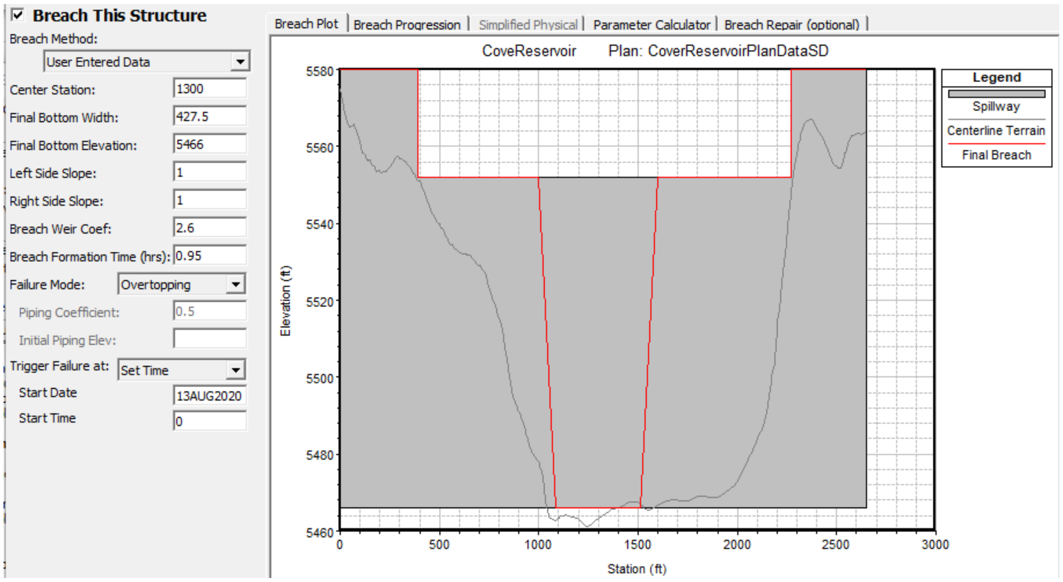
Computation Interval: 30 Second

Hydrograph Output Interval: 12 Minute

Mapping Output Interval: 12 Minute

Detailed Output Interval: 1 Hour

Storage Area Connection Breach Data



☑ Breach This Structure

Breach Method: User Entered Data

Center Station: 1300

Final Bottom Width: 427.5

Final Bottom Elevation: 5466

Left Side Slope: 1

Right Side Slope: 1

Breach Weir Coef: 2.6

Breach Formation Time (hrs): 0.95

Failure Mode: Overtopping

Piping Coefficient: 0.5

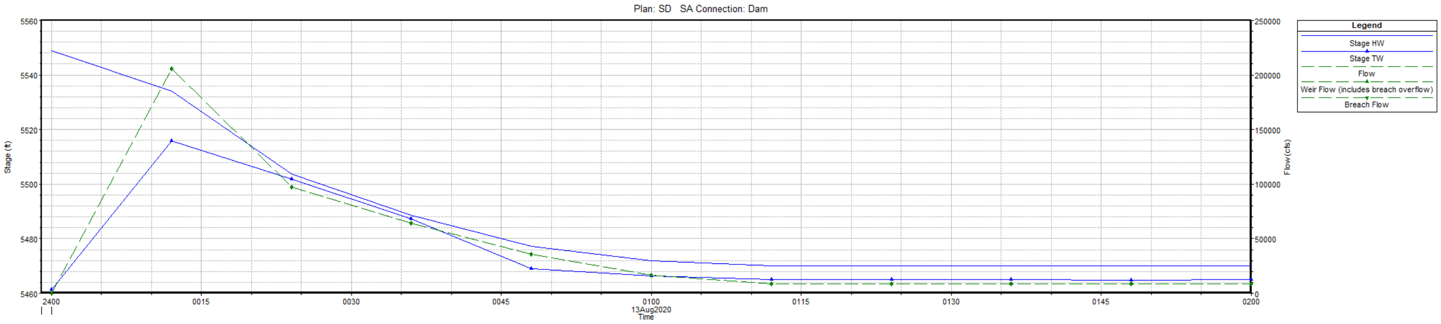
Initial Piping Elev:

Trigger Failure at: Set Time

Start Date 13AUG2020

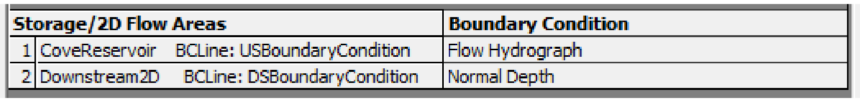
Start Time 0

Stage and Flow Hydrograph



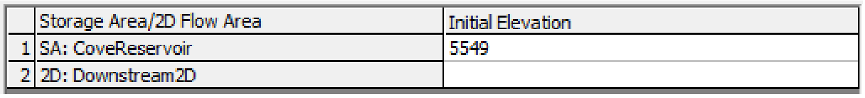
Rainy Day

Unsteady Flow Data



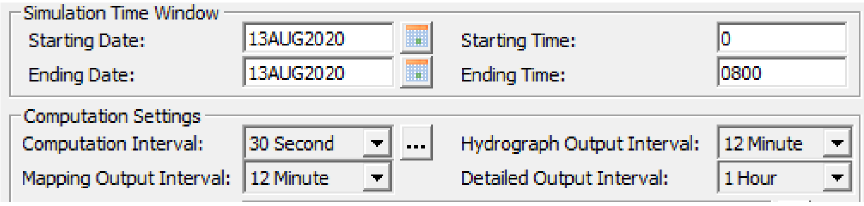
	Storage/2D Flow Areas	Boundary Condition
1	CoveReservoir BCLine: USBoundaryCondition	Flow Hydrograph
2	Downstream2D BCLine: DSBoundaryCondition	Normal Depth

Flow Hydrograph = FBH-L



	Storage Area/2D Flow Area	Initial Elevation
1	SA: CoveReservoir	5549
2	2D: Downstream2D	

Unsteady Flow Analysis



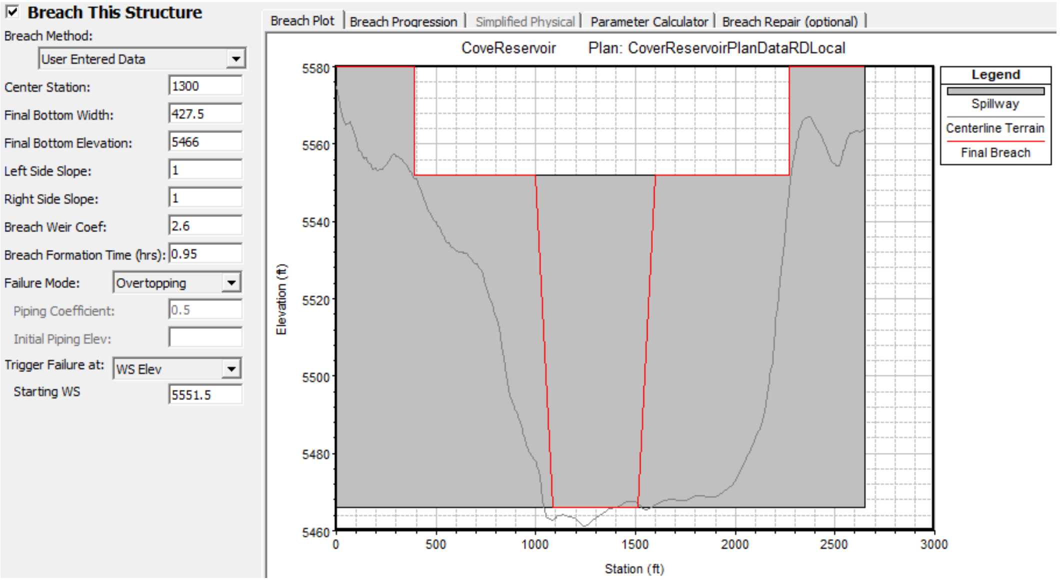
Simulation Time Window

Starting Date: 13AUG2020
Starting Time: 0
Ending Date: 13AUG2020
Ending Time: 0800

Computation Settings

Computation Interval: 30 Second
Hydrograph Output Interval: 12 Minute
Mapping Output Interval: 12 Minute
Detailed Output Interval: 1 Hour

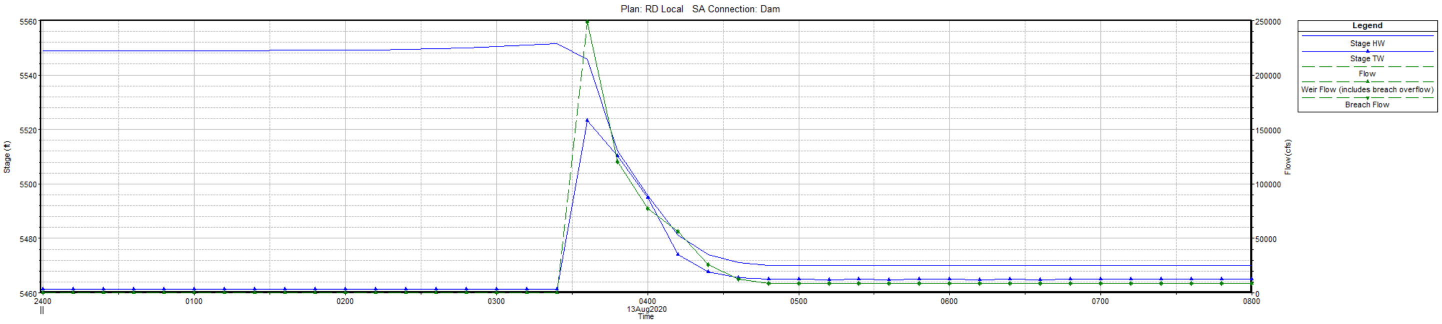
Storage Area Connection Breach Data



☑ **Breach This Structure**

Breach Method: User Entered Data
Center Station: 1300
Final Bottom Width: 427.5
Final Bottom Elevation: 5466
Left Side Slope: 1
Right Side Slope: 1
Breach Weir Coef: 2.6
Breach Formation Time (hrs): 0.95
Failure Mode: Overtopping
Piping Coefficient: 0.5
Initial Piping Elev:
Trigger Failure at: WS Elev
Starting WS 5551.5

Stage and Flow Hydrograph



APPENDIX E-13

COVE DAM FEASIBILITY STUDY

Cove Dam Feasibility Study

Near Orderville, Kane County, Utah

June 2004

RB&G ENGINEERING, INC.

RB&G
ENGINEERING, INC.

June 16, 2004

Kane County Water Conservancy District
76 North Main Street
Kanab, UT 84741

Attn: Mike Noel

Subject: Cove Dam
Feasibility Study

Gentlemen:

A Feasibility Study has been completed for the proposed Cove Dam near Orderville, Kane County, Utah. The investigation has been conducted in accordance with a proposal submitted to your organization for the work, and the results of the study are summarized in the report transmitted herewith.

We appreciate the opportunity of providing this service for you. If there are any questions relating to the information contained herein, please call.

Sincerely,

RB&G ENGINEERING, INC.

Bradford E. Price, P.E.

bep/jag

1435 WEST 820 NORTH, PROVO, UTAH 84601-1343
PROVO 801-374-5771 SALT LAKE CITY 801-521-5771 FAX 801-374-5773

Feasibility Study

Cove Dam

near Orderville
Kane County, Utah

June 14, 2004

RB&G ENGINEERING, INC.

TABLE OF CONTENTS

COVE DAM

Kane County Water Conservancy District

Feasibility Study – Executive Summary

This report summarizes the results of a feasibility study performed for the proposed Cove Reservoir to be located about 1 mile southwest of Orderville, Utah. The purpose of the reservoir is to provide off-stream storage for the district to aid in water distribution for municipal and agricultural purposes. Water will be delivered to the off-stream reservoir via pipeline.

Surficial deposits in the study area consist of Quaternary alluvial deposits overlying the Tropic Shale Formation. This formation consists predominantly of dark gray shale with some gray sandstone. At the site, the formation also contains thin layers of grayish-white bentonite and minor to very minor gypsum lenses, stringers, and fracture infill. Bedrock in the upper 25 to 50 feet of the abutments is highly fractured and will require a grout curtain to reduce seepage through the abutments.

Based upon the results of field and laboratory testing, it is our opinion that a homogeneous clay earthfill embankment with an internal filter and drainage system will be the most efficient type of structure for this site. It is anticipated that clay fill can be obtained from required excavations and the reservoir basin. Filter, drain, riprap bedding, and riprap material must be imported from off-site sources. Sources have been identified within a 5 mile radius of the site.

A maximum dam height of between 100 and 110 feet is available at the site. Assuming 10 feet of freeboard, this results in an available capacity of between 6800 and 8800 acre feet. Our opinion of probable cost for a 100 foot high dam 10.7 million dollars, increasing to 14.5 million dollars for a 110 foot high structure. This results in a cost per acre foot of $1,578 for the 100 foot high structure and $1,644 for the 110 foot high structure. These values do not include the cost of land or piping to bring water to the reservoir.

COVE DAM
Kane County Water Conservancy District

Feasibility Study

I. INTRODUCTION

1. PROJECT DESCRIPTION

The proposed Cove Dam and Reservoir is located about 1 mile southwest of Orderville, Utah at the approximate location shown on the vicinity map in Figure 1. The reservoir site is situated in a natural off-stream drainage basin and will be enclosed by a single dam near the mouth of the basin. The drainage basin is located ½ mile west of the East Fork Virgin River. A new diversion structure and pipeline will route water into the reservoir. A site plan of the reservoir is shown in Figure 2. The purpose of the project is to provide water storage for Kane County Water Conservancy District to aid in water distribution for municipal and agricultural purposes.

2. PURPOSE AND SCOPE

The purpose and scope of this study was to (1) perform sufficient surface and subsurface investigations at the reservoir site to determine the feasibility of construction of the dam and reservoir, (2) perform sufficient field and laboratory investigations to identify borrow sources for the dam embankment, (3) evaluate dam type options, (4) provide recommendations relative to the best option for this site, and (5) provide preliminary cost estimates for the selected sections and appurtenant structures required to meet the safety, storage, and operation requirements of the owner.

Consideration has been given to potential borrow sources for earthfill, rockfill, and roller compacted concrete type structures. Borrow sources for impervious (clay/silt) type material, granular (sand/gravel) type material, and rock for use as riprap were identified within the basin or in the surrounding area. The work has been performed in accordance with the proposal and is discussed under the following headings:

- Geologic Investigations
- Field and Laboratory Testing Procedures
- Foundation Investigation
- Borrow Investigation
- Feasibility Analysis and Conclusions

3. PREVIOUS STUDIES

The following studies were reviewed for this report:

"Memorandum", State of Utah - Division of Water Resources; Engineering Geology Section; Oct. 6, 1997; Author: Ben Everitt, Engineering Geologist

"Proposed Cove Canyon Dam and Reservoir Near Orderville, Utah; Reconnaissance-Level Evaluation", June 1996; Franson-Noble & Associates, Inc.

II. GEOLOGIC INVESTIGATIONS

1. REGIONAL GEOLOGY

The Orderville area is located within the Grand Staircase section of the Colorado Plateau Physiographic Province. The Grand Staircase contains a series of terraces and cliffs, which rise northward from the Grand Canyon to the south to the High Plateaus to the north. The Hurricane Fault bounds the area to the west, the Kiabab Monocline bounds the area to the east (Stokes, 1987).

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, 1987).

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 were derived from continental deposits

The Orderville area is located within the less tectonically active Colorado Plateau Province. Bedrock in the Orderville area shows evidence of some ancient normal faulting as well as younger Quaternary faults. This general region has been less disrupted by compressional forces from the Sevier Orogeny, which was more prominent across the northwestern side of the state.

The area is located within the western edge of the Intermountain Seismic Belt (ISB). The ISB is a zone of seismic activity which trends from northern Arizona up through northern Montana in the U.S.A.

The study area is located east of the general transition zone between the Basin and Range Province and the Colorado Plateau Province. The area is located on the western edge of the potentially active Sevier Fault. The Sevier Fault is the eastern most major extensional fault in southern Utah.

2. SITE GEOLOGY

Figure 3 is a portion of a geologic map of Kane County showing the location of the study area. As shown on the map, surficial deposits in the study area consist of Quaternary alluvial deposits overlying bedrock. Bedrock throughout the reservoir basin and proposed dam abutments consists of the Cretaceous age Tropic Shale Formation (Doelling, etal, 1989, Doelling, 1999). No competent outcrops of Tropic Shale were observed at the site from which strike and dip could be measured. Based on information from drill holes, and topographic and structural geology maps, bedrock in the area appears to dip 2 to 3° down toward the northeast (Doelling, etal, 1989). The strike of the bedrock taken from a structural geologic map is about North 30° West. Interpretations taken from topographic and geologic maps show the strike to be about North 60° West.

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, by Hellmut H. Doelling and Fritzhugh D. Davis"... published in 1987 and Interim geologic map of the Kanab 30'X60" Quadrangle…, Open-File Report 366,1999. Deposits are listed from youngest to oldest, with personal comments relative to the study area in italics.

	Quaternary
Qa	Alluvium - sand and silty clay with lenses of sandy silt and gravel sediments consist of unconsolidated clay, silt, sand and gravel, deposited in stream bed and flood-plains. *(During this 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 predominate terrace deposits along the east side of the East Fork of the 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 , med 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. The unit is well exposed 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. *(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).*

3. SEISMIC CONSIDERATIONS

A detailed seismic evaluation for the site has not been completed as part of the Feasibility Study. However, the Utah Dam Safety Map for the *No Fault Specific* seismic event with a 5,000 year return interval indicates that the extreme event could generate a Peak Ground Acceleration (PGA) of about 0.29g. A preliminary seismic evaluation finds that the nearest seismic source is the southern section of the Sevier (Toroweap) Fault, located about 1.9 miles (3 km) east of the site. This fault is Quaternary in age (Late Pleistocene 10-130 k years ago) with no documented Holocene movement. No recurrence interval information is currently available for this fault, however an estimated slip rate of 0.2-1mm/yr has been given by others (Anderson and Christenson, 1989; Hecker, 1993; Black and others, 2003). This section of the fault is about 55 miles (88 km) long and may be capable of generating a Maximum Credible Earthquake (MCE) with a magnitude of about 7.2 to 7.4. Due to the close proximity of the fault, a 7.2 to7.4 earthquake could generate Peak Horizontal Ground Acceleration (PGA) values of between 0.62g to 0.65g.

4. GEOLOGIC HAZARDS

Geologic hazards which should be considered at this site include seismic, slope stability, and potential embankment and foundation hazards. These hazards are discussed below as follows:

Seismic

As mentioned previously, ground shaking during a moderate to large seismic event near the site is a potential hazard. While the activity rate of the Sevier Fault is not fully understood, evidence suggests that it has the potential to generate a large magnitude earthquake. Since the site is located a couple of miles west of the fault surface, fault rupture during a seismic event is unlikely. Hazards include tectonic subsidence and deformation. Tectonic deformation should be addressed during the design of the dam.

Liquefaction

Current and previous studies have identified some scattered alluvial sand and gravel deposits in the basin which may have a potential for liquefaction. Information to date indicates that the deposits are relatively localized and discontinuous. It is possible that loose sand deposits exist beneath the dam footprint, which will require mitigation. Sufficient investigation should be performed during final design to determine if mitigation measures are required.

Non-seismic Slope Failure

A review of the site did not find any evidence of rock fall, debris flow or landslide deposits. The stability of abutment slopes under saturated sudden draw down conditions should be addressed during design of the dam.

Foundation and Embankment Hazards

Several geologic hazard maps indicated that the Tropic Shale Formation and the alluvial material in the basin has a potential for swelling and shrinking with changes in moisture content (bentonite layers have very high potential) (Doelling etal, 1989; Mulvey, 1992). It should be noted that during site visits between April and June (2004), relatively large polygonal desiccation cracks were observed within the alluvial material covering the basin and abutments. These cracks were observed to be up to 1 inch wide and 1 foot deep. In many places the cracks were difficult to see due to the popcorn texture of the soil at the surface.

Doelling's map also mentions that the Tropic Shale has a high sulfate content which may react with concrete (Doelling etal, 1989). For this project, site specific testing should be conducted to verify the sulfate content in the area. Gypsum is moderately soluble and may dissolve over time when exposed to water. Dissolution of the gypsum may gradually create voids within the foundation of the reservoir. During this preliminary investigation relatively little visible gypsum was observed in the test borings or test pits. Additional testing should be performed to determine the percent of soluble salts in the embankment and foundation materials. Test pits within the basin also encountered some collapsible soils. Testing results are discussed later in this report.

Based on observations at the site the bedrock contact beneath alluvium in the basin may be somewhat undulating. Three small knolls are located within the center of the basin in an east-west direction. Test Pit 04-5 was excavated in the eastern knoll and encountered bedrock at a depth of about 4.5 feet. It is assumed that the other knolls also have shallow bedrock. These exposures indicate that bedrock may also be located at varying depths beneath the foundation of the dam. Depending on the final design of the dam, variations in the depth of bedrock could have an effect on differential settlement of the structure. Additional investigations will be needed to better define the bedrock contact beneath the dam.

III. FIELD AND LABORATORY TESTING PROCEDURES

The borings were drilled using a CME 55 rotary drill rig with a tri-cone rock bit and NW casing to advance the boring and water as the drilling fluid through the over-burden. Continuous coring was performed in bedrock using an NQ size wireline system. In addition, test pits were excavated with a 310 SE John Deere backhoe. Sampling of over-burden in the borings was performed at about five-foot intervals, while sampling in the test pits was performed at approximately three-foot intervals or at each significant change of material type. Both disturbed and undisturbed samples were obtained during the field investigations. Disturbed samples from the borings were obtained by driving a 2-inch split spoon sampling tube through a distance of 18 inches using a 140-pound weight dropped from a distance of 30 inches. The number of blows to drive the sampling spoon through each 6 inches of penetration is shown on the boring logs. The sum of the last two blow counts, which represents the number of blows to drive the sampling spoon through 12 inches, is defined as the standard penetration value. The standard penetration value, corrected for overburden and hammer energy, provides a good indication of the in-place density of sandy material; however, it only provides an indication of the relative stiffness of the cohesive material, since the penetration resistance of materials of this type is a function of the moisture content.

Undisturbed samples in the borings were obtained by pushing a thin-walled sampling tube into the subsurface material using the hydraulic pressure on the drill rig. Undisturbed samples in the test pits were recovered by cutting block samples or by pushing consolidation rings into undisturbed benches excavated into the side walls of the test pit. The location at which the undisturbed samples were obtained is shown on the boring and test pit logs.

Miniature vane shear tests, which provide an indication of the undrained shearing strength of cohesive materials, were performed on samples of the clay soil during the field investigations. The results of these tests are shown on the boring logs as the torvane value in tons per square foot (tsf).

Each sample obtained in the field was classified in the laboratory according to the Unified Soil Classification System. The symbol designating the soil type according to this system, is presented on the boring or test pit log. A description of the Unified Soil Classification System is presented in the appendix, and the meaning of the various symbols, shown on the log sheet, can be obtained from this figure.

Laboratory tests performed during this investigation to define the characteristics of the subsurface material throughout the proposed site and at the identified granular and rock borrow sources included in-place dry unit weight, natural moisture content, moisture-density (proctor) tests, Atterberg Limits, mechanical analyses, direct shear tests, laboratory permeability tests, dispersive clay tests, slaking tests, specific gravity tests, and consolidation tests. Testing was performed following procedures outlined in the American Society for Testing and Materials (ASTM) standards.

IV. FOUNDATION INVESTIGATION

Prior to beginning the subsurface investigation, a site reconnaissance was made to determine the optimal alignment for the dam. Topographically, the ridges at the southern end of the valley appear to provide the most efficient alignment for the dam enclosure. It was apparent that the ridges are relatively narrow and, to provide adequate abutment support, it was our opinion that the alignment shown on Figures 2 and 4 should be used for the embankment.

The characteristics of the subsurface material at the site were evaluated by drilling five borings to depths ranging from 39 to 101 feet and excavating two test pits to depths of about twelve feet. The drill hole and test pit locations are shown in Figure 4. The logs for the borings and test pits are presented in Test Hole Log section of this report. 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 this site. Bedrock core was recovered from four of the borings to assess the competency and condition of the foundation bedrock. Photographs of the core from the drill holes are included in the Test Hole Log section of this report.

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 Figure 4. The test holes are also shown on the profile presented in Figure 5.

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. The percent recovery and Rock Quality Designation (RQD), along with the results of field permeability tests are shown on the logs and in profile view on Figure 5.

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 can not always be determined. Terms on the drill logs such as vertical fractures and angles of bedding, refer to how they appear relative to the cored sample and not to actual vertical and horizontal at the surface.

Test Pit 04-1 was completed between the right abutment and the maximum section beneath the upstream shell portion of an earthfill type structure at approximately elevation 5463 feet. Test Pit 04-7 was completed on the centerline alignment at the maximum section of the proposed structure midway between DH 04-4 and DH 04-2 at elevation 5458 feet.

1. SOIL PROFILE

It will be observed from DH 04-1, 04-2 and 04-4 that the depth of soil overburden on the valley floor varies at these particular locations from 20 to 47 feet. Deeper channels may also be present which were not encountered by these borings. It should also be noted that TP 04-5 excavated on the small knoll at the upstream toe near the maximum section encountered heavily weathered shale bedrock at a depth of only four 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. The silt and clay deposits were visually observed to have a low to moderate mineral content. A close examination of the sidewall of these test pits showed that the interbedded layers of silty sand were generally fine grained and from one to six 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 ¼ to 1 inch. The gravel layers which made up these scattered deposits were observed to be from one to three feet in thickness. A few cobbles and boulders were encountered with maximum particle size of about 12 inches. A pin-hole type structure was readily evident in the silt and clay type deposits in the test pits. The moisture content of the samples varied from dry to very dry.

Standard Penetration Test (SPT) values ranged from 6 to 55 indicating the material is in a firm to hard condition. Thirteen disturbed samples were recovered 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.

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 twice as long as the cored diameter (segment at least 4 inches long). The core generally consisted of gray mudstone (Tropic Shale Formation) with occasional bentonite layers. It will be noted from the boring logs and Figure 5 that the percent recovery and RQD ranged from 63 to 100% in DH 04-1 and DH 04-2 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 with the layer between 32 and 38 feet having 0 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.

3. GROUNDWATER

Ground water was not encountered in the test pits. Temporary monitoring wells consisting one inch PVC pipe were installed in each of the drill holes completed in April/May 2004. Each of the wells was bailed out upon completion of drilling. On June 3, 2004 the wells were bailed out again and ground water levels were recorded. The results are shown on the following table:

Water Table Readings - Recorded June 3, 2004

Drill		Depth		Elevation		Water Table	
Hole	Orientation	Angle	Vertical	Top	Bottom	Depth	Elevation
04-1	Vertical	-	90	5454	5364	46.8'	5407.2
04-2	Vertical	-	39	5458	5419	17.0'	5441.0
04-3	60° Dip	100.5	87	5546	5445.5	71.0'	5484.5
04-4	Vertical	-	41	5458	Caved at 29'	Dry @ 29'	-
04-5	60° Dip	101	87.5	5542.5	5441.5	36.0'	5511.3

The groundwater level at each bore hole is also shown on the Geologic Profile in Figure 5 and it will be observed that the gradient is toward the center of the basin.

4. PERMEABILITY

Permeability tests were conducted in both the soil overburden and the foundation bedrock. The test results are shown on the boring logs and the profile view in Figure 5. Permeability calculations are included in the appendix. It will be observed from Figure 5 that the permeability of the silt and clay overburden varied from 0 to 189 ft/yr. It will also be observed that the permeability of the Tropic Shale Formation is relatively low except within the upper 50 feet of the abutments in the more heavily fractured rock. Permeability tests in the upper 50 feet on the abutments in DH 04-3 and DH 04-5 show rates varying from 300 to 6,000 ft/yr. Below a depth of 50 feet in DH 04-3 on the right abutment, the permeability ranged from 0 to 394 ft/yr. Below a depth of 45 feet in DH 04-5 on the left abutment, the permeability ranged from 0 to 5 ft/yr.

5. LABORATORY TESTING

Laboratory tests performed to define the characteristics of the dam foundation included (1) Atterberg Limits, (2) in-place density, (3) consolidation (4) direct shear, and (5) slake durability. The results of the mechanical analyses, Atterberg Limits, dry unit weight and moisture content tests are summarized on the logs and in Table 1, Summary of Test Data contained in the Laboratory Testing Section of this report. The results of all tests are discussed below as follows:

A. Atterberg Limits

Fourteen Atterberg Limits tests were completed on soil samples recovered from the drill holes and test pits within the foundation area to determine the plasticity characteristics. It will be observed from Table 1 that the liquid limit varied from 20 to 58 while the plasticity index ranged from 5 to 34. Thirteen of the 14 samples classify as lean clay, with one sample classifying as fat clay.

Eight sections of bedrock core were pulverized from TP 5 at 6 and 9 feet, DH 04-1 at 53 and 73 feet, DH 04-2 at 26 feet, DH 04-3 at 14 feet and DH 04-5 at 41 and 48 feet to define the characteristics of the Tropic Shale mudstone. The liquid limit of these samples ranged from 43 to 82 while the plasticity index varied from 24 to 50. Six of the eight samples classify as fat clay, with two classifying as lean clay.

B. In-Place Density

The in-place dry density was determined for nine samples obtained at select locations, and the results of these tests are also included in Table 1, Summary of Test Data. It will be observed that the in-place density varied from 82.0 to 120.3 pcf.

C. Consolidation Tests

The compressibility, collapse and expansive characteristics of the clay were evaluated by performing eight consolidation tests on undisturbed samples recovered from DH 04-1, DH 04-2 and TP 7. The results of the consolidation tests are presented in the Laboratory Testing Section of this report. During the performance of the consolidation tests, each sample was loaded at the natural moisture content until a load intensity of 0.28 tsf had been reached. At this point in the loading cycle, each sample was permitted to absorb water without any increase in the load intensity. Soils having collapsible characteristics settle without any increase in the load when they become wet or saturated. It will be observed from these figures that the two samples from Test Pit 7 at 3 and 9 feet in depth exhibited some slight collapse characteristics.

Expansive soils always experience an increase in void ratio on absorbing water. It will be observed that five of the eight samples from the drill holes swelled when water was added. A summary of the Atterberg Limits and percent swell/collapse for each of the samples tested is shown on the following table.

Test Hole	Depth (ft)	Soil Type	Atterberg Limits		Dry Unit Weight (pcf)	Moisture Content (%)	Percent Swell (%)
			Liquid Limit	Plastic Index			
DH 1	5-6.5	CL-1	32	14	120.3	9.8	1.4
DH 1	15-16.5	CL-2	37	19	119.4	8.7	3.1
DH 1	25-26.5	CL-2	34	18	112.4	14.3	1.2
DH 1	35-36.5	CL-2	49	31	105.2	17.5	1.6
DH 1	45-46	CH	50	34	100.7	23.1	0
DH 2	15-16.5	CH	58	34	111.8	19.3	4.3
							Percent Collapse (%)
TP 7	3-4	CL-ML	26	6	86.9	6.5	1.2
TP 7	9-10	CL-1	33	15	89.6	9.1	< 0.5

D. Direct Shear

To obtain an indication of the drained shear strength of the cohesive material, two consolidated drained direct shear tests were performed on samples from TP 7 at 6 feet. One test was performed on an undisturbed block of the lean clay, and one test was performed on a re-molded sample compacted to a density of approximately 98% of the maximum density as determined by ASTM D 698. The results are presented in the Laboratory Testing Section of this report. A summary of the results from the direct shear tests are shown in the following table:

Test Hole	Depth (ft)	Soil Type	Condition	Friction Angle ϕ (degrees)	Cohesion (psf)
TP 7	6	CL-2	Undisturbed	29.9	144
TP 7	6	CL-2	Remolded	30.2	288

E. Slake Durability

Slaking tests were performed in accordance with ASTM D 4644 on the weathered shale / mudstone. The results of the test are shown in the following table:

Test Hole	Depth (ft)	Classification	Location	Slake Durability Index (%)
04-1	53	CH	MAX. SECTION	34.2
04-1	73	CH	MAX. SECTION	6.7
04-2	26	CH	TOE LEFT ABUTMENT	2.9
04-3	14	CH	RIGHT ABUTMENT	0.0
04-5	41	CL-2	LEFT ABUTMENT	3.4
04-5	48	CL-2	LEFT ABUTMENT	2.4

V. BORROW INVESTIGATION

1. IMPERVIOUS BORROW

Based upon the geologic studies, test holes located within the foundation footprint and observation of soils within gullies throughout the basin, sufficient impervious material appears to exist with the reservoir basin to construct an earthen embankment. In addition to the drill holes and test pits performed in the foundation area, 11 additional test pits were excavated throughout the basin at locations as shown in Figure 2. The test pit logs are included in the Test Hole Log Section and it will be observed that the soil profile in 10 of the 11 pits consists predominately of dry, hard lean clay with some interbedded silt and sand. Test Pit 13, located at the upper end of the basin, encountered silty sand with clay layers to a depth of 12 feet.

Information on material type and material distribution for test pits from the 1997 Engineering Memorandum (included in the appendix) was considered satisfactory and, as such, these areas within the basin were not covered with test pits during this investigation.

A. Laboratory Testing

Laboratory tests performed to define the characteristics of the impervious borrow included (1) Atterberg Limits, (2) mechanical analysis, (3) in-place density and natural moisture content, (4) soil moisture-density relation (proctor), (6) direct shear, (8) dispersive clay, and (9) laboratory permeability. The results of the mechanical analyses, Atterberg Limits, dry unit weight and moisture content tests are summarized on the logs and in Table 1, Summary of Test Data. The results of all tests are discussed below as follows:

(1) Atterberg Limits

Twenty six Atterberg Limits tests were completed on soil samples recovered from the drill holes and test pits within the foundation and reservoir basin area to determine the plasticity characteristics. It will be observed from Table 1 that the liquid limit varied from 20 to 58 while the plasticity index ranged from 5 to 34. Twenty five of the 26 samples classify as lean clay, with one sample classifying as fat clay.

(2) Mechanical Analyses

Mechanical analyses were completed on twenty-six samples of the soil overburden recovered from the reservoir basin. The clay and silt samples contained 0% percent gravel and between 0 and 47% sand. The percent finer than a No. 200 sieve ranged from 53 to 100, with an average of 90%. A sand layer encountered in TP 3 from 0 to 1 feet had 25% gravel and 2% silt. A sand layer encountered in TP 4 at 5.5 feet had 0% gravel and 18% silt.

(3) Natural Moisture Content

The natural moisture content of twenty six samples was determined with values ranging from 3.4 to 23.1%. It will be noted that the natural moisture content of the samples from the test pits, which varied from 3 to 12 in depth, were all below 10%.

(4) Soil Moisture-Density Relation (Proctor) Tests

Three proctor tests were completed on samples of the lean clay / silty clay obtained from TP 04-1 at 3 feet, and TP 04-7 at 3 and 6 feet. The tests were completed in accordance with procedures outlined in ASTM D 698. The proctor curves are included in the Laboratory Testing Section. It will be noted that the maximum dry unit weight varies from 114 to 116 pcf and the optimum moisture content ranges from 14 to 16%.

(5) Dispersive Clay Tests

The dispersive characteristics of the impervious material were evaluated by performing pinhole tests on nine samples. The results of these tests are shown on Table 1 in the Laboratory Testing Section. Tests were conducted on samples from the test pits in the reservoir basin. The following table is a summary of the classification categories:

DISPERSIVE CLAY CHARACTERISTICS BY PIN HOLE TEST METHOD

CATEGORY	DESCRIPTION
D1, D2	DISPERSIVE
ND 3, ND 4	SLIGHTLY TO MODERATELY DISPERSIVE
ND 2, ND 1	NON-DISPERSIVE

It will be observed from the Summary of Test Data that 5 of the 9 samples classified as ND 2: non-dispersive, with the remaining 4 samples classifying as ND 3: slightly dispersive.

(6) Laboratory Permeability Tests

Constant head laboratory permeability tests were performed on three remolded samples of the lean clay obtained from the test pits in the reservoir basin. TP 1 at 3 feet, and TP 7 at 3 and 6 feet. The samples were placed in the permeability mold at 98% compaction and saturated using back-pressure techniques. The results of the tests are shown in the following table.

Test Hole	**Depth (ft)**	**Soil Type**	**Coefficient of Permeability (ft/yr)**
04-1	3	CL-1	0.09
04-7	3	CL-ML	0.23
04-7	6	CL-2	0.07

2. GRANULAR BORROW MATERIALS

Work performed during the investigation for granular borrow included identification of potential borrow areas, and limited laboratory testing of select soil samples to determine material properties. As stated above, no significant granular borrow sources were identified within the reservoir basin. Two commercially available granular borrow sources were identified within about 1 mile of the site as shown in Figure 3. The first site, referred to as Rose Pit, and is located across Highway 89 and just east of the Virgin River adjacent to Orderville. The second source is referred to as the Tate Pit and is located just east of the town of Mt. Carmel. Bucket samples of bank run material were collected from both the Rose and Tate gravel pits for laboratory testing. The sidewall of the cuts was also observed for variation in material layering. It was noted that in both of the cuts the sidewalls showed clay layers up to 6 feet thick interbedded among the sand and gravel deposits.

Gradation tests were completed on the bulk samples, and gradation curves are shown in the Laboratory Testing section of this report. The material in the Rose Pit classified as a well-graded gravel with silt and sand (GW-GM), while the material in Tate Pit classified as a poorly graded gravel with sand (GP).

Specific gravity and absorption tests were conducted these samples. The results of the tests show the gravelly sand at the Rose Pit to have an apparent specific gravity of 2.67 with absorption of 1.6%. The sandy gravel at the Tate Pit has an apparent specific gravity of 2.67 with absorption of 2.3%.

3. RIPRAP

No significant rock borrow sources were identified within the immediate vicinity of the reservoir basin. The most likely potential source of rock for use as riprap is a basalt formation near the town of Glendale or the limestone rock just south of the Orderville sewer lagoons. This same limestone unit is also exposed at the northeast end of town. Potential riprap sources are identified in Figure 3.

Specific gravity and absorption tests were conducted both the limestone and basalt rock samples. The results of the tests show the basalt rock with an apparent specific gravity of 2.68 and an absorption of 0.9%. The limestone rock has an apparent specific gravity of 2.65 with an absorption of 0.8%.

Further testing of the rock material intended for use as riprap will be required during the final design stage of this project; however, it appears that either the limestone or basalt rock will serve satisfactorily as slope protection.

VI. FEASIBILITY ANALYSIS AND CONCLUSIONS

Based upon the information summarized in the previous sections, it is our opinion that a reservoir can be constructed at this site with a maximum storage capacity of about 8800 acre feet covering an area of 210 acres. We believe that an earthfill dam will be the most efficient structure for the reservoir. This opinion is based upon (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 an RCC or rockfill type structure. Detailed analyses have, therefore, been limited to an earthfill type embankment.

1. EARTHFILL EMBANKMENT CROSS SECTION

The plan view and maximum section for the proposed embankment are presented in Figures 4 and 6. It will be observed from Figure 6 that a homogeneous embankment with an internal chimney filter/drain is proposed. Zone I will consist of relatively impervious material from foundation excavation and the reservoir basin. The material will be predominately lean clay. Material within the borrow is several percent below optimum moisture for placement and pre-wetting of the borrow areas will be required. Excavation methods will require mixing to blend silt and sand layers with the clay to achieve at least 50% minus No. 200 material. An 8 foot wide chimney filter/drain has been located downstream of centerline and will be designed as a crack stopper 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 is recommended to cap the crest of the dam to provide a finished surface. The crest should be sloped at 2% downward toward the reservoir to prevent ponding of rainwater.

A crest width of 25 feet has been assumed, with an upstream slope of 3 horizontal to 1 vertical and downstream slope of 2 horizontal to 1 vertical based upon the nature of the materials. It is anticipated that a freeboard of between 7 and 10 feet will be required above the spillway level to provide protection from wave action and deformation associated with potential seismic activity. A conservative freeboard of 10 feet has been assumed for the feasibility study.

2. STABILITY ANALYSIS

Preliminary slope stability analyses were performed using strength parameters based upon limited field and laboratory testing. The analyses for the dam were performed for the upstream and downstream slopes for steady-state reservoir full conditions and the upstream slope for sudden draw-down conditions.

The stability analyses were performed using the slope stability program UTEXAS2, developed by Stephen Wright at the University of Texas for the U.S. Corps of Engineers. Spencer's Method satisfies both force and moment equilibrium and is considered to be a satisfactory procedure for solving limiting equilibrium problems The factor of safety is determined by dividing the forces resisting movement by those causing movement.

The phreatic surface was modeled for steady state seepage using a reservoir full condition and for sudden drawdown as shown on Figure 6. The results of the stability analyses are shown in Figure 6 and summarized in the following table:

Analysis	FACTOR OF SAFETY	REQUIRED MINUMUM FACTOR OF SAFETY
Downstream Slope Steady State	1.51	1.5
Upstream Slope Steady State	2.18	1.5
Upstream Slope Sudden Drawdown	1.2	1.2

Based upon the results of the preliminary stability analyses, it is our opinion that the proposed cross section will be adequate, with minor adjustments.

3. SETTLEMENT ANALYSIS

A settlement analysis was performed for the maximum section using the results of consolidation tests performed on undisturbed samples obtained from Drill Hole 04-1, 04-2 and Test Pit 04-7 and the computer model EMBANK. A settlement of 48 inches was computed at the center of the maximum section with about 1 inch at the upstream and downstream toes. Eighteen of the 48 inches occurs in the upper 10 feet where collapsible type soils were encountered. Based upon field observations as discussed previously, it is expected that the foundation bedrock will have an irregular surface which could lead to differential movement. It is our opinion that the embankment cannot tolerate this magnitude of settlement without adverse effects (i.e. cracking). It is recommended that excavation of the dam footprint be performed such that settlement is limited to less than 6 inches. This will require excavation of a portion of the overburden as shown in the cross section on Figure 6.

4. FOUNDATION TREATMENT

It is recommended that a portion of the overburden soil be excavated as discussed above to limit settlement. The excavated material can be used as embankment fill. Pre-wetting of this soil should be performed prior to excavation to allow for utilization as fill. A cutoff trench will be required extending 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 primary permeability. To mitigate the potential harmful effects of large seepage losses, we anticipate that final design to include the following:

A. Impervious Clay Cut-Off Trench

We recommend that an impervious clay cut-off trench extend through the overburden soil and weathered bedrock and be seated a minimum of 5 feet into competent bedrock. Fractures and joints beneath the impervious cut-off and sand filter should be cleaned for a depth of at least twice the width of the fracture opening and filled with dental grout. The base of the cutoff should not be exposed for more than ~24 hours to prevent air slacking and cracking of the mudstone.

B. Grout Curtain

Based on the permeability test results and the condition of the recovered bedrock core, we recommend a foundation grouting program for the abutments. To assess the costs of such a program, a preliminary grout curtain design has been completed. The grout curtain will be located beneath the centerline of an earthfill type structure and will consist of a triple row grout curtain placed up both abutments as shown in Figure 5.

C. Downstream Filter and Drain

A downstream filter and drainage blanket is recommended beneath the downstream side of the dam as shown in Figure 6. This mitigates potential for piping of embankment material and facilitates drainage of seepage which may bypass the cut-off.

A collector toe drain is recommended for the entire length of the dam. In addition to the toe drain, interceptor finger drains should be placed at select locations throughout the downstream footprint of the dam to identify areas where seepage occurs and carry the seepage to the downstream toe drain. Manholes should be placed at the intersection of each finger drain with the toe drain to allow monitoring.

5. OPINION OF PROBABLE COST

Based upon results of the preliminary investigation and the proposed embankment cross section discussed above, a cost analysis has been performed which represents our opinion of probable cost (OPC) associated with construction of the dam embankment. The cost is shown in the following tables below. The value does not include the cost of land or piping to bring water to the reservoir. It should be recognized that the quantity of foundation excavation and, hence, earthfill is based on limited borings across the valley floor and that these quantities may vary significantly when additional data is obtained. The cost assumes that sand, gravel and riprap will be available from sources identified within a 5 mile radius of the site. Although hydraulic analysis and spillway design was beyond the scope of this study, it is assumed that the spillway can be designed to pass around the right abutment.

OPC FOR TOP OF DAM ELEVATION 5550 FEET

Item	Quantity	Unit	Unit Price	Total Price
Mobilization & Demobilization (10%)	1	Lump Sum		$ 750,345.00
Earthfill, Zone I – Dam Embank.	1,401,650	CU. YD.	$ 3.00	$ 4,204,950.00
Earthfill, Zone II – Filter / Drain	69,500	CU. YD.	$ 25.00	$ 1,737,500.00
Rock Riprap	23,700	CU. YD.	$ 30.00	$ 711,000.00
Grout Curtain	25,000	LIN. FT.	$ 30.00	$ 750,000.00
Outlet Pipe & Appurtenant Structures	500	LIN. FT.	$ 200.00	$ 100,000.00
		SUBTOTAL		**$ 8,253,795.00**
Engineering / Contingencies		(Estimated at 30% for Feasibility Stage)		$ 2,476,138.00
		TOTAL		**$ 10,729,934.00**

OPC FOR TOP OF DAM ELEVATION 5560 FEET

Item	Quantity	Unit	Unit Price	Total Price
Mobilization & Demobilization (10%)	1	Lump Sum		$ 1,011,460.00
Earthfill, Zone I – Dam Embank.	2,026,200	CU. YD.	$ 3.00	$ 6,078,600.00
Earthfill, Zone II – Filter / Drain	91,400	CU. YD.	$ 25.00	$ 2,285,000.00
Rock Riprap	29,700	CU. YD.	$ 30.00	$ 891,000.00
Grout Curtain	25,000	LIN. FT.	$ 30.00	$ 750,000.00
Outlet Pipe & Appurtenant Structures	550	LIN. FT.	$ 200.00	$ 110,000.00
		SUBTOTAL		**$ 11,126,060.00**
Engineering / Contingencies		(Estimated at 30% for Feasibility Stage)		$ 3,337,818.00
		TOTAL		**$ 14,463,878.00**

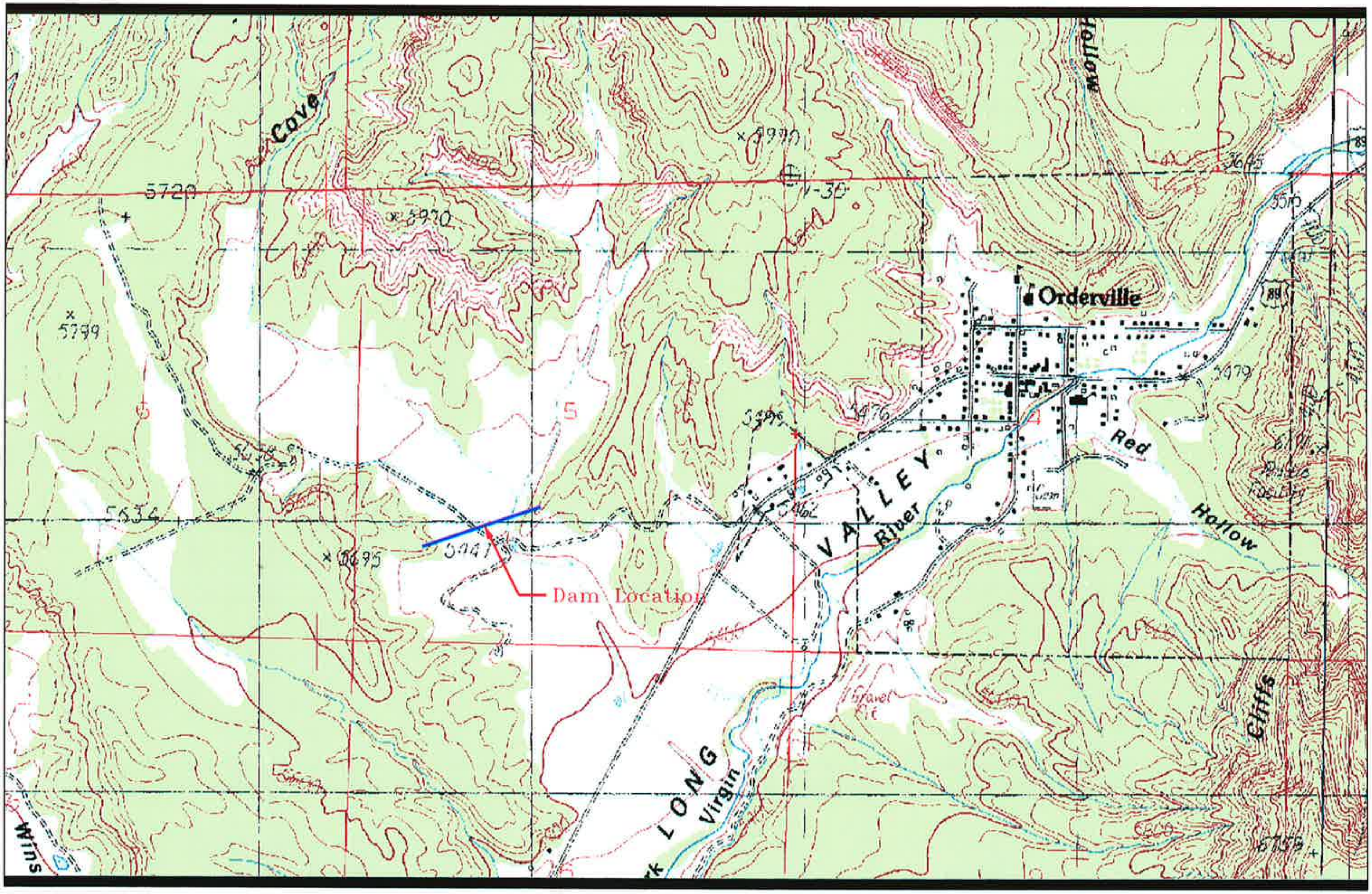
Assuming 10 feet of freeboard, a storage capacity of 6800 ac ft is obtained with the top of dam at elevation 5550 feet, resulting in a cost per acre foot of $1,578. A capacity of 8800 ac ft is obtained with the top of dam at elevation 5560 feet, resulting in a cost per acre foot of $1,644.

6. ADDITIONAL STUDIES REQUIRED FOR FINAL DESIGN

Work required to complete the reservoir design includes the following:

- Hydrologic analysis for freeboard, spillway and outlet work design.
- Outlet works and spillway design.(It appears that the spillway can be efficiently designed to pass around the right abutment.)
- Additional foundation investigation-anticipated to include about one boring every two hundred feet along the embankment alignment.
- Additional borrow investigations to verify that at least 1.5 times the quantity of materials needed for construction exist within the proposed borrow areas.
- Additional laboratory testing to evaluate properties of foundation and embankment materials. These tests will include triaxial shear, and sulfate tests.
- Final stability, seepage, and settlement analyses.
- Final embankment design
- Final design report.
- Preparation of plans and specifications.

Figures



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Provo, Utah

Figure 1 **SITE PLAN**

Cove Dam
Orderville, Utah

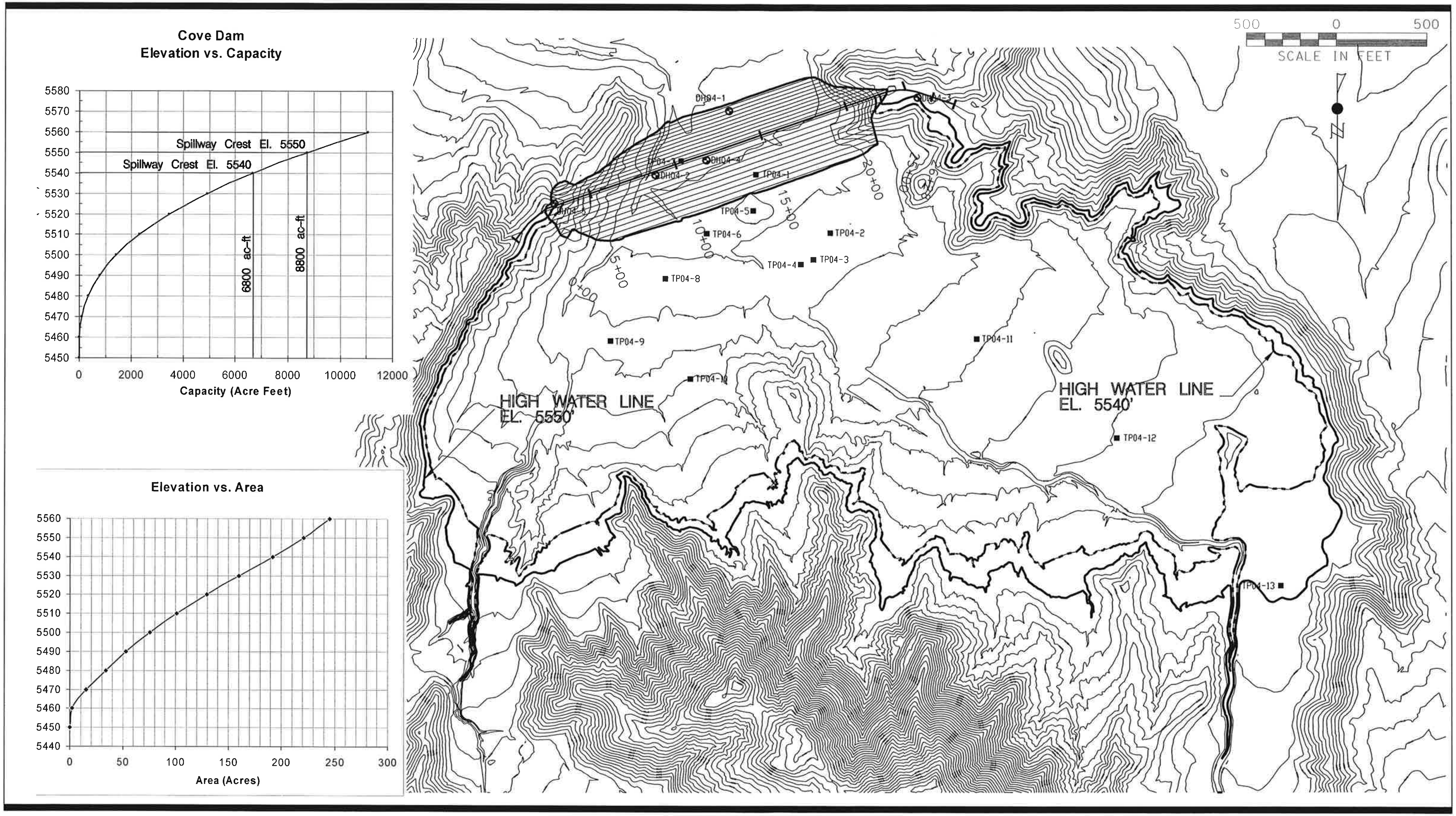

Figure 2

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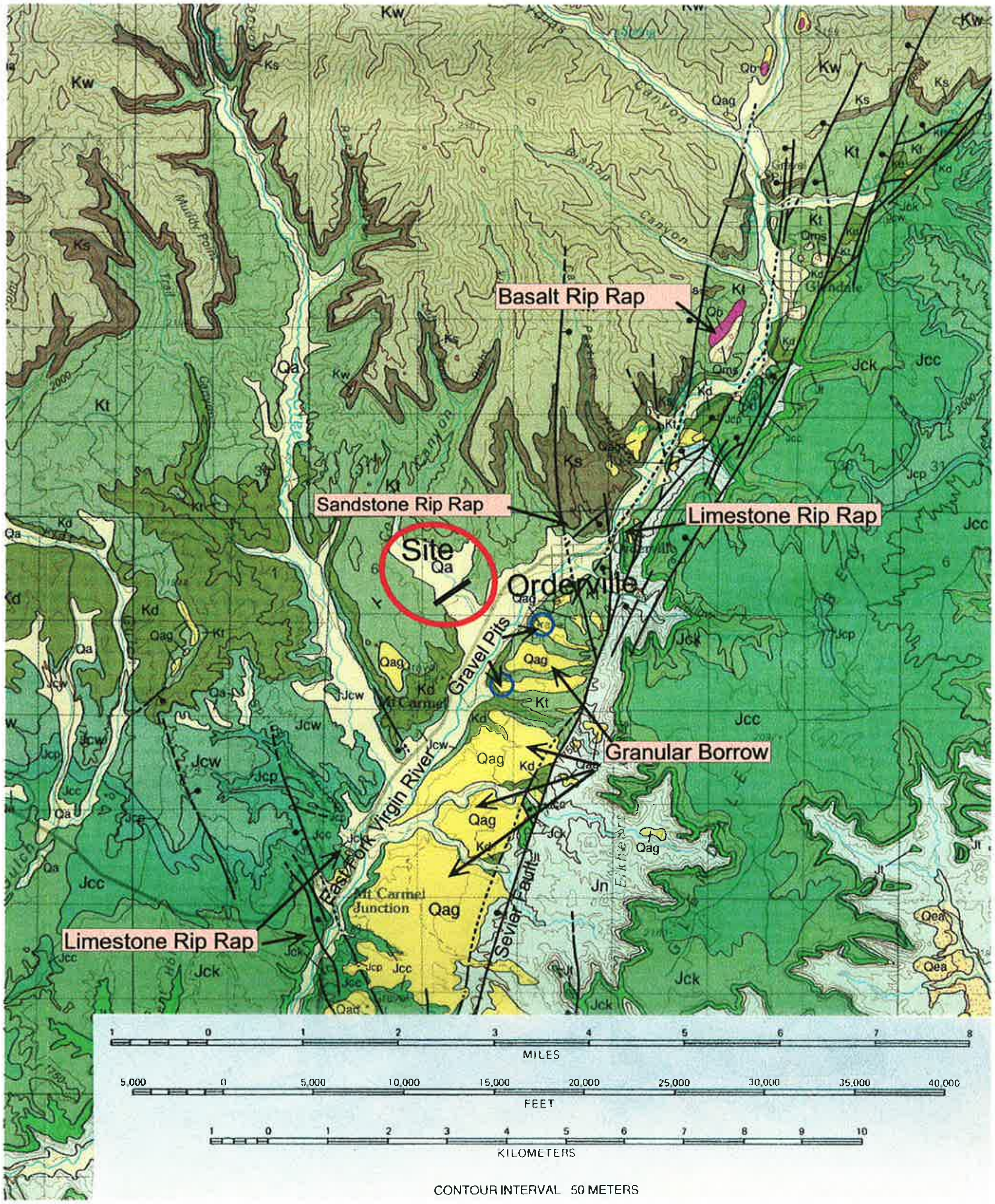
Provo, Utah

Cove Dam
Orderville, Utah

Reservoir Basin



See text for description of Geologic Units

Modifed from Geologic Map of Kane County, Doelling etal, 1989

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Provo, Utah

Figure 3	Geologic Map of Cove Dam Area with Potential Borrow Sources
Project	*Cove Dam Site, Feasibility Study*
Location	*Orderville, Kane County, Utah*

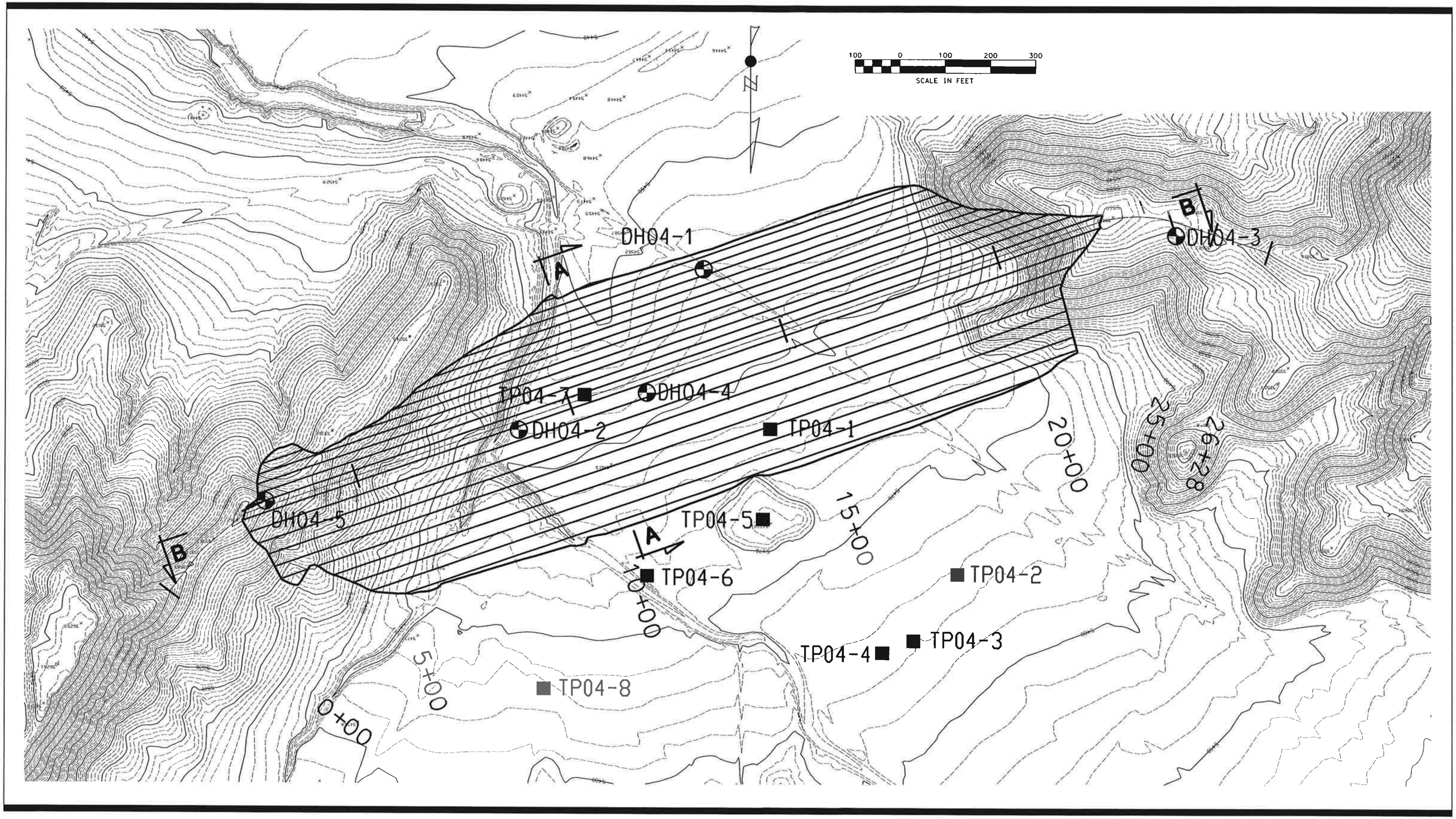

Figure 4

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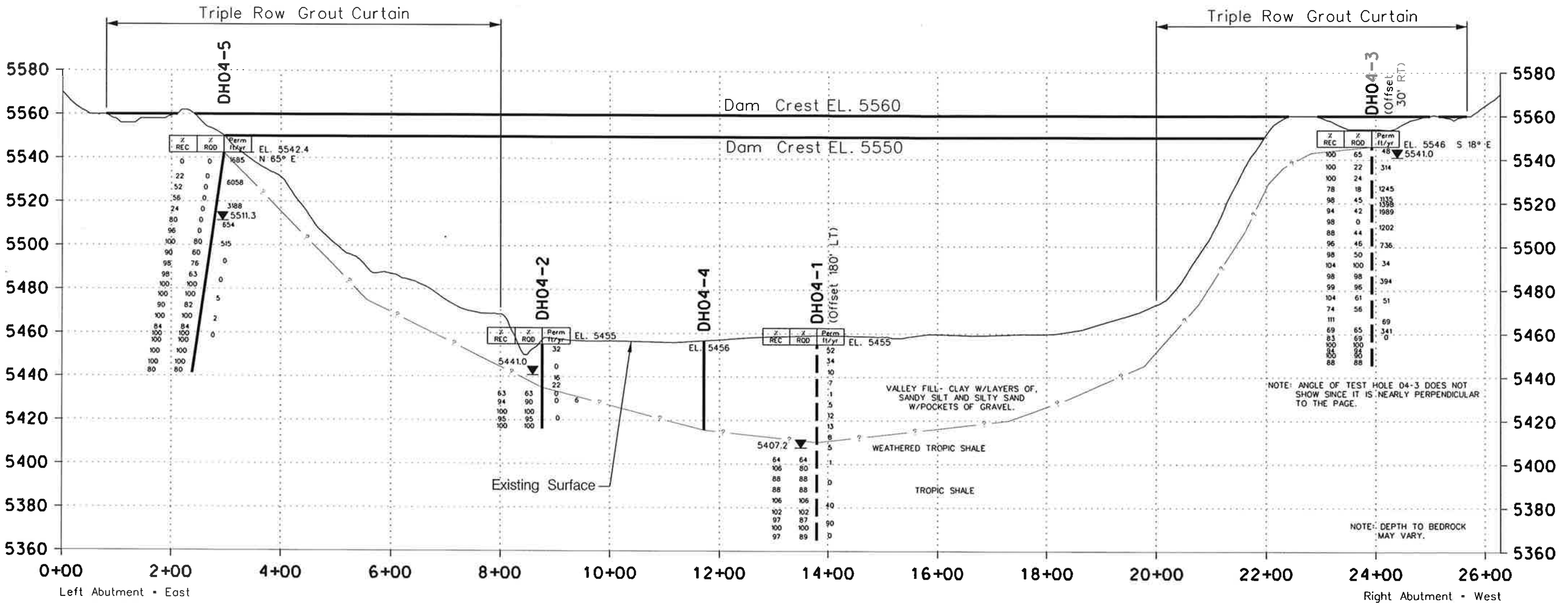
Cove Dam
Orderville, Utah

Dam Plan View,
Test Pit and Drill Hole
Locations



GEOLOGIC CROSS-SECTION (PROFILE)

Note: Exaggerated Vertical Scale.
Scale: 1"=50' Vertical
1"=200' Horizontal

Figure 5

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Cove Dam
Near Orderville, Utah

Geologic Profile

Material Description	Total Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)
ZONE I - LEAN CLAY	130	30	250
ZONE II - SAND & GRAVEL FILTER DRAIN	135	36	0
FOUNDATION - LEAN CLAY	100	30	150
FOUNDATION - WEATHERED BEDROCK	140	30	200
FOUNDATION - COMPETENT BEDROCK	145	45	500

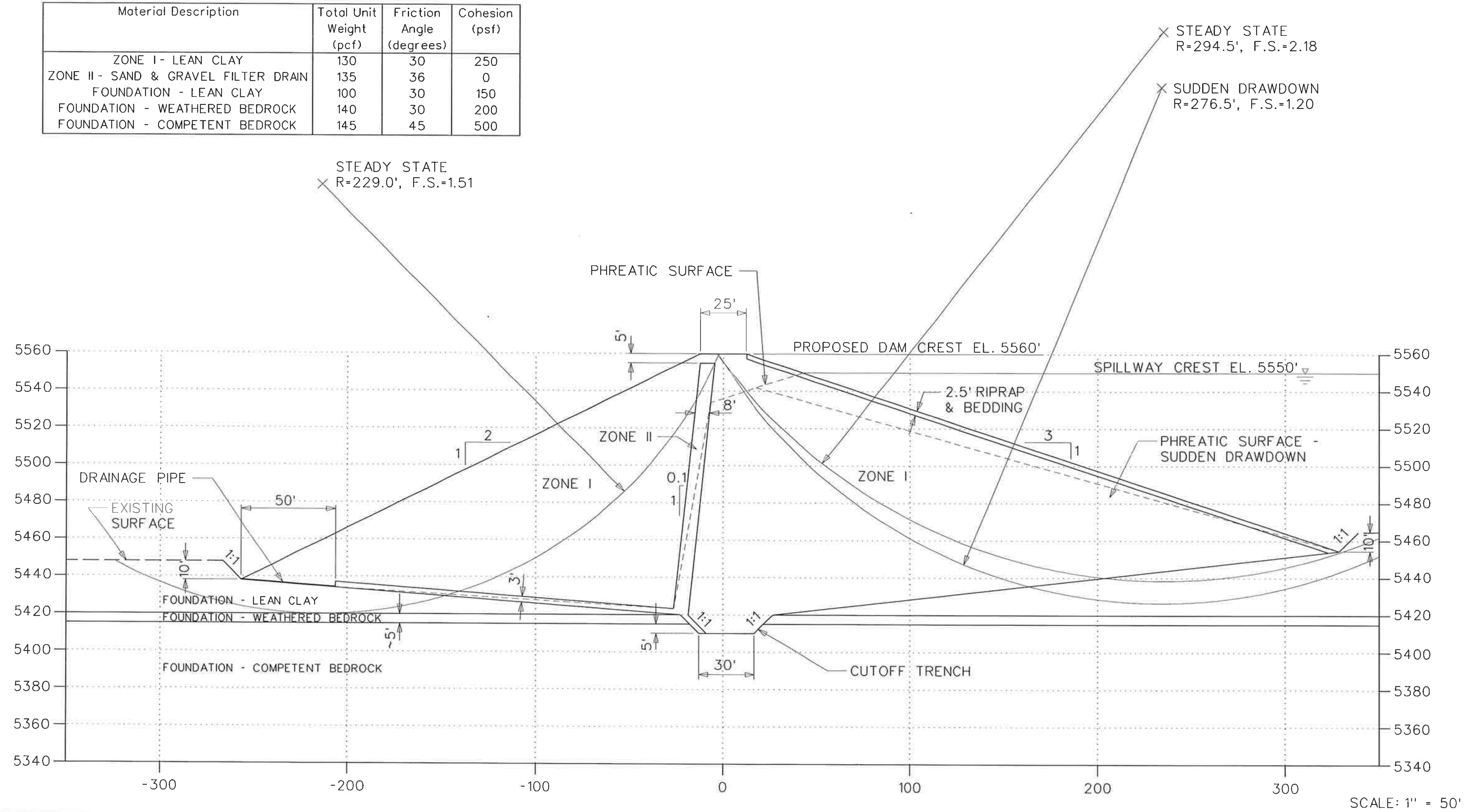

Figure 6

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COVE DAM
Orderville, Utah

Maximum Dam Section – Station 10+40

Borings

DRILL HOLE LOG

BORING NO. 04-1

Sheet: 1 of 2

PROJECT: COVE DAM
PROJECT NO.: 200401.025
CLIENT: K.C.W.C.D.
DATE: 4/13/04
LOCATION: SEE SITE PLAN - MAXIMUM SECTION
ELEVATION: ~5454.0'
DRILLER: D. SAMPSON, N. BAILEY
LOGGED BY: M.H., V.N.B.
EQUIP./DRILL METHOD: CME-55 / N.W. CASING TO 51.5'
DEPTH TO WATER - INITIAL: ≡ N.M. AFTER 24 HOURS: ≡ 46.8' 6/3/04

Elev. (Feet)	Depth (Feet)	Type	Rec. (In.)	See Legend	USCS	Material Description		Permeability, ft/yr	Dry Density, pcf	Moisture Content, %	Liquid Limit, %	Plasticity Index, %	Gravel, %	Sand, %	Silt/Clay, %	Other Tests
		■	6	5,3,3	CL-ML	lt. brown, dry, firm	SILTY CLAY W/SAND calcareous	52								
5450	5	☒	8	Pushed 1.00+	CL-1	lt. brown, dry, hard	LEAN CLAY	34	120.3	9.8	32	14	0	10	90	CT
5445	10	■	5	7,9,11	CL	lt. brown, dry, very stiff	CLAY W/SAND	10								
5440	15	☒	12	Pushed 1.00+	CL-2	lt. brown, dry, hard	SANDY CLAY	7	119.4	8.7	37	19	0	17	83	CT
5435	20	■	5	9,12,17	CL,SM	lt. brown, dry, very stiff	SILTY CLAY W/SILTY SAND LENSES & LAYERS	1								
5430	25	☒	12	Pushed 1.00+	CL-2	lt. brown, dry, hard	LEAN CLAY	5	112.4	14.3	34	18	0	6	94	CT
5425	30	■	6	8,12,13	CL	med. to lt. brown, dry, very stiff, w/white stringers		12								
5420	35	☒	18	Pushed 1.00+	CL-2	med. brown, moist, very stiff		13	105.2	17.5	49	31	0	3	97	CT
5415	40	■	18	4,6,8 0.72	CL	med. brown, moist to slightly wet, stiff		8								
5410	45	☒	12	Pushed 0.72	CL-2/CH	grayish-med. brown, moist, stiff, w/white stringers	LEAN TO FAT CLAY W/SOME SAND	5	100.7	23.1	50	34	0	6	94	CT
5405	50						TROPIC SHALE FORMATION									

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LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
Core
100,60 ← Rock Quality Designation (RQD)
Percent Sample Recovery
☒ Undisturbed Sample
≡ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

RB&G ENGINEERING INC.
Provo, Utah

DRILL HOLE LOG

BORING NO. 04-1

Sheet: 2 of 2

PROJECT: COVE DAM
PROJECT NO.: 200401.025
CLIENT: K.C.W.C.D.
DATE: 4/13/04
LOCATION: SEE SITE PLAN - MAXIMUM SECTION
ELEVATION: ~5454.0'
DRILLER: D. SAMPSON, N. BAILEY
LOGGED BY: M.H., V.N.B.
EQUIP./DRILL METHOD: CME-55 / N.W. CASING TO 51.5'
DEPTH TO WATER - INITIAL: ≟ N.M. AFTER 24 HOURS: ≟ 46.8' 6/3/04

Elev. (Feet)	Depth (Feet)	Lith-ology	SAMPLE Type	SAMPLE Rec. (In.)	SAMPLE See Legend	SAMPLE USCS	Material Description		Permeability, ft/yr	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Atter. Plasticity Index, %	Gradation Gravel, %	Gradation Sand, %	Gradation Silt/Clay, %	Other Tests
				18	18,28,36	CL	dk. gray, moist, hard	**SLIGHTLY SHALEY CLAY**	1								
5400				19	Core 64,64	CH		very highly weathered bedrock, w/many gypsum stringers			16.4	80	50	0	0	100	
	55			64	Core 106,80	-	dk. gray	**HIGHLY WEATHERED MUDSTONE** few gypsum stringers									
5395							dk. gray	**LESS WEATHERED MUDSTONE** shells									
	60			53	Core 88,88	-	dk. gray		0								
5390	65			53	Core 88,88	-	dk. gray slickenside	**SLIGHTLY WEATHERED MUDSTONE**									
5385	70			64	Core 106,106	-	0.25" clay seam										
5380						CH	white-gray	**BENTONITE W/SAND & LIMESTONE GRAVEL**	40		13.2	70	45	0	0	100	
	75			61	Core 102,102	-	dk. gray										
5375	80			35	Core 97,87	-	broken zone	**MUDSTONE**									
5370	85			50	Core 100,100	-	dk. gray, some black corbonaceous lenses		90								
							white-gray	**BENTONITE**									
5365				44	Core 97,89	-	dk. gray, some black corbonaceous lenses	**MUDSTONE**	0								
	90																
5360	95																
5355	100																

06/16/04
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LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
Core
100,60 ← Rock Quality Designation (RQD)
Percent Sample Recovery
☒ ← Undisturbed Sample
≟ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

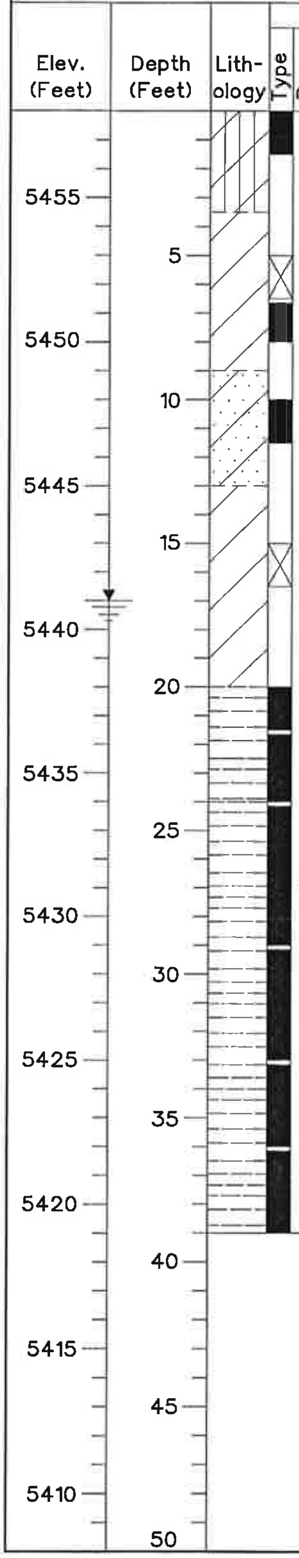
RB&G ENGINEERING INC.
Provo, Utah

DRILL HOLE LOG

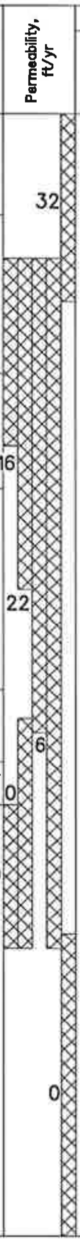
BORING NO. 04-2

Sheet: 1 of 1

PROJECT: COVE DAM
PROJECT NO.: 200401.025
CLIENT: K.C.W.C.D.
DATE: 4/16/04
LOCATION: SEE SITE PLAN - TOE, LEFT ABUTMENT
ELEVATION: ~5458.0'
DRILLER: D. SAMPSON, N. BAILEY
LOGGED BY: M.H., V.N.B.
EQUIP./DRILL METHOD: CME-55 / N.W. CASING TO 21.5' THEN N.Q. CORE
DEPTH TO WATER - INITIAL: N.M. AFTER 24 HOURS: 17.0' 6/3/04



Rec. (In.)	See Legend	USCS	Material Description		Dry Density, pcf	Moisture Content, %	Liquid Limit, %	Plasticity Index, %	Gravel, %	Sand, %	Silt/Clay, %	Other Tests
9	2,4,6	CL	lt. brown, dry to moist, firm, w/roots	SILTY CLAY								
14	Pushed 1.00+	CL	dk. brown, slightly moist, hard	LEAN CLAY W/GYPSUM STRINGERS								
7	14,22,33	CL-2	dk. brown, slightly moist, hard			12.2	45	31	0	2		98
10	15,22,33	CL	dk. brown, moist, hard, some gypsum	LEAN CLAY W/SOME SAND SIZE SANDSTONE FRAGMENTS								
18	Pushed 1.00+	CH	dk. brown, moist, hard	FAT CLAY	111.8	19.3	58	34	0	0	100	CT
18	9,15,33	-	dk. gray	VERY HIGHLY WEATHERED MUDSTONE very high slaking, rapid								
26	Core 63,63	-		LESS WEATHERED MUDSTONE								
56	Core 94,90	CH	dk. gray, dry mech. open 0.2' joint 0.25" clay seam			12.5	70	47	0	0	100	
48	Core 100,100	-	dk. gray, wealky calcareous	MUDSTONE calcareous, high slaking								
34	Core 95,95	-	a few white silt lenses									
36	Core 100,100	-										



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LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
Core
100,60 ← Rock Quality Designation (RQD)
Percent Sample Recovery
Undisturbed Sample
Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

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Provo, Utah

DRILL HOLE LOG

BORING NO. 04-3

Sheet: 1 of 2

PROJECT: COVE DAM
CLIENT: K.C.W.C.D.
LOCATION: SEE SITE PLAN - RIGHT ABUTMENT
DRILLER: D. SAMPSON, M. BARBOUR
EQUIP./DRILL METHOD: CME-55 / N.Q. CORE AT 60° FROM HORIZONTAL, TREND S18° E
DEPTH TO WATER - INITIAL: ⊽ N.M. AFTER 24 HOURS: ⊽ 71.0' 6/3/04

PROJECT NO.: 200401.025
DATE: 4/26/04
ELEVATION: ~5546.0'
LOGGED BY: M.H., V.N.B.

Elev. (Feet)	Depth (Feet)	Lith-ology	SAMPLE Type	Rec. (In.)	See Legend	USCS	Material Description	Permeability, ft/yr	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Plasticity Index, %	Gradation Gravel, %	Sand, %	Silt/Clay, %	Other Tests
5545							gray-brown **CLAY/VERY WEATHERED MUDSTONE**	48								
	5			24	Core 100,65	-	gray-brown to brown-gray gypsum									
5540																
	10			60	Core 100,22	-	gray-brown	314								
5535																
	15			61	Core 100,24	CH	gray-brown, dry **SILTY MUDSTONE** calcareous coating, very highly weathered & fractured, multiple angle - haphazard, some gypsum coating on joints, shaley & friable			13.7	54	33	0	0	100	
5530	20			23	Core 78,18	-		1245								
5525	25			59	Core 98,45	-		1135								
							gray-white, some rust staining **BENTONITE**									
							brown **SHALEY MUDSTONE**	1398								
							100% water loss									
5520	30			56	Core 94,42	-	dk. gray w/white bedding **SILTSTONE/MUDSTONE**	1989								
5515	35			59	Core 98,0	-	interbedded dk. gray & brown, gypsum bedding **SILTY MUDSTONE** calcareous	1202								
	40			53	Core 88,44	-	interbedded dk. gray & brown w/white stratification									
5510							clay seam									
	45			58	Core 96,46	-	**MUDSTONE** dk. gray w/brown, some rust stains, some shells, slow slaking	736								
5505	50			59	Core 98,50	-										

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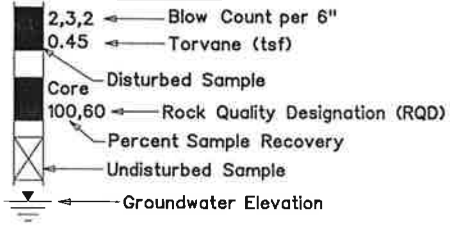
LEGEND



UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

RB&G ENGINEERING INC.
Provo, Utah

DRILL HOLE LOG

BORING NO. 04-3

Sheet: 2 of 2

PROJECT: COVE DAM
PROJECT NO.: 200401.025
CLIENT: K.C.W.C.D.
DATE: 4/26/04
LOCATION: SEE SITE PLAN - RIGHT ABUTMENT
ELEVATION: ~5546.0'
DRILLER: D. SAMPSON, M. BARBOUR
LOGGED BY: M.H., V.N.B.
EQUIP./DRILL METHOD: CME-55 / N.Q. CORE AT 60° FROM HORIZONTAL, TREND S18° E
DEPTH TO WATER - INITIAL: ▽ N.M.   AFTER 24 HOURS: ▼ 71.0' 6/3/04

Elev. (Feet)	Depth (Feet)	Type	Rec. (In.)	See Legend	USCS	Material Description	Permeability, ft/yr	Dry Density, pcf	Moisture Content, %	Liquid Limit, %	Plasticity Index, %	Gravel, %	Sand, %	Silt/Clay, %	Other Tests
5500	55	■	62	Core 104,100	-	dk. gray more competent, no bedding, shells, open joint at 53.4' to 53.7', 0.2" clay seam **MUDSTONE**	34								
5495	60	■	59	Core 98,98	-	dk. gray, some white bedding, trace of gypsum	394								
5490	65	■	59	Core 99,96	-	rust stain & coating **SILTY MUDSTONE**									
5485 ▼	70	■	62	Core 104,61	-	shells very hard septarian nodule	51								
5480	75	■	44	Core 74,56	-	gray, high slaking **SHALE** gray **BENTONITE**									
5475	80	■	62	Core 111,?	-	core is stuck in inner barrel and has not been removed, may contain bentonite 100% water loss	69								
	85	■	41	Core 69,65	-	dk. gray **MUDSTONE** 40° slickenside calcareous, some slaking, some lt. gray wavy bedding	341 0								
5470		■	29	Core 83,69	-	0.25" clay seam									
	90	■	60	Core 100,100	-	dk. gray clay seam, not calcareous									
5465		■	28	Core 94,94	-										
	95	■	24	Core 100,100	-	lt. gray **BENTONITE** black & white **LIMESTONE/VOLCANIC ASH** **BENTONITE**									
5460	100	■	42	Core 88,88	-	dk. gray **MUDSTONE**									

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Provo, Utah

LEGEND

- 2,3,2 ← Blow Count per 6"
- 0.45 ← Torvane (tsf)
- ☐ Disturbed Sample
- ■ Core 100,60 ← Rock Quality Designation (RQD)
- Percent Sample Recovery
- ☒ ← Undisturbed Sample
- ▼ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

06/15/04
04:02:52

DRILL HOLE LOG

BORING NO. 04-4

Sheet: 1 of 1

PROJECT: COVE DAM
PROJECT NO.: 200401.025
CLIENT: K.C.W.C.D.
DATE: 4/30/04
LOCATION: SEE SITE PLAN - MAXIMUM SECTION
ELEVATION: ~5458.0'
DRILLER: D. SAMPSON, M. BARBOUR
LOGGED BY: M.H., V.N.B.
EQUIP./DRILL METHOD: CME-55 / N.W. CASING
DEPTH TO WATER - INITIAL: ⊽ N.M. AFTER 24 HOURS: ⊽ DRY AT 29.3' 6/3/04

Elev. (Feet)	Depth (Feet)	Lith-ology	SAMPLE				Material Description		Permeability, ft/yr	Dry Density, pcf	Moisture Content, %	Atter.		Gradation			Other Tests
			Type	Rec. (In.)	See Legend	USCS						Liquid Limit, %	Plasticity Index, %	Gravel, %	Sand, %	Silt/Clay, %	
5455						CL	lt. brown, dry	SANDY LEAN CLAY									
	5																
5450																	
	10																
			■	7	7,11,14	CL	lt. brown, dry, very stiff	SILTY CLAY									
5445																	
	15																
5440																	
	20																
			■	10	11,14,19	CL	lt. brown, dry, very stiff	SILTY CLAY W/SILTY SAND LENSES									
5435																	
	25																
							gray	harder									
5430																	
	30																
			■	14	11,15,20	CL/SC	mottled rusty & yellow-brown, slightly moist to dry, hard	SANDY CLAY									
5425																	
	35																
			■	18	15,32,56	-	brown-gray, slightly moist, hard	VERY HIGHLY WEATHERED MUDSTONE TO VERY HARD CLAY w/gypsum, w/calcite crystals & stringers									
5420																	
	40																
			■	12	24,66	-	brown-gray, slightly moist, hard	HIGHLY WEATHERED CLAYEY MUDSTONE									
								BEDROCK - TROPIC SHALE FORMATION									
5415																	
	45																
5410																	
	50																

06/16/04
10:47:25 A

LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
Core
100,60 ← Rock Quality Designation (RQD)
Percent Sample Recovery
☒ ← Undisturbed Sample
⊽ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

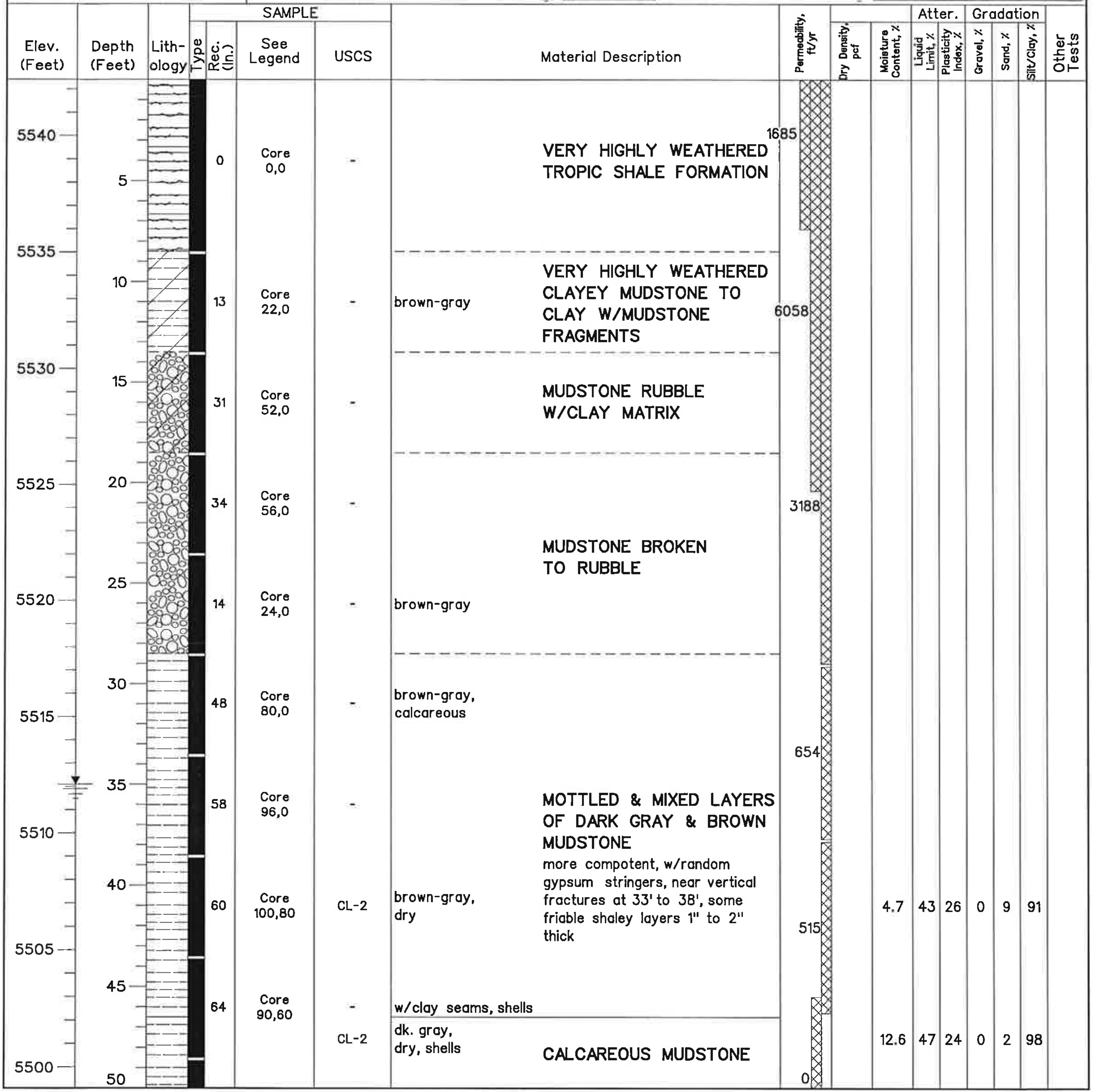
RB&G ENGINEERING INC.
Provo, Utah

DRILL HOLE LOG

BORING NO. 04-5

Sheet: 1 of 2

PROJECT: COVE DAM
PROJECT NO.: 200401.025
CLIENT: K.C.W.C.D.
DATE: 5/4/04
LOCATION: SEE SITE PLAN - LEFT ABUTMENT
ELEVATION: ~5542.4'
DRILLER: D. SAMPSON, M. BARBOUR
LOGGED BY: M.H., V.N.B.
EQUIP./DRILL METHOD: CME-55 / N.Q. CORE AT 60° FROM HORIZONTAL, TREND N65° E
DEPTH TO WATER - INITIAL: N.M. AFTER 24 HOURS: 35.0' 6/3/04



Type	Rec. (In.)	See Legend	USCS		Material Description	Permeability, ft/yr	Dry Density, pcf	Moisture Content, %	Liquid Limit, %	Plasticity Index, %	Gravel, %	Sand, %	Silt/Clay, %	Other Tests
	0	Core 0,0	-		VERY HIGHLY WEATHERED TROPIC SHALE FORMATION	1685								
	13	Core 22,0	-	brown-gray	VERY HIGHLY WEATHERED CLAYEY MUDSTONE TO CLAY W/MUDSTONE FRAGMENTS	6058								
	31	Core 52,0	-		MUDSTONE RUBBLE W/CLAY MATRIX									
	34	Core 56,0	-		MUDSTONE BROKEN TO RUBBLE	3188								
	14	Core 24,0	-	brown-gray										
	48	Core 80,0	-	brown-gray, calcareous	MOTTLED & MIXED LAYERS OF DARK GRAY & BROWN MUDSTONE more compotent, w/random gypsum stringers, near vertical fractures at 33' to 38', some friable shaley layers 1" to 2" thick	654								
	58	Core 96,0	-											
	60	Core 100,80	CL-2	brown-gray, dry		515		4.7	43	26	0	9	91	
	64	Core 90,60	-	w/clay seams, shells										
			CL-2	dk. gray, dry, shells	CALCAREOUS MUDSTONE	0		12.6	47	24	0	2	98	

06/16/04
04:03:11 P

LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
Core
100,60 ← Rock Quality Designation (RQD)
Percent Sample Recovery
Undisturbed Sample
Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

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INC.
Provo, Utah

DRILL HOLE LOG

BORING NO. 04-5

Sheet: 2 of 2

PROJECT: COVE DAM
CLIENT: K.C.W.C.D.
LOCATION: SEE SITE PLAN - LEFT ABUTMENT
DRILLER: D. SAMPSON, M. BARBOUR
EQUIP./DRILL METHOD: CME-55 / N.Q. CORE AT 60° FROM HORIZONTAL, TREND N65°E
DEPTH TO WATER - INITIAL: ⊽ N.M. AFTER 24 HOURS: ⊽ 35.0' 6/3/04

PROJECT NO.: 200401.025
DATE: 5/4/04
ELEVATION: ~5542.4'
LOGGED BY: M.H., V.N.B.

Elev. (Feet)	Depth (Feet)	Lith-ology	SAMPLE				Material Description	Permeability, ft/yr	Dry Density, pcf	Moisture Content, %	Atter.		Gradation			Other Tests
			Type	Rec. (In.)	See Legend	USCS					Liquid Limit, %	Plasticity Index, %	Gravel, %	Sand, %	Silt/Clay, %	
				59	Core 98,76	-	dk. gray									
5495	55			54	Core 98,63	-	dk. gray	0								
5490	60			53	Core 100,100	-	dk. gray, few shells **SHALEY MUDSTONE** friable, very slow slaking									
5485	65			60	Core 100,100	-	dk. gray, no gypsum, w/big white shells	5								
	70			54	Core 90,82	-										
5480							**SHALE TO BENTONITE**									
	75			60	Core 100,100	-	dk. gray w/few white lenses **CALCAREOUS MUDSTONE**	2								
5475							dk. to lt. gray, very soft dk. gray **SHALEY BENTONITE**									
	80			50	Core 84,84	-	dk. gray									
5470				12	Core 100,100	-	**CALCAREOUS MUDSTONE**	0								
	85			60	Core 100,100	-										
5465							very soft **SHALEY BENTONITE**									
	90			60	Core 100,100	-	dk. gray **CALCAREOUS MUDSTONE**									
5460	95			52	Core 100,100	-										
							LIMESTONE									
	100			24	Core 80,80	-	dk. gray **CALCAREOUS MUDSTONE W/SHELLS**									
5455																

LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
Core
100,60 ← Rock Quality Designation (RQD)
Percent Sample Recovery
☒ ← Undisturbed Sample
⊽ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

06/16/04
10:49:46 A

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Top
04-1

Bottom

Depth Cored
51.5 to 90 feet

NQ Core Dia. 1.875 in.
Length of Core Box 2 ft.

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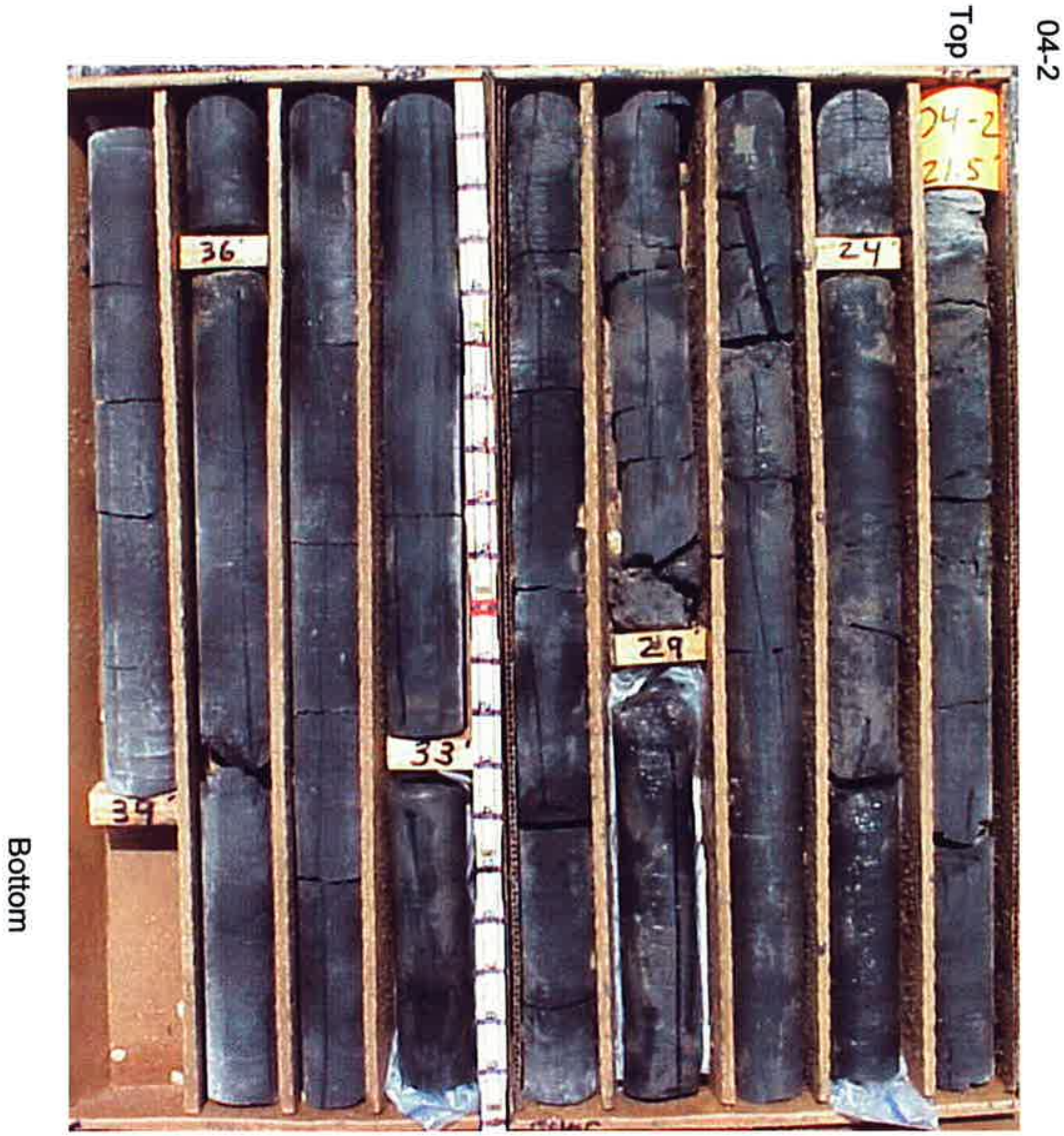
Figure	Core Photos, Drill Hole # 04-1 *Center Section*
Project	*Cove DamSite Feasibility Study*
Location	*Orderville, Kane County, Utah*



Depth Cored
21.5 to 39 feet

NQ Core Dia. 1.875 in.
Length of Core Box 2 ft.

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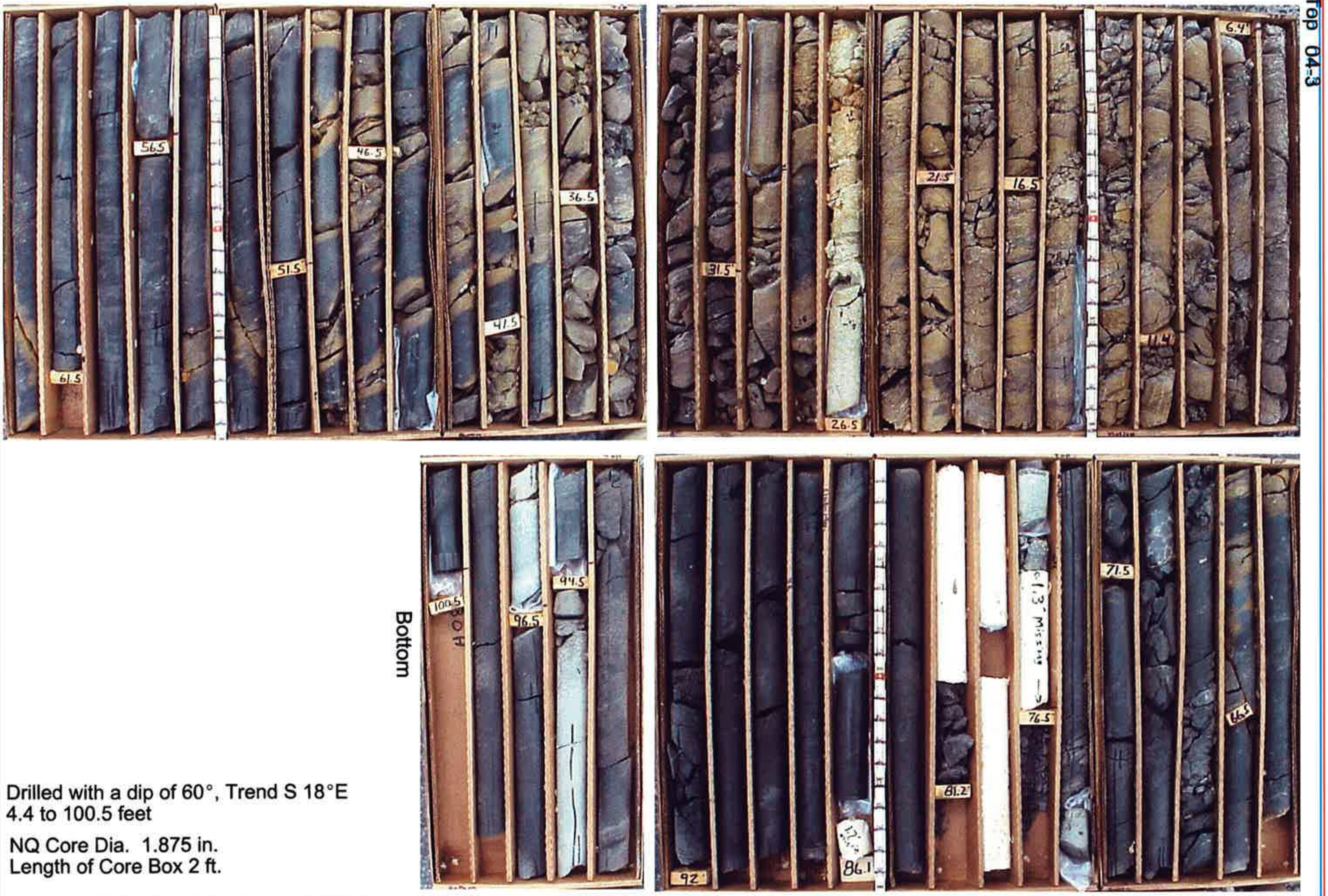
Figure	Core Photos, Drill Hole # 04-2 Max ~~Center~~ Section
Project	*Cove DamSite Feasibility Study*
Location	*Orderville, Kane County, Utah*

near toe of slope
@ left abutment



Drilled with a dip of 60°, Trend S 18°E
4.4 to 100.5 feet

NQ Core Dia. 1.875 in.
Length of Core Box 2 ft.

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Figure	Core Photos, Drill Hole # 04-3 *Right Abutment*
Project	*Cove Dam Site Feasibility Study*
Location	*Orderville, Kane County, Utah*

Drilled with a dip of 60°, Trend N 65° E
8.5 to 101 feet

NQ Core Dia. 1.875 in.
Length of Core Box 2 ft.

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Figure	Core Photos, Drill Hole # 04-5 *Left Abutment*
Project	*Cove Dam Site Feasibility Study*
Location	*Orderville, Kane County, Utah*

Test Pits

TEST PIT LOG

PIT NO. 04-1

Sheet: 1 of 1

PROJECT: **COVE DAM**
CLIENT: K.C.W.C.D.
LOCATION: SEE SITE PLAN
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: ▽ DRY AFTER 24 HOURS: ▽ DRY

PROJECT NO.: **200401.025**
DATE: 6/1/04
ELEVATION: ~5463.0'
LOGGED BY: M. STILSON

Elev. (Feet)	Depth (Feet)	Lith-ology	SAMPLE Type		Type	USCS	Material Description		Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Atter. Plasticity Index, %	Gradation Gravel, %	Gradation Sand, %	Gradation Silt/Clay, %	Other Tests
5460			☒		3 Rings Block Bucket	CL-1	1" fine silty sand layer			4.8	26	12	0	3	97	
	5															
			☒		Ring Block	CL-2		**LEAN CLAY** lt. brown to brown, dry, hard, some pinhole structure, minor mineral stringers	95.1	6.4	35	16	0	2	98	
							1" fine silty sand layer									
5455																
			☒		Ring Block	CL-2				3.4	31	15	0	26	74	
	10															
							1" fine silty sand layer									
			■		Bag	CL	1" fine silty sand layer									
5450																
	15															
5445																
	20															

06/15/04
11:02:09 AM

LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
■ ← Disturbed Sample
☒ ← Undisturbed Sample
▽ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

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TEST PIT LOG

PIT NO. 04–2

Sheet: 1 of 1

PROJECT: **COVE DAM**
CLIENT: K.C.W.C.D.
LOCATION: SEE SITE PLAN
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: ▽ DRY AFTER 24 HOURS: ▼ DRY

PROJECT NO.: **200401.025**
DATE: 6/2/04
ELEVATION: ~5474.0'
LOGGED BY: M. STILSON

Elev. (Feet)	Depth (Feet)	Lithology	Sample Type	Sample USCS	Material Description	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Atter. Plasticity Index, %	Gradation Gravel, %	Gradation Sand, %	Gradation Silt/Clay, %	Other Tests
			Bag	CL									
5470	5												
			Bag	CL-2	**LEAN CLAY W/FINE SAND** lt. brown to brown, very dry, hard, sand intermixed throughout entire depth of test pit, some distinct pockets but no continuous layers, some pinhole structure, macro-hole structure in upper 3', trace minerals		8.6	40	20	0	2	98	
5465													
	10		Bag	CL									
			Bag	CL-1			5.8	31	13	0	12	88	
5460	15												
5455	20												

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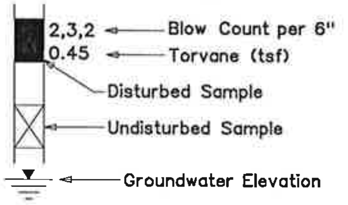
LEGEND



- 2,3,2 — Blow Count per 6"
- 0.45 — Torvane (tsf)
- Disturbed Sample
- Undisturbed Sample
- Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

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Provo, Utah

TEST PIT LOG

PIT NO. 04-3

Sheet: 1 of 1

PROJECT: COVE DAM
CLIENT: K.C.W.C.D.
LOCATION: SEE SITE PLAN
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: ▽ DRY AFTER 24 HOURS: ▼ NOT MEASURED

PROJECT NO.: 200401.025
DATE: 6/2/04
ELEVATION: ~5476.0'
LOGGED BY: M. STILSON

Elev. (Feet)	Depth (Feet)	Lithology	SAMPLE Type		SAMPLE Type	SAMPLE USCS	Material Description	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Atter. Plasticity Index, %	Gradation Gravel, %	Gradation Sand, %	Gradation Silt/Clay, %	Other Tests
			■		Bag	SP	**SAND W/GRAVEL** medium grained sand, fine grained gravel					25	73	2	
5475															
			■		Bag	CL									
						SM	2" silty sand layer								
	5														
5470															
			■		Bag	CL									
							LEAN CLAY W/SAND lt. brown to brown, dry, hard, intermixed, fine, some pinhole structure, some silt lenses, calcite stringers								
			■		Bag	CL									
	10														
						SP-SM	2" sand w/silt layer								
5465															
						SM	2" silty sand layer								
			■		Bag	CL									
	15														
5460															
	20														

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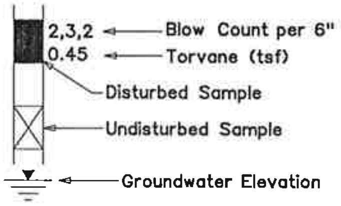
LEGEND



UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

TEST PIT LOG

PIT NO. 04-4

Sheet: 1 of 1

PROJECT: COVE DAM

PROJECT NO.: 200401.025

CLIENT: K.C.W.C.D.

DATE: 6/2/04

LOCATION: SEE SITE PLAN

ELEVATION: ~5475.0'

LOGGED BY: M. STILSON

EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE

DEPTH TO WATER - INITIAL: ▽ DRY AFTER 24 HOURS: ▽ NOT MEASURED

Elev. (Feet)	Depth (Feet)	Lith-ology	SAMPLE Type	SAMPLE Type	SAMPLE USCS	Material Description	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Atter. Plasticity Index, %	Gradation Gravel, %	Gradation Sand, %	Gradation Silt/Clay, %	Other Tests
		▨	■	Bag	CL									
5470	5	▨												
		▨			SM	2" sand layer at 5.5'					0	82	18	
		▨	■	Bag	CL	**LEAN CLAY** lt. brown to brown, dry, hard, some small sand pockets, pinhole structure, trace minerals								
		▨	■	Bag	CL									
5465	10	▨												
5460	15													
	20													

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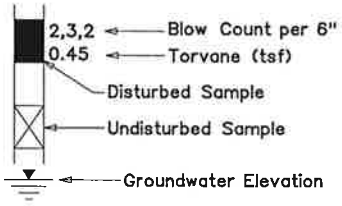
LEGEND



UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

TEST PIT LOG

PIT NO. 04-5

Sheet: 1 of 1

PROJECT: COVE DAM
PROJECT NO.: 200401.025
CLIENT: K.C.W.C.D.
DATE: 6/2/04
LOCATION: SEE SITE PLAN
ELEVATION: ~5477.0'
LOGGED BY: M. STILSON
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: ▽ DRY AFTER 24 HOURS: ▽ NOT MEASURED

Elev. (Feet)	Depth (Feet)	Lithology	SAMPLE Type		Type	USCS	Material Description	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Atter. Plasticity Index, %	Gradation Gravel, %	Gradation Sand, %	Gradation Silt/Clay, %	Other Tests
						CL	**LEAN CLAY**								
5475			■		Bag	GP	**GRAVEL W/SAND** fairly clean, sub-angular, mostly 0.75" to 3" sizes, a few cobbles up to 12"								
5470	5		■		Bag	CH	**HEAVILY WEATHERED MUDSTONE** dk. brown, moist, very hard			58	34				
	10		■		Bag	CH				59	31				
5465															
5460	15														
	20														

06/15/04
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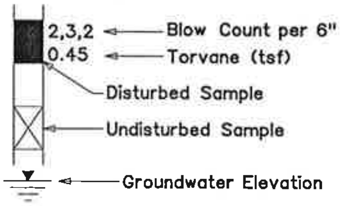
LEGEND



UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

TEST PIT LOG

PIT NO. 04-6

Sheet: 1 of 1

PROJECT: COVE DAM
PROJECT NO.: 200401.025
CLIENT: K.C.W.C.D.
DATE: 6/2/04
LOCATION: SEE SITE PLAN
ELEVATION: ~5466.0'
LOGGED BY: M. STILSON
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: DRY AFTER 24 HOURS: NOT MEASURED

			SAMPLE						Atter.		Gradation			
Elev. (Feet)	Depth (Feet)	Lith-ology	Type	Type	USCS	Material Description	Dry Density, pcf	Moisture Content, %	Liquid Limit, %	Plasticity Index, %	Gravel, %	Sand, %	Silt/Clay, %	Other Tests
5465														
				Bag	CL									
	5													
5460						**LEAN CLAY W/FINE SAND** lt. brown to brown, dry, hard, intermixed, some sand pockets, pinhole structure, minerals								
				Bag	CL									
				Bag	CL									
	10													
5455														
				Bag	CL									
	15													
5450														
	20													

06/11/04
10:59:49 AM

LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
Undisturbed Sample
Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

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INC.
Provo, Utah

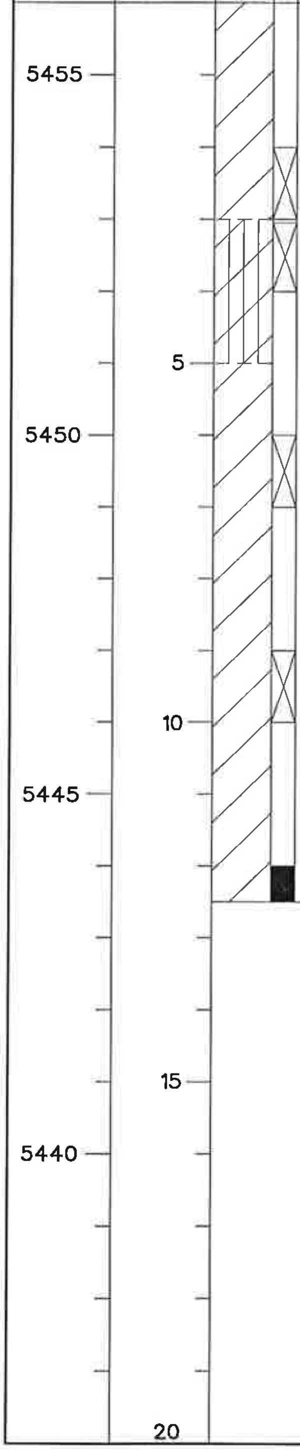
TEST PIT LOG

PIT NO. 04-7

Sheet: 1 of 1

PROJECT: COVE DAM
CLIENT: K.C.W.C.D.
LOCATION: SEE SITE PLAN
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: ≡ DRY AFTER 24 HOURS: ≡ NOT MEASURED

PROJECT NO.: 200401.025
DATE: 6/2/04
ELEVATION: ~5456.0'
LOGGED BY: M. STILSON



Sample Type	USCS	Material Description	Dry Density, pcf	Moisture Content, %	Liquid Limit, %	Plasticity Index, %	Gravel, %	Sand, %	Silt/Clay, %	Other Tests
Ring	CL-1	**LEAN CLAY** dry, pinhole structure, macro-holes to 3'	82.0	9.1	28	11	0	13	87	
2 Blocks	CL-ML	**SILTY CLAY**	86.9	6.5	26	6	0	10	90	CT
Block Bucket	CL-2	**LEAN CLAY** lt. brown to brown, dry, hard, pinhole structure			37	18	0	3	97	DS
Block	CL-2		89.6	9.1	33	15	0	3	97	
Bag	CL									

06/14/04
03:09:18 PM

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LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
☒ Undisturbed Sample
≡ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test
DS - Direct Shear Test

TEST PIT LOG

PIT NO. 04-8

Sheet: 1 of 1

PROJECT: **COVE DAM**
PROJECT NO.: **200401.025**
CLIENT: K.C.W.C.D.
DATE: 6/2/04
LOCATION: SEE SITE PLAN
ELEVATION: ~5475.0'
LOGGED BY: M. STILSON
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: DRY
AFTER 24 HOURS: NOT MEASURED

Elev. (Feet)	Depth (Feet)	Sample Type	Sample USCS	Material Description	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Atter. Plasticity Index, %	Gradation Gravel, %	Gradation Sand, %	Gradation Silt/Clay, %	Other Tests
				SILTY CLAY W/SAND lt. brown to brown, dry, hard, pinhole structure								
		Bag	CL-1			6.9	33	14	0	6	94	
5470	5											
		Bag	CL									
				LEAN CLAY lt. brown to brown, dry, hard, pinhole structure, minerals								
		Bag	CL-2			6.7	46	25	0	2	98	
5465	10											
		Bag	CL									
5460	15											
	20											

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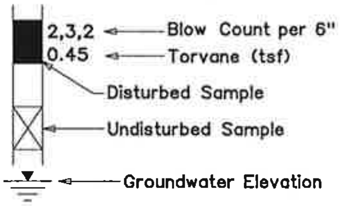
LEGEND



UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

TEST PIT LOG

PIT NO. 04–9

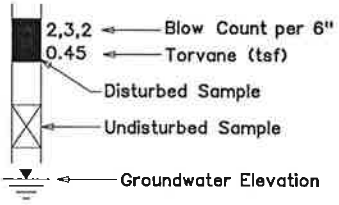
Sheet: 1 of 1

PROJECT: COVE DAM
PROJECT NO.: 200401.025
CLIENT: K.C.W.C.D.
DATE: 6/2/04
LOCATION: SEE SITE PLAN
ELEVATION: ~5483.0'
LOGGED BY: M. STILSON
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: ▽ DRY AFTER 24 HOURS: ▽ NOT MEASURED

Elev. (Feet)	Depth (Feet)	Lithology	SAMPLE Type		Type	USCS	Material Description	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Atter. Plasticity Index, %	Gradation Gravel, %	Gradation Sand, %	Gradation Silt/Clay, %	Other Tests
5480			■		Bag	CL									
	5														
			■		Bag	CL-2	**LEAN CLAY W/FINE SAND** lt. brown to brown, dry, hard, pinhole structure, trace minerals		7.8	37	21	0	1	99	
5475															
	10		■		Bag	CL									
			■		Bag	CL-2			6.3	31	15	0	6	94	
5470															
	15														
5465															
	20														

06/11/04
11:00:31 AM

LEGEND



UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

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INC.
Provo, Utah

TEST PIT LOG

PIT NO. 04–10

Sheet: 1 of 1

PROJECT: COVE DAM
PROJECT NO.: 200401.025
CLIENT: K.C.W.C.D.
DATE: 6/2/04
LOCATION: SEE SITE PLAN
ELEVATION: ~5500.0'
LOGGED BY: M. STILSON
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: ≚ DRY AFTER 24 HOURS: ≚ NOT MEASURED

Elev. (Feet)	Depth (Feet)	Lithology	SAMPLE Type		Type	USCS	Material Description	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Atter. Plasticity Index, %	Gradation Gravel, %	Gradation Sand, %	Gradation Silt/Clay, %	Other Tests
		▨	■		Bag	CL-2			6.9	38	20	0	6	94	
5495	5	▨													
		▨	■		Bag	CL	**LEAN CLAY** lt. brown to brown, dry, hard, trace pinhole structure, more minerals, trace sand at 3'								
		▨	■		Bag	CL-2			8.5	43	22	0	6	94	
5490	10	▨													
		▨	■		Bag	CL									
5485	15														
	20														

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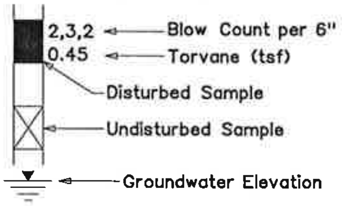
LEGEND



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UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

TEST PIT LOG

PIT NO. 04-11

Sheet: 1 of 1

PROJECT: COVE DAM

PROJECT NO.: 200401.025

CLIENT: K.C.W.C.D.

DATE: 6/2/04

LOCATION: SEE SITE PLAN

ELEVATION: ~5498.0'

LOGGED BY: M. STILSON

EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE

DEPTH TO WATER - INITIAL: ▽ DRY   AFTER 24 HOURS: ▽ NOT MEASURED

Elev. (Feet)	Depth (Feet)	Lith-ology	SAMPLE				Material Description	Dry Density, pcf	Moisture Content, %	Atter.		Gradation			Other Tests
			Type		Type	USCS				Liquid Limit, %	Plasticity Index, %	Gravel, %	Sand, %	Silt/Clay, %	
5495			■		Bag	CL-ML	**SILTY CLAY W/SAND** lt. brown to brown, dry, hard, pinhole structure, fine sand - intermixed		4.4	20	5	0	43	57	
	5														
			■		Bag	CL-ML									
5490															
			■		Bag	CL-2	**LEAN CLAY W/SAND** lt. brown to brown, dry, hard, pinhole structure, fine sand - intermixed		5.7	34	16	0	17	83	
	10														
			■		Bag	CL-ML	**SILTY CLAY W/SAND** lt. brown to brown, dry, hard, pinhole structure, fine sand - intermixed								
5485															
	15														
5480															
	20														

06/11/04
11:01:01 AM

LEGEND

■ 2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
☐ ← Disturbed Sample
☒ ← Undisturbed Sample
▽ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

RB&G ENGINEERING INC.
Provo, Utah

TEST PIT LOG

PIT NO. 04-12

Sheet: 1 of 1

PROJECT: COVE DAM
PROJECT NO.: 200401.025
CLIENT: K.C.W.C.D.
DATE: 6/2/04
LOCATION: SEE SITE PLAN
ELEVATION: ~5520.0'
LOGGED BY: M. STILSON
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: DRY AFTER 24 HOURS: NOT MEASURED

Elev. (Feet)	Depth (Feet)	Lith-ology	SAMPLE Type		Type	USCS	Material Description	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Atter. Plasticity Index, %	Gradation Gravel, %	Gradation Sand, %	Gradation Silt/Clay, %	Other Tests
					Bag	CL-ML	**SILTY CLAY W/SAND** lt. brown to brown, dry, hard								
5515	5														
					Bag/ Block	ML	shows layering **SANDY SILT** lt. brown to brown, dry, hard		4.4		NP	0	47	53	
					Bag	CL-ML	**SILTY CLAY W/SAND** lt. brown to brown, dry, hard								
5510	10														
					Bag	CL-2	**LEAN CLAY** lt. brown to brown, dry, hard		7.2	36	16	0	2	98	
5505	15														
	20														

06/11/04
11:01:14 AM

LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
Undisturbed Sample
Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

RB&G ENGINEERING INC.
Provo, Utah

TEST PIT LOG

PIT NO. 04-13

Sheet: 1 of 1

PROJECT: COVE DAM
CLIENT: K.C.W.C.D.
LOCATION: SEE SITE PLAN
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: ⏚ DRY AFTER 24 HOURS: ⏚ NOT MEASURED

PROJECT NO.: 200401.025
DATE: 6/2/04
ELEVATION: ~5548.0'
LOGGED BY: M. STILSON

Elev. (Feet)	Depth (Feet)	Lith-ology	SAMPLE Type		Type	USCS	Material Description	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Plasticity Index, %	Gradation Gravel, %	Sand, %	Silt/Clay, %	Other Tests
							6" clay layer								
			■		Bag	SM									
							8" clay layer								
5515	5														
			■		Bag	SM	**SILTY SAND W/CLAY LAYERS** lt. brown to brown, dry								
							12" clay layer								
			■		Bag	SM									
5510	10														
			■		Bag	SM									
5505	15														
	20														

06/11/04
11:01:30 AM

RB&G ENGINEERING INC.
Provo, Utah

LEGEND

■ 2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
☐ Disturbed Sample
☒ Undisturbed Sample
⏚ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

Laboratory Testing

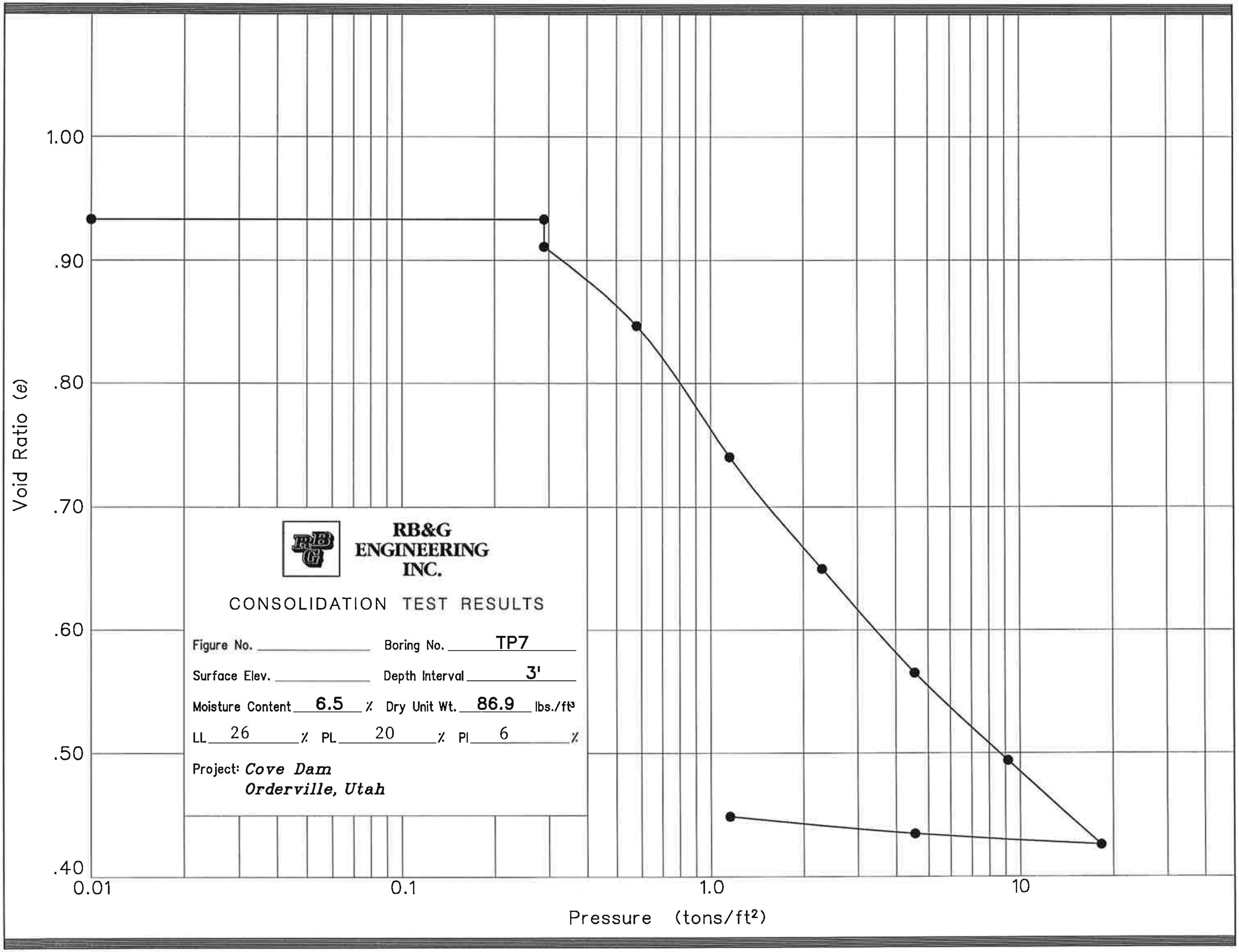
Table 1

SUMMARY OF TEST DATA

PROJECT	Cove Dam	PROJECT NO.	200401-025
LOCATION	Kane County, Utah	FEATURE	

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	MATERIAL	IN-PLACE		PINHOLE TEST RESULTS	ATTERBERG LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM (modified)
			DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY	
DH-1	5-6	Soil	120.3	9.8		32	18	14	0	10	90	CL-1
	15-16.5	Soil	119.4	8.7		37	18	19	0	17	83	CL-2
	25-26.5	Soil	112.4	14.3		34	16	18	0	6	94	CL-2
	35-36.5	Soil	105.2	17.5		49	18	31	0	3	97	CL-2
	45-46	Soil	100.7	23.1		50	16	34	0	6	94	CL-2/CH
	53	Bedrock		16.4		82	30	50	0	0	100	CH
	73	Bedrock		13.2		70	25	45	0	0	100	CH
DH-2	6.5-8	Soil		12.2		45	14	31	0	2	98	CL-2
	15-16.5	Soil	111.8	19.3		58	24	34	0	0	100	CH
	26	Bedrock		13.5		70	23	47	0	0	100	CH
DH-3	14	Bedrock		13.7		54	21	33	0	0	100	CH
DH-5	41	Bedrock		4.7		43	17	26	0	9	91	CL-2
	48	Bedrock		12.6		47	23	24	0	2	98	CL-2
TP-1	3-4	Soil		4.8	ND2	26	16	12	0	3	97	CL-1
	6-7	Soil		6.4	ND2	35	19	6	0	2	98	CL-2
	9-10	Soil		3.4	ND3	31	16	15	0	26	74	CL-2
TP-2	6-7	Soil		8.6		40	20	20	0	2	98	CL-2
	12-12.5	Soil		5.8	ND3	31	18	13	0	12	88	CL-1
TP-3	0-1	Soil							25	73	2	SP
TP-4	5.5	Soil							0	82	18	SM
TP-5	6	Bedrock				58	24	34				CH
	9	Bedrock				59	28	31				CH
TP-7	2	Soil	82.0	9.1	ND2	28	17	11	0	13	87	CL-1
	2-3	Soil	86.9	6.5	ND3	26	20	6	0	10	90	CL-ML
	6-7	Soil		4.0	ND2	37	19	18	0	3	97	CL-2
	9-10	Soil	89.6	9.1		33	18	15	0	3	97	CL-2
TP-8	3-4	Soil		6.9	ND3	33	19	14	0	6	94	CL-1
	9-10	Soil		6.7	ND2	46	21	25	0	2	98	CL-2
TP-9	6-7	Soil		7.8		37	16	21	0	1	99	CL-2
	12-12.5	Soil		6.3		31	16	15	0	6	94	CL-2
TP-10	3-4	Soil		6.9		38	18	20	0	6	94	CL-2
	9-10	Soil		8.5		43	21	22	0	6	94	CL-2
TP-11	3-4	Soil		4.4		20	15	5	0	43	57	CL-ML
	9-10	Soil		5.7		34	18	16	0	17	83	CL-2
TP-12	6-7	Soil		4.4				NP	0	47	53	ML
	12-12.5	Soil		7.2		36	20	16	0	2	98	CL-2

NP=Nonplastic



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

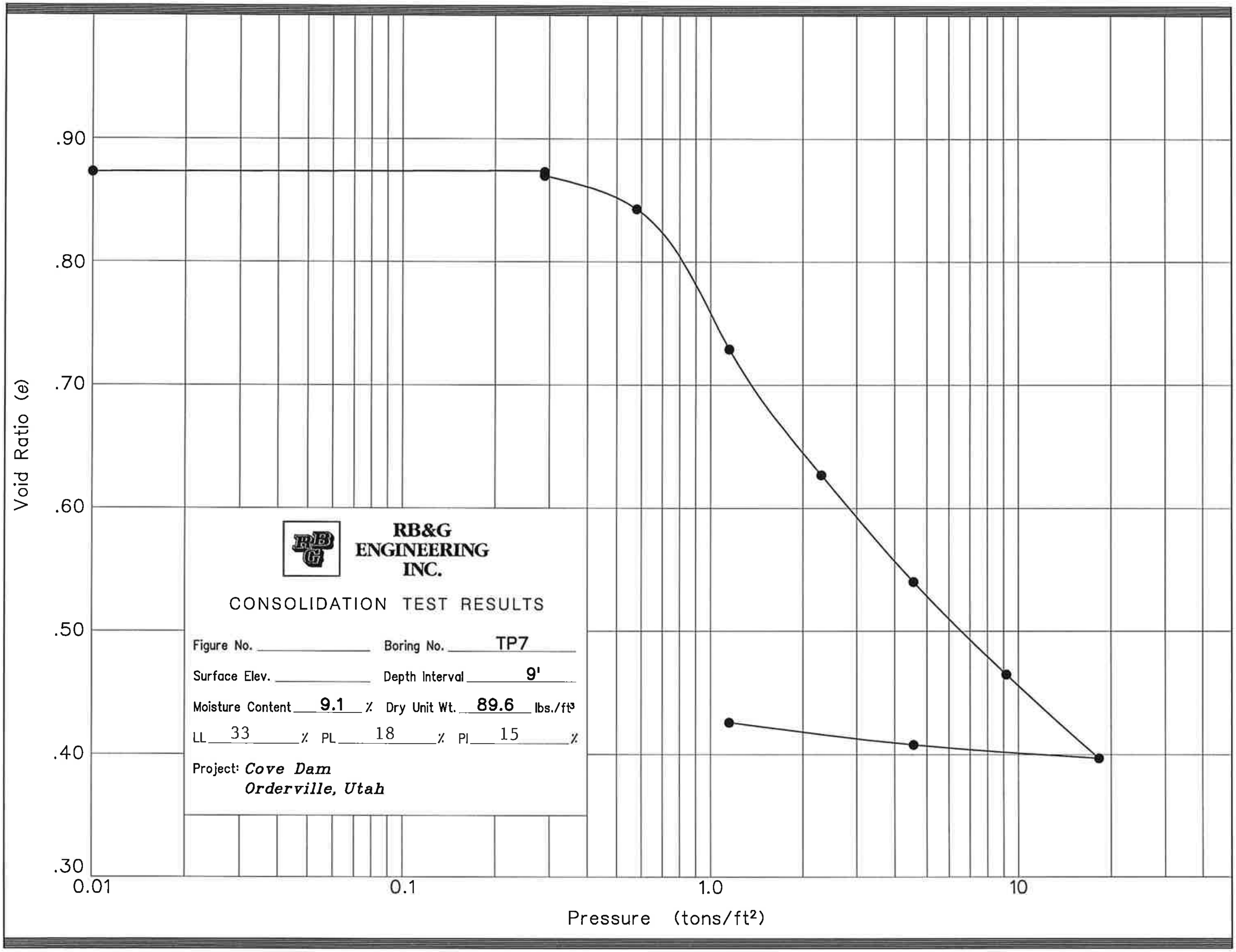
Figure No. ______ Boring No. TP7

Surface Elev. ______ Depth Interval 3'

Moisture Content 6.5 % Dry Unit Wt. 86.9 lbs./ft³

LL 26 % PL 20 % PI 6 %

Project: *Cove Dam*
Orderville, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

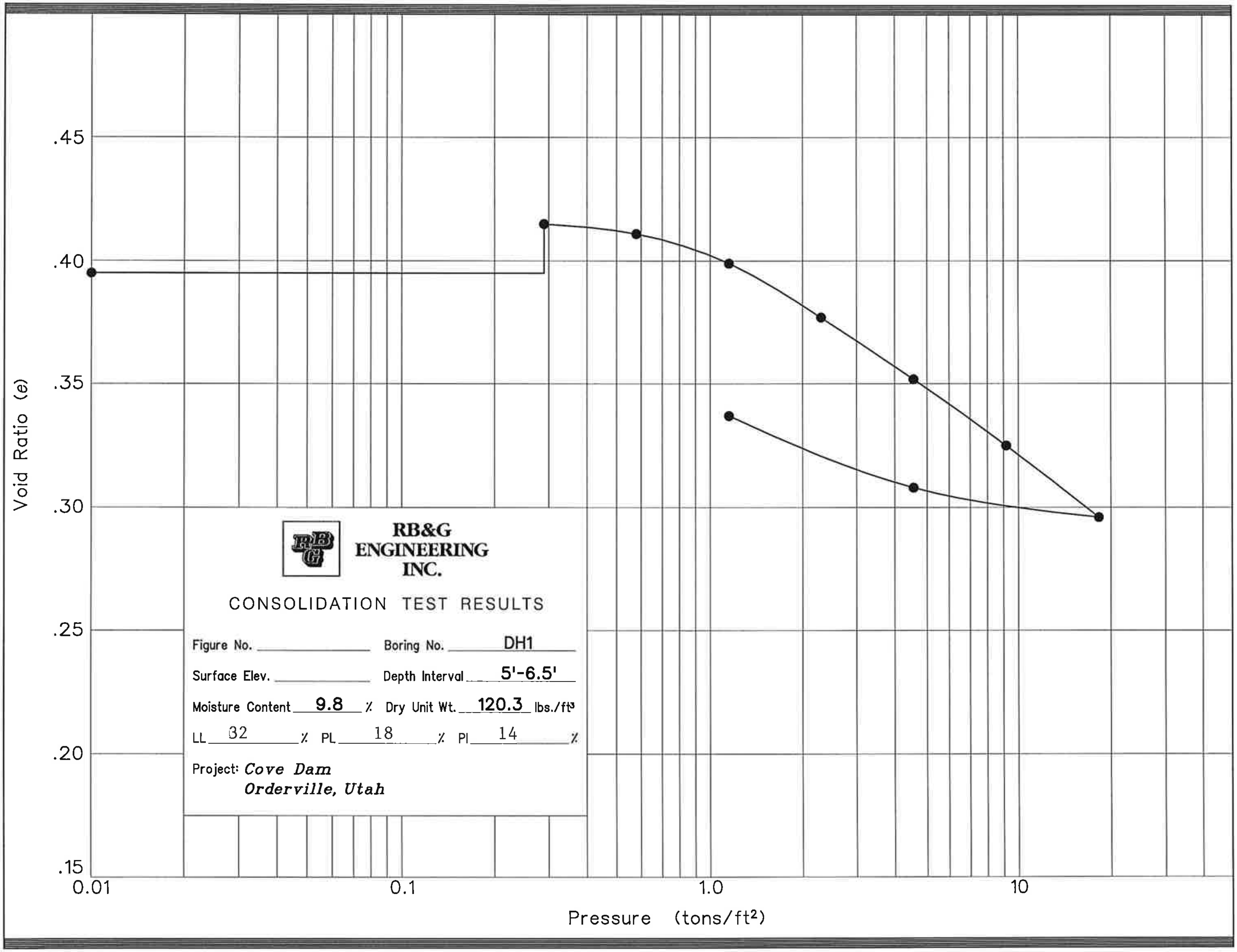
Figure No. ______ Boring No. TP7

Surface Elev. ______ Depth Interval 9'

Moisture Content 9.1 % Dry Unit Wt. 89.6 lbs./ft³

LL 33 % PL 18 % PI 15 %

Project: *Cove Dam*
Orderville, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

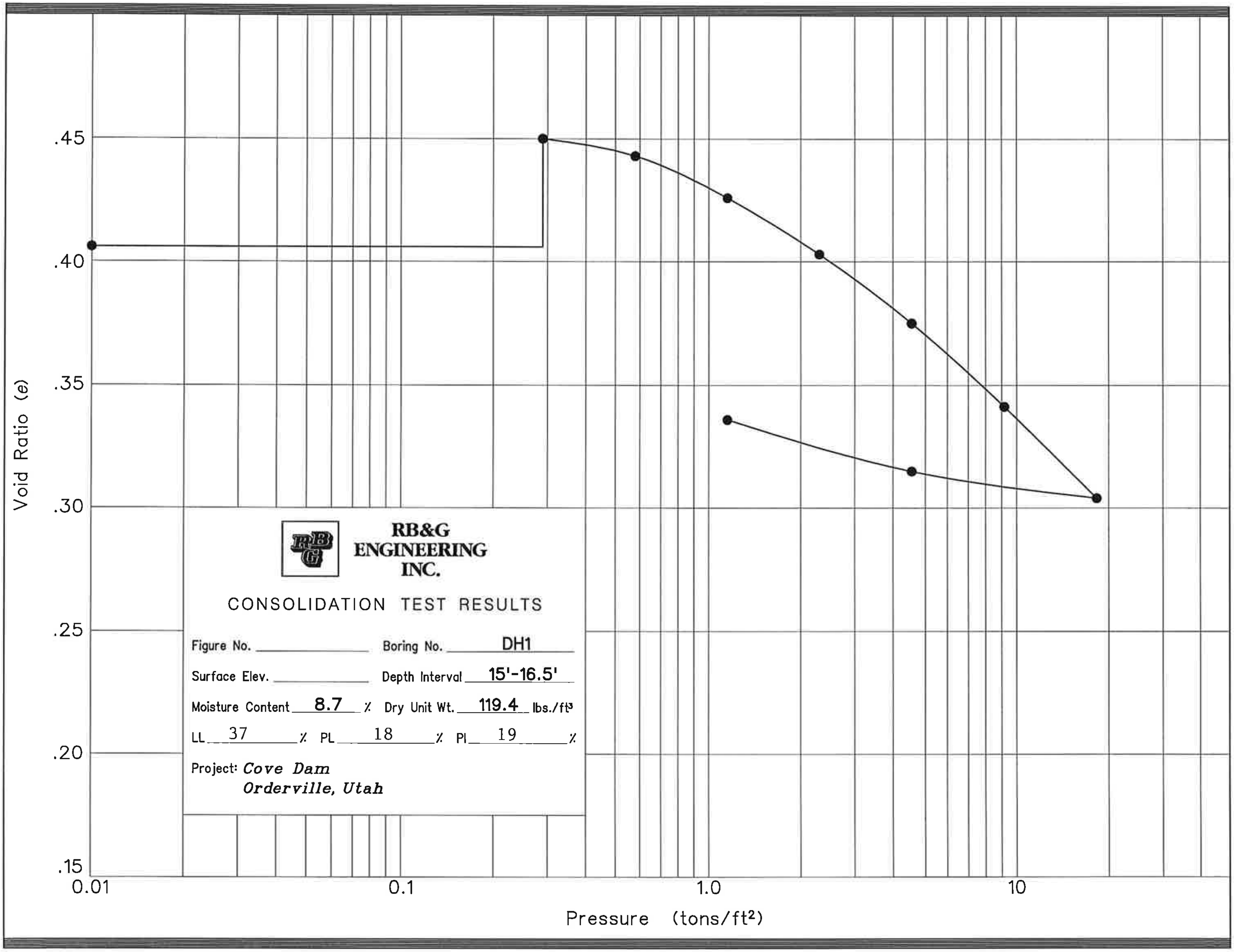
Figure No. ____________ Boring No. DH1

Surface Elev. ____________ Depth Interval 5'-6.5'

Moisture Content 9.8 % Dry Unit Wt. 120.3 lbs./ft³

LL 32 % PL 18 % PI 14 %

Project: *Cove Dam*
Orderville, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

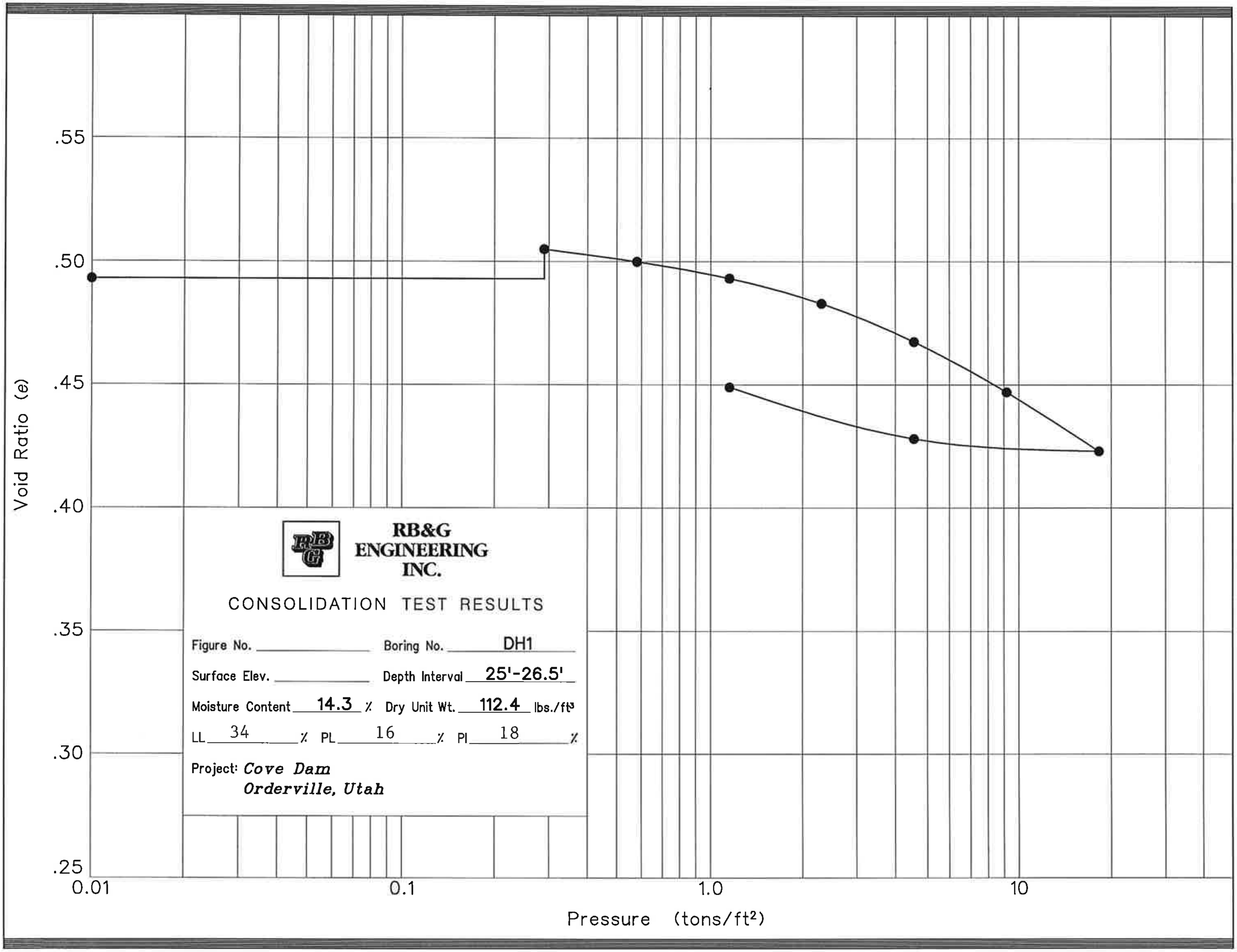
Figure No. ______ Boring No. DH1

Surface Elev. ______ Depth Interval 15'-16.5'

Moisture Content 8.7 % Dry Unit Wt. 119.4 lbs./ft³

LL 37 % PL 18 % PI 19 %

Project: *Cove Dam*
Orderville, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

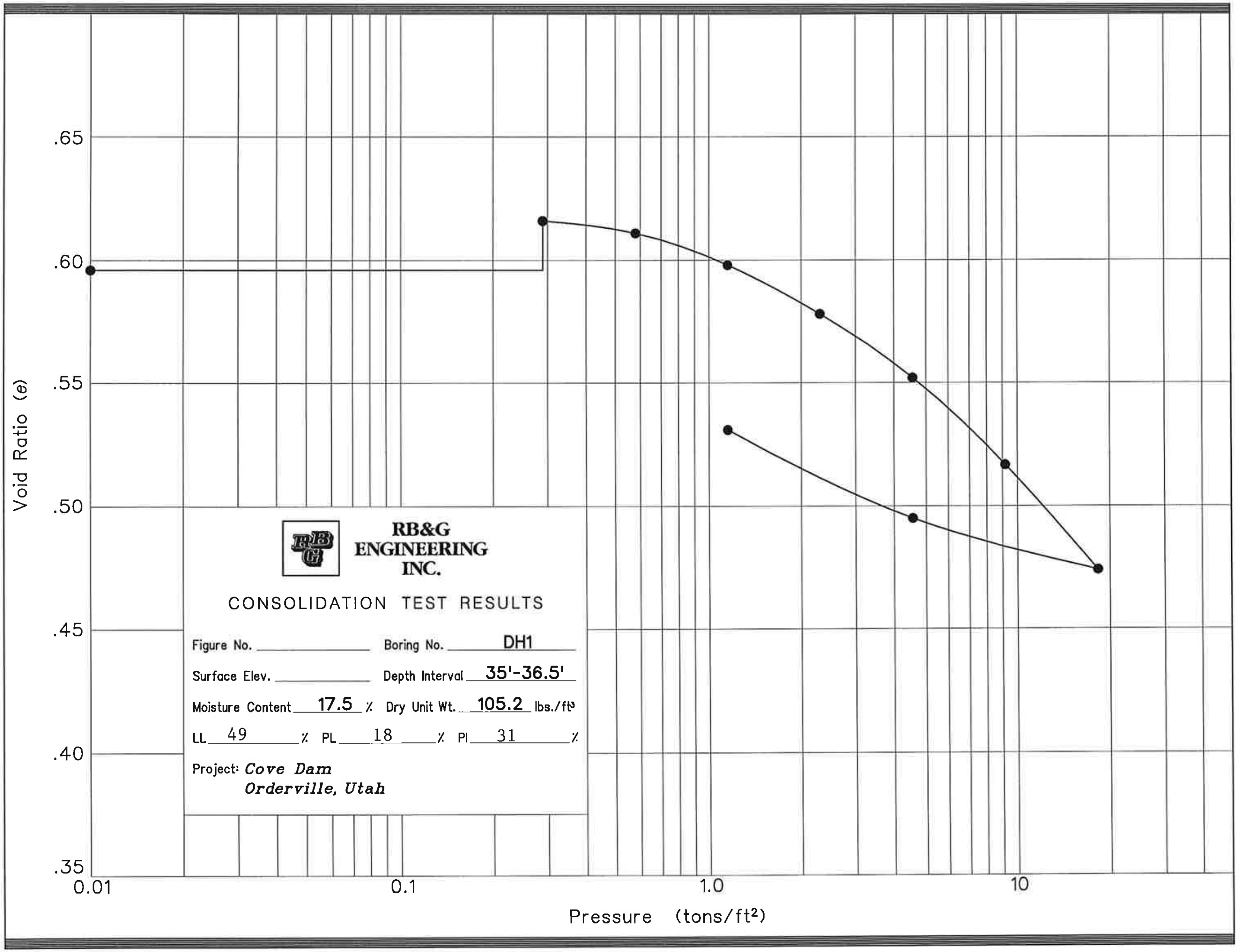
Figure No. ______ Boring No. DH1

Surface Elev. ______ Depth Interval 25'-26.5'

Moisture Content 14.3 % Dry Unit Wt. 112.4 lbs./ft³

LL 34 % PL 16 % PI 18 %

Project: *Cove Dam*
Orderville, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

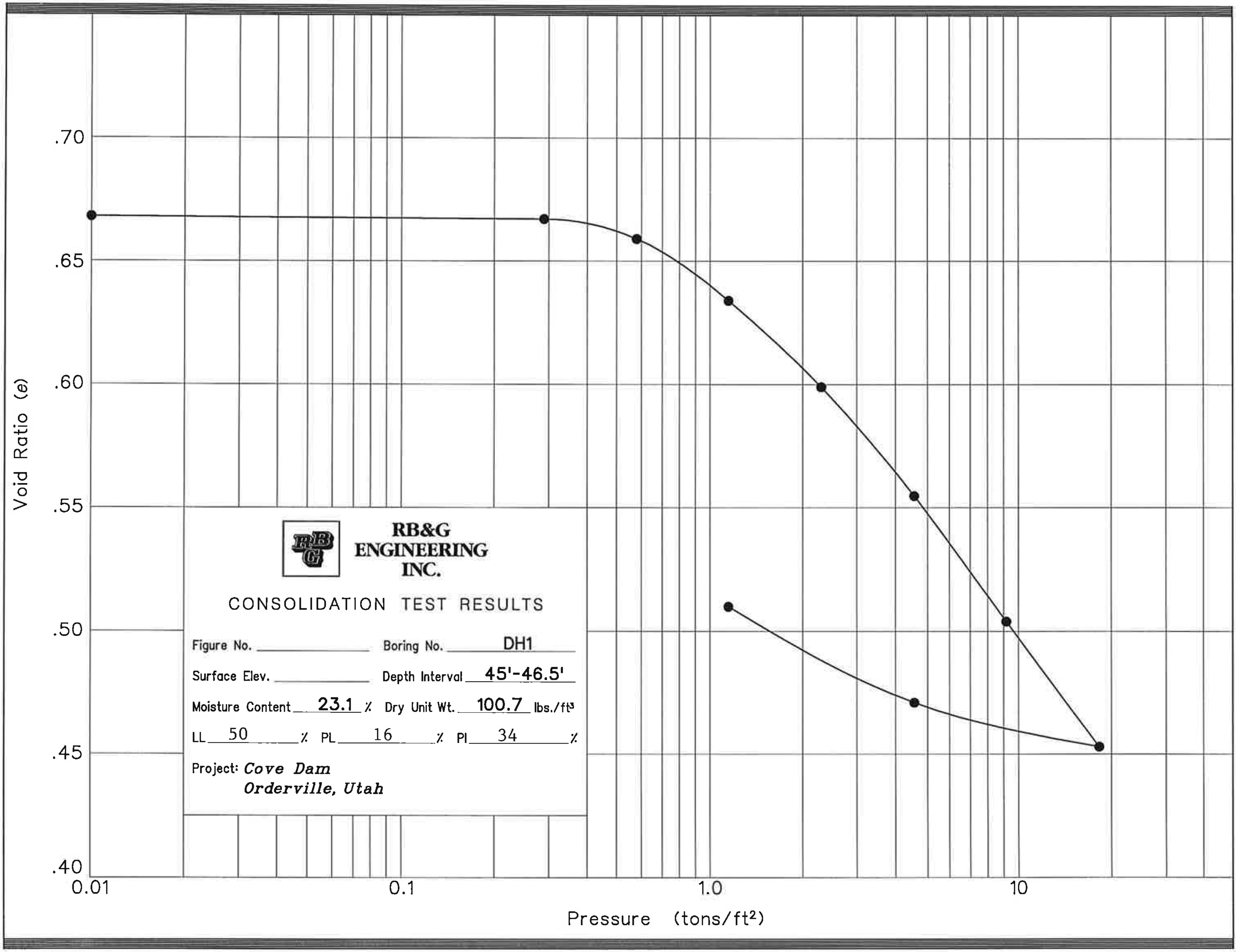
Figure No. ______ Boring No. DH1

Surface Elev. ______ Depth Interval 35'-36.5'

Moisture Content 17.5 % Dry Unit Wt. 105.2 lbs./ft³

LL 49 % PL 18 % PI 31 %

Project: *Cove Dam*
Orderville, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

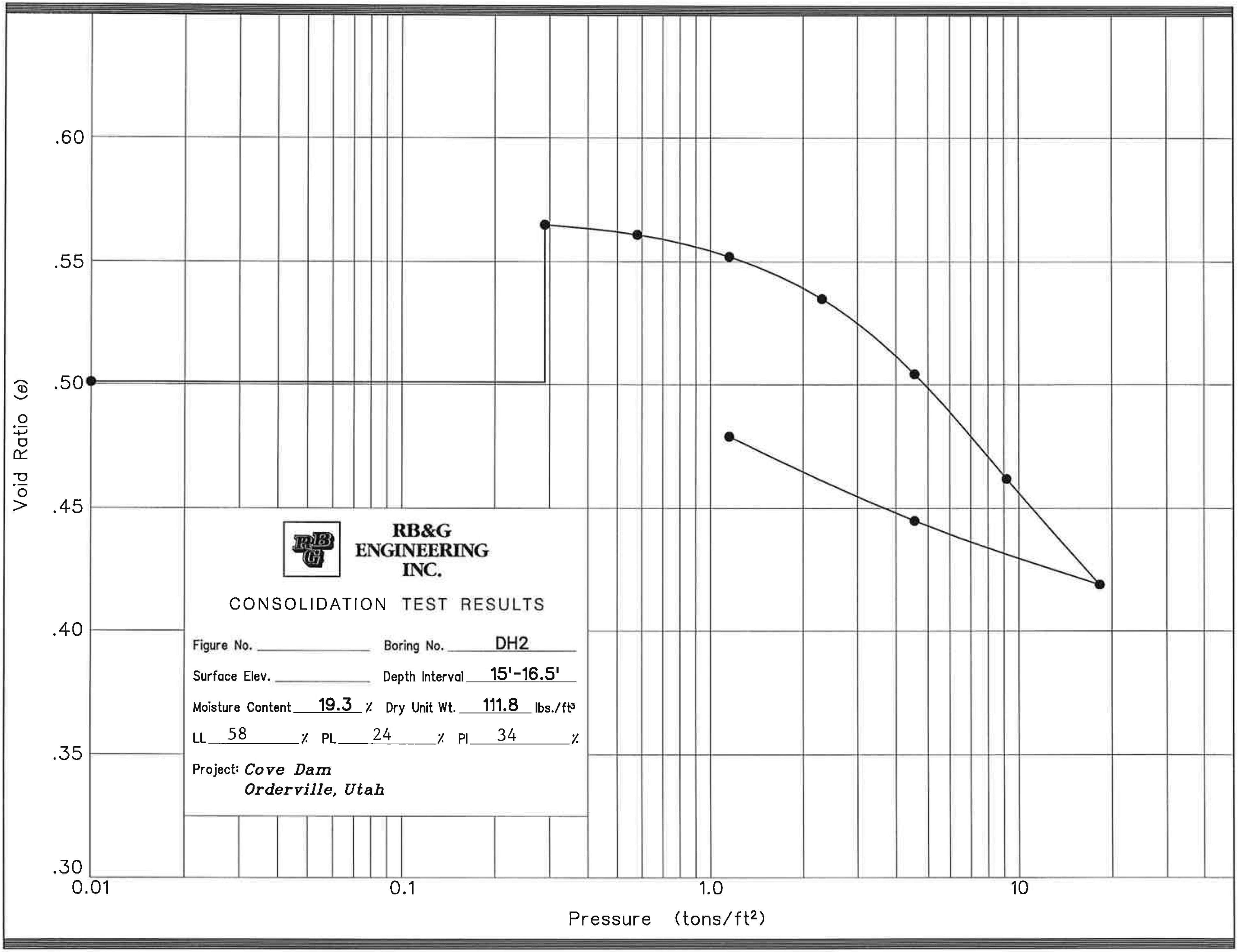
Figure No. ______ Boring No. DH1

Surface Elev. ______ Depth Interval 45'-46.5'

Moisture Content 23.1 % Dry Unit Wt. 100.7 lbs./ft³

LL 50 % PL 16 % PI 34 %

Project: *Cove Dam*
Orderville, Utah



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ENGINEERING
INC.

CONSOLIDATION TEST RESULTS

Figure No. ______ Boring No. DH2

Surface Elev. ______ Depth Interval 15'-16.5'

Moisture Content 19.3 % Dry Unit Wt. 111.8 lbs./ft³

LL 58 % PL 24 % PI 34 %

Project: *Cove Dam*
Orderville, Utah

RB&G ENGINEERING INC.
1435 West 820 North, Provo, Utah 84601
801 374-5771 Provo
801 521-5771 Salt Lake City

PROJECT NO.	200401.025

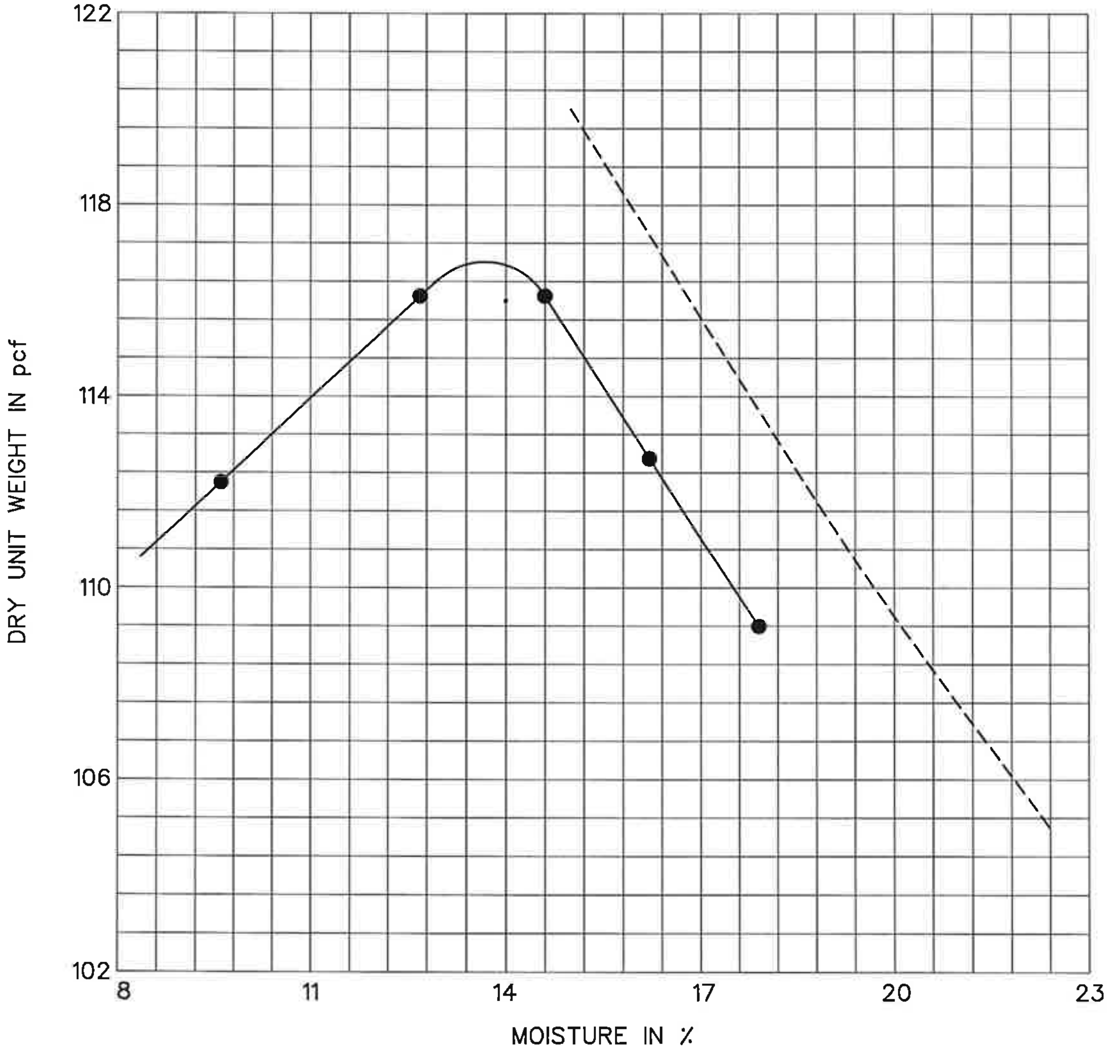
MOISTURE-DENSITY RELATION (PROCTOR)

Project	COVE DAM			Date	6/9/04
Location	ORDERVILLE, UTAH / TEST PIT NO. 1 AT 3'			Technician	G. PEASLEE
Material Description	LT. BROWN TO BROWN LEAN CLAY	USCS	CL-1	Method	ASTM D 698

Procedure Used[1]	A
Classification Procedure[2]	Test

[1] A-No. 4 Sieve, B-3/8" Sieve, C-3/4" Sieve
[2] Visual as per ASTM D 2488, Test as per ASTM D 2487

Preparation Method	Moist
Rammer Used	Manual
As-Received Moisture Content (%)	-



Maximum Dry Density (pcf)	116.0
Optimum Moisture Content (%)	14.0
Modified Maximum Density (pcf)	
Modified Optimum Moisture Content (%)	

Specific Gravity of Soil	2.70	Est.

OVERSIZE CORRECTION-ASTM D 4718

Specific Gravity of Soil +3/4		
Percent Oversize		

------ 100% Saturation Curve

Type of Specific Gravity is BULK Unless Otherwise Indicated

RB&G ENGINEERING INC.
1435 West 820 North, Provo, Utah 84601
801 374-5771 Provo
801 521-5771 Salt Lake City

PROJECT NO.	200401.025

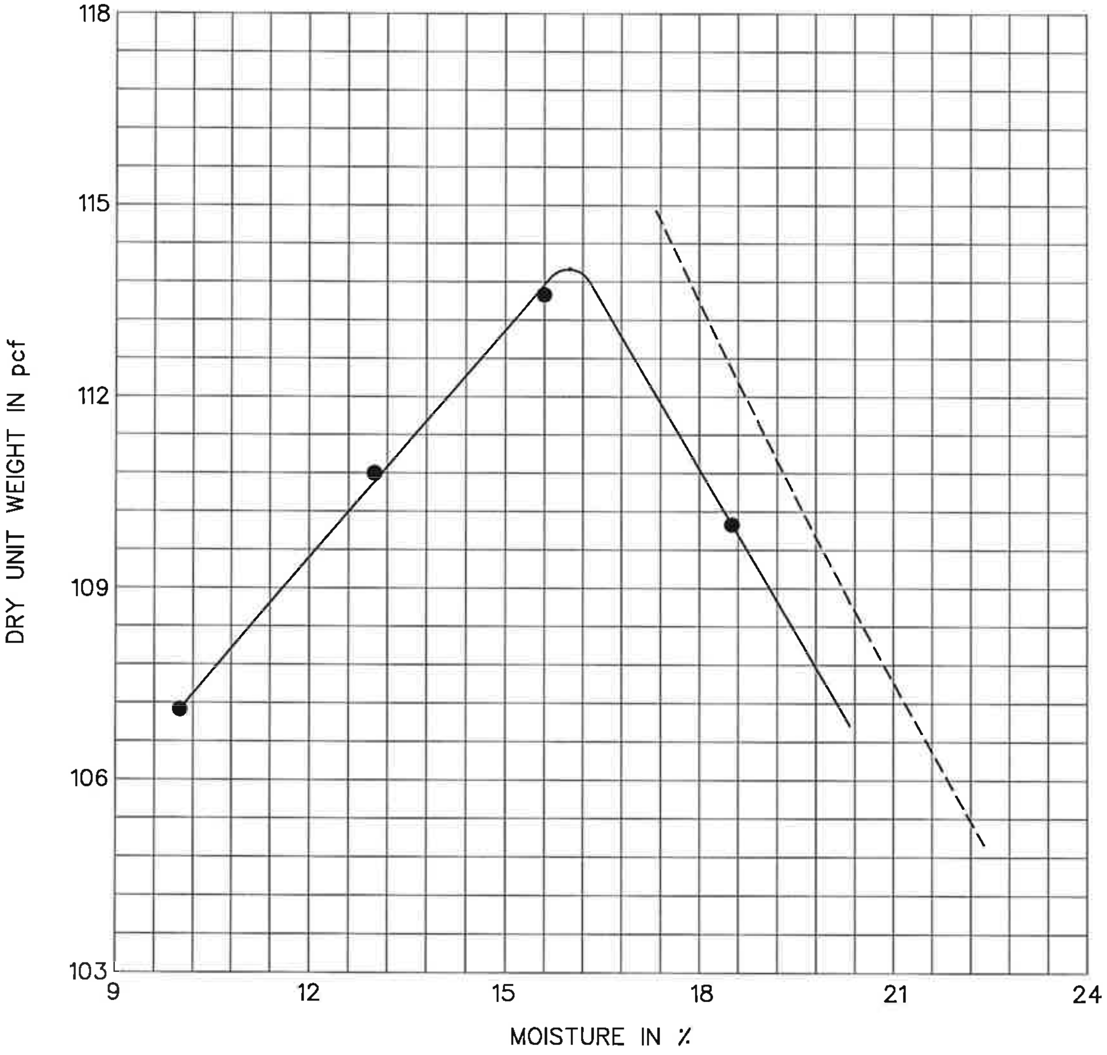
MOISTURE-DENSITY RELATION (PROCTOR)

Project	COVE DAM			Date	6/9/04
Location	ORDERVILLE, UTAH / TEST PIT NO. 7 AT 3'-4'			Technician	G. PEASLEE
Material Description	LT. BROWN TO BROWN SILTY CLAY	USCS	CL-ML	Method	ASTM D 698

Procedure Used[1]	A
Classification Procedure[2]	Test

[1] A-No. 4 Sieve, B-3/8" Sieve, C-3/4" Sieve
[2] Visual as per ASTM D 2488, Test as per ASTM D 2487

Preparation Method	Moist
Rammer Used	Manual
As-Received Moisture Content (%)	-



Maximum Dry Density (pcf)	114.0
Optimum Moisture Content (%)	16.0
Modified Maximum Density (pcf)	
Modified Optimum Moisture Content (%)	

------100% Saturation Curve

Specific Gravity of Soil	2.70	Est.

OVERSIZE CORRECTION-ASTM D 4718

Specific Gravity of Soil +3/4		
Percent Oversize		

Type of Specific Gravity is BULK Unless Otherwise Indicated

RB&G ENGINEERING INC.
1435 West 820 North, Provo, Utah 84601
801 374-5771 Provo
801 521-5771 Salt Lake City

PROJECT NO.	200401.025

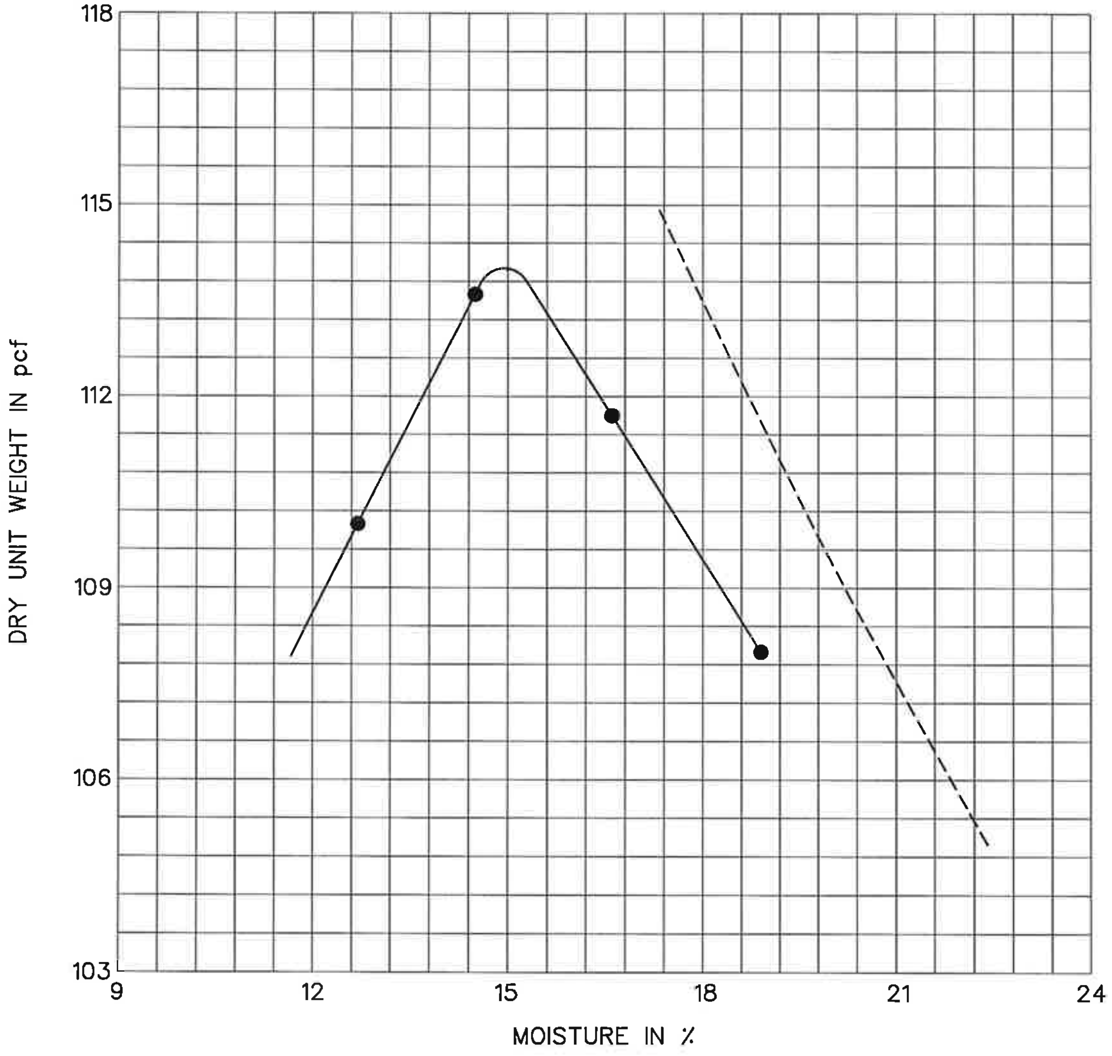
MOISTURE-DENSITY RELATION (PROCTOR)

Project	COVE DAM			Date	6/9/04
Location	ORDERVILLE, UTAH / TEST PIT NO. 7 AT 6'			Technician	G. PEASLEE
Material Description	LT. BROWN TO BROWN LEAN CLAY	USCS	CL-2	Method	ASTM D 698

Procedure Used[1]	A
Classification Procedure[2]	Test

[1] A-No. 4 Sieve, B-3/8" Sieve, C-3/4" Sieve
[2] Visual as per ASTM D 2488, Test as per ASTM D 2487

Preparation Method	Moist
Rammer Used	Manual
As-Received Moisture Content (%)	4.0



Maximum Dry Density (pcf)	114.0
Optimum Moisture Content (%)	15.0
Modified Maximum Density (pcf)	
Modified Optimum Moisture Content (%)	

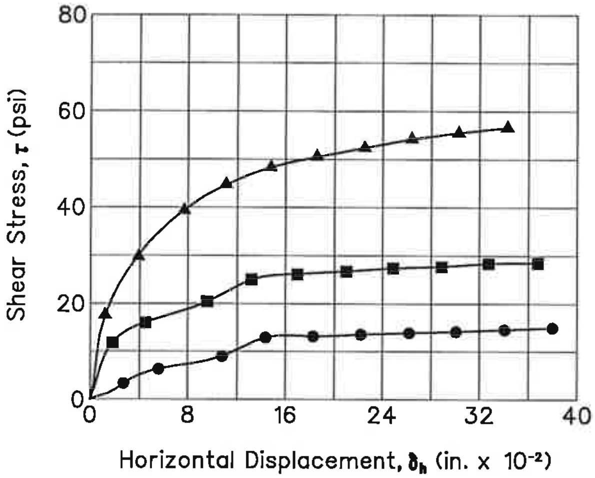
Specific Gravity of Soil	2.70	Est.

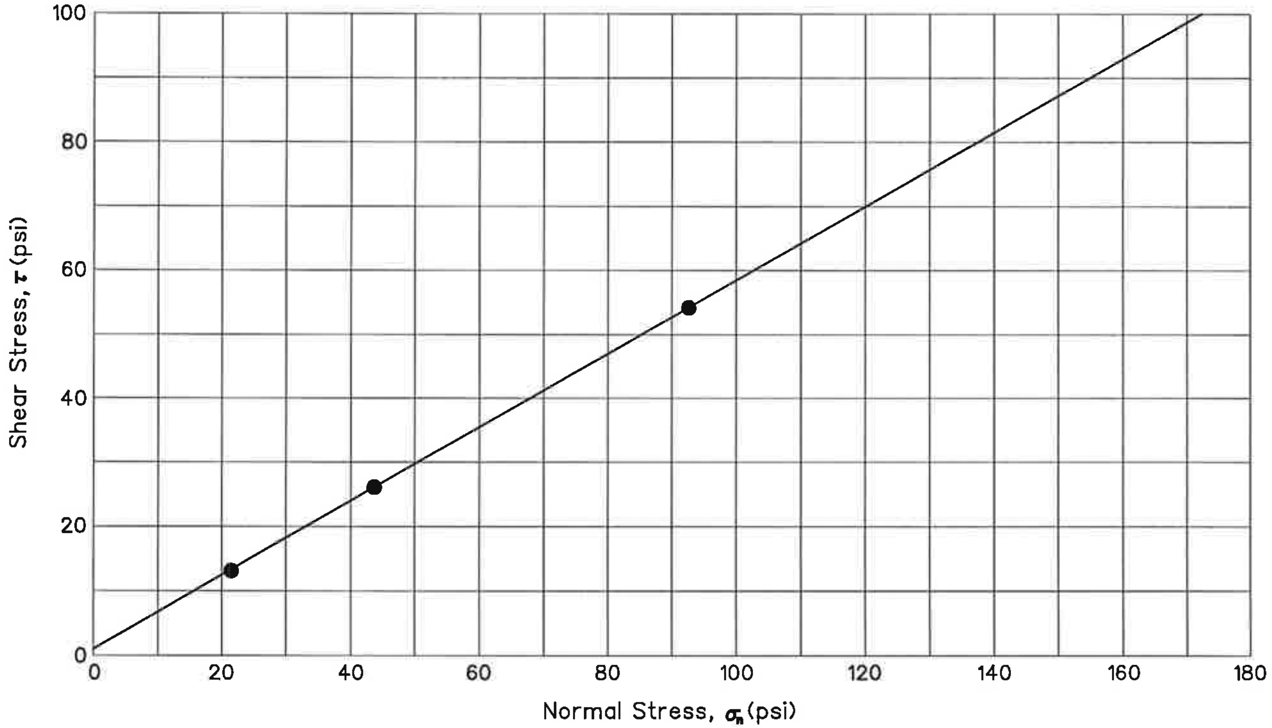
OVERSIZE CORRECTION-ASTM D 4718

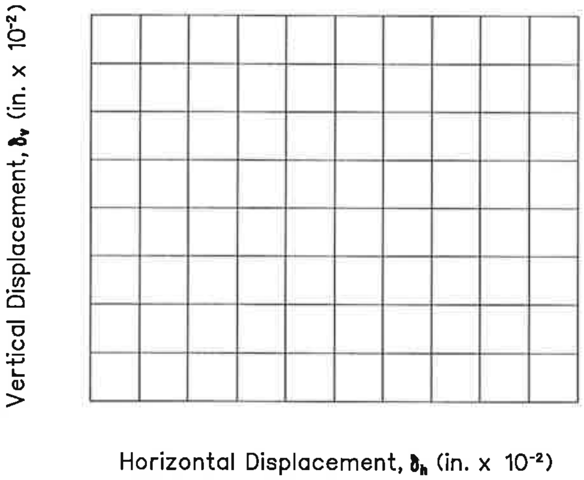
Specific Gravity of Soil +3/4		
Percent Oversize		

------ 100% Saturation Curve

Type of Specific Gravity is BULK Unless Otherwise Indicated







Test No. or Symbol	Sample Size (inches)	Sample Data		Degree of Saturation (%)	Normal Stress δ_n (psi)	Maximum Shear Stress τ (psi)	Strain Rate (inches/ minute)	Shear Strength Parameters	
		Dry Density (pcf)	Moisture Content (%)					Friction Angle φ (degrees)	Cohesion (c/psi)
●	2.375	80.4	10.4	~100	21.5	12.9	.0013	29.9	1
■	2.375	82.3	10.4	~100	43.7	26.1	.0013		
▲	2.375	87.1	8.5	~100	92.6	54.2	.0013		

RB&G ENGINEERING INC.
Provo, Utah

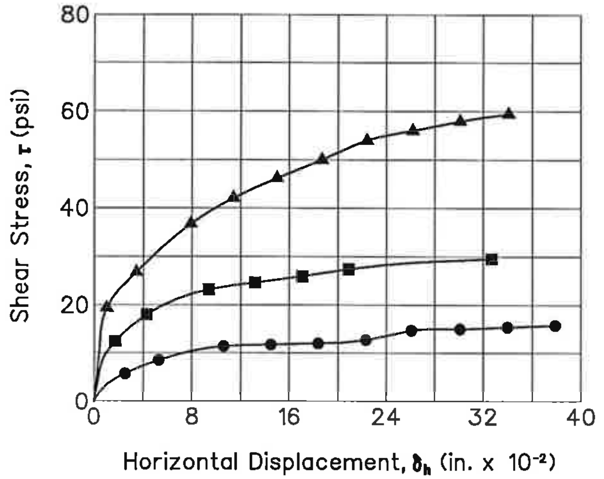
DIRECT SHEAR TEST

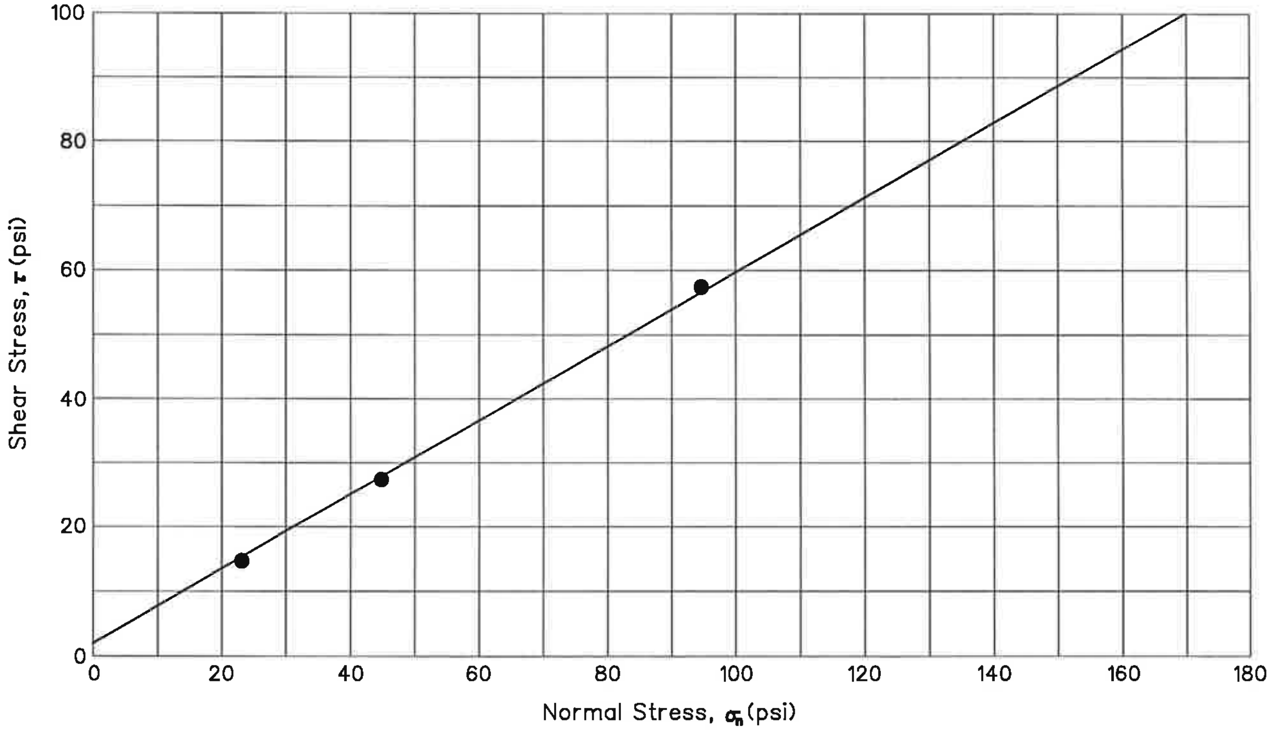
Project: *Cove Dam*
Orderville, Utah

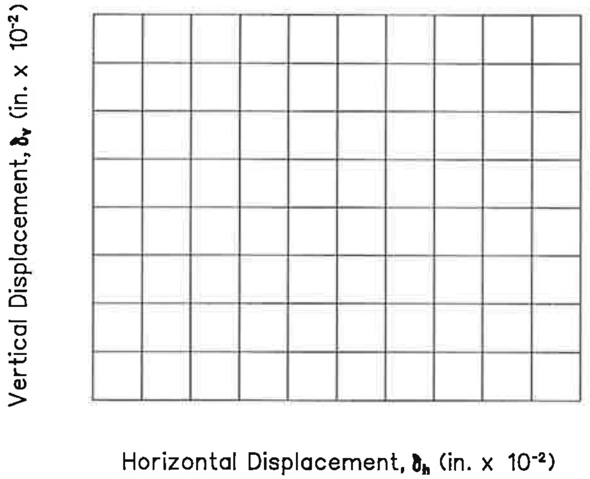
HOLE NO.: TP7

DEPTH: 6'

Figure







REMOLDED SAMPLE COMPACTED TO 98% MAXIMUM DENSITY

Test No. or Symbol	Sample Size (inches)	Sample Data		Degree of Saturation (%)	Normal Stress δ_n (psi)	Maximum Shear Stress τ (psi)	Strain Rate (inches/ minute)	Shear Strength Parameters	
		Dry Density (pcf)	Moisture Content (%)					Friction Angle ϕ (degrees)	Cohesion (c/psi)
●	2.375	111.5	15.1	100	23.1	14.7	.0013	30.2	2
■	2.375	111.5	15.1	100	44.8	27.4	.0013		
▲	2.375	111.5	15.1	100	94.6	57.9	.0013		

RB&G ENGINEERING INC.
Provo, Utah

DIRECT SHEAR TEST
Project: *Cove Dam*
Orderville, Utah

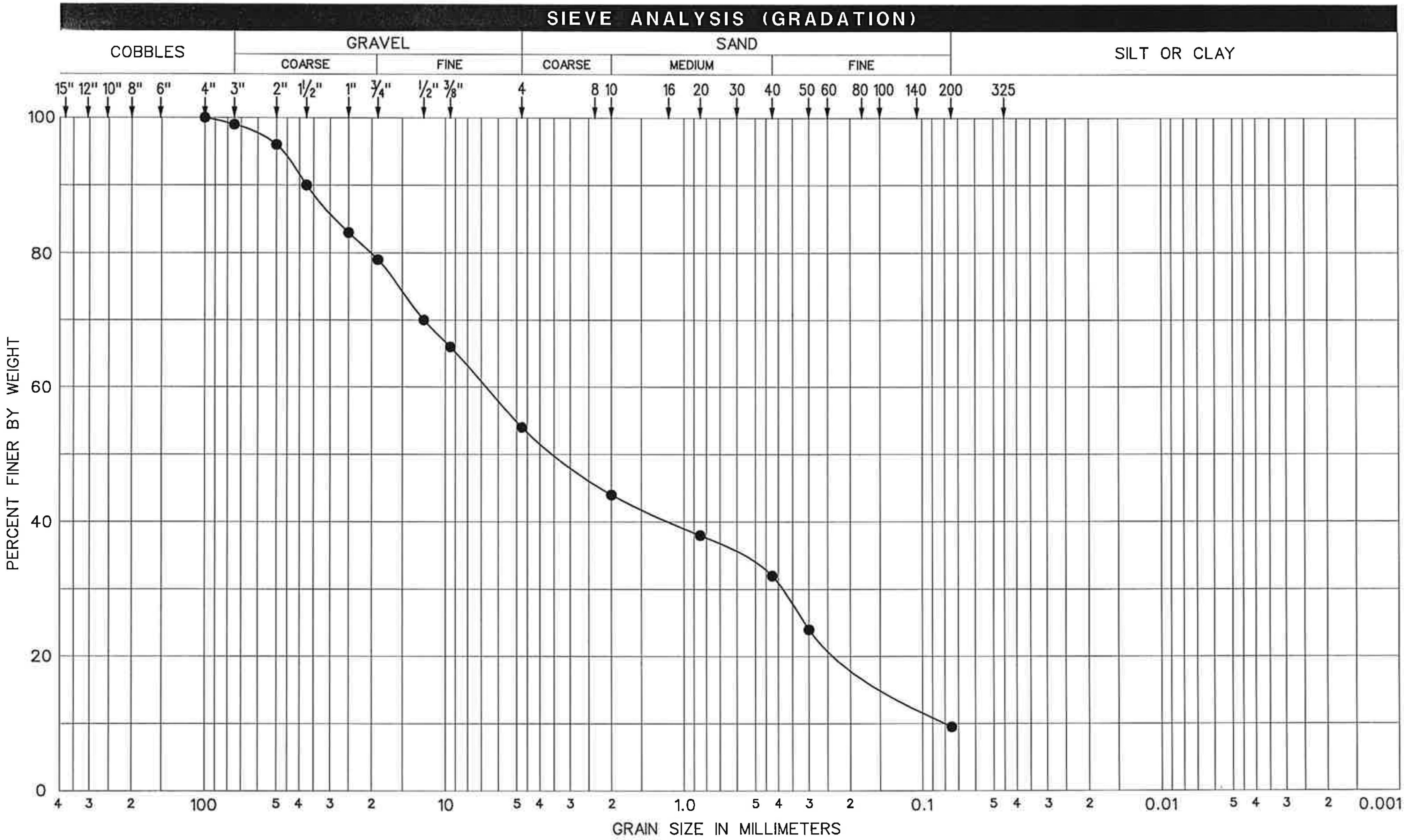
HOLE NO.: TP7

DEPTH: 6'

Figure

RB&G ENGINEERING INC.
1435 West 820 North, Provo, Utah 84601
801 374-5771 Provo
801 521-5771 Salt Lake City

PROJECT NO.	200401.025



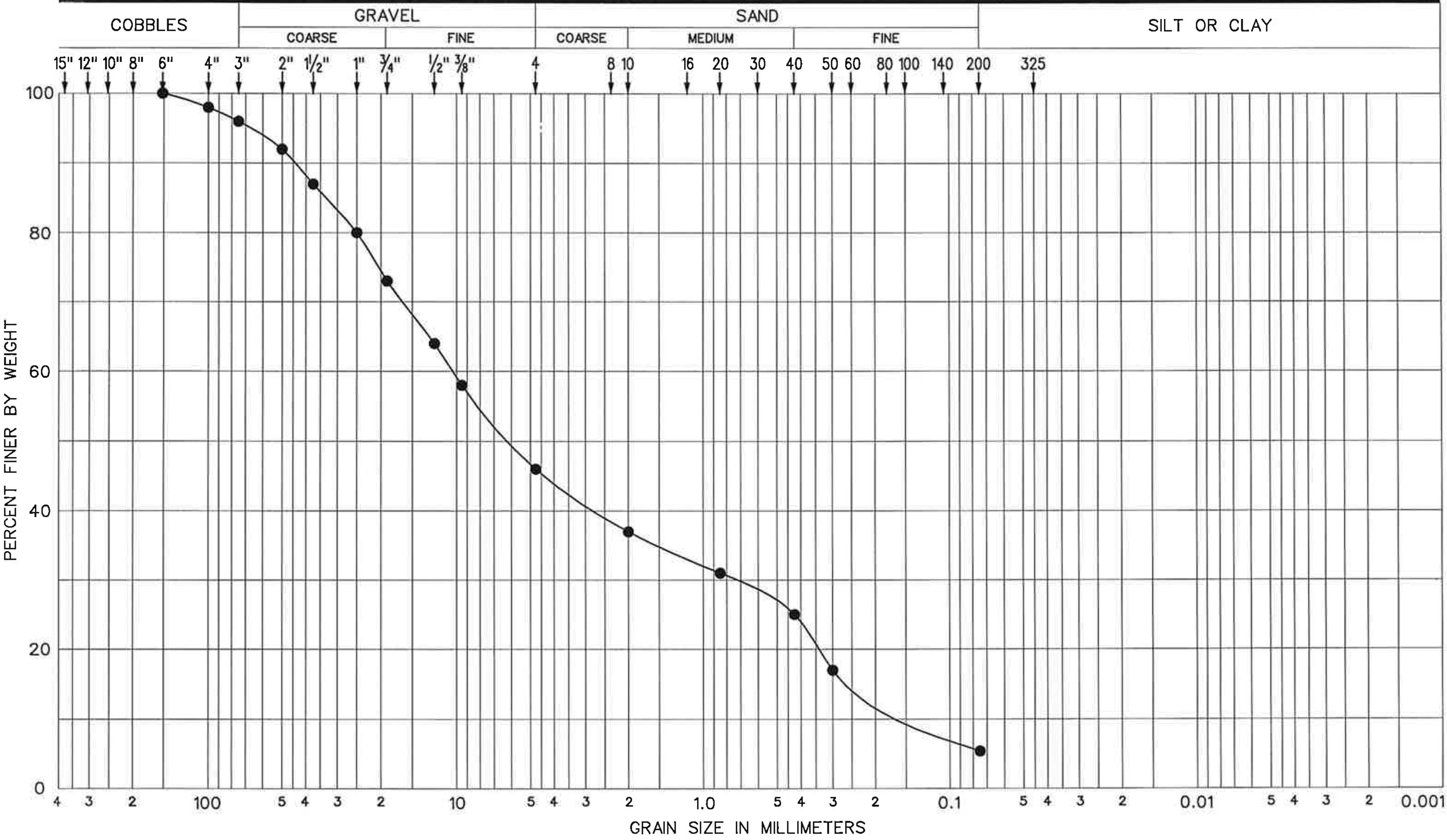
Project	COVE DAM		
Location	ORDERVILLE, UTAH		
Sample No./Depth	ROSE PIT		
Material Description	WELL GRADED GRAVEL W/SILT & SAND	USCS	GW-GM

Date	6/10/04
Technician	K. BRADFORD
Procedure	PLAIN WATER
Method	ASTM C117, C136, C566

RB&G ENGINEERING INC.
1435 West 820 North, Provo, Utah 84601
801 374-5771 Provo
801 521-5771 Salt Lake City

PROJECT NO.	200401.025

SIEVE ANALYSIS (GRADATION)



Project	COVE DAM		
Location	ORDERVILLE, UTAH		
Sample No./Depth	TATE PIT		
Material Description	POORLY GRADED GRAVEL W/SAND	USCS	GP

Date	6/10/04
Technician	K. BRADFORD
Procedure	PLAIN WATER
Method	ASTM C117, C136, C566

Appendix

DIVISION OF WATER RESOURCES
Engineering Geology Section
1594 West North Temple, Suite 310
Box 145201
Salt Lake City, Utah 84114-6201

MEMORANDUM

October 6, 1997

Post-it® Fax Note 7671

Date 10/10/03	# of pages ▶ 15
To Brad Price	From Dan Aubrey
Co./Dept. RB46	Co. Water Resources
Phone #	Phone # 538-7283
Fax # 801-374-5773	Fax #

TO: Ben Everitt
Chief Geologist
FROM: Dan Aubrey
Engineering Geologist
SUBJECT: Test Pits At Cove Dam Site Near Orderville, Kane County, Utah.

Introduction and Location

On Wednesday, June 4th at the request of Kane County Water Conservancy District I supervised the digging of a number of test pits along the proposed alignments for two offstream damsites in the lower reaches of Cove Canyon. The lower alignment, including both abutments is located in the SW¼ of Sec.5, T41S, R7W, SLB&M. The right abutment of the upper alignment is located in the SE¼ of Sec. 6, while the left abutment is located in the NW¼ of Sec. 5, T41S, R7W, SLB&M (see Figure 1). A total of nine test pits were located and logged, six pertaining to the upper alignment and three along the lower alignment (see Figure 1).

These sites had been identified during a reconnaissance level inventory of Virgin River damsites during the mid- to late 1980's. Not until 1996 did this location receive any further attention concerning its viability as a potential damsite(s). Franson-Nobel & Associates, Inc., in June of 1996, completed a reconnaissance level evaluation, in part, to help in the preparation of preliminary cost estimates. Continued interest in the site by both the Kane County Water Conservancy District and the Washington County Water Conservancy District resulted in this first review of the site from a geology and geotechnical point of view.

Given a storage of 6,700 acre-feet, a dam at the lower alignment would have to be approximately 98 feet high and at the upper alignment a dam would have to be about 103 feet high to store this amount of water. A dam of this height at the upper site may require the placement of a dike in the saddle just upstream of the right abutment.

Geologic Setting

The proposed Cove damsites are located in an alluvial valley, tributary to Long Valley and the East Fork Virgin River, that has been cut into a sequence of Cretaceous and Tertiary sedimentary rocks consisting mostly of sandstone and shale. Based on a review of pertinent geologic maps and literature the bedrock exposed in the abutments and underlying the alluvium in the reservoir basins is of the Cretaceous aged Tropic Shale Formation. The shale is predominantly gray, carbonaceous, calcareous, and includes bentonitic horizons and thin lenticular sandstones. The residual soil is a silty to sandy clay (CL to CH). Capping abutment ridges is a thin light brown deposit of gravel containing pebbles and cobbles of gray and red quartzite, grey to black chert, and grey limestone. Alluvium which covers the flat valley floor of the Cove is predominantly light to medium brown, fine to very fine grained sand with silt, and clay.

Based on research of water well logs, depth to bedrock in Long Valley (underlying the East Fork Virgin River) is approximately 50 feet. Making the assumption that tributaries are graded to the main valley results in projected depth to bedrock under the lower alignment of about 40-45 feet, and under the upper alignment of about 35-40 feet. The valley is approximately 1,000 feet wide at the lower alignment and about 1,500 feet wide at the upper alignment.

Discussion of Test Pits and Geotechnical Considerations

Figure 2 is a graphic representation of the materials encountered in the test pits. In general the materials encountered were very fine grained sand to silt and clay (SM, ML, & CL). The two test pits (#'s 2 & 7) located at the base of the right abutment, at each damsite, encountered some gravel. The gravel is contributed from the colluvial slopes of the abutment. Test pit #5 which was located in the drainage near the left abutment of the upper alignment encountered the most granular material. Here 6.5 feet of poorly graded sandy gravel contains cobbles to 14" diameter. Calcite (calcium carbonate) stringers are moderately abundant to very abundant in the test pits below 6 or 7 feet, in most of the test pits. Restricted access prevented us from placing test pits on or near the left abutments of either alignment.

Based on the test pits it appears that there is an abundance of cohesive material available for dam construction, however, the test pits did not identify an adequate source of granular material. At this level of investigation (considering only the geology and geotechnical aspects) it does not appear that one alignment has any advantage over the other.

Geologic Hazards

Following digging of the test pits, I performed a preliminary geologic hazards review of the sites. The summary of geologic hazards (see Table 1) accompanies this report. While most of the hazards listed in the summary, rate in the unlikely hazards category there are two geologic hazards which fall into the probable category and five which rate as possible hazards. These are identified as follows:

Probable Hazards — 1. Ground shaking due to an earthquake centered on the nearby Sevier Fault, and 2. Expansive clays which occur in the Tropic Formation throughout southern Utah.

Possible Hazards -- 1. Liquefaction, 2. Tectonic subsidence, and 3. Slope failure are all related to proximity of the Sevier Fault. 4. Collapsible soils and 5. Pipable/Erodible hazards are related to the identification in the test pits of very fine grained sand and non-cohesive silt.

Further study will be necessary to determine what impact these seven hazards might have on a dam constructed at either of these sites.

Conclusions and Recommendations

Based on information from the test pits and geologic hazards evaluation the following conclusions can be reached:

1. There is an abundance of cohesive material available, including some bentonite outcroppings in the Tropic Shale.

2. Only a very limited amount of granular material is available, and nothing that is suitable as rip rap was identified.
3. At this level of investigation one site does not seem to have any substantial advantage over the other.
4. Either site is capable of storing 6,700 acre-feet of water.
5. Proximity of these sites to the Sevier Fault and the presence of expansive clays and very fine grained non-cohesive soils are geologic hazards.
6. As part of a preliminary design, additional studies should address specific hazards.

The following recommendations are suggested:

1. A seismic hazards evaluation of the Sevier Fault will be needed to determine what impact this hazard might have on these damsites.
2. Laboratory testing of soil samples is necessary to determine if a soils/foundation hazard exists.
3. A careful cost estimate ought to be prepared for these sites so a benefit /cost ratio can be developed.
4. From a geologic and geotechnical view the next step would be to pursue investigation of the subsurface conditions by drilling, sampling and testing (permeability, blow counts, etc.) along the proposed alignment.

ABLE # 1

SUMMARY OF GEOLOGIC HAZARDS

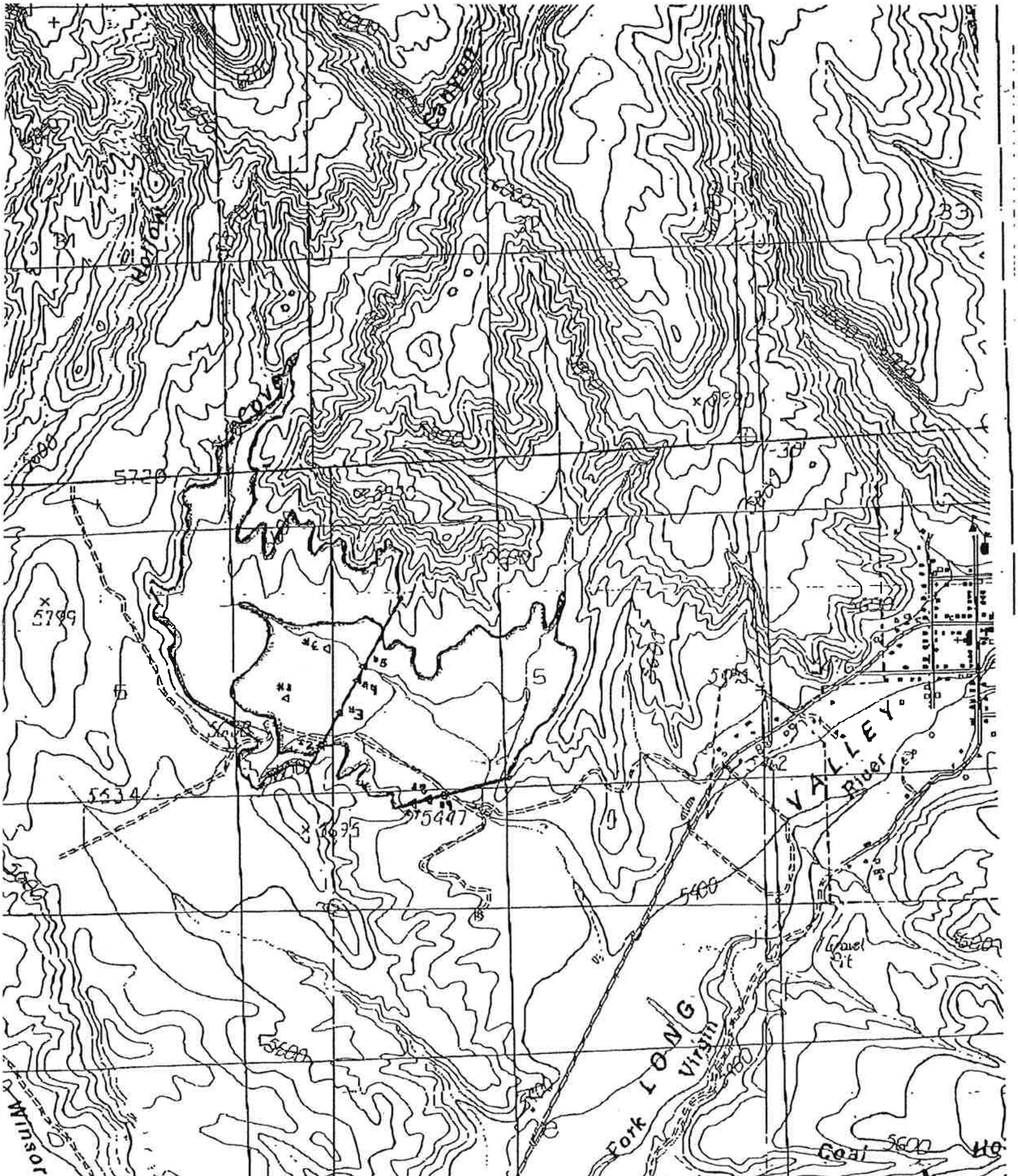
COVE DAMSITES

	Hazard Rating*			Further Study Recommended**
	Probable Hazard	Possible Hazard	Unlikely Hazard	
arthquake				
Ground shaking	E,F			G
Liquefaction		AF		S
Surface faulting			X	
Tectonic deformation		E,RB		G
Slope failure		A,RB		G
Seiche			X	
Slope Failure (Non-seis)				
Rock fall			X	
Landslide			X	
Debris flow			X	
Found/Embank Problems				
Collapsible soils		AF		S
Expansive clays	F,A			S
Sensitive clays			X	
Organic soils			X	
Soluble salts			X	
Pipable/Erodible		E		S
Karst			X	
Differential settlement			X	
Non-engineered fill			X	
Hydrologic				
Shallow ground-water			X	
Springs/Seeps			X	
Flooding				
Stream/Lake			X	
Upstream dam failure			X	
Spillway capacity			X	
Dam overtopping			X	

*Hazard Rating - Probable-evidence is strong that the hazard exists and mitigation measures should be taken. Possible-hazard may exist, but evidence is uncertain and further study is recommended. Unlikely-no evidence was found to indicate that the hazard is present.

Abbreviations; E = embankment, F = foundation, AF = alluvial foundation, BF = bedrock foundation, A = abutments, RB = reservoir basin, SL = shore line, DST = down stream toe, UST = up stream toe, DSF = down stream face, USF = up stream face, SP = spillway, & NA = Not applicable.

**Further Study (S-soil/foundation, G-geotecnical/engineering, H-hydrologic, SIP-study in progress, MIP-mitigation measures in progress) is recommended to address the hazard (see Conclusions and Recommendations).



Hollow
Canyon
Cove
31
33
30
5720
5799
6
5
5634
5695
5447
5400
5600
LONG
VALLEY
Virgin
River
Fork
Coal
Gravel Pit
Windsor
#1
#2
#3
#4
#5
5377

Upper Alignment

ML-CL
lt-md tan, calcareous
sandy clayey silt to
sandy silty clay.
sand fine to very
fine grained.
dry, loose to
compact with depth
calcite stringers 7-14'

TP#2

ML-CL
md brn to gy-brn
20% caliche covered
gravel and cobbles to 12".
mostly sandy clayey silt
to silty sandy clay
dry, loose
calcareous.
sand very fine grained.
gravel subrounded to
subangular

TP#3

SM-ML-CL
md orange-brn to brn
silty sand to
sandy clayey silt to
sandy silty clay
dry, loose, crumbles
easily.
calcareous
calcite stringers
from 7' to 14'.
clay content increases
with depth
sand very fine
grained.

TP#4

SM-ML-CL
lt orange-brn
silty sand, to
sandy clayey silt to
sandy silty clay.
dry, loose,
crumbles easily.
calcareous
calcite stringers
from 6" to 14.5"
clay content increases
with depth, more
compact.
roots to 6' deep.

TP#5

GP, CH
poorly graded sand,
gravel mix with
cobbles to 14". 0"-6.5"
caliche coated, subangular
to rounded gravel.
most gravel is less
than 3" dia.
6.5" to 15' damp to
moist, grey clay-high
plasticity, white
calcite stringers
throughout.
calcareous.

TP#6

SM-CH
ground cove
close to wi
spaced brn
sandstone
and boulde
0"-2½. ye
silty sand
loose, crum
2½"-12' sa
to clay. lt
md gy-br
calcareous
stringers

Lower Alignment

TP#1

CL-CH
lt-brn to md-gy-brn
sandy, silty clay.
dry, loose, dense from
8-12".
calcareous - abundant
calcite stringers below
8". dense clay is gy.
occassional pebbles
in upper 5'.

TP#2

SM-ML-CL
light brown
silty sand to
sandy silt, to
sandy, silty clay
dry, loose
crumbles easily
calcareous

TP#3

SM-ML-CL
light brown
silty sand to
sandy silt to
sandy, silty clay
dry, loose
crumbles easily
clay content
increase with
depth, more
compact.
calcareous,
calcite stringers
from 6"-15"

See Map for Test Pit Locatic

Figure #2

APPENDIX E-14

SUBSURFACE INVESTIGATION DATA

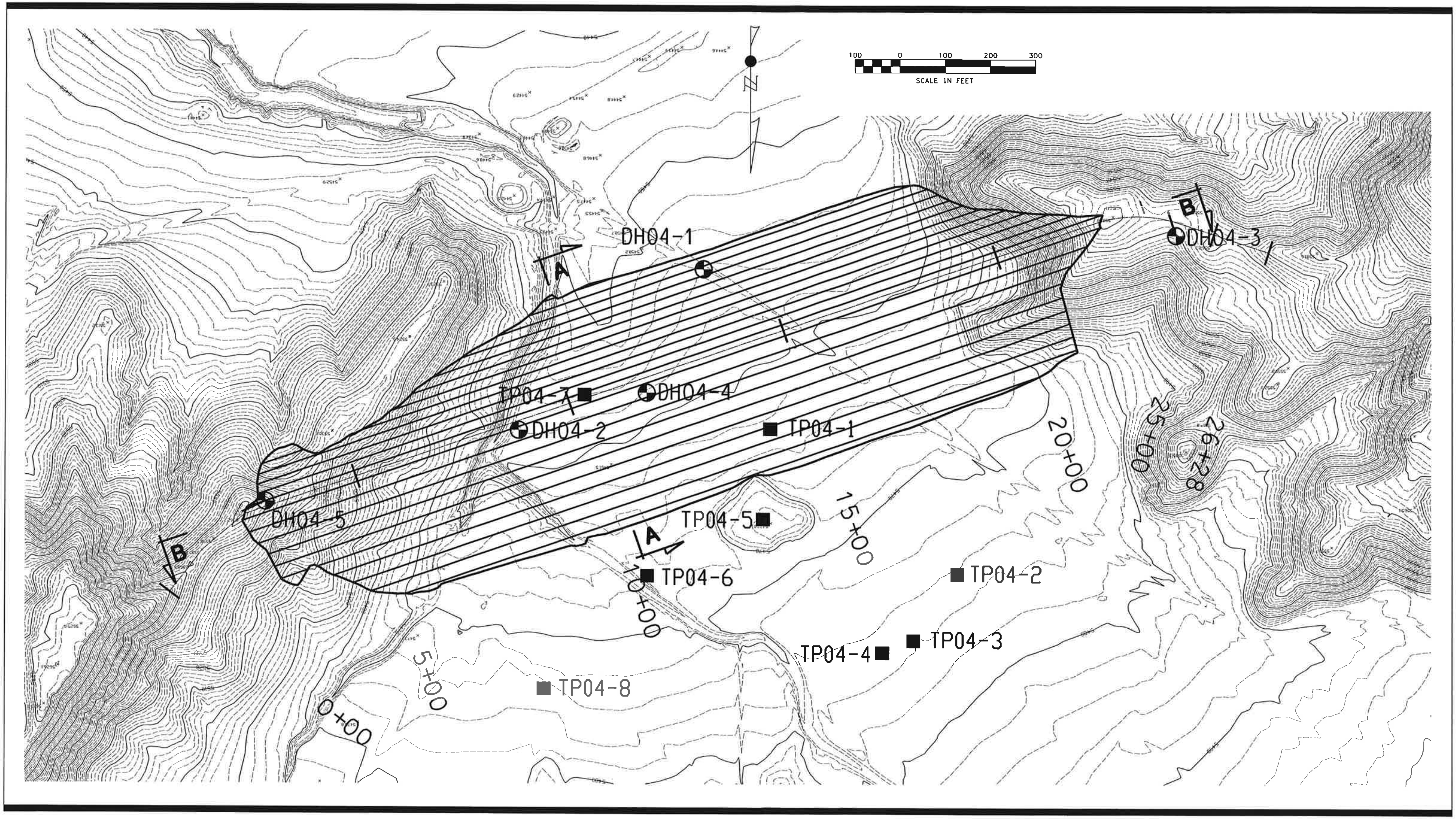
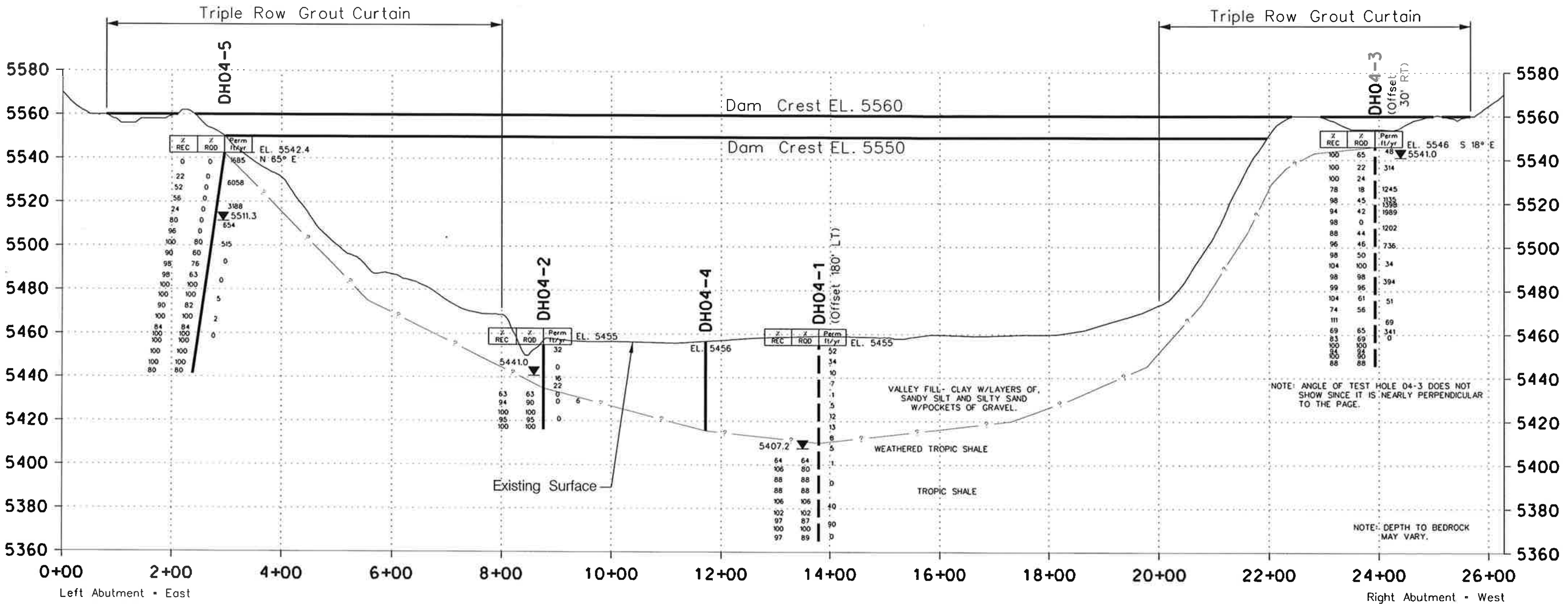


Figure 4

RB&G ENGINEERING INC.
Provo, Utah

Cove Dam
Orderville, Utah

Dam Plan View,
Test Pit and Drill Hole
Locations



GEOLOGIC CROSS-SECTION (PROFILE)

Note: Exaggerated Vertical Scale.
Scale: 1"=50' Vertical
1"=200' Horizontal

Figure 5

RB&G ENGINEERING INC.
Provo, Utah

Cove Dam
Near Orderville, Utah

Geologic Profile

Borings

DRILL HOLE LOG

BORING NO. 04-1

Sheet: 1 of 2

PROJECT: COVE DAM
CLIENT: K.C.W.C.D.
LOCATION: SEE SITE PLAN - MAXIMUM SECTION
DRILLER: D. SAMPSON, N. BAILEY
EQUIP./DRILL METHOD: CME-55 / N.W. CASING TO 51.5'
DEPTH TO WATER - INITIAL: ▽ N.M. AFTER 24 HOURS: ▽ 46.8' 6/3/04

PROJECT NO.: 200401.025
DATE: 4/13/04
ELEVATION: ~5454.0'
LOGGED BY: M.H., V.N.B.

Elev. (Feet)	Depth (Feet)	Type	Rec. (In.)	See Legend	USCS	Material Description		Permeability, ft/yr	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Atter. Plasticity Index, %	Gradation Gravel, %	Gradation Sand, %	Gradation Silt/Clay, %	Other Tests
		■	6	5,3,3	CL-ML	lt. brown, dry, firm	SILTY CLAY W/SAND calcareous	52								
5450	5	☒	8	Pushed 1.00+	CL-1	lt. brown, dry, hard	LEAN CLAY	34	120.3	9.8	32	14	0	10	90	CT
5445	10	■	5	7,9,11	CL	lt. brown, dry, very stiff	CLAY W/SAND	10								
5440	15	☒	12	Pushed 1.00+	CL-2	lt. brown, dry, hard	SANDY CLAY	7	119.4	8.7	37	19	0	17	83	CT
5435	20	■	5	9,12,17	CL,SM	lt. brown, dry, very stiff	SILTY CLAY W/SILTY SAND LENSES & LAYERS	1								
5430	25	☒	12	Pushed 1.00+	CL-2	lt. brown, dry, hard		5	112.4	14.3	34	18	0	6	94	CT
5425	30	■	6	8,12,13	CL	med. to lt. brown, dry, very stiff, w/white stringers	LEAN CLAY	12								
5420	35	☒	18	Pushed 1.00+	CL-2	med. brown, moist, very stiff		13	105.2	17.5	49	31	0	3	97	CT
5415	40	■	18	4,6,8 0.72	CL	med. brown, moist to slightly wet, stiff		8								
5410	45	☒	12	Pushed 0.72	CL-2/CH	grayish-med. brown, moist, stiff, w/white stringers	LEAN TO FAT CLAY W/SOME SAND	5	100.7	23.1	50	34	0	6	94	CT
5405	50						TROPIC SHALE FORMATION									

06/16/04
10:46:01 AM

LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
Core
100,60 ← Rock Quality Designation (RQD)
Percent Sample Recovery
☒ Undisturbed Sample
▽ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

RB&G
ENGINEERING
INC.
Provo, Utah

DRILL HOLE LOG

BORING NO. 04-1

Sheet: 2 of 2

PROJECT: COVE DAM
PROJECT NO.: 200401.025
CLIENT: K.C.W.C.D.
DATE: 4/13/04
LOCATION: SEE SITE PLAN - MAXIMUM SECTION
ELEVATION: ~5454.0'
DRILLER: D. SAMPSON, N. BAILEY
LOGGED BY: M.H., V.N.B.
EQUIP./DRILL METHOD: CME-55 / N.W. CASING TO 51.5'
DEPTH TO WATER - INITIAL: ⊻ N.M.   AFTER 24 HOURS: ⊻ 46.8' 6/3/04

Elev. (Feet)	Depth (Feet)	Lith- ology	SAMPLE				Material Description		Permeability, ft/yr	Dry Density, pcf	Moisture Content, %	Atter.		Gradation			Other Tests
			Type	Rec. (In.)	See Legend	USCS						Liquid Limit, %	Plasticity Index, %	Gravel, %	Sand, %	Silt/Clay, %	
				18	18,28,36	CL	dk. gray, moist, hard	**SLIGHTLY SHALEY CLAY**	1								
				19	Core 64,64	CH		very highly weathered bedrock, w/many gypsum stringers			16.4	80	50	0	0	100	
5400	55						dk. gray	**HIGHLY WEATHERED MUDSTONE** few gypsum stringers									
				64	Core 106,80	-											
							dk. gray	**LESS WEATHERED MUDSTONE** shells									
5395	60																
				53	Core 88,88	-	dk. gray										
									0								
5390	65							**SLIGHTLY WEATHERED MUDSTONE**									
				53	Core 88,88	-	dk. gray										
							slickenside										
5385	70																
				64	Core 106,106	-	0.25" clay seam										
						CH	white-gray	**BENTONITE W/SAND & LIMESTONE GRAVEL**	40		13.2	70	45	0	0	100	
5380	75																
				61	Core 102,102	-	dk. gray										
5375								**MUDSTONE**									
	80			35	Core 97,87	-											
							broken zone										
5370									90								
	85			50	Core 100,100	-	dk. gray, some black corbonaceous lenses										
							white-gray	**BENTONITE**									
									0								
				44	Core 97,89	-	dk. gray, some black corbonaceous lenses	**MUDSTONE**									
5365	90																
5360	95																
5355	100																

06/16/04
10:46:17 A

RB&G ENGINEERING INC.
Provo, Utah

LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
Core
100,60 ← Rock Quality Designation (RQD)
Percent Sample Recovery
☒ ← Undisturbed Sample
⊻ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

DRILL HOLE LOG

BORING NO. 04-2

Sheet: 1 of 1

PROJECT: COVE DAM
CLIENT: K.C.W.C.D.
LOCATION: SEE SITE PLAN - TOE, LEFT ABUTMENT
DRILLER: D. SAMPSON, N. BAILEY
EQUIP./DRILL METHOD: CME-55 / N.W. CASING TO 21.5' THEN N.Q. CORE
DEPTH TO WATER - INITIAL: ⊻ N.M. AFTER 24 HOURS: ⊻ 17.0' 6/3/04

PROJECT NO.: 200401.025
DATE: 4/16/04
ELEVATION: ~5458.0'
LOGGED BY: M.H., V.N.B.

Elev. (Feet): 5455, 5450, 5445, 5440, 5435, 5430, 5425, 5420, 5415, 5410

Depth (Feet): 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

Type	Rec. (In.)	See Legend	USCS	Material Description		Permeability, ft/yr	Dry Density, pcf	Moisture Content, %	Liquid Limit, %	Plasticity Index, %	Gravel, %	Sand, %	Silt/Clay, %	Other Tests
									Atter.		Gradation			
■	9	2,4,6	CL	lt. brown, dry to moist, firm, w/roots	SILTY CLAY	32								
☒	14	Pushed 1.00+	CL	dk. brown, slightly moist, hard	LEAN CLAY W/GYPSUM STRINGERS									
■	7	14,22,33	CL-2	dk. brown, slightly moist, hard		0		12.2	45	31	0	2		98
■	10	15,22,33	CL	dk. brown, moist, hard, some gypsum	LEAN CLAY W/SOME SAND SIZE SANDSTONE FRAGMENTS	16								
☒	18	Pushed 1.00+	CH	dk. brown, moist, hard	FAT CLAY	22	111.8	19.3	58	34	0	0	100	CT
■	18	9,15,33	-	dk. gray	VERY HIGHLY WEATHERED MUDSTONE very high slaking, rapid	6								
■	26	Core 63,63	-		LESS WEATHERED MUDSTONE	0								
■	56	Core 94,90	CH	dk. gray, dry mech. open 0.2' joint 0.25" clay seam		0		12.5	70	47	0	0	100	
■	48	Core 100,100	-	dk. gray, wealky calcareous	MUDSTONE calcareous, high slaking									
■	34	Core 95,95	-	a few white silt lenses		0								
■	36	Core 100,100	-											

06/16/04
10:46:33 A

LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
Core
100,60 ← Rock Quality Designation (RQD)
Percent Sample Recovery
☒ ← Undisturbed Sample
⊻ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

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INC.
Provo, Utah

DRILL HOLE LOG

BORING NO. 04-3

Sheet: 1 of 2

PROJECT: COVE DAM
PROJECT NO.: 200401.025
CLIENT: K.C.W.C.D.
DATE: 4/26/04
LOCATION: SEE SITE PLAN - RIGHT ABUTMENT
ELEVATION: ~5546.0'
DRILLER: D. SAMPSON, M. BARBOUR
LOGGED BY: M.H., V.N.B.
EQUIP./DRILL METHOD: CME-55 / N.Q. CORE AT 60° FROM HORIZONTAL, TREND S18° E
DEPTH TO WATER - INITIAL: ▽ N.M. AFTER 24 HOURS: ▽ 71.0' 6/3/04

Elev. (Feet)	Depth (Feet)	Rec. (In.)	See Legend	USCS	Material Description		Permeability, ft/yr	Dry Density, pcf	Moisture Content, %	Liquid Limit, %	Plasticity Index, %	Gravel, %	Sand, %	Silt/Clay, %	Other Tests
5545					gray-brown	**CLAY/VERY WEATHERED MUDSTONE**	48								
	5	24	Core 100,65	-	gray-brown to brown-gray gypsum										
5540															
	10	60	Core 100,22	-	gray-brown		314								
5535						**SILTY MUDSTONE**									
	15	61	Core 100,24	CH	gray-brown, dry	calcareous coating, very highly weathered & fractured, multiple angle - haphazard, some gypsum coating on joints, shaley & friable			13.7	54	33	0	0	100	
5530	20	23	Core 78,18	-			1245								
5525	25	59	Core 98,45	-			1135								
					gray-white, some rust staining	**BENTONITE**									
					brown	**SHALEY MUDSTONE**	1398								
					100% water loss										
5520	30	56	Core 94,42	-	dk. gray w/white bedding	**SILTSTONE/MUDSTONE**	1989								
5515	35	59	Core 98,0	-	interbedded dk. gray & brown, gypsum bedding	**SILTY MUDSTONE** calcareous	1202								
	40	53	Core 88,44	-	interbedded dk. gray & brown w/white stratification										
5510					clay seam										
	45	58	Core 96,46	-	dk. gray w/brown, some rust stains, some shells, slow slaking	**MUDSTONE**	736								
5505	50	59	Core 98,50	-											

06/16/04
10:46:49 A

LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
Core
100,60 ← Rock Quality Designation (RQD)
Percent Sample Recovery
☒ ← Undisturbed Sample
▽ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

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ENGINEERING
INC.
Provo, Utah

DRILL HOLE LOG

BORING NO. 04-3

Sheet: 2 of 2

PROJECT: COVE DAM
PROJECT NO.: 200401.025
CLIENT: K.C.W.C.D.
DATE: 4/26/04
LOCATION: SEE SITE PLAN - RIGHT ABUTMENT
ELEVATION: ~5546.0'
DRILLER: D. SAMPSON, M. BARBOUR
LOGGED BY: M.H., V.N.B.
EQUIP./DRILL METHOD: CME-55 / N.Q. CORE AT 60° FROM HORIZONTAL, TREND S18° E
DEPTH TO WATER - INITIAL: ▽ N.M. AFTER 24 HOURS: ▼ 71.0' 6/3/04

Elev. (Feet)	Depth (Feet)	Lithology	SAMPLE Type	Rec. (In.)	See Legend	USCS	Material Description	Permeability, ft/yr	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Plasticity Index, %	Gradation Gravel, %	Sand, %	Silt/Clay, %	Other Tests
5500	55		Core	62	Core 104,100	-	dk. gray more competent, no bedding, shells, open joint at 53.4' to 53.7', 0.2" clay seam **MUDSTONE**	34								
5495	60		Core	59	Core 98,98	-	dk. gray, some white bedding, trace of gypsum	394								
5490	65		Core	59	Core 99,96	-	rust stain & coating **SILTY MUDSTONE**									
5485 ▼	70		Core	62	Core 104,61	-	shells very hard septarian nodule	51								
5480	75		Core	44	Core 74,56	-	gray, high slaking **SHALE** gray **BENTONITE**									
5475	80		Core	62	Core 111,?	-	core is stuck in inner barrel and has not been removed, may contain bentonite 100% water loss	69								
	85		Core	41	Core 69,65	-	dk. gray **MUDSTONE** 40° slickenside calcareous, some slaking, some lt. gray wavy bedding	341 0								
5470			Core	29	Core 83,69	-	0.25" clay seam									
	90		Core	60	Core 100,100	-	dk. gray clay seam, not calcareous									
5465			Core	28	Core 94,94	-										
	95		Core	24	Core 100,100	-	lt. gray **BENTONITE** black & white **LIMESTONE/VOLCANIC ASH** **BENTONITE**									
5460	100		Core	42	Core 88,88	-	dk. gray **MUDSTONE**									

LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
Core
100,60 ← Rock Quality Designation (RQD)
Percent Sample Recovery
☒ ← Undisturbed Sample
▼ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

RB&G ENGINEERING INC.
Provo, Utah

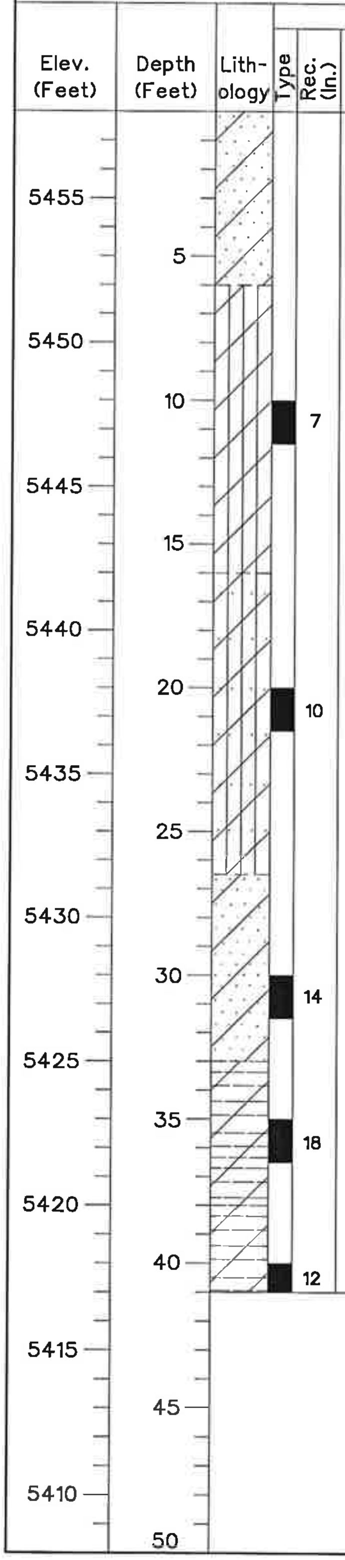
06/15/04
04:02:52

DRILL HOLE LOG

BORING NO. 04-4

Sheet: 1 of 1

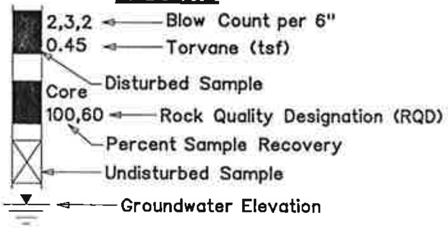
PROJECT: COVE DAM
PROJECT NO.: 200401.025
CLIENT: K.C.W.C.D.
DATE: 4/30/04
LOCATION: SEE SITE PLAN - MAXIMUM SECTION
ELEVATION: ~5458.0'
DRILLER: D. SAMPSON, M. BARBOUR
LOGGED BY: M.H., V.N.B.
EQUIP./DRILL METHOD: CME-55 / N.W. CASING
DEPTH TO WATER - INITIAL: ▽ N.M. AFTER 24 HOURS: ▼ DRY AT 29.3' 6/3/04



Rec. (In.)	See Legend	USCS	Material Description		Permeability, ft/yr	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Atter. Plasticity Index, %	Gradation Gravel, %	Gradation Sand, %	Gradation Silt/Clay, %	Other Tests
		CL	lt. brown, dry	SANDY LEAN CLAY									
7	7,11,14	CL	lt. brown, dry, very stiff	SILTY CLAY									
10	11,14,19	CL	lt. brown, dry, very stiff	SILTY CLAY W/SILTY SAND LENSES									
			gray	harder									
14	11,15,20	CL/SC	mottled rusty & yellow-brown, slightly moist to dry, hard	SANDY CLAY									
18	15,32,56	-	brown-gray, slightly moist, hard	VERY HIGHLY WEATHERED MUDSTONE TO VERY HARD CLAY w/gypsum, w/calcite crystals & stringers									
12	24,66	-	brown-gray, slightly moist, hard	HIGHLY WEATHERED CLAYEY MUDSTONE									

BEDROCK -
TROPIC SHALE FORMATION

LEGEND



06/16/04
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UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

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DRILL HOLE LOG

BORING NO. 04-5

Sheet: 1 of 2

PROJECT: COVE DAM
PROJECT NO.: 200401.025
CLIENT: K.C.W.C.D.
DATE: 5/4/04
LOCATION: SEE SITE PLAN - LEFT ABUTMENT
ELEVATION: ~5542.4'
DRILLER: D. SAMPSON, M. BARBOUR
LOGGED BY: M.H., V.N.B.
EQUIP./DRILL METHOD: CME-55 / N.Q. CORE AT 60° FROM HORIZONTAL, TREND N65° E
DEPTH TO WATER - INITIAL: ▽ N.M. AFTER 24 HOURS: ▼ 35.0' 6/3/04

Elev. (Feet)	Depth (Feet)	Type	Rec. (In.)	See Legend	USCS		Material Description	Permeability, ft/yr	Dry Density, pcf	Moisture Content, %	Liquid Limit, %	Plasticity Index, %	Gravel, %	Sand, %	Silt/Clay, %	Other Tests
5540	5	Core	0	Core 0,0	-		**VERY HIGHLY WEATHERED TROPIC SHALE FORMATION**	1685								
5535	10	Core	13	Core 22,0	-	brown-gray	**VERY HIGHLY WEATHERED CLAYEY MUDSTONE TO CLAY W/MUDSTONE FRAGMENTS**	6058								
5530	15	Core	31	Core 52,0	-		**MUDSTONE RUBBLE W/CLAY MATRIX**									
5525	20	Core	34	Core 56,0	-		**MUDSTONE BROKEN TO RUBBLE**	3188								
5520	25	Core	14	Core 24,0	-	brown-gray										
5515	30	Core	48	Core 80,0	-	brown-gray, calcareous	**MOTTLED & MIXED LAYERS OF DARK GRAY & BROWN MUDSTONE**	654								
5510	35 ▼	Core	58	Core 96,0	-		more compotent, w/random gypsum stringers, near vertical fractures at 33' to 38', some friable shaley layers 1" to 2" thick									
5505	40	Core	60	Core 100,80	CL-2	brown-gray, dry		515		4.7	43	26	0	9	91	
	45	Core	64	Core 90,60	-	w/clay seams, shells										
5500	50				CL-2	dk. gray, dry, shells	**CALCAREOUS MUDSTONE**	0		12.6	47	24	0	2	98	

06/16/04
04:03:11 P

LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
Core
100,60 ← Rock Quality Designation (RQD)
Percent Sample Recovery
☒ ← Undisturbed Sample
▽ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

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INC.
Provo, Utah

DRILL HOLE LOG

BORING NO. 04-5

Sheet: 2 of 2

PROJECT: COVE DAM
PROJECT NO.: 200401.025
CLIENT: K.C.W.C.D.
DATE: 5/4/04
LOCATION: SEE SITE PLAN - LEFT ABUTMENT
ELEVATION: ~5542.4'
DRILLER: D. SAMPSON, M. BARBOUR
LOGGED BY: M.H., V.N.B.
EQUIP./DRILL METHOD: CME-55 / N.Q. CORE AT 60° FROM HORIZONTAL, TREND N65°E
DEPTH TO WATER - INITIAL: ⊻ N.M. AFTER 24 HOURS: ⊻ 35.0' 6/3/04

Elev. (Feet)	Depth (Feet)	Sample: Rec. (In.)	Sample: See Legend	Sample: USCS	Material Description	Permeability, ft/yr	Dry Density, pcf	Moisture Content, %	Atter.: Liquid Limit, %	Atter.: Plasticity Index, %	Gradation: Gravel, %	Gradation: Sand, %	Gradation: Silt/Clay, %	Other Tests
		59	Core 98,76	-	dk. gray									
5495	55	54	Core 98,63	-	dk. gray	0								
5490	60	53	Core 100,100	-	dk. gray, few shells SHALEY MUDSTONE friable, very slow slaking									
5485	65	60	Core 100,100	-	dk. gray, no gypsum, w/big white shells	5								
	70	54	Core 90,82	-										
5480					SHALE TO BENTONITE									
	75	60	Core 100,100	-	dk. gray w/few white lenses CALCAREOUS MUDSTONE	2								
5475					dk. to lt. gray, very soft dk. gray SHALEY BENTONITE									
	80	50	Core 84,84	-	dk. gray									
5470		12	Core 100,100	-	CALCAREOUS MUDSTONE	0								
	85	60	Core 100,100	-										
5465					very soft SHALEY BENTONITE									
	90	60	Core 100,100	-	dk. gray CALCAREOUS MUDSTONE									
5460	95	52	Core 100,100	-										
					LIMESTONE									
5455	100	24	Core 80,80	-	dk. gray CALCAREOUS MUDSTONE W/SHELLS									

06/16/04
10:49:46 A

LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
Core
100,60 ← Rock Quality Designation (RQD)
Percent Sample Recovery
☒ ← Undisturbed Sample
⊻ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

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Top
04-1

Bottom

Depth Cored
51.5 to 90 feet

NQ Core Dia. 1.875 in.
Length of Core Box 2 ft.

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Figure	Core Photos, Drill Hole # 04-1 *Center Section*
Project	*Cove DamSite Feasibility Study*
Location	*Orderville, Kane County, Utah*

Depth Cored
21.5 to 39 feet

NQ Core Dia. 1.875 in.
Length of Core Box 2 ft.

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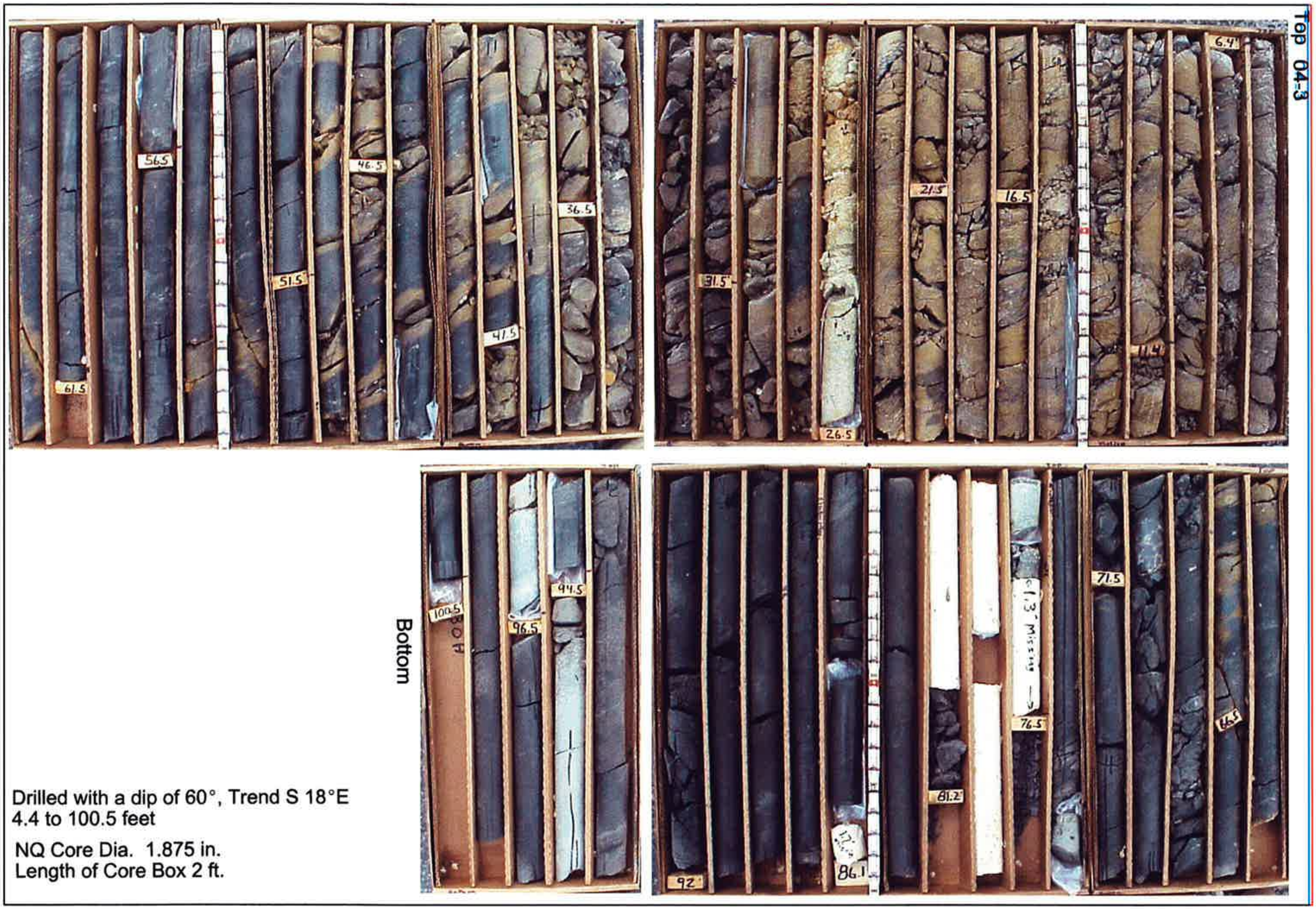
Provo, Utah

Figure	Core Photos, Drill Hole # 04-2 max ~~Center~~ Section
Project	*Cove DamSite Feasibility Study*
Location	*Orderville, Kane County, Utah*

near toe of slope
@ left abutment



Drilled with a dip of 60°, Trend S 18°E
4.4 to 100.5 feet

NQ Core Dia. 1.875 in.
Length of Core Box 2 ft.

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Figure	Core Photos, Drill Hole # 04-3 *Right Abutment*
Project	*Cove Dam Site Feasibility Study*
Location	*Orderville, Kane County, Utah*

Drilled with a dip of 60°, Trend N 65° E
8.5 to 101 feet

NQ Core Dia. 1.875 in.
Length of Core Box 2 ft.

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Figure	Core Photos, Drill Hole # 04-5 *Left Abutment*
Project	*Cove Dam Site Feasibility Study*
Location	*Orderville, Kane County, Utah*

Test Pits

TEST PIT LOG

PIT NO. 04-1

Sheet: 1 of 1

PROJECT: **COVE DAM**
CLIENT: K.C.W.C.D.
LOCATION: SEE SITE PLAN
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: DRY AFTER 24 HOURS: DRY

PROJECT NO.: **200401.025**
DATE: 6/1/04
ELEVATION: ~5463.0'
LOGGED BY: M. STILSON

Elev. (Feet)	Depth (Feet)	Lithology	SAMPLE Type		SAMPLE Type	USCS	Material Description		Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Atter. Plasticity Index, %	Gradation Gravel, %	Gradation Sand, %	Gradation Silt/Clay, %	Other Tests
5460		▨	☒		3 Rings Block Bucket	CL-1	1" fine silty sand layer			4.8	26	12	0	3	97	
	5	▨														
		▨	☒		Ring Block	CL-2		**LEAN CLAY** lt. brown to brown, dry, hard, some pinhole structure, minor mineral stringers	95.1	6.4	35	16	0	2	98	
		▨					1" fine silty sand layer									
5455		▨														
		▨	☒		Ring Block	CL-2				3.4	31	15	0	26	74	
	10	▨														
		▨					1" fine silty sand layer									
		▨	■		Bag	CL	1" fine silty sand layer									
5450																
	15															
5445																
	20															

06/15/04
11:02:09 AM

LEGEND

■ 2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
← Disturbed Sample
☒ ← Undisturbed Sample
← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

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TEST PIT LOG

PIT NO. 04-2

Sheet: 1 of 1

PROJECT: **COVE DAM**

PROJECT NO.: **200401.025**

CLIENT: K.C.W.C.D.

DATE: 6/2/04

LOCATION: SEE SITE PLAN

ELEVATION: ~5474.0'

LOGGED BY: M. STILSON

EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE

DEPTH TO WATER - INITIAL: ▽ DRY AFTER 24 HOURS: ▼ DRY

Elev. (Feet)	Depth (Feet)	Lith-ology	SAMPLE Type		Type	USCS	Material Description	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Atter. Plasticity Index, %	Gradation Gravel, %	Gradation Sand, %	Gradation Silt/Clay, %	Other Tests
			■		Bag	CL									
5470															
	5														
			■		Bag	CL-2	**LEAN CLAY W/FINE SAND** lt. brown to brown, very dry, hard, sand intermixed throughout entire depth of test pit, some distinct pockets but no continuous layers, some pinhole structure, macro-hole structure in upper 3', trace minerals		8.6	40	20	0	2	98	
5465															
			■		Bag	CL									
	10														
			■		Bag	CL-1			5.8	31	13	0	12	88	
5460															
	15														
5455															
	20														

06/11/04
10:58:58 AM

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LEGEND

■ 2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
☐ ← Disturbed Sample
☒ ← Undisturbed Sample
▼ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

TEST PIT LOG

PIT NO. 04-3

Sheet: 1 of 1

PROJECT: COVE DAM
CLIENT: K.C.W.C.D.
LOCATION: SEE SITE PLAN
PROJECT NO.: 200401.025
DATE: 6/2/04
ELEVATION: ~5476.0'
LOGGED BY: M. STILSON
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: DRY AFTER 24 HOURS: NOT MEASURED

Elev. (Feet)	Depth (Feet)	SAMPLE Type	USCS	Material Description	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Plasticity Index, %	Gradation Gravel, %	Sand, %	Silt/Clay, %	Other Tests
		Bag	SP	**SAND W/GRAVEL** medium grained sand, fine grained gravel					25	73	2	
5475												
		Bag	CL									
			SM	2" silty sand layer								
	5											
5470												
		Bag	CL	**LEAN CLAY W/SAND** lt. brown to brown, dry, hard, intermixed, fine, some pinhole structure, some silt lenses, calcite stringers								
		Bag	CL									
	10											
			SP-SM	2" sand w/silt layer								
5465												
			SM	2" silty sand layer								
		Bag	CL									
	15											
5460												
	20											

06/15/04
11:02:30 AM

LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
Undisturbed Sample
Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

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TEST PIT LOG

PIT NO. 04-4

Sheet: 1 of 1

PROJECT: COVE DAM
PROJECT NO.: 200401.025
CLIENT: K.C.W.C.D.
DATE: 6/2/04
LOCATION: SEE SITE PLAN
ELEVATION: ~5475.0'
LOGGED BY: M. STILSON
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: ⊽ DRY AFTER 24 HOURS: ⊽ NOT MEASURED

Elev. (Feet)	Depth (Feet)	Lith-ology	SAMPLE				Material Description	Dry Density, pcf	Moisture Content, %	Atter.		Gradation			Other Tests
			Type		Type	USCS				Liquid Limit, %	Plasticity Index, %	Gravel, %	Sand, %	Silt/Clay, %	
		▨	■		Bag	CL									
5470	5	▨													
		▨				SM	2" sand layer at 5.5'					0	82	18	
		▨	■		Bag	CL	**LEAN CLAY** lt. brown to brown, dry, hard, some small sand pockets, pinhole structure, trace minerals								
		▨	■		Bag	CL									
5465	10	▨													
5460	15														
	20														

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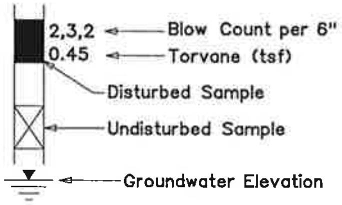
LEGEND



UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

TEST PIT LOG

PIT NO. 04-5

Sheet: 1 of 1

PROJECT: COVE DAM
CLIENT: K.C.W.C.D.
LOCATION: SEE SITE PLAN
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: ⊻ DRY AFTER 24 HOURS: ⊻ NOT MEASURED

PROJECT NO.: 200401.025
DATE: 6/2/04
ELEVATION: ~5477.0'
LOGGED BY: M. STILSON

Elev. (Feet)	Depth (Feet)	Lithology	Sample Type	Sample Type	USCS	Material Description	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Atter. Plasticity Index, %	Gradation Gravel, %	Gradation Sand, %	Gradation Silt/Clay, %	Other Tests
					CL	**LEAN CLAY**								
5475			■	Bag	GP	**GRAVEL W/SAND** fairly clean, sub-angular, mostly 0.75" to 3" sizes, a few cobbles up to 12"								
5470	5		■	Bag	CH	**HEAVILY WEATHERED MUDSTONE** dk. brown, moist, very hard			58	34				
	10		■	Bag	CH				59	31				
5465														
	15													
5460														
	20													

06/15/04
11:03:01 AM

LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
☒ Undisturbed Sample
⊻ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

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Provo, Utah

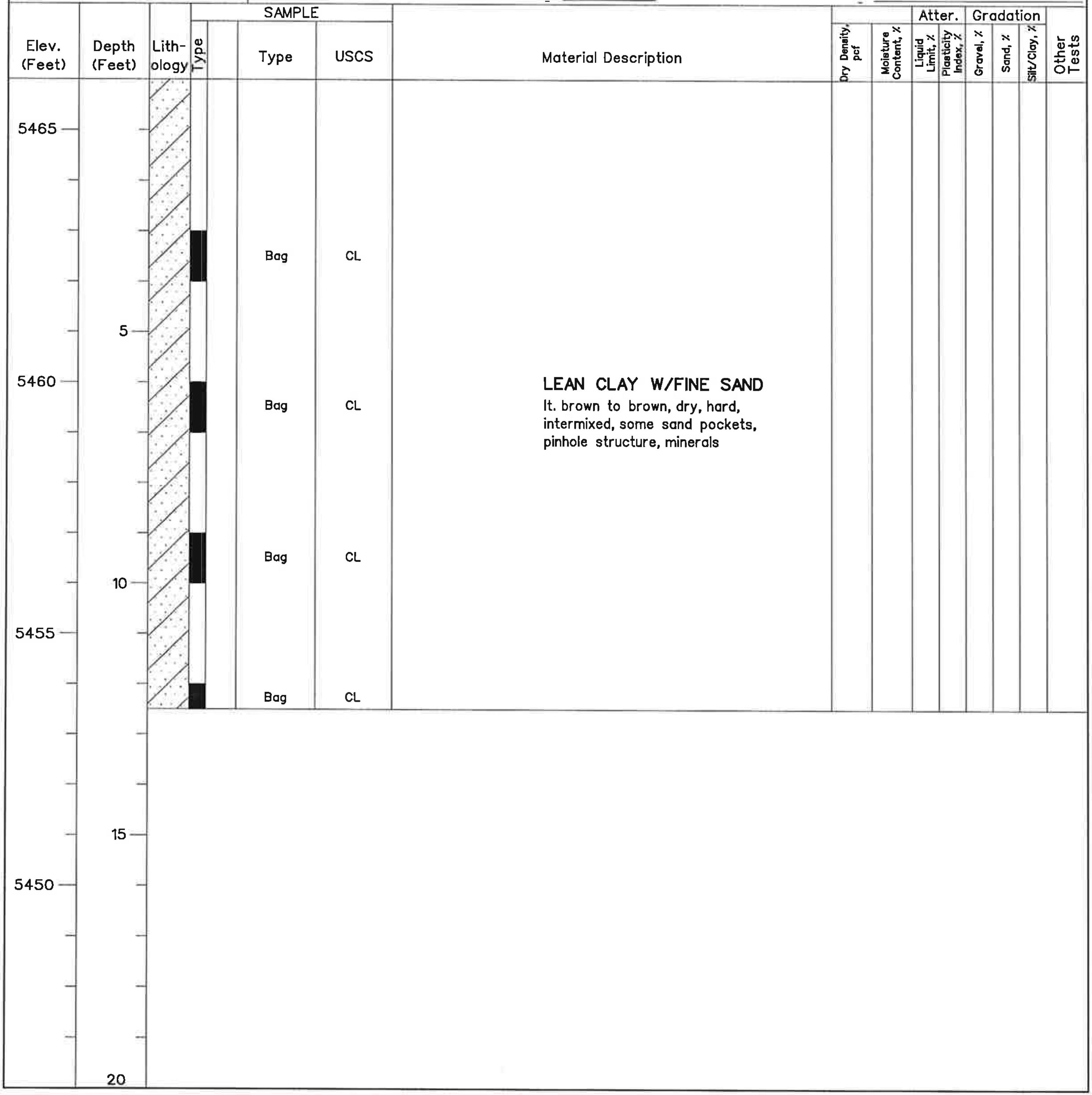
TEST PIT LOG

PIT NO. 04-6

Sheet: 1 of 1

PROJECT: COVE DAM
CLIENT: K.C.W.C.D.
LOCATION: SEE SITE PLAN
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: ▽ DRY AFTER 24 HOURS: ▼ NOT MEASURED

PROJECT NO.: 200401.025
DATE: 6/2/04
ELEVATION: ~5466.0'
LOGGED BY: M. STILSON



Type	USCS
Bag	CL
Bag	CL
Bag	CL
Bag	CL

LEAN CLAY W/FINE SAND
lt. brown to brown, dry, hard, intermixed, some sand pockets, pinhole structure, minerals

Dry Density, pcf	Moisture Content, %	Atter.		Gradation			Other Tests
		Liquid Limit, %	Plasticity Index, %	Gravel, %	Sand, %	Silt/Clay, %	

06/11/04
10:59:49 AM

LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
☒ ← Undisturbed Sample
▽ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

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Provo, Utah

TEST PIT LOG

PIT NO. 04-7

Sheet: 1 of 1

PROJECT: COVE DAM

CLIENT: K.C.W.C.D.

LOCATION: SEE SITE PLAN

EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE

DEPTH TO WATER - INITIAL: ⊽ DRY AFTER 24 HOURS: ⊽ NOT MEASURED

PROJECT NO.: 200401.025

DATE: 6/2/04

ELEVATION: ~5456.0'

LOGGED BY: M. STILSON

Elev. (Feet)	Depth (Feet)	Lithology	Sample Type	Sample Type	USCS	Material Description	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Atter. Plasticity Index, %	Gradation Gravel, %	Gradation Sand, %	Gradation Silt/Clay, %	Other Tests
5455						**LEAN CLAY** dry, pinhole structure, macro-holes to 3'								
			☒	Ring	CL-1		82.0	9.1	28	11	0	13	87	
			☒	2 Blocks	CL-ML	**SILTY CLAY**	86.9	6.5	26	6	0	10	90	CT
	5													
5450														
			☒	Block Bucket	CL-2	**LEAN CLAY** lt. brown to brown, dry, hard, pinhole structure			37	18	0	3	97	DS
			☒	Block	CL-2		89.6	9.1	33	15	0	3	97	
	10													
5445														
			■	Bag	CL									
	15													
5440														
	20													

06/14/04
03:09:18 PM

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LEGEND

- 2,3,2 ← Blow Count per 6"
- 0.45 ← Torvane (tsf)
- ☐ ← Disturbed Sample
- ☒ ← Undisturbed Sample
- ⊽ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test
DS - Direct Shear Test

TEST PIT LOG

PIT NO. 04–8

Sheet: 1 of 1

PROJECT: **COVE DAM**
PROJECT NO.: **200401.025**
CLIENT: K.C.W.C.D.
DATE: 6/2/04
LOCATION: SEE SITE PLAN
ELEVATION: ~5475.0'
LOGGED BY: M. STILSON
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: DRY AFTER 24 HOURS: NOT MEASURED

			SAMPLE						Atter.		Gradation			
Elev. (Feet)	Depth (Feet)	Lithology	Type		Type	USCS	Material Description	Dry Density, pcf	Moisture Content, %	Liquid Limit, %	Plasticity Index, %	Gravel, %	Sand, %	Silt/Clay, %	Other Tests
		▨					**SILTY CLAY W/SAND** lt. brown to brown, dry, hard, pinhole structure								
		▨	■		Bag	CL-1			6.9	33	14	0	6	94	
5470	5	▨													
		▨	■		Bag	CL									
		▨					**LEAN CLAY** lt. brown to brown, dry, hard, pinhole structure, minerals								
		▨	■		Bag	CL-2			6.7	46	25	0	2	98	
5465	10	▨													
		▨	■		Bag	CL									
5460	15														
	20														

06/11/04
11:00:17 AM

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LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
☒ Undisturbed Sample
Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

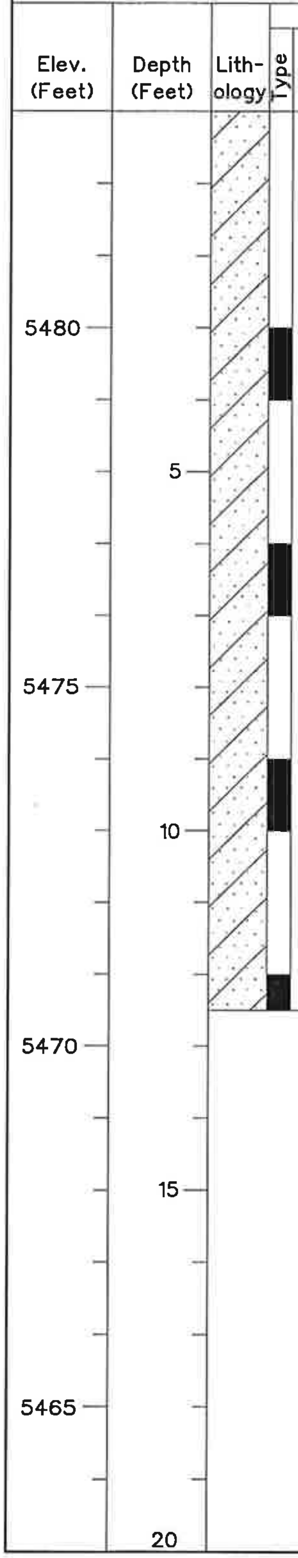
TEST PIT LOG

PIT NO. 04-9

Sheet: 1 of 1

PROJECT: COVE DAM
CLIENT: K.C.W.C.D.
LOCATION: SEE SITE PLAN
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: ⊻ DRY AFTER 24 HOURS: ⊻ NOT MEASURED

PROJECT NO.: 200401.025
DATE: 6/2/04
ELEVATION: ~5483.0'
LOGGED BY: M. STILSON



Sample Type	USCS	Material Description	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Atter. Plasticity Index, %	Gradation Gravel, %	Gradation Sand, %	Gradation Silt/Clay, %	Other Tests
Bag	CL									
Bag	CL-2	**LEAN CLAY W/FINE SAND** lt. brown to brown, dry, hard, pinhole structure, trace minerals		7.8	37	21	0	1	99	
Bag	CL									
Bag	CL-2			6.3	31	15	0	6	94	

06/11/04
11:00:31 AM

LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
Undisturbed Sample
⊻ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

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Provo, Utah

TEST PIT LOG

PIT NO. 04-10

Sheet: 1 of 1

PROJECT: COVE DAM
PROJECT NO.: 200401.025
CLIENT: K.C.W.C.D.
DATE: 6/2/04
LOCATION: SEE SITE PLAN
ELEVATION: ~5500.0'
LOGGED BY: M. STILSON
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: ▽ DRY AFTER 24 HOURS: ▽ NOT MEASURED

Elev. (Feet)	Depth (Feet)	Lithology	SAMPLE Type		Type	USCS	Material Description	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Atter. Plasticity Index, %	Gradation Gravel, %	Gradation Sand, %	Gradation Silt/Clay, %	Other Tests
		▨	■		Bag	CL-2			6.9	38	20	0	6	94	
5495	5	▨													
		▨	■		Bag	CL	**LEAN CLAY** lt. brown to brown, dry, hard, trace pinhole structure, more minerals, trace sand at 3'								
		▨	■		Bag	CL-2			8.5	43	22	0	6	94	
5490	10	▨													
		▨	■		Bag	CL									
5485	15														
	20														

06/11/04
11:00:46 AM

LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
☒ Undisturbed Sample
▽ ← Groundwater Elevation

RB&G
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INC.
Provo, Utah

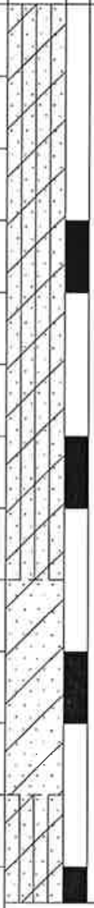
UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

TEST PIT LOG

PIT NO. 04-11

Sheet: 1 of 1

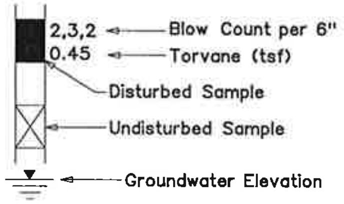
PROJECT: COVE DAM
PROJECT NO.: 200401.025
CLIENT: K.C.W.C.D.
DATE: 6/2/04
LOCATION: SEE SITE PLAN
ELEVATION: ~5498.0'
LOGGED BY: M. STILSON
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: ▽ DRY AFTER 24 HOURS: ▽ NOT MEASURED



Elev. (Feet)	Depth (Feet)	Sample Type	Sample USCS	Material Description	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Atter. Plasticity Index, %	Gradation Gravel, %	Gradation Sand, %	Gradation Silt/Clay, %	Other Tests
5495		Bag	CL-ML	**SILTY CLAY W/SAND** lt. brown to brown, dry, hard, pinhole structure, fine sand - intermixed		4.4	20	5	0	43	57	
	5											
		Bag	CL-ML									
5490												
	10	Bag	CL-2	**LEAN CLAY W/SAND** lt. brown to brown, dry, hard, pinhole structure, fine sand - intermixed		5.7	34	16	0	17	83	
		Bag	CL-ML	**SILTY CLAY W/SAND** lt. brown to brown, dry, hard, pinhole structure, fine sand - intermixed								
5485												
	15											
5480												
	20											

06/11/04
11:01:01 AM

LEGEND



RB&G ENGINEERING INC.
Provo, Utah

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

TEST PIT LOG

PIT NO. 04-12

Sheet: 1 of 1

PROJECT: COVE DAM
CLIENT: K.C.W.C.D.
LOCATION: SEE SITE PLAN
PROJECT NO.: 200401.025
DATE: 6/2/04
ELEVATION: ~5520.0'
LOGGED BY: M. STILSON
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: ⊻ DRY AFTER 24 HOURS: ⊻ NOT MEASURED

Elev. (Feet)	Depth (Feet)	SAMPLE Type	SAMPLE USCS	Material Description	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Atter. Plasticity Index, %	Gradation Gravel, %	Gradation Sand, %	Gradation Silt/Clay, %	Other Tests
		Bag	CL-ML	**SILTY CLAY W/SAND** lt. brown to brown, dry, hard								
5515	5											
		Bag/ Block	ML	shows layering **SANDY SILT** lt. brown to brown, dry, hard		4.4		NP	0	47	53	
5510	10	Bag	CL-ML	**SILTY CLAY W/SAND** lt. brown to brown, dry, hard								
		Bag	CL-2	**LEAN CLAY** lt. brown to brown, dry, hard		7.2	36	16	0	2	98	
5505	15											
	20											

06/11/04
11:01:14 AM

LEGEND

2,3,2 ← Blow Count per 6"
0.45 ← Torvane (tsf)
Disturbed Sample
☒ Undisturbed Sample
⊻ ← Groundwater Elevation

UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

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INC.
Provo, Utah

TEST PIT LOG

PIT NO. 04-13

Sheet: 1 of 1

PROJECT: COVE DAM
CLIENT: K.C.W.C.D.
LOCATION: SEE SITE PLAN
EQUIP./DRILL METHOD: 310 SE J.D. BACKHOE
DEPTH TO WATER - INITIAL: ⏚ DRY   AFTER 24 HOURS: ⏚ NOT MEASURED

PROJECT NO.: 200401.025
DATE: 6/2/04
ELEVATION: ~5548.0'
LOGGED BY: M. STILSON

Elev. (Feet)	Depth (Feet)	Lith-ology	SAMPLE Type		Type	USCS	Material Description	Dry Density, pcf	Moisture Content, %	Atter. Liquid Limit, %	Plasticity Index, %	Gradation Gravel, %	Sand, %	Silt/Clay, %	Other Tests
							6" clay layer								
			■		Bag	SM									
							8" clay layer								
5515	5														
							SILTY SAND W/CLAY LAYERS lt. brown to brown, dry								
			■		Bag	SM									
							12" clay layer								
			■		Bag	SM									
5510	10														
			■		Bag	SM									
5505	15														
	20														

06/11/04
11:01:30 AM

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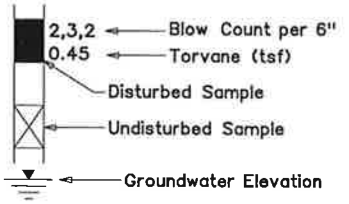
Provo, Utah

LEGEND



UC - Unconfined Compression Test
CT - Consolidation Test
SG - Specific Gravity Test

Laboratory Testing

Table 1

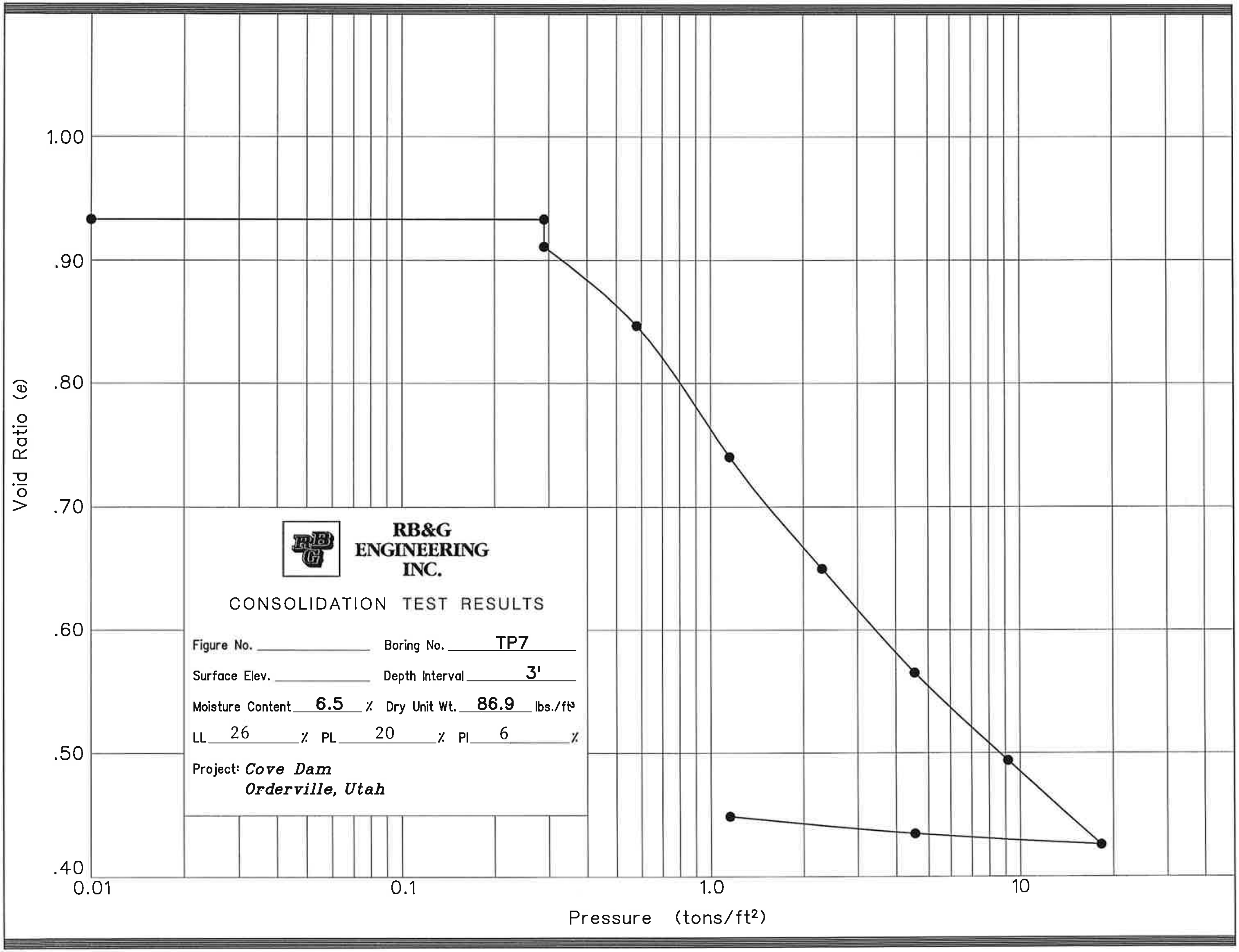
SUMMARY OF TEST DATA

PROJECT Cove Dam
LOCATION Kane County, Utah

PROJECT NO. 200401-025
FEATURE

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	MATERIAL	IN-PLACE		PINHOLE TEST RESULTS	ATTERBERG LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM (modified)
			DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY	
DH-1	5-6	Soil	120.3	9.8		32	18	14	0	10	90	CL-1
	15-16.5	Soil	119.4	8.7		37	18	19	0	17	83	CL-2
	25-26.5	Soil	112.4	14.3		34	16	18	0	6	94	CL-2
	35-36.5	Soil	105.2	17.5		49	18	31	0	3	97	CL-2
	45-46	Soil	100.7	23.1		50	16	34	0	6	94	CL-2/CH
	53	Bedrock		16.4		82	30	50	0	0	100	CH
	73	Bedrock		13.2		70	25	45	0	0	100	CH
DH-2	6.5-8	Soil		12.2		45	14	31	0	2	98	CL-2
	15-16.5	Soil	111.8	19.3		58	24	34	0	0	100	CH
	26	Bedrock		13.5		70	23	47	0	0	100	CH
DH-3	14	Bedrock		13.7		54	21	33	0	0	100	CH
DH-5	41	Bedrock		4.7		43	17	26	0	9	91	CL-2
	48	Bedrock		12.6		47	23	24	0	2	98	CL-2
TP-1	3-4	Soil		4.8	ND2	26	16	12	0	3	97	CL-1
	6-7	Soil		6.4	ND2	35	19	6	0	2	98	CL-2
	9-10	Soil		3.4	ND3	31	16	15	0	26	74	CL-2
TP-2	6-7	Soil		8.6		40	20	20	0	2	98	CL-2
	12-12.5	Soil		5.8	ND3	31	18	13	0	12	88	CL-1
TP-3	0-1	Soil							25	73	2	SP
TP-4	5.5	Soil							0	82	18	SM
TP-5	6	Bedrock				58	24	34				CH
	9	Bedrock				59	28	31				CH
TP-7	2	Soil	82.0	9.1	ND2	28	17	11	0	13	87	CL-1
	2-3	Soil	86.9	6.5	ND3	26	20	6	0	10	90	CL-ML
	6-7	Soil		4.0	ND2	37	19	18	0	3	97	CL-2
	9-10	Soil	89.6	9.1		33	18	15	0	3	97	CL-2
TP-8	3-4	Soil		6.9	ND3	33	19	14	0	6	94	CL-1
	9-10	Soil		6.7	ND2	46	21	25	0	2	98	CL-2
TP-9	6-7	Soil		7.8		37	16	21	0	1	99	CL-2
	12-12.5	Soil		6.3		31	16	15	0	6	94	CL-2
TP-10	3-4	Soil		6.9		38	18	20	0	6	94	CL-2
	9-10	Soil		8.5		43	21	22	0	6	94	CL-2
TP-11	3-4	Soil		4.4		20	15	5	0	43	57	CL-ML
	9-10	Soil		5.7		34	18	16	0	17	83	CL-2
TP-12	6-7	Soil		4.4				NP	0	47	53	ML
	12-12.5	Soil		7.2		36	20	16	0	2	98	CL-2

NP=Nonplastic



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CONSOLIDATION TEST RESULTS

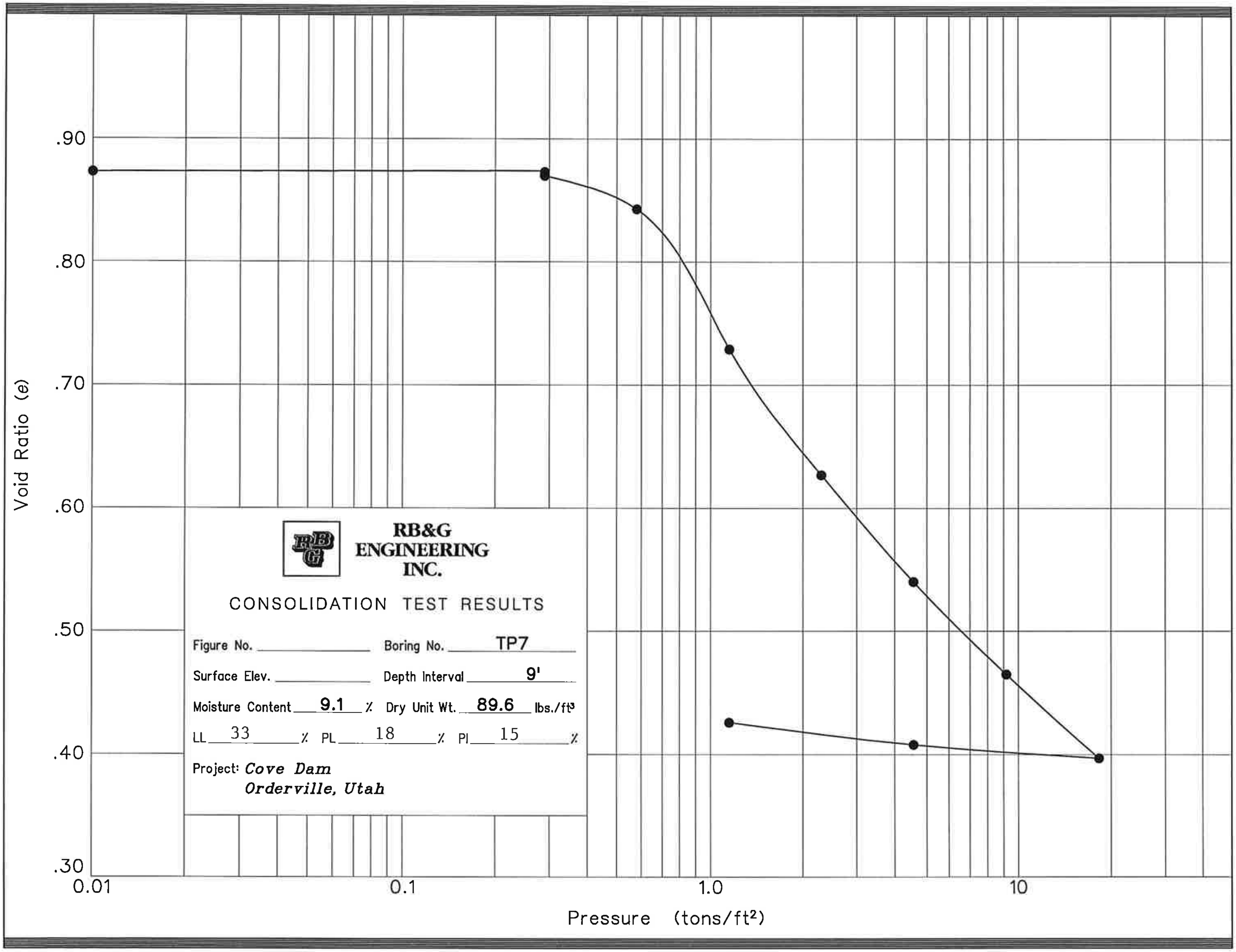
Figure No. _____ Boring No. TP7

Surface Elev. _____ Depth Interval 3'

Moisture Content 6.5 % Dry Unit Wt. 86.9 lbs./ft³

LL 26 % PL 20 % PI 6 %

Project: *Cove Dam*
Orderville, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

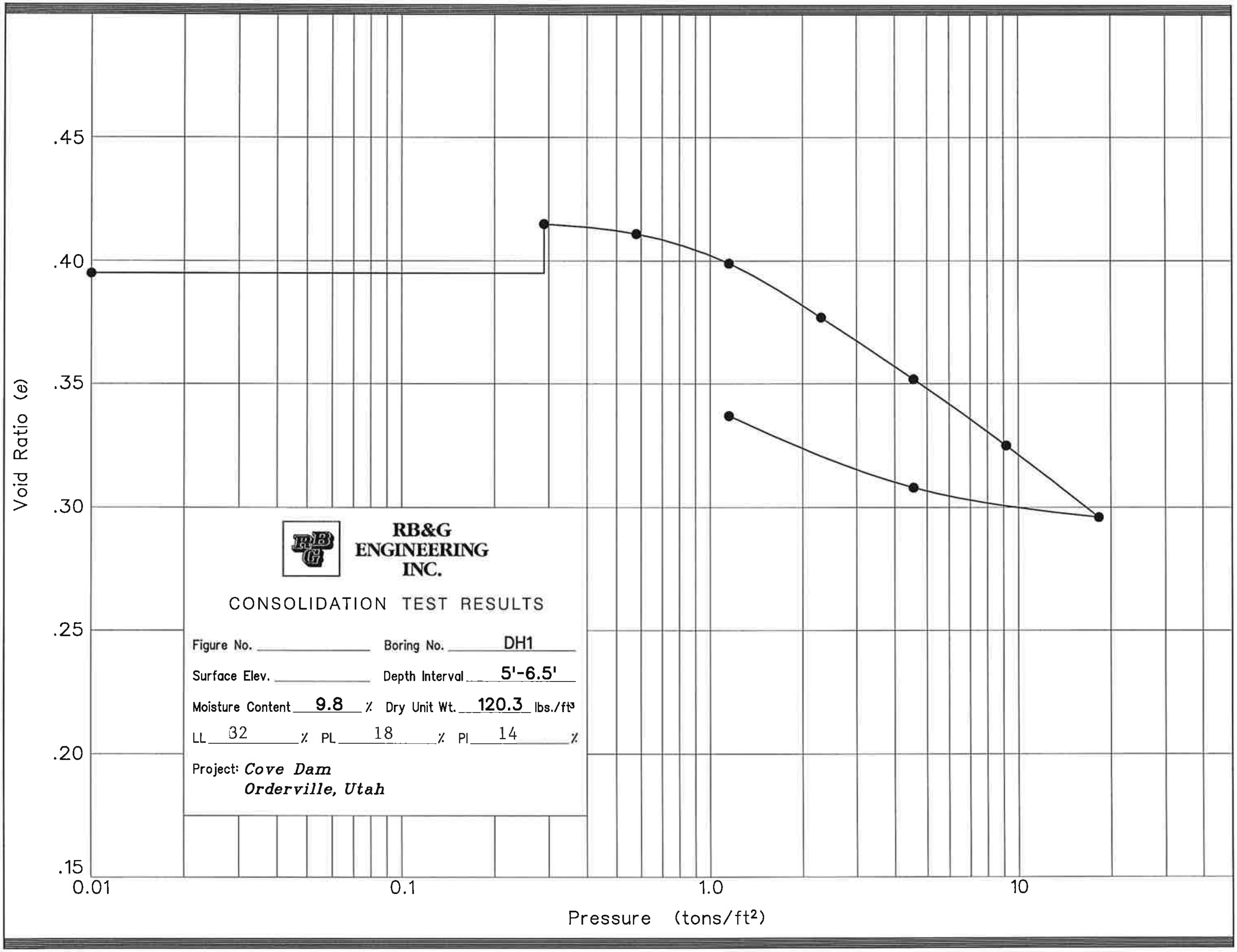
Figure No. ______ Boring No. TP7

Surface Elev. ______ Depth Interval 9'

Moisture Content 9.1 % Dry Unit Wt. 89.6 lbs./ft³

LL 33 % PL 18 % PI 15 %

Project: *Cove Dam*
Orderville, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

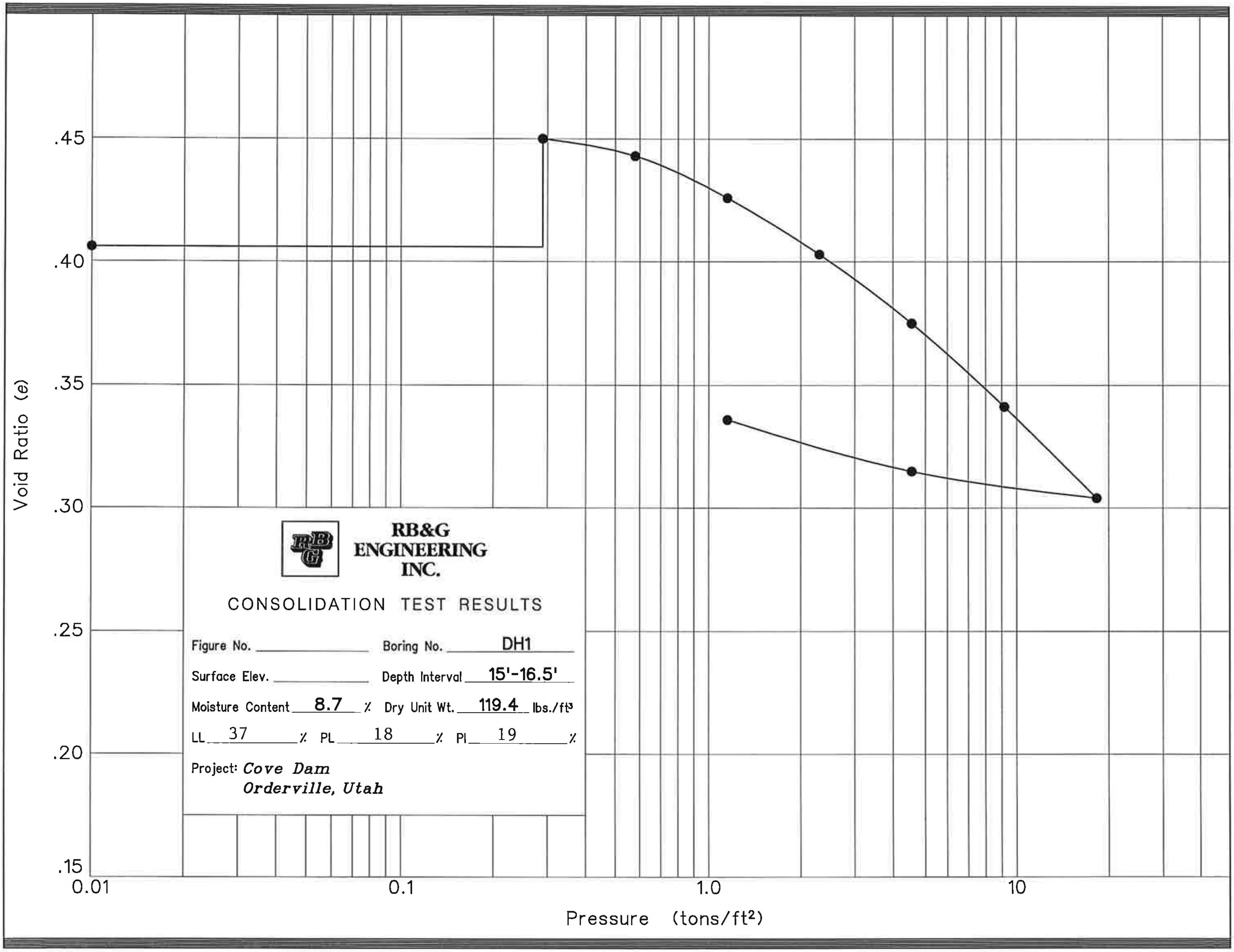
Figure No. ________ Boring No. DH1

Surface Elev. ________ Depth Interval 5'-6.5'

Moisture Content 9.8 % Dry Unit Wt. 120.3 lbs./ft³

LL 32 % PL 18 % PI 14 %

Project: *Cove Dam*
Orderville, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

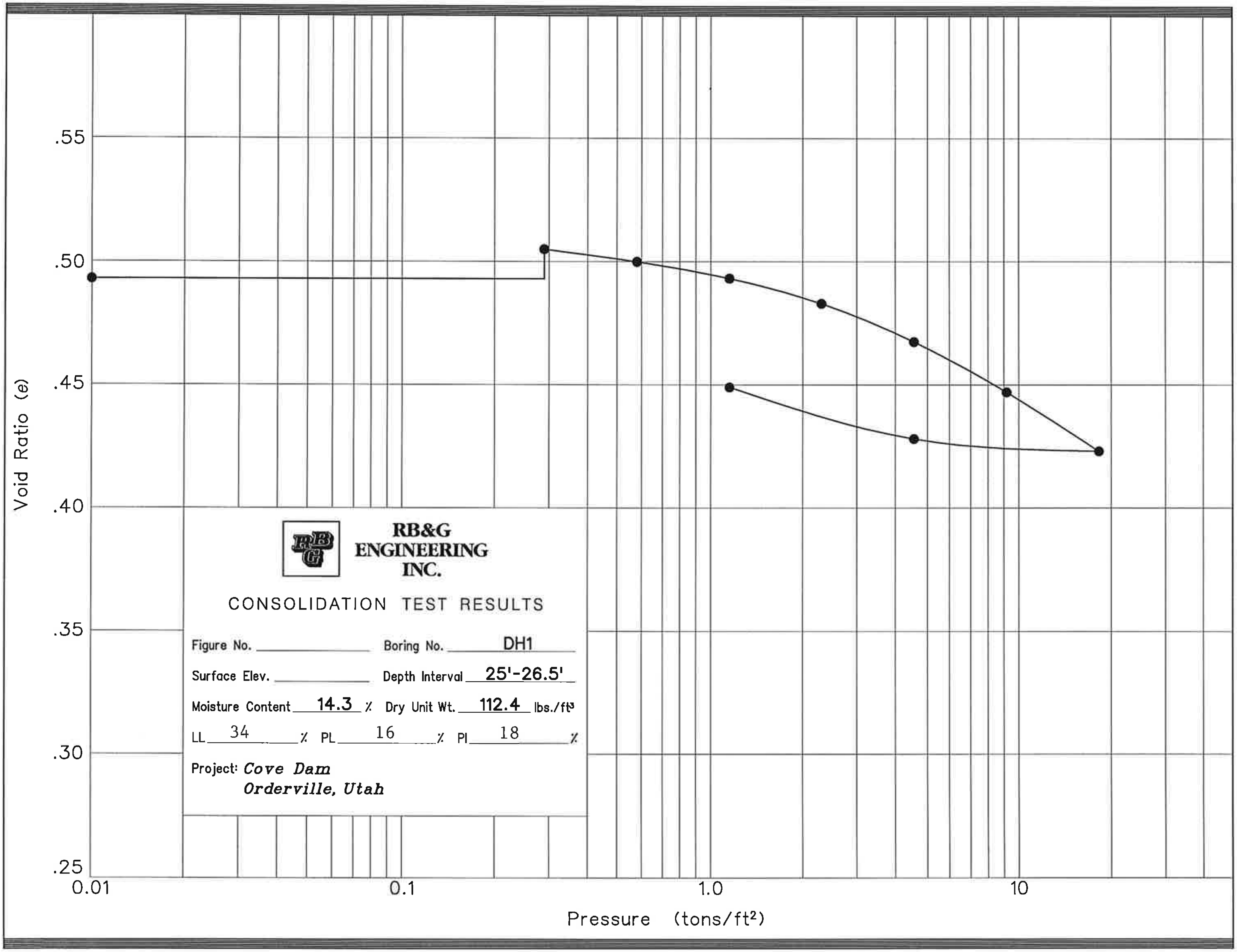
Figure No. ______ Boring No. DH1

Surface Elev. ______ Depth Interval 15'-16.5'

Moisture Content 8.7 % Dry Unit Wt. 119.4 lbs./ft³

LL 37 % PL 18 % PI 19 %

Project: *Cove Dam*
Orderville, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

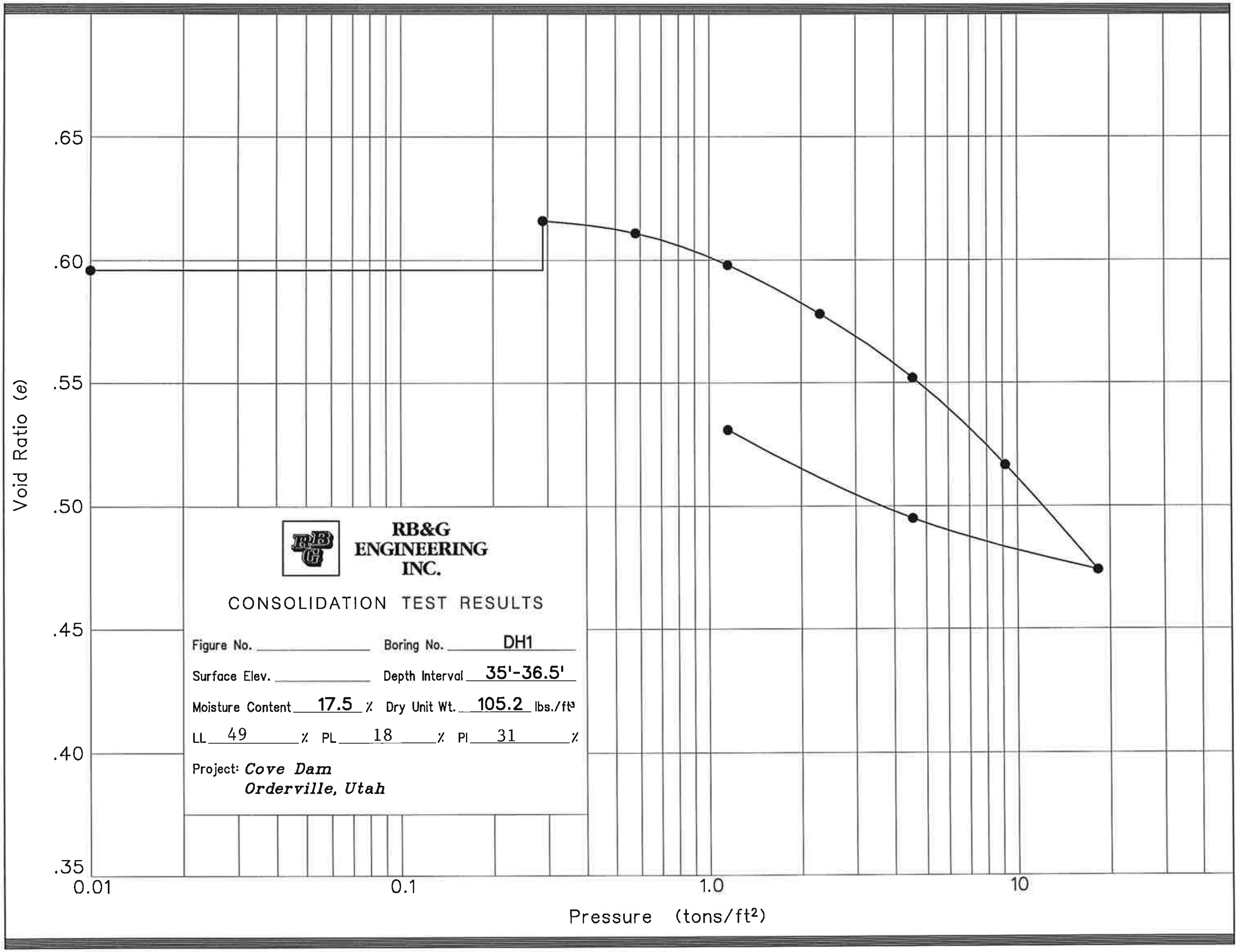
Figure No. ______ Boring No. DH1

Surface Elev. ______ Depth Interval 25'-26.5'

Moisture Content 14.3 % Dry Unit Wt. 112.4 lbs./ft³

LL 34 % PL 16 % PI 18 %

Project: *Cove Dam*
Orderville, Utah



RB&G ENGINEERING INC.

CONSOLIDATION TEST RESULTS

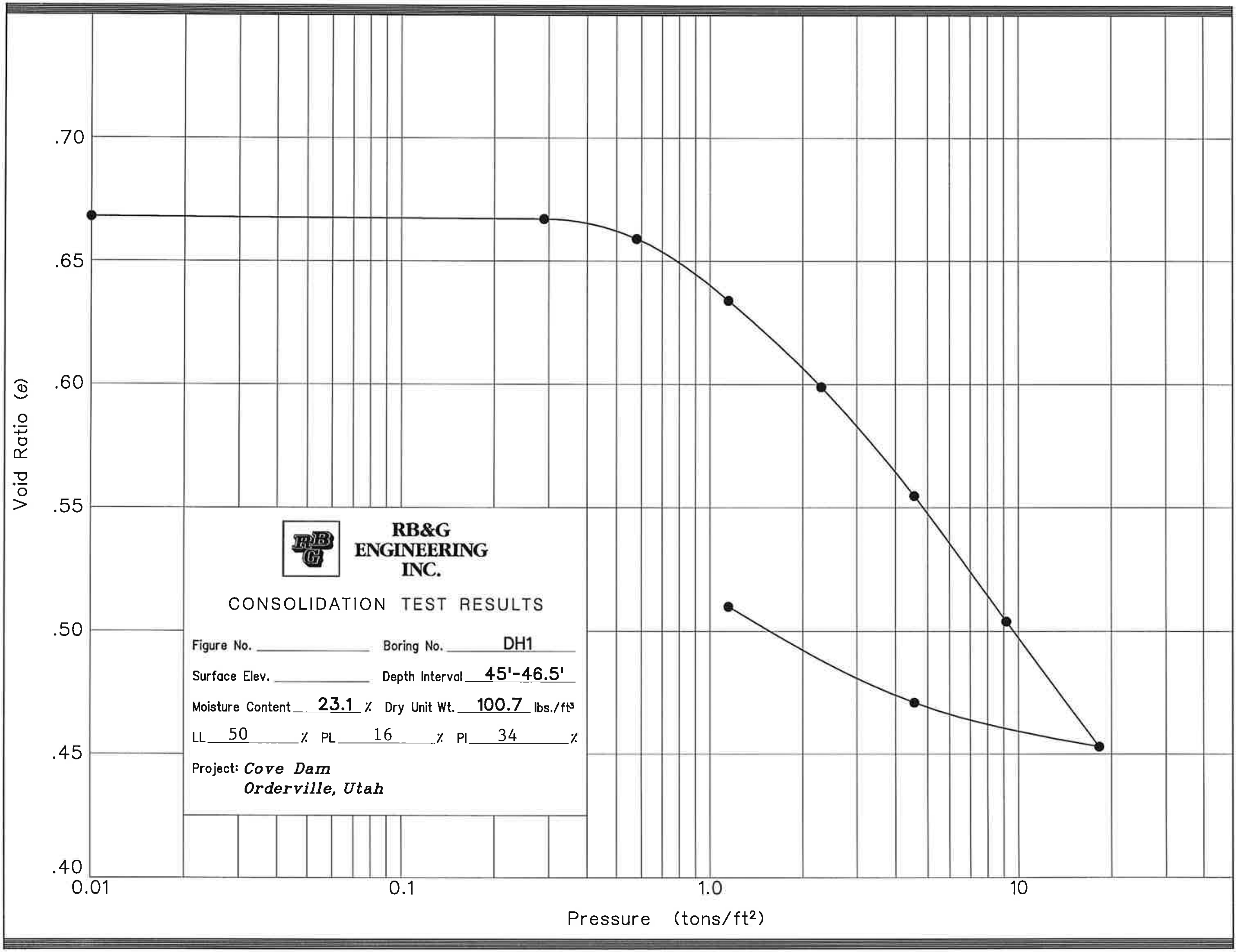
Figure No. ____ Boring No. DH1

Surface Elev. ____ Depth Interval 35'-36.5'

Moisture Content 17.5 % Dry Unit Wt. 105.2 lbs./ft³

LL 49 % PL 18 % PI 31 %

Project: *Cove Dam*
Orderville, Utah



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CONSOLIDATION TEST RESULTS

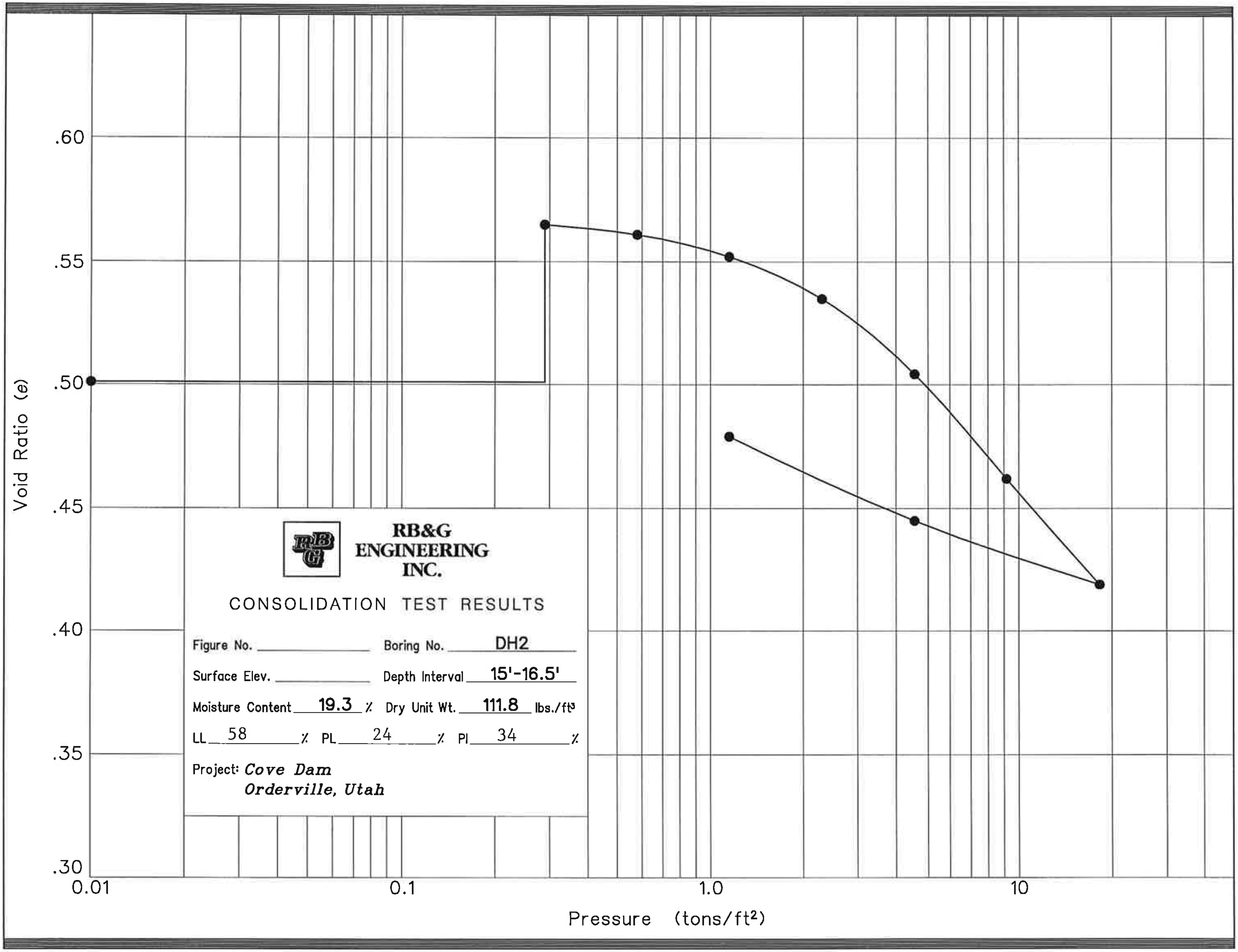
Figure No. ______ Boring No. DH1

Surface Elev. ______ Depth Interval 45'-46.5'

Moisture Content 23.1 % Dry Unit Wt. 100.7 lbs./ft³

LL 50 % PL 16 % PI 34 %

Project: *Cove Dam*
Orderville, Utah



RB&G
ENGINEERING
INC.

CONSOLIDATION TEST RESULTS

Figure No. ________ Boring No. DH2

Surface Elev. ________ Depth Interval 15'-16.5'

Moisture Content 19.3 % Dry Unit Wt. 111.8 lbs./ft³

LL 58 % PL 24 % PI 34 %

Project: *Cove Dam*
Orderville, Utah

RB&G ENGINEERING INC.
1435 West 820 North, Provo, Utah 84601
801 374-5771 Provo
801 521-5771 Salt Lake City

PROJECT NO.	200401.025

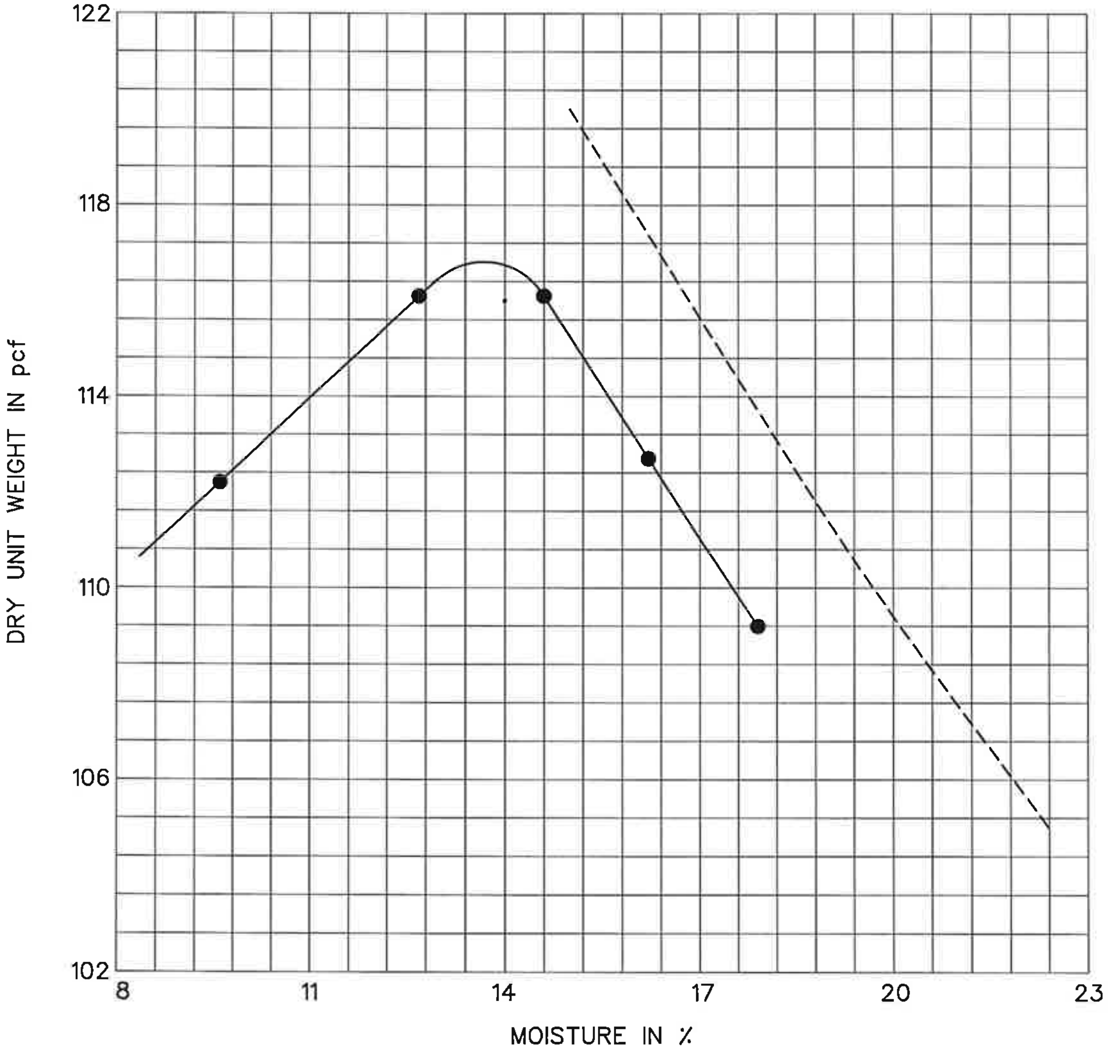
MOISTURE-DENSITY RELATION (PROCTOR)

Project	COVE DAM			Date	6/9/04
Location	ORDERVILLE, UTAH / TEST PIT NO. 1 AT 3'			Technician	G. PEASLEE
Material Description	LT. BROWN TO BROWN LEAN CLAY	USCS	CL-1	Method	ASTM D 698

Procedure Used[1]	A
Classification Procedure[2]	Test

[1] A-No. 4 Sieve, B-3/8" Sieve, C-3/4" Sieve
[2] Visual as per ASTM D 2488, Test as per ASTM D 2487

Preparation Method	Moist
Rammer Used	Manual
As-Received Moisture Content (%)	-



Maximum Dry Density (pcf)	116.0
Optimum Moisture Content (%)	14.0
Modified Maximum Density (pcf)	
Modified Optimum Moisture Content (%)	

------ 100% Saturation Curve

Specific Gravity of Soil	2.70	Est.

OVERSIZE CORRECTION-ASTM D 4718

Specific Gravity of Soil +3/4		
Percent Oversize		

Type of Specific Gravity is BULK Unless Otherwise Indicated

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PROJECT NO.	200401.025

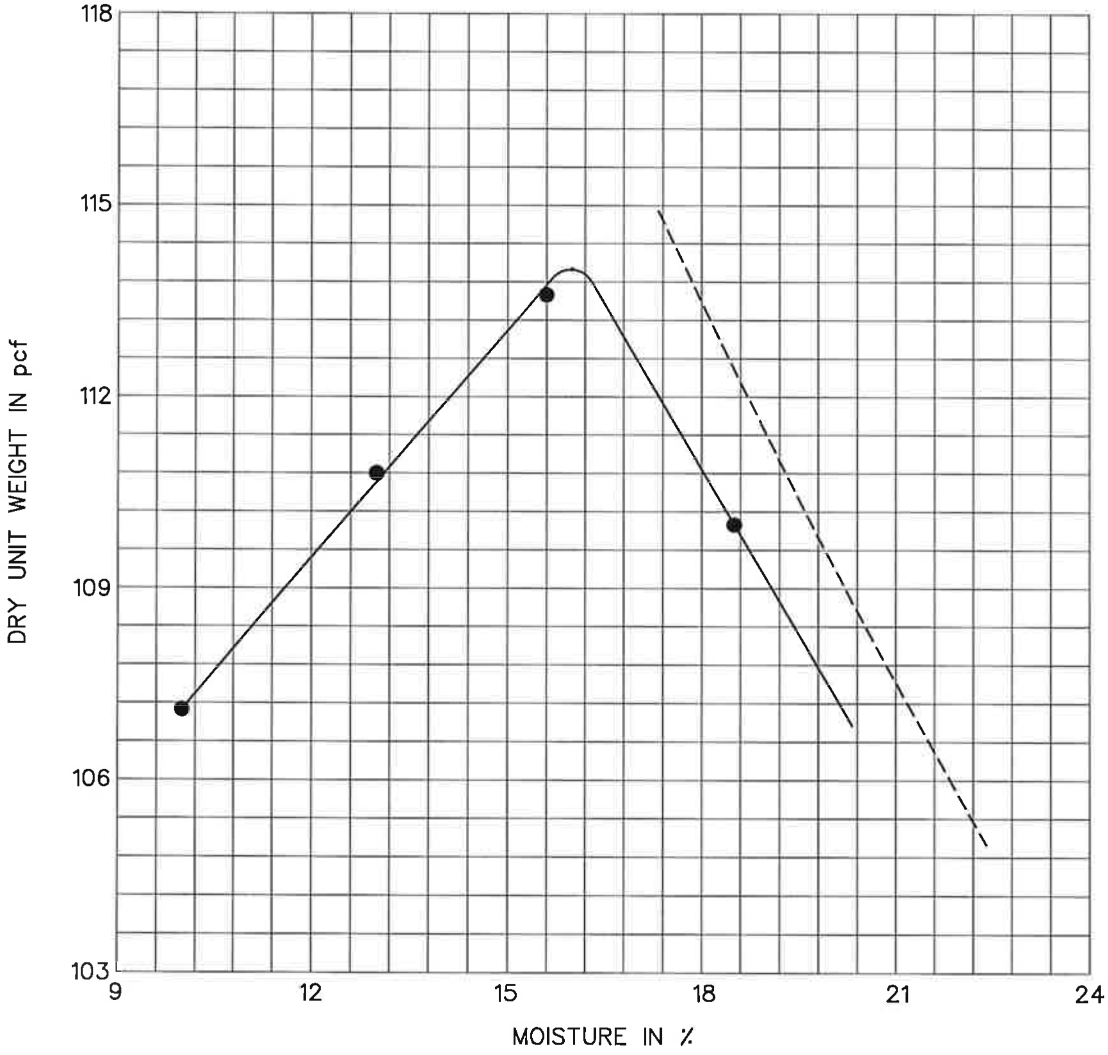
MOISTURE-DENSITY RELATION (PROCTOR)

Project	COVE DAM			Date	6/9/04
Location	ORDERVILLE, UTAH / TEST PIT NO. 7 AT 3'-4'			Technician	G. PEASLEE
Material Description	LT. BROWN TO BROWN SILTY CLAY	USCS	CL-ML	Method	ASTM D 698

Procedure Used[1]	A
Classification Procedure[2]	Test

[1] A-No. 4 Sieve, B-3/8" Sieve, C-3/4" Sieve
[2] Visual as per ASTM D 2488, Test as per ASTM D 2487

Preparation Method	Moist
Rammer Used	Manual
As-Received Moisture Content (%)	-



Maximum Dry Density (pcf)	114.0
Optimum Moisture Content (%)	16.0
Modified Maximum Density (pcf)	
Modified Optimum Moisture Content (%)	

------ 100% Saturation Curve

Specific Gravity of Soil	2.70	Est.

OVERSIZE CORRECTION-ASTM D 4718

Specific Gravity of Soil +3/4		
Percent Oversize		

Type of Specific Gravity is BULK Unless Otherwise Indicated

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PROJECT NO.	200401.025

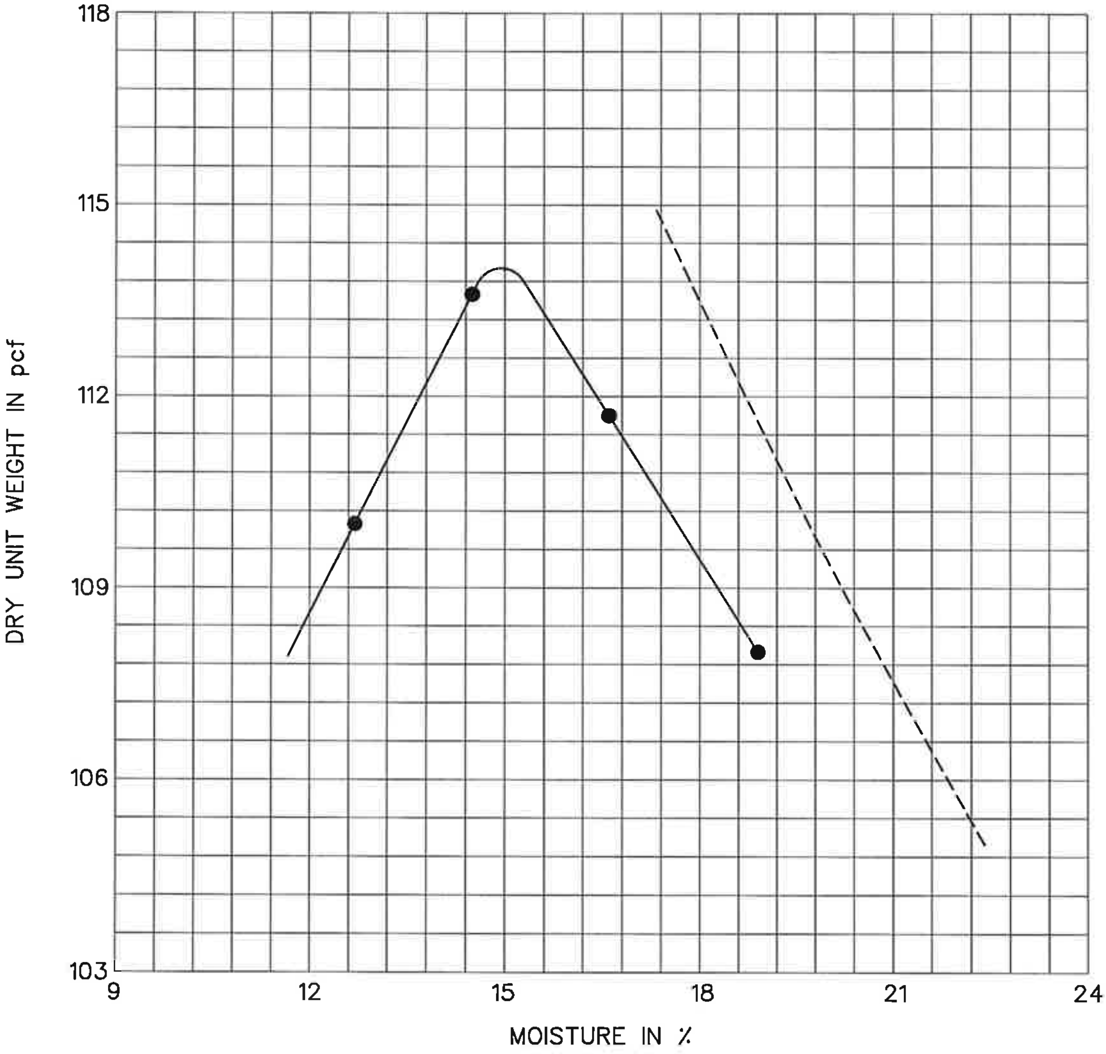
MOISTURE-DENSITY RELATION (PROCTOR)

Project	COVE DAM			Date	6/9/04
Location	ORDERVILLE, UTAH / TEST PIT NO. 7 AT 6'			Technician	G. PEASLEE
Material Description	LT. BROWN TO BROWN LEAN CLAY	USCS	CL-2	Method	ASTM D 698

Procedure Used[1]	A
Classification Procedure[2]	Test

[1] A-No. 4 Sieve, B-3/8" Sieve, C-3/4" Sieve
[2] Visual as per ASTM D 2488, Test as per ASTM D 2487

Preparation Method	Moist
Rammer Used	Manual
As-Received Moisture Content (%)	4.0



Maximum Dry Density (pcf)	114.0
Optimum Moisture Content (%)	15.0
Modified Maximum Density (pcf)	
Modified Optimum Moisture Content (%)	

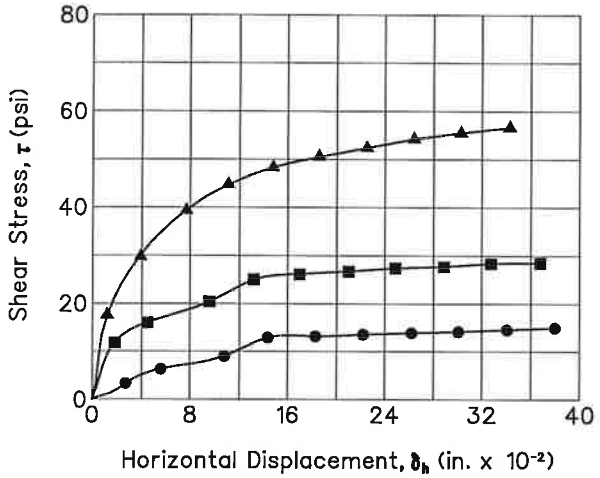
------ 100% Saturation Curve

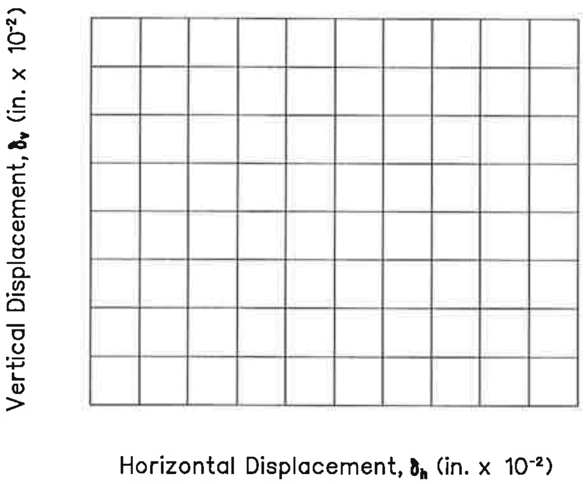
Specific Gravity of Soil	2.70	Est.

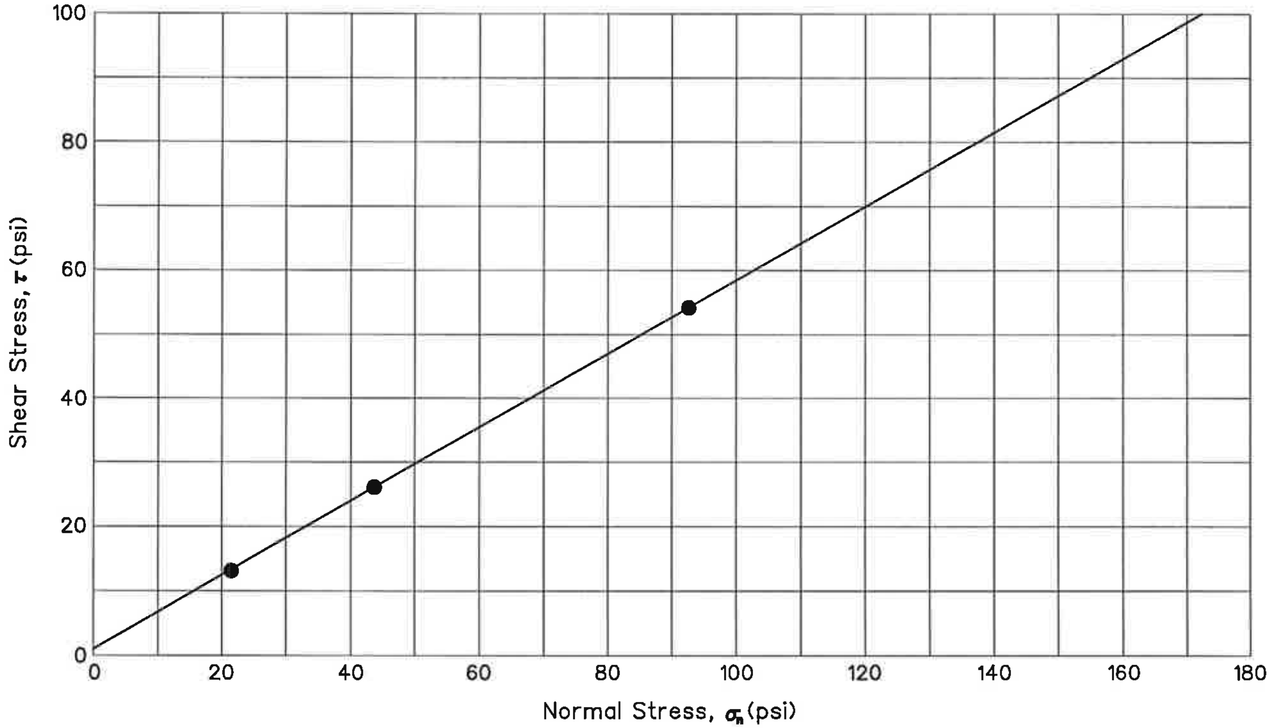
OVERSIZE CORRECTION-ASTM D 4718

Specific Gravity of Soil +3/4		
Percent Oversize		

Type of Specific Gravity is BULK Unless Otherwise Indicated







Test No. or Symbol	Sample Size (inches)	Sample Data		Degree of Saturation (%)	Normal Stress δ_n (psi)	Maximum Shear Stress τ (psi)	Strain Rate (inches/ minute)	Shear Strength Parameters	
		Dry Density (pcf)	Moisture Content (%)					Friction Angle ϕ (degrees)	Cohesion (c/psi)
●	2.375	80.4	10.4	~100	21.5	12.9	.0013	29.9	1
■	2.375	82.3	10.4	~100	43.7	26.1	.0013		
▲	2.375	87.1	8.5	~100	92.6	54.2	.0013		

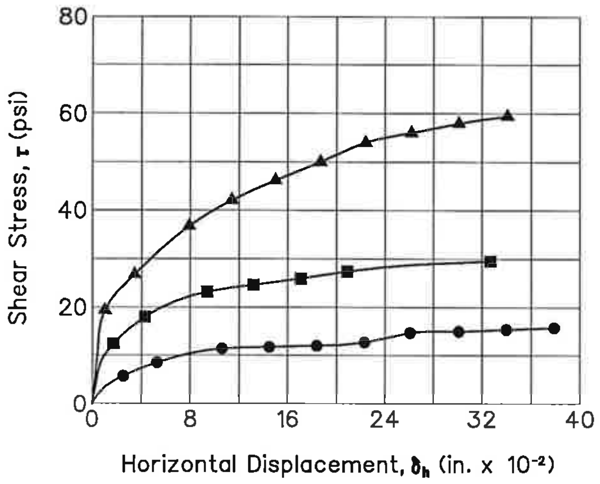
RB&G ENGINEERING INC.
Provo, Utah

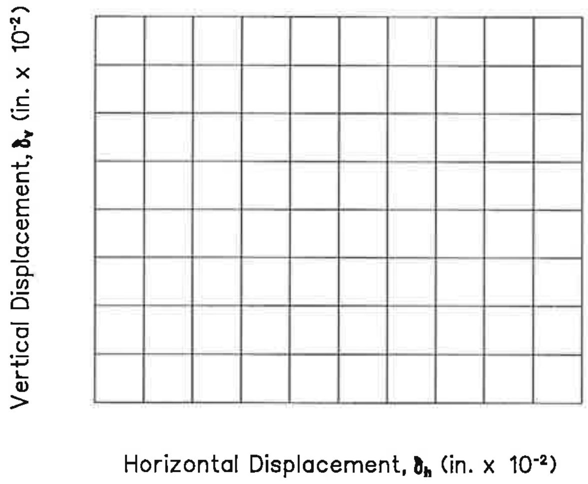
DIRECT SHEAR TEST
Project: *Cove Dam*
Orderville, Utah

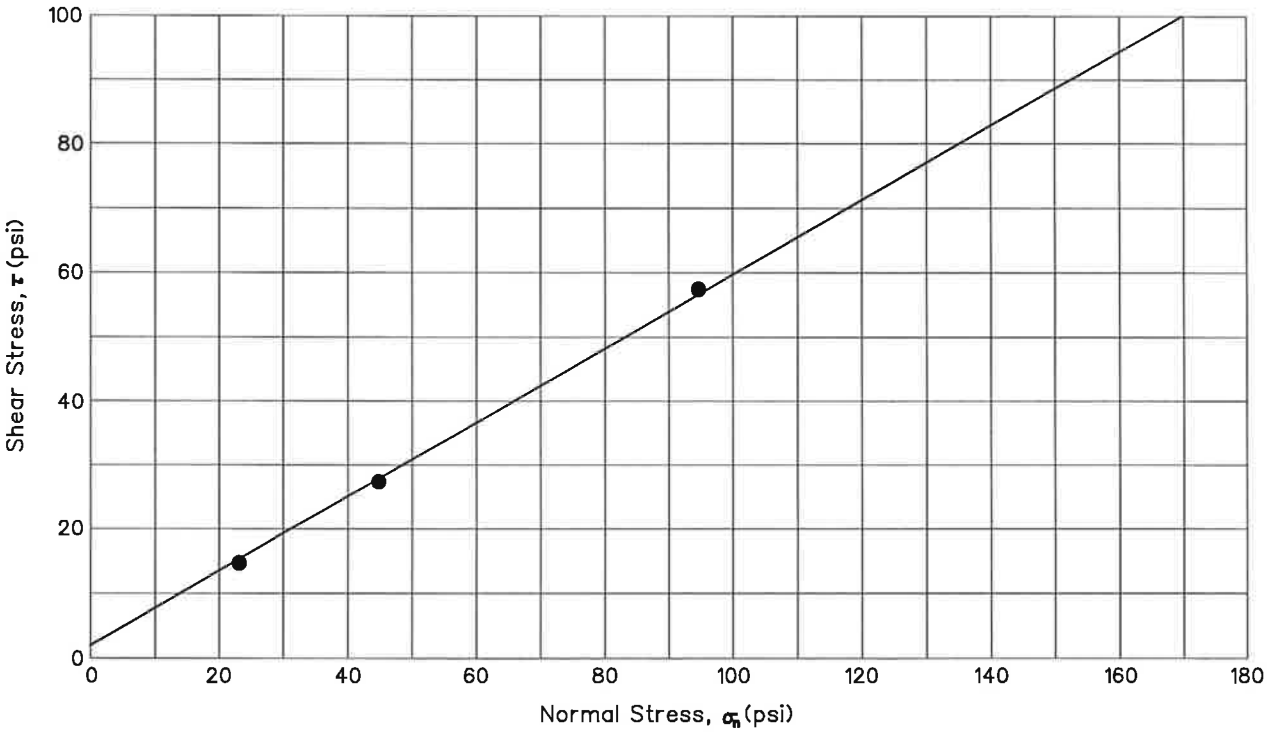
HOLE NO.: TP7

DEPTH: 6'

Figure







REMOLDED SAMPLE COMPACTED TO 98% MAXIMUM DENSITY

Test No. or Symbol	Sample Size (inches)	Sample Data		Degree of Saturation (%)	Normal Stress δ_n (psi)	Maximum Shear Stress τ (psi)	Strain Rate (inches/ minute)	Shear Strength Parameters	
		Dry Density (pcf)	Moisture Content (%)					Friction Angle ϕ (degrees)	Cohesion (c/psi)
●	2.375	111.5	15.1	100	23.1	14.7	.0013	30.2	2
■	2.375	111.5	15.1	100	44.8	27.4	.0013		
▲	2.375	111.5	15.1	100	94.6	57.9	.0013		

RB&G ENGINEERING INC.
Provo, Utah

DIRECT SHEAR TEST
Project: *Cove Dam*
Orderville, Utah

HOLE NO.: TP7

DEPTH: 6'

Figure

RB&G ENGINEERING INC.
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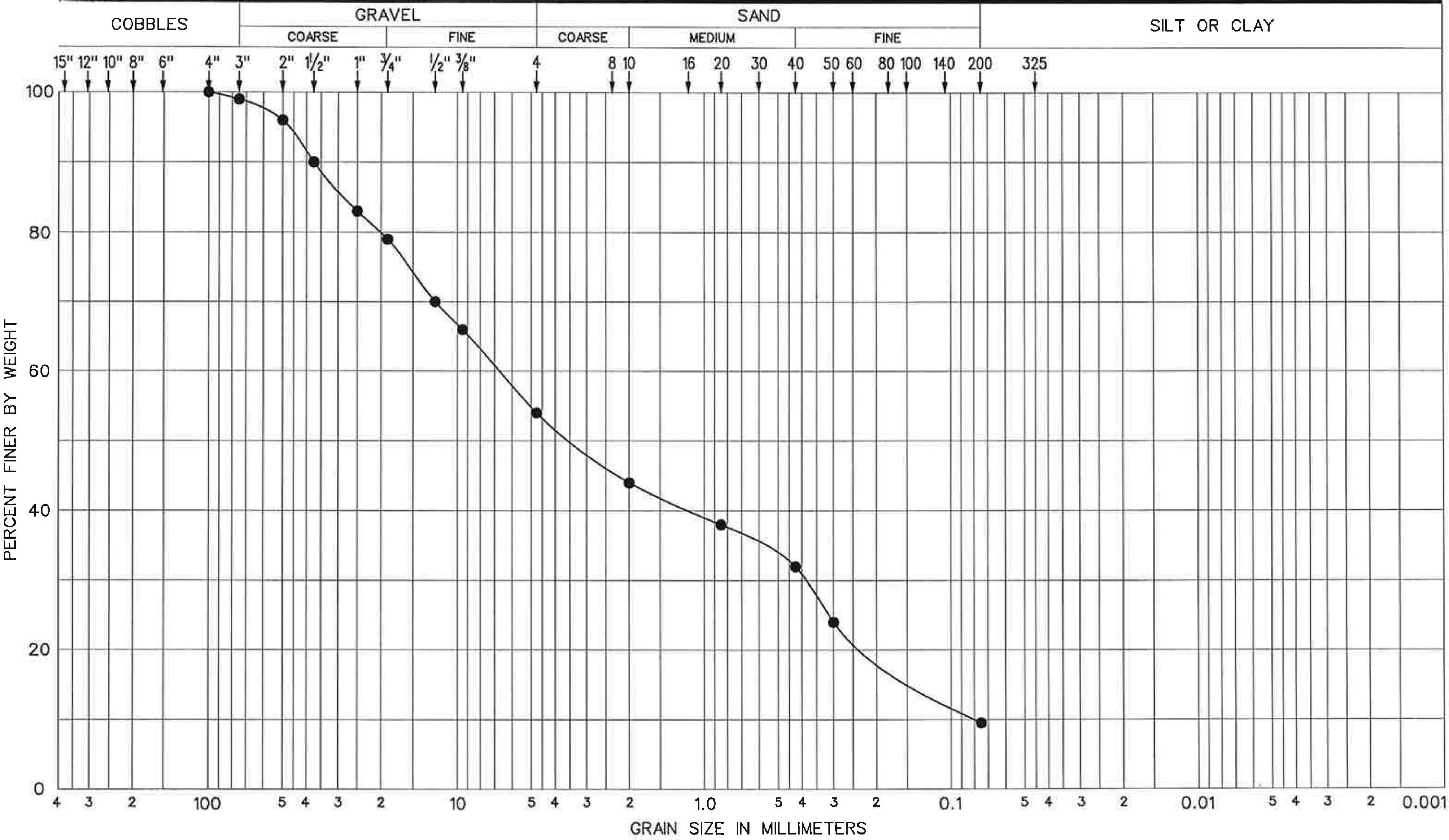
PROJECT NO.	200401.025

SIEVE ANALYSIS (GRADATION)



Project	COVE DAM		
Location	ORDERVILLE, UTAH		
Sample No./Depth	ROSE PIT		
Material Description	WELL GRADED GRAVEL W/SILT & SAND	USCS	GW-GM

Date	6/10/04
Technician	K. BRADFORD
Procedure	PLAIN WATER
Method	ASTM C117, C136, C566

RB&G ENGINEERING INC.
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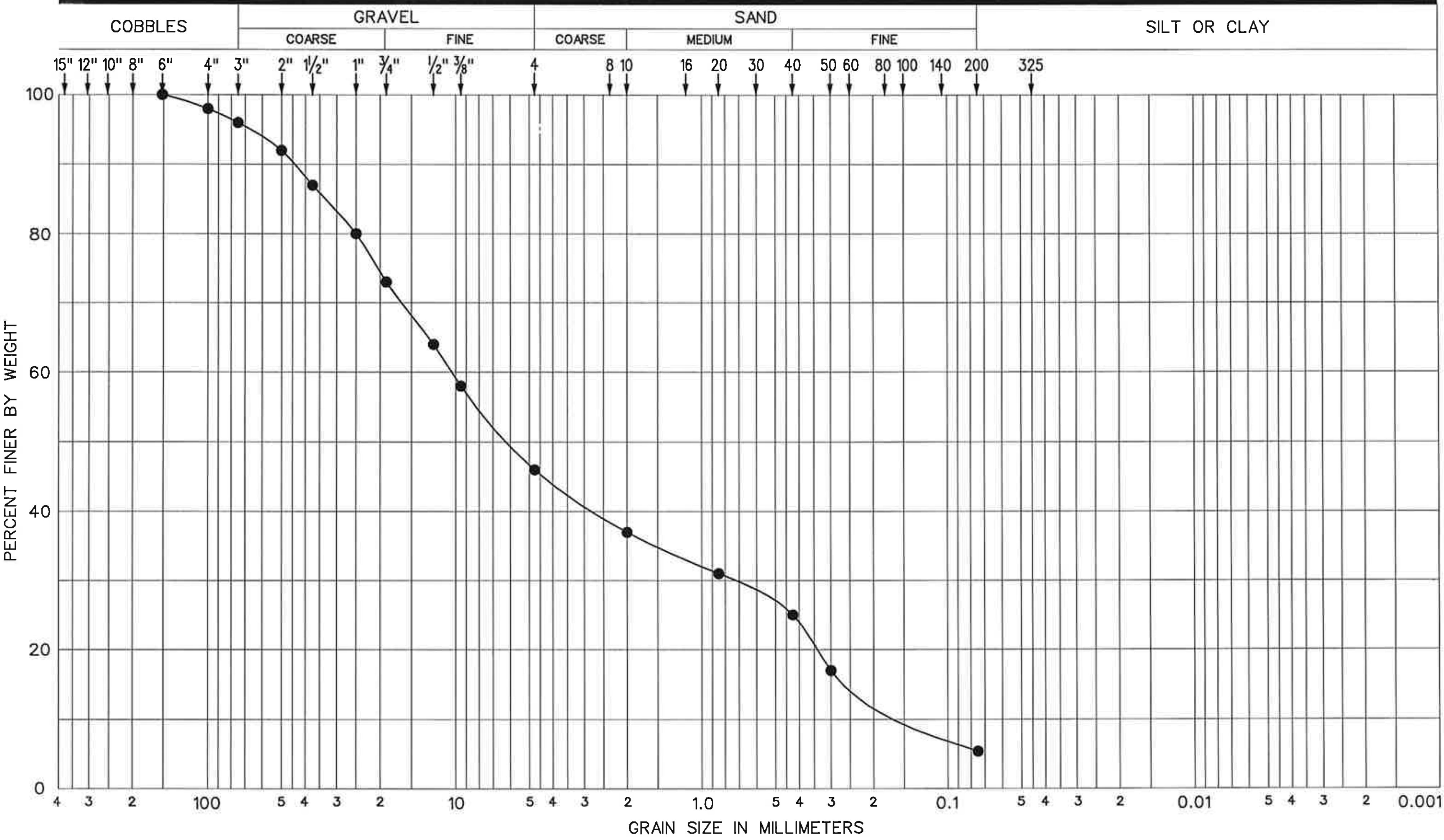
PROJECT NO.	200401.025

SIEVE ANALYSIS (GRADATION)



Project	COVE DAM		
Location	ORDERVILLE, UTAH		
Sample No./Depth	TATE PIT		
Material Description	POORLY GRADED GRAVEL W/SAND	USCS	GP

Date	6/10/04
Technician	K. BRADFORD
Procedure	PLAIN WATER
Method	ASTM C117, C136, C566

APPENDIX E-15

CONCEPTUAL EMBANKMENT DESIGN

Material Description	Total Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)
ZONE I - LEAN CLAY	130	30	250
ZONE II - SAND & GRAVEL FILTER DRAIN	135	36	0
FOUNDATION - LEAN CLAY	100	30	150
FOUNDATION - WEATHERED BEDROCK	140	30	200
FOUNDATION - COMPETENT BEDROCK	145	45	500

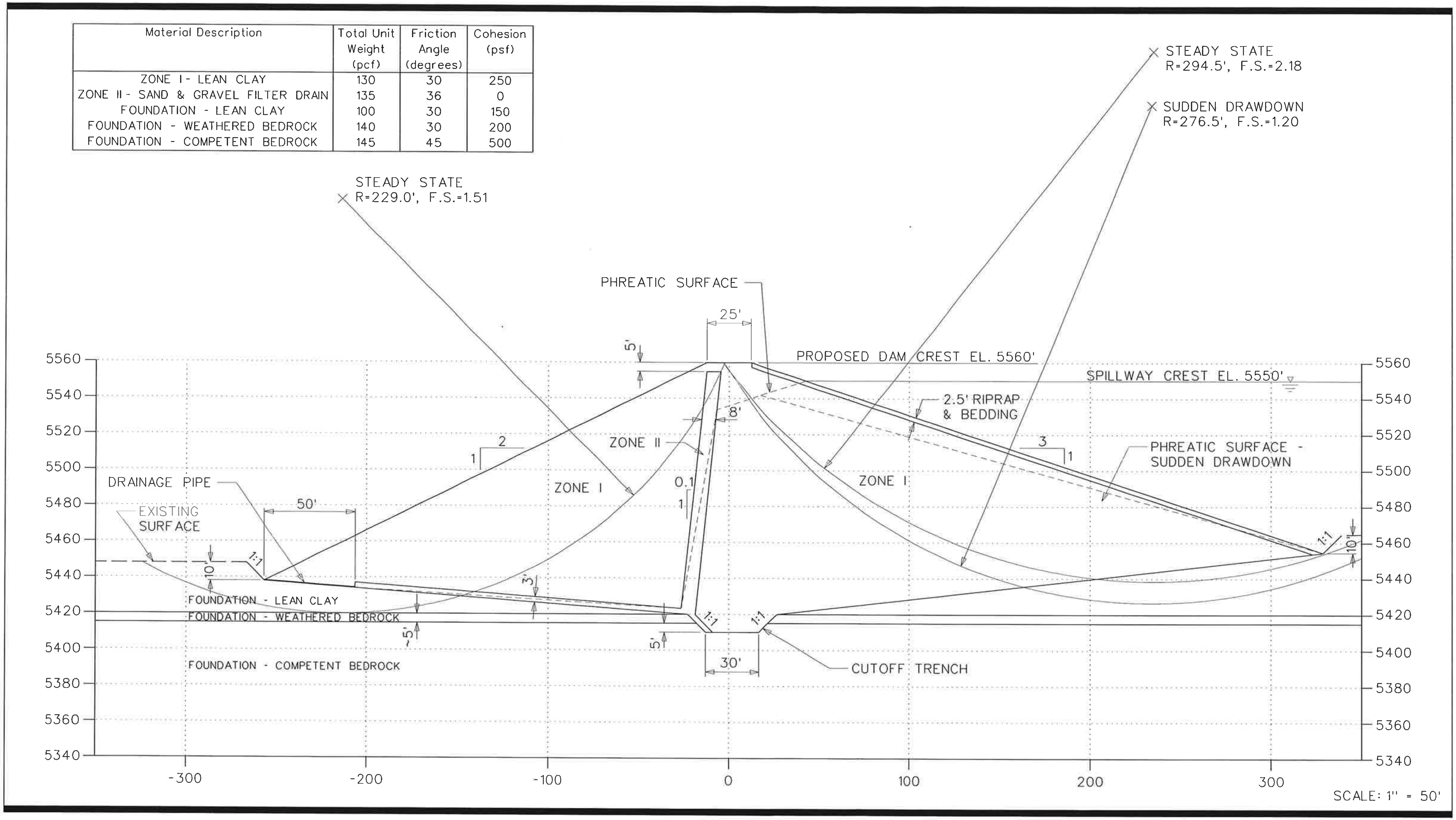


Figure 6

RB&G ENGINEERING INC.
Provo, Utah

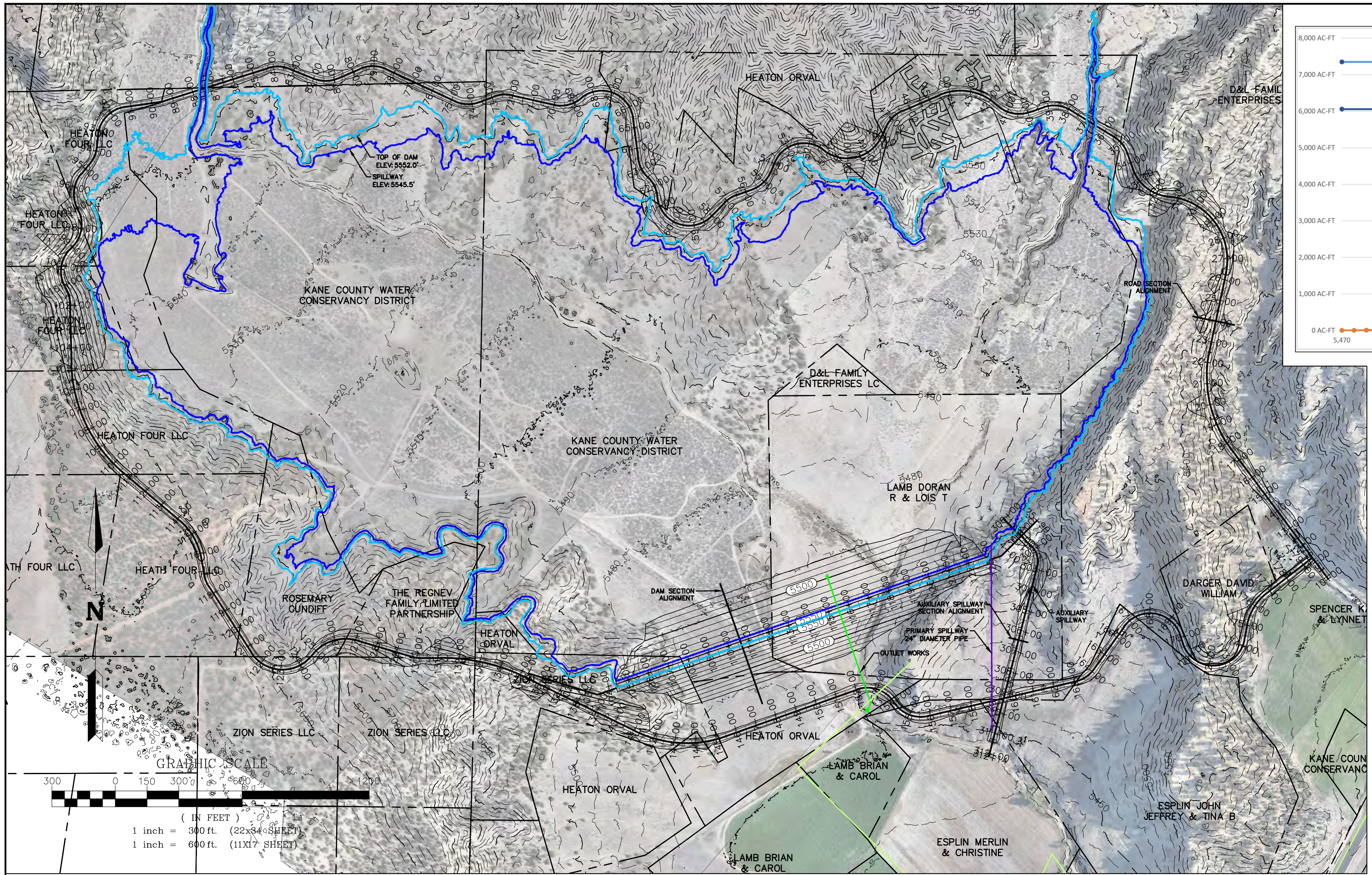
COVE DAM
Orderville, Utah

Maximum Dam Section – Station 10+40

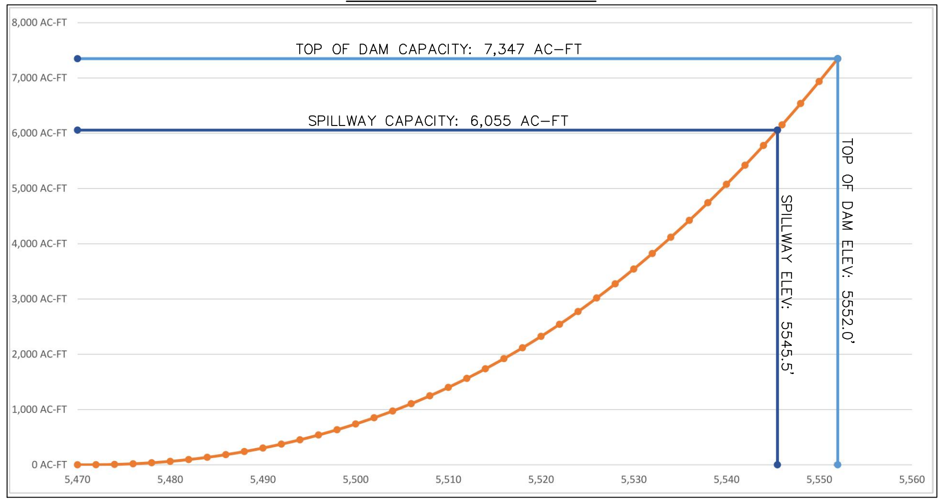
APPENDIX E-16

CONCEPT DESIGN DRAWINGS

P:\357-21 KCWCD Cove Reservoir Environmental and Design\Drawings\Exhibit Drawings\357-21 Overall EXH.dwg, 8/5/2019 11:40:53 AM

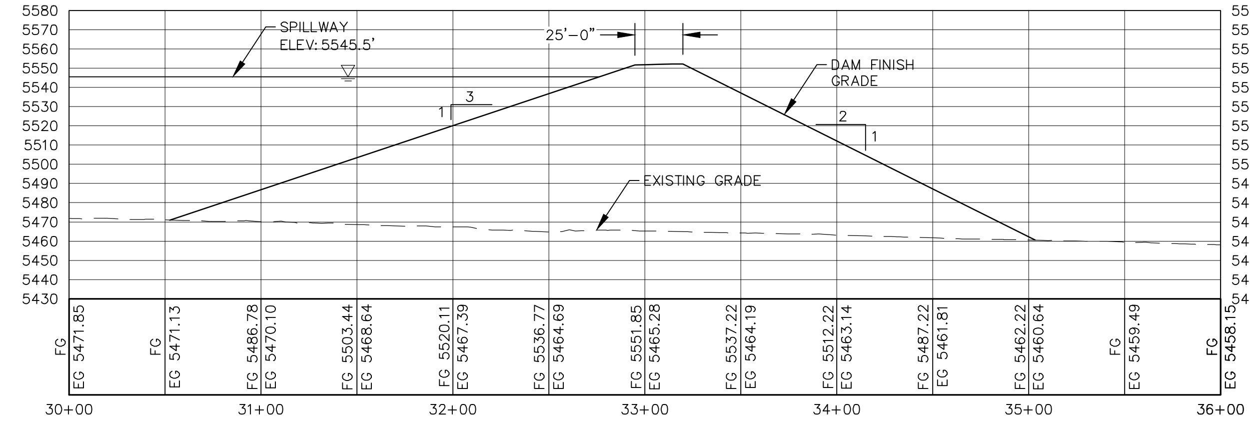


STAGE-STORAGE CURVE

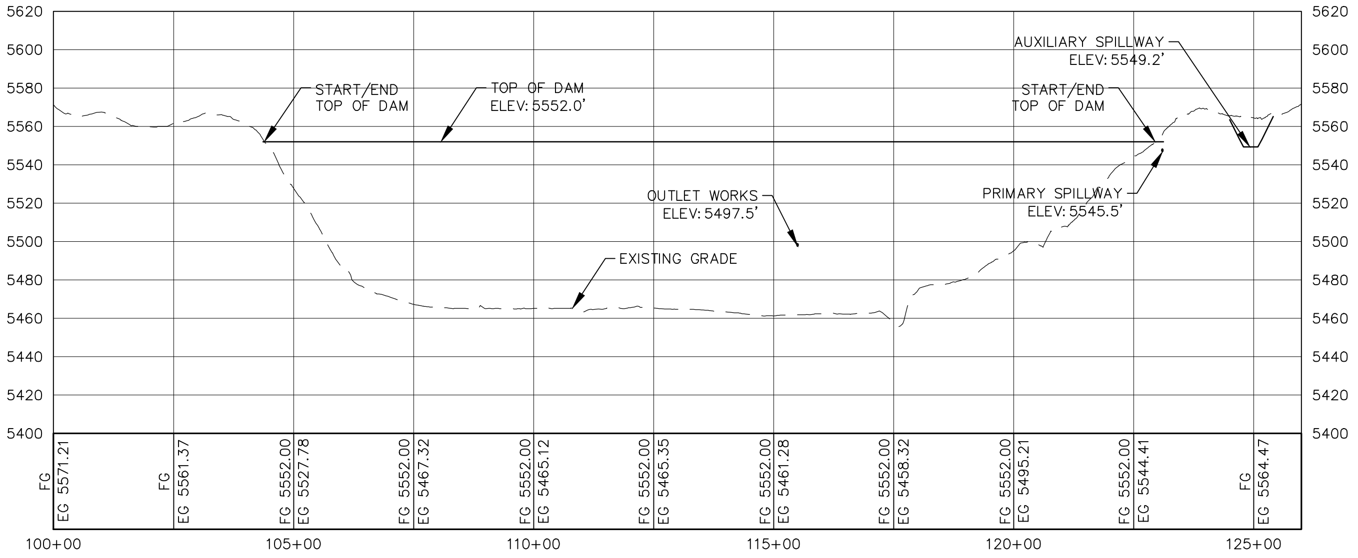


STAGE-STORAGE TABLE

ELEVATION	AREA, AC	VOLUME, AC-FT
5,466	0.00	0.00
5,468	0.02	0.02
5,470	0.13	0.18
5,472	1.68	1.99
5,474	4.07	7.74
5,476	6.77	18.58
5,478	11.20	36.54
5,480	14.53	62.26
5,482	18.32	95.11
5,484	22.19	135.62
5,486	26.14	183.95
5,488	29.87	239.95
5,490	33.57	303.40
5,492	37.23	374.20
5,494	41.28	452.71
5,496	45.36	539.35
5,498	49.59	634.30
5,500	54.14	738.03
5,502	58.79	850.95
5,504	63.64	973.38
5,506	68.52	1,105.55
5,508	73.59	1,247.65
5,510	78.85	1,400.09
5,512	84.15	1,563.09
5,514	89.59	1,736.82
5,516	95.09	1,921.50
5,518	100.30	2,116.89
5,520	105.82	2,323.02
5,522	112.68	2,541.52
5,524	119.15	2,773.35
5,526	125.03	3,017.53
5,528	131.10	3,273.65
5,530	137.23	3,541.97
5,532	143.52	3,822.72
5,534	150.00	4,116.24
5,536	156.26	4,422.50
5,538	162.83	4,741.60
5,540	169.38	5,073.81
5,542	175.81	5,419.00
5,544	182.25	5,777.07
5,545.5	**188.36**	**6,055.03**
5,546	189.85	6,149.18
5,548	196.21	6,535.24
5,550	203.47	6,934.92
5,552	**208.79**	**7,347.18**



DAM SECTION
HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 100'



DAM PROFILE
HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 100'

NO.	DATE	BY	DESCRIPTION

REVISIONS

ALPHA ENGINEERING
43 South 100 East, Suite 100 • St George, Utah 84770
T: 435.628.6500 • F: 435.628.6553 • alphaengineering.com

TITLE
PRELIMINARY DESIGN EXHIBIT

PROJECT
COVE RESERVOIR
KANE COUNTY WATER CONSERVANCY DISTRICT

PROJECT # 357-21
NAME JTM
DATE AUGUST 2, 2019
SCALE AS NOTED

SHEET
1
1 OF 1

FILE
357-21 Overall EXH.dwg

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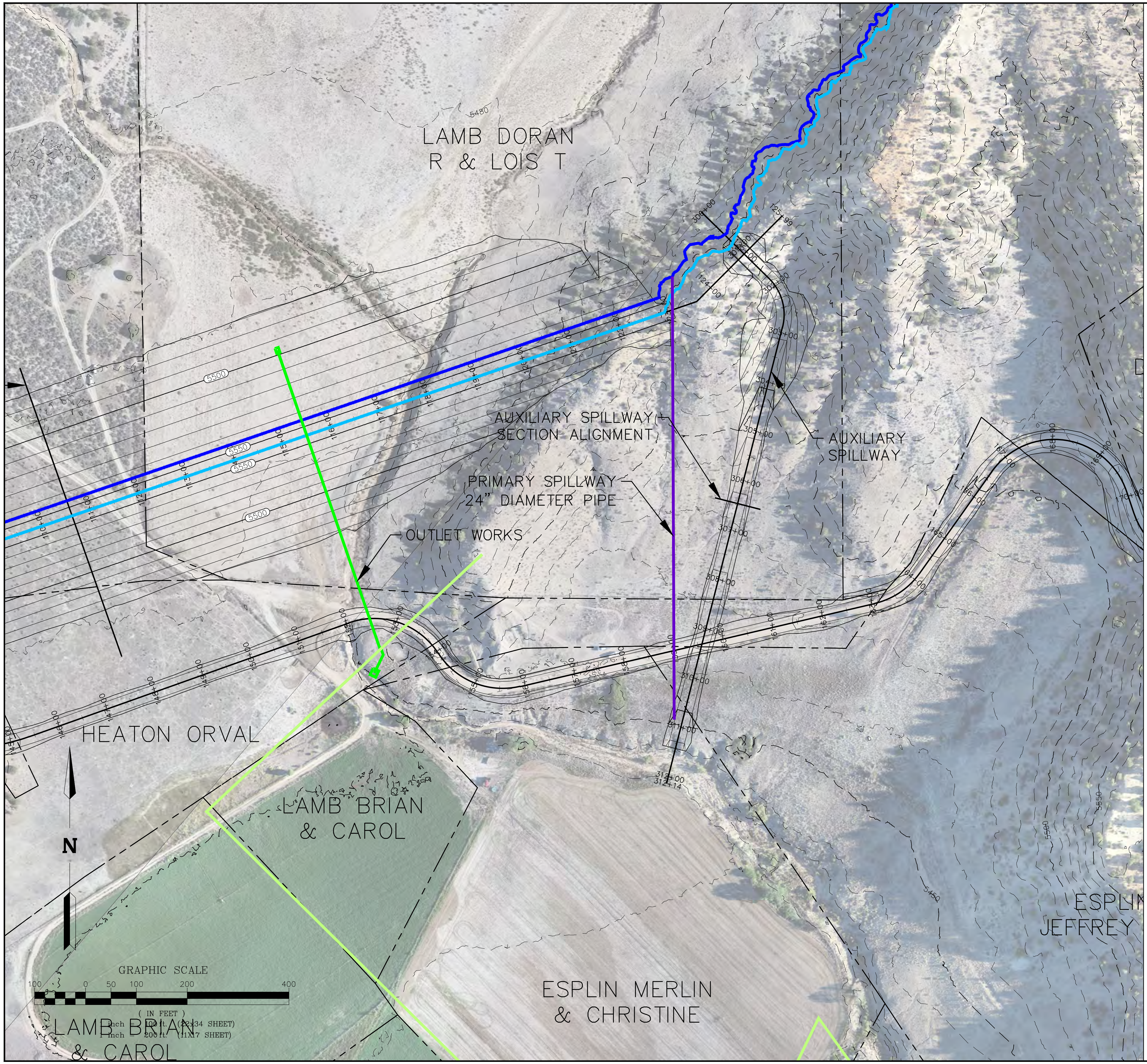
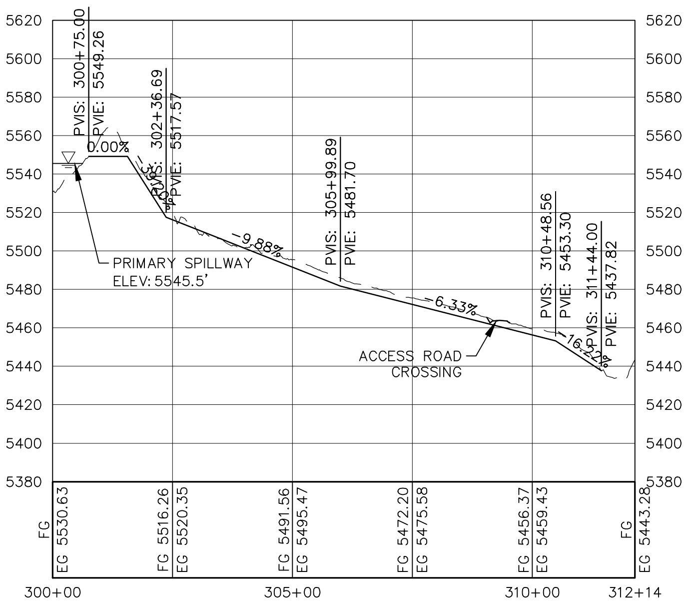
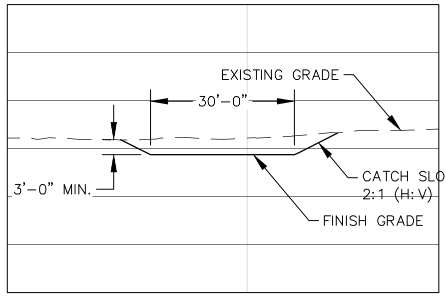




AUXILIARY SPILLWAY PROFILE
HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 100'



AUXILIARY SPILLWAY SECTION
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 40'

NO.	DATE	BY	DESCRIPTION

REVISIONS

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TITLE
PRELIMINARY SPILLWAY AND
OUTLET WORKS DESIGN EXHIBIT

PROJECT
COVE RESERVOIR
KANE COUNTY WATER CONSERVANCY DISTRICT

PROJECT # 357-21
NAME JTM
DATE AUGUST 2, 2019
SCALE AS NOTED

SHEET
1
1 OF 1

FILE
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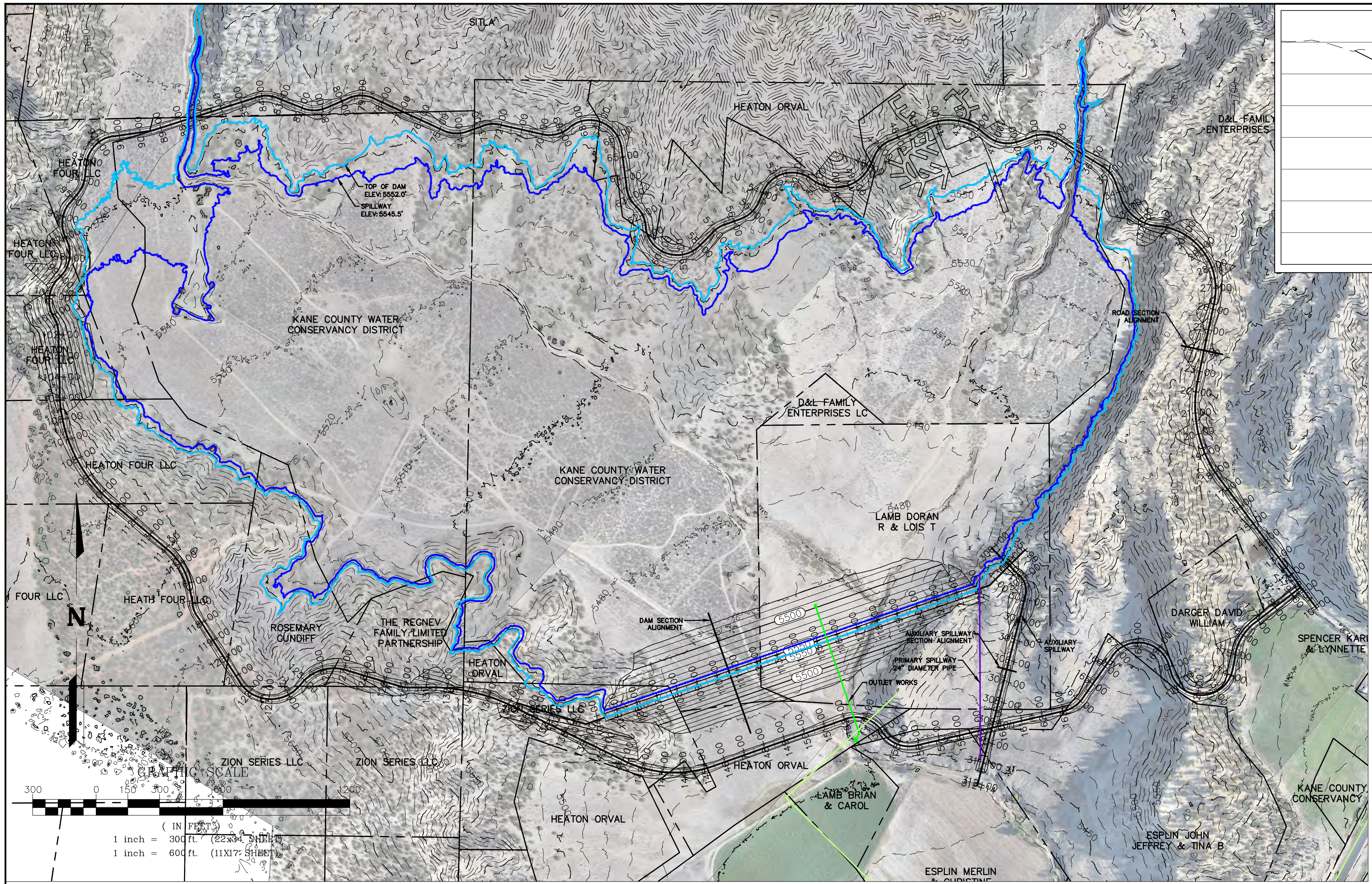
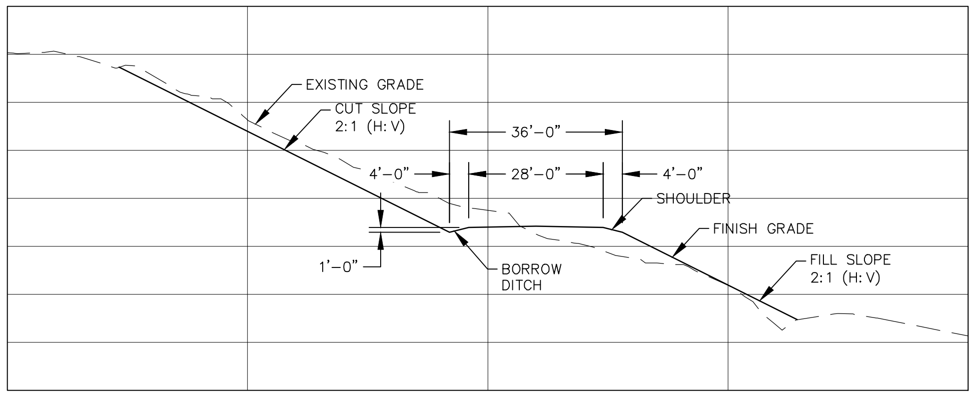
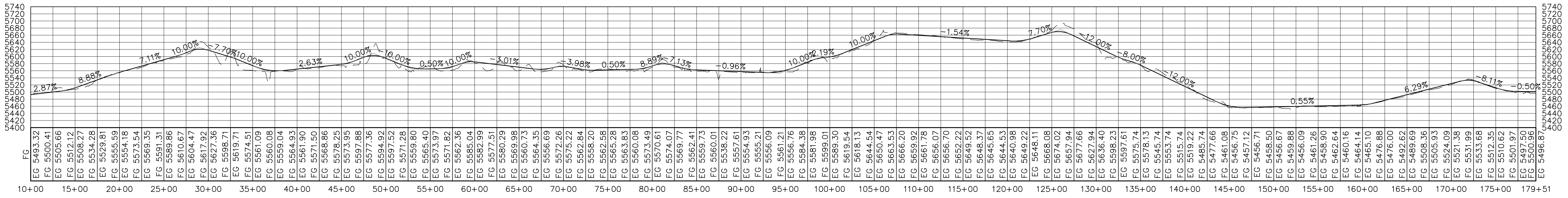




TYPICAL ROAD SECTION
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 40'

ROAD DESIGN CRITERIA

DESIGN SPEED: 25 MPH
HORIZONTAL CURVE RADIUS: 150' MIN
VERTICAL CURVE, SAG K: 26
VERTICAL CURVE, CREST K: 12



ROAD PROFILE
HORIZONTAL SCALE: 1" = 1200' (11x17)
VERTICAL SCALE: 1" = 300'

NO.	DATE	BY	DESCRIPTION

REVISIONS

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TITLE
PRELIMINARY ACCESS ROAD DESIGN EXHIBIT

PROJECT
COVE RESERVOIR
KANE COUNTY WATER CONSERVANCY DISTRICT

PROJECT # 357-21
NAME JTM
DATE AUGUST 2, 2019
SCALE AS NOTED
SHEET 1
1 OF 1
FILE 357-21 Overall EXH.dwg

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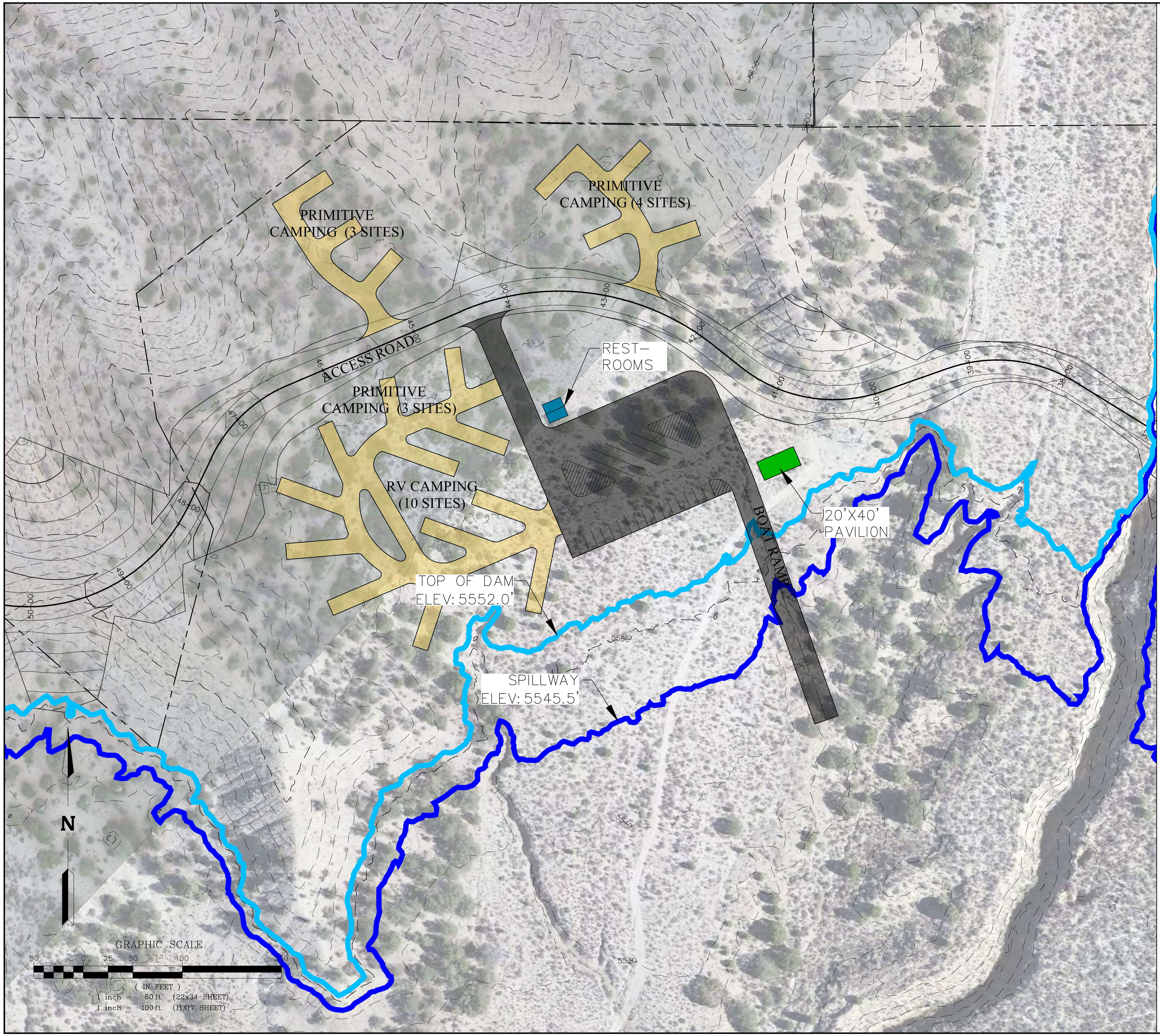


NO.	DATE	BY	DESCRIPTION

REVISIONS

ALPHA ENGINEERING

43 South 100 East, Suite 100 • St George, Utah 84770
T: 435.628.6500 • F: 435.628.6553 • alphaengineering.com

TITLE

PRELIMINARY RECREATION PLAN DESIGN EXHIBIT

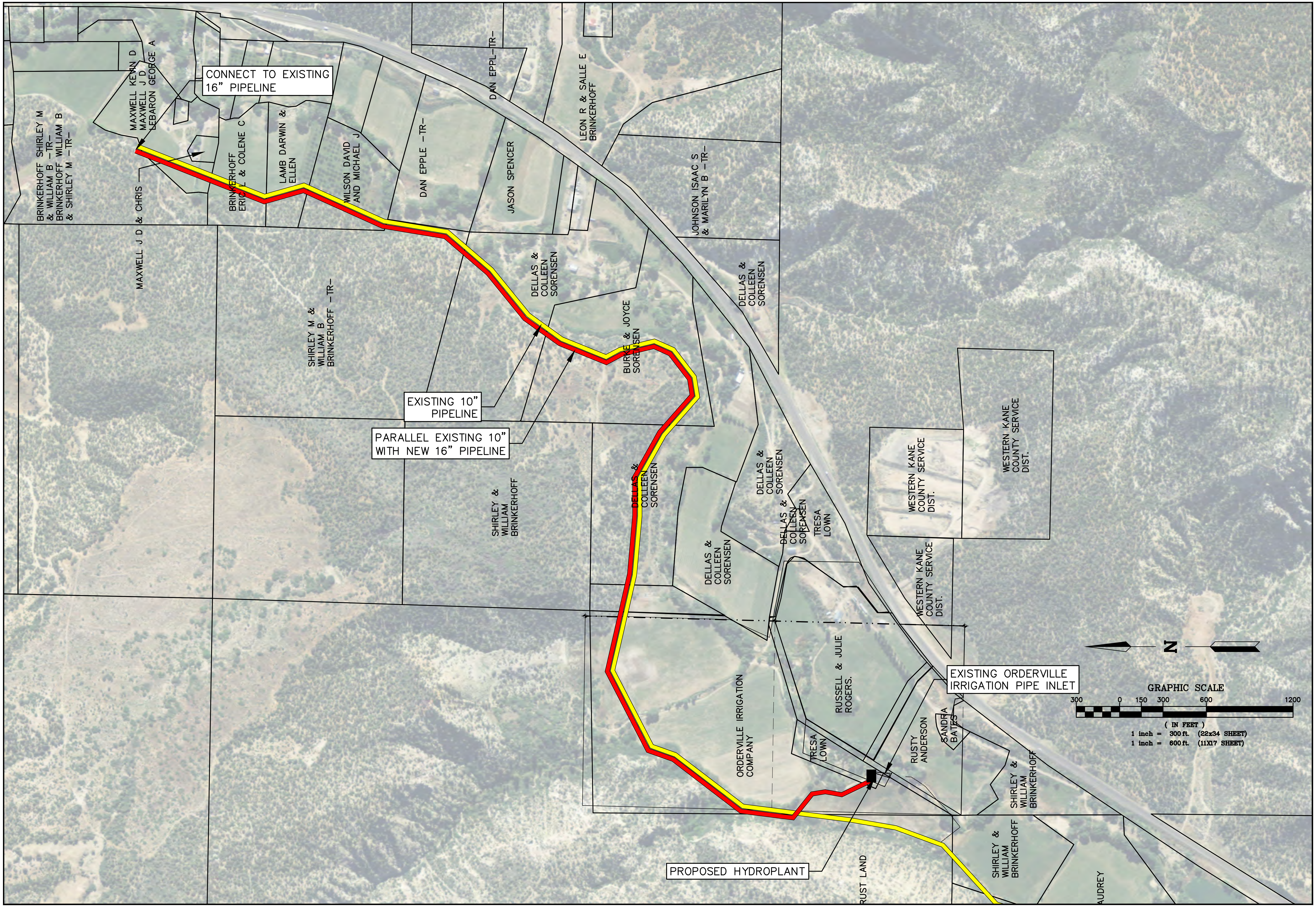
PROJECT

COVE RESERVOIR
KANE COUNTY WATER CONSERVANCY DISTRICT

PROJECT # 357-21
NAME JTM
DATE AUGUST 2, 2019
SCALE AS NOTED

SHEET 1
1 OF 1

FILE 357-21 Overall EXH.dwg



NO. DATE BY DESCRIPTION

REVISIONS

ALPHA ENGINEERING

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TITLE
GLENDALE IRRIGATION EXHIBIT
COVE RESERVOIR

PROJECT
KANE COUNTY WATER CONSERVANCY DISTRICT

PROJECT #
357-18

NAME
JSB

DATE
MAY 16, 2018

SCALE
AS NOTED

SHEET
1
1 OF 1

FILE
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jmadsen, DWG To PDF.pc3

APPENDIX E-17

SITES EROSION ANALYSIS

RB&G
ENGINEERING, INC.

1435 West 820 North
Provo, Utah 84601
801-374-5771 Provo
801-521-5771 Salt Lake City
801-374-5773 Fax

Cove Reservoir
SITES Analysis

Kane County, Utah

MEMORANDUM

To: Brent Gardner, P.E.

From: Brandon Horrocks, P.E.

Date: November 13, 2019

This memorandum describes auxiliary spillway stability and integrity analyses performed for the proposed Cove Dam, located in Kane County, Utah. The purpose of these analyses was to evaluate if the planned auxiliary spillway to be excavated into the native materials near the left abutment of the dam will meet NRCS stability and integrity design requirements. It is anticipated that this memorandum will be included in Appendix D of the project Environmental Assessment, and that the studies and documents referenced herein, such as the hydrological analyses, 2004 Cove Dam Feasibility Study, and preliminary design drawings will also be included in Appendix D, and the reader will have access to these documents for reference.

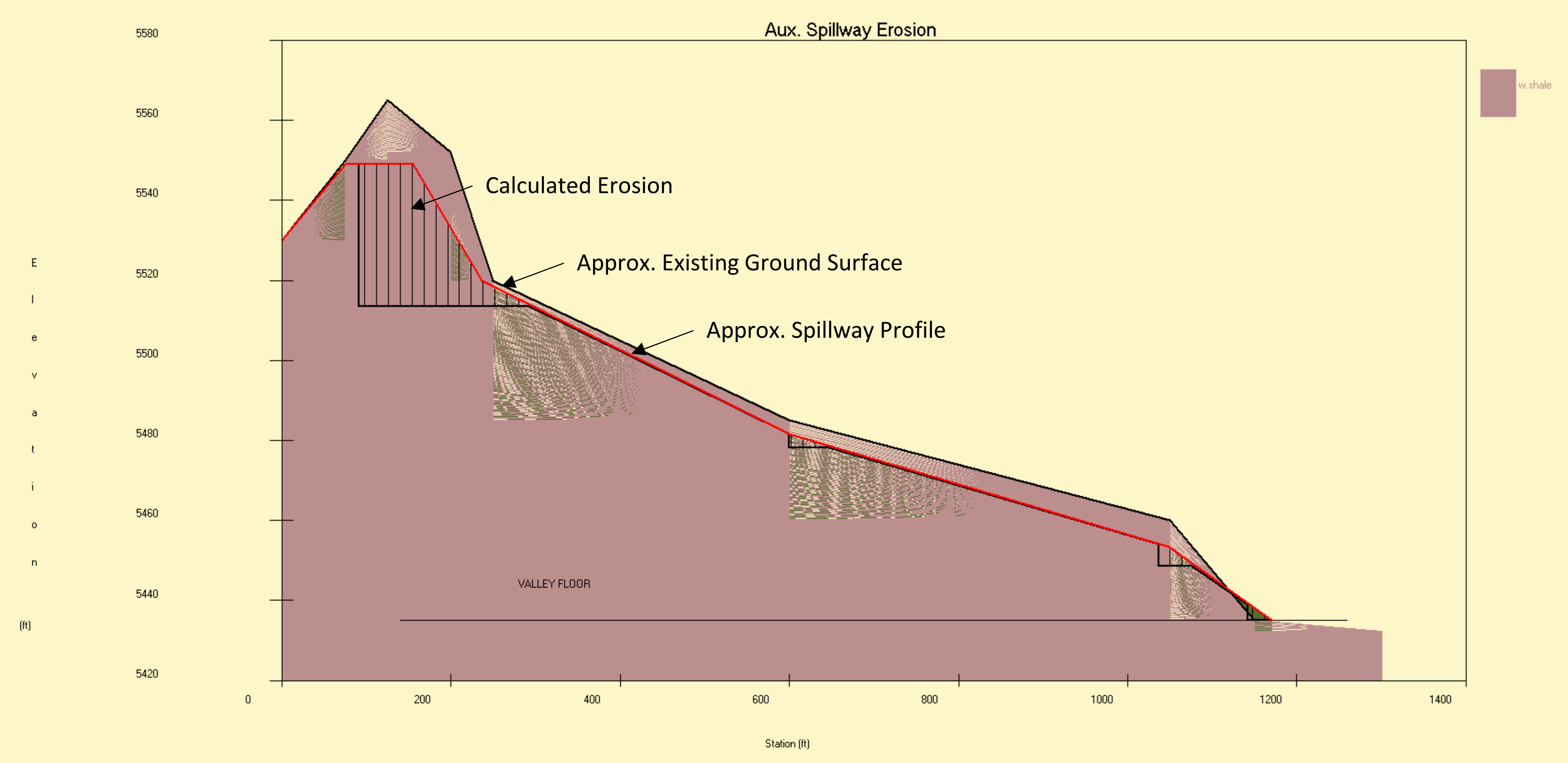
Flood routing and spillway evaluation analyses were performed for the calculated Stability Design Hydrograph (SDH) and Freeboard Hydrograph (FBH). The reservoir inflow hydrographs were provided to us by Alpha Engineering. The calculated SDH and FBH provided to us have peak reservoir inflows of 1,516 and 3,524 cfs, respectively. Routing analyses performed indicated that the SDH can be routed through the proposed Cove Reservoir and principal spillway without use of the auxiliary spillway; therefore, no erosion within the auxiliary spillway 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 auxiliary spillway while passing the FBH was performed using the NRCS SITES computer program (version 2015.1.8). The calculated peak flow through the auxiliary spillway while routing the FBH through the reservoir is 378 cfs. NRCS requires that the spillway be designed to not breach during passage of the FBH.

The boring completed on the left abutment nearest the proposed auxiliary spillway 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 existing ground surface and proposed spillway profile along the planned auxiliary spillway alignment were inputted into the SITES model. The existing topography along the planned spillway is as steep as about 1.5H:1V (Horizontal:Vertical). The planned spillway profile will require excavation into the native subsurface materials, resulting in spillway flowline grades as steep as about 3H:1V.

The results of the SITES analysis are illustrated on the attached output graphic, and it will be noted that the estimated erosion as a result of the FBH does not result in a spillway breach. The results of the analysis indicate that NRCS auxiliary spillway integrity requirements are satisfied.

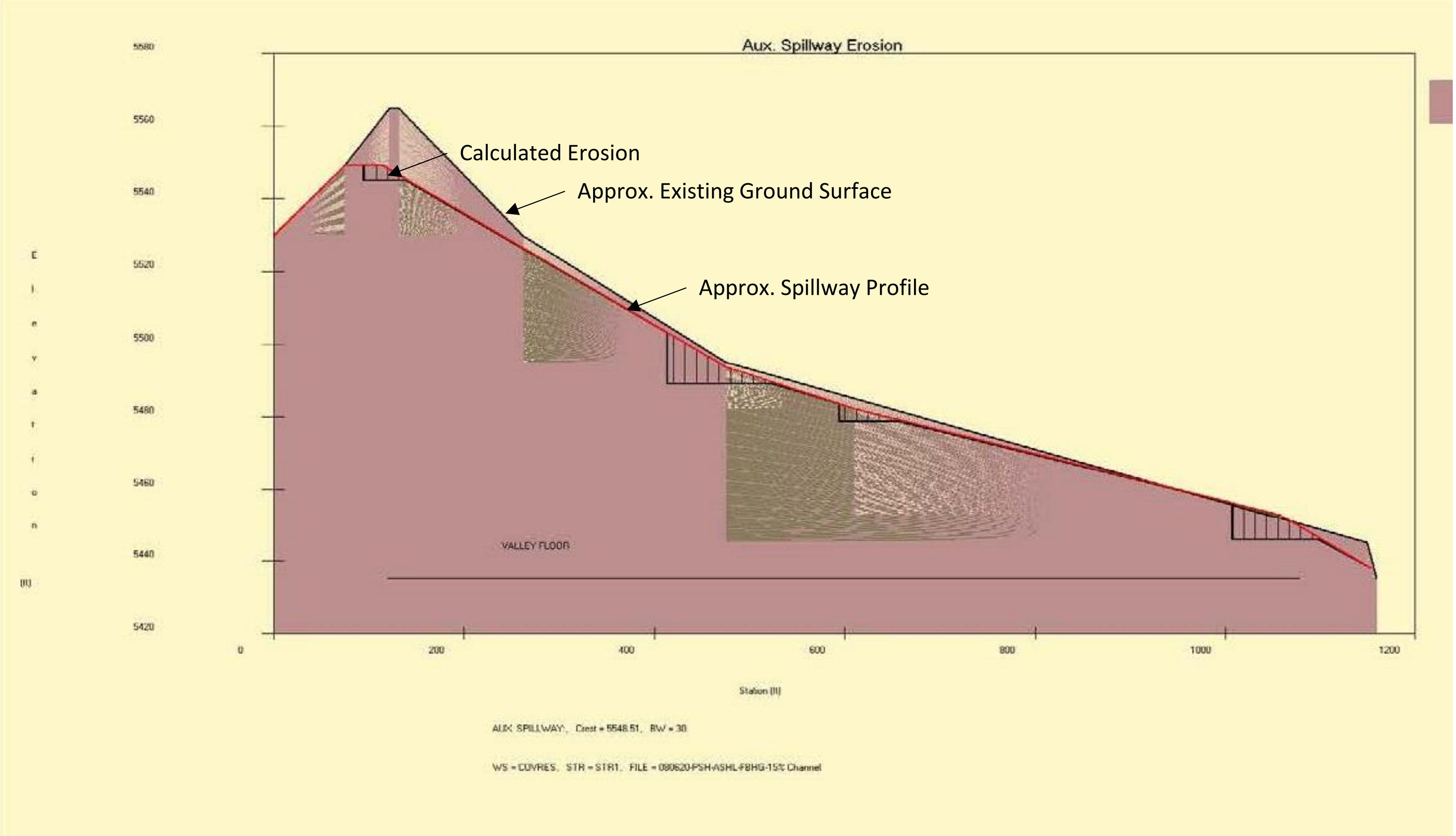
We appreciate the opportunity to provide this service to you. Please feel free to contact us if you have any questions.



Calculated Erosion

Approx. Existing Ground Surface

Approx. Spillway Profile



Calculated Erosion

Approx. Existing Ground Surface

Approx. Spillway Profile

```
*******************************************************************************
SITES XEQ 08/28/2020   WATER RESOURCE SITE ANALYSIS COMPUTER PROGRAM
     VER 2005.1.8            (USER MANUAL - DATED DECEMBER 2005)
     TIME 16:21:21

************************* 80-80 LIST OF INPUT Data *************************

SITES     01/01/2005COVRES    COV RES                       4.74      C3
SAVMOV    0    101
SAVMOV    101  1                                                      1
STRUCTURE STR1      Cove Res
                    5470                                    0.18
                    5480                                    62.26
                    5490                                    303.40
                    5500                                    738.03
                    5510                                    1400.09
                    5520                                    2323.02
                    5530                                    3541.97
                    5540                                    5073.81
                    5545.5                                  6055.03
                    5550                                    6934.92
                    5552                                    7347.18
                    5552.5                                  7450.25
ENDTABLE
HYD       1                   Principal Spillway
                    1
                    0         11        14        15        15
                    15        15        15        15        15
                    15        16        16        16        16
                    16        16        16        16        16
                    16        17        17        17        17
                    17        17        17        17        17
                    17        18        18        18        18
                    18        18        18        18        19
                    19        19        19        19        19
                    20        20        20        20        20
                    20        21        21        21        21
                    21        21        22        22        22
                    22        23        23        23        23
                    24        24        24        24        25
                    25        25        26        26        26
                    27        27        27        28        28
                    29        29        29        30        30
                    31        31        32        33        33
                    34        35        35        36        37
                    38        39        40        41        42
                    43        45        46        48        49
                    51        53        56        58        61
                    65        69        74        80        87
                    96        109       127       157       219
                    850       479       259       172       132
                    111       98        88        81        75
                    70        65        62        59        56
                    54        51        50        48        46
                    45        43        42        41        40
                    39        38        37        36        35
                    35        34        33        33        32
                    32        31        30        30        29
                    29        29        28        28        27
```

```
                    27        27        26        26        26
                    25        25        25        24        24
                    24        24        23        23        23
                    23        22        22        22        22
                    22        21        21        21        21
                    21        20        20        20        20
                    20        20        19        19        19
                    19        19        19        19        18
                    18        18        18        18        18
                    18        17        17        17        17
                    17        17        17        17        17
                    17        16        16        16        16
                    16        16        16        16        16
                    16        15        15        15        15
                    15        15        15        15        15
                    15        4         1
ENDTABLE
HYD       3                   Auxiliary Spillway (Local)
                    0.3
                    0         0         0         0         0
                    6         39        194       687       1365
                    2027      2180      1955      1683      1441
                    1248      1107      1001      924       874
                    833       748       589       423       283
                    180       112       73        47        28
                    16        9         5         3         1
                    1         0
ENDTABLE
HYD       5                   Freeboard (General)
                    1.2
                    0         0         4         35        84
                    195       425       1352      3365      3296
                    2008      1331      1060      912       792
                    742       664       624       613       611
                    547       262       90        24        5
                    1         0
ENDTABLE
WSDATA    2C CR               4.74
PDIRECT                                 9.40      16.00
POOLDATA  ELEV                5545.5              5552      5435      SC
PSINLET             1         3.75
PSDATA    1         1000      30                  0.012     5450
ASSPRFL   41
          0         5530      75        5549.2    115       5549.2
          475       5493.8    610       5482.3    1057      5453
          1153      5438
ENDTABLE
ASSURFACE 41        1170      1
          0         1170      .025      0         1
ENDTABLE
ASDATA    41                            2                             1
BTMWIDTH  FEET      30
ASMATERIAL
          1         50        1         75        115       .25
ENDTABLE
ASCOORD    1        W.Shale   N
          0         5530      75        5549.3    122       5565
          132       5565      262       5530      475       5495
          1150      5445      1155      5440      1160      5435
```

```
 ENDTABLE
 GRAPHICS  I
 GO,DESIGN LCPIO     TYPE2     24
 SAVMOV    2    101  1                   STR1
 ENDJOB

 ******************************************************************************

 ***** MESSAGE - DEFAULT TOPSOIL FILL MATERIAL PARAMETERS USED.

 ***** MESSAGE - AUXILIARY SPILLWAY CREST ELEVATION IS SET TO  5549.20
                 FROM THE ASSPRFL RECORDS.

 ***** MESSAGE - VALUES FROM ASSURFACE, REACH  1 IMPLY NO VEGETAL COVER WITH
                 "n" OF 0.025.


1SITES -------------------------------------------------------------------------
 XEQ 08/28/2020                   COV RES                        WSID= COVRES
 VER 2005.1.8                       Cove Res                       SUBW= CR
 TIME 16:21:21            SITE = STR1              PASS=    1     PART=   1



 **********************    MATERIAL PROPERTIES    ****************************
                                DRY                 PERCENT       DETACH.      REP.
      MATERIAL       PI     DENSITY         Kh        CLAY          RATE      DIAMETER
                            lbs/CuFt                             (Ft/H)/(lb/SqFt)  inches
    W.Shale        50.       115.       0.25        75.0          --        1.00000
    TS_FILL         0.       100.       0.05         0.0          --        0.05000
    GEN_FILL       50.       115.       0.25        75.0          --        1.00000

 ***************************    BASIC Data    *********************************
 HUMID- SUBHUMID CLIMATE AREA                        DESIGN CLASS  C

 INFLOW HYDROGRAPH(S) ENTERED

 PRECIP. - Q-PS,1-DAY    Q-PS,10-DAY       P-SD          P-FB
              0.00          0.00           9.40         16.00

 WSDATA -       CN          DA-SM          TC/L           -/H           QRF
              0.00          4.74           0.00          0.00          0.00

 SITEDATA- PERM POOL     CREST PS        FP SED        VALLEY FL         378?
              0.00        5545.50          0.00        5435.00            NO

          BASEFLOW      INITIAL EL     EXTRA VOL      SITE TYPE
              0.00          0.00           0.00         DESIGN

 PSDATA -  NO. COND        COND L         DIA/W           -/H
              1.00        1000.00         30.00          0.00

               PS N            KE         WEIR L         TW EL
             0.012          1.00           3.75       5450.00

           2ND STG          ORF H          ORF L      START AUX.
              0.00          0.00           0.00          0.00

 ASCRESTS -   AUX.1          AUX.2          AUX.3          AUX.4          AUX.5
```

```
            5549.20          0.00          0.00           0.00          0.00

 AUX.Data -  REF.NO.    RETARD. Ci   TIE STATION    INLET LENGTH
                 41          0.00        115.00              0

 AUX.Data - INLET N     SIDE SLOPE       EXIT N      EXIT SLOPE     ACTUAL AUX?
             0.025          2.00         0.025          0.154            NO

 BTM WIDTH -    BW1            BW2           BW3            BW4           BW5
   ft        30.00          0.00          0.00           0.00          0.00

 AUXILIARY SPILLWAY RATING DEVELOPED USING WSPVRT.

1********************     DETAILED LIST OF BASIC Data     ********************
 WEIR COEF. FOR ORIFICES.......... 3.10    RATIO OF Ia TO S (CH.10,NEH4). 0.20
 WEIR COEF. FOR DROP INLET........ 3.10    TIME INCS TO PEAK OF UNIT HYD.  10.
 DISCHARGE COEF. FOR ORIFICES..... 0.60    NO. POINTS FOR DESIGN HYD. ... 5000

 HOOD, WEIR INLET COEF. .......... 0.60    DRAWDOWN TIME LIMIT - DAYS.... 10.0
 HOOD, PIPE ENTRANCE COEF. ....... 0.60    DRAWDOWN RATIO STORAGE LIMIT.. 0.15
 HOOD, SLUG FLOW COEF. ........... 0.00    OTHER DRAWDOWN RATIOS APPLY ?.   NO

 PS ACCURACY OF FULL FLOW CALC.,FT 0.01    WSP ALLOWABLE FSS VEL. CHANGE. 0.05
 FILLET SIZE FOR BOX CONDUITS..... 6.00    WSP FSS CALC. PRECISION, FT.. 0.005

 GRAVITATIONAL CONSTANT.......... 32.16    AUX. SPILLWAY MIN. CAP. COEF. 237.0
 MIN. NHCP378 PS PIPE AREA SQFT.. 0.545    AUX. SPILLWAY MIN. CAP. EXP.  0.493

 MIN. TR60 DEPTH AUX. TO TOP DAM.. 3.00    MIN. AUX. BW IN BW SOLUTION,FT 20.0
 MIN. NHCP378 DEPTH AUX.TO TOP DAM 2.00    PRECISION OF BW SOLUTION......  1.0
 MIN. NHCP378 DEPTH PS - AUX.CREST 1.00    OLD TR60 CRITERIA USED .......   NO
 MIN. NHCP378 DEPTH DESIGN Q - TOD 1.00    OLD NHCP378 CRITERIA USED ....   NO

 EMBANKMENT TEMPLATE:  TOP WIDTH = (calc.),  MAX. CROWN = 0.667 ft,
 SIDE SLOPE   WAVE BERM   MULTIPLE STABILITY BERMS    SEPARATE STABILITY BERMS
    RATIOS      WIDTH      U&D/S WIDTHS   DELTA H     WIDTHS, ft   HEIGHTS, ft
   U/S  D/S      ft             ft          ft          U/S   D/S    U/S   D/S
  2.50 2.50      10.0           0.0        0.00        0.00  0.00   0.00  0.00


 DIMENSIONLESS UNIT HYDROGRAPH
 STANDARD DIMENSIONLESS UNIT HYDROGRAPH
 PEAK FACTOR = 484.0 | TIME INC. =0.020 | NO. INC. TO PEAK =  10.
 VOLUME FACTOR =  48.3429

      0.0000     0.0300     0.1000     0.1900     0.3100
      0.4700     0.6600     0.8200     0.9300     0.9900
      1.0000     0.9900     0.9300     0.8600     0.7800
      0.6800     0.5600     0.4600     0.3900     0.3300
      0.2800     0.2410     0.2070     0.1740     0.1470
      0.1260     0.1070     0.0910     0.0770     0.0660
      0.0550     0.0470     0.0400     0.0340     0.0290
      0.0250     0.0210     0.0180     0.0150     0.0130
      0.0110     0.0090     0.0080     0.0070     0.0060
      0.0050     0.0040     0.0030     0.0020     0.0010
      0.0000

 EXISTING NATURAL SURFACE AT AUXILIARY SPILLWAY SITE - X,Y COORDINATES:
```

```
                 0.     5530.00
                75.     5549.30
               122.     5565.00
               132.     5565.00
               262.     5530.00
               475.     5495.00
              1150.     5445.00
              1155.     5440.00
              1160.     5435.00


1NRCS DESIGN STORM RAINFALL DISTRIBUTION  (CHAPTER 21, NEH4 & TR-60).

       0.000      0.008      0.016      0.025      0.033
       0.043      0.052      0.063      0.074      0.086
       0.099      0.112      0.126      0.142      0.160
       0.180      0.205      0.255      0.345      0.437
       0.530      0.603      0.633      0.660      0.684
       0.705      0.724      0.742      0.759      0.775
       0.790      0.804      0.818      0.831      0.844
       0.856      0.868      0.879      0.890      0.900
       0.910      0.920      0.930      0.939      0.948
       0.957      0.966      0.975      0.983      0.992
       1.000


 24 HOUR TYPE II RAINFALL DISTRIBUTION
 IDENTIFICATION NAME IS TYPE2  GIVEN DURATION =  24.0 HRS

       0.000      0.001      0.002      0.003      0.004
       0.005      0.006      0.007      0.008      0.009
       0.010      0.012      0.013      0.014      0.015
       0.016      0.017      0.018      0.020      0.021
       0.022      0.023      0.024      0.026      0.027
       0.028      0.029      0.031      0.032      0.033
       0.034      0.036      0.037      0.038      0.040
       0.041      0.042      0.044      0.045      0.047
       0.048      0.049      0.051      0.052      0.054
       0.055      0.057      0.058      0.060      0.061
       0.063      0.065      0.066      0.068      0.070
       0.071      0.073      0.075      0.076      0.078
       0.080      0.082      0.084      0.085      0.087
       0.089      0.091      0.093      0.095      0.097
       0.099      0.101      0.103      0.105      0.107
       0.109      0.111      0.113      0.116      0.118
       0.120      0.122      0.125      0.127      0.130
       0.132      0.135      0.138      0.141      0.144
       0.147      0.150      0.153      0.157      0.160
       0.163      0.166      0.170      0.173      0.177
       0.181      0.185      0.189      0.194      0.199
       0.204      0.209      0.215      0.221      0.228
       0.235      0.243      0.251      0.261      0.271
       0.283      0.307      0.354      0.431      0.568
       0.663      0.682      0.699      0.713      0.725
       0.735      0.743      0.751      0.759      0.766
       0.772      0.778      0.784      0.789      0.794
       0.799      0.804      0.808      0.812      0.816
       0.820      0.824      0.827      0.831      0.834
       0.838      0.841      0.844      0.847      0.850
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       0.854      0.856      0.859      0.862      0.865
       0.868      0.870      0.873      0.875      0.878
       0.880      0.882      0.885      0.887      0.889
       0.891      0.893      0.895      0.898      0.900
       0.902      0.904      0.906      0.908      0.910
       0.912      0.914      0.915      0.917      0.919
       0.921      0.923      0.925      0.926      0.928
       0.930      0.931      0.933      0.935      0.936
       0.938      0.939      0.941      0.942      0.944
       0.945      0.947      0.948      0.949      0.951
       0.952      0.953      0.955      0.956      0.957
       0.958      0.960      0.961      0.962      0.964
       0.965      0.966      0.967      0.968      0.970
       0.971      0.972      0.973      0.975      0.976
       0.977      0.978      0.979      0.981      0.982
       0.983      0.984      0.985      0.986      0.988
       0.989      0.990      0.991      0.992      0.993
       0.994      0.996      0.997      0.998      0.999
       1.000


1SITES -------------------------------------------------------------------------
 XEQ 08/28/2020                    COV RES                        WSID= COVRES
 VER 2005.1.8                        Cove Res                       SUBW= CR
 TIME 16:21:21            SITE = STR1              PASS=    1     PART=   2

MESSAGE ---- Climatic Index changed from 0.0 to 1.0 for this run.

 CREST PS       5545.50 FT    6055.0 ACFT      0.00 AC     126.3 CFS

 SED ACCUM      5545.50 FT    6055.0 ACFT      0.00 AC     126.3 CFS

 START ELEV     5545.50 FT    6055.0 ACFT      0.00 AC       0.0 CFS

 INFLOW HYDROGRAPH PROVIDED IN LOCATION  1,  PEAK=    850.00 CFS, AT 120.00 HRS.
 TITLE = Principal Spillway


 HYD       PO              4.74Cove Res                                 COVRES  1
           0             1.0000                                         STR1    2
                           0.03      0.03      0.10      0.18      0.26   PO D  3
                           0.34      0.41      0.49      0.57      0.65   PO D  4
                           0.73      0.81      0.89      0.97      1.05   PO D  5
                           1.13      1.22      1.30      1.38      1.45   PO D  6
                           1.53      1.61      1.70      1.78      1.86   PO D  7
                           1.95      2.03      2.11      2.19      2.27   PO D  8
                           2.35      2.43      2.51      2.60      2.68   PO D  9
                           2.77      2.85      2.93      3.01      3.10   PO D 10
                           3.18      3.27      3.35      3.44      3.52   PO D 11
                           3.61      3.70      3.79      3.87      3.96   PO D 12
                           4.05      4.14      4.23      4.32      4.41   PO D 13
                           4.50      4.59      4.68      4.77      4.87   PO D 14
                           4.96      5.05      5.15      5.25      5.34   PO D 15
                           5.44      5.54      5.64      5.74      5.84   PO D 16
                           5.95      6.05      6.16      6.26      6.37   PO D 17
                           6.48      6.59      6.70      6.82      6.93   PO D 18
                           7.05      7.17      7.28      7.40      7.53   PO D 19
                           7.65      7.78      7.91      8.04      8.17   PO D 20
                           8.31      8.45      8.60      8.74      8.89   PO D 21
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9.05	9.21	9.37	9.54	9.71	PO D 22
9.89	10.08	10.27	10.47	10.67	PO D 23
10.89	11.11	11.34	11.59	11.85	PO D 24
12.13	12.43	12.75	13.09	13.47	PO D 25
13.90	14.38	14.94	15.63	17.26	PO D 26
22.38	28.72	32.09	33.90	35.07	PO D 27
35.92	36.60	37.15	37.62	38.02	PO D 28
38.36	38.65	38.90	39.11	39.29	PO D 29
39.45	39.58	39.68	39.78	39.85	PO D 30
39.90	39.94	39.97	39.98	39.99	PO D 31
39.98	39.97	39.94	39.91	39.87	PO D 32
39.82	39.77	39.70	39.64	39.57	PO D 33
39.49	39.41	39.33	39.23	39.14	PO D 34
39.04	38.94	38.84	38.73	38.62	PO D 35
38.50	38.39	38.27	38.15	38.03	PO D 36
37.91	37.78	37.65	37.52	37.39	PO D 37
37.26	37.13	36.99	36.85	36.72	PO D 38
36.58	36.44	36.30	36.16	36.02	PO D 39
35.88	35.74	35.59	35.45	35.30	PO D 40
35.16	35.02	34.87	34.72	34.58	PO D 41
34.43	34.29	34.14	33.99	33.85	PO D 42
33.70	33.55	33.41	33.27	33.12	PO D 43
32.97	32.82	32.68	32.53	32.39	PO D 44
32.25	32.10	31.95	31.80	31.66	PO D 45
31.51	31.37	31.23	31.09	30.95	PO D 46
30.81	30.67	30.52	30.38	30.24	PO D 47
30.10	29.96	29.82	29.68	29.55	PO D 48
29.41	29.28	29.14	29.00	28.86	PO D 49
28.72	28.58	28.45	28.32	28.19	PO D 50
28.06	27.87	27.62	27.36	27.10	PO D 51
26.84	26.58	26.33	26.08	25.83	PO D 52
25.59	25.35	25.10	24.87	24.63	PO D 53
24.40	24.17	23.94	23.71	23.49	PO D 54
23.26	23.04	22.83	22.61	22.40	PO D 55
22.18	21.98	21.77	21.56	21.36	PO D 56
21.16	20.96	20.76	20.57	20.37	PO D 57
20.18	19.99	19.80	19.62	19.43	PO D 58
19.25	19.07	18.89	18.72	18.54	PO D 59
18.37	18.20	18.03	17.86	17.69	PO D 60
17.53	17.36	17.20	17.04	16.88	PO D 61
16.73	16.57	16.42	16.26	16.11	PO D 62
15.96	15.82	15.69	15.61	15.53	PO D 63
15.45	15.37	15.29	15.22	15.14	PO D 64
15.06	14.99	14.91	14.83	14.76	PO D 65
14.69	14.61	14.54	14.46	14.39	PO D 66
14.32	14.25	14.17	14.10	14.03	PO D 67
13.96	13.89	13.82	13.75	13.68	PO D 68
13.61	13.55	13.48	13.41	13.34	PO D 69
13.28	13.21	13.14	13.08	13.01	PO D 70
12.95	12.88	12.82	12.75	12.69	PO D 71
12.63	12.56	12.50	12.44	12.38	PO D 72
12.32	12.25	12.19	12.13	12.07	PO D 73
12.01	11.95	11.89	11.83	11.78	PO D 74
11.72	11.66	11.60	11.54	11.49	PO D 75
11.43	11.37	11.32	11.26	11.21	PO D 76
11.15	11.10	11.04	10.99	10.93	PO D 77
10.88	10.83	10.77	10.72	10.67	PO D 78
10.61	10.56	10.51	10.46	10.41	PO D 79
10.36	10.31	10.26	10.21	10.16	PO D 80

10.11	10.06	10.01	9.96	9.91	PO D 81
9.86	9.81	9.77	9.72	9.67	PO D 82
9.62	9.58	9.53	9.48	9.44	PO D 83
9.39	9.35	9.30	9.26	9.21	PO D 84
9.17	9.12	9.08	9.04	8.99	PO D 85
8.95	8.91	8.86	8.82	8.78	PO D 86
8.74	8.69	8.65	8.61	8.57	PO D 87
8.53	8.49	8.45	8.41	8.37	PO D 88
8.33	8.29	8.25	8.21	8.17	PO D 89
8.13	8.09	8.05	8.02	7.98	PO D 90
7.94	7.90	7.87	7.83	7.79	PO D 91
7.75	7.72	7.68	7.64	7.61	PO D 92
7.57	7.54	7.50	7.47	7.43	PO D 93
7.40	7.36	7.33	7.29	7.26	PO D 94
7.23	7.19	7.16	7.12	7.09	PO D 95
7.06	7.03	6.99	6.96	6.93	PO D 96
6.90	6.86	6.83	6.80	6.77	PO D 97
6.74	6.71	6.68	6.65	6.61	PO D 98
6.58	6.55	6.52	6.49	6.46	PO D 99
6.43	6.41	6.38	6.35	6.32	PO D100
6.29	6.26	6.23	6.20	6.18	PO D101
6.15	6.12	6.09	6.06	6.04	PO D102
6.01	5.98	5.96	5.93	5.90	PO D103
5.88	5.85	5.82	5.80	5.77	PO D104
5.74	5.72	5.69	5.67	5.64	PO D105
5.62	5.59	5.57	5.54	5.52	PO D106
5.49	5.47	5.45	5.42	5.40	PO D107
5.37	5.35	5.33	5.30	5.28	PO D108
5.26	5.23	5.21	5.19	5.16	PO D109
5.14	5.12	5.10	5.08	5.05	PO D110
5.03	5.01	4.99	4.97	4.94	PO D111
4.92	4.90	4.88	4.86	4.84	PO D112
4.82	4.80	4.78	4.76	4.74	PO D113
4.72	4.70	4.68	4.66	4.64	PO D114
4.62	4.60	4.58	4.56	4.54	PO D115
4.52	4.50	4.48	4.46	4.44	PO D116
4.43	4.41	4.39	4.37	4.35	PO D117
4.33	4.32	4.30	4.28	4.26	PO D118
4.24	4.23	4.21	4.19	4.17	PO D119
4.16	4.14	4.12	4.11	4.09	PO D120
4.07	4.06	4.04	4.02	4.01	PO D121
3.99	3.97	3.96	3.94	3.93	PO D122
3.91	3.89	3.88	3.86	3.85	PO D123
3.83	3.82	3.80	3.79	3.77	PO D124
3.76	3.74	3.73	3.71	3.70	PO D125
3.68	3.67	3.65	3.64	3.62	PO D126
3.61	3.60	3.58	3.57	3.55	PO D127
3.54	3.53	3.51	3.50	3.49	PO D128
3.47	3.46	3.45	3.43	3.42	PO D129
3.41	3.39	3.38	3.37	3.35	PO D130
3.34	3.33	3.32	3.30	3.29	PO D131
3.28	3.27	3.25	3.24	3.23	PO D132
3.22	3.21	3.19	3.18	3.17	PO D133
3.16	3.15	3.14	3.12	3.11	PO D134
3.10	3.09	3.08	3.07	3.06	PO D135
3.04	3.03	3.02	3.01	3.00	PO D136
2.99	2.98	2.97	2.96	2.95	PO D137
2.94	2.93	2.92	2.90	2.89	PO D138
2.88	2.87	2.86	2.85	2.84	PO D139

2.83	2.82	2.81	2.80	2.79	PO D140
2.78	2.78	2.77	2.76	2.75	PO D141
2.74	2.73	2.72	2.71	2.70	PO D142
2.69	2.68	2.67	2.66	2.65	PO D143
2.65	2.64	2.63	2.62	2.61	PO D144
2.60	2.59	2.58	2.58	2.57	PO D145
2.56	2.55	2.54	2.53	2.52	PO D146
2.52	2.51	2.50	2.49	2.48	PO D147
2.48	2.47	2.46	2.45	2.44	PO D148
2.44	2.43	2.42	2.41	2.41	PO D149
2.40	2.39	2.38	2.38	2.37	PO D150
2.36	2.35	2.35	2.34	2.33	PO D151
2.32	2.32	2.31	2.30	2.30	PO D152
2.29	2.28	2.27	2.27	2.26	PO D153
2.25	2.25	2.24	2.23	2.23	PO D154
2.22	2.21	2.21	2.20	2.19	PO D155
2.19	2.18	2.17	2.17	2.16	PO D156
2.16	2.15	2.14	2.14	2.13	PO D157
2.12	2.12	2.11	2.11	2.10	PO D158
2.09	2.09	2.08	2.08	2.07	PO D159
2.07	2.06	2.05	2.05	2.04	PO D160
2.04	2.03	2.03	2.02	2.01	PO D161
2.01	2.00	2.00	1.99	1.99	PO D162
1.98	1.98	1.97	1.97	1.96	PO D163
1.96	1.95	1.95	1.94	1.94	PO D164
1.93	1.92	1.92	1.91	1.91	PO D165
1.91	1.90	1.90	1.89	1.89	PO D166
1.88	1.88	1.87	1.87	1.86	PO D167
1.86	1.85	1.85	1.84	1.84	PO D168
1.83	1.83	1.83	1.82	1.82	PO D169
1.81	1.81	1.80	1.80	1.79	PO D170
1.79	1.79	1.78	1.78	1.77	PO D171
1.77	1.76	1.76	1.76	1.75	PO D172
1.75	1.74	1.74	1.74	1.73	PO D173
1.73	1.72	1.72	1.72	1.71	PO D174
1.71	1.70	1.70	1.70	1.69	PO D175
1.69	1.69	1.68	1.68	1.67	PO D176
1.67	1.67	1.66	1.66	1.66	PO D177
1.65	1.65	1.65	1.64	1.64	PO D178
1.64	1.63	1.63	1.63	1.62	PO D179
1.62	1.62	1.61	1.61	1.61	PO D180
1.60	1.60	1.60	1.59	1.59	PO D181
1.59	1.58	1.58	1.58	1.57	PO D182
1.57	1.57	1.56	1.56	1.56	PO D183
1.56	1.55	1.55	1.55	1.54	PO D184
1.54	1.54	1.53	1.53	1.53	PO D185
1.53	1.52	1.52	1.52	1.51	PO D186
1.51	1.51	1.51	1.50	1.50	PO D187
1.50	1.50	1.49	1.49	1.49	PO D188
1.48	1.48	1.48	1.48	1.47	PO D189
1.47	1.47	1.47	1.46	1.46	PO D190
1.46	1.46	1.45	1.45	1.45	PO D191
1.45	1.44	1.44	1.44	1.44	PO D192
1.43	1.43	1.43	1.43	1.43	PO D193
1.42	1.42	1.42	1.42	1.41	PO D194
1.41	1.41	1.41	1.41	1.40	PO D195
1.40	1.40	1.40	1.39	1.39	PO D196
1.39	1.39	1.39	1.38	1.38	PO D197
1.38	1.38	1.38	1.37	1.37	PO D198

1.37	1.37	1.37	1.36	1.36	PO D199
1.36	1.36	1.36	1.35	1.35	PO D200
1.35	1.35	1.35	1.34	1.34	PO D201
1.34	1.34	1.34	1.33	1.33	PO D202
1.33	1.33	1.33	1.33	1.32	PO D203
1.32	1.32	1.32	1.32	1.32	PO D204
1.31	1.31	1.31	1.31	1.31	PO D205
1.31	1.30	1.30	1.30	1.30	PO D206
1.30	1.30	1.29	1.29	1.29	PO D207
1.29	1.29	1.29	1.28	1.28	PO D208
1.28	1.28	1.28	1.28	1.28	PO D209
1.27	1.27	1.27	1.27	1.27	PO D210
1.27	1.27	1.26	1.26	1.26	PO D211
1.26	1.26	1.26	1.26	1.25	PO D212
1.25	1.25	1.25	1.25	1.25	PO D213
1.25	1.24	1.24	1.24	1.24	PO D214
1.24	1.24	1.24	1.24	1.23	PO D215
1.23	1.23	1.23	1.23	1.23	PO D216
1.23	1.23	1.22	1.22	1.22	PO D217
1.22	1.22	1.22	1.22	1.22	PO D218
1.21	1.21	1.21	1.21	1.21	PO D219
1.21	1.21	1.21	1.21	1.20	PO D220
1.20	1.20	1.20	1.20	1.20	PO D221
1.20	1.20	1.20	1.19	1.19	PO D222
1.19	1.19	1.19	1.19	1.19	PO D223
1.19	1.19	1.19	1.18	1.18	PO D224
1.18	1.18	1.18	1.18	1.18	PO D225
1.18	1.18	1.18	1.17	1.17	PO D226
1.17	1.17	1.17	1.17	1.17	PO D227
1.17	1.17	1.17	1.17	1.16	PO D228
1.16	1.16	1.16	1.16	1.16	PO D229
1.16	1.16	1.16	1.16	1.16	PO D230
1.15	1.15	1.15	1.15	1.15	PO D231
1.15	1.15	1.15	1.15	1.15	PO D232
1.15	1.15	1.15	1.14	1.14	PO D233
1.14	1.14	1.14	1.14	1.14	PO D234
1.14	1.14	1.14	1.14	1.14	PO D235
1.14	1.13	1.13	1.13	1.13	PO D236
1.13	1.13	1.13	1.13	1.13	PO D237
1.13	1.13	1.13	1.13	1.13	PO D238
1.12	1.12	1.12	1.12	1.12	PO D239
1.12	1.12	1.12	1.12	1.12	PO D240
1.12	1.12	1.12	1.12	1.12	PO D241
1.11	1.11	1.11	1.11	1.11	PO D242
1.11	1.11	1.11	1.11	1.11	PO D243
1.11	1.11	1.11	1.11	1.11	PO D244
1.11	1.11	1.10	1.10	1.10	PO D245
1.10	1.10	1.10	1.10	1.10	PO D246
1.10	1.10	1.10	1.10	1.10	PO D247
1.10	1.10	1.10	1.10	1.10	PO D248
1.10	1.09	1.09	1.09	1.09	PO D249
1.09	1.09	1.09	1.09	1.09	PO D250
1.09	1.09	1.09	1.09	1.09	PO D251
1.09	1.09	1.09	1.09	1.09	PO D252
1.09	1.08	1.08	1.08	1.08	PO D253
1.08	1.08	1.08	1.08	1.08	PO D254
1.08	1.08	1.08	1.08	1.08	PO D255
1.08	1.08	1.08	1.08	1.08	PO D256
1.08	1.08	1.08	1.08	1.07	PO D257

1.07	1.07	1.07	1.07	1.07	PO D258
1.07	1.07	1.07	1.07	1.07	PO D259
1.07	1.07	1.07	1.07	1.07	PO D260
1.07	1.07	1.07	1.07	1.07	PO D261
1.07	1.07	1.07	1.07	1.07	PO D262
1.07	1.06	1.06	1.06	1.06	PO D263
1.06	1.06	1.06	1.06	1.06	PO D264
1.06	1.06	1.06	1.06	1.06	PO D265
1.06	1.06	1.06	1.06	1.06	PO D266
1.06	1.06	1.06	1.06	1.06	PO D267
1.06	1.06	1.06	1.06	1.06	PO D268
1.06	1.05	1.05	1.05	1.05	PO D269
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1.05	1.05	1.05	1.05	1.05	PO D271
1.05	1.05	1.05	1.05	1.05	PO D272
1.05	1.05	1.05	1.05	1.05	PO D273
1.05	1.05	1.05	1.05	1.05	PO D274
1.05	1.05	1.05	1.05	1.05	PO D275
1.05	1.05	1.05	1.04	1.04	PO D276
1.04	1.04	1.04	1.04	1.04	PO D277
1.04	1.04	1.04	1.04	1.04	PO D278
1.04	1.04	1.04	1.04	1.04	PO D279
1.04	1.04	1.04	1.04	1.04	PO D280
1.04	1.04	1.04	1.04	1.04	PO D281
1.04	1.04	1.04	1.04	1.04	PO D282
1.04	1.04	1.04	1.04	1.04	PO D283
1.04	1.04	1.04	1.04	1.04	PO D284
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1.03	1.03	1.03	1.03	1.03	PO D286
1.03	1.03	1.03	1.03	1.03	PO D287
1.03	1.03	1.03	1.03	1.03	PO D288
1.03	1.03	1.03	1.03	1.03	PO D289
1.03	1.03	1.03	1.03	1.03	PO D290
1.03	1.03	1.03	1.03	1.03	PO D291
1.03	1.03	1.03	1.03	1.03	PO D292
1.03	1.03	1.03	1.03	1.03	PO D293
1.03	1.03	1.03	1.03	1.03	PO D294
1.03	1.03	1.03	1.03	1.03	PO D295
1.03	1.03	1.03	1.03	1.03	PO D296
1.03	1.03	1.03	1.03	1.03	PO D297
1.03	1.03	1.02	1.02	1.02	PO D298
1.02	1.02	1.02	1.02	1.02	PO D299
1.02	1.02	1.02	1.02	1.02	PO D300
1.02	1.02	1.02	1.02	1.02	PO D301
1.02	1.02	1.02	1.02	1.02	PO D302
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1.02	1.02	1.02	1.02	1.02	PO D305
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1.02	1.02	1.02	1.02	1.02	PO D308
1.02	1.02	1.02	1.02	1.02	PO D309
1.02	1.02	1.02	1.02	1.02	PO D310
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1.02	1.02	1.02	1.02	1.02	PO D312
1.02	1.02	1.02	1.02	1.02	PO D313
1.02	1.02	1.02	1.02	1.02	PO D314
1.02	1.02	1.02	1.02	1.02	PO D315
1.02	1.02	1.02	1.02	1.02	PO D316

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1.01	1.01	1.01	1.01	1.01	PO D318
1.01	1.01	1.01	1.01	1.01	PO D319
1.01	1.01	1.01	1.01	1.01	PO D320
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1.01	1.01	1.01	1.01	1.01	PO D323
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1.01	1.01	1.01	1.01	1.01	PO D338
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1.00	1.00	1.00	1.00	1.00	PO D419
1.00	1.00	1.00	1.00	1.00	PO D420
1.00	1.00	1.00	1.00	1.00	PO D421
1.00	1.00	1.00	1.00	1.00	PO D422
1.00	1.00	1.00	1.00	1.00	PO D423
1.00	1.00	1.00	1.00	1.00	PO D424
1.00	1.00	1.00	1.00	1.00	PO D425
1.00	1.00	1.00	1.00	1.00	PO D426
1.00	1.00	1.00	1.00	1.00	PO D427
1.00	1.00	1.00	1.00	1.00	PO D428
1.00	1.00	1.00	1.00	1.00	PO D429
1.00	1.00	1.00	1.00	1.00	PO D430
1.00	1.00	1.00	1.00	1.00	PO D431
1.00	1.00	1.00	1.00	1.00	PO D432
1.00	1.00	1.00	1.00	1.00	PO D433
1.00	1.00	1.00	1.00	1.00	PO D434

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                           1.00      1.00      1.00      1.00      1.00   PO D435
                           1.00      1.00      1.00      1.00      1.00   PO D436
                           1.00      1.00      1.00      1.00      1.00   PO D437
                           1.00      1.00      1.00      1.00      1.00   PO D438
                           1.00      1.00      1.00      1.00      1.00   PO D439
                           1.00      1.00      1.00      1.00      1.00   PO D440
                           1.00      1.00      1.00      1.00      1.00   PO D441
                           1.00      1.00      1.00      1.00      1.00   PO D442
                           1.00      1.00      1.00      1.00      1.00   PO D443
                           1.00      1.00      1.00      1.00      1.00   PO D444
                           1.00      1.00      1.00      1.00      1.00   PO D445
                           1.00      1.00      1.00      1.00      1.00   PO D446
                           1.00      1.00      1.00      1.00      1.00   PO D447
                           1.00      1.00      1.00      1.00      1.00   PO D448
                           1.00      1.00      1.00      1.00      1.00   PO D449
                           1.00      1.00      1.00      1.00      1.00   PO D450
                           1.00      1.00      1.00      1.00      1.00   PO D451
                           1.00      1.00      1.00      1.00      1.00   PO D452
                           1.00      1.00      1.00      1.00      1.00   PO D453
                           1.00      1.00      1.00      1.00      1.00   PO D454
                           1.00      1.00      1.00      1.00      1.00   PO D455
                           1.00      1.00      1.00      1.00      1.00   PO D456
                           1.00      1.00      1.00      1.00      1.00   PO D457
                           1.00      1.00      1.00      1.00      1.00   PO D458
                           1.00      1.00      1.00      1.00      1.00   PO D459
                           1.00      1.00      1.00      1.00      1.00   PO D460
                           1.00      1.00      1.00      1.00      1.00   PO D461
                           1.00      1.00      1.00      1.00      1.00   PO D462
                           1.00      1.00      1.00      1.00      1.00   PO D463
                           1.00      1.00      1.00      1.00      1.00   PO D464
                           1.00      1.00      1.00      1.00      1.00   PO D465
                           1.00      1.00      1.00      1.00      1.00   PO D466
                           1.00      1.00      1.00      1.00      1.00   PO D467
                           1.00      1.00      1.00      1.00      1.00   PO D468
                           1.00      1.00      1.00      1.00      1.00   PO D469
                           1.00      1.00      1.00      1.00      1.00   PO D470
                           1.00      1.00      1.00      1.00      1.00   PO D471
                           1.00      1.00      1.00      1.00      1.00   PO D472
                           1.00      1.00      1.00      1.00      1.00   PO D473
                           1.00      1.00      1.00      1.00      1.00   PO D474
                           1.00      1.00      1.00      1.00      1.00   PO D475
                           1.00      1.00      1.00      1.00      1.00   PO D476
                           1.00      1.00      1.00      1.00      1.00   PO D477
                           1.00      1.00      1.00      1.00      1.00   PO D478
                           1.00      1.00      1.00      1.00      1.00   PO D479
                           1.00      1.00      1.00      1.00      1.00   PO D480
                           1.00      1.00      1.00      1.00      1.00   PO D481
                           1.00      1.00      1.00      1.00      1.00   PO D482
                           1.00      1.00      1.00      1.00      1.00   PO D483
                           1.00      1.00      1.00      1.00      1.00   PO D484
                           1.00      1.00      1.00      1.00      1.00   PO D485
                           1.00      1.00      1.00      1.00      1.00   PO D486
                           1.00      1.00      1.00      1.00      1.00   PO D487
                           1.00      1.00      1.00      1.00      1.00   PO D488
 ENDTABLE                                                              P 1,T 1489
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CREST PS       5545.50 FT    6055.0 ACFT      0.00 AC     126.3 CFS

SED ACCUM      5545.50 FT    6055.0 ACFT      0.00 AC     126.3 CFS

START ELEV     5545.50 FT    6055.0 ACFT      0.00 AC       0.0 CFS


NRCS-PSH  RAINFALL   1-DAY =   0.00 IN    10-DAY =   0.00 IN    DA =   4.74 SM
          RUNOFF     1-DAY =   0.00 IN    10-DAY =   0.00 IN

     CLIMATIC INDEX = 1.00    CN 10-DAY =  0.    CN 1-DAY =   0.

     PEAK =       850.0 CFS, AT  120.0 HRS.


ROUTED RESULT - HYD TYPE      EMAX         VOL-MAX        AMAX         QMAX
                NRCS-PSH   5547.76 FT    6496.1 ACFT      0.00 AC     40.0 CFS

     PS STORAGE     441.0 ACFT,  BETWEEN AUX. CREST AND SED. ACCUM ELEVATIONS.

DRAWDOWN (DDT) TEST       5545.84 FT    6121.2 ACFT      4.35 CFS
     CONTROL IS 0.150 DETENTION STORAGE

     TIME LIMIT REACHED = 10.00 DAYS. FLOW WAS     9.73 CFS,  ELEV =  5546.26
     (ELEVATION TO START ROUTING SDH AND/OR FBH HAS BEEN RAISED.)

     TIME TO DDT TEST DISCHARGE IS 15.79 DAYS - DRAWDOWN STOPPED.

***** NOTE - CREST OF AUX. RAISED TO HOLD   148.03 ACFT NOT EVACUATED IN
             DRAWDOWN TIME LIMIT.  TOTAL STORAGE REQUIRED =  6644.08 ACFT,
             NEW ELEVATION OF AUXILIARY SPILLWAY CREST    =  5548.51 FT.

PLOT OF PRINCIPAL SPILLWAY HYDROGRAPH,  1 INCH=     200. CFS
                                                 0.      200.      400.      600.      800
 Time    Qin  Qout   Elev    Vol   Area  ExtVel  I         I         I         I         I
  0.00   0.0   0.0 5545.5  6055.5   0.0          .
  1.00  11.0   0.0 5545.5  6055.5   0.0          .I
  2.00  14.0   0.1 5545.5  6056.5   0.0          .I
  3.00  15.0   0.2 5545.5  6057.7   0.0          .I
  4.00  15.0   0.3 5545.5  6058.9   0.0          .I
  5.00  15.0   0.3 5545.5  6060.1   0.0          .I
  6.00  15.0   0.4 5545.5  6061.3   0.0          .I
  7.00  15.0   0.5 5545.5  6062.5   0.0          .I
  8.00  15.0   0.6 5545.5  6063.7   0.0          .I
  9.00  15.0   0.7 5545.6  6064.9   0.0          .I
 10.00  15.0   0.7 5545.6  6066.1   0.0          .I
 11.00  16.0   0.8 5545.6  6067.3   0.0          .I
 12.00  16.0   0.9 5545.6  6068.6   0.0          .I
 13.00  16.0   1.0 5545.6  6069.8   0.0          .I
 14.00  16.0   1.1 5545.6  6071.1   0.0          .I
 15.00  16.0   1.1 5545.6  6072.3   0.0          .I
 16.00  16.0   1.2 5545.6  6073.5   0.0          .I
 17.00  16.0   1.3 5545.6  6074.7   0.0          .I
 18.00  16.0   1.4 5545.6  6076.0   0.0          .I
 19.00  16.0   1.5 5545.6  6077.2   0.0          .I
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   20.00  16.0   1.5 5545.6  6078.4   0.0           .I
   21.00  17.0   1.6 5545.6  6079.6   0.0           .I
   22.00  17.0   1.7 5545.6  6080.9   0.0           .I
   23.00  17.0   1.8 5545.6  6082.1   0.0           .I
   24.00  17.0   1.9 5545.6  6083.4   0.0           .I
   25.00  17.0   1.9 5545.7  6084.6   0.0           .I
   26.00  17.0   2.0 5545.7  6085.9   0.0           .I
   27.00  17.0   2.1 5545.7  6087.1   0.0           .I
   28.00  17.0   2.2 5545.7  6088.3   0.0           .I
   29.00  17.0   2.3 5545.7  6089.5   0.0           .I
   30.00  17.0   2.3 5545.7  6090.8   0.0           .I
   31.00  18.0   2.4 5545.7  6092.0   0.0           .I
   32.00  18.0   2.5 5545.7  6093.3   0.0           .I
   33.00  18.0   2.6 5545.7  6094.6   0.0           .I
   34.00  18.0   2.7 5545.7  6095.8   0.0           .I
   35.00  18.0   2.8 5545.7  6097.1   0.0           .I
   36.00  18.0   2.8 5545.7  6098.4   0.0           .I
   37.00  18.0   2.9 5545.7  6099.6   0.0           .I
   38.00  18.0   3.0 5545.7  6100.8   0.0           .I
   39.00  19.0   3.1 5545.7  6102.1   0.0           .I
   40.00  19.0   3.2 5545.7  6103.4   0.0           .I
   41.00  19.0   3.3 5545.8  6104.7   0.0           .I
   42.00  19.0   3.4 5545.8  6106.0   0.0           .I
   43.00  19.0   3.4 5545.8  6107.3   0.0           .I
   44.00  19.0   3.5 5545.8  6108.6   0.0           .I
   45.00  20.0   3.6 5545.8  6109.9   0.0           .I
   46.00  20.0   3.7 5545.8  6111.3   0.0           .I
   47.00  20.0   3.8 5545.8  6112.6   0.0           .I
   48.00  20.0   3.9 5545.8  6114.0   0.0           .I
   49.00  20.0   4.0 5545.8  6115.3   0.0           .I
   50.00  20.0   4.0 5545.8  6116.6   0.0           .I
   51.00  21.0   4.1 5545.8  6118.0   0.0           .I
   52.00  21.0   4.2 5545.8  6119.4   0.0           .I
   53.00  21.0   4.3 5545.8  6120.7   0.0           .I
   54.00  21.0   4.4 5545.8  6122.1   0.0           .I
   55.00  21.0   4.5 5545.9  6123.5   0.0           .I
   56.00  21.0   4.6 5545.9  6124.8   0.0           .I
   57.00  22.0   4.7 5545.9  6126.2   0.0           .I
   58.00  22.0   4.8 5545.9  6127.7   0.0           .I
   59.00  22.0   4.9 5545.9  6129.1   0.0           .I
   60.00  22.0   5.0 5545.9  6130.5   0.0           .I
   61.00  23.0   5.1 5545.9  6131.9   0.0           .I
   62.00  23.0   5.2 5545.9  6133.4   0.0           .I
   63.00  23.0   5.2 5545.9  6134.9   0.0           .I
   64.00  23.0   5.3 5545.9  6136.4   0.0           .I
   65.00  24.0   5.4 5545.9  6137.8   0.0           .I
   66.00  24.0   5.5 5545.9  6139.4   0.0           .I
   67.00  24.0   5.6 5545.9  6140.9   0.0           .I
   68.00  24.0   5.7 5545.9  6142.4   0.0           .I
   69.00  25.0   5.8 5546.0  6144.0   0.0           .I
   70.00  25.0   5.9 5546.0  6145.5   0.0           .I
   71.00  25.0   6.1 5546.0  6147.1   0.0           .I
   72.00  26.0   6.2 5546.0  6148.7   0.0           .I
   73.00  26.0   6.3 5546.0  6150.3   0.0           .I
   74.00  26.0   6.4 5546.0  6152.0   0.0           .I
   75.00  27.0   6.5 5546.0  6153.6   0.0           .I
   76.00  27.0   6.6 5546.0  6155.3   0.0           .I
   77.00  27.0   6.7 5546.0  6157.0   0.0           .I
   78.00  28.0   6.8 5546.0  6158.7   0.0           .I
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  79.00  28.0   6.9 5546.0  6160.5   0.0          .I
  80.00  29.0   7.0 5546.0  6162.2   0.0          .I
  81.00  29.0   7.2 5546.1  6164.1   0.0          .I
  82.00  29.0   7.3 5546.1  6165.9   0.0          .I
  83.00  30.0   7.4 5546.1  6167.7   0.0          . I
  84.00  30.0   7.5 5546.1  6169.5   0.0          . I
  85.00  31.0   7.7 5546.1  6171.4   0.0          . I
  86.00  31.0   7.8 5546.1  6173.4   0.0          . I
  87.00  32.0   7.9 5546.1  6175.3   0.0          . I
  88.00  33.0   8.0 5546.1  6177.3   0.0          . I
  89.00  33.0   8.2 5546.1  6179.4   0.0          . I
  90.00  34.0   8.3 5546.1  6181.5   0.0          . I
  91.00  35.0   8.5 5546.2  6183.6   0.0          . I
  92.00  35.0   8.6 5546.2  6185.8   0.0          . I
  93.00  36.0   8.7 5546.2  6188.1   0.0          . I
  94.00  37.0   8.9 5546.2  6190.3   0.0          . I
  95.00  38.0   9.0 5546.2  6192.7   0.0          . I
  96.00  39.0   9.2 5546.2  6195.1   0.0          . I
  97.00  40.0   9.4 5546.2  6197.6   0.0          . I
  98.00  41.0   9.5 5546.2  6200.2   0.0          . I
  99.00  42.0   9.7 5546.3  6202.8   0.0          . I
 100.00  43.0   9.9 5546.3  6205.5   0.0          . I
 101.00  45.0  10.1 5546.3  6208.3   0.0          .PI
 102.00  46.0  10.3 5546.3  6211.3   0.0          .PI
 103.00  48.0  10.5 5546.3  6214.3   0.0          .PI
 104.00  49.0  10.7 5546.3  6217.4   0.0          .PI
 105.00  51.0  10.9 5546.3  6220.7   0.0          .P I
 106.00  53.0  11.1 5546.4  6224.0   0.0          .P I
 107.00  56.0  11.3 5546.4  6227.6   0.0          .P I
 108.00  58.0  11.6 5546.4  6231.4   0.0          .P I
 109.00  61.0  11.9 5546.4  6235.3   0.0          .P I
 110.00  65.0  12.1 5546.4  6239.5   0.0          .P I
 111.00  69.0  12.4 5546.5  6244.1   0.0          .P I
 112.00  74.0  12.7 5546.5  6248.9   0.0          .P  I
 113.00  80.0  13.1 5546.5  6254.2   0.0          .P  I
 114.00  87.0  13.5 5546.5  6260.0   0.0          .P  I
 115.00  96.0  13.9 5546.6  6266.5   0.0          .P   I
 116.00 109.0  14.4 5546.6  6273.8   0.0          .P   I
 117.00 127.0  14.9 5546.7  6282.3   0.0          .P    I
 118.00 157.0  15.6 5546.7  6292.8   0.0          .P      I
 119.00 219.0  17.3 5546.8  6307.0   0.0          .P         I
 120.00 850.0  22.4 5547.0  6349.5   0.0          .P
 121.00 479.0  28.7 5547.3  6402.3   0.0          .P                      I
 122.00 259.0  32.1 5547.4  6430.3   0.0          . P          I
 123.00 172.0  33.9 5547.5  6445.4   0.0          . P      I
 124.00 132.0  35.1 5547.5  6455.1   0.0          . P    I
 125.00 111.0  35.9 5547.6  6462.2   0.0          . P   I
 126.00  98.0  36.6 5547.6  6467.8   0.0          . P  I
 127.00  88.0  37.2 5547.6  6472.5   0.0          . P I
 128.00  81.0  37.6 5547.7  6476.4   0.0          . P I
 129.00  75.0  38.0 5547.7  6479.7   0.0          . P I
 130.00  70.0  38.4 5547.7  6482.5   0.0          . P I
 131.00  65.0  38.7 5547.7  6484.9   0.0          . PI
 132.00  62.0  38.9 5547.7  6487.0   0.0          . PI
 133.00  59.0  39.1 5547.7  6488.7   0.0          . PI
 134.00  56.0  39.3 5547.7  6490.2   0.0          . PI
 135.00  54.0  39.4 5547.7  6491.5   0.0          . PI
 136.00  51.0  39.6 5547.7  6492.6   0.0          . PI
 137.00  50.0  39.7 5547.7  6493.5   0.0          . PI
```

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138.00  48.0  39.8 5547.7  6494.3   0.0          . P
139.00  46.0  39.8 5547.7  6494.9   0.0          . P
140.00  45.0  39.9 5547.8  6495.3   0.0          . P
141.00  43.0  39.9 5547.8  6495.7   0.0          . P
142.00  42.0  40.0 5547.8  6495.9   0.0          . P
143.00  41.0  40.0 5547.8  6496.0   0.0          . P
144.00  40.0  40.0 5547.8  6496.1   0.0          . X
145.00  39.0  40.0 5547.8  6496.0   0.0          . P
146.00  38.0  40.0 5547.8  6495.9   0.0          . P
147.00  37.0  39.9 5547.8  6495.7   0.0          . P
148.00  36.0  39.9 5547.8  6495.4   0.0          . P
149.00  35.0  39.9 5547.8  6495.0   0.0          . P
150.00  35.0  39.8 5547.7  6494.6   0.0          . P
151.00  34.0  39.8 5547.7  6494.2   0.0          . P
152.00  33.0  39.7 5547.7  6493.7   0.0          . P
153.00  33.0  39.6 5547.7  6493.1   0.0          . P
154.00  32.0  39.6 5547.7  6492.6   0.0          . P
155.00  32.0  39.5 5547.7  6491.9   0.0          . P
156.00  31.0  39.4 5547.7  6491.3   0.0          . P
157.00  30.0  39.3 5547.7  6490.5   0.0          . P
158.00  30.0  39.2 5547.7  6489.8   0.0          . P
159.00  29.0  39.1 5547.7  6489.0   0.0          .IP
160.00  29.0  39.0 5547.7  6488.1   0.0          .IP
161.00  29.0  38.9 5547.7  6487.3   0.0          .IP
162.00  28.0  38.8 5547.7  6486.5   0.0          .IP
163.00  28.0  38.7 5547.7  6485.6   0.0          .IP
164.00  27.0  38.6 5547.7  6484.6   0.0          .IP
165.00  27.0  38.5 5547.7  6483.7   0.0          .IP
166.00  27.0  38.4 5547.7  6482.7   0.0          .IP
167.00  26.0  38.3 5547.7  6481.8   0.0          .IP
168.00  26.0  38.1 5547.7  6480.8   0.0          .IP
169.00  26.0  38.0 5547.7  6479.8   0.0          .IP
170.00  25.0  37.9 5547.7  6478.7   0.0          .IP
171.00  25.0  37.8 5547.7  6477.7   0.0          .IP
172.00  25.0  37.7 5547.7  6476.6   0.0          .IP
173.00  24.0  37.5 5547.7  6475.5   0.0          .IP
174.00  24.0  37.4 5547.6  6474.4   0.0          .IP
175.00  24.0  37.3 5547.6  6473.3   0.0          .IP
176.00  24.0  37.1 5547.6  6472.2   0.0          .IP
177.00  23.0  37.0 5547.6  6471.1   0.0          .IP
178.00  23.0  36.9 5547.6  6470.0   0.0          .IP
179.00  23.0  36.7 5547.6  6468.8   0.0          .IP
180.00  23.0  36.6 5547.6  6467.7   0.0          .IP
181.00  22.0  36.4 5547.6  6466.5   0.0          .IP
182.00  22.0  36.3 5547.6  6465.3   0.0          .IP
183.00  22.0  36.2 5547.6  6464.2   0.0          .IP
184.00  22.0  36.0 5547.6  6463.0   0.0          .IP
185.00  22.0  35.9 5547.6  6461.8   0.0          .IP
186.00  21.0  35.7 5547.6  6460.7   0.0          .IP
187.00  21.0  35.6 5547.6  6459.5   0.0          .IP
188.00  21.0  35.4 5547.6  6458.3   0.0          .IP
189.00  21.0  35.3 5547.6  6457.1   0.0          .IP
190.00  21.0  35.2 5547.6  6455.9   0.0          .IP
191.00  20.0  35.0 5547.5  6454.7   0.0          .IP
192.00  20.0  34.9 5547.5  6453.4   0.0          .IP
193.00  20.0  34.7 5547.5  6452.2   0.0          .IP
194.00  20.0  34.6 5547.5  6451.0   0.0          .IP
195.00  20.0  34.4 5547.5  6449.8   0.0          .IP
196.00  20.0  34.3 5547.5  6448.6   0.0          .IP
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197.00  19.0  34.1 5547.5  6447.4   0.0          .IP
198.00  19.0  34.0 5547.5  6446.2   0.0          .IP
199.00  19.0  33.8 5547.5  6444.9   0.0          .IP
200.00  19.0  33.7 5547.5  6443.7   0.0          .IP
201.00  19.0  33.6 5547.5  6442.5   0.0          .IP
202.00  19.0  33.4 5547.5  6441.3   0.0          .IP
203.00  19.0  33.3 5547.5  6440.1   0.0          .IP
204.00  18.0  33.1 5547.5  6438.9   0.0          .IP
205.00  18.0  33.0 5547.5  6437.7   0.0          .IP
206.00  18.0  32.8 5547.5  6436.4   0.0          .IP
207.00  18.0  32.7 5547.4  6435.2   0.0          .IP
208.00  18.0  32.5 5547.4  6434.0   0.0          .IP
209.00  18.0  32.4 5547.4  6432.8   0.0          .IP
210.00  18.0  32.2 5547.4  6431.6   0.0          .IP
211.00  17.0  32.1 5547.4  6430.4   0.0          .IP
212.00  17.0  32.0 5547.4  6429.2   0.0          .IP
213.00  17.0  31.8 5547.4  6427.9   0.0          .IP
214.00  17.0  31.7 5547.4  6426.7   0.0          .IP
215.00  17.0  31.5 5547.4  6425.5   0.0          .IP
216.00  17.0  31.4 5547.4  6424.3   0.0          .IP
217.00  17.0  31.2 5547.4  6423.1   0.0          .IP
218.00  17.0  31.1 5547.4  6422.0   0.0          .IP
219.00  17.0  30.9 5547.4  6420.8   0.0          .IP
220.00  17.0  30.8 5547.4  6419.7   0.0          .IP
221.00  16.0  30.7 5547.4  6418.5   0.0          .IP
222.00  16.0  30.5 5547.4  6417.3   0.0          .IP
223.00  16.0  30.4 5547.3  6416.1   0.0          .IP
224.00  16.0  30.2 5547.3  6414.9   0.0          .IP
225.00  16.0  30.1 5547.3  6413.7   0.0          .IP
226.00  16.0  30.0 5547.3  6412.6   0.0          .P
227.00  16.0  29.8 5547.3  6411.4   0.0          .P
228.00  16.0  29.7 5547.3  6410.3   0.0          .P
229.00  16.0  29.5 5547.3  6409.2   0.0          .P
230.00  16.0  29.4 5547.3  6408.1   0.0          .P
231.00  15.0  29.3 5547.3  6406.9   0.0          .P
232.00  15.0  29.1 5547.3  6405.7   0.0          .P
233.00  15.0  29.0 5547.3  6404.6   0.0          .P
234.00  15.0  28.9 5547.3  6403.4   0.0          .P
235.00  15.0  28.7 5547.3  6402.3   0.0          .P
236.00  15.0  28.6 5547.3  6401.2   0.0          .P
237.00  15.0  28.5 5547.3  6400.0   0.0          .P
238.00  15.0  28.3 5547.3  6398.9   0.0          .P
239.00  15.0  28.2 5547.3  6397.8   0.0          .P
 Time    Qin  Qout   Elev    Vol   Area  ExtVel  I         I         I         I         I
                                                 0.      200.      400.      600.      800
        END NRCS-PSH   PLOT


*******************************************************************************
RATING TABLE DEVELOPED, SITE = STR1 :
 BY PROGRAM FOR PS AND AUX. SPILLWAYS
 AUX. RATING USED WSPVRT METHOD.


RATING TABLE NUMBER  1
       ELEV.    Q-TOTAL    Q-PS     Q-AUX.    VOLUME     AREA
       FEET       CFS       CFS       CFS      AC-FT     ACRE
  1  5545.50      0.00      0.00      0.00   6055.03      0.00
  2  5546.72     15.71     15.71      0.00   6294.00      0.00
```

```
   3  5547.94     44.43     44.43      0.00   6532.97      0.00
   4  5549.17     81.62     81.62      0.00   6771.95      0.00
                                            FULL CONDUIT FLOW, ELEV = 5550.39 FT
   5  5550.39    125.65    125.65      0.00   7015.04      0.00
   6  5550.65    125.84    125.84      0.00   7069.39      0.00
   7  5550.92    126.01    126.01      0.00   7123.74      0.00
   8  5551.18    126.17    126.17      0.00   7178.09      0.00
   9  5551.44    126.34    126.34      0.00   7232.44      0.00
  10  5551.71    126.50    126.50      0.00   7286.79      0.00
  11  5551.97    126.67    126.67      0.00   7341.14      0.00
  12  5552.23    126.83    126.83      0.00   7395.49      0.00
  13  5552.50    126.99    126.99      0.00   7449.85      0.00

 INFLOW HYDROGRAPH PROVIDED IN LOCATION  3,  PEAK=   2180.00 CFS, AT   3.30 HRS.
 TITLE = Auxiliary Spillway (Local)


 INFLOW HYDROGRAPH PROVIDED IN LOCATION  5,  PEAK=   3365.00 CFS, AT   9.60 HRS.
 TITLE = Freeboard (General)



1SITES --------------------------------------------------------------------------
 XEQ 08/28/2020                    COV RES                        WSID= COVRES
 VER 2005.1.8                        Cove Res                       SUBW= CR
 TIME 16:21:21            SITE = STR1             PASS=    1     PART=   4


 AUX. CREST     5548.51 FT    6644.1 ACFT      0.00 AC      61.7 CFS

      PS STORAGE    589.1 ACFT,  BETWEEN AUX. CREST AND SED. ACCUM ELEVATIONS.

 START ELEV     5546.26 FT    6203.0 ACFT      0.00 AC       9.7 CFS

 ***** WARNING - AUXILIARY CREST LOWER THAN LOW POINT IN SITE.

 NRCS-SDH   INFLOW HYDROGRAPH INPUT, DA =    4.74 SQUARE MILES

      PEAK =      2180.0 CFS, AT    3.3 HRS.

 NRCS-FBH   INFLOW HYDROGRAPH INPUT, DA =    4.74 SQUARE MILES

      PEAK =      3365.0 CFS, AT    9.6 HRS.

 ***** WARNING - MAXIMUM AUX. SURFACE PROFILE ELEVATION ( 5549.20) AND AUXILIARY
                 CREST ( 5548.51) ELEVATION Do NOT MATCH.  MAXIMUM AUX. SURFACE
                 PROFILE ELEVATION USED IN WSPVRT PROCEDURE.


 ***** MESSAGE - INPUT(5549.14) TO INTERPOLATION ROUTINE IS BELOW
                 ARRAY LIMIT(5549.20).


 ******************************************************************************
 RATING TABLE DEVELOPED, SITE = STR1 :
  BY PROGRAM FOR PS AND AUX. SPILLWAYS
  AUX. RATING USED WSPVRT METHOD.
```

```
RATING TABLE NUMBER  2
       ELEV.    Q-TOTAL    Q-PS     Q-AUX.    VOLUME     AREA
       FEET       CFS       CFS       CFS      AC-FT     ACRE
  1  5545.50      0.00      0.00      0.00   6055.03      0.00
  2  5545.83      2.25      2.25      0.00   6120.52      0.00
  3  5546.17      6.37      6.37      0.00   6186.02      0.00
  4  5546.50     11.71     11.71      0.00   6251.52      0.00
  5  5546.84     18.03     18.03      0.00   6317.01      0.00
  6  5547.17     25.20     25.20      0.00   6382.51      0.00
  7  5547.51     33.12     33.12      0.00   6448.00      0.00
  8  5547.84     41.74     41.74      0.00   6513.50      0.00
  9  5548.18     50.99     50.99      0.00   6578.99      0.00
 10  5548.51     60.85     60.85      0.00   6644.49      0.00
 11  5549.14     80.67     80.67      0.00   6766.41      0.00
 12  5549.76    128.97    102.35     26.63   6888.71      0.00
                                           FULL CONDUIT FLOW, ELEV = 5550.39 FT
 13  5550.39    227.03    125.67    101.36   7015.14      0.00
 14  5550.49    242.46    125.75    116.71   7036.88      0.00
 15  5550.60    260.89    125.81    135.07   7058.62      0.00
 16  5550.79    295.79    125.93    169.86   7097.77      0.00
 17  5551.02    338.51    126.08    212.44   7145.68      0.00
 18  5551.44    429.26    126.34    302.92   7232.64      0.00
 19  5551.97    558.86    126.67    432.19   7341.44      0.00
 20  5552.50    706.93    126.99    579.94   7450.25      0.00
 ***************************************************************************

SUMMARY OF AUXILIARY SPILLWAY SURFACE CONDITIONS USED IN COMPUTATIONS BY REACH

REACH  FROM     TO   SLOPE  RETARDANCE  VEGETAL  MAINT. ROOTING  REACH
       STA     STA            CURVE      COVER    CODE   DEPTH  LOCATION
       (ft)    (ft)   (%)     INDEX@     FACTOR     +    (ft)     *
-----  ----    ----  ------ ----------  -------  -----  ------- --------
  1      0.     75.  -25.6     0.025       **       **     **    INLET
  2     75.    115.    0.0     0.025       **       **     **    CREST
  3    115.    475.   15.4     0.025     0.00       1            EXIT !
  4    475.    610.    8.5     0.025     0.00       1            EXIT
  5    610.   1057.    6.6     0.025     0.00       1            EXIT
  6   1057.   1153.   15.6     0.025     0.00       1            EXIT

 @ The program interprets retardance curve index entries of less than 1 as
   Manning's n values.
 + The minimum maintenance code value of 2 is used in INTEGRITY computations
     (the program changes values of 1 to 2 during computation).
 * Upper case indicates a reach of constructed spillway channel.
** The program does not use vegetal cover factor, maintenance code, and
     rooting depth for inlet and crest reaches in computations.
 ! Reach   3 used in computing exit channel velocities.
 ***************************************************************************

HYD       AO              4.74Cove Res                                 COVRES  1
          0             0.3000                                         STR1    2
                          7.76      7.76      7.79      8.01      8.88   AO D  3
                         10.93     14.81     20.04     25.63     31.00   AO D  4
                         35.80     40.07     43.92     47.45     50.65   AO D  5
                         53.79     56.77     59.50     61.84     63.63   AO D  6
                         64.79     65.46     65.79     65.90     65.87   AO D  7
                         65.76     65.58     65.37     65.13     64.89   AO D  8
                         64.63     64.38     64.12     63.87     63.62   AO D  9
                         63.36     63.11     62.86     62.62     62.37   AO D 10
```

```
                                 62.12      61.87      61.63      61.39      61.14   AO D 11
                                 60.90      60.67      60.45      60.23      60.01   AO D 12
                                 59.79      59.57      59.35      59.14      58.92   AO D 13
                                 58.70      58.49      58.27      58.06      57.85   AO D 14
                                 57.64      57.43      57.22      57.01      56.80   AO D 15
                                 56.59      56.38      56.18      55.97      55.77   AO D 16
                                 55.56      55.36      55.16      54.96      54.76   AO D 17
                                 54.56      54.36      54.16      53.96      53.76   AO D 18
                                 53.57      53.37      53.17      52.98      52.79   AO D 19
                                 52.59      52.40      52.21      52.02      51.83   AO D 20
                                 51.64      51.45      51.26      51.08      50.90   AO D 21
                                 50.72      50.55      50.38      50.20      50.03   AO D 22
                                 49.86      49.69      49.52      49.35      49.18   AO D 23
                                 49.01      48.84      48.68      48.51      48.34   AO D 24
                                 48.18      48.01      47.85      47.68      47.52   AO D 25
                                 47.36      47.20      47.03      46.87      46.71   AO D 26
                                 46.55      46.39      46.23      46.08      45.92   AO D 27
                                 45.76      45.60      45.45      45.29      45.14   AO D 28
                                 44.98      44.83      44.68      44.52      44.37   AO D 29
                                 44.22      44.07      43.92      43.77      43.62   AO D 30
                                 43.47      43.32      43.17      43.03      42.88   AO D 31
                                 42.73      42.59      42.44      42.30      42.15   AO D 32
                                 42.01      41.86      41.72      41.59      41.46   AO D 33
                                 41.33      41.19      41.06      40.93      40.80   AO D 34
                                 40.67      40.54      40.41      40.29      40.16   AO D 35
                                 40.03      39.90      39.78      39.65      39.53   AO D 36
                                 39.40      39.27      39.15      39.03      38.90   AO D 37
                                 38.78      38.66      38.53      38.41      38.29   AO D 38
                                 38.17      38.05      37.93      37.81      37.69   AO D 39
                                 37.57      37.45      37.33      37.21      37.09   AO D 40
                                 36.97      36.86      36.74      36.62      36.51   AO D 41
                                 36.39      36.28      36.16      36.05      35.93   AO D 42
                                 35.82      35.71      35.59      35.48      35.37   AO D 43
                                 35.26      35.15      35.03      34.92      34.81   AO D 44
                                 34.70      34.59      34.48      34.37      34.27   AO D 45
                                 34.16      34.05      33.94      33.83      33.73   AO D 46
                                 33.62      33.51      33.41      33.30      33.20   AO D 47
                                 33.10      33.00      32.90      32.81      32.71   AO D 48
                                 32.62      32.52      32.43      32.33      32.24   AO D 49
                                 32.15      32.05      31.96      31.87      31.78   AO D 50
                                 31.68      31.59      31.50      31.41      31.32   AO D 51
                                 31.23      31.14      31.05      30.96      30.87   AO D 52
                                 30.78      30.69      30.60      30.51      30.42   AO D 53
                                 30.33      30.25      30.16      30.07      29.98   AO D 54
                                 29.90      29.81      29.72      29.64      29.55   AO D 55
                                 29.47      29.38      29.30      29.21      29.13   AO D 56
                                 29.04      28.96      28.87      28.79      28.71   AO D 57
                                 28.62      28.54      28.46      28.38      28.30   AO D 58
                                 28.21      28.13      28.05      27.97      27.89   AO D 59
                                 27.81      27.73      27.65      27.57      27.49   AO D 60
                                 27.41      27.33      27.25      27.17      27.09   AO D 61
                                 27.02      26.94      26.86      26.78      26.71   AO D 62
                                 26.63      26.55      26.48      26.40      26.32   AO D 63
                                 26.25      26.17      26.10      26.02      25.95   AO D 64
                                 25.87      25.80      25.72      25.65      25.57   AO D 65
                                 25.50      25.43      25.35      25.28      25.21   AO D 66
  ENDTABLE                                                                      P 1,T 2 67
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1SITES -------------------------------------------------------------------------
 XEQ 08/28/2020                    COV RES                        WSID= COVRES
 VER 2005.1.8                        Cove Res                       SUBW= CR
 TIME 16:21:21            SITE = STR1              PASS=    1     PART=   5


 ROUTED       BTM WIDTH  MAX ELEV   VOL-MAX  AREA-MAX   AUX.-HP   VOL-AUX.
 RESULTS          FT        FT        ACFT      AC         FT       ACFT
 NRCS-SDH          30.0  5548.67    6675.5       0.0      0.16      31.0

           PEAK - CFS        Q-PS     Q-AUX.    Q-TOT.
           DISCHARGE  =      65.7       0.2      65.9

                         CRITICAL  CRITICAL   CRITICAL  25% OF Q
                           DEPTH   VELOCITY   SLOPE-Sc     Sc
           AUXILIARY         FT      FT/SEC     FT/FT     FT/FT
           SPILLWAY ---     0.01      0.57     0.039     0.054

           AUXILIARY SPILLWAY DURATION FLOW =        8.7 HOURS

 ***** MESSAGE - MAX. DISCHARGE OF       0. CFS IS BELOW CREST AUXILIARY
                 SPILLWAY.  NO STABILITY STRESS COMPUTED.

           PLOT NRCS-SDH                  1 IN =    500. CFS
                                                  0.      500.     1000.     1500.     2000
  Time    Qin  Qout   Elev    Vol   Area  ExtVel  I         I         I         I         I
   1.50      0      8 5546.3  6203.0   0.0   0.00   .
   1.80      6      8 5546.3  6203.0   0.0   0.00   .
   2.10     39      8 5546.3  6203.4   0.0   0.00   .I
   2.40    194      8 5546.3  6206.1   0.0   0.00   .   I
   2.70    687      9 5546.3  6216.8   0.0   0.00   .             I
   3.00   1365     11 5546.5  6242.0   0.0   0.00   .                          I
   3.30   2027     15 5546.7  6283.7   0.0   0.00   .
   3.60   2180     20 5546.9  6335.4   0.0   0.00   .
   3.90   1955     26 5547.2  6386.1   0.0   0.00   .P                                     I
   4.20   1683     31 5547.4  6430.5   0.0   0.00   .P                                I
   4.50   1441     36 5547.6  6468.4   0.0   0.00   .P                           I
   4.80   1248     40 5547.8  6500.8   0.0   0.00   .P                       I
   5.10   1107     44 5547.9  6528.9   0.0   0.00   .P                    I
   5.40   1001     47 5548.1  6553.9   0.0   0.00   .P                  I
   5.70    924     51 5548.2  6576.6   0.0   0.00   .P                I
   6.00    874     54 5548.3  6597.6   0.0   0.00   .P               I
   6.30    833     57 5548.4  6617.4   0.0   0.00   .P               I
   6.60    748     60 5548.5  6635.5   0.0   0.00   .P             I
   6.90    589     62 5548.5  6650.6   0.0   0.00   .A          I
   7.20    423     64 5548.6  6661.6   0.0   0.00   .A      I
   7.50    283     65 5548.6  6668.8   0.0   0.00   .A    I
   7.80    180     65 5548.7  6672.9   0.0   0.00   .A  I
   8.10    112     66 5548.7  6674.9   0.0   0.00   .AI
   8.40     73     66 5548.7  6675.5   0.0   0.00   .X
   8.70     47     66 5548.7  6675.4   0.0   0.00   .A
   9.00     28     66 5548.7  6674.7   0.0   0.00   .A
   9.30     16     66 5548.7  6673.6   0.0   0.00   .A
   9.60      9     65 5548.7  6672.3   0.0   0.00   .A
   9.90      5     65 5548.6  6670.8   0.0   0.00   .A
  10.20      3     65 5548.6  6669.3   0.0   0.00   .A
  10.50      1     65 5548.6  6667.8   0.0   0.00   .A
  10.80      1     64 5548.6  6666.2   0.0   0.00   .A
  11.10      0     64 5548.6  6664.6   0.0   0.00   .A
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  11.40     0    64 5548.6  6663.1   0.0   0.00   .A
  11.70     0    64 5548.6  6661.5   0.0   0.00   .A
  12.00     0    63 5548.6  6660.0   0.0   0.00   .A
  12.30     0    63 5548.6  6658.4   0.0   0.00   .A
  12.60     0    63 5548.6  6656.9   0.0   0.00   .A
  12.90     0    63 5548.6  6655.4   0.0   0.00   .A
  13.20     0    62 5548.6  6653.8   0.0   0.00   .A
  13.50     0    62 5548.6  6652.3   0.0   0.00   .A
  13.80     0    62 5548.5  6650.8   0.0   0.00   .A
  14.10     0    62 5548.5  6649.3   0.0   0.00   .A
  14.40     0    61 5548.5  6647.8   0.0   0.00   .A
  14.70     0    61 5548.5  6646.3   0.0   0.00   .A
  15.00     0    61 5548.5  6644.8   0.0   0.00   .A
  15.30     0    61 5548.5  6643.3   0.0   0.00   .P
  15.60     0    60 5548.5  6641.9   0.0   0.00   .P
  15.90     0    60 5548.5  6640.4   0.0   0.00   .P
  16.20     0    60 5548.5  6638.9   0.0   0.00   .P
  16.50     0    60 5548.5  6637.5   0.0   0.00   .P
  16.80     0    60 5548.5  6636.0   0.0   0.00   .P
  17.10     0    59 5548.5  6634.5   0.0   0.00   .P
  17.40     0    59 5548.5  6633.1   0.0   0.00   .P
  17.70     0    59 5548.4  6631.7   0.0   0.00   .P
  18.00     0    59 5548.4  6630.2   0.0   0.00   .P
  18.30     0    58 5548.4  6628.8   0.0   0.00   .P
  18.60     0    58 5548.4  6627.4   0.0   0.00   .P
  18.90     0    58 5548.4  6626.0   0.0   0.00   .P
  19.20     0    58 5548.4  6624.6   0.0   0.00   .P
  19.50     0    58 5548.4  6623.1   0.0   0.00   .P
  19.80     0    57 5548.4  6621.7   0.0   0.00   .P
  20.10     0    57 5548.4  6620.3   0.0   0.00   .P
  20.40     0    57 5548.4  6619.0   0.0   0.00   .P
  20.70     0    57 5548.4  6617.6   0.0   0.00   .P
  21.00     0    57 5548.4  6616.2   0.0   0.00   .P
  21.30     0    56 5548.4  6614.8   0.0   0.00   .P
  21.60     0    56 5548.4  6613.4   0.0   0.00   .P
  21.90     0    56 5548.3  6612.1   0.0   0.00   .P
  22.20     0    56 5548.3  6610.7   0.0   0.00   .P
  22.50     0    56 5548.3  6609.4   0.0   0.00   .P
  22.80     0    55 5548.3  6608.0   0.0   0.00   .P
  23.10     0    55 5548.3  6606.7   0.0   0.00   .P
  23.40     0    55 5548.3  6605.3   0.0   0.00   .P
  23.70     0    55 5548.3  6604.0   0.0   0.00   .P
  24.00     0    55 5548.3  6602.7   0.0   0.00   .P
  24.30     0    54 5548.3  6601.3   0.0   0.00   .P
  24.60     0    54 5548.3  6600.0   0.0   0.00   .P
  24.90     0    54 5548.3  6598.7   0.0   0.00   .P
  25.20     0    54 5548.3  6597.4   0.0   0.00   .P
  25.50     0    54 5548.3  6596.1   0.0   0.00   .P
  25.80     0    53 5548.3  6594.8   0.0   0.00   .P
  26.10     0    53 5548.3  6593.5   0.0   0.00   .P
  26.40     0    53 5548.2  6592.2   0.0   0.00   .P
  26.70     0    53 5548.2  6590.9   0.0   0.00   .P
  27.00     0    53 5548.2  6589.6   0.0   0.00   .P
  27.30     0    52 5548.2  6588.4   0.0   0.00   .P
  27.60     0    52 5548.2  6587.1   0.0   0.00   .P
  27.90     0    52 5548.2  6585.8   0.0   0.00   .P
  28.20     0    52 5548.2  6584.5   0.0   0.00   .P
  28.50     0    52 5548.2  6583.3   0.0   0.00   .P
  28.80     0    51 5548.2  6582.0   0.0   0.00   .P
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 29.10     0    51 5548.2  6580.8   0.0   0.00   .P
 29.40     0    51 5548.2  6579.5   0.0   0.00   .P
 29.70     0    51 5548.2  6578.3   0.0   0.00   .P
 30.00     0    51 5548.2  6577.1   0.0   0.00   .P
 30.30     0    51 5548.2  6575.8   0.0   0.00   .P
 30.60     0    50 5548.2  6574.6   0.0   0.00   .P
 30.90     0    50 5548.2  6573.4   0.0   0.00   .P
 31.20     0    50 5548.1  6572.2   0.0   0.00   .P
 31.50     0    50 5548.1  6571.0   0.0   0.00   .P
 31.80     0    50 5548.1  6569.8   0.0   0.00   .P
 32.10     0    50 5548.1  6568.5   0.0   0.00   .P
 32.40     0    49 5548.1  6567.3   0.0   0.00   .P
 32.70     0    49 5548.1  6566.1   0.0   0.00   .P
 33.00     0    49 5548.1  6565.0   0.0   0.00   .P
 33.30     0    49 5548.1  6563.8   0.0   0.00   .P
 33.60     0    49 5548.1  6562.6   0.0   0.00   .P
 33.90     0    49 5548.1  6561.4   0.0   0.00   .P
 34.20     0    48 5548.1  6560.2   0.0   0.00   .P
 34.50     0    48 5548.1  6559.1   0.0   0.00   .P
 34.80     0    48 5548.1  6557.9   0.0   0.00   .P
 35.10     0    48 5548.1  6556.7   0.0   0.00   .P
 35.40     0    48 5548.1  6555.6   0.0   0.00   .P
 35.70     0    48 5548.1  6554.4   0.0   0.00   .P
 36.00     0    47 5548.0  6553.3   0.0   0.00   .P
 36.30     0    47 5548.0  6552.1   0.0   0.00   .P
 36.60     0    47 5548.0  6551.0   0.0   0.00   .P
 36.90     0    47 5548.0  6549.8   0.0   0.00   .P
 37.20     0    47 5548.0  6548.7   0.0   0.00   .P
 37.50     0    47 5548.0  6547.6   0.0   0.00   .P
 37.80     0    46 5548.0  6546.4   0.0   0.00   .P
 38.10     0    46 5548.0  6545.3   0.0   0.00   .P
 38.40     0    46 5548.0  6544.2   0.0   0.00   .P
 38.70     0    46 5548.0  6543.1   0.0   0.00   .P
 39.00     0    46 5548.0  6542.0   0.0   0.00   .P
 39.30     0    46 5548.0  6540.9   0.0   0.00   .P
 39.60     0    45 5548.0  6539.8   0.0   0.00   .P
 39.90     0    45 5548.0  6538.7   0.0   0.00   .P
 40.20     0    45 5548.0  6537.6   0.0   0.00   .P
 40.50     0    45 5548.0  6536.5   0.0   0.00   .P
 40.80     0    45 5548.0  6535.4   0.0   0.00   .P
 41.10     0    45 5548.0  6534.3   0.0   0.00   .P
 41.40     0    45 5547.9  6533.2   0.0   0.00   .P
 41.70     0    44 5547.9  6532.1   0.0   0.00   .P
 42.00     0    44 5547.9  6531.1   0.0   0.00   .P
 42.30     0    44 5547.9  6530.0   0.0   0.00   .P
 42.60     0    44 5547.9  6528.9   0.0   0.00   .P
 42.90     0    44 5547.9  6527.9   0.0   0.00   .P
 43.20     0    44 5547.9  6526.8   0.0   0.00   .P
 43.50     0    43 5547.9  6525.7   0.0   0.00   .P
 43.80     0    43 5547.9  6524.7   0.0   0.00   .P
 44.10     0    43 5547.9  6523.6   0.0   0.00   .P
 44.40     0    43 5547.9  6522.6   0.0   0.00   .P
 44.70     0    43 5547.9  6521.6   0.0   0.00   .P
 45.00     0    43 5547.9  6520.5   0.0   0.00   .P
 45.30     0    43 5547.9  6519.5   0.0   0.00   .P
 45.60     0    42 5547.9  6518.5   0.0   0.00   .P
 45.90     0    42 5547.9  6517.4   0.0   0.00   .P
 46.20     0    42 5547.9  6516.4   0.0   0.00   .P
 46.50     0    42 5547.9  6515.4   0.0   0.00   .P
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   46.80      0    42 5547.8  6514.4   0.0   0.00   .P
   47.10      0    42 5547.8  6513.4   0.0   0.00   .P
   47.40      0    42 5547.8  6512.4   0.0   0.00   .P
   47.70      0    41 5547.8  6511.4   0.0   0.00   .P
   48.00      0    41 5547.8  6510.4   0.0   0.00   .P
   48.30      0    41 5547.8  6509.4   0.0   0.00   .P
   48.60      0    41 5547.8  6508.4   0.0   0.00   .P
   48.90      0    41 5547.8  6507.4   0.0   0.00   .P
   49.20      0    41 5547.8  6506.4   0.0   0.00   .P
   49.50      0    41 5547.8  6505.4   0.0   0.00   .P
   49.80      0    41 5547.8  6504.4   0.0   0.00   .P
   50.10      0    40 5547.8  6503.4   0.0   0.00   .P
   50.40      0    40 5547.8  6502.5   0.0   0.00   .P
   50.70      0    40 5547.8  6501.5   0.0   0.00   .P
   51.00      0    40 5547.8  6500.5   0.0   0.00   .P
   51.30      0    40 5547.8  6499.6   0.0   0.00   .P
   51.60      0    40 5547.8  6498.6   0.0   0.00   .P
   51.90      0    40 5547.8  6497.6   0.0   0.00   .P
   52.20      0    40 5547.8  6496.7   0.0   0.00   .P
   52.50      0    39 5547.8  6495.7   0.0   0.00   .P
   52.80      0    39 5547.7  6494.8   0.0   0.00   .P
   53.10      0    39 5547.7  6493.8   0.0   0.00   .P
   53.40      0    39 5547.7  6492.9   0.0   0.00   .P
   53.70      0    39 5547.7  6491.9   0.0   0.00   .P
   54.00      0    39 5547.7  6491.0   0.0   0.00   .P
   54.30      0    39 5547.7  6490.1   0.0   0.00   .P
   54.60      0    39 5547.7  6489.1   0.0   0.00   .P
   54.90      0    38 5547.7  6488.2   0.0   0.00   .P
   55.20      0    38 5547.7  6487.3   0.0   0.00   .P
   55.50      0    38 5547.7  6486.4   0.0   0.00   .P
   55.80      0    38 5547.7  6485.4   0.0   0.00   .P
   56.10      0    38 5547.7  6484.5   0.0   0.00   .P
   56.40      0    38 5547.7  6483.6   0.0   0.00   .P
   56.70      0    38 5547.7  6482.7   0.0   0.00   .P
   57.00      0    38 5547.7  6481.8   0.0   0.00   .P
   57.30      0    37 5547.7  6480.9   0.0   0.00   .P
   57.60      0    37 5547.7  6480.0   0.0   0.00   .P
   57.90      0    37 5547.7  6479.1   0.0   0.00   .P
   58.20      0    37 5547.7  6478.2   0.0   0.00   .P
   58.50      0    37 5547.7  6477.3   0.0   0.00   .P
   58.80      0    37 5547.7  6476.4   0.0   0.00   .P
   59.10      0    37 5547.7  6475.5   0.0   0.00   .P
   59.40      0    37 5547.6  6474.6   0.0   0.00   .P
   59.70      0    37 5547.6  6473.7   0.0   0.00   .P
   60.00      0    36 5547.6  6472.9   0.0   0.00   .P
   60.30      0    36 5547.6  6472.0   0.0   0.00   .P
   60.60      0    36 5547.6  6471.1   0.0   0.00   .P
   60.90      0    36 5547.6  6470.2   0.0   0.00   .P
   61.20      0    36 5547.6  6469.4   0.0   0.00   .P
   61.50      0    36 5547.6  6468.5   0.0   0.00   .P
   61.80      0    36 5547.6  6467.7   0.0   0.00   .P
   62.10      0    36 5547.6  6466.8   0.0   0.00   .P
   62.40      0    35 5547.6  6465.9   0.0   0.00   .P
   62.70      0    35 5547.6  6465.1   0.0   0.00   .P
   63.00      0    35 5547.6  6464.2   0.0   0.00   .P
   63.30      0    35 5547.6  6463.4   0.0   0.00   .P
   63.60      0    35 5547.6  6462.5   0.0   0.00   .P
   63.90      0    35 5547.6  6461.7   0.0   0.00   .P
   64.20      0    35 5547.6  6460.9   0.0   0.00   .P
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64.50     0    35 5547.6  6460.0   0.0   0.00   .P
64.80     0    35 5547.6  6459.2   0.0   0.00   .P
65.10     0    34 5547.6  6458.4   0.0   0.00   .P
65.40     0    34 5547.6  6457.5   0.0   0.00   .P
65.70     0    34 5547.6  6456.7   0.0   0.00   .P
66.00     0    34 5547.5  6455.9   0.0   0.00   .P
66.30     0    34 5547.5  6455.1   0.0   0.00   .P
66.60     0    34 5547.5  6454.2   0.0   0.00   .P
66.90     0    34 5547.5  6453.4   0.0   0.00   .P
67.20     0    34 5547.5  6452.6   0.0   0.00   .P
67.50     0    34 5547.5  6451.8   0.0   0.00   .P
67.80     0    34 5547.5  6451.0   0.0   0.00   .P
68.10     0    33 5547.5  6450.2   0.0   0.00   .P
68.40     0    33 5547.5  6449.4   0.0   0.00   .P
68.70     0    33 5547.5  6448.6   0.0   0.00   .P
69.00     0    33 5547.5  6447.8   0.0   0.00   .P
69.30     0    33 5547.5  6447.0   0.0   0.00   .P
69.60     0    33 5547.5  6446.2   0.0   0.00   .P
69.90     0    33 5547.5  6445.4   0.0   0.00   .P
70.20     0    33 5547.5  6444.6   0.0   0.00   .P
70.50     0    33 5547.5  6443.8   0.0   0.00   .P
70.80     0    33 5547.5  6443.1   0.0   0.00   .P
71.10     0    32 5547.5  6442.3   0.0   0.00   .P
71.40     0    32 5547.5  6441.5   0.0   0.00   .P
71.70     0    32 5547.5  6440.7   0.0   0.00   .P
72.00     0    32 5547.5  6439.9   0.0   0.00   .P
72.30     0    32 5547.5  6439.2   0.0   0.00   .P
72.60     0    32 5547.5  6438.4   0.0   0.00   .P
72.90     0    32 5547.5  6437.6   0.0   0.00   .P
73.20     0    32 5547.5  6436.9   0.0   0.00   .P
73.50     0    32 5547.4  6436.1   0.0   0.00   .P
73.80     0    32 5547.4  6435.4   0.0   0.00   .P
74.10     0    31 5547.4  6434.6   0.0   0.00   .P
74.40     0    31 5547.4  6433.8   0.0   0.00   .P
74.70     0    31 5547.4  6433.1   0.0   0.00   .P
75.00     0    31 5547.4  6432.3   0.0   0.00   .P
75.30     0    31 5547.4  6431.6   0.0   0.00   .P
75.60     0    31 5547.4  6430.8   0.0   0.00   .P
75.90     0    31 5547.4  6430.1   0.0   0.00   .P
76.20     0    31 5547.4  6429.4   0.0   0.00   .P
76.50     0    31 5547.4  6428.6   0.0   0.00   .P
76.80     0    31 5547.4  6427.9   0.0   0.00   .P
77.10     0    31 5547.4  6427.1   0.0   0.00   .P
77.40     0    31 5547.4  6426.4   0.0   0.00   .P
77.70     0    30 5547.4  6425.7   0.0   0.00   .P
78.00     0    30 5547.4  6425.0   0.0   0.00   .P
78.30     0    30 5547.4  6424.2   0.0   0.00   .P
78.60     0    30 5547.4  6423.5   0.0   0.00   .P
78.90     0    30 5547.4  6422.8   0.0   0.00   .P
79.20     0    30 5547.4  6422.1   0.0   0.00   .P
79.50     0    30 5547.4  6421.3   0.0   0.00   .P
79.80     0    30 5547.4  6420.6   0.0   0.00   .P
80.10     0    30 5547.4  6419.9   0.0   0.00   .P
80.40     0    30 5547.4  6419.2   0.0   0.00   .P
80.70     0    30 5547.4  6418.5   0.0   0.00   .P
81.00     0    29 5547.4  6417.8   0.0   0.00   .P
81.30     0    29 5547.4  6417.1   0.0   0.00   .P
81.60     0    29 5547.3  6416.4   0.0   0.00   .P
81.90     0    29 5547.3  6415.7   0.0   0.00   .P
```

```
  82.20     0    29 5547.3  6415.0   0.0   0.00   .P
  82.50     0    29 5547.3  6414.3   0.0   0.00   .P
  82.80     0    29 5547.3  6413.6   0.0   0.00   .P
  83.10     0    29 5547.3  6412.9   0.0   0.00   .P
  83.40     0    29 5547.3  6412.2   0.0   0.00   .P
  83.70     0    29 5547.3  6411.5   0.0   0.00   .P
  84.00     0    29 5547.3  6410.8   0.0   0.00   .P
  84.30     0    29 5547.3  6410.2   0.0   0.00   .P
  84.60     0    28 5547.3  6409.5   0.0   0.00   .P
  84.90     0    28 5547.3  6408.8   0.0   0.00   .P
  85.20     0    28 5547.3  6408.1   0.0   0.00   .P
  85.50     0    28 5547.3  6407.4   0.0   0.00   .P
  85.80     0    28 5547.3  6406.8   0.0   0.00   .P
  86.10     0    28 5547.3  6406.1   0.0   0.00   .P
  86.40     0    28 5547.3  6405.4   0.0   0.00   .P
  86.70     0    28 5547.3  6404.8   0.0   0.00   .P
  87.00     0    28 5547.3  6404.1   0.0   0.00   .P
  87.30     0    28 5547.3  6403.4   0.0   0.00   .P
  87.60     0    28 5547.3  6402.8   0.0   0.00   .P
  87.90     0    28 5547.3  6402.1   0.0   0.00   .P
  88.20     0    27 5547.3  6401.4   0.0   0.00   .P
  88.50     0    27 5547.3  6400.8   0.0   0.00   .P
  88.80     0    27 5547.3  6400.1   0.0   0.00   .P
  89.10     0    27 5547.3  6399.5   0.0   0.00   .P
  89.40     0    27 5547.3  6398.8   0.0   0.00   .P
  89.70     0    27 5547.3  6398.2   0.0   0.00   .P
  90.00     0    27 5547.3  6397.5   0.0   0.00   .P
  90.30     0    27 5547.2  6396.9   0.0   0.00   .P
  90.60     0    27 5547.2  6396.3   0.0   0.00   .P
  90.90     0    27 5547.2  6395.6   0.0   0.00   .P
  91.20     0    27 5547.2  6395.0   0.0   0.00   .P
  91.50     0    27 5547.2  6394.3   0.0   0.00   .P
  91.80     0    27 5547.2  6393.7   0.0   0.00   .P
  92.10     0    26 5547.2  6393.1   0.0   0.00   .P
  92.40     0    26 5547.2  6392.4   0.0   0.00   .P
  92.70     0    26 5547.2  6391.8   0.0   0.00   .P
  93.00     0    26 5547.2  6391.2   0.0   0.00   .P
  93.30     0    26 5547.2  6390.6   0.0   0.00   .P
  93.60     0    26 5547.2  6389.9   0.0   0.00   .P
  93.90     0    26 5547.2  6389.3   0.0   0.00   .P
  94.20     0    26 5547.2  6388.7   0.0   0.00   .P
  94.50     0    26 5547.2  6388.1   0.0   0.00   .P
  94.80     0    26 5547.2  6387.5   0.0   0.00   .P
  95.10     0    26 5547.2  6386.9   0.0   0.00   .P
  95.40     0    26 5547.2  6386.2   0.0   0.00   .P
  95.70     0    26 5547.2  6385.6   0.0   0.00   .P
  96.00     0    26 5547.2  6385.0   0.0   0.00   .P
  96.30     0    25 5547.2  6384.4   0.0   0.00   .P
  96.60     0    25 5547.2  6383.8   0.0   0.00   .P
  96.90     0    25 5547.2  6383.2   0.0   0.00   .P
  97.20     0    25 5547.2  6382.6   0.0   0.00   .P
  Time    Qin  Qout   Elev    Vol   Area  ExtVel  I         I         I         I         I
                                                 0.       500.     1000.     1500.     2000
          END NRCS-SDH   PLOT

 HYD       FO            4.74Cove Res                               COVRES  1
           0           1.2000                                       STR1    2
                         7.74      7.74      7.84      8.25      9.31   FO D  3
                        11.73     20.36     49.54    130.06    325.02   FO D  4
```

```
                         458.59    540.79    594.66    627.20    644.87   FO D  5
                         652.22    651.18    647.05    642.62    634.58   FO D  6
                         605.49    552.09    496.87    443.06    398.14   FO D  7
                         359.06    325.87    298.36    273.18    250.64   FO D  8
                         232.38    215.72    199.82    185.09    171.45   FO D  9
                         158.83    147.14    136.31    127.58    122.72   FO D 10
                         118.04    113.55    109.22    105.07    101.07   FO D 11
                          97.22     93.53     89.97     86.56     83.27   FO D 12
                          80.44     79.17     77.92     76.69     75.48   FO D 13
                          74.28     73.11     71.96     70.82     69.71   FO D 14
                          68.61     67.53     66.46     65.41     64.38   FO D 15
                          63.37     62.37     61.39     60.46     59.58   FO D 16
                          58.71     57.85     57.01     56.18     55.36   FO D 17
                          54.56     53.77     52.98     52.21     51.46   FO D 18
                          50.73     50.03     49.35     48.68     48.01   FO D 19
                          47.36     46.72     46.08     45.45     44.83   FO D 20
                          44.22     43.62     43.03     42.44     41.87   FO D 21
                          41.33     40.81     40.29     39.78     39.28   FO D 22
                          38.78     38.29     37.81     37.33     36.86   FO D 23
                          36.40     35.94     35.48     35.04     34.60   FO D 24
                          34.16     33.73     33.31     32.91     32.53   FO D 25
                          32.15     31.78     31.41     31.05     30.69   FO D 26
                          30.33     29.98     29.64     29.30     28.96   FO D 27
                          28.63     28.30     27.97     27.65     27.33   FO D 28
                          27.02     26.71     26.40     26.10     25.80   FO D 29
                          25.50     25.21     24.95     24.69     24.43   FO D 30
                          24.18     23.93     23.68     23.44     23.20   FO D 31
                          22.96     22.72     22.48     22.25     22.02   FO D 32
                          21.80     21.57     21.35     21.13     20.91   FO D 33
                          20.70     20.49     20.27     20.07     19.86   FO D 34
                          19.66     19.46     19.26     19.06     18.86   FO D 35
                          18.67     18.48     18.29     18.11     17.93   FO D 36
                          17.77     17.61     17.45     17.30     17.14   FO D 37
                          16.99     16.84     16.69     16.54     16.39   FO D 38
                          16.24     16.10     15.95     15.81     15.67   FO D 39
                          15.53     15.39     15.25     15.12     14.98   FO D 40
                          14.85     14.72     14.59     14.46     14.33   FO D 41
                          14.20     14.08     13.95     13.83     13.71   FO D 42
                          13.59     13.47     13.35     13.23     13.11   FO D 43
                          13.00     12.89     12.77     12.66     12.55   FO D 44
                          12.44     12.33     12.22     12.12     12.01   FO D 45
                          11.90     11.80     11.70     11.61     11.53   FO D 46
                          11.44     11.36     11.28     11.19     11.11   FO D 47
                          11.03     10.95     10.87     10.79     10.71   FO D 48
                          10.63     10.56     10.48     10.40     10.33   FO D 49
                          10.25     10.18     10.10     10.03      9.96   FO D 50
                           9.89      9.81      9.74      9.67      9.60   FO D 51
                           9.53      9.46      9.40      9.33      9.26   FO D 52
 ENDTABLE                                                              P 1,T 2 53


1SITES --------------------------------------------------------------------------
 XEQ 08/28/2020                    COV RES                        WSID= COVRES
 VER 2005.1.8                        Cove Res                       SUBW= CR
 TIME 16:21:21            SITE = STR1              PASS=    1     PART=   6


 ROUTED       BTM WIDTH  MAX ELEV   VOL-MAX  AREA-MAX   AUX.-HP   VOL-AUX.
 RESULTS          FT        FT        ACFT      AC         FT       ACFT
```

```
 NRCS-FBH          30.0   5552.31    7410.0       0.0      3.79     765.6

           PEAK - CFS        Q-PS     Q-AUX.    Q-TOT.
           DISCHARGE  =     126.9     525.3     652.2

                         CRITICAL  CRITICAL   CRITICAL  25% OF Q
                           DEPTH   VELOCITY   SLOPE-Sc     Sc
           AUXILIARY         FT      FT/SEC     FT/FT     FT/FT
           SPILLWAY ---     2.02      7.63     0.008     0.010

           INTEGRITY ANALYSIS - REACH SURFACE PERFORMANCE SUMMARY
            (The auxiliary spillway began flow at time =    9.6 hours
             and peaked at time =   20.4 hours.)


             REACH   3: FROM STATION    115. TO    475. ON   15.4% SLOPE.
                Non-vegetated conditions implied: flow concentration
                 assumed with minimal flow: Time =   12.0 hours.


             REACH   4: FROM STATION    475. TO    610. ON    8.5% SLOPE.
                Non-vegetated conditions implied: flow concentration
                 assumed with minimal flow: Time =   12.0 hours.


             REACH   5: FROM STATION    610. TO   1057. ON    6.6% SLOPE.
                Non-vegetated conditions implied: flow concentration
                 assumed with minimal flow: Time =   12.0 hours.


             REACH   6: FROM STATION   1057. TO   1153. ON   15.6% SLOPE.
                Non-vegetated conditions implied: flow concentration
                 assumed with minimal flow: Time =   12.0 hours.


           INTEGRITY ANALYSIS - HEADCUT EROSION DAMAGE SUMMARY

             The most upstream headcut began at station    115.
             and progressed upstream to station     94.
             The final height of the headcut was    4.3 ft.

             The headcut having the maximum final overfall height began
             at station    475. and progressed upstream to station   414.
             The final height of the headcut was   14.1 ft.

           THE HYDROGRAPH WAS NOT ADJUSTED FOR THE EFFECTS OF EROSION.

                          DURATION    ATTACK   DIST. FROM MOST U/S
                            FLOW       OE/B    HEADCUT TO U/S EDGE
           AUXILIARY         HRS     ACFT/FT     AUX. CREST, FT
           SPILLWAY ---     73.2       28.0            19.

           EXIT CHANNEL FLOW SUPERCRITICAL: MAX VELOCITY=  19.8 FT/SEC
                                            EXIT SLOPE  = 0.154 FT/FT
                                            FLOW DEPTH  =   0.8 FT

           PLOT NRCS-FBH                  1 IN =    500. CFS
                                                  0.      500.     1000.     1500.     2000
  Time    Qin  Qout   Elev    Vol   Area  ExtVel  I         I         I         I         I
```

```
   2.40     0     8 5546.3  6203.0   0.0   0.00   .
   3.60     4     8 5546.3  6203.0   0.0   0.00   .
   4.80    35     8 5546.3  6204.0   0.0   0.00   .I
   6.00    84     8 5546.3  6209.1   0.0   0.00   . I
   7.20   195     9 5546.4  6222.1   0.0   0.00   .   I
   8.40   425    12 5546.5  6251.8   0.0   0.00   .        I
   9.60  1352    20 5546.9  6338.3   0.0   0.00   .                          I
  10.80  3365    50 5548.1  6568.7   0.0   0.00   .P
  12.00  3296   130 5549.8  6890.1   0.0   6.33   .  A
  13.20  2008   325 5550.9  7130.6   0.0  13.72   .      A                                I
  14.40  1331   459 5551.6  7257.3   0.0  16.69   .        A                 I
  15.60  1060   541 5551.9  7326.3   0.0  18.14   .          A         I
  16.80   912   595 5552.1  7367.8   0.0  19.00   .           A     I
  18.00   792   627 5552.2  7391.7   0.0  19.48   .            A  I
  19.20   742   645 5552.3  7404.6   0.0  19.73   .            A I
  20.40   664   652 5552.3  7410.0   0.0  19.84   .            X
  21.60   624   651 5552.3  7409.3   0.0  19.82   .           IA
  22.80   613   647 5552.3  7406.2   0.0  19.77   .           IA
  24.00   611   643 5552.3  7403.0   0.0  19.70   .           IA
  25.20   547   635 5552.2  7397.1   0.0  19.59   .          I A
  26.40   262   605 5552.1  7375.7   0.0  19.16   .    I      A
  27.60    90   552 5551.9  7335.8   0.0  18.33   . I        A
  28.80    24   497 5551.7  7289.4   0.0  17.39   .         A
  30.00     5   443 5551.5  7244.2   0.0  16.39   .        A
  31.20     1   398 5551.3  7202.8   0.0  15.47   .       A
  32.40     0   359 5551.1  7165.4   0.0  14.58   .      A
  33.60     0   326 5551.0  7131.5   0.0  13.75   .      A
  34.80     0   298 5550.8  7100.6   0.0  12.99   .     A
  36.00     0   273 5550.7  7072.4   0.0  12.22   .    A
  37.20     0   251 5550.5  7046.5   0.0  11.46   .    A
  38.40     0   232 5550.4  7022.7   0.0  10.78   .    A
  39.60     0   216 5550.3  7000.6   0.0  10.21   .   A
  40.80     0   200 5550.2  6980.1   0.0   9.67   .   A
  42.00     0   185 5550.1  6961.1   0.0   9.12   .   A
  43.20     0   171 5550.0  6943.5   0.0   8.55   .  A
  44.40     0   159 5550.0  6927.2   0.0   7.97   .  A
  45.60     0   147 5549.9  6912.1   0.0   7.38   .  A
  46.80     0   136 5549.8  6898.2   0.0   6.74   .  A
  48.00     0   128 5549.7  6885.2   0.0   6.18   .  A
  49.20     0   123 5549.7  6872.9   0.0   5.93   . A
  50.40     0   118 5549.6  6861.0   0.0   5.67   . A
  51.60     0   114 5549.6  6849.7   0.0   5.39   . A
  52.80     0   109 5549.5  6838.7   0.0   5.11   . A
  54.00     0   105 5549.5  6828.2   0.0   4.80   . A
  55.20     0   101 5549.4  6818.1   0.0   4.48   . A
  56.40     0    97 5549.4  6808.3   0.0   4.12   . A
  57.60     0    94 5549.3  6799.0   0.0   3.73   . A
  58.80     0    90 5549.3  6790.0   0.0   3.28   . A
  60.00     0    87 5549.2  6781.3   0.0   2.74   . A
  61.20     0    83 5549.2  6773.0   0.0   1.98   . A
  62.40     0    80 5549.1  6765.0   0.0   0.00   . A
  63.60     0    79 5549.1  6757.2   0.0   0.00   . A
  64.80     0    78 5549.1  6749.5   0.0   0.00   . A
  66.00     0    77 5549.0  6741.9   0.0   0.00   . A
  67.20     0    75 5549.0  6734.4   0.0   0.00   . A
  68.40     0    74 5548.9  6727.1   0.0   0.00   .A
  69.60     0    73 5548.9  6719.9   0.0   0.00   .A
  70.80     0    72 5548.9  6712.8   0.0   0.00   .A
  72.00     0    71 5548.8  6705.8   0.0   0.00   .A
```

```
  73.20     0    70 5548.8  6699.0   0.0   0.00   .A
  74.40     0    69 5548.8  6692.2   0.0   0.00   .A
  75.60     0    68 5548.7  6685.6   0.0   0.00   .A
  76.80     0    66 5548.7  6679.0   0.0   0.00   .A
  78.00     0    65 5548.7  6672.6   0.0   0.00   .A
  79.20     0    64 5548.6  6666.2   0.0   0.00   .A
  Time    Qin  Qout   Elev    Vol   Area  ExtVel  I         I         I         I         I
                                                  0.      500.     1000.     1500.     2000
         END NRCS-FBH   PLOT
 --------------------------------------------------------------------------------

 Inflow Hyd 1 PSH-Peak =         39.99 CFS  at  143.00 hrs.,  Location Point

 Inflow Hyd 1 SDH-Peak =         65.90 CFS  at    8.10 hrs.,  Location Point

 Inflow Hyd 1 FBH-Peak =        652.22 CFS  at   19.20 hrs.,  Location Point
HYDOUT   1     STR1

1SITES....JOB NO.  1 COMPLETE.
 --------------------------------------------------------------------------------

 COVRES        COV RES

       0 SUBWATERSHED(S) ANALYZED.

       1 STRUCTURE(S) ANALYZED.

       3 HYDROGRAPHS ROUTED AT LOWEST SITE.

       0 TRIALS TO OBTAIN BOTTOM WIDTH FOR SPECIFIED STRESS OR VELOCITY.

 ********************************************************************************



 SITES.....COMPUTATIONS COMPLETE


                               SUMMARY TABLE  1          SITES VERSION 2005.1.8
                              ----------------                DATED 01/01/2005


 WATERSHED ID                       RUN DATE                           RUN TIME
 ------------                       --------                           --------
 COVRES                           08/28/2020                           16:21:21

 >>>   SITE   SUBWS   SUBWS DA   CURVE    TC   TOTAL DA   TYPE    STRUC    <<<
       ID       ID     (SQ MI)    NO.    (HRS)  (SQ MI)  DESIGN   CLASS
       -----   ----   --------   -----   ----   -------  -----    -----
       STR1     CR        4.74      0.   0.00      4.74    TR60     C

 PASS  DIA./  AUX.CREST  BTM.  MAX.    MAX.    EMB.  INTEGR.*  EXIT*    TYPE
  NO.  WIDTH    ELEV    WIDTH   HP     ELEV    VOL.   DIST.     VEL.     HYD
      (IN/FT)   (FT)     (FT)  (FT)    (FT)    (CY)   (FT)   (FT/SEC)
 ----  -----  -------  ------  ----  -------  -------  -----  ------  ---------
    1   30.0   5548.5    30.0   3.8   5552.3       0.    19.    19.8  NRCS-FBH
```

```
 *  INTEGRITY DIST. AND EXIT VEL. VALUES ARE BASED ON THE ROUTED
    HYDROGRAPH SHOWN UNDER TYPE HYD.




 SITES.......SUMMARY TABLE 1 COMPLETED.


                   NRCS  SITES    VERSION 2005.1.8  ,01/01/2005
                            COVRES   FILES

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APPENDIX E-18

COVE DAM OPINION OF PROBABLE COST

COVE DAM
OPINION OF PROBABLE COST
RB&G - March 1, 2019
Dam crest = 5550 ft, high water = 5545 ft, ~6,000 ac-ft storage

Item	Quantity	Unit	Unit Price	Total Price
Mobilization & Demobilization (5%)	1	Lump Sum	$ 925,610.00	$ 925,610
Excavation	644,000	CU. YD.	$ 3.30	$ 2,125,200
Foundation Preperation	12,000	SQ. YD.	$ 11.00	$ 132,000
Earthfill, Zone I – Dam Embank.	1,575,000	CU. YD.	$ 4.00	$ 6,300,000
Earthfill, Zone II – Filter / Drain*	82,000	CU. YD.	$ 50.00	$ 4,100,000
Roadbase / Riprap Bedding	19,000	CU. YD.	$ 36.00	$ 684,000
Rock Riprap	28,000	CU. YD.	$ 47.00	$ 1,316,000
Grout Curtain	31,500	LIN. FT.	$ 100.00	$ 3,150,000
Outlet Pipe	550	LIN. FT.	$ 300.00	$ 165,000
Spillway	1	Lump Sum	$ 500,000	$ 500,000
Instrumentation	1	Lump Sum	$ 40,000	$ 40,000
			SUBTOTAL	**$ 19,438,000**
			Contingency (20%)	**$ 3,887,000**
			Engineering, Legal and Fiscal (15%)	**$ 2,916,000**
			Land Rights Additional Ground Purchase Cost (Approx. 100 Acres @ $6,000/acre)	**$ 600,000**
			Proportinal Cost of Road	**$ 1,310,000**
			TOTAL	**$ 28,151,000**

MP Structure			
Construction	$19,491,600	$4,542,400	$24,034,000
Engineering	$2,437,000	$568,000	$3,005,000
Land Rights	$487,000	$113,000	$600,000
SubTotal	$22,415,600	$5,223,400	$27,639,000
Road			
Construction	$944,000	$220,000	$1,164,000
Engineering	$146,000		$146,000
Subtotal	$1,090,000	$220,000	$1,310,000
SubTotal MP Structure	$23,505,600	$5,443,400	$28,949,000

Average Annual Cost Calculations

Amort, 2.5%, 100 years =	0.0273
Amort, 2.5%, 103 years =	0.0271
AAC for Dam @ 103 yrs=	$763,000
Operation And Maintenance	$12,000
Replacement	$400
Total AAC	**$775,400**

amort 100 yrs =	$769,000
amort 103 yrs =	$763,000

The dam and reservoir are anticipated to have a 100-year life, but the gate structure will probably require replacement once every 50 years. An amount of $50,000 should be budgeted for this item. /1

PV of 1, 2.5%, 50 years hence =			0.2909
times	$50,000	=	$14,545

0.0271

We anticipate the operation and maintenance of the Cove Reservoir and associated facilities will require and average of 2 man-days per month. It is anticipated that a budget should be provided of $1,000 per month or $12,000 per year. /1

/1 See MEMO dated 5/19/2020 fro Alpha Engineering to Scott Hoag

APPENDIX E-19

COVE RESERVOIR RECREATION FACILITIES PROBABLE COST

Cove Reservoir Recreation Improvements (No Utilities) Kane County Water Conservancy District Preliminary Engineer's Opinion of Probable Cost 5-21-19

ITEM	DESCRIPTION	QUANTITY	UNITS	UNIT PRICE	TOTAL
1	Mobilization at 5%	1	L.S.	$21,350.00	$21,350
2	Excavation and Subgrade Prep	88,000	S.F.	$1.50	$132,000
3	6" Reinforced Concrete (Boat Ramp)	6,500	S.F.	$10.00	$65,000
4	6" Untreated Base Course (Boat Ramp)	6,500	S.F.	$1.00	$6,500
5	6" Untreated Base Course (Parking)	28,500	S.F.	$1.00	$28,500
6	6" Untreated Base Course (Roads)	53,000	S.F.	$1.00	$53,000
7	Camp/RV Site Facilities (Barbeque Grill, Table, Fire Pit)	20	Each	$1,000.00	$20,000
8	Pavilion	1	Each	$50,000.00	$50,000
9	Signage	5	Each	$400.00	$2,000
10	Restroom Facility (Assume septic tank	2	Each	$35,000.00	$70,000
				Subtotal	$448,350
				Contingency (20%)	$89,670
				Engineering, Legal, and Fiscal (15%)	$67,253
SCHEDULE A TOTAL					**$605,000**
			Proportional road cost[1/]		**$308,000**
			Land Rights		**$120,000**
			Total Recreation		**$1,033,000**

Average Cost Calculations

Amort, 2..5%, 100 years =		0.0273
Amort, 2.5%, 103 years =		0.0271
AAC for Recreation Facilities		$28,000
Operation And Maintenance		$12,000
Replacement		$0
	Total	$40,000
Amort, 2..5%, 100 years =		$28,000
Amort, 2.5%, 103 years =		$28,000

The recreation component of the project will most likely require 8 man-days per month (lower skill level) for 6 months to maintain the rest rooms and camp sites which would be an annual cost of approximately $12,000

/1 See MEMO dated 5/19/2020 fro Alpha Engineering to Scott Hoag

APPENDIX E-20

COVE RESERVOIR ACCESS ROAD PROBABLE COST

Cove Reservoir Access Road Kane County Water Conservancy District Preliminary Engineer's Opinion of Probable Cost 5-21-19

ITEM	DESCRIPTION	QUANTITY	UNITS	UNIT PRICE	TOTAL
1	Mobilization at 5%	1	L.S.	$ 57,060	$57,060
2	Excavation and Subgrade Prep	145,000	C.Y.	$5.00	$725,000
3	6" Untreated Base Course	440,726	S.F.	$0.85	$374,617
4	Misc. Culverts	1	L.S.	$40,000.00	$40,000
5	Signage	4	Each	$400.00	$1,600
				SUBTOTAL	$1,198,277
		Contingency (20%)			$239,655.42
		Engineering, Legal Fiscal (15%)			$179,741.57
				TOTAL	$1,618,000

Amort, 2..5%, 100 years =				0.0273					
Amort, 2.5%, 103 years =				0.0271	AAC				
	Const Cost		Total Cost		103 yrs	100 yrs			0.0273
Reservoir Access	$1,310,000	80.96%			$35,500	$35,800	$35,763	$35,501.0000	
Recreation Road	$308,000	19.04%			$8,300	$8,300			
Total	$1,618,000		$1,378,000		$43,800	$44,100			

Recreation and Access Road Improvements

Attached are the estimates for the recreation components and access road around the proposed Cove Reservoir. The recreation area consists of a boat ramp including parking area, 20 campground spots, pavilion, and restrooms is $605,000. There is also an access road being constructed around the reservoir that is approximately 17,850 feet in length with an estimated cost of $1,618,000. Of this amount approximately 3,400 feet of the roadway is needed for access to the recreation facilities. The proportionate cost for the roadway needed for the recreation facilities would be $308,000. The remainder of the roadway is needed to re-establish access to properties surrounding the reservoir that was eliminated by construction of the reservoir

See MEMO of 5/31/2019 from Alpha Engineering to Scott Hoag

	Cost	%	
Total Cost of Road=	$1,618,000		
Cost of Road for Recreation Facilities=	$308,000	19%	Assigned to Recreation Facilities Cost
Cost of Road for Reservoir Access=	$1,310,000	81%	Assigned to Cove Reservoir Construction

APPENDIX E-21

GLENDALE PIPING PROBABLE COST

Glendale Piping
Kane County Water Conservancy District
Preliminary Engineer's Opinion of Probable Cost 8-7-2020

ITEM	DESCRIPTION	QUANTITY	UNITS	UNIT PRICE	TOTAL
1	Mobilization at 5%	1	L.S.	$28,150	$28,150
2	Replace Line from Existing Glendale Hydro to Orderville Diversion Dam w/ 14" Pipeline	9,200	L.F.	$50	$460,000
3	Replace Existing 18" and 14" BV Valves with Gate Valves	2	Each	$8,000	$16,000
4	Clean Pipeline	1	L.S.	$22,000	$22,000
5	Furnish and Install 12" Plunger Valve and Vault	1	L.S.	$55,000	$55,000
6	Power Interconnection	1	Each	$10,000	$10,000
				Subtotal	$591,150
				Contingency (20%)	$118,230
				Engineering, Legal Fiscal (15%)	$88,673
				SCHEDULE A TOTAL	**$798,000**

Average Annual Cost - Piping

Amort, 2.5%, 103 yrs	0.0273	$22,000		Amort, 2.5%, 100 yrs =	$22,000	
O&M		$6,000				
Replacement		$6,000	@ 50 years = 2.5, PV of 1, 50 yrs			
TOTAL		$34,000				
				1186	882	74.4%
				15700	$ 11,676	

Glendale Piping Net Benefits	
Average Annual Benefit	$15,700
Average Annual Cost	$34,000
Net Benefit	($18,300)

3) There will be additional water available to run through the Quail Creek piping system to provide additional power production through existing hydro facilities. The additional 1,186 AF of yield being provided to the WCWCD reservoirs will produce an additional 313,200 Kw-Hrs of energy (average of 15 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 a value of $15,660.

7) We do not see any change to the power production of the existing Orderville Hydro facility except for the additional yield that is being provided to the WCWCD from the Cove Reservoir. This will provide for a flow of 15 cfs over 40 days which would provide for the addition of approximately 172,800 kW-Hrs. The annual revenue derived from the additional production would be $6,912.

APPENDIX E-22

COVE RESERVOIR TOTAL PROJECT COST

Total Project Cost - Cove Reservoir

Item	**Total Cost**	**AAC**
Multipurpose Structure [1/]	$28,151,000	$775,400
Recreation Facilities [/2]	$1,033,000	$40,000
Road Cost - $1,618,000		
Glendale Piping	$798,000	$34,000
Total	**$29,982,000**	**$849,400**

$809,400

<--Apportioned to Multipurpose Structure - $1,310,000 and $308,000 to Recreation

[1/] Includes $600,000 for Land Rights and $1,310,000 for Proportional Road Cost - See Cost of Road tab

[2/] Includes $120,000 for Land Rights and $308,000 for Proportional Cost of Road

	O&M	Replace	total	Amort,2.5%,103yrs	AAC		
Dam	$12,000	$400	$12,400			dam*	$28,151,000
Rec	$12,000		$12,000			rec*	$1,033,000
Glendale	$6,000	$6,000	$12,000			road	$1,618,000
total	$30,000	$6,400	$36,400	$812,512	$849,000	glendale	$798,000
							$29,982,000

* cost of road included in dam and rec

Cove Reservoir Project Costs [/1]

	engineering		Construction	SubTotal 1	Land Rights	SubTotal 2
MPS	$2,916,000		$23,325,000	$26,241,000	$600,000	$26,841,000
access road	$180,000		$1,438,000	$1,618,000		$1,618,000
glendale piping	$89,000		$709,000	$798,000		$798,000
recreation	$67,000		$538,000	$605,000	$120,000	$725,000
Land Rights						$0
	$3,320,000		$26,010,000	$29,262,000	$720,000	$29,982,000

/1 see Cost Estimates for Appendix D & E

APPENDIX E-23

PROJECT COST SUMMARY

Project Costs

	Dam		Rec		Glendale		Road		Total
Cost Est	$ 19,438,000		$448,000		$591,000		$1,198,000		$ 21,675,000
Contingency	$ 3,887,000		$90,000		$118,000		$240,000		$ 4,335,000
Engineering	$ 2,916,000		$67,000		$89,000		$180,000		$ 3,252,000
Land Right	$ 600,000		$120,000						$ 720,000
Road	$ 1,310,000		$308,000						$ 1,618,000
Total	$ 28,151,000		$1,033,000		$798,000				$ 29,982,000

Average Annual Cost

Amortization	$ 763,000		$ 28,000		$ 22,000				$ 813,000
O&M	$ 12,000		$ 12,000		$ 6,000				$ 30,000
Replace	$ 400				$ 6,000				$ 6,400
Tot AAC	$775,400		$40,000		$34,000				$849,400

*Cost of Road ($1,310,000 for the dam and $308,000 for the rec facilities = $1,618,000) is included in the amortization for dam and rec

Benefits

Irrigation	$ 826,100								$ 826,100
Recreation			$ 176,000						$ 176,000
Glendale					$ 11,200				$ 11,200
Total	$826,100		$176,000		$ 11,200				$ 1,013,300

Net Benefits	$163,900
B:C Ratio	1.19

APPENDIX E-24

ECONOMIC ANALYSIS WORKBOOKS

Economic Analysis Workbooks

1 Cost Estimates for Appendix D & E

This Workbook contains 5 sheets with the engineers cost estimates for each of the project components and are totaled in the Total Project Cost sheet.

- Cost of Dam
- Recreation Facilities
- Cost of Road
- Glendale Piping
- Total Project Cost

2 Cove SCRB - 082020

This Workbook details the cost allocation process.

3 Incremental Analysis

This Workbook describes the incremental analysis moving from a 3,000 acft reservoir to a 6,055 actf reservoir

4 Irrigation Benefit Analysis

This Workbook details the Irrigation Analysis in a series of sheets showing Alfalfa and Alfalfa Establishment for Kane and Washington Counties

Crop budgets are from: Budget prepared by: E. Bruce Godfrey, Cody Bingham and Kevin Heaton
go to: https://extension.usu.edu/apec/agribusiness-food/crops
scroll to *Kane* , click *Alfalfa*

and for Washington County Budget prepared by: E. Bruce Godfrey, Cody Bingham and Dean Miner
goto: https://extension.usu.edu/apec/agribusiness-food/crops
scroll to *Washington* , click *alfalfa*

5 Recreation Analysis Spreadsheets

The sheets in this workbook describe the recreation analysis and provide traffic counts on Highway 89 through Oderville, Mt Carmel and Glendale. There is also National Park use data and State Park use data.

6 Work Plan Tables - 10-14-2020 for plan-ea

The sheets in this Workbook are the basis for tables in the Plan/EA

APPENDIX E-25

COVE SCRB TABLE

9/29/2020 10/28/2020

Example 6–1 Separable cost - remaining benefit method

Table 6–1 Separable cost - remaining benefit cost allocation

		Purposes			
Step		Flood Prevention	Irrigation	Recreation	Total
1	Benefits	$ 10,000	$ 8,000	$ 4,000	$ 22,000
2	Alternative cost	$ 8,000	$ 8,000	$ 10,000	$ 26,000
3	Lesser of step 1&2	$ 8,000	$ 8,000	$ 4,000	$ 20,000
4	Separable cost	$ 1,000	$ 6,000	$ 3,000	$ 10,000
5	Remaining benefits	$ 7,000	$ 2,000	$ 1,000	$ 10,000
5a	Percentage of remaining benefits	70%	20%	10%	100%
6	Allocated joint cost	$ 5,600	$ 1,600	$ 800	$ 8,000
7	Total allocated cost	$ 6,600	$ 7,600	$ 3,800	$ 18,000

Cove Reservoir Separable cost - remaining benefit (SCRB) cost allocation

		Purposes		
Step		Irrigation	Recreation	Total
1	Benefits	$30,670,000	$6,446,886	$37,116,886
2	Alternative cost	$28,226,000	$27,154,000	$55,380,000
3	Lesser of step 1&2	$28,226,000	$6,446,886	$34,672,886
4	Separable cost	$1,661,000	$1,036,000	$2,697,000
5	Remaining benefits	$26,565,000	$5,410,886	$31,975,886
5a	Percentage of remaining benefits	83%	17%	100%
6	Allocated joint cost	$22,668,000	$4,617,000.00	$ 27,285,000
7	Total allocated cost	$ 24,329,000	$ 5,653,000	$29,982,000
Percent of Total Cost for each purpose =		81.1%	18.9%	100.00%

Step 1 Report the benefits for each purpose for which the plan was formulated. Benefits are shown in present value terms.

Step 2 The alternative cost is the financial cost of achieving the same or equivalent benefits by a single- purpose project.

Step 3 Record the lesser of the benefits or the alternative cost, by purpose.

Step 4 Separable cost is the cost of adding each purpose to the multiple purpose project. This figure indicates the minimum cost that will be allocated to the purpose. If the separable cost for a purpose exceeds the amount shown in step 3, the project contains an infeasible purpose.

Step 5 Remaining benefits are equal to the difference between the amount in step 3 and the separable cost (step 4).

Step 5a Calculate the remaining benefits for a purpose as a percentage of the total remaining benefits.

Step 6 The allocated joint cost in the total column is the difference between project financial cost and the sum of the separable costs for all of the purposes. The total allocated joint cost is distributed to each purpose by the percentage shown for that purpose in step 5a.

Step 7 Total allocated cost for each purpose is the sum of the separable cost and allocated joint cost for the purpose.

Separable cost—The difference between the cost of a multiple-purpose project and the cost of the project with that purpose omitted. In calculating separable cost, each purpose should be treated as if it were the last addition of the multiple-purpose project. This calculation shows the added cost of increasing project size, changes in design, or other factors that would be necessary to add to the purpose to the project.

Joint cost—The difference between the cost of the multiple-purpose project and the sum of the separable costs for each purpose.

Alternative cost—The least cost method of achieving by use of a single purpose project, the same or equivalent benefits that accrue to that purpose in the multiple-purpose project. The alternative single-purpose project should be realistically devised; e.g., it should be one that could be built and one that could provide equivalent benefits. However, the physical project may be entirely different from the multipurpose project.

APPENDIX E-26

COVE RESERVOIR BENEFITS AND COSTS

Cove Reservoir Benefits and Costs

Cove Reservoir Project Costs

					Proportional Cost of Access Road	Glendale Piping	Land Rights	Cost of Dam	Irr Cost	Rec Cost
Dam Construction/1			$28,946,000	--->	$1,310,000	$798,000	$720,000	$26,118,000	$28,226,000	$27,154,000
Recreation/2			$1,036,000	--->	$308,000					
TOTAL			$29,982,000		$1,618,000			$1,661,050		

/1 Includes Reservoir Construction, Proportional Cost of Access Road,
Glendale Piping and Land Rights

/2 Includes Proportional Cost of Access Road

Project Costs/1

MPS		$28,946,000
Recreation Facilities		$1,036,000
Glendale Piping*		$798,000
		$29,982,000

/1 See Cost Estimates for Appendix D and E and notes below

*Glendal Piping included in MPS

13) We anticipate the following cost allocation for the Cove Reservoir:

Irrigation 5700 AF/ 6000 AF x $28,271,000 =	$27,284,950
Recreation 300 AF/ 6000 AF x $28,271,000 =	$1,413,550

Cove Reservoir Project Benefits

Agricultural Water Management/1		$826,100
Recreation/2		$176,000
Glendale Piping /3		$11,200
TOTAL		$1,013,300

/1 See Irrigation Benefit Anaysis

/2 See Recreation Analysis Spreadsheets

/3 See Cost Estimates for Appendix D and E and attached paragraph

Average Annual Project Costs

		Amort	OM&R	Total AAC
	MPS/1	$785,000	$24,400	$809,400
Recreation Facilities/2		$28,000	$12,000	$40,000
	TOTAL	$813,000	$36,400	$849,400

Cove Reservoir B/C Ratio and Net Benefits

Project Benefits		$1,013,300
Project Costs		$849,400
B/C Ratio		1.19
Net Benefits		$163,900

/1c FW: Virgin River Simulation
Yahoo/Inbox
Brent Gardner <brentgardner@alphaengineering.com>
To:Brian Parker,Ronald Bolander,Scott Hoag Jr
Cc:Michael Noel,Zach Renstrom,Dirk Clayson
Mon, Sep 28 at 1:49 PM

I have talked with Scott Hoag and he indicated that going to the yield of 1638 AF with 756 AF going to the KCWCD and 882 AF going to the WCWCD will still provide for a benefit cost ratio of over 1.

Operation and Maintenance Costs from MEMO of 5/31/2019 from Alpha Engineering to Scott Hoag.
8) We anticipate the operation and maintenance of the Cove Reservoir and associated facilities will require and average of 2 man-days per month. It is anticipated that a budget should be provided of $1,000 per month or $12,000 per year.
9) The KCWCD currently has a functioning hydroelectric facility which will require similar costs for operation and maintenance as the proposed Glendale Hydro. The budget for O&M for the existing hydro plant is $4,000 per year.
10) The recreation component of the project will most likely require 8 man-days per month (lower skill level) for 6 months to maintain the rest rooms and camp sites which would be an annual cost of approximately $12,000.

Repair and Replacement Costs from MEMO of 5/31/2019 from Alpha Engineering to Scott Hoag.
11) The dam and reservoir are anticipated to have a 100-year life, but the gate structure will probably require replacement once every 50 years. An amount of $50,000 should be budgeted for this item.
12) It is anticipated the piping and hydroelectric facility will have a 50-year life. The costs associated with the piping and mechanical and electrical components of these facilities has a present value of approximately $656,000.

There is also an access road being constructed around the reservoir that is approximately 17,850 feet in length with an estimated cost of $1,618,000. Of this amount approximately 3,400 feet of the roadway is needed for access to the recreation facilities. The proportionate cost for the roadway needed for the recreation facilities would be $308,000.

APPENDIX E-27

COVE SCRB PROJECT SUMMARY

Amortization

amort100	0.0273
amort3	0.0271
PV150	0.2909

Project Costs

	Dam		Rec		Glendale		Road		Total
Cost Est	$ 19,438,000		$448,000		$591,000		$1,198,000		$ 21,675,000
Contingency	$ 3,887,000		$90,000		$118,000		$240,000		$ 4,335,000
Engineering	$ 2,916,000		$67,000		$89,000		$180,000		$ 3,252,000
Land Right	$ 600,000		$120,000						$ 720,000
Road	$ 1,310,000		$308,000						$ 1,618,000
Total	$ 28,151,000		$1,033,000		$798,000		$1,618,000		$ 29,982,000

Average Annual Cost

Amortization	$ 763,000		$ 28,000		$ 22,000				$ 813,000
O&M	$ 12,000		$ 12,000		$ 6,000				$ 30,000
Replace	$ 400				$ 6,000				$ 6,400
Tot AAC	$775,400		$40,000		$34,000				$849,400

*Cost of Road ($1,310,000 for the dam and $308,000 for the rec facilities = $1,618,000) is included in the amortization for dam and rec

Benefits

Irrigation	$ 826,100								$ 826,100
Recreation			$ 176,000						$ 176,000
Glendale					$ 11,200				$ 11,200
Total	$826,100		$176,000		$ 11,200				$ 1,013,300

Net Benefits	$163,900
B:C Ratio	1.19

APPENDIX E-28

INCREMENTAL ANALYSIS—DAM

Dam crest = 5531 ft, high water = 5526 ft, ~3,000 ac-ft storage

Item	DESCRIPTION	Quantity	Unit	Unit Price	Total Price
1	Mobilization & Demobilization (5%)	1	Lump Sum	$ 712,845	$ 712,845
2	Excavation	523,000	CU. YD.	$ 3	$ 1,725,900
3	Foundation Preperation	11,000	SQ. YD.	$ 11	$ 121,000
4	Earthfill, Zone I – Dam Embank.	1,050,000	CU. YD.	$ 4	$ 4,200,000
5	Earthfill, Zone II – Filter / Drain*	64,000	CU. YD.	$ 50	$ 3,200,000
6	Roadbase / Riprap Bedding	15,000	CU. YD.	$ 36	$ 540,000
7	Rock Riprap	20,000	CU. YD.	$ 47	$ 940,000
8	Grout Curtain	29,000	LIN. FT.	$ 100	$ 2,900,000
9	Outlet Pipe	300	LIN. FT.	$ 300	$ 90,000
10	Spillway	1	Lump Sum	$ 500,000	$ 500,000
11	Instrumentation	1	Lump Sum	$ 40,000	$ 40,000

SUBTOTAL	$ 14,969,745
Contingencies(Estimated at 20% at EA Stage) 20%	$ 2,993,949
Engineering, Legal and Fiscal (15%)	$ 2,245,462
Land Rights	$ 600,000
Proportional Road Cost	$ 1,310,000
TOTAL	**$ 22,119,000**

Amortization of Installation Cost at 2.5% for 100 years	0.0273	$ 604,000
Operation and Maintenance Cost		$ 12,000
Replacement Cost		$ 400
		$ 616,400

Cove Reservoir Recreation Improvements (No Utilities) Kane County Water Conservancy District Preliminary Engineer's Opinion of Probable Cost 5-21-19 6055 AF Reservloir

ITEM	DESCRIPTION	QUANTITY	UNITS	UNIT PRICE	TOTAL
1	Mobilization at 5%	1	L.S.	$21,350.00	$21,350
2	Excavation and Subgrade Prep	88,000	S.F.	$1.50	$132,000
3	6" Reinforced Concrete (Boat Ramp)	6,500	S.F.	$10.00	$65,000
4	6" Untreated Base Course (Boat Ramp)	6,500	S.F.	$1.00	$6,500
5	6" Untreated Base Course (Parking)	28,500	S.F.	$1.00	$28,500
6	6" Untreated Base Course (Roads)	53,000	S.F.	$1.00	$53,000
7	Camp/RV Site Facilities (Barbeque Grill, Table, Fire Pit)	20	Each	$1,000.00	$20,000
8	Pavilion	1	Each	$50,000.00	$50,000
9	Signage	5	Each	$400.00	$2,000
10	Restroom Facility (Assume septic tank system)	2	Each	$35,000.00	$70,000
				Subtotal	$448,350

	Contingency (20%)	$89,670
	Engineering, Legal, and Fiscal (15%)	$67,253
SCHEDULE A TOTAL	**TOTAL**	**$605,000**
	Land Rights	**$120,000**
	Proportional road cost$^{1/}$	**$308,000**
	Total Recreation	**$1,033,000**

1/ From Cost Estimates for Appendix D & E.xlsx Cost of Road

Cove Reservoir Recreation Improvements (No Utilities) Kane County Water Conservancy District Preliminary Engineer's Opinion of Probable Cost 5-21-19 3000 AF Reservloir

ITEM	DESCRIPTION	QUANTITY	UNITS	UNIT PRICE	TOTAL
1	Mobilization at 5%	1	L.S.	$14,500	$14,500
2	Excavation and Subgrade Prep	44,000	S.F.	$1.50	$66,000
3	6" Reinforced Concrete (Boat Ramp)	6,500	S.F.	$10.00	$65,000
4	6" Untreated Base Course (Boat	6,500	S.F.	$1.00	$6,500
5	6" Untreated Base Course (Parking)	15,000	S.F.	$1.00	$15,000
6	6" Untreated Base Course (Roads)	40,000	S.F.	$1.00	$40,000
7	Camp/RV Site Facilities (Barbeque Grill, Table, Fire Pit)	10	Each	$1,000.00	$10,000
8	Pavilion	1	Each	$50,000.00	$50,000
9	Signage	5	Each	$400.00	$2,000
10	Restroom Facility (Assume septic tank system)	1	Each	$35,000.00	$35,000

14475

Subtotal	$304,000
Contingency (20%)	$60,800
Engineering, Legal, and Fiscal (15%)	$45,600
TOTAL	**$410,400**
Proportional road cost$^{1/}$	**$308,000**
Land Rights	**$120,000**
Total Recreation	**$838,000**

/1 See Cost Estimates for Appendix D and E. Includes MPS at $26,241,000; Land Rights at $600,000; proportional Road Cost at $1,310,000 =

/2 See Cost Estimates for Appendix D and E. Includes Facilities at $605,000; Land Rights at $120,000; Proportional Road Cast at $308,000 =

Average Amnual Cost Calculations

Amort, 2.5%, 100 years =	0.0273
AAC for Recreation Facilities	$28,000
Proportional Road Cost	$8,000
Operation And Maintenance	$12,000
Replacement	$0
Total	$48,000

Average Amnual Cost Calculations

Amort, 2.5%, 100 years =	0.0273
AAC for Recreation Facilities	$23,000
Proportional Road Cost	$8,000
Operation And Maintenance	$6,000
Replacement	$0
Total	$37,000

/1 See Cost Estimates for Appendix D and E. Includes MPS at $26,241,000; Land Rights at $600,000; proportional Road Cost at $1,310,000 =	$28,151,000
/2 See Cost Estimates for Appendix D and E. Includes Facilities at $605,000; Land Rights at $120,000; Proportional Road Cast at $308,000 =	$1,033,000
Glendale Piping =	$798,000
Total	$29,982,000

APPENDIX E-29

INCREMENTAL ANALYSIS—IRRIGATION BENEFITS

Brent Gardner <brentgardner@alphaengineering.com>
To:Ronald Bolander
Cc:Brian Parker,Scott Hoag Jr
Mon, Oct 5 at 3:37 PM

The three irrigation companies in Kane County have a water right to irrigate roughly 1,110 acres of ground between them. The latest DOWR model shows an increase of yield of 1,638 AF of water. We are proposing that 882 AF of that yield goes to WCWCD – St. George/Washington Canal and 756 AF goes to three irrigation companies namely Glendale, Orderville, and Mt. Carmel who have a right to irrigated 1,110 acres. When we looked at this originally we thought we would put the same ratio of benefit to acreage that the KCWCD has. However we can't separate the water right into a smaller service area. I have asked Scott to put the 882 AF of increased water right over the total 10,000* acres being irrigated by the St. George/Washington Canal. The water would be provided when stream flows are below the on farm requirement in July and August when water is needed thus providing increased production to the acreage being served.

* see change beginning at N9

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 From 10/22/2020 email to Scott Hoag from Alpha Engineering

1) The cost estimate for the Cove Reservoir is $26,961,000 with 6,055 AF capacity. For an incremental cost analysis an estimate of the reservoir with 3,000 AF was provided. The estimated cost of the reservoir with this capacity was $20,209,000. The smaller reservoir would also have a decreased yield associated with it as there would not be enough capacity in the reservoir to carry over through drought years. It is anticipated you would only have half the yield or 1,056 AF additional yield. The cost per acre foot yield for the smaller reservoir would be approximately $19,000 and the larger reservoir $12,700

See MEMO from Alpha Engineering to Scott Hoag dated 8072020

The cost estimate for Cove Reservoir is currently $28,949,000 and includes road ($1,310,000), Glendale Piping ($798,000) and land rights ($600,000)
see Cost Estimates for Appendix D

Cove Reservoir, para 1 - The 1056 AF is more than the 926 AF for the Kane Co irrigators. So for the inc anal can we assume a full irrigation supply for Kane Co and none for WA Co? I think the yield of 1,056 AF would be pro-rated between the two districts as it was with the larger reservoir. 593 AF to WCWCD and 463 AF to KCWCD.

Email from Alpha Engineering to Scott Hoag dated 8172020

3) The Division of Water Resources updated their model in February 2020 which now indicates an increased yield in the system of 2,112 AF. As modeled 926 AF would be distributed to Kane County irrigators and 1,186 AF to WCWCD and the irrigators they serve.

See MEMO from Alpha Engineering to Scott Hoag dated 8072020

total	kcwcd	wcwcd
1638	756	882
78%	28%	36%
2112	926	1186
	44%	56%

Everything has changed with the DOWR 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.

Email fro m Alpha Engineering, October 22,2020 to Scott Hoag

	kcwcd	wcwcd	total	1632
6055 acft	756	882	1638	77%
3000 acft				
50% reduction				

For purposes of an incremental analysis for a 3000 AF Cove Reservoir, irigation net benefits for Kane County would 50% of the benefis assessed for a 6055 AF Cove Reservoir.

Kane County Irrigation Benefits - 6055 acft Reservoir = $118,800

Kane Co Irrigation Benefits for 3000 AF reservoir= $59,400

$118,800
$707,300

For purposes of an incremental analysis for a 3000 AF Cove Reservoir, irigation net benefits for Washington County would 50% of the benefis assessed for a 6055 AF Cove Reservoir.

Washington County Irrigation Benefits - 6055 acft Reservoir = $707,300

Washington Co Irrigation Benefits for 3000 AF reservoir= $353,650

Total Irrigation Benefits 3000 acft reservoir = $413,050

APPENDIX E-30

INCREMENTAL ANALYSIS—RECREATION BENEFITS

	10/1/2016	10/1/2018	Multiplier
CPI[3/]	241.432	252.146	1.04
2019 Water Resource Discount Rate			2.875%

3/ Consumer Price Index 1983-84 =100

	Kane Co	Glendale	Mt Carmel	Orderville
Total population	7,216	215	60	771
Glendale, Mt. Carmel, Oderville				1046
Kane Co Population net of Glendale, Mt				6,170
Population within 150 mi radius of Orderville[/1]				130,564

1/ From: https://www.freemaptools.com/find-population.htm

Recreation Benefits

Cove Reservoir Recreation Analysis 6055 AF Reservoir

Activity	2016 Recreation Day Value		2018 Recreation Day Value	
			No.	Value
Leisure Bicycling	$47.52		17	$49.63
Camping	$23.73		59	$24.78
Freshwater Fishing	$88.20		63	$92.11
Nonmotorized Boating	$122.23		47	$127.65
Beach	$58.61		24	$61.21
Hiking	$73.98		81	$77.26
Motorized Boating	$53.68		21	$56.06
Picnicking	$21.98		9	$22.96
Sightseeing	$52.46		16	$54.79
Swimming	$31.63		8	$33.03
Wildlife Viewing	$78.62		126	$82.11
General Recreation	$36.68		98	$38.31
Other Recreation	$41.70		68	$43.55
TOTAL			637	$40,579
Ave Rec Day Value Cove Reservloir				$63.70

Cove Reservoir Recreation Analysis 3000 AF Reservoir

2) For the incremental analysis, if a smaller reservoir were constructed there would be fewer surface acres of water for recreational benefits. The surface area with 6,055 AF of capacity would be 188 acres. The surface area of the reservoir with 3,000 AF of capacity would be 125 acres. There would be approximately 1/3rd less surface area of water to recreate with the smaller size reservoir.

From 8/07/2020 MEMO from Alpha Engineering to Scott Hoag

Utah State Parks in Proximity to Cove Reservoir

Visitor Data

Park	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jun 2018	July 2018	Aug 2018	Sept 2018	Total	Camp Sites	Visitors per Campsite
Coral Pink Sand Dunes State Park	6,888	26,228	3,613	2,379	2,889	11,118	12,472	14,593	12,443	12,542	8,950	14,190	128,305	22	5,832
Gunlock State Park	546	290	46	124	199	228	2,425	6,197	11,777	9,368	4,556	3,815	39,571	4	9,893
Sand Hollow State Park	14,799	52,093	10,848	13,418	21,907	44,597	97,150	121,468	118,732	101,343	71,391	72,914	740,661	49	15,116
Quail Creek State Park	2,272	6,716	1,478	1,538	2,146	5,661	13,616	19,676	29,279	26,075	17,455	12,966	138,878	20	6,944
											Total Visitor Days		1,047,416	95	11,025
														Average for 4 Sites	2,756
														Average Annual Benefit based on campsites at 4 reservoirs near	$176,000

From: https://stateparks.utah.gov/resources/park-visitation-data/ FY2018 and 2019

With 1/3 less surface area on the reservoir, we can expect the benefits to be reduced by 1/3. Therefore recreation benefits for a 3000 AcFt reservoir would be $176,000 x .667 = $117,000

Cove Reservoir Recreation Improvements (No Utilities) Kane County Water Conservancy
District Preliminary Engineer's Opinion of Probable Cost 5-21-19

I DESCRIPTION	QUANTITY	UNITS	UNIT PRICE	TOTAL
Mobilization at 5%	1	L.S.	$21,350	$21,350
Excavation and Subgrade Prep	88,000	S.F.	$1.50	$132,000
6" Reinforced Concrete (Boat Ramp)	6,500	S.F.	$10.00	$65,000
6" Untreated Base Course (Boat Ramp)	6,500	S.F.	$1.00	$6,500
6" Untreated Base Course (Parking)	28,500	S.F.	$1.00	$28,500
6" Untreated Base Course (Roads)	53,000	S.F.	$1.00	$53,000
Camp/RV Site Facilities (Barbeque Grill, Tab	20	Each	$1,000	$20,000
Pavilion	1	Each	$50,000	$50,000
Signage	5	Each	$400.00	$2,000
Restroom Facility (Assume septic tank syste	2	Each	$35,000	$70,000
			Subtotal	$448,350
			Contingency (20%)	$89,670
			Engineering, Legal, and Fiscal (15%)	$67,253
			SCHEDULE A TOTAL	$605,000
			Proportional road cost[1/]	$308,000
			Land Rights	$120,000
			Total Recreation	$1,033,000

1/ From Cost Estimates for Appendix D & E.xlsx Cost of Road

The recreation facilities would be reduced with 13 campsites. Therefore the recreation facilities cost would be reduced by 1/3. Recreation facilities cost would be .667 x $605,000 = $404,000

plus proportion road cost	$308,000
plus landrights	$120,000
	$832,000

Average Cost Calculations

Amort, 2.5%, 100 years =	0.0273
AAC for Recreation Facilities	$23,000
Operation And Maintenance	$9,000
Total	$32,000

Average Cost Calculations

Amort, 2.875%, 100 years =	0.0273
AAC for Recreation Facilities	$28,000
Operation And Maintenance	$12,000
Total	$40,000

The recreation component of the project will most likely require 8 man-days per month (lower skill level) for 6 months to maintain the rest rooms and camp sites which would be an annual cost of approximately $12,000

/1 See MEMO dated 5/19/2020 fronm Alpha Engineering to Scott Hoag

APPENDIX E-31

RESULTS OF INCREMENTAL ANALYSIS

	AV Ann Benefits				Project Costs				Av Ann Cost				Net Benefit	
Reservoir	Irr	Recreation	Piping	Total	Reservoir	Rec Facilities	Piping	Total	Reservoir	Rec Facilities	Piping	Total		
3000 AF	$413,050	$117,000	$11,200	$541,250	$22,119,000	$838,000	$798,000	$23,755,000	$616,400	$32,000	$34,000	$682,400	($141,150)	0.79
6055 AF	$826,100	$176,000	$11,200	$1,013,300	$28,151,000	$1,033,000	$798,000	$29,982,000	$780,400	$40,000	$34,000	$854,400	$158,900	

10/1/2020

Change in Benefits = $472,050
Change in Cost = $172,000
change in Net Ben = $300,050

Therefore adding 3,055 AcFt is a beneficial increment

APPENDIX E-32

IRRIGATION BENEFIT ANALYSIS EXPLANATORY NOTES

Explanatory Notes for Irrigation Analysis

1 Kane County Crop Budgets tab - 2006 budget data by USU Extension https://extension.usu.edu/apec/agribusiness-food/crops scroll to *Kane* , click *Alfalfa* or *Oat Hay*
be sure to include the entire link in your browser

1a Washington County Crop Budgets tab - 2006 budget data by USU Extension https://extension.usu.edu/apec/agribusiness-food/crops scroll to *Washington* , click *Alfalfa* or *Oat Hay*
be sure to include the entire link in your browser

2 Alfalfa Hay NR Tab - Without and With analysis of the base budget from Utah State University Extension Service. Net return for alfalfa hay calculated based on Costs and Returns for Growing Alfafa Hay, Kane County, 2006, USU. Cost data was brought to current value using Producers Prices Paid 2006 to 2020. Value of hay is based on UT State level current normalized prices.

3 Oat Hay NR Tab - Without and With analysis of the base budget from Utah State University Extension Service Net return for oat hay calculated based on Costs and Returns for Growing Oat Hay, Kane County, 2006, USU. Cost data was brought to current value using Producers Prices Paid 2006 to 2020. Value of hay is based on UT State level current normalized prices.

* Same ananlysis for Washington County as in 2 and 3 above

4 Weighted Net Return - Weighted per acre net return based on a 10 year rotation - 8 yrs alfalfa and 2 yrs oat hay. This tab shows the calculations for irrigation in Kane and Washington Counties

5 Project Costs - Each of the panels in this tab show the engineer's estimate for each of the construction componenents of the project. This tab also shows the average annual cost calculations as well as memos concerning the cost figures. The memos also discuss the derivation of the F&W and the Power benefits.

6 Benefit-Cost ia a summary of project benefits and costs.

7 Price and Indices Tab - Producer Prices Paid and Received and current normalized price for hay - FY 2019 values

The WO/Proj crop budget production costs were updated from 2006 to current value using a multiplier calculated by dividing the 2020 prices paid index by the 2006 prices paid index
The W/Proj crop budget production costs were updated from 2006 to current value using a multiplier calculated by dividing the 2020 prices paid index by the 2006 prices paid index
The W/Proj crop budget production costs were also increased to account for the increased crop production.
Gross return is calculated using estimated production times the Utah current normalized price for hay in both the WO/ and W/Proj scenarios
Ownership costs were held constant in the without and with project situations since hay production in the benefit area is a well-established, long-term, and ongoing production activity. Producers have a full complement of machinery and wheel-line irrigation systems

APPENDIX E-33

KANE COUNTY CROP BUDGETS

Utah **S**tate **U**niversity
Extension **E**conomics

Modify Colored Columns

Costs and Returns per acre from growing alfalfa hay, 2006
Kane County

Receipts	**Quantity per acre**	**Unit**	**Price/cost per unit**	**Value/cost per acre**	**Base Value**
Alfalfa hay	3.3	tons	$88.57	$292.27	$292.27
Residue	0.25	AUM	$11.53	$2.88	$2.88
Subtotal				$295.15	$295.15
Operating costs					
Fertilization					
Phosphate	125	pounds	$0.18	$22.31	$22.31
Custom ap	1	acre	$7.82	$7.82	$7.82
Pesticides/herbicides					
Furadan	1.00	pints	$10.50	$10.50	$10.50
Custom ap	1	acre	$7.82	$7.82	$7.82
Irrigation (wheel line)	7	irrigations			
Labor	2.33	hours	$10.00	$23.33	$23.33
Water asse	1	share	$20.00	$20.00	$20.00
Repairs/ma	1	acre	$2.30	$2.30	$2.30
Pumping	43	acre inch	$0.00	$0.00	$0.00
Harvesting					
Swathing	3	acre	$15.56	$46.68	$46.68
Turning	3	acre	$4.69	$14.07	$14.07
Baling	3.30	tons	$4.79	$15.81	$15.81
Hauling/sta	3.30	tons	$3.63	$11.98	$11.98
Interest on operating capital			7.61%	$4.40	$5.24
Subtotal				$187.02	$232.11
Ownership costs (excludes cost of land)				$117.83	$117.83
Farm insurance	1	acre	$2.00	$2.00	$2.00
Machinery ownership	1	acre	$107.58	$107.58	$107.58
Irrigation equipment c	1	acre	$8.25	$8.25	$8.25
Total costs				$304.84	$349.94
Net returns to owner for unpaid labor, management, equity and risk					
Above operating costs				$108.14	$63.04
Above total listed costs				-$9.69	-$54.78

Assumptions
1. Alfalfa already established. Harvested in June, August, September.
2. Interest computed on fertilization/herbicide costs for 6 months and operating costs for 3 months.
3. Custom rates for all field operations.
4. Only owned machinery are a loader and truck.

Budget prepared by: E. Bruce Godfrey, Cody Bingham and Kevin Heaton
go to: https://extension.usu.edu/apec/agribusiness-food/crops
be sure to include the entire link in your browser
scroll to *Kane* , click *Alfalfa*

Utah **S**tate **U**niversity
Extension **E**conomics

Modify Colored Columns

Costs and Returns per acre from establishing alfalfa in oat hay, 2006
Kane County

Receipts	**Quantity per acre**	**Unit**	**Price/cost per unit**	**Value/cost per acre**	**Base Value**
Oat hay	2.3	tons	$67.67	$155.63	$155.63
Residue	-	AUM	$0.00	$0.00	$0.00
Subtotal				$155.63	$155.63
Operating costs					
Land preparation					
Plowing	1	acre	$22.78	$22.78	$22.78
Roller harrow	2	acre	$14.33	$28.66	$28.66
Planting	1	acre	$12.21	$12.21	$12.21
Seed					
Oat seed	20	pounds	$0.17	$3.40	$3.40
Alfalfa seed	16	pounds	$2.52	$40.32	$40.32
Fertilization					
Nitrogen (34-0-0)	294	pounds	$0.18	$52.48	$52.48
Phosphate (11-52-0)	96	pounds	$0.18	$17.14	$17.14
Custom application	1	acre	$7.82	$7.82	$7.82
Irrigation (wheel line)	6	irrigations			
Labor	2.00	hours	$10.00	$20.00	$20.00
Water assessment	1	share	$20.00	$20.00	$20.00
Repairs/maintenance	1	acre	$2.30	$2.30	$2.30
Pumping	43	acre inch	$0.00	$0.00	$0.00
Harvesting					
Swathing	1	acre	$15.56	$15.56	$15.56
Turning/raking	1	acre	$4.69	$4.69	$4.69
Baling	2.30	tons	$4.79	$11.02	$11.02
Hauling/stacking	2.30	tons	$3.63	$8.35	$8.35
Interest on operating capital			7.61%	$11.36	$11.36
Subtotal				$278.09	$308.93
Ownership costs (excludes cost of land)				$117.83	$117.83
Farm insurance	1	acre	$2.00	$2.00	$2.00
Machinery ownership costs	1	acre	$107.58	$107.58	$107.58
Irrigation equipment costs	1	acre	$8.25	$8.25	$8.25
Total costs				$395.91	$426.75
Net returns to owner for unpaid labor, management, equity and risk					
Above operating costs				-$122.45	-$182.00
Above total listed costs				-$240.28	-$271.12

Assumptions
1. Grain and alfalfa planted in May and harvested in July.
2. Interest computed on land preparation and planting costs for 10 months and fertilization/herbicide/irrigation costs for 6 months.
3. Custom rates for all field operations.
4. Only owned machinery are a loader and truck.

Budget prepared by: E. Bruce Godfrey, Cody Bingham and Kevin Heaton
go to: https://extension.usu.edu/apec/agribusiness-food/crops
be sure to include the entire link in your browser
scroll to *Kane* , click *Established Alfalfa Oat Hay*

APPENDIX E-34

KANE COUNTY COSTS AND RETURNS PER ACRE FOR GROWING ALFALFA HAY

Costs and Returns per acre from growing alfalfa hay, 2006
Kane County

					WO/Project			W/Project		
Receipts	**Quantity per acre**	**Unit**	**Price/cost per unit**	**Value/cost per acre**	**Quantity per acre**	**Price/cost per unit**	**Value/cost per acre**	**Quantity per acre**	**Price/cost per unit**	**Value/cost per acre**
Alfalfa hay	3.3	tons	$88.57	$292.27	3.3	$149.07	$491.93	4.8	$149.07	$715.54
Residue	0.25	AUM	$11.53	$2.88	0.25	$14.20	$3.55	0.4	$14.20	$5.68
Subtotal				$295.15			$495.48			$721.22
Operating costs										
Fertilization										
Phosphate (11-52-0)	125	pounds	$0.18	$22.31	125	$0.27	$33.17	125	$0.27	$33.17
Custom application	1	acre	$7.82	$7.82	1	$11.62	$11.62	1	$11.62	$11.62
Pesticides/herbicides										
Furadan	1.00	pints	$10.50	$10.50	1.00	$15.61	$15.61	1.00	$15.61	$15.61
Custom application	1	acre	$7.82	$7.82	1	$11.62	$11.62	1	$11.62	$11.62
Irrigation (wheel line)	7	irrigations			7			7	$0.00	$0.00
Labor	2.33	hours	$10.00	$23.33	2.33	$14.86	$34.68	2.33	$14.86	$34.68
Water assessment	1	share	$20.00	$20.00	1	$29.73	$29.73	1	$29.73	$29.73
Repairs/maintenance	1	acre	$2.30	$2.30	1	$3.42	$3.42	1	$3.42	$3.42
Pumping	43	acre inch	$0.00	$0.00	43	$0.00	$0.00	43	$0.00	$0.00
Harvesting										
Swathing	3	acre	$15.56	$46.68	2.5	$23.13	$57.82	4.0	$23.13	$92.52
Turning	3	acre	$4.69	$14.07	2.5	$6.97	$17.43	4.0	$6.97	$27.89
Baling	3.30	tons	$4.79	$15.81	3.3	$7.12	$23.50	4.8	$7.12	$34.18
Hauling/stacking	3.30	tons	$3.63	$11.98	3.3	$5.40	$17.81	4.8	$5.40	$25.90
Interest on operating capital			7.61%	$4.40		1.375%	$6.25		1.375%	$7.46
Subtotal				$187.02			$216.89			$327.81
Ownership costs (excludes cost of land)				$117.83						
Farm insurance	1	acre	$2.00	$2.00						
Machinery ownership costs	1	acre	$107.58	$107.58						
Irrigation equipment costs	1	acre	$8.25	$8.25						
Total costs				$304.84						
Net returns to owner for unpaid labor, management, equity and risk										
Above operating costs				$108.14			$278.59			$393.41
Above total listed costs				-$9.69						

Current Operating Loan interest from Troy Henri, FSA Panguitch, UT

	Change in NR - Hay	
per acre		$114.82
acres =	1,110	
Tot WS		$127,452

Budget prepared by: E. Bruce Godfrey, Cody Bingham and Kevin Heaton

go to: https://extension.usu.edu/apec/agribusiness-food/crops

be sure to include the entire link in your browser

scroll to *Kane* , click *Alfalfa*

1. Alfalfa already established. Harvested in June, August, September.
2. Interest computed on fertilization/herbicide costs for 6 months and operating costs for 3 months.
3. Custom rates for all field operations.
4. Only owned machinery are a loader and truck.

APPENDIX E-35

KANE COUNTY COSTS AND RETURNS PER ACRE FOR ESTABLISHING ALFALFA IN OAT HAY

Costs and Returns per acre from establishing alfalfa in oat hay, 2006
Kane County

						WO/Project			W/Project		
Receipts	**Quantity per acre**	**Price/cost per unit**	**Price/cost per unit**	**Value/cost per acre**	**Base Value**	**Quantity per acre**	**Price/cost per unit**	**Value/cost per acre**	**Quantity per acre**	**Price/cost per unit**	**Value/cost per acre**
Oat hay	2.3	tons	$67.67	$155.63	$155.63	2.3	$149.07	$342.86	3	$149.07	$447.21
Residue	0.20	AUM	$11.53	$2.31	$0.00	0.2	$14.20	$2.84	0.3	$14.20	$4.26
Subtotal				$157.94	$155.63			$345.70			$451.47
Operating costs											
Land preparation											
Plowing	1	acre	$22.78	$22.78	$22.78	1	$33.86	$33.86	1	$33.86	$33.86
Roller harrow	2	acre	$14.33	$28.66	$28.66	2	$21.30	$42.60	2	$21.30	$42.60
Planting	1	acre	$12.21	$12.21	$12.21	1	$18.15	$18.15	1	$18.15	$18.15
Seed											
Oat seed	20	pounds	$0.17	$3.40	$3.40	20	$0.25	$5.05	20	$0.25	$5.05
Alfalfa seed	16	pounds	$2.52	$40.32	$40.32	16	$3.75	$59.94	16	$3.75	$59.94
Fertilization											
Nitrogen (34-0-0)	294	pounds	$0.18	$52.48	$52.48	294	$0.27	$78.01	294	$0.27	$78.01
Phosphate (11-52-0)	96	pounds	$0.18	$17.14	$17.14	96	$0.27	$25.47	96	$0.27	$25.47
Custom application	1	acre	$7.82	$7.82	$7.82	1	$11.62	$11.62	1	$11.62	$11.62
Irrigation (wheel line)	6	irrigations				6			6	$0.00	
Labor	2.00	hours	$10.00	$20.00	$20.00	2.00	$14.86	$29.73	2.00	$14.86	$29.73
Water assessment	1	share	$20.00	$20.00	$20.00	1	$29.73	$29.73	1	$29.73	$29.73
Repairs/maintenance	1	acre	$2.30	$2.30	$2.30	1	$3.42	$3.42	1	$3.42	$3.42
Pumping	43	acre inch	$0.00	$0.00	$0.00	43			43		
Harvesting											
Swathing	2.3	acre	$15.56	$35.79	$15.56	2.3	$23.13	$53.20	3.00	$23.13	$69.39
Turning/raking	2.3	acre	$4.69	$10.79	$4.69	2.3	$6.97	$16.03	3.00	$6.97	$20.91
Baling	2.30	tons	$4.79	$11.02	$11.02	2.30	$7.12	$16.38	3.00	$7.12	$21.36
Hauling/stacking	2.30	tons	$3.63	$8.35	$8.35	2.30	$5.40	$12.41	3.00	$5.40	$16.19
Interest on operating capital			7.61%	$11.36	$11.36		1.375%	$3.73		1.375%	$3.93
Subtotal				$304.41	$308.93			$439.34			$469.37
						Current Operating Loan interest from Troy Henri, FSA Panguitch, UT					
Ownership costs (excludes cost of land)				$117.83	$117.83						
Farm insurance	1	acre	$2.00	$2.00	$2.00						
Machinery ownership costs	1	acre	$107.58	$107.58	$107.58						
Irrigation equipment costs	1	acre	$8.25	$8.25	$8.25						
Total costs				$422.24	$426.75						
Net returns to owner for unpaid labor, management, equity and risk											
Above operating costs				-$146.47	-$182.00			-$93.63			-$17.90
Above total listed costs				-$264.30	-$271.12						

	Change in NR - Hay	
per acre		$75.73
acres =	1,110	
Tot WS		$84,062

Assumptions

1. Grain and alfalfa planted in May and harvested in July.
2. Interest computed on land preparation and planting costs for 10 months and fertilization/herbicide/irrigation costs for 6 months.
3. Custom rates for all field operations.
4. Only owned machinery are a loader and truck.

Budget prepared by: E. Bruce Godfrey, Cody Bingham and Kevin Heaton
go to: https://extension.usu.edu/apec/agribusiness-food/crops
be sure to include the entire link in your browser
scroll to *Kane* , click *Established Alfalfa Oat Hay*

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.

APPENDIX E-36

WASHINGTON COUNTY CROP BUDGETS

Utah **S**tate **U**niversity
Extension **E**conomics

Modify Colored Columns

Costs and Returns per acre from growing alfalfa hay, 2006
Washington County

Receipts	**Quantity per acre**	**Unit**	**Price/cost per unit**	**Value/cost per acre**	**Base Value**
Alfalfa hay	4.2	tons	$88.57	$371.98	$371.98
Residue	-	AUM	$0.00	$0.00	$0.00
Subtotal				$371.98	$371.98
Operating costs					
Fertilization					
Phosphate (11-52-0)	48	pounds	$0.18	$8.57	$8.57
Custom application	1	acre	$7.82	$7.82	$7.82
Pesticides/herbicides					
Furadan	1	pint	$10.50	$10.50	$10.50
Custom application	1	acre	$7.82	$7.82	$7.82
Irrigation (wheel line)	9	irrigations			
Labor	3.00	hours	$10.00	$30.00	$30.00
Water assessment	1	share	$10.00	$10.00	$10.00
Repairs/maintenance	1	acre	$2.30	$2.30	$2.30
Pumping	46	acre inch	$0.00	$0.00	$0.00
Harvesting					
Swathing	4	acre	$15.56	$62.24	$62.24
Turning	4	acre	$4.69	$18.76	$18.76
Baling	4.20	tons	$4.79	$20.12	$20.12
Hauling/stacking	4.20	tons	$3.63	$15.25	$15.25
Interest on operating capital			7.61%	$4.34	$5.41
Subtotal				$197.71	$255.10
Ownership costs (excludes cost of land)				$44.37	$44.37
Insurance	1	acre	$2.00	$2.00	$2.00
Machinery ownership costs	1	acre	$34.12	$34.12	$34.12
Irrigation equipment costs	1	acre	$8.25	$8.25	$8.25
Total costs				$242.08	$299.47
Net returns to owner for unpaid labor, management, equity and risk					
Above operating costs				$174.27	$116.88
Above total listed costs				$129.90	$72.51

Assumptions

1. Alfalfa already established. Harvested in June, July, August, and September.
2. Interest computed on fertilization/herbicide costs for 6 months and operating costs for 3 months.
3. Custom rates for all field operations.
4. Only owned machinery are a loader and truck.

Budget prepared by: E. Bruce Godfrey, Cody Bingham and Dean Miner
goto: https://extension.usu.edu/apec/agribusiness-food/crops
scroll to *Washington* , click *alfalfa*

Utah **S**tate **U**niversity
Extension **E**conomics

Modify Colored Columns

Costs and Returns per acre from establishing alfalfa with oat hay, 2006
Washington County

Receipts	**Quantity per acre**	**Unit**	**Price/cost per unit**	**Value/cost per acre**	**Base Value**
Oat hay	2.3	tons	$67.67	$155.63	$155.63
Alfalfa	1.5	tons	$88.57	$132.85	$132.85
Subtotal				$288.48	$288.48
Operating costs					
Land preparation					
Plowing	1	acre	$22.78	$22.78	$22.78
Discing	1	acre	$11.56	$11.56	$11.56
Roller harrow	2	acre	$14.33	$28.66	$28.66
Planting	1	acre	$12.21	$12.21	$12.21
Seed					
Oat seed	90	pounds	$0.17	$15.30	$15.30
Alfalfa seed	16	pounds	$2.52	$40.32	$40.32
Fertilization					
Nitrogen (34-0-0)	249	pounds	$0.18	$44.45	$44.45
Phosphate (11-52-0)	48	pounds	$0.18	$8.57	$8.57
Custom application	1	acre	$7.82	$7.82	$7.82
Pesticides/herbicides					
2-4-D	-	pint	$2.75	$0.00	$0.00
Custom application	1	acre	$7.82	$7.82	$7.82
Irrigation (wheel line)	4	irrigations			
Labor	1.33	hours	$10.00	$13.33	$13.33
Water assessment	1	share	$10.00	$10.00	$10.00
Repairs/maintenance	1	acre	$2.30	$2.30	$2.30
Pumping	22	acre inch	$0.00	$0.00	$0.00
Harvesting					
Swathing	2	acre	$15.56	$31.12	$31.12
Turning	2	acre	$4.69	$9.38	$9.38
Baling	3.80	tons	$4.79	$18.20	$18.20
Hauling/stacking	3.80	tons	$3.63	$13.79	$13.79
Interest on operating capital			7.61%	$10.09	$10.09
Subtotal				$307.70	$358.66
Ownership costs (excludes cost of land)				$44.37	$44.37
Insurance	1	acre	$2.00	$2.00	$2.00
Machinery ownership costs	1	acre	$34.12	$34.12	$34.12
Irrigation equipment costs	1	acre	$8.25	$8.25	$8.25
Total costs				$352.08	$403.03
Net returns to owner for unpaid labor, management, equity and risk					
Above operating costs				-$19.22	-$70.18
Above total listed costs				-$63.59	-$114.55

Assumptions

1. Oat hay planted in late March and harvested in July.
2. Interest computed on land preparation and plan
3. Custom rates for all field operations.
4. Only owned machinery are a loader and truck.

Budget prepared by: E. Bruce Godfrey, Cody Bingham and Dean Miner
https://extension.usu.edu/apec/agribusiness-food/crops
scroll to *Washington* , click *Established Alfalfa Oat Hay*

APPENDIX E-37

WASHINGTON COUNTY COSTS AND RETURNS PER ACRE FOR GROWING ALFALFA HAY

Costs and Returns per acre from growing alfalfa hay, 2006
Washington County

						WO/Project			**W/Project**			
Receipts	**Quantity per acre**	**Unit**	**Price/cost per unit**	**Value/cost per acre**	**Base Value**	**Quantity per acre**	**Price/cost per unit**	**Value/cost per acre**	**Quantity per acre**	**Price/cost per unit**	**Value/cost per acre**	
Alfalfa hay	4.2	tons	$88.57	$371.98	$371.98	4.2	$149.07	$626.09	5.2	$149.07	$775.16	
Residue	0.25	AUM	$11.53	$2.88	$0.00	0.25	$14.20	$3.55	0.31	$14.20	$4.40	
Subtotal				$374.86	$371.98			$629.64			$779.57	
Operating costs												
Fertilization												
Phosphate (11-52-0)	48	pounds	$0.18	$8.57	$8.57	48	$0.27	$12.74	48	$0.27	$12.74	
Custom application	1	acre	$7.82	$7.82	$7.82	1	$11.62	$11.62	1	$11.62	$11.62	
Pesticides/herbicides												
Furadan	1	pint	$10.50	$10.50	$10.50	1	$15.61	$15.61	1	$15.61	$15.61	
Custom application	1	acre	$7.82	$7.82	$7.82	1	$11.62	$11.62	1	$11.62	$11.62	
Irrigation (wheel line)	9	irrigations				9			9			
Labor	3.00	hours	$10.00	$30.00	$30.00	3.00	$14.86	$44.59	3.00	$14.86	$44.59	
Water assessment	1	share	$10.00	$10.00	$10.00	1	$14.86	$14.86	1	$14.86	$14.86	
Repairs/maintenance	1	acre	$2.30	$2.30	$2.30	1	$3.42	$3.42	1	$3.42	$3.42	
Pumping	46	acre inch	$0.00	$0.00	$0.00	46	$0.00	$0.00	46	$0.00	$0.00	
Harvesting												
Swathing	4	acre	$15.56	$62.24	$62.24	4	$23.13	$92.52	4.0	$23.13	$92.52	
Turning	4	acre	$4.69	$18.76	$18.76	4	$6.97	$27.89	4.0	$6.97	$27.89	
Baling	4.20	tons	$4.79	$20.12	$20.12	4.20	$7.12	$29.91	5.20	$7.12	$37.03	
Hauling/stacking	4.20	tons	$3.63	$15.25	$15.25	4.20	$5.40	$22.66	5.20	$5.40	$28.06	
Interest on operating capital			7.61%	$4.34	$5.41		1.375%	$1.17		1.375%	$1.21	
Subtotal				$197.71	$255.10			$288.61			$301.17	297.64
						Current Operating Loan interest from Troy Henri, FSA Panguitch, UT						
Ownership costs (excludes cost of land)				$44.37	$44.37							
Insurance	1	acre	$2.00	$2.00	$2.00							
Machinery ownership costs	1	acre	$34.12	$34.12	$34.12	Net Return per Acre		$341.03			$478.40	-$297.64
Irrigation equipment costs	1	acre	$8.25	$8.25	$8.25							
Total costs				$242.08	$299.47				Change in NR - Hay			
						per acre					$137.36	
Net returns to owner for unpaid labor, management, equity and risk						acres =		4,958				
Above operating costs				$177.15	$116.88	Tot WS					$681,044	$691,073
Above total listed costs				$132.78	$72.51							

Assumptions

1. Alfalfa already established. Harvested in June, July, August, and September.
2. Interest computed on fertilization/herbicide costs for 6 months and operating costs for 3 months.
3. Custom rates for all field operations.
4. Only owned machinery are a loader and truck.

	Inc in Prod per acre	production for 2235 ac	Inc in Prod for 10,000 ac
Hay	1.80	4,023.00	0.4023
Residue	0.06	134.1	0.01341

2235 ac 5 tons = 11175
10000 ac 1.1175

Budget prepared by: E. Bruce Godfrey, Cody Bingham and Dean Miner
https://extension.usu.edu/apec/agribusiness-food/crops
scroll to *Washington*, click *Alfalfa*

5.3

On Thursday, October 8, 2020, 12:21:05 PM MDT, Brent Gardner <brentgardner@alphaengineering.com> wrote:

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 later 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 10,000 acres being irrigated.
would provide for an increase of up to 1 ton per acre.
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.

Brent E. Gardner, PE

APPENDIX E-38

WASHINGTON COUNTY COSTS AND RETURNS PER ACRE FOR ESTABLISHING ALFALFA IN OAT HAY

Costs and Returns per acre from establishing alfalfa with oat hay, 2006
Washington County

						WO/Project			W/Project		
Receipts	**Quantity per acre**	**Unit**	**Price/cost per unit**	**Value/cost per acre**	**Base Value**	**Quantity per acre**	**Price/cost per unit**	**Value/cost per acre**	**Quantity per acre**	**Price/cost per unit**	**Value/cost per acre**
Oat hay	2.3	tons	$67.67	$155.63	$155.63	2.3	$149.07	$342.86	3.0	$149.07	$447.21
Alfalfa	1.5	tons	$88.57	$132.85	$132.85	1.5	$149.07	$223.61	2.0	$149.07	$298.14
Subtotal				$288.48	$288.48			$566.47			$745.35
Operating costs											
Land preparation											
Plowing	1	acre	$22.78	$22.78	$22.78	1	$33.86	$33.86	1	$33.86	$33.86
Discing	1	acre	$11.56	$11.56	$11.56	1	$17.18	$17.18	1	$17.18	$17.18
Roller harrow	2	acre	$14.33	$28.66	$28.66	2	$21.30	$42.60	2	$21.30	$42.60
Planting	1	acre	$12.21	$12.21	$12.21	1	$18.15	$18.15	1	$18.15	$18.15
Seed											
Oat seed	90	pounds	$0.17	$15.30	$15.30	90	$0.25	$22.74	90	$0.25	$22.74
Alfalfa seed	16	pounds	$2.52	$40.32	$40.32	16	$3.75	$59.94	16	$3.75	$59.94
Fertilization											
Nitrogen (34-0-0)	249	pounds	$0.18	$44.45	$44.45	249	$0.27	$66.07	249	$0.27	$66.07
Phosphate (11-52-0)	48	pounds	$0.18	$8.57	$8.57	48	$0.27	$12.74	48	$0.27	$12.74
Custom application	1	acre	$7.82	$7.82	$7.82	1	$11.62	$11.62	1	$11.62	$11.62
Pesticides/herbicides											
2-4-D	-	pint	$2.75	$0.00	$0.00	-	$4.09	$0.00	-	$4.09	$0.00
Custom application	1	acre	$7.82	$7.82	$7.82	1	$11.62	$11.62	1	$11.62	$11.62
Irrigation (wheel line)	4	irrigations				4		$0.00	4		
Labor	1.33	hours	$10.00	$13.33	$13.33	1.33	$14.86	$19.82	1.33	$14.86	$19.82
Water assessment	1	share	$10.00	$10.00	$10.00	1	$14.86	$14.86	1	$14.86	$14.86
Repairs/maintenance	1	acre	$2.30	$2.30	$2.30	1	$3.42	$3.42	1	$3.42	$3.42
Pumping	22	acre inch	$0.00	$0.00	$0.00	22	$0.00	$0.00	22	$0.00	$0.00
Harvesting											
Swathing	2	acre	$15.56	$31.12	$31.12	2	$23.13	$46.26	2	$23.13	$46.26
Turning	2	acre	$4.69	$9.38	$9.38	2	$6.97	$13.94	2	$6.97	$13.94
Baling	3.80	tons	$4.79	$18.20	$18.20	3.80	$7.12	$27.06	5.00	$7.12	$35.60
Hauling/stacking	3.80	tons	$3.63	$13.79	$13.79	3.80	$5.40	$20.50	5.00	$5.40	$26.98
Interest on operating capital			7.61%	$10.09	$10.09		1.375%	$2.71		1.375%	$2.71
Subtotal				$307.70	$358.66			$445.11			$460.13
						Current Operating Loan interest from Troy Henri, FSA Panguitch, UT					
Ownership costs (excludes cost of land)				$44.37	$44.37						
Insurance	1	acre	$2.00	$2.00	$2.00						
Machinery ownership costs	1	acre	$34.12	$34.12	$34.12						
Irrigation equipment costs	1	acre	$8.25	$8.25	$8.25						
Total costs				$352.08	$403.03						
Net returns to owner for unpaid labor, management, equity and risk											
Above operating costs				-$19.22	-$70.18			$121.36			$285.22
Above total listed costs				-$63.59	-$114.55						

Change in NR - Establish Alfalfa		
per acre		$163.86
acres =	4,958	
Tot WS		$812,440

641686

Assumptions

1. Oat hay planted in late March and harvested in July.
2. Interest computed on land preparation and planting costs for 10 months and fertilization/herbicide/irrigation costs for 3 months.
3. Custom rates for all field operations.
4. Only owned machinery are a loader and truck.

	Inc in Prod per acre	production for 2235 ac	Inc in Prod per Acre or 10,000 ac
oat hay	1.50	3352.5	0.33525
alfalfa	0.3	670.5	0.06705

Budget prepared by: E. Bruce Godfrey, Cody Bingham and Dean Miner
goto: https://extension.usu.edu/apec/agribusiness-food/crops
scroll to *Washington* , click *Established Alfalfa Oat Hay*

APPENDIX E-39

WEIGHTED NET RETURN FOR ALFALFA HAY AND OAT HAY

9/29/2020

Weighted Net Return for Alfalfa hay and Oat hay assuming a 10 year rotation
Kane County

		Net return per acre		Irrigation Net Benefit	Weighted Average
		WO Project	W Project		
8 years in alfalfa=	80%	$279	$393	$115	$92
2 years in oat hay=	20%	-$94	-$18	$76	$15
		Weighted Average Net return per acre			$107

Weighted Net Return for Alfalfa hay and Oat hay assuming a 10 year rotation
Washington County

		Net return per acre		Irrigation Net Benefit	Weighted Average
		WO Project	W Project		
8 years in alfalfa=	80%	$341	$478	$137	$109.89
2 years in oat hay=	20%	$121	$285	$164	$32.77
		Weighted Average Net return per acre			$142.66

FW: Virgin River Simulation
Yahoo/Inbox
Brent Gardner <brentgardner@alphaengineering.com>
To:Brian Parker,Ronald Bolander,Scott Hoag Jr
Cc:Michael Noel,Zach Renstrom,Dirk Clayson
Mon, Sep 28 at 1:49 PM

I have talked with Scott Hoag and he indicated that going to the yield of 1638 AF with 756 AF going to the KCWCD and 882 AF going to the WCWCD will still provide for a benefit cost ratio of over 1. When we get into the final design phase we will get the program updated to take the other items into account which should increase the overall yield of the system.

/1See Memo from UT Dvision of Water Resources to Alpha Engineering

Recent Studies on Cove Reservoir Simulation Division of Water Resources August 2020

Based on the yield predicted by UT DOWR, irrigation benefits are 78% of full irrigation at a 2112 AcFt yield

		OM&R
/1 Dam Includes MPS at $26,241,000; Land Rights at $600,000; proportional Road Cost at $1,310,000 =	$28,151,000	$12,400
/2 Rec Includes Facilities at $605,000; Land Rights at $120,000; Proportional Road Cast at $308,000 =	$1,033,000	$12,000
Glendale Piping =	$798,000	$12,000
Total Project Cost	$29,982,000	$36,400

AAC @ 2.5, 103 yrs

0.0271	$812,512
O&M	$36,400
	$848,912

		Benefit by County	Benefit at 1638 AcFt
Kane County Irrigated Acres	1110	$118,800	
Washington County Irrigated Acres	4958	$707,300	
Total acres	6068		
Total Irrigation Benefit		$826,100	$640,700
Recreation Benefit		$176,000	
Glendale		$11,200	
total		$1,013,300	
Net Benefit		$164,388	
B/C Ratio		1.24711974	

Acre Feet Yield/1

Feb-20	Sep-20	
2112	1638	78%

APPENDIX E-40

IRRIGATION BENEFIT ANALYSIS SUMMARY

Benefits

Irrigation	$826,100
Recreation	$176,000
Glendale Piping	$11,200
PPPI	1.49
PPRI	1.23

Costs

Dam	$26,841,000
Rec	$725,000
Road	$1,618,000
damrd	$1,310,000
recrd	$308,000
Glen	$798,000
Total	$29,982,000

Amortization

amort100	0.0273
amort3	0.0271
PV150	0.2909

Project Costs

	Dam		Rec		Glendale		Road		Total
Cost Est	$ 19,438,000		$448,000		$591,000		$1,198,000		$ 21,675,000
Contingency	$ 3,887,000		$90,000		$118,000		$240,000		$ 4,335,000
Engineering	$ 2,916,000		$67,000		$89,000		$180,000		$ 3,252,000
Land Right	$ 600,000		$120,000						$ 720,000
Road	$ 1,310,000		$308,000						$ 1,618,000
Total	$ 28,151,000		$1,033,000		$798,000		$1,618,000		$ 29,982,000

Average Annual Cost

Amortization	$ 763,000		$ 28,000		$ 22,000				$ 813,000
O&M	$ 12,000		$ 12,000		$ 6,000				$ 30,000
Replace	$ 400				$ 6,000				$ 6,400
Tot AAC	$775,400		$40,000		$34,000				$849,400

*Cost of Road ($1,310,000 for the dam and $308,000 for the rec facilities = $1,618,000) is included in the amortization for dam and rec

Benefits

Irrigation	$ 826,100								$ 826,100
Recreation			$ 176,000						$ 176,000
Glendale					$ 11,200				$ 11,200
Total	$826,100		$176,000		$ 11,200				$ 1,013,300

Net Benefits	$163,900
B:C Ratio	1.19

APPENDIX E-41

IRRIGATION BENEFIT ANALYSIS PRICES AND INDICES

Table 3—State-level normalized price received estimates for commodities
(ERS report year = 2020)

	Hay, all types, baled
	$ / ton
Utah	$ 149.07

Source: USDA, Economic Research Service using data from USDA, National Agricultural Statistics Service.

Contact: Aaron Hrozencik, 816-926-1444, aaron.hrozencik@usda.gov.

Release date: September 30, 2020.

Amortization Rate at 2.50%

100 years	0.0273
103 years	0.0271

Producer Prices Paid Indices		Producer Prices Received Indices	
PPPI		PPRI	
Year	Index		Index
	1992=100		1992=100
2006	148		121
2020	220		149
Multiplier	1.49		1.23

CCI (ENR's Construction Cost Index) (Ann. Avg.) **2.**

Year	Index
1913=100	
2013	9546.66
2018	**11498.81**
Multiplier	1.20

Data Sources:

1. Prices paid and Received by Farmers, ERS/NASS data provided through Cornell University.
http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1002
http://www.nass.usda.gov/Charts_and_Maps/graphics/data/pitw.txt
Note: The Limited Resource Farmer index is based on the October, 2004 PPPI of 125.

2. Engineering News Review, Construction Cost Index History
http://enr.construction.com/economics/default.asp
The ENR website only provides the current month CCI. History of CCI available to subscribers.
Values for prior years are averages of the monthly indexes.

3. Consumer Price Index-All Urban Consumers
http://www.bls.gov/news.release/cpi.t01.htm
The annual average CPI is reported.

4. FY Plan Formulation Rate For Federal Water Projects, updated annually in early October
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/cntsc/?&cid=nrcs143_009685

5. OMB Circ. A-94 10-Year Nominal Discount Rate, Updated annually in January
https://www.whitehouse.gov/omb/circulars/
https://www.whitehouse.gov/wp-content/uploads/2017/11/DISCHIST-2018-1.pdf

APPENDIX E-42

RECREATION ANALYSIS EXPLANATORY NOTES

3/14/2019 sh

Explanatory Notes for Recreation Analysis

1 Population Tab - Day use recreation value and population data
2 NP Use Data Tab - Visitor days at Nattioal Parks near Cove
3 UT State Park Use Data Tab - Use data for State Parks in proximity to Cove
4 Benefits Tab - Benefit calculations based on data from several sources
5 Recreation AAC Tab - Ave Ann Cost Calculation based on Engineer Cost Estimate (converted .pdf to Excel format)
6 B:C Ration and Net Benefits Tab - Calculation of B:C Ratio and Net Benefits for Benefit data from 3 sources (Tab 4)
7 Int and Ann Tab - Interest and annuity factors the Water Resource Discount Rate of 2.875%

APPENDIX E-43

COVE RESERVOIR RECREATION ANALYSIS—POPULATION

Cove Reservoir Recreation Analysis

Activity	2016 Recreation Day Value		2018 Recreation Day Value		Cove Res User Days
			No.	Value	No.
Leisure Bicycling	$47.52		17	$49.63	
Camping	$23.73		59	$24.78	
Freshwater Fishing	$88.20		63	$92.11	
Nonmotorized Boating	$122.23		47	$127.65	
Beach	$58.61		24	$61.21	
Hiking	$73.98		81	$77.26	
Motorized Boating	$53.68		21	$56.06	
Picnicking	$21.98		9	$22.96	
Sightseeing	$52.46		16	$54.79	
Swimming	$31.63		8	$33.03	
Wildlife Viewing	$78.62		126	$82.11	
General	$36.68		98	$38.31	
Other Recreation	$41.70		68	$43.55	
TOTAL			637	$40,578.60	
Ave Rec Day Value Cove Reservloir				$63.70	

From: RECREATION USE VALUES DATABASE – SUMMARY

Randall S. Rosenberger, Oregon State University, Nov 2016

	10/1/2016	10/1/2018	Multiplier
CPI[3/]	241.432	252.146	1.04
2019 Water Resource Discount Rate			2.875%

3/ Consumer Price Index 1983-84 =100

	Kane Co	Glendale	Mt Carmel	Orderville
Total population	7,216	215	60	771
Glendale, Mt. Carmel, Oderville Population				1046
Kane Co Population net of Glendale, Mt Carmel, Oderville				6,170
Population within 150 mi radius of Orderville[/1]				130,564

1/ From: https://www.freemaptools.com/find-population.htm

APPENDIX E-44

NPS USE DATA

Crisis in our national parks: How tourists are loving nature to death

By Charlotte Simmonds, Annette McGivney, Patrick Reilly, Brian Maffly, Todd Wilkinson, Gabrielle Canon, Michael Wright and Monte Whaley

Bozeman Daily Chronicle 11/25/2018

Editor's Note

This story originally appeared in The Guardian as part of its two-year series, This Land Is Your Land, with support from the Society of Environmental Journalists. It was reported and published in collaboration with The Denver Post, The Missoulian, the Salt Lake Tribune, Mountain Journal and the Bozeman Daily Chronicle.

Recreation Use Selected Utah National Parks

	Site	Horseshoe Bend			Zion N.P.				Bryce N.P	
	Use	53,051			4,335,124				2,694,626	
	Year	2018			2018				2018	
	Dec Visits				Dec Visits				Dec Visits	
12/18 est		4,817		12/18 est		162,885		12/18 est		59110
12/17/2017	2,986	0.651396161		12/17/2017	138,866	1.115945		12/17/2017	49,013	1.272239
12/17/2016	4,584	0.399825556		12/17/2016	124,438	1.276248		12/17/2016	38,525	1.120956
12/1/2015	11,465	3.870695476		12/1/2015	97,503	0.956043		12/1/2015	34,368	1.158069
12/1/2014	2,962	1.530749354		12/1/2014	101,986	1.343636		12/1/2014	29,677	1.272762
12/1/2013	1,935			12/1/2013	75,903			12/1/2013	23,317	
5 year average December Increase		1.613166637				1.172968				1.206006

from: https://irma.nps.gov/Stats/SSRSReports/Park%20Specific%20Reports/Recreation%20Visitors%20By%20Month%20(1979%20-%20Last%20Calendar%20Year)?Park=BRCA

Recreation Visits by Month (1979 - Last Calender Year) https://irma.nps.gov/Stats/Reports/Park/BRCA

APPENDIX E-45

UTAH STATE PARKS IN PROXIMITY TO COVE RESERVOIR

Utah State Parks in Proximity to Cove Reservoir

Visitor Data

Park	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jun 2018	July 2018	Aug 2018	Sept 2018	Total	Camp Sites	Visitors per Campsite
Coral Pink Sand Dunes State Park	6,888	26,228	3,613	2,379	2,889	11,118	12,472	14,593	12,443	12,542	8,950	14,190	128,305	22	5,832
Gunlock State Park	546	290	46	124	199	228	2,425	6,197	11,777	9,368	4,556	3,815	39,571	4	9,893
Sand Hollow State Park	14,799	52,093	10,848	13,418	21,907	44,597	97,150	121,468	118,732	101,343	71,391	72,914	740,661	49	15,116
Quail Creek State Park	2,272	6,716	1,478	1,538	2,146	5,661	13,616	19,676	29,279	26,075	17,455	12,966	138,878	20	6,944
										Total Visitor Days			1,047,416	95	11,025
										Average for 4 Sites					2,756
										Average Annual Benefit					$175,587.30

From: https://stateparks.utah.gov/resources/park-visitation-data/ FY2018 and 2019

APPENDIX E-46

RECREATION ANALYSIS—BENEFITS

Recreation Use Selected Utah National Parks

Site	Horseshoe Bend		Zion N.P.		Bryce N.P
Use	53,051		4,335,124		2,694,626
Year	2018		2018		2018

from: https://irma.nps.gov/Stats/SSRSReports/Park%20Specific%20Reports/Recreation%20Visitors%20By%20Month%20(1979%20-%20Last%20Calendar%20Year)?Park=BRCA

Recreation Visits by Month (1979 - Last Calender Year) https://irma.nps.gov/Stats/Reports/Park/BRCA

Population within 150 mi radius of Orderville/1	130,564

1/ From: https://www.freemaptools.com/find-population.htm

Utah State Parks in Proximity to Cove Reservoir

Visitor Data

Park	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jun 2018	July 2018	Aug 2018	Sept 2018	Total	Camp Sites	Visitors per Campsite
Coral Pink Sand Dunes State Park	6,888	26,228	3,613	2,379	2,889	11,118	12,472	14,593	12,443	12,542	8,950	14,190	128,305	22	5,832
Gunlock State Park	546	290	46	124	199	228	2,425	6,197	11,777	9,368	4,556	3,815	39,571	4	9,893
Sand Hollow State Park	14,799	52,093	10,848	13,418	21,907	44,597	97,150	121,468	118,732	101,343	71,391	72,914	740,661	49	15,116
Quail Creek State Park	2,272	6,716	1,478	1,538	2,146	5,661	13,616	19,676	29,279	26,075	17,455	12,966	138,878	20	6,944
From: https://stateparks.utah.gov/resources/park-visitation-data/ FY2018 and 2019											Total Visitor Days		1,047,416	95	11,025
														Average for 4 Sites	2,756

Average Annual Benefit $176,000
based on campsites
at 4 reservoirs near
Cove Reservoir

Jackson Flat Reservoir

From Mike and Dirk		1,200 people/month or 40/day average visitation rate	
From Kelly Brown		30-40 a day during week days and 40-50 a day on weekends	

Average Annual Traffic Count for Route 89 through Glendale, Mt Carmel and Orderville

ROUTE NAME	BEG. ACCUM. MILEAGE	END ACCUM. MILEAGE	BEGIN MILEAGE LOCATION DESCRIPTION	2017 AADT	2016 AADT	2015 AADT	2014 AADT
0089	000.000	007.293	Arizona St Line via SR 89 - Ethan Allen Visitor Center	4,391	4,000	3,600	3,000
0089	007.293	054.629	Ethan Allen Visitor Ctr via SR 89 - Johnson Cyn Rd *ATR 411*	3,230	3,000	2,700	2,200
0089	054.629	062.908	Johnson Canyon Rd via SR 89 - 900 E Kanab	4,263	3,800	3,400	2,800
0089	062.908	063.832	900 E via SR 89 (300 S) - 100 E Kanab	2,367	2,300	2,200	2,100
0089	063.832	064.940	SR 89A (300 S) via 100 E/Center St/300 W - 300 N Kanab	10,448	10,000	9,600	9,200
0089	064.940	081.211	300 N Kanab via SR 89 - SR 9 Mt Carmel Jct	2,829	3,600	3,400	3,300
0089	081.211	085.212	SR 9 Mt. Carmel via SR 89 - Frost Lane Orderville	2,621	2,500	2,400	2,300
0089	085.212	086.222	Frost Lane via SR 89 (State St) - Sand St (100 N) Orderville	3,725	3,600	3,400	3,300
0089	086.222	089.294	100 N Orderville via SR 89 - 400 S Glendale	2,419	2,700	2,500	2,400
0089	089.294	090.018	400 S via SR 89 (Main St) - 300 N Glendale	283	270	260	250
0089	090.018	103.684	300 N Glendale via SR 89 - SR 14 Long Valley Jct	1,970	1,900	1,800	1,700
0089	103.684	114.480	SR 14 Long Valley Jct via SR 89 - Fish Hatchery Rd	1,803	1,700	1,600	1,600
0089	114.480	115.847	Fish Hatchery Rd via SR 89 - 200 S Hatch	3,963	3,800	3,700	3,500

0089	115.847	116.423	200 S via SR 89 - 300 N Hatch	2,014	2,000	1,900	1,800
0089	116.423	124.227	300 N Hatch via SR 89 - SR 12 (Bryce Cyn Jct)	2,058	2,400	2,300	2,200
0089	124.227	130.562	SR 12 (Bryce Cyn Jct) via SR 89 - 500 E Panquitch	4,055	3,900	3,700	3,600
0089	130.562	131.088	500 E via Center St - SR 143 (Main St) Panguitch	4,426	4,300	4,100	3,900
0089	131.088	131.980	Center St via Main St - Rodeo Gnds Panguitch	2,325	3,600	3,400	3,300

From: https://www.udot.utah.gov/main/f?p=100:pg:0::::V,T:,529

Contact Info: Send requests for information to: trafficcount@utah.gov -or- call Nicolas Black at 385-215-527

APPENDIX E-47

RECREATION ANALYSIS AVERAGE COST CALCULATIONS

Cove Reservoir Recreation Improvements (No Utilities) Kane County Water Conservancy District Preliminary Engineer's Opinion of Probable Cost 5-21-19

ITEM	DESCRIPTION	QUANTITY	UNITS	UNIT PRICE	TOTAL
1	Mobilization at 5%	1	L.S.	$21,350.00	$21,350
2	Excavation and Subgrade Prep	88,000	S.F.	$1.50	$132,000
3	6" Reinforced Concrete (Boat Ramp)	6,500	S.F.	$10.00	$65,000
4	6" Untreated Base Course (Boat Ramp)	6,500	S.F.	$1.00	$6,500
5	6" Untreated Base Course (Parking)	28,500	S.F.	$1.00	$28,500
6	6" Untreated Base Course (Roads)	53,000	S.F.	$1.00	$53,000
7	Camp/RV Site Facilities	20	Each	$1,000.00	$20,000
8	Pavilion	1	Each	$50,000.00	$50,000
9	Signage	5	Each	$400.00	$2,000
10	Restroom	2	Each	$35,000.00	$70,000
				Subtotal	$448,350

Contingency (20%)	$89,670
Engineering, Legal, and Fiscal (15%)	$67,253
SCHEDULE A TOTAL	**$605,000**
Proportional road cost[1/]	**$308,000**
Land Rigjhts	**$120,000**
Total Recreation	**$1,033,000**

1/ From Cost Estimates for Appendix D & E.xlsx Cost of Road

Average Cost Calculations

Amort, 2.5%, 103 years =	0.0271
AAC for Recreation Facilities	$28,000
Operation And Maintenance	$12,000
Replacement	$0
Total	$40,000

The recreation component of the project will most likely require 8 man-days per month (lower skill level) for 6 months to maintain the rest rooms and camp sites which would be an annual cost of approximately $12,000

/1 See MEMO dated 5/19/2020 fro Alpha Engineering to Scott Hoag

APPENDIX E-48

RECREATION ANALYSIS SUMMARY

Amortization

amort100	0.0273
amort3	0.0271
PV150	0.2909

Project Costs

	Dam		Rec		Glendale		Road		Total
Cost Est	$ 19,438,000		$448,000		$591,000		$1,198,000		$ 21,675,000
Contingency	$ 3,887,000		$90,000		$118,000		$240,000		$ 4,335,000
Engineering	$ 2,916,000		$67,000		$89,000		$180,000		$ 3,252,000
Land Right	$ 600,000		$120,000						$ 720,000
Road	$ 1,310,000		$308,000						$ 1,618,000
Total	$ 28,151,000		$1,033,000		$798,000		$1,618,000		$ 29,982,000

Average Annual Cost

Amortization	$ 763,000		$ 28,000		$ 22,000				$ 813,000
O&M	$ 12,000		$ 12,000		$ 6,000				$ 30,000
Replace	$ 400				$ 6,000				$ 6,400
Tot AAC	$775,400		$40,000		$34,000				$849,400

*Cost of Road ($1,310,000 for the dam and $308,000 for the rec facilities = $1,618,000) is included in the amortization for dam and rec

Benefits

Irrigation	$ 826,100								$ 826,100
Recreation			$ 176,000						$ 176,000
Glendale					$ 11,200				$ 11,200
Total	$826,100		$176,000		$ 11,200				$ 1,013,300

Net Benefits	$163,900
B:C Ratio	1.19

APPENDIX E-49

RECREATION ANALYSIS COMPOUND INTEREST AND ANNUITY TABLES

COMPOUND INTEREST AND ANNUITY TABLES

2.875 Percent

NO. OF YEARS HENCE	COM-POUND	PRESENT VALUE OF ONE DOLLAR	AMORTI-ZATION	VALUE OF AN ANNUITY - ONE PER YEAR		PRESENT VALUE OF AN ANNUITY	
				Present	Future	Increasing	Decreasing
1	1.03	0.972	1.029	0.972	1.000	0.972	0.972
2	1.06	0.945	0.522	1.917	2.029	2.862	2.889
3	1.09	0.918	0.353	2.835	3.087	5.617	5.724
4	1.12	0.893	0.268	3.728	4.176	9.189	9.453
5	1.15	0.868	0.218	4.596	5.296	13.528	14.049
6	1.19	0.844	0.184	5.440	6.448	18.589	19.488
7	1.22	0.820	0.160	6.260	7.634	24.330	25.748
8	1.25	0.797	0.142	7.057	8.853	30.707	32.805
9	1.29	0.775	0.128	7.832	10.108	37.680	40.637
10	1.33	0.753	0.116	8.585	11.398	45.212	49.222
11	1.37	0.732	0.107	9.317	12.726	53.266	58.539
12	1.41	0.712	0.100	10.029	14.092	61.806	68.567
13	1.45	0.692	0.093	10.720	15.497	70.799	79.288
14	1.49	0.672	0.088	11.393	16.942	80.213	90.681
15	1.53	0.654	0.083	12.047	18.429	90.018	102.727
16	1.57	0.635	0.079	12.682	19.959	100.184	115.409
17	1.62	0.618	0.075	13.300	21.533	110.684	128.709
18	1.67	0.600	0.072	13.900	23.152	121.491	142.609
19	1.71	0.584	0.069	14.484	24.818	132.579	157.093
20	1.76	0.567	0.066	15.051	26.531	143.925	172.143
21	1.81	0.551	0.064	15.602	28.294	155.505	187.746
22	1.87	0.536	0.062	16.138	30.108	167.298	203.884
23	1.92	0.521	0.060	16.659	31.973	179.282	220.543
24	1.97	0.506	0.058	17.166	33.892	191.437	237.709
25	2.03	0.492	0.057	17.658	35.867	203.745	255.367
26	2.09	0.479	0.055	18.137	37.898	216.188	273.504
27	2.15	0.465	0.054	18.602	39.988	228.748	292.106
28	2.21	0.452	0.052	19.054	42.137	241.410	311.160
29	2.28	0.440	0.051	19.494	44.349	254.157	330.654
30	2.34	0.427	0.050	19.921	46.624	266.975	350.575
31	2.41	0.415	0.049	20.336	48.964	279.850	370.911
32	2.48	0.404	0.048	20.740	51.372	292.770	391.651
33	2.55	0.392	0.047	21.132	53.849	305.720	412.784
34	2.62	0.381	0.046	21.514	56.397	318.690	434.298
35	2.70	0.371	0.046	21.885	59.018	331.669	456.182
36	2.77	0.360	0.045	22.245	61.715	344.645	478.428
37	2.85	0.350	0.044	22.596	64.489	357.609	501.023
38	2.94	0.341	0.044	22.936	67.343	370.551	523.959
39	3.02	0.331	0.043	23.267	70.280	383.463	547.227
40	3.11	0.322	0.042	23.589	73.300	396.335	570.816

41	3.20	0.313	0.042	23.902	76.407	409.161	594.718
42	3.29	0.304	0.041	24.206	79.604	421.932	618.924
43	3.38	0.296	0.041	24.502	82.893	434.642	643.425
44	3.48	0.287	0.040	24.789	86.276	447.284	668.214
45	3.580	0.279	0.040	25.068	89.756	459.852	693.282
46	3.68	0.271	0.039	25.340	93.337	472.341	718.622
47	3.79	0.264	0.039	25.604	97.020	484.744	744.225
48	3.90	0.257	0.039	25.860	100.810	497.057	770.085
49	4.01	0.249	0.038	26.109	104.708	509.276	796.195
55	4.754	0.2104	0.0364	27.466	130.567	580.375	957.711
100	17.0210	0.0588	0.0305	32.7391	557.2518	967.1390	2,339.5097

APPENDIX E-50

TABLE S-2: ESTIMATED PROJECT COSTS

Table S-2. Estimated Project Costs

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
Land Rights	$60,000	$660,000	$720,000
Total	$21,426,000	$8,556,000	$29,982,000

*Note: Funds contributed by KCWCD, WCWCD, and Utah Division of Wildlife Resources (UDWR). See Section 6.8 for details

APPENDIX E-51

TABLE 1: ESTIMATED INSTALLATION COST

Table 1. Estimated Installation Cost, Cove Reservoir, UT (Dollars)[/1]

Works of Improvement		Number	Estimated Cost (Dollars)1/		
			Public Law 83-566 Funds	Other Funds	Total
Multipurpose Structure/2		1	$20,859,000	$8,090,000	$28,949,000
Recreation Facilities/3		1	$567,000	$466,000	$1,033,000
Total			$21,426,000	$8,556,000	$29,982,000

/1 Price Base: FY 2021

Prepared: 10/2020

/2 Includes Dam Construction, Proportion of Access Road ($1,310,000), Land Rights ($600,000),Glendale Piping ($799,000)

/3 Includes construction and proportion of access road ($308,000), Land Rights ($120,000)

71.5% 28.5%

	amort, 2.5%, 103 yr	om&r	total	Benefits
dam	$763,000	$12,400	$775,400	
rec	$28,000	$12,000	$40,000	
glendale	$22,000	$12,000	$34,000	
	$813,000	$36,400	$849,400	
dam + glendale	$785,000	$24,400	$809,400	
rec	$28,000	$12,000	$40,000	
	$813,000	$36,400	$849,400	

APPENDIX E-52

TABLE 2: ESTIMATED COST DISTRIBUTION

Table 2. Estimated Cost Distribution—Water Resource Project Measures Cove Reservoir, UT (Dollars) [1/]

	Installation Cost - Public Law 83-566				Installation Cost - Other						
Works of Improvement	Construction	Engineering	Real property rights	Total Public Law 566	Construction	Engineering	Real property rights	Total Other	Total		
Multipurpose Structure /2	$16,890,000	$3,005,000		$19,895,000	$7,144,000			$7,144,000	$27,039,000		
Road	$818,000	$146,000		$964,000	$346,000			$346,000	$1,310,000	$28,949,000	96.6%
Land Rights							$600,000	$600,000	$600,000		
Recreation Facilities /2	$269,000	$67,000		$336,000	$269,000			$269,000	$605,000		$29,982,000
Road	$137,000	$34,000		$171,000	$137,000			$137,000	$308,000		
Land Rights			$60,000	$60,000			$60,000	$60,000	$120,000	$1,033,000	3.4%
TOTAL	$18,114,000	$3,252,000	$60,000	**$21,426,000**	$7,896,000		$660,000	$8,556,000	$29,982,000		

/1 Price Base: FY 2021

Prepared: 10/2020

/2 Includes proportional road cost = $1,310,000 for the MPS and$308,000 for Recreation

construction	$26,010,000
eng	$3,252,000
land rights	$720,000
	$29,982,000

APPENDIX E-53

TABLE 2A: COST ALLOCATION AND COST SHARING SUMMARY

Table 2a – Cost Allocation and Cost Sharing Summary Water Resource Project Measures Cove Reservoir, UT (Dollars) 1/

	Cost Allocation/2			Cost Sharing						
	Purpose			Public Law 83-566			Other			
Item	Irrigation	Recreation	Total	Irrigation	Recreation	Total	Irrigation	Recreation	Total	TOTAL
MP Structure										
Construction	$19,492,000	$4,542,000	$24,034,000	$14,619,000	$2,271,000	$16,890,000	$4,873,000	$2,271,000	$7,144,000	$24,034,000
Engineering	$2,437,000	$568,000	$3,005,000	$2,437,000	$568,000	$3,005,000				$3,005,000
Land Rights	$487,000	$113,000	$600,000				$600,000		$600,000	$600,000
SubTotal	$22,416,000	$5,223,000	$27,639,000	$17,056,000	$2,839,000	$19,895,000	$5,473,000	$2,271,000	$7,744,000	$27,639,000
Road										
Construction	$944,000	$220,000	$1,164,000	$708,000	$110,000	$818,000	$236,000	$110,000	$346,000	$1,164,000
Engineering	$146,000		$146,000	$146,000		$146,000				$146,000
Subtotal	$1,090,000	$220,000	$1,310,000	$854,000	$110,000	$964,000	$236,000	$110,000	$346,000	$1,310,000
SubTotal MP Structure	$23,506,000	$5,443,000	$28,949,000	$17,910,000	$2,949,000	$20,859,000	$5,709,000	$2,381,000	$8,090,000	$28,949,000
Recreation Facilities										
Construction		$538,000	$538,000		$269,000	$269,000		$269,000	$269,000	$538,000
Engineering		$67,000	$67,000		$67,000	$67,000				$67,000
Land Rights		$120,000	$120,000		$60,000	$60,000		$60,000	$60,000	$120,000
SubTotal		$725,000	$725,000		$396,000	$396,000		$329,000	$329,000	$725,000
Road										
Construction		$274,000	$274,000		$137,000	$137,000		$137,000	$137,000	$274,000
Engineering		$34,000	$34,000		$34,000	$34,000				$34,000
SubTotal		$308,000	$308,000		$171,000	$171,000		$137,000	$137,000	$308,000
SubTotal Recreation		$1,033,000	$1,033,000		$567,000	$567,000		$466,000	$466,000	$1,033,000
TOTAL	**$23,506,000**	**$6,476,000**	**$29,982,000**	**$17,910,000**	**$3,516,000**	**$21,426,000**	**$5,709,000**	**$2,847,000**	**$8,556,000**	**$29,982,000**

/1 Price Base: FY 2021 Prepared: 10/2020

/2 Based on Separable Costs-Remaining Benefits Cost Allocation including construction, engineering, and land rights

6.7.1 Total Project Cost

- Agricultural Water Management—96.6 percent ($28,949,000) 96.6%
- Recreation—3.4 percent ($1,033,000) 3.4%

6.7.2 NRCS Cost Sharing

NRCS total contributed funds (including construction, engineering, and land rights) would be allocated as follows:

· Agricultural Water Management—97.4 percent ($17,910,000) $17,910,000 83.6%
· Recreation—2.6 percent ($3,516,000) $3,516,000 16.4%

6.7.2 NRCS Cost Sharing For Agricultural Water Management

- $18,435,300 of NRCS funds will be used for construction of the reservoir, access road, and Glendale pipeline (75 percent of the total construction cost of $24,580,700) excluding engineering and land rights allocations
  const $15,327,000 $20,436,000
  75%

- $989,150 of NRCS funds will be used for construction of the recreation facilities and associated portion of the access road (50 percent of total construction cost of $1,978,300)
  const $406,000 $812,000
  50%

6.7.3 Sponsor Cost Sharing including construction, engineering and land rights

- Agricultural Water Management—87.2 percent ($6,832,800) $5,709,000 66.7%

- Recreation—12.8 percent ($1,005,450) $2,847,000 33.3%

For Agricultural Water Management, excluding engineering and land rights allocations, sponsor contributed funds would be allocated as follows:

- $6,145,400 of KCWCD, WCWCD, and UDWR funds will be used for construction of the reservoir, access road, and Glendale pipeline (25 percent of the total construction cost of $24,580,700)

const $5,109,000 $20,436,000
25%

For Recreation, excluding engineering and land rights allocations, sponsor contributed funds would be allocated as follows:

- $989,150 of KCWCD, WCWCD, and UDWR funds will be used for construction of the recreation facilities and associated portion of the access road (50 percent of total construction cost of $1,978,300)

const $2,787,000 $5,574,000
50%

APPENDIX E-54

TABLE 2B: RECREATIONAL FACILITIES—ESTIMATED CONSTRUCTION COST

Table 2b – Recreational Facilities—Estimated Construction Costs Cove Reservoir, UT [Dollars] 1/

Item	Number	Unit	Estimated unit cost	Total Construction
Mobilization at 5%	1	L.S.	$21,350	$21,350
Excavation and	88,000	S.F.	$1.50	$132,000
6" Reinforced	6,500	S.F.	$10.00	$65,000
6" Untreated Base	6,500	S.F.	$1.00	$6,500
6" Untreated Base	28,500	S.F.	$1.00	$28,500
6" Untreated Base	53,000	S.F.	$1.00	$53,000
Camp/RV Site Facilities	20	Each	$1,000	$20,000
Pavilion	1	Each	$50,000	$50,000
Signage	5	Each	$400	$2,000
Restroom Facility (Assume septic tank	2	Each	$35,000	$70,000
Access Road	3,400	Ft	$91	$308,000
			Subtotal	$756,000
			Contingency (20%)	$90,000
	Engineering, Legal, and Fiscal (15%)			$67,000
			Total	$913,000

/1 Price Base: FY 2019 Prepared: 06/2019

APPENDIX E-55

TABLE 4: ESTIMATED AVERAGE ANNUAL NED COSTS

Table 4 – Estimated Average Annual NED Costs Cove Reservoir, UT (Dollars) 1/

	Project Outlays		
Works of Improvement	Amortization of Installation Cost	Operation, Maintenance, and Replacement Cost	Total
MP Structure	$785,000	$24,400	$809,400
Recreation Facilities	$28,000	$12,000	$40,000
Total	**$813,000**	**$36,400**	**$849,400**

1/ Price base: FY 2021, amortized over 103 years at a discount rate of 2.50 percent.

Prepared: 10/2020

APPENDIX E-56

TABLE 6: COMPARISON OF NED BENEFITS AND COST

Economic Table 6 – Comparison of NED Benefits and Costs, Cove Reservoir, UT (Dollars)[1]

Works of Improvement	Agriculture Water Management	Recreation	Other Economic Effects	Average Annual Benefits	Average Annual Costs[2]	Benefit to Cost Ratio	Net Benefit
			Glendale Piping				
Multipurpose Structure	$826,100		$11,200	$837,300	$809,400	1.03	$27,900
Recreation Facilities		$176,000		$176,000	$40,000	4.40	$136,000
Total Project	**$826,100**	**$176,000**	**$11,200**	**$1,013,300**	**$849,400**	**1.19**	**$163,900**

1/ Price base: FY 2021

2/ From Table 4.

Prepared: 10/2020

APPENDIX E-57

WORK PLAN TABLES SUMMARY

amort100	0.0273
amort103	0.0271
pv1-50yrs	0.0209
IrrAlloc	81.1%
RecAlloc	18.9%

Project Costs

	Dam		Rec		Glendale		Road		Total
Cost Est	$ 19,438,000		$448,000		$591,000		$1,198,000		$ 21,675,000
Contingency	$ 3,887,000		$90,000		$118,000		$240,000		$ 4,335,000
Engineering	$ 2,916,000		$67,000		$89,000		$180,000		$ 3,252,000
Land Right	$ 600,000		$120,000						$ 720,000
Road	$ 1,310,000		$308,000						$ 1,618,000
Total	$ 28,151,000		$1,033,000		$798,000		$1,618,000		$ 29,982,000

Average Annual Cost

Amortization	$ 763,000		$ 28,000		$ 22,000				$ 813,000
O&M	$ 12,000		$ 12,000		$ 6,000				$ 30,000
Replace	$ 400				$ 6,000				$ 6,400
Tot AAC	$775,400		$40,000		$34,000				$849,400

*Cost of Road ($1,310,000 for the dam and $308,000 for the rec facilities = $1,618,000) is included in the amortization for dam and rec

Benefits

Irrigation	$ 826,100								$ 826,100
Recreation			$ 176,000						$ 176,000
Glendale					$ 11,200				$ 11,200
Total	$826,100		$176,000		$ 11,200				$ 1,013,300

	Ag Water Mgmt	Recreation
AAC	$809,400	$40,000
Benefits*	$837,300	$176,000
Net Benefits	$27,900	$136,000
B:C Ratio	1.03	4.40

* includes Glendale Piping Benefits ($11,200)

Project Net Benefits	$163,900
Project B:C Ratio	1.19