RECLAMATION

Managing Water in the West

High Lakes Stabilization Technical Memorandum

Kidney Lake

Uinta Basin Replacement Project

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

April 2009

High Lakes Stabilization Technical Memorandum

Kidney Lake

Uinta Basin Replacement Project

prepared by

Provo Area Office
Upper Colorado Region

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

April 2009

Concurrence

The undersigned concur with the recommendations identified in this Technical Memorandum. This Technical Memorandum will serve as a Decision Memorandum.

4/20/2009

David Marble, Assistant Utah State Engineer, Dam Safety — Date

5/29/09

Reed R. Murray
Department of the Interior
CUPCA Office — Date

May 22, 2009.

Harv Forsgren
Regional Forester
U.S. Forest Service — Date

5/29/09

Michael C. Weland
Executive Director
Utah Reclamation Mitigation and Conservation Commission — Date

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Introduction

The Uinta Basin Replacement Project (UBRP Project) was authorized by Section 203 of the Central Utah Project Completion Act [CUPCA: Titles II through VI of P.L. 102-575, as amended]. The UBRP Project is located in Duchesne County near the towns of Altamont, Upalco, and Roosevelt, within the Uinta Basin of northeastern Utah. Its purposes are to increase efficiency, enhance beneficial uses, and achieve greater water conservation within the Uinta Basin. The Central Utah Water Conservancy District (District) is implementing the water development portions of the UBRP Project, and the Utah Reclamation Mitigation and Conservation Commission (Mitigation Commission) is responsible for mitigating project impacts to fish, wildlife and wetland habitats. Funding for mitigation measures is provided under Title II of CUPCA through the U.S. Department of the Interior. The Final Environmental Assessment for the UBRP Project was prepared by the District and was signed by the Department of the Interior in October 2001. Project construction began in 2003. The Commission issued a Decision Notice and Finding of No Significant Impact in February 2004 for implementing fish and wildlife mitigation features of the UBRP Project. Stabilization of the thirteen reservoirs is one of those requirements.

A component of the UBRP Project is that thirteen high mountain lakes formerly used to store water rights would be stabilized at No-Hazard levels, and the water rights transferred downstream for storage in the enlarged Big Sand Wash Reservoir, another feature of the UBRP Project. The stabilization of the thirteen reservoirs is mitigation for the enlargement of Big Sand Wash Reservoir. Because of the breach potential of the High Lakes Dams, and the difficulty in monitoring and maintaining these dams in the Wilderness area, the Mitigation Commission is undertaking the stabilization of thirteen of these dam structures. The storage water rights will be transferred downstream in the expanded Big Sand Wash Reservoir where maintenance and monitoring is practical. These wilderness dams vary in size, hazard rating and condition and have peak breach flow potential ranging from hundreds to several thousand cubic feet per second (cfs). Breach flows of this magnitude far exceed the carrying capacity of existing streams and they would cause extensive damage to the downstream forest resource, campgrounds, trails, roads, dams and in some cases, private property and residents. The “Do Nothing” option was not considered appropriate because of the eventuality of the deterioration and catastrophic failure of these dams.

There are no absolute criteria for defining a No-Hazard dam. The Utah State Engineer is authorized to make that determination. Section R655-10-5 of The State of Utah Statutes and Administrative Rules for Dam Safety dated July 1996 states “The State Engineer is the ultimate authority on the hazard classification designation for a given dam”. However, the Forest Service also has dam safety responsibilities and the two agencies have outlined a number of protocols regarding dam safety matters in a memorandum of understanding between the two agencies (see Appendix A). Therefore, all decisions and recommendations regarding these structures are mutually agreed on by both parties.

Essentially, the No-Hazard rating is achieved by demonstrating that in the event of failure, there is no appreciable damage or adverse affects downstream of the dam. For the more significant structures, this demonstration is accomplished through a dam break analysis. Various stabilized reservoir elevations are assumed and the resulting flood from a sunny day break is compared to the existing downstream channel capacity. When the analyses show that a stabilized reservoir elevation would result in a flood that can be contained within the downstream channel, the dam can be considered to be No-Hazard. A guidance design criterion from the State of Utah is that the dam break should produce a maximum flow of less than 500 cubic feet per second (cfs).

Stabilization of the thirteen high mountain lakes at No-Hazard levels will provide constant lake water levels year-round. Nine of the lakes (Bluebell, Drift, Five Point, Superior, Water Lily, Farmers, East Timothy, White Miller, and Deer) are located in the Upper Yellowstone River watershed and four (Brown Duck, Island, Kidney and Clements) are in the Brown Duck Basin of upper Lake Fork watershed. Consequently, streamflows originating in these upper watersheds will return to natural hydrologic runoff patterns, wilderness fishery and recreational values will be restored within the High Uintas Wilderness Area (HUWA), and operation and maintenance impacts will be eliminated in the HUWA.

The thirteen reservoirs are located in the High Uintas Wilderness Area. The U.S. Forest Service, Moon Lake Water Users Association, U.S. Bureau of Reclamation and Duchesne County Water Conservancy District all have knowledge and experience with operation, maintenance and stabilization of the high mountain lakes. The Commission entered into Interagency Agreement No. 05-AA-UT-1300 with Reclamation to provide engineering, design, construction, and oversight services for the stabilization project. This technical memorandum is a work product under the Interagency Agreement and addresses design criteria needed to achieve a “No Hazard” rating as defined by the State of Utah and as agreed to by the Forest Service, for Kidney Lake in Brown Duck Basin.

Typically, the stabilization of these dams will require the excavation of a outlet notch, with stable side slopes, through the middle of the embankment and either removal or plugging of the existing low level outlet. An armored, stabilized low level channel would then be constructed in the notch to pass normal runoff as well as large storm events without jeopardizing the remaining structure by impounding excess water. In some cases the embankment may be removed or buttressed to decrease the height and increase the stability and ability of the remaining embankment to withstand any seismic event or overtopping during extreme events. This work is the minimum necessary to stabilize these dam structures and restore natural hydrologic flows to the greatest extent possible, while still meeting a "No Hazard" dam safety rating.

Kidney Lake is the only lake in the Brown Duck Basin that remains to be stabilized. Clements Lake was stabilized in 2007. Brown Duck and Island Lakes were stabilized in 2008. Kidney Lake Dam was placed under a “Do Not Store” order by the Utah State Engineer in 2006 due to a hole which developed on the upstream face and top of the dam. Kidney Lake is planned to be stabilized in 2009. The stated objective for this lake is to create conditions such that any dam, if remaining, is assigned a “No Hazard” classification with a minimum design life of 100 years (essentially a permanent fix).

An additional constraint is that the Kidney Lake dam stabilization project needs to be completed in one construction season (usually July through September) because of the vulnerability of a partially removed embankment. A partially completed dam could easily overtop and fail from snow melt runoff or storms, even if the outlet were still in place and open. Breach flow potential would be extensive even from the reduced lake storage volumes. Existing spillways would be too high to assist in flood routing under these circumstances and it would be prohibitive to build auxiliary or temporary spillways over the excavated embankment or on bedrock at the proper level, even if it could be located.

Multi-year construction projects to stabilize a single dam have serious potential problems, including:

- Increased vulnerability to failure from hydraulic overloading when partial breaches may not be adequately stabilized;
- High potential for erosion and soil disruption from over-wintering and unexpected weather events;
- Additional required work and disturbance to reconstruct and stabilize the dam at the end of each construction season;
- Increased mobilization and demobilization costs from additional work cycles;
- Increased site disturbance from multi-year operations at camps, travel routes, and activity on-site;
- The U.S. Forest Service does not allow riprap spillways on moderate-hazard earth fill dams; therefore any intermediate "spillway" or outlet channel on a partially stabilized dam would be required to be hardened, probably with concrete; and
- High potential for unexpected, early adverse weather conditions which could close the construction project prior to adequate stabilization.

In addition, because this dam was constructed at the turn of the century there is no guarantee that plans are accurate. Once breached, there may be unexpected materials or inappropriate materials in the dam that would not support a partial breach option. A partial breach may also create unanticipated new flow regimes.

Other considerations with multi-year projects include:

- Uncertainty of weather from year to year which may require additional measures to ensure partially breached dams are secure;
- Longer exposure of crews to accident vectors during the multi-seasons;
- Increased risk of personnel changes leading to loss of skills and experience; and
- Loss of availability of equipment.

Based on past experience, success with multi-year staged construction projects has been low.

The Forest Service does not recommend planning for a multi-year project to stabilize an individual dam. Further, they have advised that at the completion of each season of activity the partially-stabilized dam will be required to fully meet State of Utah and U.S. Forest Service dam safety specifications. Due to the existing condition of many of the dams, achieving this requirement could entail even more

extensive work and could be more difficult to achieve than completing the stabilization to its final proposed configuration.
It was determined that this risk possibility was inconsistent with the projects goals of safety and stabilization as well as minimum impact and the preservation of the Wilderness resources and values.

As indicated by the concurrence page, the purposes of this memorandum are to document the design decisions and rationale used in the final design and to ensure that each of the participating agencies are in agreement with and approve of the final design. This memorandum describes the design of the proposed stabilized Kidney Lake dam in the Brown Duck Basin.

The appendices contain design drawings and backup data that support the design conclusions and recommendations. Appendix A contains a copy of the MOU between the State of Utah and the U.S. Forest Service for dam safety. Appendix B contains design drawings showing a location map and applicable details for Kidney Lake. Appendix C contains portions of the HEC-1 output files for the inflow hydrology that was performed. The total output file for this work contains numerous pages, most of which is hydrograph data that is not necessarily meaningful to most readers. Rather than include the entire output, a select page that contains relevant flow data has been provided. The remaining output will be kept on file and made available upon request. Appendix D contains a summary table of the construction quantities for the designed work. Appendix E contains a summary of the Simplified Dam Break analysis. The total output file for the dam break analysis also contains additional pages which are kept on file and are available upon request. Appendix F contains historical drawings of the dam and associated features.

Another item of note concerns the apparent elevation discrepancies between the various data sets. Each dam was topographically surveyed using global positioning satellite (GPS) equipment. The elevations measured and used for the drawings are actual elevations tied to the State Plane Coordinate System. However, the Digital Elevation Models (DEM) used for the hydrology and dam break analyses were obtained from the U.S. Geologic Survey (USGS) data base which does not necessarily match the State Plane elevations. Because of these differences, model adjustments were made accordingly.

Design Considerations

A number of issues and considerations must be accounted for in the design. These include the following:

- Inflow hydrology
- Dam break analysis
- Outlet works removal or plugging with associated cutoffs and filters
- Outlet channel configuration including width, armoring, and side slopes
- Downstream connection to existing channel needs to accommodate drop in elevation between outlet channel and original ground. The downstream connection will be arranged in the field.
- All reasonable efforts will be made to blend outlet channel into the natural drainage in the area, to the extent that it does not require a significant increase in resources to do so.

Table 1. Summary of SCS Type II 6-hour 100-year Storm Hydraulics

Lake	Surface Area (ac)	Res. Volume (ac ft)	Dam Height (ft)	Basin Area (sq mi)	AMC III Composite CN	100 yr. Storm (in)	Peak Runoff (cfs)	Maximum Routed Flow (cfs)
Kidney	175	3725	22	3.5	69.0	2.65	514	20

Kidney Lake

Kidney Lake is located near the top of Brown Duck Creek. It has a surface area of about 175 acres at the existing spillway and holds approximately 3,725 acre-feet of water. The dam is a homogeneous embankment 22 feet high and has a 30-inch diameter low-level outlet located at the maximum section. Kidney Lake is currently under filling restrictions due to the development of a hole in the embankment in 2006. The outlet works gate has remained fully open to prevent any reservoir storage at or above the hole location.

Inflow Hydrology

The Kidney Lake drainage basin is 3.5 square miles in area and is comprised of partially wooded slopes, interspersed with brush and grassy areas. Significant areas of rock and talus slopes are also present. The Watershed Modeling System (WMS) software package was used to model the drainage basin using the DEM obtained from the USGS web site. Hydrologic characteristics for the basin were then incorporated for full analysis. The 100-year, 6-hour storm estimate of 2.65 inches was obtained from the National Oceanic and Atmospheric Administration's (NOAA) Precipitation Frequency Data Server, Atlas 14, Volume 1, Version 3. This storm has a peak runoff of 514 cfs. However, when routed through the reservoir, the peak runoff is attenuated to a maximum flow of 20 cfs through the spillway.

The Basin Average method was combined with the U.S. Soil Conservation Service (SCS) Type-II, 6-hour curve to define the series. The SCS curve number method was used to model the basin losses, with a curve number of 69 (corresponding to AMC III 'fair" conditions). The SCS method was used within WMS to compute a Lag time of 1.5 hours. The Muskingum-Cunge method was used for stream routing with averaged stream characteristics based on actual survey data. Actual reservoir area-capacity curves were input for routing purposes.

Dam Break Analysis

The Simple Dam Break (SMPDBK) model contained within the WMS package was used to model multiple runs of dam break scenarios using varying parameters. Various breach elevations were modeled to obtain maximum flows in the downstream channel so that the effects of a dam break could be understood and acceptable limits set. The dam break scenario table in Appendix C tabulates the results of various reservoir elevations and the corresponding dam break maximum flow.

A 15-foot-wide breach was used with a 300 minute time-to-breach, corresponding to half of the inflow hydrograph. A sunny day break of Kidney Lake Dam with the outlet channel at elevation 10,274.5 produces a maximum flow of 391 cubic feet per second and a water depth in the downstream channel averaging about 2.3 feet. By the time the breach flow reaches Moon Lake in 6.3 hours it is 1.4 feet deep. Stream cross sections were determined by WMS from the DEM data and verified by cross-sectional surveys obtained by Reclamation survey crews.

Outlet Works

In order to have a no hazard classification there can be no operable outlet works. The existing outlet works could either be left in place and plugged, or the entire outlet works could be removed. In either case the existing outlet works gate would be removed.

Leaving the outlet pipe in place and plugging the pipe with cement is the proposed alternative. The outlet pipes at Clements Lake, Brown Duck Lake and Island Lake were treated in this manner and were done effectively. The outlet pipe at Kidney Lake is 108 feet in length. It would require 20 CY of cement to seal completely.

As shown on the drawings, the plugged outlet pipe will be protected on the upstream and downstream ends with a grouted rock gabion basket cutoff wall. The plugged outlet pipe will have additional protection at the downstream end in the form of a filter material that will prevent migration of fines in the event that some water is able to flow through the grouted pipe. The upstream cutoff will be designed to prevent any water flows through the grouted pipe, but the filter is an additional protection that provides redundancy in the design and will help to ensure a permanent fix.

The filter material will consist of a well-graded sand that will be obtained onsite. During excavation, sandy materials encountered will be stockpiled for use as the downstream filter. A 3/8-inch minus screen will be utilized to remove any oversized material. The filter will be placed to a length of 8 feet of the outlet works trench resulting in an approximate volume of 5 to 6 cubic yards of material required**.** In the unlikely event that adequate sand is not available from onsite excavations, contingency plans would be required. This would include either locating an adequate source within the proximity of the work area or flying in bagged sand by helicopter. Geotextile fabrics were not considered due to the potential of plugging over time.

Inlet Channel

The inlet channel that was excavated from the natural lake margin in order to release water from below the natural lake elevation, should be filled with rubble and fine-grained material removed from the embankment of the dam to create the outlet channel. Filling this trench will provide additional security by reducing hydraulic pressure against the face of the upstream gabion placed at the mouth of the outlet pipe that will be grouted in place. It is estimated that 600 yards of material will be required to fill this channel.

Outlet Channel

Based on the results of the dam break analysis and as shown on the drawings, the maximum recommended outlet channel invert elevation is 10,274.5 feet. The recommended width at the invert is 15 feet. Keeping the outlet channel a minimum width of 15 feet will help reduce plugging due to ice, snow, and debris.

The outlet channel will be located through the dam to the right side of the outlet pipe. The excavated notch will not need to be riprapped for the first 50 feet (see Appendix B) because it will be inside the natural lake basin. However, if the engineer in charge of the project determines some riprap or other form of protection should be added to this portion of the channel, it will be incorporated at that time.

A grouted rock gabion basket cutoff wall will be constructed at the upstream end of the outlet channel to insure a stabilized elevation. The top of gabion elevation will be 10,274.5. A second grouted gabion cutoff wall will be constructed at approximately station 0+80 (about halfway through the channel) and another at the downstream end of the outlet channel. A boulder-pool channel will be constructed to transition the new channel slope into the existing downstream grade.

Once the channel cuts through the embankment, it will be armored with a 24”-thick layer of 12” D_{50} riprap along the invert and for a vertical height of 4 feet on the side slopes. The remainder of the outlet channel side slopes will consist of smaller riprap armoring. The armoring of the invert and side slopes will provide protection against erosion and will ensure stable and permanent side slopes. It is critical that the toe of the side slopes does not experience erosion because of slope stability issues. Without toe protection, substantial erosion or undermining of the bottom of the side slopes could result in a complete slope failure.

A slope stability analysis was performed on the side slopes of the outlet channel. The slopes were required to be flat enough to allow a safety factor of at least 1.5 against failure. The existing embankment consists of cohesionless silty sands and an assumed friction angle of 31 degrees was used. Typical friction angle values for this type of material range from 30 to 32 degrees. To allow a higher friction angle than what was assumed would require a more thorough investigation of the material. Because of the nature of the materials, the cohesion was assumed to be zero.

Another factor that affects the results of the analysis is the assumed level of saturation within the embankment. For normal operating conditions, the saturation level will be less than 1 foot high. However, if the outlet channel was to become plugged or there was an extreme inflow event, the saturation level could become somewhat higher. The higher the saturation level, the flatter the side slopes need to be to maintain an adequate safety factor. In order to maintain a conservative design that will be considered to be permanent, a saturation level of 2 feet was used for the stability analysis. Although this level is likely to be higher than what will actually occur, the analysis did not assume any erosion of the toe and therefore should be considered as reasonable. It is possible through a combination of outlet channel plugging and high inflows that the saturation level of the embankment could rise above 1 foot. Therefore, a 2 foot high saturation level is not overly conservative. Based on the assumptions given above, the recommended slope configuration for the outlet channel is 2.5 horizontal to 1 vertical.

Because the main criteria for sizing the outlet channel width is to prevent snow, ice and debris from building up and blocking or plugging the channel, the recommended width of the channel is much greater than necessary to pass normal outlet channel outflows. Therefore, a low flow channel that will generally contain all outflows is incorporated into the design. Even for the 100 year storm outflow, the water level is less than 1.0 foot above the top of the low flow channel. Details of the low flow channel are shown on the drawings in Appendix B.

The outlet channel elevation was set to match the new reservoir level at the upstream and to tie into the existing outlet works channel on the downstream to provide as smooth and even of a transition as possible. However, in order to keep channel velocities to less than 5 or 6 feet per second, the maximum grade within the outlet channel was limited to approximately 5 percent. In order to prevent erosion at the toe of the outlet channel slopes, channel velocities need to be minimized. In some cases this will require additional riprap armoring at the downstream end of the new outlet channel and existing outlet works channel transition due to several feet of drop required. Field crews will take care to minimize this drop by lengthening the downstream transition as much as possible. The Storm Spillway Hydraulics table in Appendix C provides 100 year storm hydraulic data for the outlet channel flows.

Treatment of the hole in the dam embankment

As part of the permanent fix, it is highly recommended that the hole on the face and top of the dam be filled in. Because the proposed alignment for the armored outlet channel is through the right side abutment and not straight through the dam over top of the existing outlet pipe, most if not all of the existing hole in the embankment will not be intercepted and excavated by the cut for the new outlet channel.

Even though it will be above the stabilized reservoir level, it is possible that the public could injure themselves by falling into the hole created by the piping of fines from the embankment. Therefore this hole should be filled in. Loose material should be removed from the hole and the area should be backfilled and compacted in established lifts using competent backfill material taken from the breach excavation.

Appendix A - Memorandum of Understanding between State of Utah and U.S. Forest Service

RECEIVED
JAN 2 0 1981
DIVISION OF WATER RIGHTS
VERNAL, UTAH

MEMORANDUM OF UNDERSTANDING

Intermountain Region
Forest Service
U. S. Department of Agriculture

Division of Water Rights
Department of Natural Resources
State of Utah

THIS MEMORANDUM OF UNDERSTANDING is entered into by the Division of Water Rights, Department of Natural Resources, State of Utah, hereafter called the Division, and the Intermountain Region, Forest Service, Department of Agriculture, hereafter referred to as the Forest Service.

WHEREAS, the Forest Service and the Division have certain responsibilities for the safety of dams by virtue of land status or public safety, and

WHEREAS, the Division has been created under Utah Statutes 73-5-5, 6, 7, 12, and 13, to provide public safety and resource protection by supervision and administration of a system to safeguard dams in the State of Utah, and

WHEREAS, the Forest Service under Acts of June 4, 1897 (16 U.S.C. 551), February 1, 1905 (16 U.S.C. 473), July 22, 1937 (16 U.S.C. 1010), June 12, 1960 (16 U.S.C. 528), as amended, is directed to regulate the occupancy and use of the National Forests and National Grasslands, and

WHEREAS, the Forest Service under administrative Manual requirements is directed to supervise and administer a system of inspections to safeguard dams located on National Forest lands, and

WHEREAS, the Forest Service and the Division mutually desire:

1. To periodically inspect dams located on National Forest lands.

2. To develop and document procedural methods to minimize duplication of effort and facilitate complementary inspections of dams.

NOW THEREFORE, the parties agree as follows:

1. The Forest Service agrees:

a. To coordinate with the Division at the local and state levels in developing an annual inspection schedule for dams.

b. To provide the Division copies of dam inspection reports made by Forest Service engineers.

c. To notify the Division of suspected safety hazards of dams located on National Forest lands.

2. The Division agrees:

a. To provide notification to the appropriate Forest Supervisor of the dams scheduled for Division inspection each calendar year.

b. To provide the Forest Service copies of dam inspection reports made by Division engineers.

c. To notify the Forest Service of suspected safety hazards of dams located on, or affecting, National Forest lands.

3. It is mutually agreed:

a. To cooperate in the periodic inspection of dams located on National Forest lands in the State of Utah.

b. To develop and seek application of safety measures required to protect public safety and resources.

c. That nothing herein shall be construed in any way as limiting the authority of the Division in carrying out its legal responsibilities for management or regulation of dam safety.

d. That nothing herein shall be construed as limiting or affecting in any way the legal authority of the Forest Service in connection with the proper administration and protection of National Forest System lands, in accordance with Federal laws and regulations.

e. That nothing in the Memorandum of Understanding shall be construed as obligating the Forest Service or the Division to expend funds in any contract or other obligation for future payment of funds or services in excess of those available or authorized for expenditure.

f. That amendments to this Memorandum of Understanding may be proposed by either party and shall become effective after written approval by both parties.

g. That this Memorandum of Understanding shall continue in force unless terminated by either party upon thirty (30) days notice in writing to the other of intention to terminate upon a date indicated.

h. Forest Service and local Division inspection personnel[1] will coordinate their annual inspection schedules to avoid duplication of effort.

[1] See Exhibit 1 attached hereto.

i. That agreements between Forest Supervisors and local dam inspection personnel of the Division can be made as amendments to this document if such agreements are deemed necessary.

j. That no member of or delegate to Congress, or Resident Commissioner of the United States shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom.

k. That each and every provision of this Memorandum is subject to the laws of the State of Utah, the laws of the United States, the regulations of the Secretary of Agriculture, and the regulations of the Division.

IN WITNESS THEREOF, the parties hereto have caused this Memorandum of Understanding to be executed as of the last date signed below.

JEFF M. SIRMON
Acting Regional Forester
Intermountain Region
USDA Forest Service

Date 4/4/80

DEE C. HANSEN
State Engineer
Division of Water Rights
Department of Natural Resources
State of Utah

Date April 14, 1980

This Memorandum of Understanding is applicable to the following National Forests:

Ashley National Forest
437 East Main
Vernal, Utah 84078

Dixie National Forest
Federal Building
82 North 100 East
P.O. Box 580
Cedar City, Utah 84720

Fishlake National Forest
P.O. Box 628
170 North Main Street
Richfield, Utah 84701

Manti-LaSal National Forest
350 East Main Street
Price, Utah 84501

Uinta National Forest
P.O. Box 1428
88 West 100 North
Provo, Utah 84601

Wasatch National Forest
8226 Federal Building
125 South State Street
Salt Lake City, Utah 84138

USDA United States Department of Agriculture | Forest Service | Intermountain Region | 324 25th Street
Ogden, UT 84401
801-625-5605

File Code: 2320/7520 **Date:** February 22, 2007
Route To:

Subject: High Lakes Dam Stabilization

To: Forest Supervisor, Ashley NF

The High Lakes Dam Stabilization project represents a significant milestone in restoring watersheds of the High Uintas Wilderness that were affected by dam construction. We have significant concerns about multi-year phasing of these dam stabilization projects. This letter documents these concerns so you may adequately continue to plan successful stabilization projects.

Multi-year construction projects to stabilize a single dam have serious potential problems, which include, but are not limited to:

- Increased vulnerability to failure from hydraulic overloading when partial breaches may not be adequately stabilized
- High potential for erosion and soil disruption from over-wintering and unexpected weather events
- Additional required work and disturbance to reconstruct and stabilize the dam at the end of each construction season
- Increased mobilization and demobilization costs from additional work cycles
- Increased site disturbance from multi-year operations at camps, travel routes, and on-site activity
- The Forest Service does not allow riprap spillways on moderate-hazard earthfill dams, therefore any intermediate "spillway" or outlet channel on a partially stabilized dam would be required to be hardened, probably with concrete
- High potential for unexpected, early adverse weather which could close the construction project prior to adequate stabilization

In addition, because these dams were constructed at the turn of the century, there is no guarantee that plans are accurate. Once breached, there may be unexpected, inappropriate materials in the dam that would not adequately resist scour and potential failure. Partial breaches may also create unanticipated new flow regimes.

Other considerations with multi-year projects include:

- Uncertainty of weather from year to year which may require additional measures to ensure partially breached dams are secure
- Longer exposure of crews to accident factors during the multi-seasons
- Increased risk of personnel changes leading to loss of skills and experience
- Loss of availability of equipment

Based on past experience, success with multi-year staged construction projects has been low. We do not recommend planning for a multi-year project to stabilize individual dams. Consider the above concerns when planning for the High Lakes Stabilization projects. It is our understanding that the State of Utah also shares these concerns. Should you consider a multi-year staged approach to any of these dams, be advised that at the completion of each season of activity, the partially completed dam must meet State of Utah and Forest Service dam safety specifications. Due to the existing condition of many of the dams, we expect that achieving this requirement could entail even more extensive work and could be more difficult to achieve than completing the stabilization to its final proposed configuration in a single season.

Questions may be addressed to Bill Self, Dam Safety Engineer, at 801-625-5227, or Randy Welsh, Wilderness Program Leader, at 801-625-5250.

/s/ Liz Close
ELIZABETH G. CLOSE
Director of Recreation

/s/ Merv Eriksson (for)
KEITH SIMILA
Director, Engineering

cc: Mark Holden
Mitigation Commission

High Lakes Stabilization
CUP Mitigation Commission
Uinta Basin Replacement Project

Technical Memo
June 1, 2006

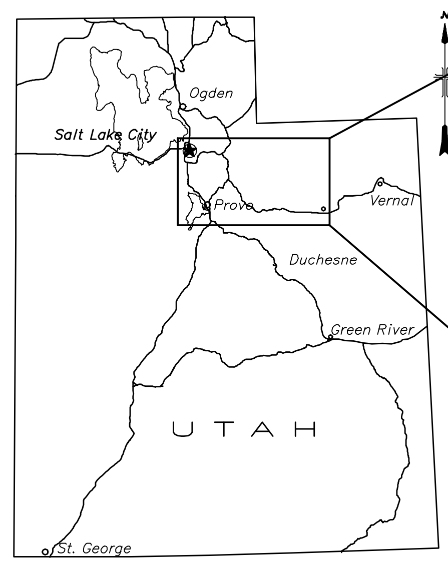
Matt Lindon, PE
Dam Safety Engineer
Utah DNR, State Engineer's Office
Dam Safety Section

Because of the breach potential of the High Lakes Dams, and the difficulty in monitoring and maintaining these dams in the Wilderness area, the CUP Mitigation Commission is undertaking the stabilization of 13 of these dam structures and replacing the storage water rights downstream in the expanded Big Sand Wash dam where maintenance and monitoring is practical. These wilderness dams vary in size, hazard rating and condition and have peak breach flow potential ranging from hundreds to several thousand CFS. Breach flows of this magnitude far exceed the carrying capacity of existing streams and they would cause extensive damage to the downstream forest resource, campgrounds, trails, roads, dams and in some cases, private property and residents. Because of this fact the "Do Nothing" option was not considered appropriate because of the eventuality of the deterioration and catastrophic failure of these dams.

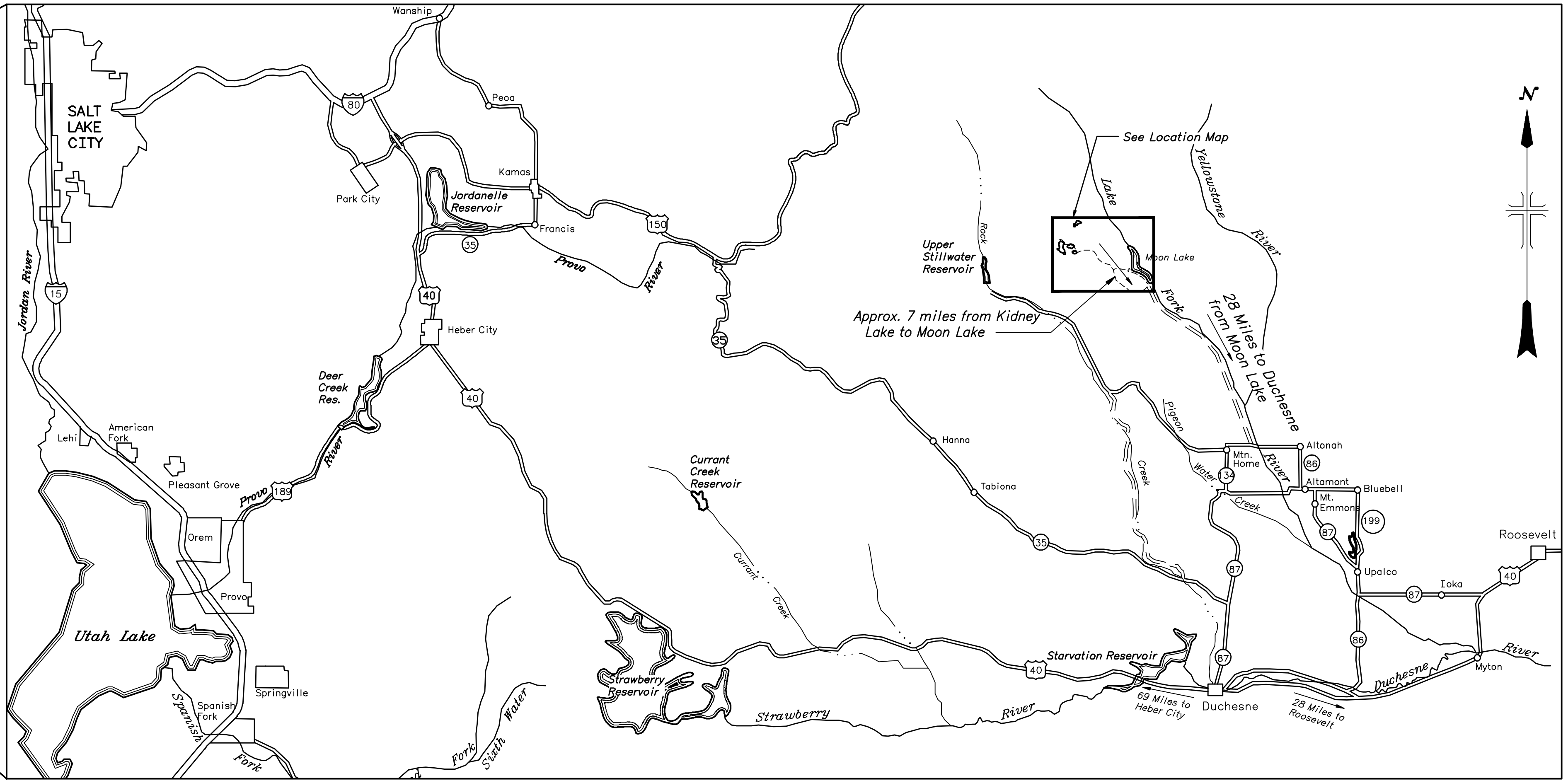
The stabilization of these dams will require the excavation of a spillway notch, with stable side slopes, through the middle of the embankment and the removal of the low level outlet. An armored, stabilized low level channel would then be constructed in the notch to pass normal runoff as well as large storm events without jeopardizing the remaining structure by impounding excess water. In some cases the embankment may be removed or rolled over on itself to decrease the height and increase the stability and ability of the remaining embankment to withstand any seismic event or overtopping during extreme events. This work is the minimum necessary to stabilize these dam structures and restore natural hydrologic flows to the greatest extent possible, while still meeting a "No Hazard" dam safety rating.

It was determined that each individual dam stabilization would need to be completed in one construction season because of the vulnerability of a partially removed embankment. These partially completed dams could easily overtop and fail from snow melt runoff or storm events, even if the outlet was still in place and open. Breach flow potential would be extensive even from the reduced lake storage volumes. Existing spillways would be too high to assist in flood routing under these circumstances and it would be prohibitive to build auxiliary or temporary spillways over the partially excavated embankment or on bedrock at the proper level, even if it could be located. It was determined that this risk possibility was inconsistent with the project's goals of safety and stabilization as well as minimum impact and the preservation of the Wilderness resources and values.

Appendix B - Drawings

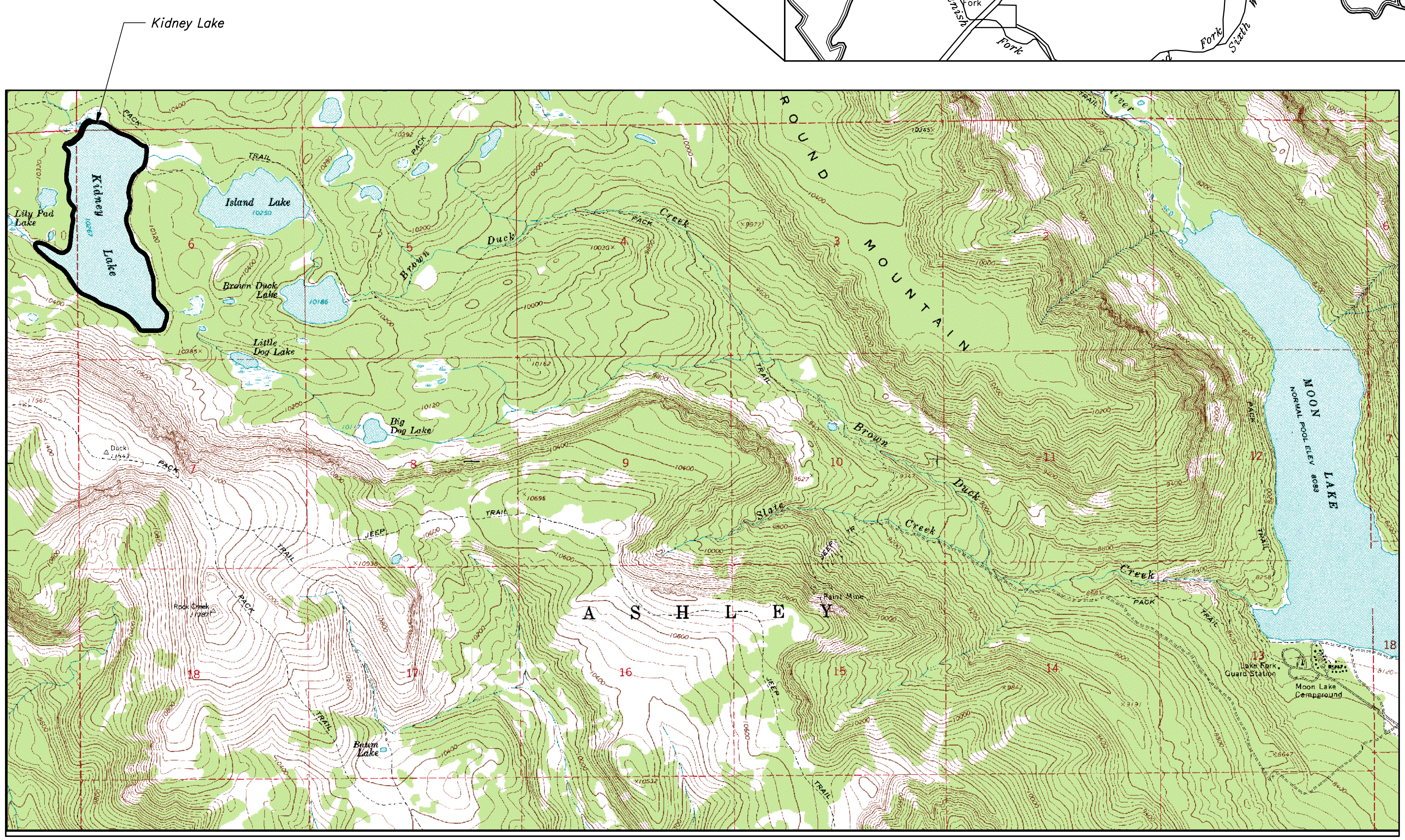


KEY MAP



VICINITY MAP

SCALE OF MILES (8 0 8 12 16)



LOCATION MAP
NOT TO SCALE

SHEET	TITLE
1	KEY MAP, VICINITY MAP, LOCATION MAP AND SHEET INDEX
2	KIDNEY LAKE SITE PLAN
3	KIDNEY LAKE PROFILE, ELEVATION AND SECTIONS
4	KIDNEY LAKE EXISTING OUTLET PROFILE

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
PROVO AREA OFFICE
PROVO, UTAH

BROWN DUCK BASIN LAKES DAM STABILIZATION

KIDNEY LAKE

VICINITY AND LOCATION MAP

DESIGNED SCOTT WINTERTON, P.E. CHECKED MIKE TALBOT, P.E.
DRAWN MICHAEL DRAPER TECH. APPR. CARY SOUTHWORTH, P.E.
CARY SOUTHWORTH, P.E.
APPROVED /S/ SCOTT RICH, P.E.
SCOTT RICH, P.E. – PEER REVIEWER

PROVO, UTAH 2009–03–02 OA58–418–77

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CAD FILENAME
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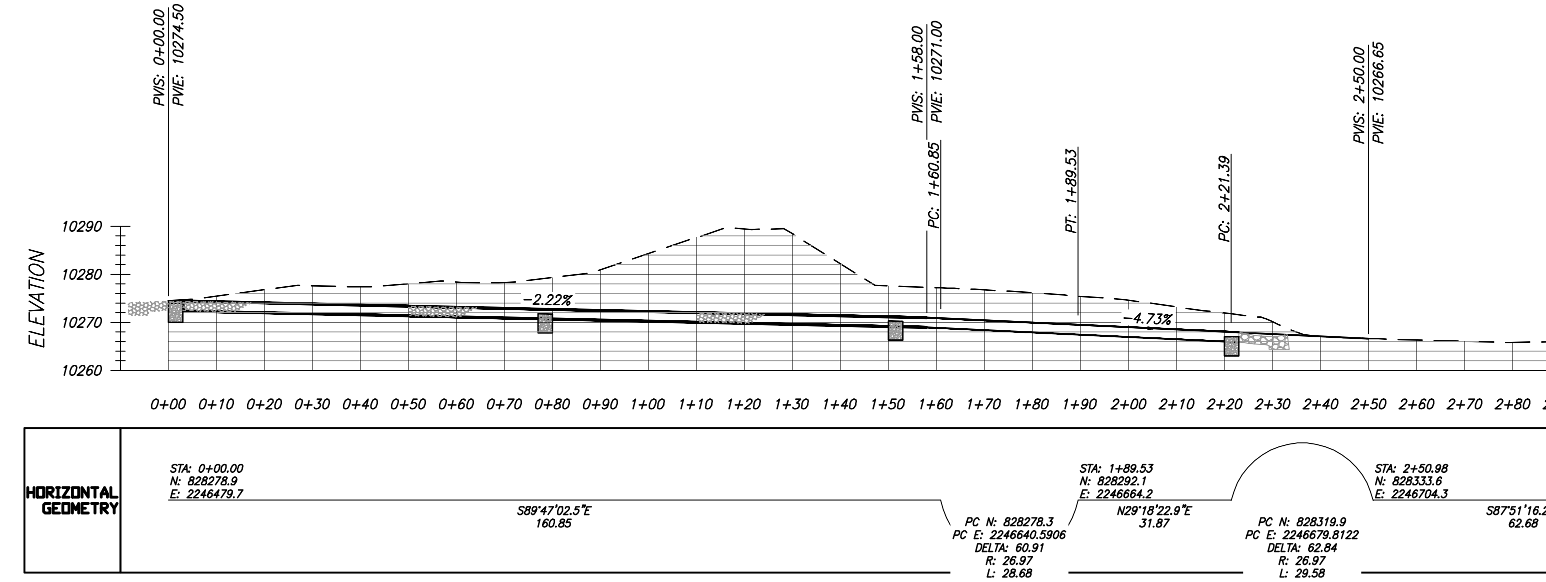
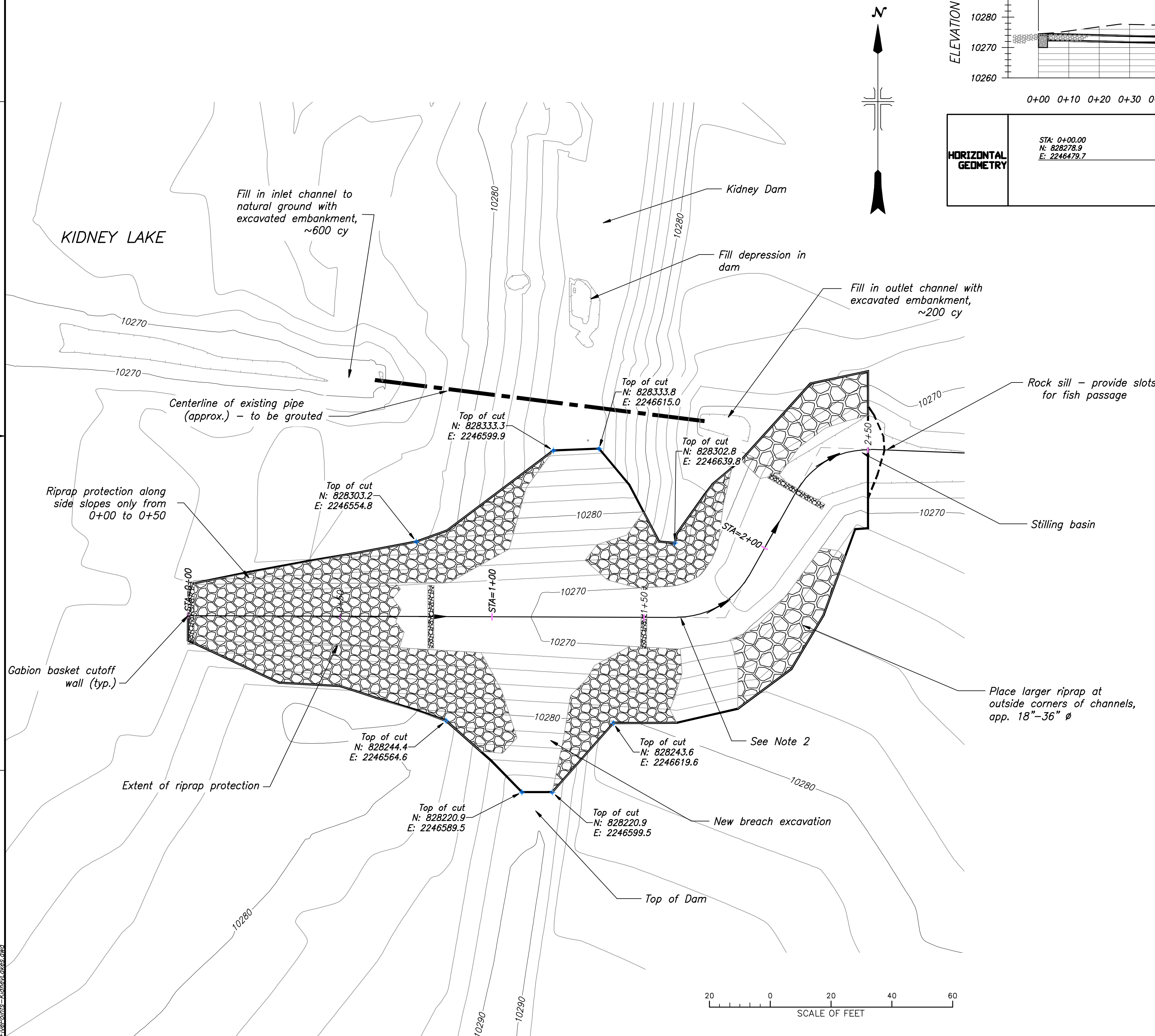


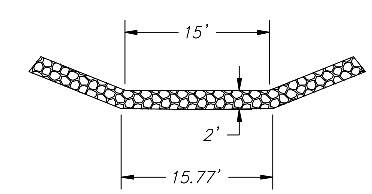
PROFILE: KIDNEY BREACH

SEE OA58-418-79 FOR ADDITIONAL DETAIL



NOTES

1. Contour interval is 2 feet.
2. Vary centerline alignment along ramp to create resting pools.
3. Breach El. 10,274.50
4. Cut vol. = 3,600 c.y.
5. Contours shown through the breach represent excavated grade below final riprap placement.
6. Grid factor = 0.99949466



Breach - 24" Riprap Thickness
15 ft. bottom width
2.5:1 Cut slopes

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PROVO AREA OFFICE
PROVO, UTAH

BROWN DUCK BASIN LAKES
DAM STABILIZATION
KIDNEY LAKE BREACH
SITE PLAN

DESIGNED SCOTT WINTERTON, P.E. CHECKED MIKE TALBOT, P.E.
DRAWN MICHAEL DRAPER TECH. APPR. CARY SOUTHWORTH, P.E.
CARY SOUTHWORTH, P.E.
APPROVED /S/ SCOTT RICH, P.E.
SCOTT RICH, P.E. - PEER REVIEWER

PROVO, UTAH 2009-03-02 OA58-418-78
SHEET NUMBER

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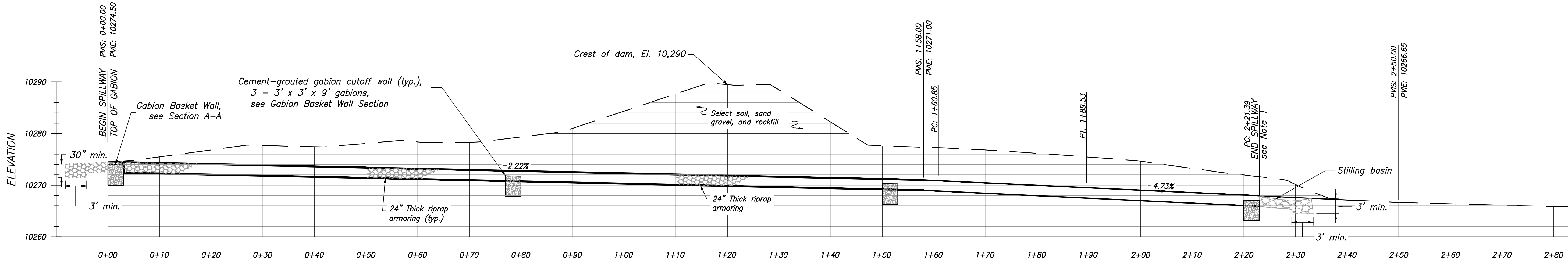
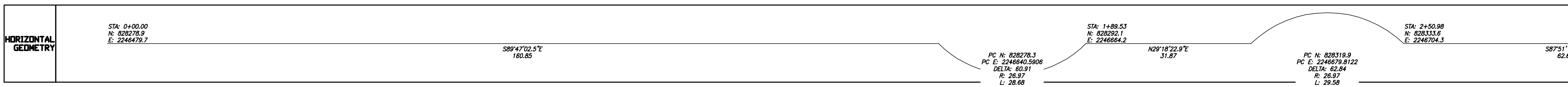
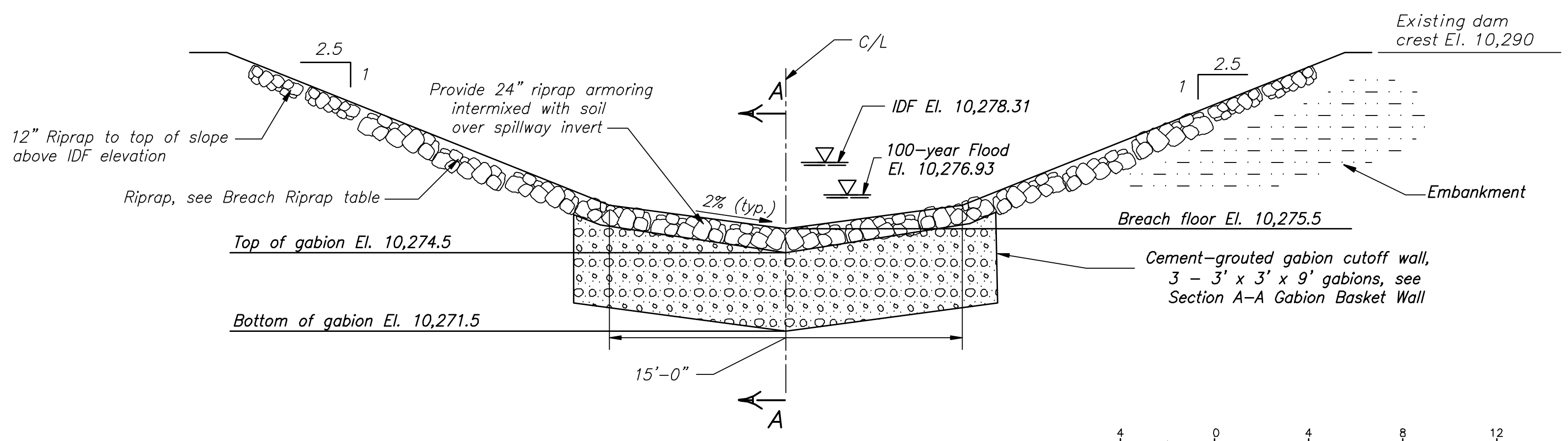
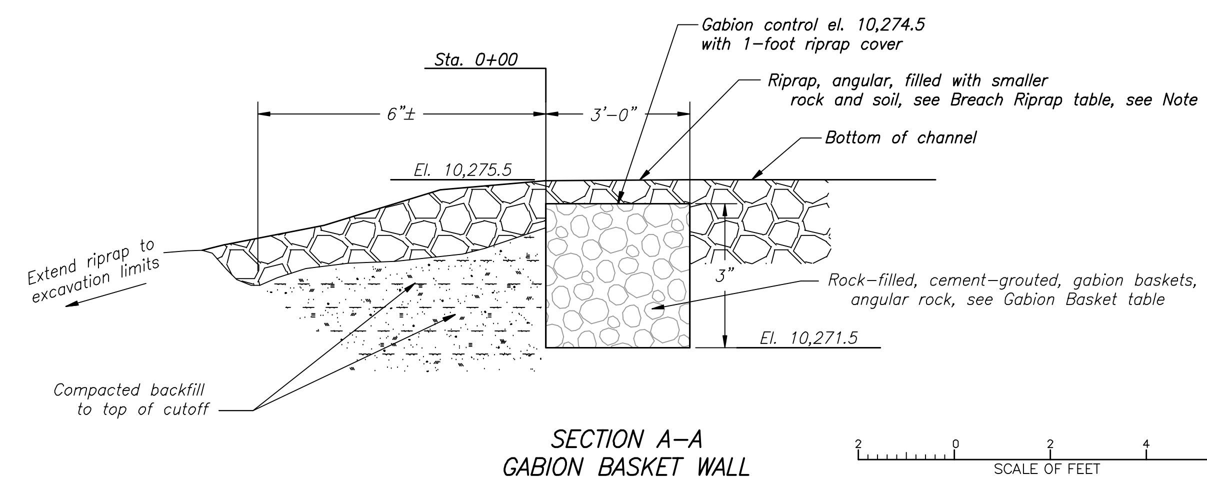






BREACH CHANNEL SECTION AT STA. 0+00

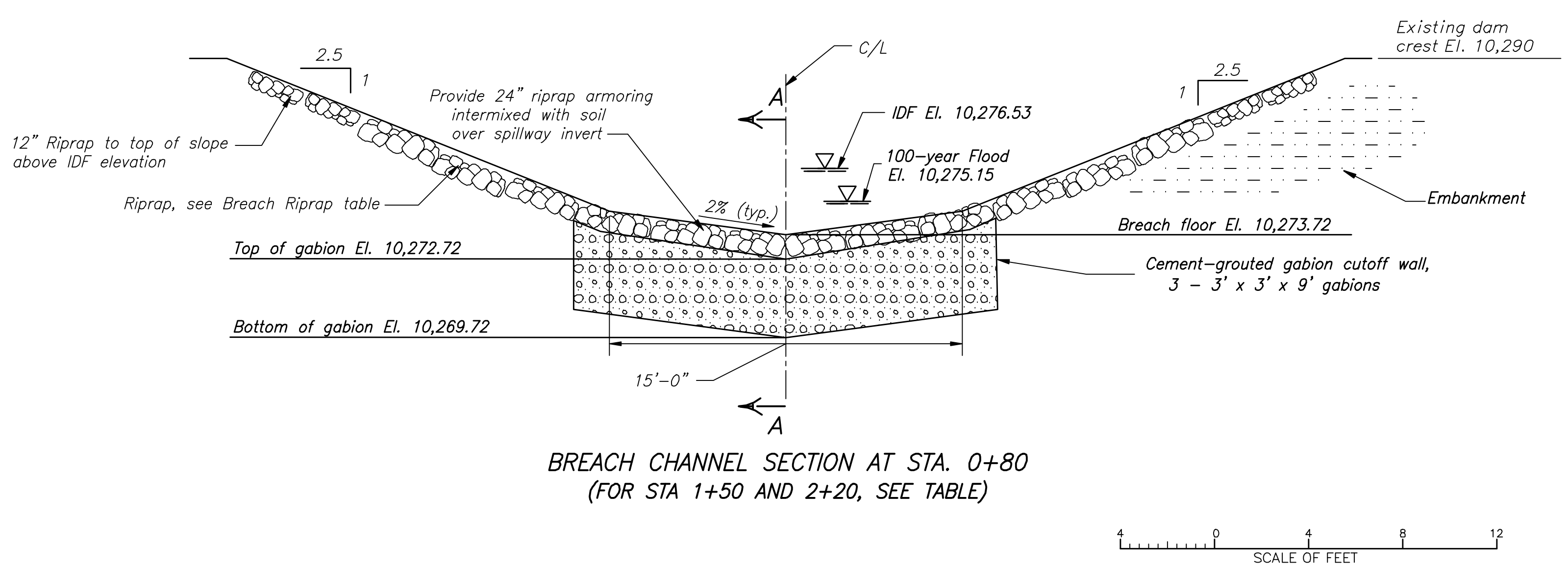


SECTION A-A
GABION BASKET WALL

BREACH RIPRAP				
D MIN.	D15	D50	D MAX.	THICKNESS MIN.
6"	8"	12"	16"	24"

NOTES

1. Provide riprap armoring from end of breach to existing ground to prevent headcutting and erosion.
2. Flood elevations through the breach represent elevations as if the existing spillway does not operate.
3. Place riprap through breach in layers to maintain correct gradations.



BREACH CHANNEL SECTION AT STA. 0+80
(FOR STA 1+50 AND 2+20, SEE TABLE)

GABION BASKET ROCK GRADATIONS			
GABION BASKET	PREDOMINATE ROCK SIZE (INCHES)	MINIMUM ROCK SIZE (INCHES)	MAXIMUM ROCK SIZE (INCHES)
36	6 to 10	4	12

GABION CUTOFF WALL ELEVATIONS					
STATION	BREACH FLOOR	TOP OF GABION	BOTTOM OF GABION	100 YEAR FLOOD ELEVATION	IDF ELEVATION
0+00	10,275.5	10,274.5	10,271.5	10,276.93	10,278.31
0+80	10,273.72	10,272.72	10,269.72	10,275.15	10,276.53
1+50	10,272.17	10,271.17	10,268.17	10,273.60	10,274.98
2+20	10,269.06	10,268.06	10,265.06	10,270.49	10,271.87

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PROVO, UTAH

BROWN DUCK BASIN LAKES DAM STABILIZATION

KIDNEY LAKE SPILLWAY MODIFICATION

BREACH PROFILE, ELEVATIONS, AND SECTIONS

DESIGNED SCOTT WINTERTON, P.E. CHECKED MIKE TALBOT, P.E.
DRAWN MICHAEL DRAPER TECH. APPR. CARY SOUTHWORTH, P.E. CARY SOUTHWORTH, P.E.
APPROVED /S/ SCOTT RICH, P.E. SCOTT RICH, P.E. - PEER REVIEWER
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SHEET NUMBER

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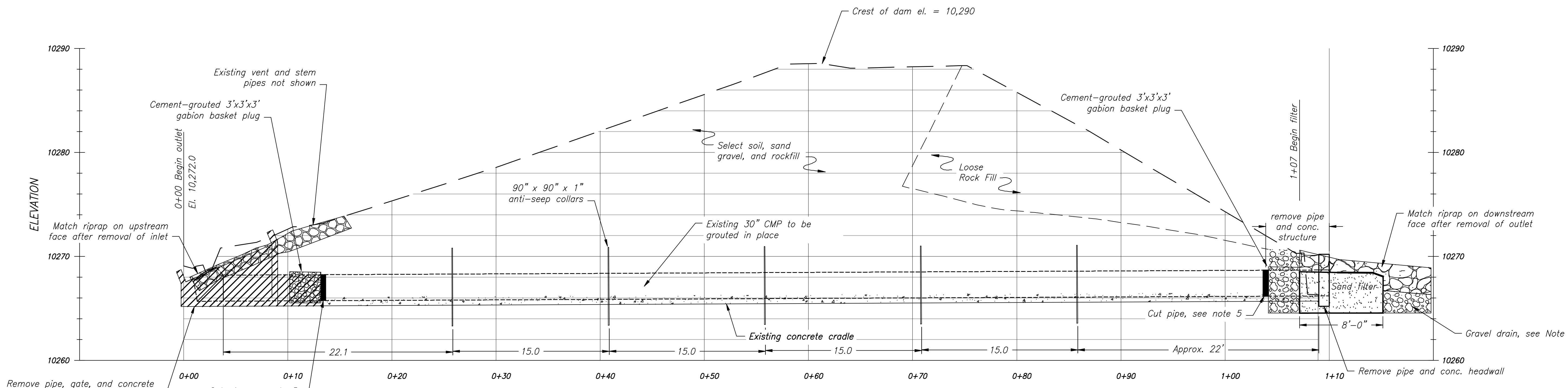


KIDNEY EXISTING OUTLET PROFILE

NOTES

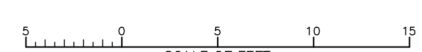
1. Provide compacted filter material over last 8' of pipe removal trench.
2. Trench walls shall be sloped to allow adequate compaction between fill and natural ground. Actual slope will depend on compaction method used.
3. Extend gravel drain through compacted sloped material to discharge under riprap.
4. Fill inlet area with embankment material compacted to 95% maximum density.
5. Do not remove outlet cutoff collar.

SAND FILTER MATERIAL GRADATION REQUIREMENTS

SIEVE SIZE	% PASSING BY WEIGHT
1/2 inch	100
3/8 inch	100
No. 4	95–100
No. 8	80–100
No. 16	50–85
No. 30	25–60
No. 50	10–30
No. 100	2–10
No. 200	0–3

GRAVEL DRAIN MATERIAL GRADATION REQUIREMENTS

SIZE	% PASSING BY WEIGHT
1 1/2 inch	90–100
3/4 inch	55–100
3/8 inch	19–75
No. 4	0–40
No. 8	0–10
No. 16	0



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PROVO, UTAH

BROWN DUCK BASIN LAKES DAM STABILIZATION

KIDNEY LAKE BREACH

EXISTING OUTLET PROFILE

DESIGNED SCOTT WINTERTON, P.E. CHECKED MIKE TALBOT, P.E.
DRAWN MICHAEL DRAPER TECH. APPR. CARY SOUTHWORTH, P.E.
CARY SOUTHWORTH, P.E.
APPROVED /S/ SCOTT RICH, P.E.
SCOTT RICH, P.E. – PEER REVIEWER

PROVO, UTAH 2009-02-23 OA58-418-85

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CAD SYSTEM AUTOCAD 2005 CAD FILENAME T:\Eng\Design\High Mountain Lakes\Garfield Basin\FivePoints-KidneyLakes_ExistOutletProfiles.dwg

Appendix C - Inflow Hydrology Output Files

Dam Break Analysis Summary

	Spillway Floor Elev.	Bottom of Breach Elev.	Time to Breach (min.)	Dam Break Max. Flow (cfs)	Max. Depth in Channel (ft.)	Max. Depth at Moon L. (ft.)
Kidney	10,274.5	10,270.0	300	391	2.29	1.36

100 yr. Storm Spillway Hydraulics (AMC III Composite CN=69)

	Flow in Spillway (cfs)**	Depth in Spillway (ft.)	Velocity in Spillway (ft.)
Kidney	130	1.43	4.9

* *100-year, 6-hour, SCS Type II event routed through the reservoir

Appendix D – Construction Quantities

Construction Quantities

	Outlet Channel Bottom Width*	Outlet Channel Elevation	Outlet Channel Excavation (cy)	Grout Volume, Outlet Pipe (cy)	Grout Volume, Gabion Baskets (cy)	Fill Volume Inlet (cy)	Fill Volume Outlet (cy)	Riprap Removed from Dam (cy)	Riprap Placed in Breach (cy)	Riprap Volume, sill	Filter Material (cy)
Kidney	15'	10,274.5	3,500	20	20	600	200	400	1,195	15	5

- 2.5:1 side slopes, both sides, finished width

	Total Bulk Amount of Material Handled **
Kidney	5,910 CY

** The sum of 'Fill Volume Inlet' + 'Fill Volume Outlet' + 'Riprap Removed from Dam' + 'Riprap Placed in Breach' + 'Riprap Volume, Sill' + 'Outlet Channel Excavation'

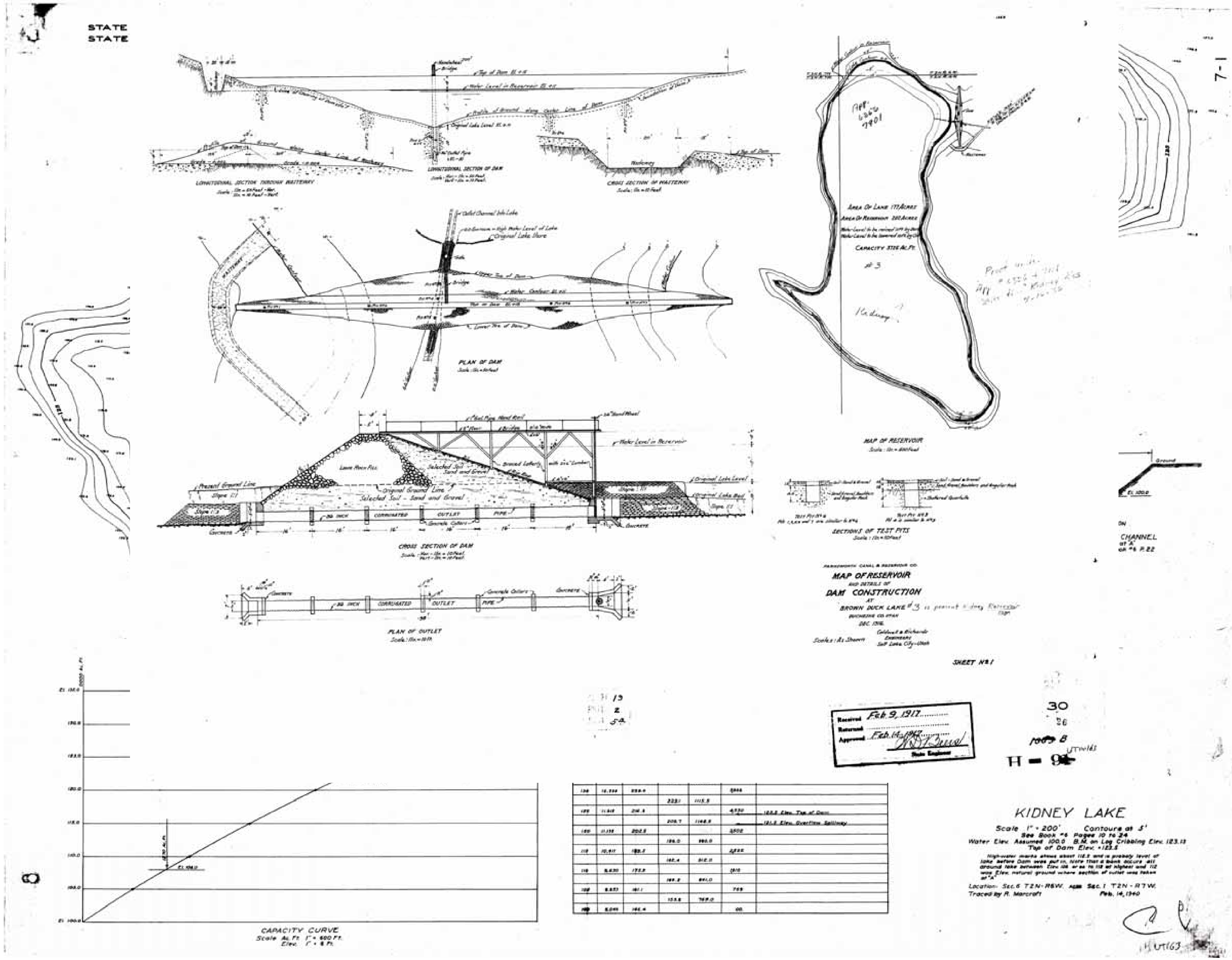
Appendix E – Dam Break Output Files

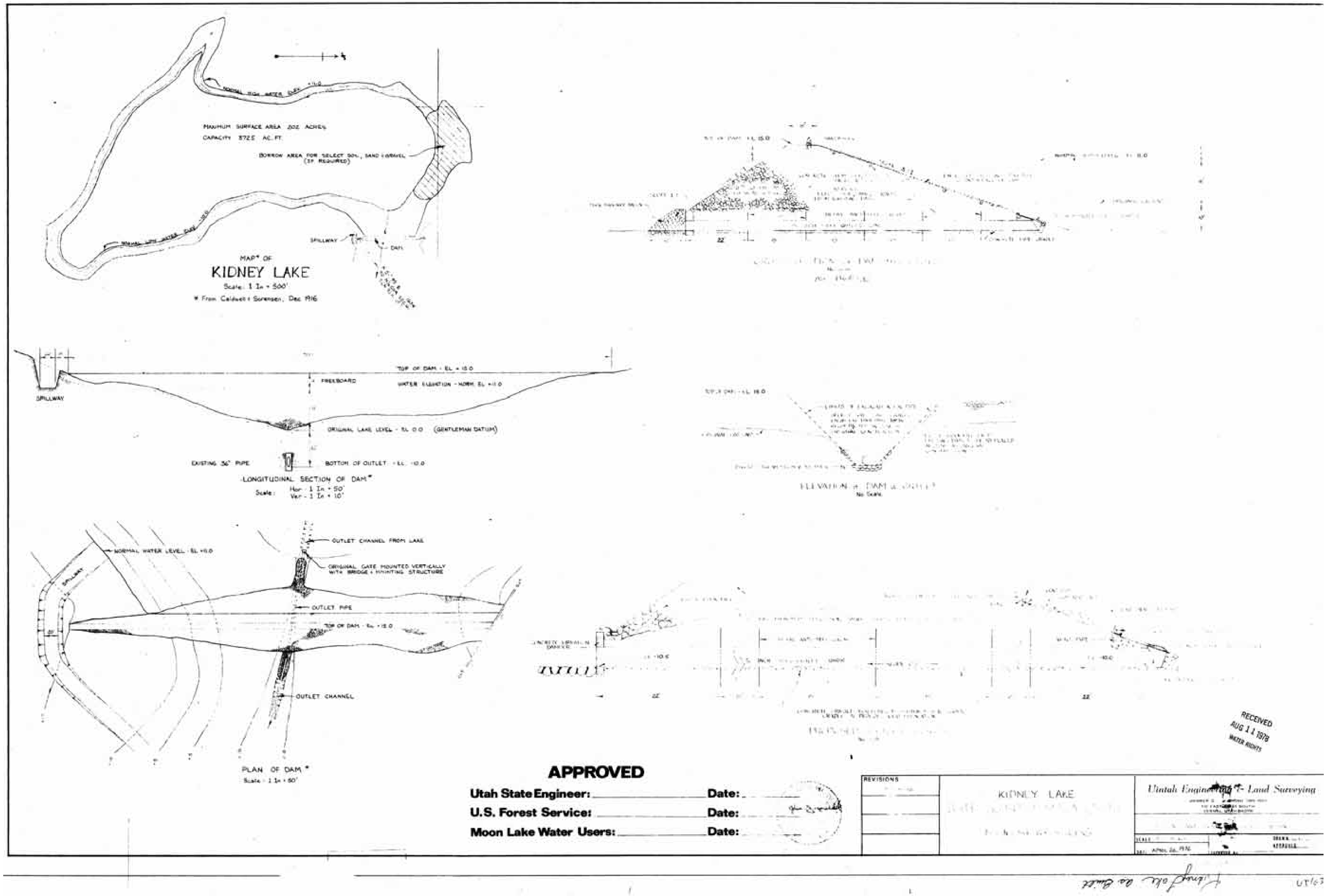
Sunny Day Dam Break – 300 minute (SMPDBK output)

Reservoir Input						Below Dam	
BOR Survey Breach El	DEM Breach El	Hydraulic Head (ft)	Cut Depth From Crest (ft)	Area (acre)	Volume (acre-ft)	Flow (cfs)	Depth (ft)
10274.5	-20.5	-20.5	20.5	159.0	690.0	391	2.29
10275	-20.0	-20.0	20.0	162.0	767.5	457	2.43
10276	-19.0	-19.0	19.0	165.0	950.0	594	2.69
10277	-18.0	-18.0	18.0	166.5	1120.0	742	2.92

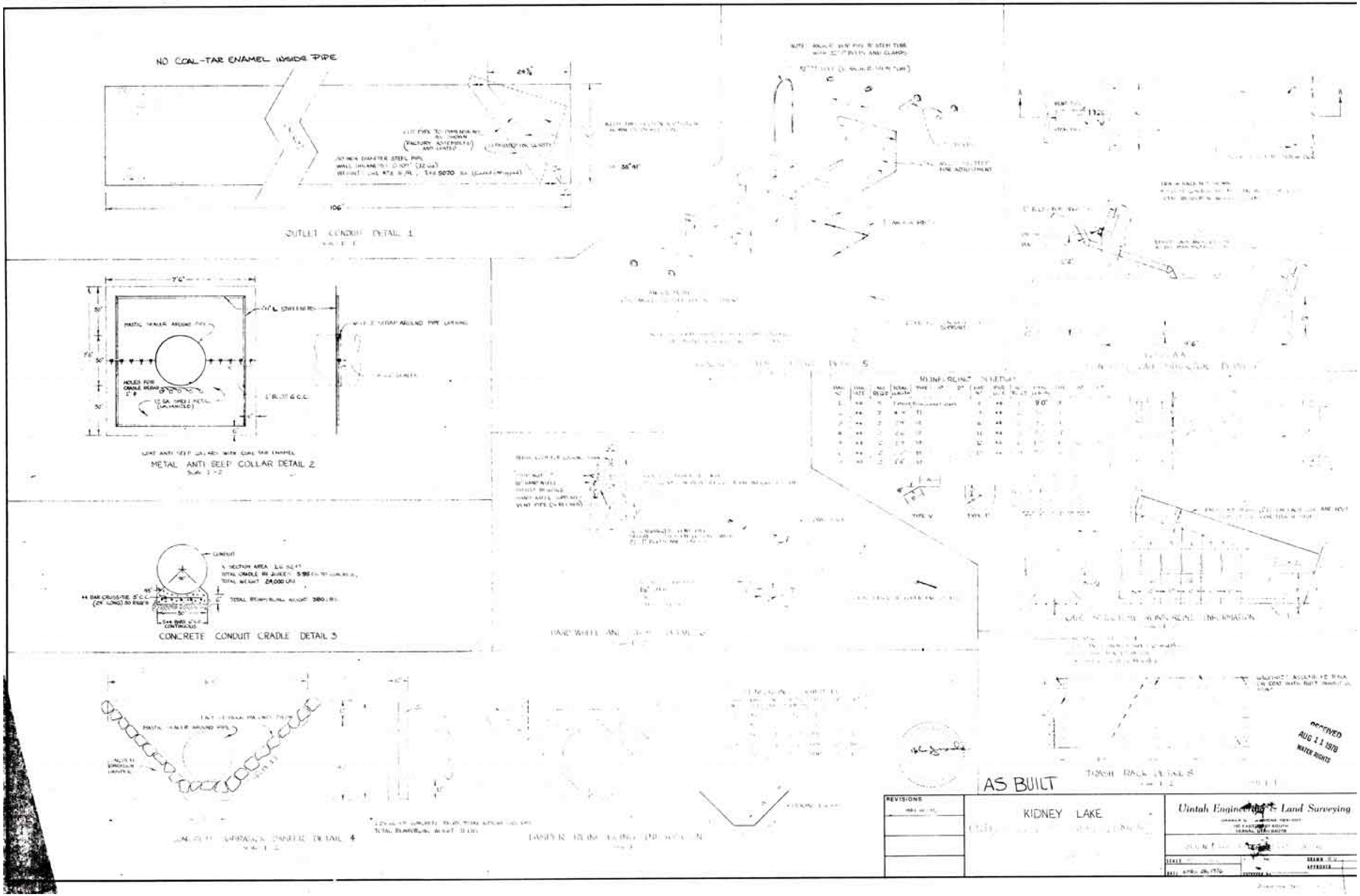
Maximum Flow Values In Downstream Channel				Flow Values at Moon Lake		
Flow (cfs)	Max Depth (ft)	Distance from Dam (mi)	Time (hour)	Depth at Moon Lake (ft)	Time (hour)	Time after Breach (min)
329	4.19	1.7	5.57	1.36	6.29	77.4
389	4.46	1.7	5.54	1.44	6.24	74.4
476	4.57	6.82	6.13	1.61	6.16	69.6
603	4.99	6.82	6.07	1.76	6.09	65.4

Appendix F – Historical Drawings


STATE
LONGITUDINAL SECTION THROUGH WASTEWAY
LONGITUDINAL SECTION OF DAM
CROSS SECTION OF WASTEWAY
PLAN OF DAM
MAP OF RESERVOIR
CROSS SECTION OF DAM
SECTIONS OF TEST PITS
PLAN OF OUTLET
MAP OF RESERVOIR
DAM CONSTRUCTION
BROWN DUCK LAKE
SHEET No 1
Received Feb. 9, 1917
Returned
Approved Feb. 14, 1917
State Engineer
30
H — 9
CAPACITY CURVE
123.5 Elev. Top of Dam
121.5 Elev. Overflow Spillway
KIDNEY LAKE
Scale 1" = 200' Contours at 5'
See Book #6 Pages 10 to 24
Water Elev. Assumed 100.0 B.M. on Log Cribbing Elev. 123.13
Top of Dam Elev. 123.5
Location: Sec. 6 T2N-R6W. Sec. 1 T2N-R7W.
Traced by R. Marcroft Feb. 14, 1940



MAXIMUM SURFACE AREA 202 ACRES
CAPACITY 3725 AC. FT.
BORROW AREA FOR SELECT SOIL, SAND & GRAVEL (IF REQUIRED)
NORMAL HIGH WATER ELEV. +11.0
NORMAL LOW WATER ELEV. 0.0
SPILLWAY
DAM
MAP* OF
KIDNEY LAKE
Scale: 1 In = 500'
* From Caldwell & Sorensen, Dec 1916
TOP OF DAM - EL +15.0
FREEBOARD
WATER ELEVATION - NORM. EL +11.0
SPILLWAY
ORIGINAL LAKE LEVEL - EL 0.0 (GENTLEMAN DATUM)
EXISTING 36" PIPE
BOTTOM OF OUTLET - EL -10.0
LONGITUDINAL SECTION OF DAM*
Scale: Hor. - 1 In = 50'
Ver. - 1 In = 10'
NORMAL WATER LEVEL - EL +11.0
OUTLET CHANNEL FROM LAKE
ORIGINAL GATE MOUNTED VERTICALLY WITH BRIDGE & HOISTING STRUCTURE
OUTLET PIPE
TOP OF DAM - EL +15.0
OUTLET CHANNEL
PLAN OF DAM*
Scale: 1 In = 60'
ELEVATION OF DAM & OUTLET
No Scale
APPROVED
Utah State Engineer: Date:
U.S. Forest Service: Date:
Moon Lake Water Users: Date:
REVISIONS
KIDNEY LAKE
Uintah Engineering & Land Surveying
RECEIVED
AUG 11 1978
WATER RIGHTS



NO COAL-TAR ENAMEL INSIDE PIPE
106"
OUTLET CONDUIT DETAIL 1
7'-0"
METAL ANTI SEEP COLLAR DETAIL 2
CONCRETE CONDUIT CRADLE DETAIL 3
AS BUILT
REVISIONS
KIDNEY LAKE
Land Surveying
RECEIVED
AUG 11 1978
WATER RIGHTS