GEI Consultants

Consulting
Engineers and
Scientists

Feasibility of Upper Beaver Brook Dam Spillway Improvement Project

FEASIBILITY STUDY APPROVAL
Pursuant to Colorado Revised Statutes 37-60-121 &122, and
In accordance with policies adopted by the Board, the
CWCB staff has determined this Feasibility Study meets all
applicable requirements for approval.

11/18/15
Date

Signed

Sponsored by:
Lookout Mountain Water District
1202 Bergen Parkway #215
Evergreen, CO 80439

In conjunction with:
Colorado Water Conservation Board
Finance Section
1313 Sherman Street #718
Denver, CO 80203

Prepared by:
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and
Lookout Mountain Water District
1202 Bergen Parkway #215
Evergreen, CO 80439

September 2015
GEI Project ID 1327820

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Lookout Mountain Water District (LMWD) Personnel

Board of Directors and Officers

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Robert Heine, Vice President
Barbara Nevins, Treasurer
Dean Snyder, Director
Robert Gray, Director
Christina Shea, Secretary

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1. Introduction

The Lookout Mountain Water District, located within Clear Creek and Jefferson Counties, has applied to the Colorado Water Conservation Board in order to finance this project within the Water Project Loan Program. The project goal for the Upper Beaver Brook Dam Spillway Improvement Project is to provide an additional 140 acre-feet of raw water storage within the reservoir, identified as the John Roscoe Reservoir at Upper Beaver Brook. Lookout Mountain Water District ("LMWD" or "District") serves a population of about 1,600 residing in the mountain communities of unincorporated areas of Evergreen and Golden, Colorado.

To provide the additional storage, GEI Consultants, Inc. ("GEI") will complete a design of a new labyrinth spillway structure to raise the normal pool elevation at Upper Beaver Brook Dam. LMWD is now in its 27th year of service, having been established in 1988 after assuming responsibility for a small service area, three reservoirs, a distribution system, and water rights previously operated by the City of Golden. The District rehabilitated the existing Upper Beaver Brook Dam and purchased additional water rights for augmentation in the early 1990s; after several multi-year droughts it became apparent that the water rights were still not sufficient to serve the existing customer base. For over ten years the LMWD Board of Directors researched alternatives, and combinations of alternatives, that would reduce the risk of a multi-year drought impact. This project is the resulting preferred and primary alternative, and in 2011 the Board applied for supplementary water rights in support of this goal.

The new spillway will be designed to accommodate the Probable Maximum Flood (PMF) according to the State Engineers Office regulations for a high hazard dam. The design process will include review of the project design with LMWD and the SEO at key design stages to ensure the project meets LMWD's goals and SEO design requirements. GEI will work directly with the special committee or the entire Board at LMWD's direction. The design of the Upper Beaver Brook Dam Spillway Improvement Project will include geotechnical field investigations and laboratory testing, wetlands surveying and mitigation plans, permitting, engineering design and analyses, final design report, plans and technical specifications, opinion of probable construction costs (OPCC), and construction support services.

2. Description of Project Sponsor

LMWD is a Colorado special district, a division of the government of the State of Colorado formed pursuant to the Special District Act, Title 32, Colorado Revised Statutes, by decree of the District Court in Jefferson County, Colorado, in Civil Action 88CV0265, March, 1988. The District has about 565 authorized taps. Approximately 502 are active and the remaining are inactive. Of the inactive taps, approximately 35 are presently assigned to property and 30 are unassigned, all of which the District has a future obligation to serve, once these taps are activated.

The active tap service composition is comprised of 95% -- residential, 2.5% -- tax-exempt or government, and 2.5% -- commercial. LMWD is authorized to set water usage rates and fees to be paid by the tap holders/customers, is empowered to disconnect water deliveries to customers that fail to make payments, as well as to assess property liens for unpaid charges. LMWD is also authorized by statute and by the electorate to levy property taxes against property within its boundaries. The LMWD Board of Directors oversees all affairs of the District and is elected to serve by the residents of the District. The LMWD by-laws are included in Appendix A.

Information about the District is available to the public on-line via the World Wide Web:

http://www.lookoutmountainwaterdistrict.org/

The District's Policies, Rules and Regulations, annual reports (water quality, financial, budgetary, transparency notices) election results, monthly Board meeting minutes, and many other records can be accessed without cost.

3. Project Service Area and Facilities

Upper Beaver Brook Dam and Reservoir (DAMID 070102) is located approximately 7.5 miles northwest of Evergreen, Colorado in Clear Creek County in Section 15, Township 4 South, Range 72 West of the 6th Principal Meridian. The dam is located on Beaver Brook, a tributary to Clear Creek and the South Platte River upstream of Golden, Colorado. Coordinates of the dam are approximately 39.694111^{o}N, 105.433125^{o}W. The reservoir parcel and embankment dam are owned by Lookout Mountain Water District (LMWD). Upper Beaver Brook Reservoir is LMWD's primary raw water storage facility. The site location is shown in Figure 1.

LMWD has two high altitude reservoirs on Beaver Brook; Upper Beaver Brook Reservoir (also known as the John Roscoe Reservoir at Upper Beaver Brook) and Lower Beaver Brook Reservoir. LMWD currently has several municipal storage water rights with priority dates ranging from 1903 to 1924, all of which are called out by the 1902 Croke Canal and occasionally other storage rights during the winter season. For this reason, LMWD has acquired two new water rights with priority dates of 2011 and 2013, together that allow an increase in reservoir storage by up to 140 acre feet (AF). The increased storage will be facilitated by a raise in the reservoir's normal water surface. In order to accommodate the additional storage without raising the existing embankment crest, modifications to the existing spillway are necessary. The proposed spillway improvement project will potentially add 134.2 AF to the existing 257.2 AF for a total storage of 391.4 AF.

4. Hydrology and Water Rights

4.1 Hydrology

The District's Hydrology Report was completed in January 2014, which is on file with the State Engineers Office; excerpts from the report can be found in Appendix B.

The report presents and compares the Inflow Design Flood (IDF) estimates for Upper Beaver Brook Dam. The IDF estimates were developed using the Probable Maximum Precipitation (PMP) estimates from the Hydrometeorological Report No. 55A (HMR 55A) methods. The report summarizes hydrometeorological analyses, precipitation estimates, parameter development and selection, inflow hydrographs, and results of routing the IDF through the reservoir and spillway.

GEI developed estimates of general-storm PMP and the local-storm PMP for the Upper Beaver Brook watershed at the dam site. Precipitation estimates were converted to inflow estimates using standard flood runoff modeling practices.

4.2 Water Rights

4.2.1 *Summary*

Lookout Mountain owns and operates two reservoirs on Beaver Brook (a tributary to Clear Creek): the Upper Beaver Brook Reservoir and the Lower Beaver Brook Reservoir. The main supply of water for Lookout Mountain comes from the Upper Beaver Brook Reservoir, which is the District's largest reservoir with a current capacity of approximately 257.2 acre-feet (ac-ft or AF). The capacity of Lower Beaver Brook Reservoir is approximately 30.8 ac-ft. The District owns Lookout Mountain Reservoir (capacity of approximately 101.1 ac-ft) which is filled with water that has been treated and carried through the water distribution system.

The District also owns six shares of the Farmers High Line Canal which diverts water from Clear Creek with priorities ranging from 1862 through 1895. This water is exchanged up Beaver Brook pursuant to the exchange decree in Case No. 87CW303 at rates of up to 4.0 cfs. Water that is stored in Lookout Mountain Reservoir can be released to Clear Creek and exchanged up Beaver Brook at a maximum rate of 2.0 cfs (cubic feet per second), per the decree in Case No. 94CW291.

Table 1: Summary of Lookout Mountain Water District's Storage Rights

Structure Name (Decree)	Amount (Type, Status)	Appropriation Date
Lower Beaver Brook Reservoir (CA 41340)	24.16 AF (Original, Absolute)	12/31/1903
Lower Beaver Brook Reservoir (CA 60054)	6.64 AF (Enlargement, Absolute)	7/29/1917
Lookout Mountain Reservoir (CA 41340)	18.92 AF (Original, Absolute)	12/31/1903
Lookout Mountain Reservoir (CA 60054)	82.17 AF (Enlargement, Absolute)	10/10/1914
Upper Beaver Brook Reservoir (CA 60052)	257.22 AF(Original, Absolute)	8/27/1924
Upper Beaver Brook Reservoir (Case No. 11CW287)	102.0 AF (1st enlargement, Conditional) 38.3 AF (Refill, Conditional)	12/29/2011
Upper Beaver Brook Reservoir (Case No. 13CW3179)	38.0 AF (2nd enlargement, Conditional) 5.8 AF (Refill, Conditional)	12/31/2013

4.3 Capacity of Upper Beaver Brook Reservoir

The District is planning to raise the spillway level in Upper Beaver Brook Reservoir's deep spillway channel which will increase the capacity of reservoir. Initial calculations and analyses indicated raising the level of the spillway by ten feet would increase the reservoir capacity by 102 ac-ft. Accordingly, the Applicant applied for an enlargement of Upper Beaver Brook Reservoir in Case No. 11CW287 for 102 ac-ft, to an anticipated capacity of 359.22 ac-ft. Upon subsequent surveying, work by GEI Consultants, and information from the Dam Safety Branch of the State Engineer's Office, the estimated storage capacity of the enlarged Upper Beaver Brook Reservoir was calculated to be 397.22 ac-ft, 38 ac-ft greater than previous estimates. Therefore, the Applicant applied for an additional 38 ac-ft storage right in Upper Beaver Brook Reservoir on December 31, 2013 in Case No. 13CW3179. Both the 11CW287 and 13CW3179 cases include an annual refill for the estimated evaporative losses from Upper Beaver Brook Reservoir. However, later analyses showed the highest water level that would satisfy Dam Safety requirements was actually El. 8409.25, which has an associated storage of 391.4 ac-ft, about 5.8 ac-ft less than the acquired water right.

To summarize, the current capacity of Upper Beaver Brook Reservoir is 257.22 ac-ft and the proposed capacity after the spillway project is 391.4 ac-ft.

4.3.1 *Annual Demand for Water*

The projected annual water use for the District was determined by J. Craig Green, P. E. (Hydrology Consultant to LMWD) to be up to 226 ac-ft, which includes an increase over average historical demands based on anticipated build-out. This estimate does not also include the water that would be lost annually from the Beaver Brook Reservoirs due to evaporation.

The actual total use of water in Water Year 2012 (a relatively dry year in the South Platte River Basin) was 179.8 ac-ft for treatment and evaporation. The actual total use of water in Water Year 2013 was 141.9 ac-ft for treatment and evaporation. The actual total use of water in Water Year 2014 from October 1, 2013 through July 31, 2014 was 123.71 ac-ft for treatment and evaporation.

Table 2: Summary of Annual Augmentation Requirements

Water Year	Augmentation Requirement (acre-feet)	Notes
2012	30.27	Amount based on difference between calculated storage amount and actual storage amount in Upper Beaver Brook Reservoir on October 31, 2012
2013	92.8	Augmentation water purchased from Golden
2014	0	No augmentation required due to the exceptionally good hydrologic conditions and the filling of a number of downstream reservoirs beginning September 2013 and continuing into the spring and summer of 2014.

Table based on information provided by J. Craig Green, P. E.

4.3.2 *District's Augmentation Requirements*

The amount of water that the District is required to replace each year based on out-of-priority depletions (typically due to storing water out of priority in Upper Beaver Brook and Lower Beaver Brook Reservoirs) varies. In the past, the District has filled its Beaver Brook Reservoirs during the winter, when its rights are out of priority or junior to calling water right which is often the 1902 Croke Canal water right. This filling was sometimes repaid through a lease of water or was considered allowable due to conditions in downstream structures, such as a fill of Standley Lake. It has been explained to the District that this type of operation is unlikely to occur in the future, and therefore, if the District is going to fill in the winter, it will need to do so under one or more of the following conditions: (1) be in priority, with a call of year 1924 or later affecting Clear Creek; (2) release water from Lookout Mountain Reservoir and exchange the water up to the Beaver Brook Reservoirs (may be difficult seasonally due to freezing); (3) obtain additional supplies of water to offset the impact to Beaver Brook and/or Clear Creek when filling reservoirs out of priority; or (4) wait until the storage rights are in priority to fill or only fill when the changed Farmers High Line Canal shares and Lookout Mountain Reservoir releases can be exchanged upstream into the Beaver Brook Reservoirs. Option (4) leads to a lowered water level in the Beaver Brook Reservoirs.

5. Project Description and Alternatives

The purpose of this project is to accommodate additional reservoir storage in Upper Beaver Brook Reservoir without raising the existing embankment crest. The proposed spillway improvement project will potentially add 134.2 AF to the existing 257.2 AF for a total storage of 391.4 AF. The additional storage will allow LMWD to provide a more reliable water supply to the tap holders it serves, especially during periods of drought. Cesare, Inc. completed an alternatives evaluation study in 2012 for increasing the storage in the LMWD system in which alternatives were evaluated and priced. The Cesare study is included in Appendix G. Four alternatives were considered (costs in 2012 USD):

0. The no-action alternative. LMWD would continue to purchase additional water from neighboring water districts/municipalities.

1. Add storage within Upper Beaver Brook Reservoir by construction of a labyrinth weir spillway ($2,914,000).

2. Add storage by dredging within Upper Beaver Brook Reservoir with construction of a possible lower labyrinth weir spillway ($4,709,000).

3. Add storage at alternative dam sites downstream of Upper Beaver Brook Dam

    a. Site 3A – New RCC Dam at Site A ($8,953,000)

    b. Site 3B – New RCC Dam at Site B ($8,026,000)

Alternative No. 0 was considered unacceptable because it would not provide LMWD with the needed storage to provide reliable service to tap owners.

Alternative No. 1 was selected since it is considered to be the least costly approach.

Alternative No. 2 was not selected due to higher costs, loss of reservoir storage during construction, and potential impacts to adjacent wetlands.

Alternative No. 3 (both sites) was ruled out due to cost and potential difficulty in permitting new dam sites.

6. Selected Project Alternative

6.1 Selected Alternative

The selected alternative, Alternative No. 1, involves construction of a new labyrinth spillway to accommodate increased reservoir storage, rehabilitation of the outlet works, construction of a downstream toe berm, addition of a toe drain and enlarging a section of the spillway chute wall. The dam access road at the reservoir will also be raised to accommodate the increased reservoir storage. The 90% spillway improvement design drawings for the selected alternative can be founding in Appendix C. The 90% outlet works rehabilitation design drawings for the selected alternative can be found in Appendix D.

6.2 Cost Estimation

The estimated cost of the completed project is $2,971,180 (revised from above based on 90% level design drawings and 2015 costs). The estimated construction cost (OPCC or Opinion of Probable Construction Costs) breakdown is summarized in Table 3.

Table 3: Estimated Project Costs

No.	Construction Item		Estimated Quantity	Units	Unit Cost (Bid Price)	Estimated Total Cost
1	**Site Work**					
		Access Improvements	1.0	LS	$ 7,000.00	$ 7,000
		Downstream Access and Turn-arounds	1.0	LS	$ 15,000.00	$ 15,000
		Reclamation and Revegatation	1.4	AC	$ 3,500.00	$ 4,791
	Subtotal					**$ 26,791**
2	**Water Control**					
		Dewatering and Unwatering	1	LS	$ 5,000.00	$ 5,000
		Cofferdam	1	LS	$ 22,000.00	$ 22,000
	Subtotal					**$ 27,000**
3	**Erosion and Sediment Control**					
		Silt Fence/Tree Protection Fencing	3,450	LF	$ 6.00	$ 20,700
		Erosion and Sediment Control/SWPPP	1	LS	$ 7,500.00	$ 7,500
		Stabilized Construction Entrance	1	LS	$ 5,000.00	$ 5,000
	Subtotal					**$ 33,200**
4	**Labyrinth Spillway**					
		Removal of Existing Weir	1	LS	$ 5,500.00	$ 5,500
		Foundation Cleaning	2,250	SY	$ 25.00	$ 56,250
		Rock Anchors (25-feet, 15-feet grouted)	21	EA	$ 2,000.00	$ 42,000
		Reinforced Concrete Walls (6000 psi)	490	CY	$ 1,200.00	$ 588,000
		Reinforced Concrete Slab (4500 psi)	775	CY	$ 900.00	$ 697,500
		Reinforced Concrete Cutoffs (4500 psi)	28	CY	$ 900.00	$ 25,200
		Foundation Grouting	1	LS	$ 150,000.00	$ 150,000
	Subtotal					**$ 1,564,450**
5	**Earthwork**					
Unclassified Excavation		Spillway and Knob	3,465	CY	$ 70.00	$ 242,550
		Access Road	300	CY	$ 70.00	$ 21,000
Earth Excavation		Spillway Chute Wall/Toe Drain	1,100	CY	$ 60.00	$ 66,000
Off-Site Disposal		Unclassified Excavation Disposal	500	CY	$ 20.00	$ 10,000
		Earth Excavation Disposal	100	CY	$ 20.00	$ 2,000
On-Site Disposal		Earth Excavation into Toe Berm	1,220	CY	$ 6.00	$ 7,320
		Unclassified Excavation into Access Road	760	CY	$ 6.00	$ 4,560
		Unclassified Excavation into SW Chute Wall	1,040	CY	$ 6.00	$ 6,240
		Unclassified Excavation into Toe Berm	2,220	CY	$ 6.00	$ 13,320
Shaping and Placement		Access Road	760	CY	$ 6.00	$ 4,560
		Spillway Chute Wall	1,040	CY	$ 6.00	$ 6,240
		Toe Berm	2,200	CY	$ 3.00	$ 6,600
		Spillway Chute Wall Grouting	535	CY	$ 60.00	$ 32,100
	Subtotal					**$ 422,490**
6	**Access Road and Fencing**					
		Dam Crest Aggregate Base Course	40	CY	$ 60.00	$ 2,400
		Geosynthetic Fabric	585	SY	$ 5.00	$ 2,925
		Road Aggregate Base Course	90	CY	$ 60.00	$ 5,400
		Fencing at Dam Crest	1	LS	$ 5,000.00	$ 5,000
	Subtotal					**$ 15,725**
7	**Toe Drain**					
		PVC Drain Pipe	150	LF	$ 20.00	$ 3,000
		Drain Gravel	40	CY	$ 60.00	$ 2,400
		Filter Sand	30	CY	$ 150.00	$ 4,500
		Separation Geotextile	560	SY	$ 5.00	$ 2,800
		Concrete Backfill	0.5	CY	$ 1,000.00	$ 500
	Subtotal					**$ 13,200**
8	**Outlet Works Modifications**					
		Divers and underwater repairs	1	LS	$ 135,000.00	$ 135,000
		Valve Stem Improvements	252	LF	$ 110.00	$ 27,720
		Staff Gauge	1	EA	$ 2,500.00	$ 2,500
	Subtotal					**$ 165,220**
BASE CONSTRUCTION SUBTOTAL						**$ 2,268,076**
		Mobilization and Demobilization @ 10%				$ 226,808
		Unlisted Items @ 10%				$ 226,808
		Contingencies (10% of BCS + Mobilization)				$ 249,488
OPINION OF PROBABLE CONSTRUCTION COSTS (OPCC)						**$ 2,971,180**

6.3 Implementation Schedule

Final design of the project modification is expected to be completed by October of 2015. Construction is anticipated to begin in April of 2016 and be completed within one construction season. Construction will proceed without significantly draining the reservoir.

6.4 Permitting

The work associated with the spillway improvements was reviewed in accordance with Section 404 of the Clean Water Act. The U.S. Army Corps of Engineers (USACE) determined that if all construction activities occur above the Ordinary High Water Mark (OHWM) the project is outside of the jurisdiction of the USACE and a Section 404 permit is not required. To maintain adherence with the USACE regulations, all construction activities related to the spillway improvement will occur above the OHWM.

LMWD is in the process of obtaining a two-year temporary permit for two staging areas from the U.S. Forest Service. Final approval is pending.

6.5 Institutional Considerations

Entities that are, or may be, involved in the design, construction, and financing of the project include:

- Lookout Mountain Water District – financing and project management
- GEI Consultants, Inc. – design and construction management
- Colorado Water Conservation Board (CWCB) – financing
- Treatment Technology – water management and reservoir/site operations
- Burns & McDonnell – rate and reserve study; financial plan

LMWD will be the lead for the financing, design and construction of the project and will be the entity entering into contracts and agreements with the various entities for the services provided by each.

6.6 Financial Analysis

6.6.1 *Financial Impact of Background and Start-up*

In 2012, the District retained engineering consultants to complete a preliminary alternatives study, for a cost of about $19,000. Between 2011 and 2013, the District incurred approximately $11,000 in support of the acquisition of water rights by legal specialists. In 2013, the District retained a surveyor to complete topographic mapping, for a cost of about $6,000. In 2013, the District retained a GEI Consultants, Inc. to begin the engineering services for this project, for an estimated cost of $390,000 and their work is ongoing and will

continue through construction. In 2014, a fee of $1,124 was paid to the United States Department of Agriculture Forest Service for two permit applications. In 2015, the District retained a consultant to begin a financial feasibility study, of which $7,750 (or 50% of the total $15,500 fee) can be attributed to this project.

In 2012 and 2013, the District applied to the Department of Local Affairs for the Energy and Mineral Impact Assistance Program, Tiers I and II. In 2013, the District was awarded a grant of $125,000 for matching toward $345,000 in engineering costs for the project.

Indirect administrative, accounting and legal supporting costs for this project have been absorbed in those budgeted categories each year and have not been independently tracked. Approximately $45,000 of direct expenditures for preliminary studies and start-up are not included in the Loan Program.

6.6.2 *Summary of Financial Impact*

In 2015, the District's consultant, Burns & McDonnell, assisted the District in completing a rate and reserve study in order to assess the financial feasibility of this project and the District's financial health and ability to finance future projects over the long-term. The study can be found in Appendix H.

Approximately $45,000 of the costs noted in the background information section above is not part of the application to the CWCB because they have already been incurred.

Below is a table showing financial parameters as they relate to the estimated project costs, based on 90% OPCC (above) and Engineering (in progress). The original loan application of $3,068,000, the total cost and estimated loan payment are noted below with an asterisk (*). Since the loan application, the OPCC has been modified and the current estimates are shown without asterisks.

Table 4: Financial Summary

Parameter	Unit
Total Project Cost	$3,409,735* / $3,361,180
Loan amount (maximum of 90% of project cost)	$3,068,000* / $3,025,062
Annual CWCB loan payment, estimated	$162,500*
Number of Taps	565
Future cost per Tap based on total project cost	$5,949
Annual future cost per Tap based on loan amount	$288
Total additional storage	134.4 acre-feet
Future cost per acre-foot based on total project cost	$25,009
Estimated useful life of project assuming maintenance	50 years
Future cost per acre-foot based divided by total useful life of project	$500
Annual future cost per acre-foot based on loan amount	$1,209

In comparison, it should be noted that the current market rate for one-time-use for water lease is about $800 to $1,000 per AF (if available); this cost does not include delivery to the reservoir, where the water is most needed and beneficial. It should also be noted that the project's useful life is estimated at 50 years with a payback period of 30 years, therefore providing a benefit of 20 years at no additional cost. The existing dam was constructed in 1924, rehabilitated in 1992, and is estimated to have a useful life of about 70 years until 2062; in 2055 the dam and the proposed spillway project should be evaluated concurrently to prepare for the next life phase and rehabilitation that may be required.

This project and related debt service, once issued, will be found within the District's Enterprise Fund on the Financial Statements and Budgets.

The primary sources of funding, as currently planned, are described in Table 5 below.

Table 5: Sources of Funding Entities

Funding Entity	Grant	Loan	Enterprise Budget	Percent Participation
LMWD			$211,118	6.3%
CWCB		$3,025,062		90.0%
DOLA	$125,000			3.7%

6.7 Credit Worthiness

The District is requesting a 30-year loan from the CWCB and annual payments are estimated at $162,500. LMWD has utilized a variety of borrowing in the form of revenue bonds, general obligation bonds, and lease purchases since inception until now, for the past 27 years. LMWD has never been in default and re-financed the general obligation bonds twice to successfully reduce the total cost and maturity date of the bonds. The District's rate structure, existing debt, operating requirements, and proposed debt service, have been analyzed in connection with this project. As noted above, the study can be found in Appendix H.

6.8 Alternative Financing Considerations

The District has actively investigated alternative financing sources for the past three years, researching grants, municipal financing (public bond issues), State Revolving Funds (loans and grants though various divisions of the State of Colorado), self-funding (levies or rates), and lease-purchases (banks and private lenders). Each of these has costs and benefits; the CWCB Water Project Loan Program was selected for being the most beneficial and least costly, when compared to other alternatives.

6.9 Economic Analysis

The economic benefit of the project is considerable. LMWD estimates the value of property affected to be $35 million within the service area ($25 million taxable property and $10 million for non-taxable property). Using an estimated total project cost of $3.5 million the project cost/benefit ratio is $35/$3.5 or 10.

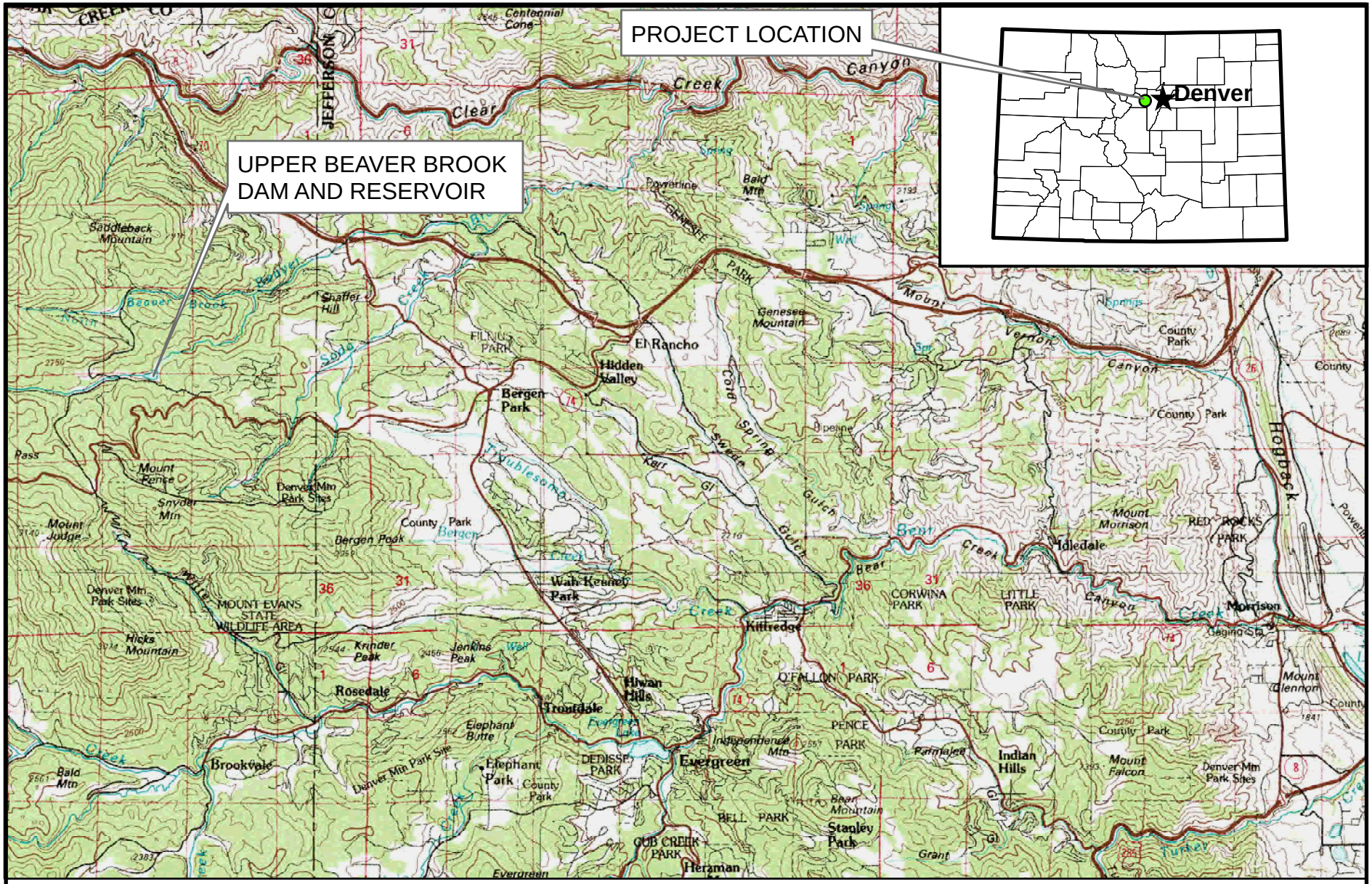
6.10 Social and Physical Impacts

The on-site project will have no significant *social impacts*, since it will support the continued operation of the existing reservoir, dam and spillway. The on-site project will have minor *physical impacts*, during and after construction. It is anticipated that after construction is complete, the access roads will be improved and the modifications made to the outlet works and inside the existing spillway would become visible from some vantage points. The existing reservoir, dam and spillway are located in an area that is not readily visible from existing structures or roadways due to the topography, forest coverage, potential for water coverage of the majority of the concrete weir, and infrequency of human contact in the area.

6.11 Conclusions

1. The Lookout Mountain Water District has the authority to enter into a contract with the CWCB for the purpose of obtaining a loan to fund this project, using the District's Enterprise Fund.
2. Rights-of Way easements and permits are adequate for the construction of this project.
3. The project would provide for the continued delivery of drinking water to current tap holders, with an increased reliability for future demand.
4. Preliminary studies, financial feasibility study, and project engineering have been started and/or are currently in progress; they have been funded or will be funded by the District's annual budgets and a grant.
5. The total estimated cost of the project is $3.361 million and this will be funded, in part, by a grant of $125,000 and a $3.025 million loan from the CWCB. The remaining balance, as an ongoing project, has been funded out of the District's current annual budget or will be funded by future appropriated budgets.
6. The project is technically and financially feasible and offers many years of benefits.

Figures



Upper Beaver Brook Spillway Improvements
Clear Creek County, Colorado

Lookout Mountain Water District
Golden, Colorado

GEI Consultants

Project 1327820

LOCATION MAP

January 2014 Figure 1

V:\Lookout Mountain Water District\Projects\1327820 Upper Beaver Brook Spillway\H&H\GIS\Figures\Location Map.mxd Jan 2014

Appendix A By-Laws

ARTICLE VIII - BYLAWS.

8.1 Board of Directors.

All powers, privileges and duties vested in, or imposed upon the District by law, shall be exercised and performed by and through the Board of Directors (hereinafter referred to as the "Board"), whether set forth specifically or implied in these by-laws. The Board may delegate to officers, employees or contractors of the District any administrative or ministerial powers.

8.2 Office.

8.2.1 Business Office.

The principal mailing address of the District shall be at 1202 Bergen Parkway, #215, Evergreen, CO 80439

8.2.2 Establishing Other Office and Relocation.

The Board, by resolution, may from time to time, designate, locate and relocate its executive and business office and such other offices as, in its judgment, are necessary to conduct the business of the District.

8.3 Meetings.

8.3.1 Regular Meetings.

Regular meetings of the Board shall be held on the second Monday of each month at 8:30 a.m. at the Highland Rescue Team Ambulance District Station at 317 S. Lookout Mountain Road, Golden, CO 80401.

8.3.2 Meeting Public.

All meetings, including work or study sessions, of a quorum of the Board at which public business is discussed or formal action is taken, other than executive sessions, shall be open to the public.

8.3.3. Notice of Meetings.

Section 8.3.1 shall constitute formal notice of regular meetings to Board members and no other notice shall be required to be given to Board members. Notice of regular and special meetings shall be given to others by posting at least seventy-two hours prior to such meetings at the office of the Clerk and Recorder for Jefferson County and at three places within the District, such locations to be established annually. Reasonable individualized notice shall be given to all persons requesting the same as required by law.

8.3.3.1 Special Notice.

Special notice shall be included with the posting for the undertaking of final determination to: issue or refund general obligation indebtedness; consolidate the District with another special district; dissolve the District; file a plan for debt adjustment under federal bankruptcy law; enter into a private contract with a Director; or not make a scheduled bond payment.

8.3.3.2 Continued Meetings.

When a regular or special meeting is for any reason continued to another time and place, notice need not be given of the continued meeting, except as required by law. At the continued meeting, any business may be transacted which might have been transacted at the original meeting.

8.3.4 24 Hour Notice and Agenda.

In addition to the three-day notice described above, notice of public meetings shall be posted at the Lookout Mountain Fire Station No. 1 no less than twenty-four hours prior to the meeting and shall include specific agenda information when possible. If an executive session is anticipated, it may be noted on the agenda.

8.3.5 Emergency Meetings.

Notwithstanding the foregoing, the Board may act without notice when unforeseen circumstances call for immediate action to protect the public health and safety or the welfare

of the District's residents. In such case, an action taken shall be effective only until the next regular or special meeting at which the Board may ratify such action.

8.4 Conduct of Business.

8.4.1 Quorum.

The presence of three Directors, in person or telephonically, shall constitute a quorum. All official business of the Board shall be transacted at a regular or special meeting at which a quorum is present.

8.4.2 Vote Requirements.

Any action of the Board shall require the affirmative vote of a majority of the Directors at a meeting at which a quorum is present. Proxy voting is not permissible. Due consideration shall be given by the Board to whether action on significant issues most appropriately should be considered and voted on by the entire Board. Such issues include the inclusion or exclusion of property, setting water rates, budget adoption and certification of the mill levy, release of retainage on a construction project; creation of new taps beyond those contemplated or enumerated in the Service Plan (except in the case of obvious clerical error or inadequacy of record keeping by Golden).

8.4.3 Order of Business.

The business of all regular meetings of the Board shall be transacted according to the following agenda:

(a) Call to order;
(b) Scheduled hearings and guests;
(c) Approval of the minutes of the previous meeting;
(d) Operator's report;
(e) Engineer's report;
(f) Special Committee reports;
(g) Legal Counsel's report;
(h) Administrator's report;
(i) Treasurer's report;
(j) Old business
(k) New business
(l) Public comment;
(m) Adjournment

8.5 Executive Sessions.

Upon the affirmative vote of at least two-thirds of the quorum present taken at a regular or special meeting following the announcement of an allowed discussion purpose, the Board may go into executive or "closed" session. The following procedure shall apply to executive sessions:

8.5.1 The Board President or acting President must announce, and the record shall reflect, one of the following allowable discussion purposes:

8.5.1.1 Purchase, acquisition, lease, transfer or sale of any property interest;

8.5.1.2 Conferences with the District's attorney regarding legal advice on specific legal questions;

8.5.1.3 Confidential matters pursuant to State or Federal law;

8.5.1.4 Security arrangements or investigations;

8.5.1.5 Negotiations;

8.5.1.6 Personnel matters, except if the employee who is the subject of the executive session has requested an open meeting; or if the personnel matter involves more than one employee, all of the employees must request an open meeting;

8.5.1.7 Items concerning mandatory nondisclosure;

8.5.1.8 If the allowable discussion topic is confidential due to State or Federal law, a specific citation to the applicable law of confidentiality shall be announced.

8.5.2 A vote shall be taken on whether or not to go into executive session.

8.5.3 The executive session shall be recorded and the tape thereof retained for at least ninety days.

8.5.4 No formal action (vote) shall be taken during an executive session.

8.6 Motions, Resolutions and Orders.

Each and every action of the Board necessary for the governing and management of the affairs of the District, for the execution of the powers vested in the District, and for carrying into effect the provisions of Article I of Title 32, C.R.S., as amended, shall be taken by the passage of motions, orders or resolutions.

8.7 Minutes.

Minutes of any each meeting shall be taken, promptly recorded, and presented to the Board for approval at the next regular or special meeting. Approval shall be evidenced by attestation by the Secretary, and only the approved minutes shall be maintained and distributed.

8.8 Electronic Communications.

If members of the Board use electronic mail to discuss public business among themselves, the electronic mail shall be subject to the provisions of the Colorado Sunshine Law. Copies of all such communications shall be provided to the Secretary or his or her designee and maintained by the District.

8.9 Board of Directors

8.9.1. Board Composition.

There shall be 5 Directors, and they shall be electors of the District. The term of each Director shall be determined by relevant statutory provisions with elections held in even numbered years and conducted in the manner prescribed by Part 8 of Article I, Title 32, C.R.S., as amended. Each Director shall sign an oath of office and, at the expense of the District, furnish a faithful performance bond as required by applicable Colorado Statute.

8.9.2 Oath of Office.

Each member of the Board, before assuming the responsibilities of one's office, shall take and subscribe an oath of office in the following form, to-wit:

OATH OF OFFICE OF DIRECTOR

STATE OF COLORADO)
) ss
COUNTY OF JEFFERSON)

I, _____, will faithfully support the Constitution of the United States and the State of Colorado, and the laws made pursuant thereto, and will faithfully perform the duties of office of Director of the Lookout Mountain Water District, upon which I am about to enter.

_____
Signature

Subscribed and sworn to before me this ___ day of XXX 20___.

_____
County Clerk, District Court Clerk,
President of the Board of Directors,
or Notary

8.9.3 Vacancies.

A Director's position shall be deemed vacant upon the occurrence of any of the events creating a vacancy set forth in the Act, including a Director's failure to attend three

consecutive regular meetings of the Board without the Board having entered it approval of the absence(s) in its minutes (except that additional absences shall be excused for temporary mental or physical disability or illness) or a Director's failure to remain qualified for the office to which he/she was elected. Any vacancy occurring on the Board shall be filled by an affirmative vote of a majority of the remaining Directors as prescribed within sixty days of the occurrence of the vacancy. The appointed elector must meet the qualifications for Directors prescribed by the Act and shall serve until the next regular election.

8.9.4 Election of Officers.

The Board of Directors shall elect from its membership a President, a Vice President, and a Treasurer, and the Board shall appoint a Secretary who need not be a member of the Board. The elected Officers shall be elected by a majority of the Directors voting at said election. The election of the Officers shall be conducted annually at the regular meeting of the Board held at the first regular meeting of the Board following the regular biennial public election of Directors held in May of even years. Unless re-elected, each officer, so elected, shall serve for a term of two years, which term shall expire upon the election of his or her successor. The Secretary shall serve under contract as approved by the Board until succeeded by another appointed individual.

8.9.4.1 President.

The President shall serve as the Chairman of the Board, preside at all meetings, guide and facilitate the functions of the Board, and act as the chief executive officer of the District. Except as otherwise authorized, the President shall sign all contracts, deeds, notes, debentures, warrants and other instruments on behalf of the District.

8.9.4.2 Vice President.

At the request of the President or in the absence of the President, the Vice President shall perform the functions of the President. The Vice President may also hold the office of Treasurer.

8.9.4.3 Secretary.

The Secretary shall keep the records and the seal of the District; may record minutes of meetings of the Board and votes taken at such meetings; shall compose a record of the proceedings of the Board and insure that the record of the meeting is filed in the business office; and shall perform all duties incident to that office. The Secretary shall affix the District's seal to and attest all contracts and instruments authorized to be executed by the Board.

8.9.4.4 Treasurer.

The Treasurer shall keep or cause to be kept strict and accurate accounts of all money received by and disbursed for and on behalf of the District in permanent records. The Treasurer shall file with the Clerk of the Court, at the expense of the District, a corporate fidelity bond in the amount required by law or such greater amount as may be determined by the Board. The Treasurer shall sign all checks unless he or she is not available for a period of five days or more, in which case, signatures of the President and another Director shall be required. Checks in the amount of $5,000 or greater shall require a second signature from one of the Directors of the District.

8.9.4.5 Office Vacancies.

The vacancy of a director's position shall cause a vacancy in any office held by such director. The office shall be filled for the remainder of the departing director's unexpired term by Board election held at the first regular meeting after the vacancy is filled.

8.9.5 Resignations.

The resignation of a Board member shall not be effective until made in writing and delivered to the Board.

8.9.6 Corporate Seal.

The seal of the District shall be a circle containing the name of the District and shall be used on all documents and in such manner as seals generally are used by public and private corporations. The Secretary shall have custody of the seal and shall be responsible for its safe-keeping and care.

8.10. Disclosure of Conflict of Interest.

Any Director who is present at a meeting at which is discussed any matter in which one has, directly or indirectly, a private pecuniary or property interest shall disclose such interest to the Board. Unless such Director has given seventy-two hours actual advance written notice to the Colorado Secretary of State and to the Board, in accordance with all statutory requirements, such Director shall refrain from advocating for or against the matter and shall disqualify oneself from voting on such matter.

8.11. Compensation.

The Board may, by resolution, elect to award compensation to Directors as prescribed by statute. No Director shall receive compensation as an employee of the District except as provided in this sub-section.

8.12. Financial Administration.

8.12.1 Fiscal Year.

The fiscal year of the District shall commence on January 1 of each year and end on December 31.

8.12.2 Budget Officer and Committee.

At or before its regular August meeting each year, the Board shall designate a qualified person to prepare the annual budget for the next fiscal year. The Board also may establish a committee, known as the Budget Committee, composed of the designated Budget Officer, the Treasurer, and such other members as may be appointed by the Board to assist in the preparation of the annual budget of the District.

8.12.3 Budget.

On or before October 15 of each year, the Budget Officer shall prepare and submit to the Board a proposed budget for the ensuing fiscal year. Such proposed budget shall be accompanied by a statement which shall describe the important features of the budget plan and by a general summary wherein shall be set forth the aggregate figures of the budget in such manner as to show the balanced relations between the total proposed expenditures and the total anticipated income or other means of financing the proposed budget for the ensuing fiscal year, as contrasted with the corresponding figures for the last completed fiscal year and the current fiscal year. It shall be supported by explanatory schedules or statements classifying the expenditures contained therein by services, subjects and funds. The anticipated income of the District shall be classified according to the nature of receipts.

8.12.4 Notice of Budget.

Upon receipt of such proposed budget, the Board shall cause to be published a notice that the proposed budget is open for inspection by the public at the business office; that the Board will consider the adoption of the proposed budget on a certain date; and that any interested elector may inspect the proposed budget and file or register any objections thereto at any time prior to its final adoption. Notice shall be published in substantial compliance with Section 29-1-108, C.R.S., as amended.

8.12.5 Adoption of Budget.

On the day set for consideration of such proposed budget, the Board shall review the proposed budget and revise, alter, increase or decrease the items as it deems necessary in view of the needs of the District and the probable income of the District. The Board shall then adopt a budget setting forth the expenditures to be made in the ensuing fiscal year. The Board

shall provide for sufficient revenues to finance budget expenditures with special consideration given to the proposed ad valorem tax levy before tax is levied.

8.12.6 Appropriating Resolution.

After its adoption of a budget and prior to its certification of a mill levy for the ensuing fiscal year, the Board shall enact a resolution making appropriations for the ensuing fiscal year. The amounts appropriated there under shall not exceed the amounts fixed therefore in the adopted budget.

8.12.7 No Contract to Exceed Appropriation.

The Board shall have no authority to enter into any contract, or otherwise bind or obligate the District to any liability for payment of money for any purposes, for which provision is not made in appropriation resolution, including any legally authorized amendment thereto, in excess of the amounts of such appropriation for that fiscal year. Any contract, verbal or written, contrary to the terms of this sub-section shall be void ab initio, and no District funds shall be expended in payment of such contracts, except as provided in the following sub-section.

8.12.8 Contingencies.

In cases of emergency caused by a natural disaster, public enemy, or some contingency which could not reasonably have been foreseen at the time of the adoption of the budget, the Board may authorize the expenditure of funds in excess of the budget by resolution duly adopted by a two-thirds vote of the entire membership of the Board. Such resolution shall set forth in full the facts concerning the emergency and shall be included in the minutes of that meeting. If so enacted, a copy of the resolution authorizing additional expenditures shall be filed with the Division of Local Government in the Department of Local Affairs and shall be published in compliance with statute requirements.

8.12.9 Levy and Collection of Taxes.

On or before December 15 of each year, the Board shall certify to the Board of County Commissioners of Jefferson County and Clear Creek County the mill levy established for the ensuing fiscal year, in order that, at the time and in the manner required by law for the levying of taxes, such Commissioners shall levy such tax upon the assessed valuation of all taxable property within the District.

8.12.10 Filing of Budget.

Within 30 days of adoption of the budget, the Board shall cause a certified copy of such budget to be filed with the Division of Local Government in the Department of Local Affairs.

8.12.11 Fiscal Audit.

8.12.11.1 Except as required by state statute, the Treasurer shall cause an audit to be made at the end of every fiscal year of all financial affairs of the District through December 31 of such fiscal year. In all events, the audit report must be submitted to the District within six months of the close of such fiscal year. Such audit shall be conducted in accordance with generally accepted auditing standards by a registered or certified public accountant, who has not maintained the books, records, and accounts of the District during the subject fiscal year.

8.12.11.2 The auditor shall prepare, and certify as to its accuracy, an audit report, including a financial statement and short form balance sheet based on such audit, an unqualified opinion or qualified opinion with explanations, and a full disclosure of violations of state law, pursuant to statutory requirements.

8.12.11.3 A copy of the audit report shall be maintained in the District office as a public record for a public inspection at all reasonable times.

8.12.11.4 The Treasurer shall forward a copy of the audit report to the State Auditor or other relevant state official, pursuant to statutory requirements, within thirty days following receipt of the audit.

8.12.12 Deposits and Investments.

District funds shall be deposited only in banks or savings and loan associations that qualify as eligible public depositories and have been so designated by the State of Colorado. All investments of public money by the District shall be in investment vehicles authorized by law.

8.13. Indemnification of Directors and Employees.

To the fullest extent allowed by law, the District shall defend, hold harmless and indemnify any Director, officer, agent, or employee, whether elective or appointive, against any tort or liability, claim or demand, whether groundless or otherwise, arising out of any alleged act or omission occurring during the performance of duty. The District may compromise and settle any such claim or suit and/or pay the amount of any settlement or judgment rendered thereon.

1) For the purposes of this Section 8.13 only, the following definitions shall apply

(a) "Employee". The term "employee" means a Director, officer, member, employee or servant (hereinafter collectively referred to as "employee") of the District, whether or not compensated, elected or appointed. The term "employee" specifically excludes any person or

organization contracting to perform services or acting for the District as an independent contractor.

(b) "Performance of Duty". The term "performance of duty" shall be interpreted as broadly as possible to include any situation in which a District employee could conceivably be deemed to be acting within the scope of one's employment. It shall specifically extend to all employees who are providing service on a voluntary basis or otherwise to any private, corporate, or governmental party other than the District, when doing so with the appropriate consent and authorization from the District. The term "performance of duty" shall not include any act or omission constituting deliberate and intentional tortious or criminal conduct, or malfeasance in office, or willful or wanton neglect of duty.

(c) The District reserves the right to designate the attorney appointed to defend any employee in any tort or liability action instituted pursuant to this Section 8.13.

(d) The District agrees to indemnify any employee up to, the maximum amounts specified under the Colorado Governmental Immunity Act (Article 10 of Title 24, C.R.S. as amended) and such additional amounts as are insured by liability insurance provided by the District. The District specifically reserves any defenses which are made available to the District or its employees by said Governmental Immunity Act.

(e) The District may maintain insurance to cover the risks enumerated in Section 8.13.

(f) All claims to be paid pursuant to this Section 8.13 shall be paid by the District or its insurer. Any judgment or settlement of a claim against the District shall be paid in accordance with the provisions of said Governmental Immunity Act.

(g) No defense or indemnification shall be provided by the District to any employee in any of the following circumstances.

1) If the employee willingly and knowingly fails to notify the District, within a reasonable time, of any incident or occurrence which one might reasonably expect to result in a claim of tort liability against said employee or the District.
2) If any employee fails to notify the District of any notice of claim or summons and complaint served upon said employee commencing a suit for damages reimbursable pursuant to this Section 8.13; such notice shall be given to the District within fifteen business days of its service upon the employee.
3) If an employee fails to exercise reasonable efforts to notify the District of any claim which is informally asserted against said employee for damages reimbursable pursuant to this Section 8.13.
4) If an employee refuses to cooperate with an investigation or defense of any lawsuit by the District, or its insurer, or by any private attorney employed by the District to furnish the defense to said employee, or any private investigator hired by the District to investigate such tort or liability claim.

(h) If the District or the employee against whom a claim reimbursable hereunder is asserted has any other valid insurance, bond or indemnification plan available covering the loss or damage alleged against said employee, such insurance, bond or other plan will be first applied to the payment of any claim. In such event, the obligation of the District to indemnify and hold harmless the employee shall exist only for liability incurred in excess of such other coverage.

(i) In the event of any payment made pursuant to this Section 8.13, the District shall be subrogated to all of the employee's rights of recovery therefore against any person or organization, and the employee shall execute and deliver instruments and papers and do whatever else is necessary to secure such rights of subrogation. The employee shall do nothing to prejudice such rights.

(j) No assignments of indemnification shall be permitted without the written consent of the District, signed by the President, and no such assignment shall bind the District unless such written consent is given prior to assignment. If, however, the employee shall die, the benefits of this Section 8.13 shall be available to, and apply fully to, the employee's successor, estate, or legal representative, but only while acting within the scope of one's duties as such.

(k) Any defense and indemnification available to any employee under this Section 8.13 shall continue to be available after the termination of one's employment, office or tenure if the act or omission causing such liability occurred during the course of one's duties while an employee of the District. Such defense and indemnification shall not be available to a former employee, however, in the event that the tort or liability claim against said former employee was asserted as a counter-claim or set-off in any suit brought by the employee, except the extent that the liability of such employee may exceed the amount of one's own claim or suit.
(l)The provisions of this Section 8.13 shall be subject to and, to the extent of any inconsistency therewith, shall be modified by said Governmental Immunity Act.

8.14 Bidding and Contracting Procedures.

Except in cases in which the District will receive aid from a government agency, a notice shall be published for bids on all construction contracts for work or material, or both, involving an expense in excess of $60,000.00 or more of public money. The District may reject any and all bids, and if it appears that the District can perform the work or secure material for less that the lowest bid, it may proceed to do so in accordance with statute.

8.14.1 No contract for work, materials, or services, regardless of amount, shall be entered into between the District and a Director unless a notice of bids has been published in accordance with statute.

8.14.2 In the letting and administration of all construction contracts, the Board shall proceed in accordance with applicable law.

8. 15. Violence and Harassment Prohibited.

The District prohibits violence or threats of violence on District property or at any location by District representatives, employees, or agents. The District prohibits harassment, including sexual harassment, against anyone (including any volunteer, employee, citizen, or District official) based on the individual's race, color, gender, national origin, religion, disability, age, marital status, sexual status, military service or veteran status, or based on those aspects in an individual's relatives, friends or associates. Harassment means verbal or physical conduct that insults or shows hostility or aversion toward an individual. Harassment may include:

- Epithets or slurs
- Negative stereotyping
- Threats, intimidation or hostile acts
- Demeaning or hostile jokes or pranks
- Insulting or hostile written or graphic material posted or circulated in the workplace.

8.15.1 Reporting Policy.

District representatives, employees and agents have an important responsibility in the effective implementation of the District's policies against harassment, sexual harassment and violence. Any representative, employee or agent member who believes that he or she has been the subject of harassment or sexual harassment, who has been harmed by violence or threatened with violence, or who has witnessed anyone else connected with the District experience or commit such conduct, should promptly notify a member of the District Board.

8.15.2 Investigation.

The District will promptly investigate a harassment or sexual harassment complaint or violence report, and will take corrective action where appropriate.

Appendix B Hydrology Summary

Executive Summary

ES.1 Background

This report presents and compares the Inflow Design Flood (IDF) estimates for Upper Beaver Brook Dam. The IDF estimates were developed using the Probable Maximum Precipitation (PMP) estimates from the Hydrometeorological Report No. 55A (HMR 55A) methods. The report summarizes hydrometeorological analyses, precipitation estimates, parameter development and selection, inflow hydrographs, and results of routing the IDF through the reservoir and spillway.

Upper Beaver Brook Dam No. 3A is located approximately 7.5 miles northwest of Evergreen, Colorado in Clear County in Section 15, Township 4 South, Range 72 West of the 6th Principal Meridian. The dam is located on Beaver Brook, a tributary to Clear Creek and the South Platte River upstream of Golden, Colorado. A project location map is shown in Figure 1.

Lookout Mountain Water District (LMWD) has two high altitude reservoirs on Beaver Brook; Beaver Brook No. 3A Reservoir (referred to herein as Upper Beaver Brook Dam/Reservoir) and Beaver Brook No. 2 Reservoir (referred to herein as Lower Beaver Brook Dam/Reservoir). Upper Beaver Brook Reservoir is LMWD's primary raw water storage facility. LMWD currently has several municipal storage water rights with priority dates ranging from 1903 to 1924, all of which are called out by the 1902 Croke Canal and occasionally other storage rights during the winter season. For this reason, LMWD has acquired a new water right with a priority date of December 29, 2011 that allows an increase in reservoir storage by 102 acre-feet (AF). The increased storage will be facilitated by a raise in the reservoir's normal water surface. In order to accommodate the additional storage without raising the existing embankment crest, modifications to the existing spillway are necessary. The proposed spillway improvement project will potentially add 102 AF to the existing 257 AF for a total storage of 359 AF.

Upper Beaver Brook Dam is a zoned earth dam with structural height of about 88 feet and impounds approximately 257 AF at the normal pool elevation (El.) 8399.0. The hydraulic height is approximately 60 feet. The original Upper Beaver Brook Dam was originally constructed around 1924 and was raised 26 feet to the current configuration in 1992. The existing dam crest is at El. 8420.0 and is about 520 feet long and has an average crest width of 25 feet. The upstream slope is approximately 2.5H:1V (Horizontal to Vertical) and the downstream slope is about 2.0H:1V.

The service spillway is excavated through rock at the left abutment. The service spillway is a rock channel with a crest width of approximately 80 feet at El. 8399.0. The excavated rock channel side slopes are nearly vertical with a 10-foot wide bench cut into the left side wall.

The rock channel is relatively flat for approximately the first 125 feet, and then becomes very steep and curves downstream towards the toe of the dam. The stilling basin is located approximately 130 feet downstream of the toe of the dam and consists of a shallow, rock-lined basin that is approximately 60-feet wide and 100 feet long.

The existing outlet works consists of a concrete headgate structure that opens to the reservoir. The outlet works is controlled by two 24-inch diameter gates, operated from the dam crest. The outlet pipe consists of the original 24-inch cast iron pipe connected to 160 foot-long section of mortar lined ductile iron pipe encased in concrete. The outlet pipe discharges to a concrete outlet structure located at the toe of the dam.

Upper Beaver Brook Reservoir has a gross watershed area of 6.5 square miles (mi^2), which is shown in Figure 3. The dam is classified as a High Hazard dam by the Colorado Office of the State Engineer (SEO) because loss of life is anticipated in the event that there is a failure of the dam. Upper Beaver Brook Dam is classified as a "Large Dam" because the embankment height is greater than 50 feet.

ES.2 Results

GEI Consultants, Inc. (GEI) developed estimates of general-storm PMP and the local-storm PMP for the Upper Beaver Brook watershed at the dam site. Precipitation estimates were converted to inflow estimates using standard flood runoff modeling practices. Modeling results for the general-storm Probable Maximum Flood () and the local-storm PMF are summarized in Tables ES-1 and ES-2, respectively.

Table ES-1: Results of the HMR 55A General-Storm PMF Model for the Existing Spillway

Parameter or Modeling Result	General-Storm PMF
Basin Average 72-hr PMP Depth (inches)	32.80
Basin Average Uniform Loss Rate (inches/hour)	0.106
Hydrologic Soil Groups (HSG)-Adjusted Excess Rainfall (inches)	26.33
SEO Allowed Reduction	0.80
SEO Reduced Average 72-hr PMP Depth (inches)	21.06
Basin Average Initial Infiltration Losses (inches)	0.50
Basin Average Initial Abstraction Losses (inches)	0.40
Basin Average Total Direct Runoff (inches)	20.05
Basin Average 72-hr Losses (inches)	12.75
Basin Average PMP Runoff Percent (%)	61.5
Maximum Reservoir Elevation (feet)	8,411.8
Inflow Volume (AF)	6,950.5
Freeboard (Dam Crest El. 8420.0)	8.2
Peak Inflow (cubic feet per second; cfs)	10,743
Peak Outflow (cfs)	10,572

Table ES-2: Results of the Local-Storm PMF Model for the Existing Spillway

Parameter or Modeling Result	Local-Storm PMF
Basin Average 6-hr PMP Depth (inches)	10.08
Basin Average Uniform Loss Rate (inches/hour)	0.106
HSG-Adjusted Excess Rainfall (inches)	9.44
SEO Allowed Reduction	0.90
SEO Reduced Average 6-hr PMP Depth (inches)	8.49
Basin Average Initial Infiltration Losses (inches)	0.50
Basin Average Initial Abstraction Losses (inches)	0.40
Basin Average Total Direct Runoff (inches)	7.60
Basin Average 6-hr Losses (inches)	2.48
Basin Average PMP Runoff Percent (%)	75.5
Maximum Reservoir Elevation (feet)	8,418.95
Freeboard (Dam Crest El. 8420.0)	1.05
Inflow Volume (AF)	2,633.7
Peak Inflow (cfs)	22,252
Peak Outflow (cfs)	20,680

The HMR 55A general-storm PMF produces a reservoir elevation of 8,411.8 feet, which is 8.2 feet below the crest of Upper Beaver Brook Dam. The general-storm peak inflow into Upper Beaver Brook Reservoir is 10,740 cubic feet per second (cfs) and the peak outflow through the spillway is 10,570 cfs. The HMR 55A local-storm PMF produces a reservoir elevation of 8,418.95 feet, which is 1.05 feet below the crest of Upper Beaver Brook Dam. The HMR 55A local-storm peak inflow into Upper Beaver Brook Reservoir is 22,252 cfs and the peak outflow is 20,680 cfs (Figure 7). Based on the modeling results, the HMR 55A local-storm produces the peak IDF inflow to the reservoir.

GEI also developed estimates of the 10-, 25-, 50- and 100-year storms for the Upper Beaver Brook Dam watershed. The results for these more frequent storms are based on using the Green and Ampt loss rate method rather than the initial and uniform loss rate method used for IDF modeling. Modeling results for the National Oceanic and Atmospheric Administration (NOAA) Atlas 10-, 25-, 50-, and 100-year storms are summarized in Table ES-3.

Table ES-3: Results of NOAA Atlas 10-, 25-, 50-, and 100-Year Storms Model

Parameter or Modeling Result	10-Year Storm	25-Year Storm	50-Year Storm	100-Year Storm
Total Watershed Average 24-hr 100-Year Storm Depth (inches)	1.79	2.16	2.47	4.56
Total Watershed Average 100-Year Storm Runoff (inches)	0.69	0.87	1.13	1.30
Total Watershed Average 24-hr 100-Year Losses (inches)	1.10	1.29	1.34	3.26
Total Watershed Average 100-Year Storm Runoff Percent (%)	38.5	40.3	54.3	28.5
Maximum Reservoir Elevation (ft)	8,401.5	8,401.9	8,402.4	8,402.8
Freeboard (Dam Crest El. 8420.0)	18.5	18.1	17.6	17.2
Inflow Volume (AF)	241	302	393	451.6
Peak Inflow (cfs)	1,003	1,243	1,610	1,828
Peak Outflow (cfs)	913	1,143	1,498	1,712

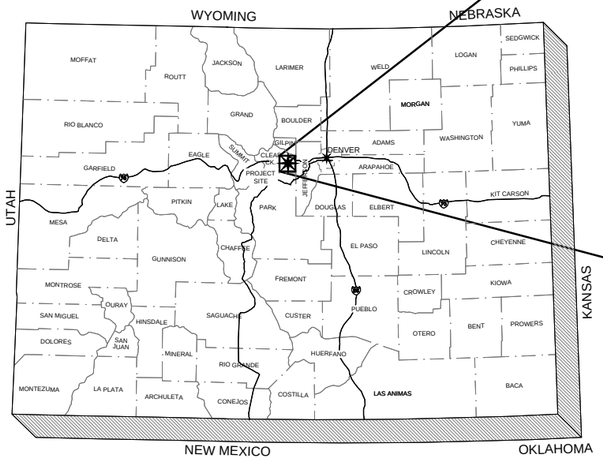
As indicated in Table ES-3, the 100-year storm produces a reservoir elevation of 8,402.8 feet, which is 17.2 feet below the crest of Upper Beaver Brook Dam. The 100-year storm peak inflow into Upper Beaver Brook Reservoir is 1,828 cfs and the peak outflow through the spillway is 1,712 cfs.

Appendix C Spillway Improvements 90% Design Drawings

DESIGN DRAWINGS FOR

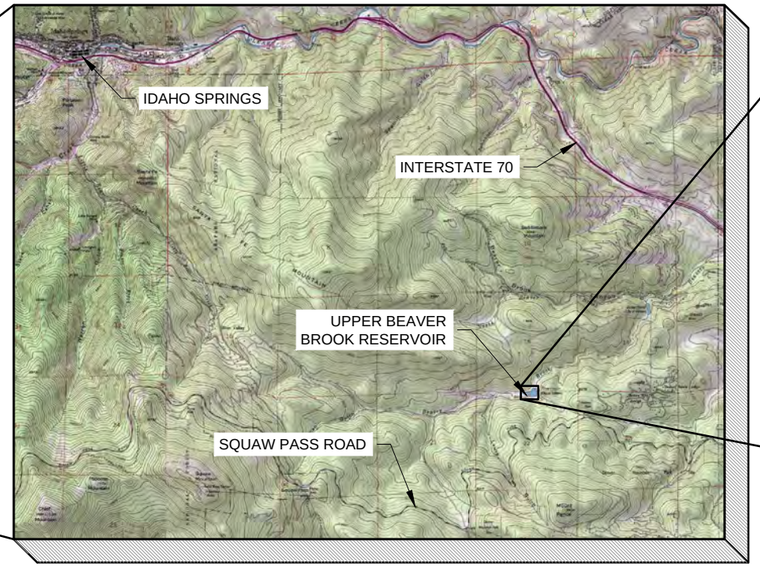
UPPER BEAVER BROOK SPILLWAY IMPROVEMENTS PROJECT

LOOKOUT MOUNTAIN WATER DISTRICT
CLEAR CREEK COUNTY, COLORADO
WATER DIVISION 1, WATER DISTRICT 7
DAMID 070103



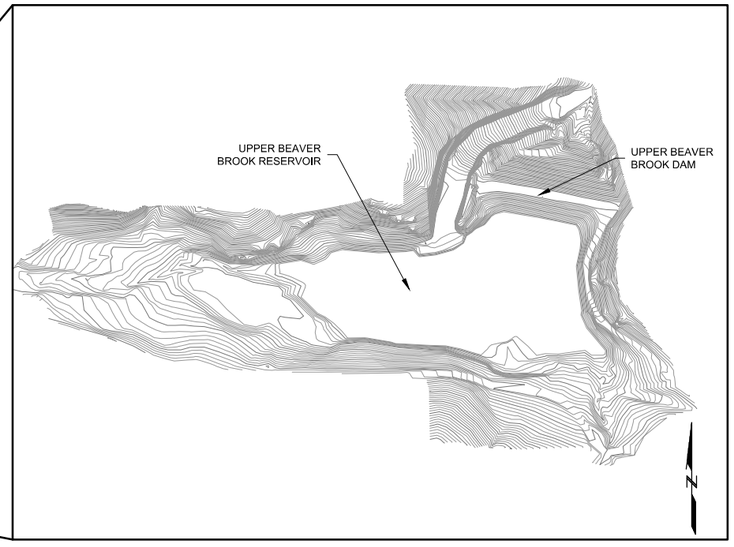
PROJECT LOCATION MAP

(NOT TO SCALE)



SITE LOCATION MAP

(NOT TO SCALE)



SITE VICINITY MAP

(NOT TO SCALE)

I HEREBY CERTIFY THAT THESE PLANS FOR THE CONSTRUCTION OF THE UPPER BEAVER BROOK SPILLWAY IMPROVEMENTS PROJECT WERE PREPARED BY ME (OR UNDER MY DIRECT SUPERVISION).

CHAD M. MASCHING, P.E. COLORADO P.E. #39806
REGISTERED ENGINEER
GEI CONSULTANTS, INC.

APPROVED ON THE _____DAY OF_____ 20____

STATE ENGINEER

WILLIAM T. MCCORMICK III, CO P.E. #29127
CHIEF - DAM SAFETY BRANCH

THESE PLANS MAY NOT BE MATERIALLY CHANGED, EXCEPT WITH THE PRIOR WRITTEN CONSENT OF THE STATE ENGINEER.

PREPARED FOR

LOOKOUT MOUNTAIN WATER DISTRICT
25958 GENESEE TRAIL ROAD #514
GOLDEN, COLORADO 80401

GOLDEN ● COLORADO

PREPARED BY

GEI Consultants

DENVER ● COLORADO

DWG. NO. G-01

SHEET NO. 1 of X

90% DESIGN DRAWINGS

P:\1327820 - Upper Beaver Brook\Civil\Production Drawings\Working Drawings\ G-01 - Cover Sheet.dwg Sep 2015

DRAWING LIST

SHEET NO.	DWG. NO.	TITLE
G-01	1	COVER SHEET
G-02	2	DRAWING LIST, GENERAL NOTES, LEGEND AND ABBREVIATIONS
G-03	3	EXISTING CONDITIONS AND GEOTECHNICAL PLAN
G-04	4	ACCESS, SURVEY CONTROL, CONTRACTOR STAGING & TEMPORARY CONTROLS
G-05	5	PLAN OF MODIFICATIONS
G-06	6	EXCAVATION PLAN
G-07	7	HYDRAULIC INFORMATION
C-01	8	SPILLWAY PLAN AND PROFILE
C-02	9	SPILLWAY SECTIONS
C-03	10	ACCESS ROAD PLAN AND PROFILE
C-04	11	ACCESS ROAD SECTIONS
C-05	12	DOWNSTREAM DAM TOE BENCH SECTIONS (1 OF 2)
C-06	13	DOWNSTREAM DAM TOE BENCH SECTIONS (2 OF 2)
C-07	14	SPILLWAY CHUTE AND DOWNSTREAM FACE ACCESS PROFILES
C-08	15	TOE DRAIN PLAN AND PROFILE
C-09	16	TOE DRAIN DETAILS
C-10	17	TEMPORARY CONTROLS DETAILS
S-01	18	STRUCTURAL NOTES AND GENERAL DETAILS
S-02	19	SPILLWAY - STRUCTURAL SECTIONS AND DETAILS (1 OF 2)
S-03	20	SPILLWAY - STRUCTURAL SECTIONS AND DETAILS (2 OF 2)

ABBREVIATIONS

AB	= ANCHOR BOLT	FLG	= FLANGE	PD	= PLAIN DOWELS
ALT	= ALTERNATE	FR	= FAR ROW	PE	= POLYETHYLENE
APPROX	= APPROXIMATE	FS	= FAR SIDE	PI	= POINT OF INTERSECTION
BF	= BOTTOM FACE	FT	= FEET OR FOOT	P	= PLATE
BH	= BORE HOLE	FTG	= FOOTING	PT	= POINT OF TANGENCY
BL	= BOTTOM LAYER	GALV	= GALVANIZED	PVC	= POLYVINYL CHLORIDE
BOC	= BOTTOM OF CONCRETE	GR	= GRADE	PL	= PROPERTY LINE
BOH	= BOTTOM OF HOLE	HK	= HOOK	RA	= RADIUS
BOT	= BOTTOM	HM	= HOLLOW METAL	REINF	= REINFORCEMENT
BR	= BOTTOM ROW	HORIZ	= HORIZONTAL	REQ'D	= REQUIRED
BRG	= BEARING	HR	= HANDRAIL	R.O.W.	= RIGHT OF WAY
CFS	= CUBIC FEET PER SECOND	HS	= HIGH STRENGTH	S	= SLOPE
CJ	= CONSTRUCTION JOINT	HSS	= HOLLOW STRUCTURAL STEEL	SCH	= SCHEDULE
CL, ℄	= CENTERLINE	HYD	= HYDRAULIC	SIM	= SIMILAR
CLR	= CLEAR	ID	= INSIDE DIAMETER	SPC, SPCS	= SPACE OR SPACES
CMP	= CORRUGATED METAL PIPE	IE	= INVERT ELEVATION	SS	= STAINLESS STEEL
CNTR	= CENTER	I.F.	= INSIDE FACE	SSP	= STEEL SHEETPILE
CONC	= CONCRETE	INV	= INVERT	STA	= STATION OR SPILLWAY STATION
CONT	= CONTINUOUS	IR	= INSIDE ROW	STL	= STEEL
CT J	= CONTRACTION JOINT	JT	= JOINT	SQ	= SQUARE
Δ	= DELTA	L	= CURVE LENGTH	SYM	= SYMMETRICAL
DBH	= DIAMETER BREAST HEIGHT	LG	= LONG	T&B	= TOP & BOTTOM
DIA, Ø	= DIAMETER	LMWD	= LOOKOUT MOUNTAIN WATER DISTRICT	TBD	= TO BE DETERMINED
DIAG	= DIAGONAL	LP	= LOW POINT	TH	= TEST HOLE
DND	= DO NOT DISTURB	MAX	= MAXIMUM	THK	= THICK
DWG, DWGS	= DRAWING OR DRAWINGS	MIN	= MINIMUM	T.O.	= TOP OF
DWL	= DOWEL	MH	= MANHOLE	T.O.C.	= TOP OF CONCRETE
E	= EAST OR EASTING	MFR	= MANUFACTURER	T.O.W.	= TOP OF WALL
EA	= EACH	NAD	= NORTH AMERICAN DATUM	TYP	= TYPICAL
EC	= EACH CORNER	NAVD	= NORTH AMERICAN VERTICAL DATUM	UBB	= UPPER BEAVER BROOK
EF	= EACH FACE	N	= NORTH OR NORTHING	UNC	= UNIFIED NATIONAL COARSE THREAD
EJ	= EXPANSION JOINT	NF	= NEAR FACE	U.N.O.	= UNLESS NOTED OTHERWISE
EL., ELEV	= ELEVATION	NGS	= NATIONAL GEODETIC SURVEY	USFS	= UNITED STATES FOREST SERVICE
EQ SPC	= EQUALLY SPACED OR EQUAL SPACES	NGVD	= NATIONAL GEODETIC VERTICAL DATUM	USGS	= UNITED STATES GEOLOGICAL SURVEY
ER	= EACH ROW	NO	= NUMBER	VERT	= VERTICAL
ES	= EACH SIDE	NR	= NEAR ROW	WS	= WATER SURFACE
EW	= EACH WAY	NS	= NEAR SIDE	YR	= YEAR
EXST	= EXISTING	NTS	= NOT TO SCALE		
EXT	= EXTENSION	NWS	= NORMAL WATER SURFACE		
EXP	= EXPANSION	O.C.	= ON CENTER		
FDN	= FOUNDATION	OD	= OUTSIDE DIAMETER		
FF	= FAR FACE	OHWM	= ORDINARY HIGH WATER MARK		
FH	= FLAT HEAD	PC	= POINT OF CURVATURE		

GENERAL NOTES

1. CONSTRUCTION IS SUBJECT TO THE RULES AND REGULATIONS OF THE COLORADO STATE ENGINEER'S OFFICE (SEO). SUBSTANTIVE CHANGES TO THE APPROVED DRAWINGS AND SPECIFICATIONS MAY REQUIRE SEO APPROVAL.
2. BASIS OF PROJECT MAPPING: HORIZONTAL: _____. PROJECTION:_____. VERTICAL: _____.
3. PRIMARY SITE ACCESS TO THE DAM IS PROVIDED FROM SQUAW PASS ROAD. FROM THE INTERSECTION OF THE EVERGREEN PARKWAY AND SQUAW PASS ROAD, TRAVEL WEST ON SQUAW PASS ROAD FOR 3.6 MILES. THE TURNOFF IS ON THE RIGHT WITH PARKING AND GATE IMMEDIATELY FOLLOWING. KEYS TO THE GATE MAY BE OBTAINED FROM _____. THE RESERVOIR IS LOCATED ABOUT 0.5 MILES FROM THE SITE ENTRANCE.
4. CONTRACTOR IS RESPONSIBLE FOR DEVELOPING AND IMPLEMENTING A SEQUENCE AND SCHEDULE FOR COMPLETION OF THE WORK IN ACCORDANCE WITH APPLICABLE PROVISIONS OF THE CONTRACT DOCUMENTS.

RESERVOIR OPERATIONS

1. PROTECT THE RESERVOIR FROM SPILLS OR OTHER CONTAMINATION THROUGHOUT CONSTRUCTION. REFER TO SPECIFICATION SECTIONS____ AND _____ FOR ADDITIONAL WATER QUALITY PROTECTION REQUIREMENTS.
2. OWNER WILL OPERATE THE RESERVOIR DURING THE CONSTRUCTION PERIOD. THE RESERVOIR WILL NOT BE LOWERED SPECIFICALLY TO FACILITATE CONSTRUCTION OF THE SPILLWAY IMPROVEMENTS. PLAN SPILLWAY IMPROVEMENT WORK TO BE ACCOMPLISHED WITH WATER SURFACE ELEVATIONS AS HIGH WAS EL. 8399. REFER TO SPECIFICATION SECTION _____ FOR OPERATIONAL REQUIREMENTS.

COORDINATION

1. SCHEDULE, COORDINATE, AND PERFORM THE WORK TO ALLOW NORMAL FACILITY OPERATIONS, INCLUDING OWNER ACTIVITIES RELATED TO OPERATION, MAINTENANCE, MONITORING, AND INSPECTION.
2. COORDINATE WITH THE OWNER FOR DESIGNATION OF SPECIFIC WORK AREAS FOR RESTRICTED ACCESS DURING PARTICULAR PERIODS OF THE WORK, AS WELL AS NEED FOR FENCING, SIGNAGE, AND OTHER MEASURES NECESSARY TO PROTECT THE PUBLIC, COMPLETED WORK, WORK IN PROGRESS, AND CONTRACTOR'S EQUIPMENT AND PROPERTY ON SITE.
3. MAINTAIN FULL AND COMPLETE ACCESS TO WORK TO OWNER, ENGINEER, AND REGULATORY PERSONNEL.

PERMITTING AND ENVIRONMENTAL

1. COMPLY WITH ALL REQUIREMENTS OF OWNER-OBTAINED PROJECT PERMITS. REFER TO SPECIFICATION SECTION _____ AND THE SPECIAL CONDITIONS FOR REQUIREMENTS OF OWNER-OBTAINED PERMITS. CONTRACTOR SHALL OBTAIN ALL OTHER PERMITS NECESSARY FOR CONSTRUCTION OF THE WORK.
2. DO NOT DISTURB WETLANDS BEYOND THE LIMITS SHOWN IN THE DRAWINGS.
3. ALL CONSTRUCTION ACTIVITIES MUST REMAIN ABOVE THE ORDINARY HIGH WATER MARK (EL. 8399). ACCESS, DREDGING, STOCKPILING, OR ANY OTHER CONSTRUCTION-RELATED ACTIVITIES MAY NOT OCCUR WITHIN THE RESERVOIR AREA BELOW EL. 8399.
4. NO TREE LARGER THAN 3" DBH SHALL BE REMOVED.
5. TREE PROTECTION FENCING AROUND STAGING AREAS SHALL BE INSTALLED IN ORDER TO PROTECT LIVE TREES IMMEDIATE ADJACENT TO STAGING AREAS.
6. CLEARING OF DOWNED TREES ON USFS LAND SHALL BE MINIMIZED TO THE GREATEST EXTENT PRACTICAL

HATCH LEGEND:

STEEL
STRUCTURAL FILL
GRANULAR FILL
FLOW FILL
SAND
ROAD FILL
NON-SHRINK GROUT
EXISTING CONCRETE OR STEEL
UNDISTURBED SOIL
STRUCTURAL CONCRETE
RIPRAP
GRAVEL/COARSE AGGREGATE
EXISTING WETLANDS

GENERAL LEGEND:

B-1 BORING LOCATION AND NUMBER
SURVEY CONTROL POINT
CONSTRUCTION CONTROL POINT

PLAN
DAM MODIFICATIONS — MAIN TITLE
0 10 20
SCALE, FEET — DRAWING SCALE IN UNITS SPECIFIED

SITE ACCESS ROUTE
PROPERTY LINE
FENCE
WATER SURFACE
34 STATE HIGHWAY
COUNTY ROAD
LIMITS OF CONTRACTOR WORK AREA

DETAIL / SPILLWAY — 1 / G-02 — DETAIL TITLE. THE NUMBER "1" REFERS TO THE DETAIL DESIGNATION. THE NUMBER "G-02" REFERS TO THE DRAWING NUMBER WHERE THE DETAIL IS CALLED OUT.

SECTION / STA. 0+00 — A / G-02 — SECTION TITLE. THE LETTER "A" REFERS TO THE SECTION DESIGNATION. THE NUMBER "G-02" REFERS TO THE DRAWING NUMBER WHERE THE SECTION IS CALLED OUT.

A / G-02 — SECTION LOCATION. THE LETTER "A" REFERS TO THE SECTION DESIGNATION. THE NUMBER "G-02" REFERS TO THE DRAWING NUMBER WHERE THE SECTION IS SHOWN.

1 / G-02 — DETAIL LOCATION. THE NUMBER "3" REFERS TO THE DETAIL DESIGNATION. THE NUMBER "G-02" REFERS TO THE DRAWING NUMBER WHERE THE DETAIL IS SHOWN.

90% DESIGN DRAWINGS

Attention: 0 1" — If this scale bar does not measure 1" then drawing is not original scale.

NO.	DATE	ISSUE/REVISION	APP
1	09/11/2015	90% DESIGN DRAWINGS	CMM
0	02/09/15	60% DESIGN DRAWINGS	CMM

DRAFT

Designed: K. PRICE
Checked: NAME
Drawn: K. PRICE
Approved By: C. MASCHING
Approval Date: DATE

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303-662-0100

Lookout Mountain Water District
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Golden, Colorado 80401

GEI Project 1327820

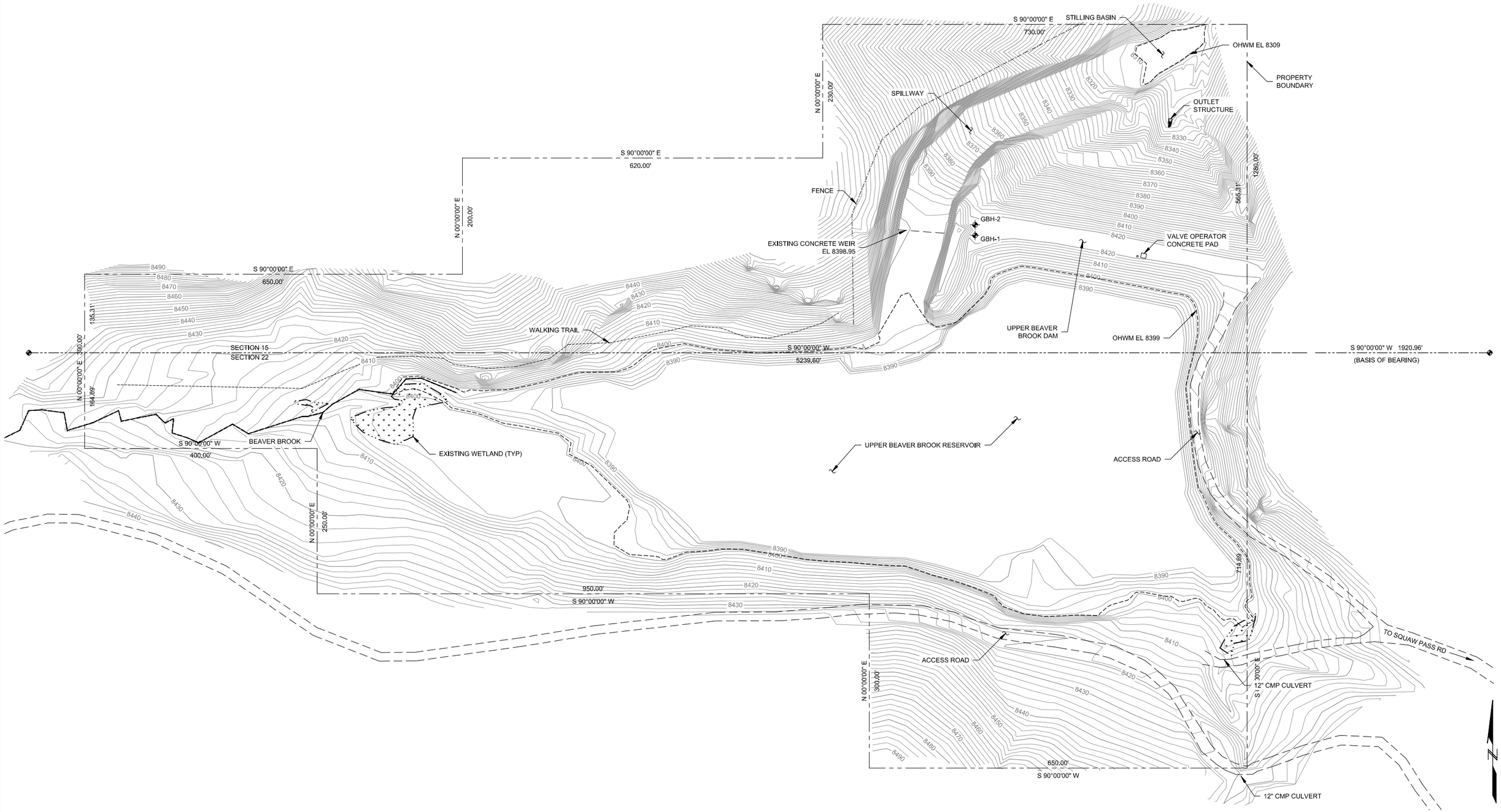
Upper Beaver Brook Spillway Improvements Project

DRAWING LIST, GENERAL NOTES, LEGENDS AND ABBREVIATIONS

DWG. NO. G-02

SHEET NO. 2 of X

P:\1327820 - Upper Beaver Brook\Civil\Production Drawings\Working Drawings\ G-02 - General Notes.dwg Sep 03, 2015 kprice



90% DESIGN DRAWINGS

0 80 160
SCALE, FEET

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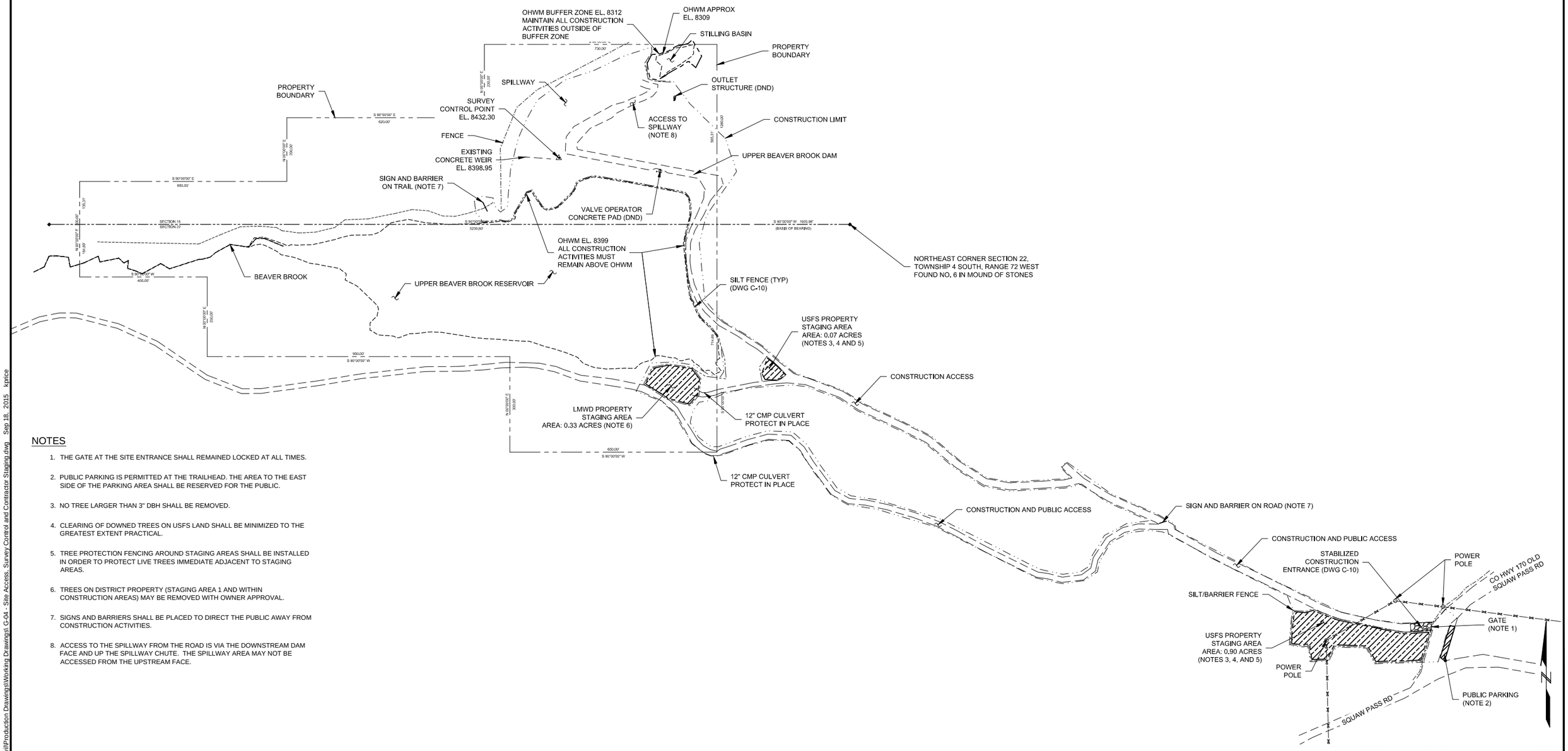
EXISTING CONDITIONS AND GEOTECHNICAL PLAN

DWG. NO. G-03

SHEET NO. 3 of X

P:\1327820 - Upper Beaver Brook\Civil\Production Drawings\Working Drawings\ G-03 - Existing Conditions and Geotechnical Plan.dwg Sep 18, 2015 kprice



NOTES

1. THE GATE AT THE SITE ENTRANCE SHALL REMAINED LOCKED AT ALL TIMES.
2. PUBLIC PARKING IS PERMITTED AT THE TRAILHEAD. THE AREA TO THE EAST SIDE OF THE PARKING AREA SHALL BE RESERVED FOR THE PUBLIC.
3. NO TREE LARGER THAN 3" DBH SHALL BE REMOVED.
4. CLEARING OF DOWNED TREES ON USFS LAND SHALL BE MINIMIZED TO THE GREATEST EXTENT PRACTICAL.
5. TREE PROTECTION FENCING AROUND STAGING AREAS SHALL BE INSTALLED IN ORDER TO PROTECT LIVE TREES IMMEDIATE ADJACENT TO STAGING AREAS.
6. TREES ON DISTRICT PROPERTY (STAGING AREA 1 AND WITHIN CONSTRUCTION AREAS) MAY BE REMOVED WITH OWNER APPROVAL.
7. SIGNS AND BARRIERS SHALL BE PLACED TO DIRECT THE PUBLIC AWAY FROM CONSTRUCTION ACTIVITIES.
8. ACCESS TO THE SPILLWAY FROM THE ROAD IS VIA THE DOWNSTREAM DAM FACE AND UP THE SPILLWAY CHUTE. THE SPILLWAY AREA MAY NOT BE ACCESSED FROM THE UPSTREAM FACE.

0 150 300
SCALE, FEET

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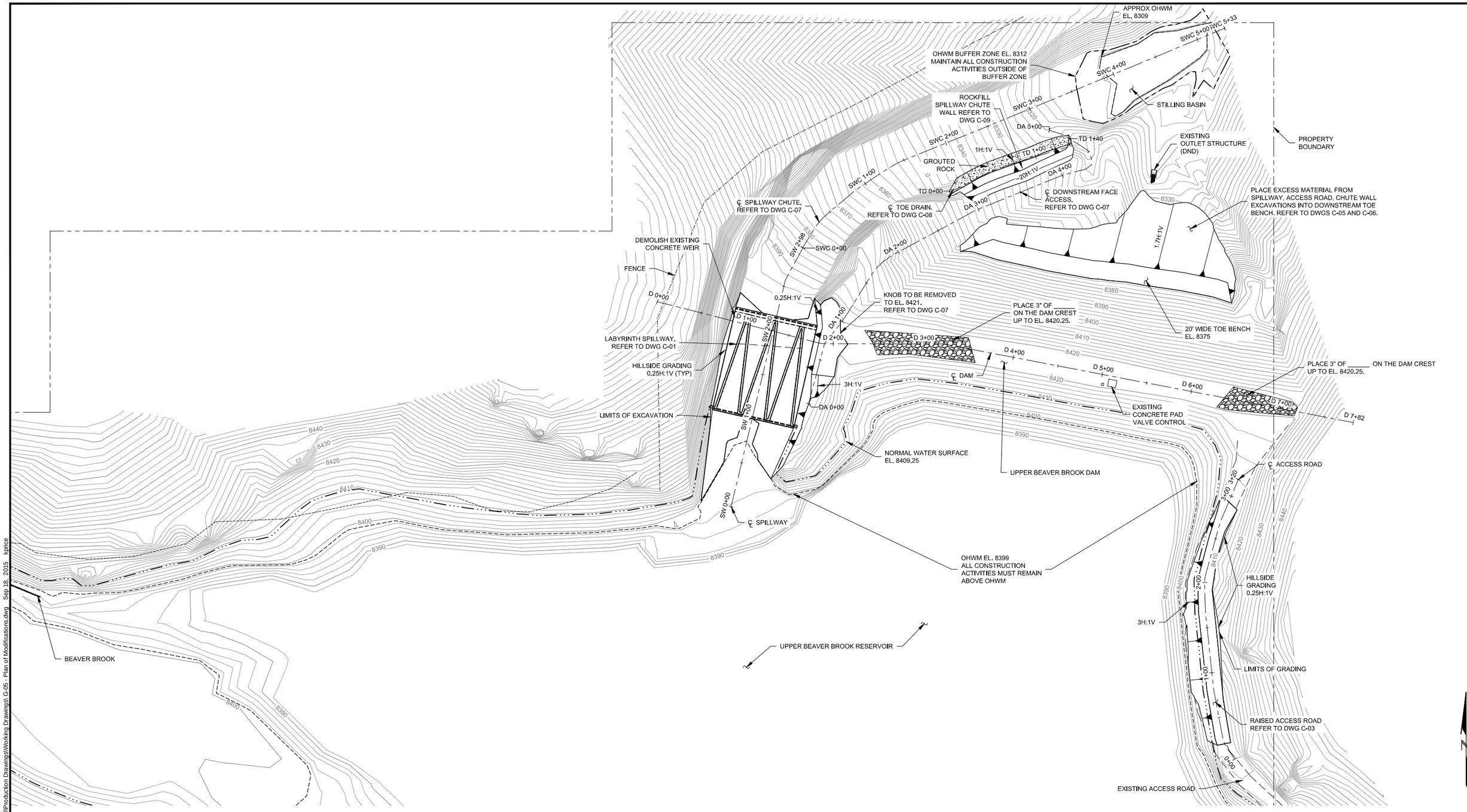
ACCESS, SURVEY CONTROL, CONTRACTOR STAGING & TEMPORARY CONTROLS

DWG. NO. G-04

SHEET NO. 4 of X

P:\1327820 - Upper Beaver Brook\Civil\Production Drawings\Working Drawings\ G-04 - Site Access, Survey Control and Contractor Staging.dwg Sep 18, 2015 kprice



90% DESIGN DRAWINGS

P:\1327820 - Upper Beaver Brook\Civil\Production Drawings\Working Drawings\ G-05 - Plan of Modifications.dwg Sep 18, 2015 kprice

Attention:

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0	02/09/15	60% DESIGN DRAWINGS	CMM

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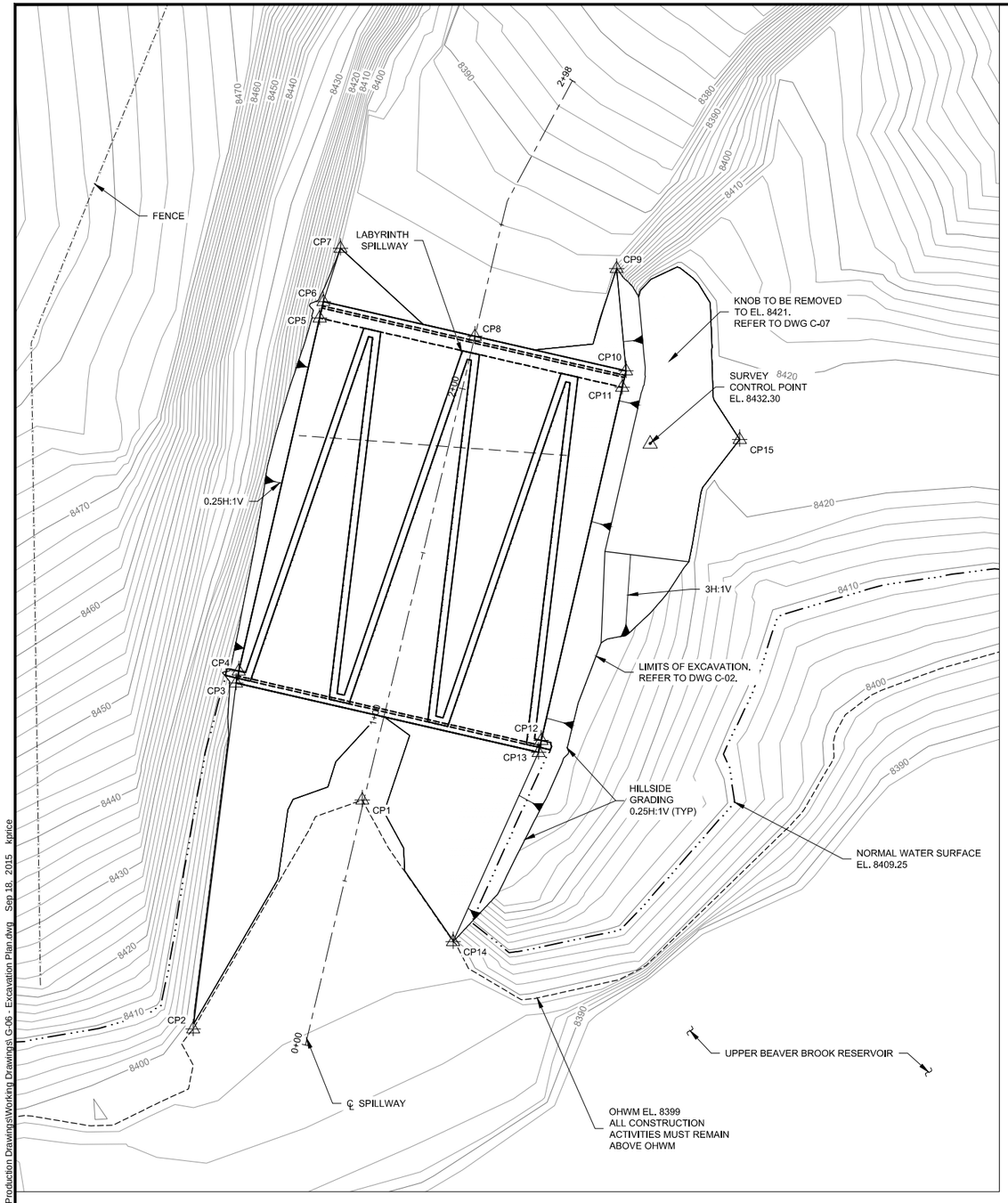
Upper Beaver Brook Spillway Improvements Project

PLAN OF MODIFICATIONS

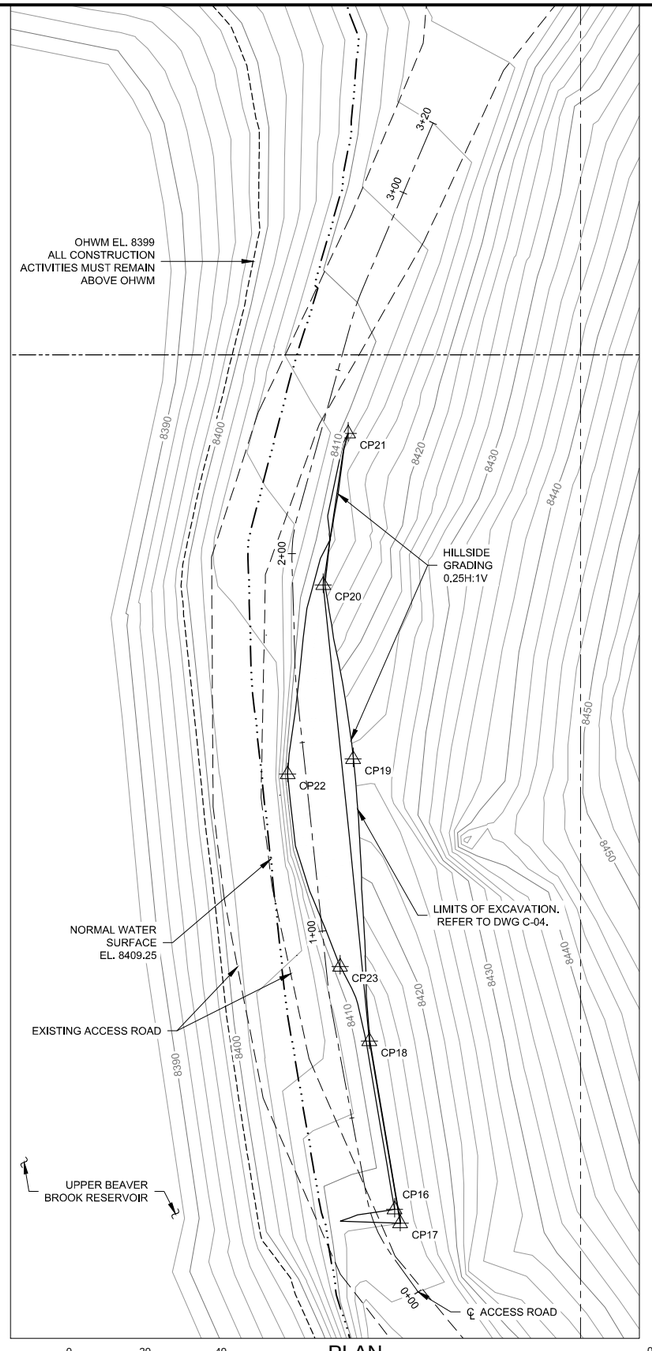
DWG. NO. G-05

SHEET NO. 5 of X



0 20 40
SCALE, FEET

PLAN
SPILLWAY EXCAVATION

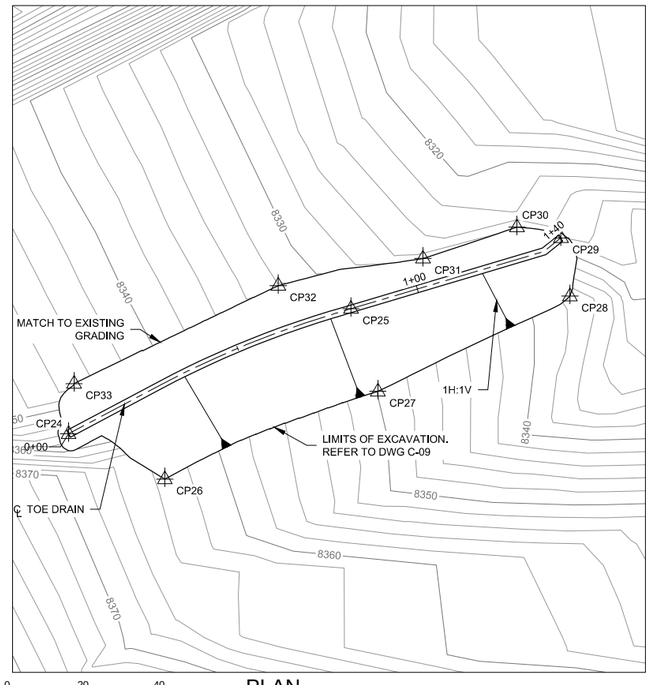


0 20 40
SCALE, FEET

PLAN
ACCESS ROAD EXCAVATION

CONTROL POINT TABLE			
POINT	NORTHING	EASTING	ELEVATION
CP1	2217.98	4598.13	8399.00
CP2	2150.13	4548.00	8399.00
CP5	2360.83	4585.49	8397.00
CP3	2252.63	4560.71	8399.00
CP9	2375.49	4673.52	8398.00
CP4	2256.21	4561.53	8399.00
CP6	2365.71	4586.61	8398.00
CP7	2381.50	4591.66	8398.00
CP8	2355.42	4631.49	8398.00
CP10	2345.16	4676.28	8398.00
CP11	2340.29	4675.17	8397.00
CP12	2235.67	4651.20	8397.50
CP13	2232.09	4650.38	8399.00
CP14	2175.99	4625.04	8399.00
CP15	2324.82	4709.99	8421.00
CP16	1888.70	5130.78	8411.50
CP17	1885.05	5132.25	8411.50

CONTROL POINT TABLE			
POINT	NORTHING	EASTING	ELEVATION
CP18	1933.12	5124.12	8411.50
CP19	2007.57	5119.85	8424.13
CP20	2053.52	5111.97	8411.50
CP21	2093.50	5118.55	8411.50
CP22	2003.57	5102.56	8411.50
CP23	1952.81	5116.41	8411.50
CP24	2493.39	4825.09	8345.60
CP25	2526.37	4899.63	8328.00
CP26	2481.44	4850.48	8363.45
CP27	2504.58	4906.71	8349.94
CP28	2529.70	4957.39	8337.27
CP29	2545.06	4955.01	8324.30
CP30	2547.90	4943.43	8325.69
CP31	2539.64	4918.62	8327.27
CP32	2532.46	4880.43	8332.59
CP33	2506.62	4826.53	8345.00



0 20 40
SCALE, FEET

PLAN
TOE DRAIN EXCAVATION

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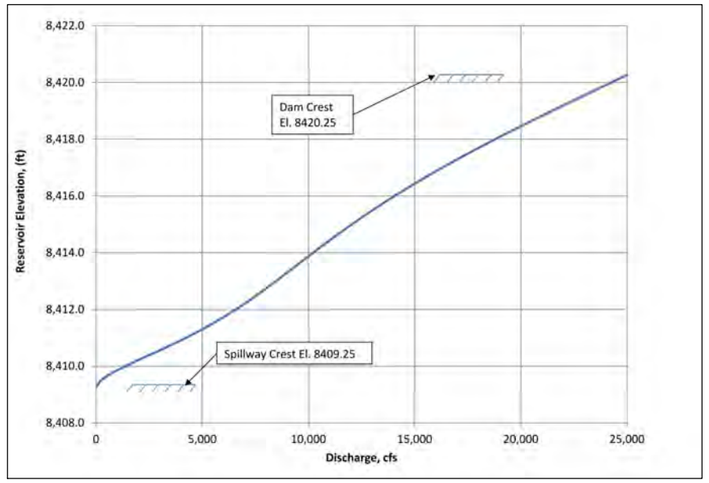
Upper Beaver Brook Spillway Improvements Project

EXCAVATION PLAN

DWG. NO. G-06

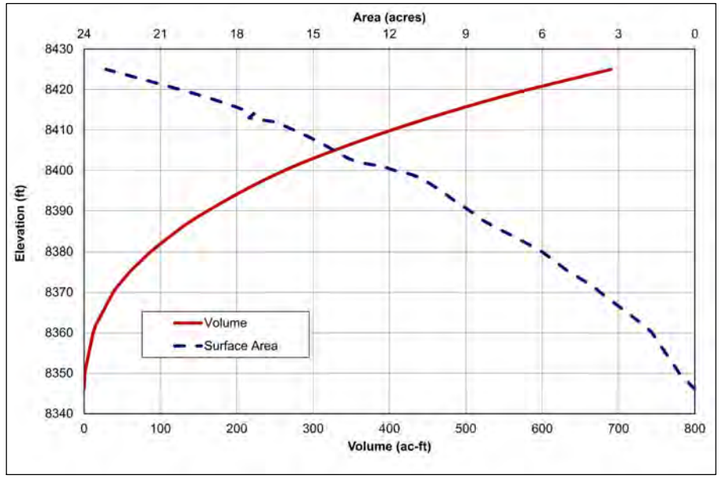
SHEET NO. 6 of X

P:\1327820 - Upper Beaver Brook\Civil\Production Drawings\Working Drawings\G-06 - Excavation Plan.dwg Sep 18, 2015 kprice



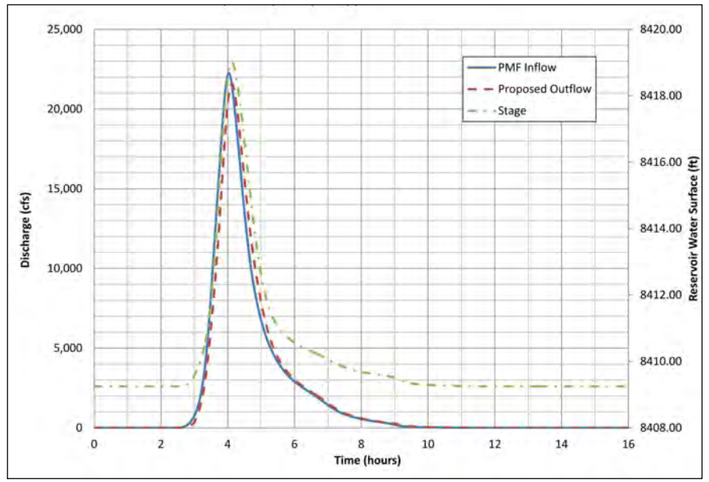
LABYRINTH SPILLWAY RATING CURVE

LABYRINTH SPILLWAY RATING TABLE	
RESERVOIR ELEVATION (FT)	SPILLWAY DISCHARGE (CFS)
8409.25	0
8409.50	220
8410.00	1378
8410.50	2833
8411.00	4235
8411.50	5485
8412.00	6584
8412.50	7567
8413.00	8477
8413.50	9353
8414.00	10226
8414.50	11118
8415.00	12047
8415.50	13024
8416.00	14057
8416.50	15150
8417.00	16304
8417.50	17521
8418.00	18799
8418.50	20129
8419.00	21482
8419.50	22853
8420.00	24239



UPPER BEAVER BROOK RESERVOIR
ELEVATION-AREA-CAPACITY CURVES

UPPER BEAVER BROOK RESERVOIR ELEVATION-AREA-CAPACITY TABLE		
RESERVOIR ELEVATION (FT)	SURFACE AREA (ACRES)	STORAGE CAPACITY (ACRE-FT)
8346	0.00	0.00
8350	0.61	0.80
8360	1.69	11.80
8370	3.72	38.20
8380	6.00	86.90
8388	8.43	144.50
8389	8.62	153.00
8390	8.84	161.80
8391	9.07	170.70
8392	9.31	179.90
8393	9.56	189.40
8394	9.76	199.00
8395	9.99	208.90
8396	10.23	219.00
8397	10.47	229.40
8398	10.76	240.00
8399	11.13	250.90
8400	11.80	262.40
8401	12.27	274.40
8402	13.24	287.20
8403	13.63	300.60
8404	13.91	314.40
8405	14.19	328.40
8406	14.47	342.80
8407	14.77	357.40
8408	15.08	372.30
8409	15.41	387.50
8409.25	15.50	397.44
8410	15.76	403.10
8411	16.12	419.10
8412	16.51	435.40
8413	17.52	452.40
8414	17.32	469.80
8415	17.74	487.30
8416	18.16	505.30
8417	18.65	523.70
8418	19.14	542.60
8419	19.67	532.00
8420	20.23	581.00
8420.25	20.37	587.40
8425	23.14	690.30



PMF HYDROGRAPHS

90% DESIGN DRAWINGS

NO.	DATE	ISSUE/REVISION	APP
1	09/11/2015	90% DESIGN DRAWINGS	CMM
0	02/09/15	60% DESIGN DRAWINGS	CMM

Attention:

0 1"

If this scale bar does not measure 1" then drawing is not original scale.

DRAFT

Designed:
Checked:
Drawn:
Approved By: C. MASCHING
Approval Date: DATE

GEI Consultants
4601 DTC Boulevard
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303-662-0100

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25958 Genesee Trail Road #514
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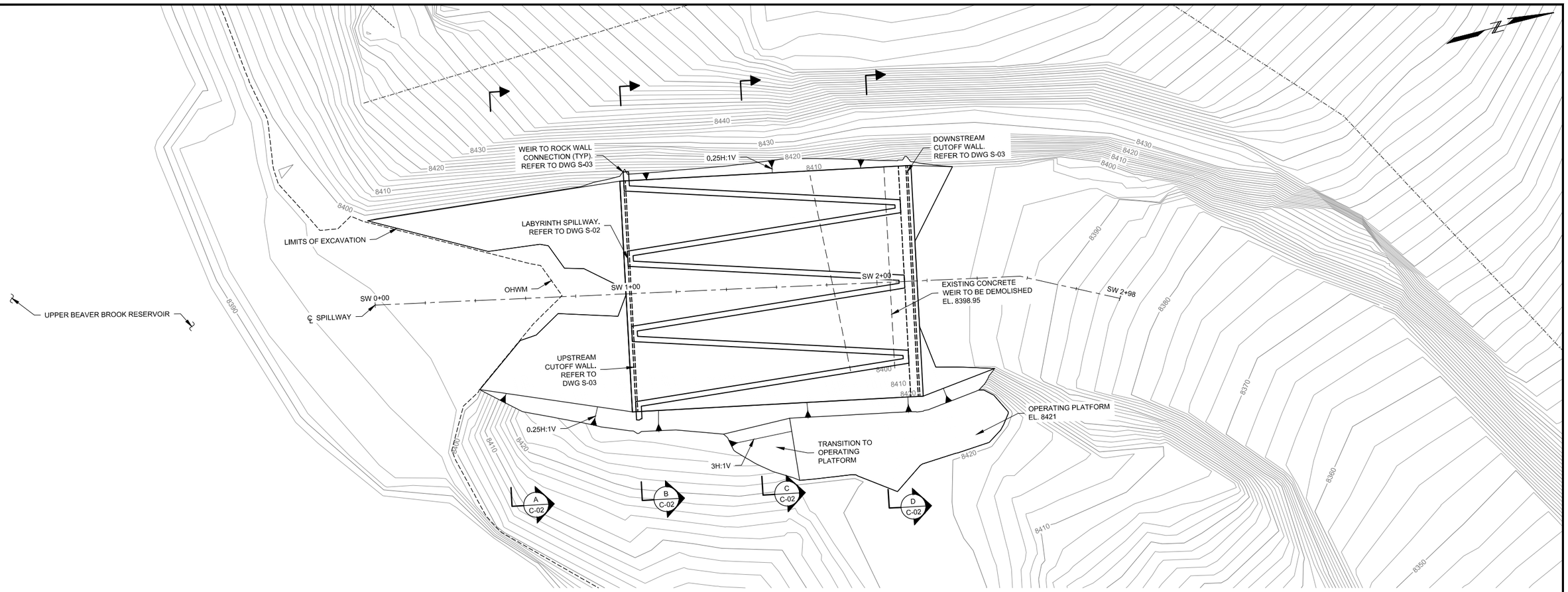
Upper Beaver Brook Spillway Improvements Project

HYDRAULIC INFORMATION

DWG. NO. G-07

SHEET NO. 7 of X

P:\1327820 - Upper Beaver Brook\Civil\Production Drawings\Working Drawings\ G-07 - Hydraulic Information.dwg Sep 18, 2015 kprice

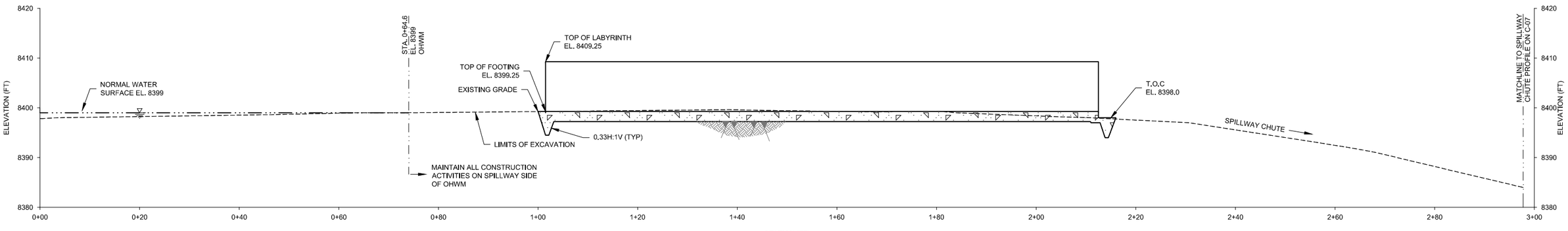


PLAN

SPILLWAY MODIFICATIONS

0 20 40

SCALE, FEET



PROFILE

SPILLWAY MODIFICATIONS

0 10 20

SCALE, FEET

90% DESIGN DRAWINGS

Attention:

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NO.	DATE	ISSUE/REVISION	APP
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0	02/09/15	60% DESIGN DRAWINGS	CMM

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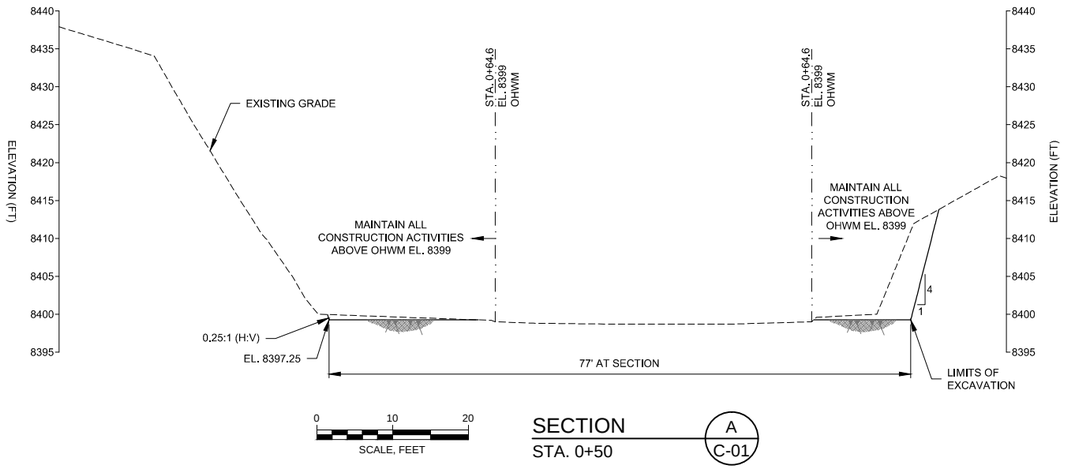
Upper Beaver Brook Spillway Improvements Project

SPILLWAY PLAN AND PROFILE

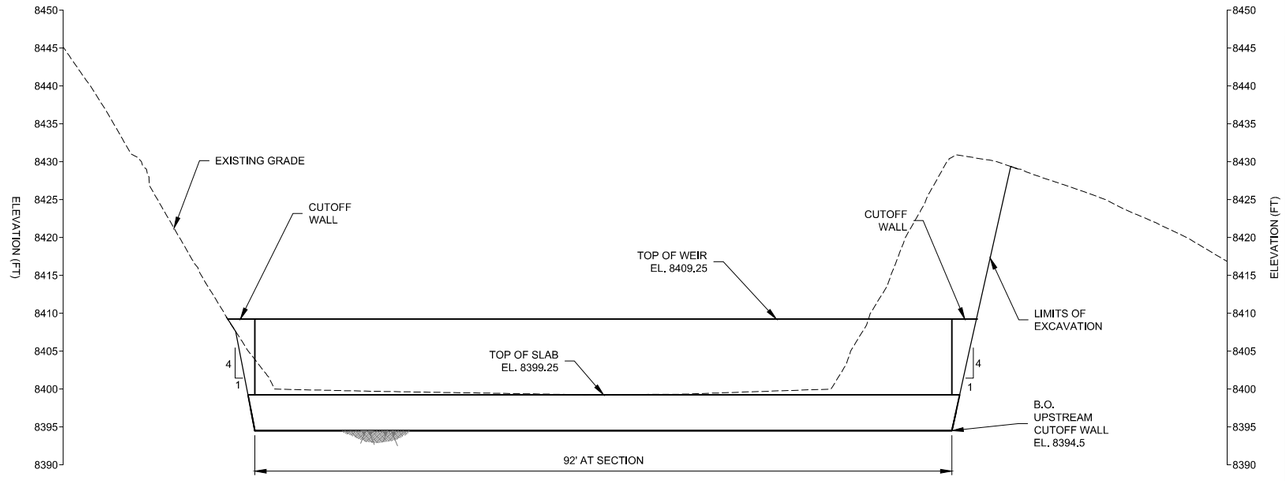
DWG. NO. C-01

SHEET NO. 8 of X

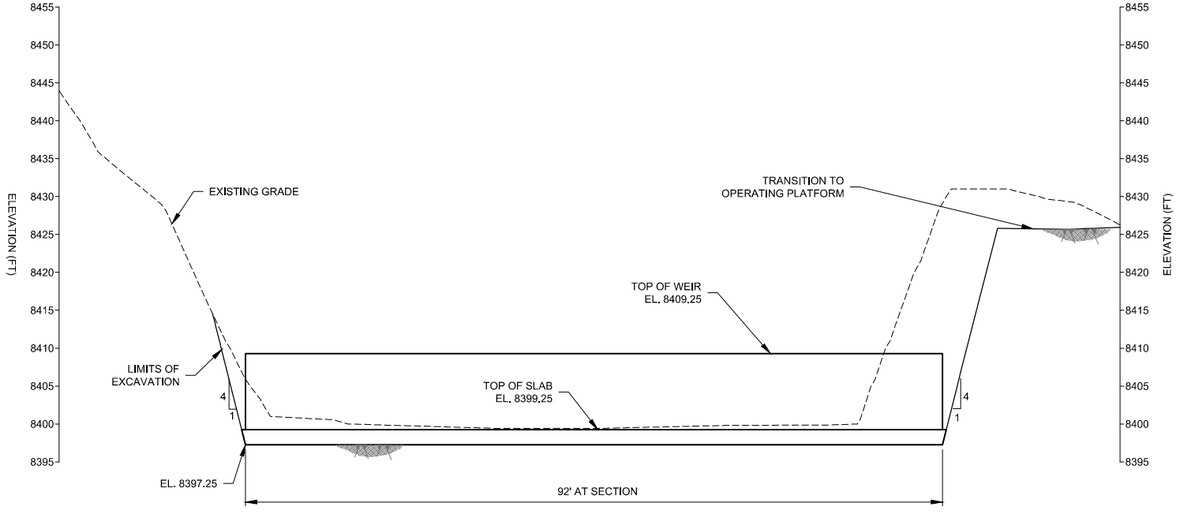
P:\1327820 - Upper Beaver Brook\Civil\Production Drawings\Working Drawings\ C-01 - Spillway Plan AND Profile.dwg Sep 18, 2015 kprice



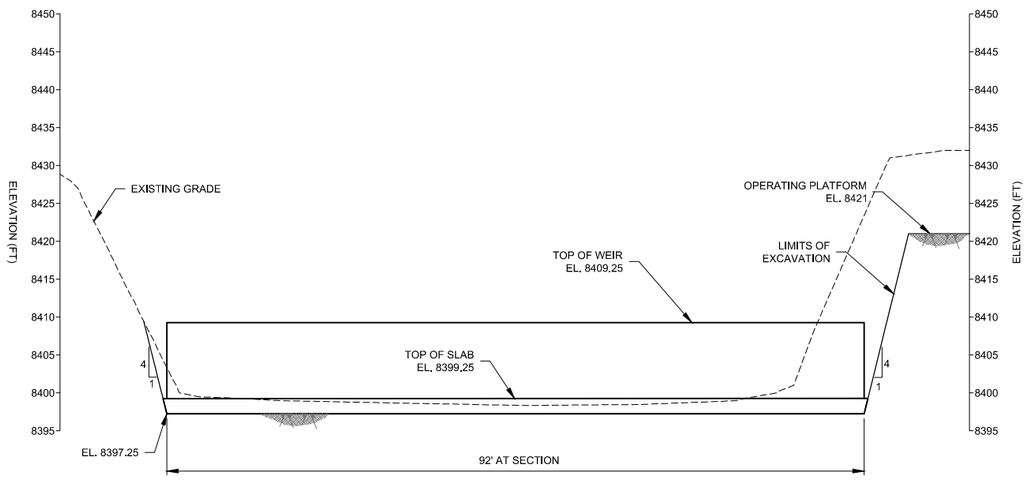
SECTION A
STA. 0+50
C-01



SECTION B
STA. 1+02
C-01



SECTION C
STA. 1+50
C-01



SECTION D
STA. 2+00
C-01

90% DESIGN DRAWINGS

NO.	DATE	ISSUE/REVISION	APP
1	09/11/2015	90% DESIGN DRAWINGS	CMM
0	02/09/15	60% DESIGN DRAWINGS	CMM

Attention:
0 1"
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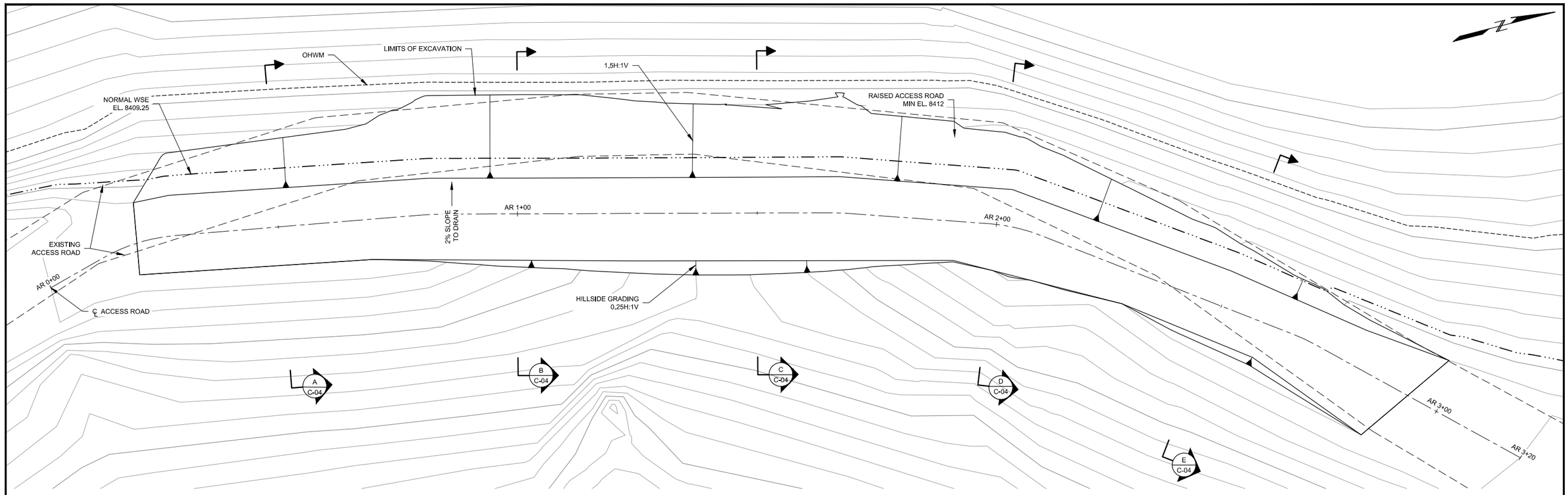
Upper Beaver Brook Spillway Improvements Project

SPILLWAY SECTIONS

DWG. NO. C-02

SHEET NO. 8 of X

P:\1327820 - Upper Beaver Brook\Civil\Production Drawings\Working Drawings\ C-02 - Spillway Sections.dwg Sep 18, 2015 kprice

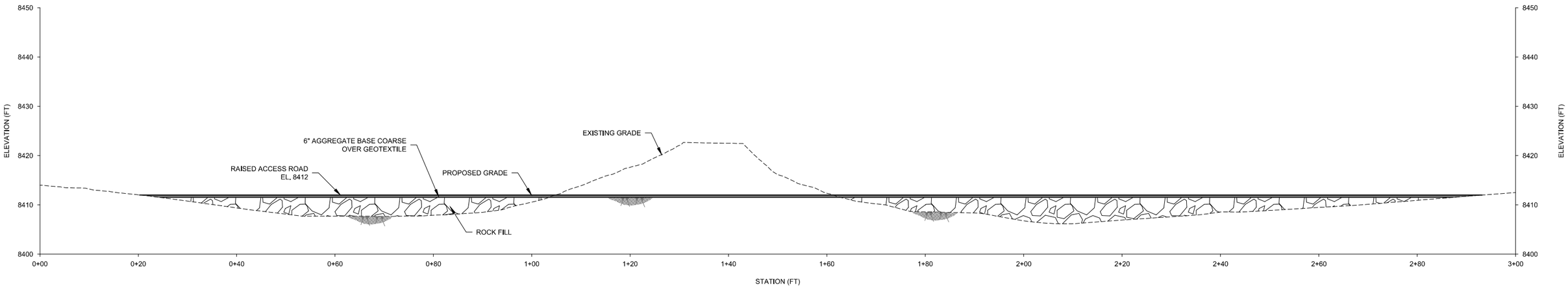


PLAN

ACCESS ROAD

0 10 20

SCALE, FEET



PROFILE

ACCESS ROAD

0 10 20

SCALE, FEET

90% DESIGN DRAWINGS

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NO.	DATE	ISSUE/REVISION	APP
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0	02/09/15	60% DESIGN DRAWINGS	CMM

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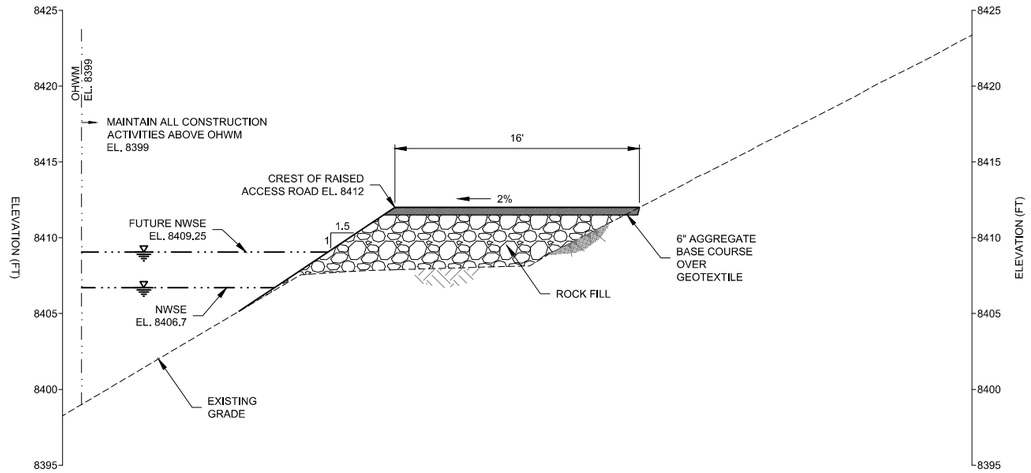
Upper Beaver Brook Spillway Improvements Project

ACCESS ROAD PLAN AND PROFILE

DWG. NO. C-03

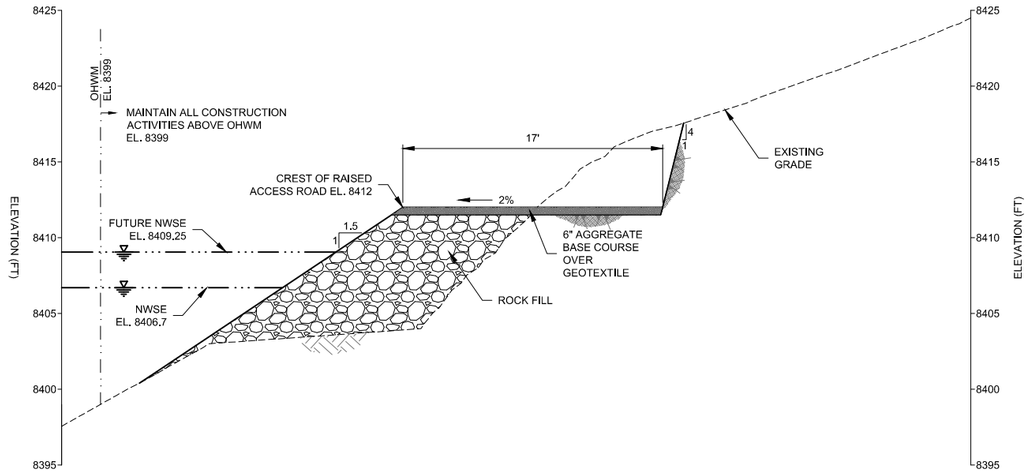
SHEET NO. 9 of X

P:\1327820 - Upper Beaver Brook\Civil\Production Drawings\Working Drawings\C-03 - Access Road Plan and Profile.dwg Sep 18, 2015 kprice



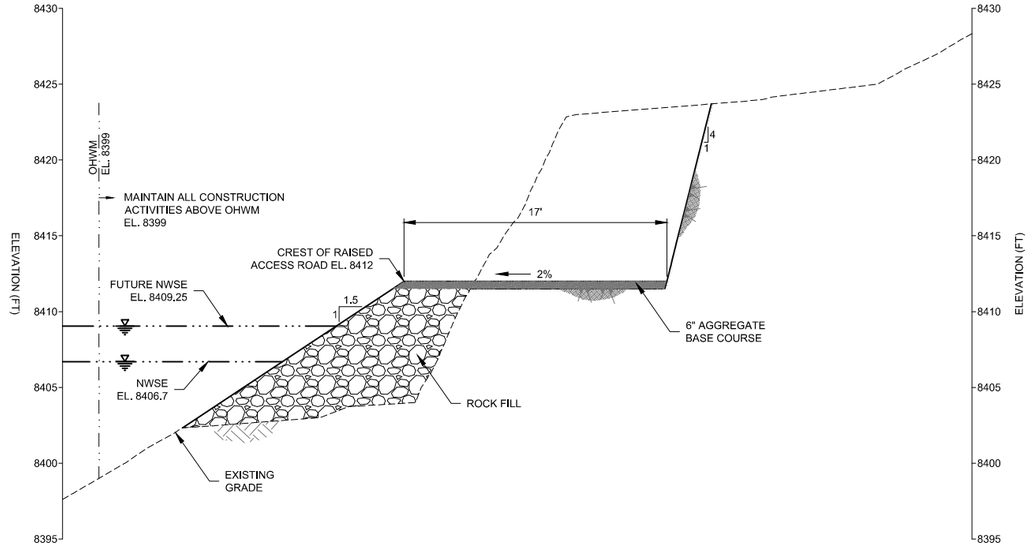
0 5 10
SCALE, FEET

SECTION A
STA. 0+50 C-03



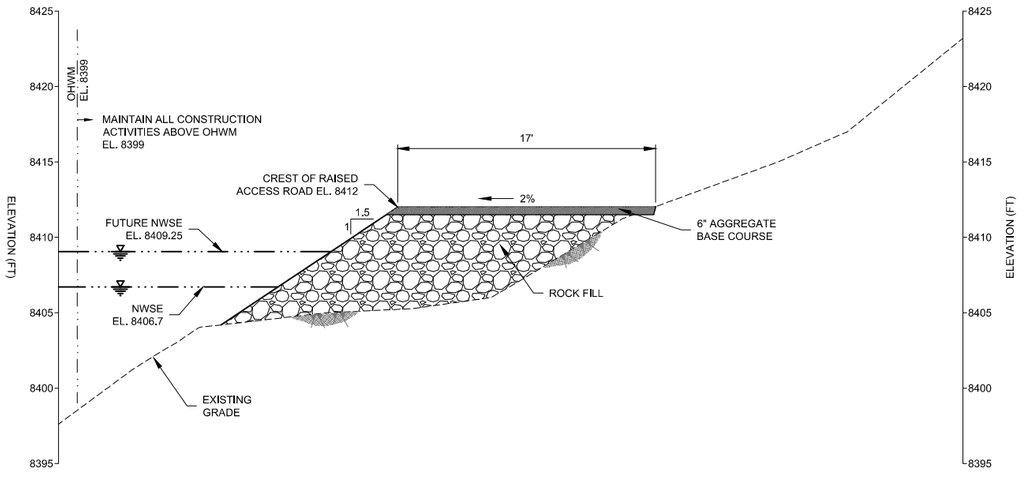
0 5 10
SCALE, FEET

SECTION B
STA. 1+50 C-03



0 5 10
SCALE, FEET

SECTION C
STA. 1+00 C-03



0 5 10
SCALE, FEET

SECTION D
STA. 2+00 C-03

90% DESIGN DRAWINGS

NO.	DATE	ISSUE/REVISION	APP
1	09/11/2015	90% DESIGN DRAWINGS	CMM
0	02/09/15	60% DESIGN DRAWINGS	CMM

Attention:
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Drawn:
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Approval Date: DATE

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303-662-0100

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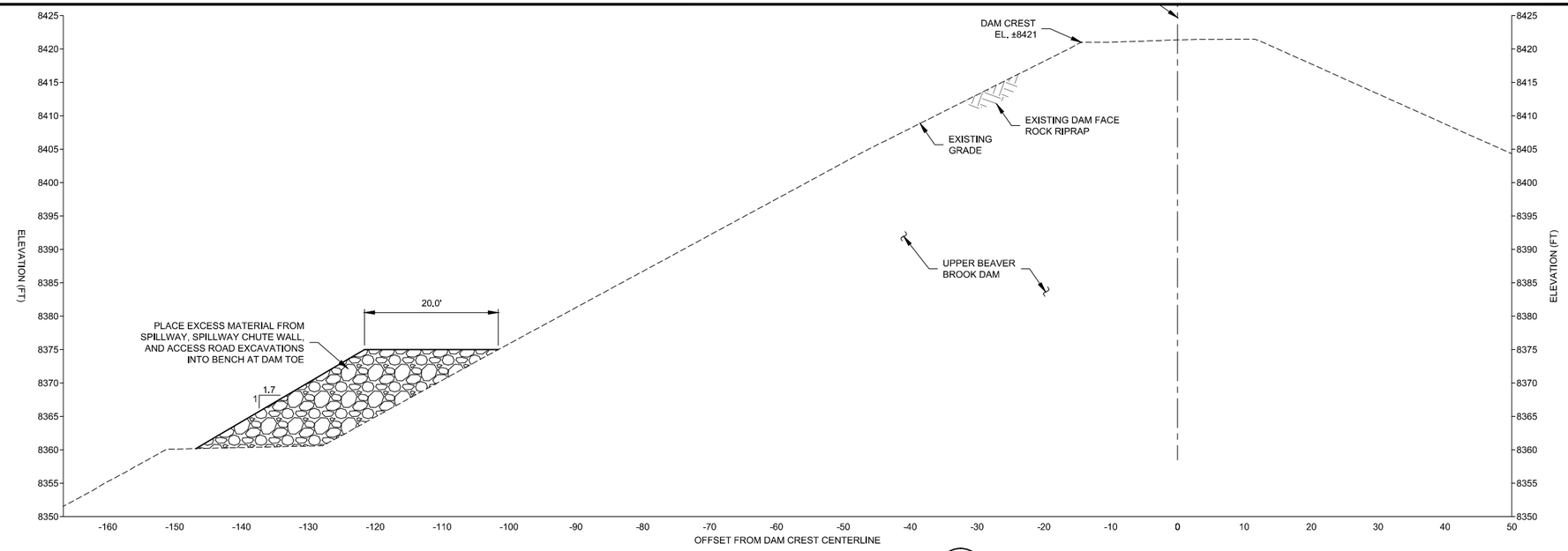
GEI Project 1327820

Upper Beaver Brook Spillway Improvements Project

ACCESS ROAD SECTIONS

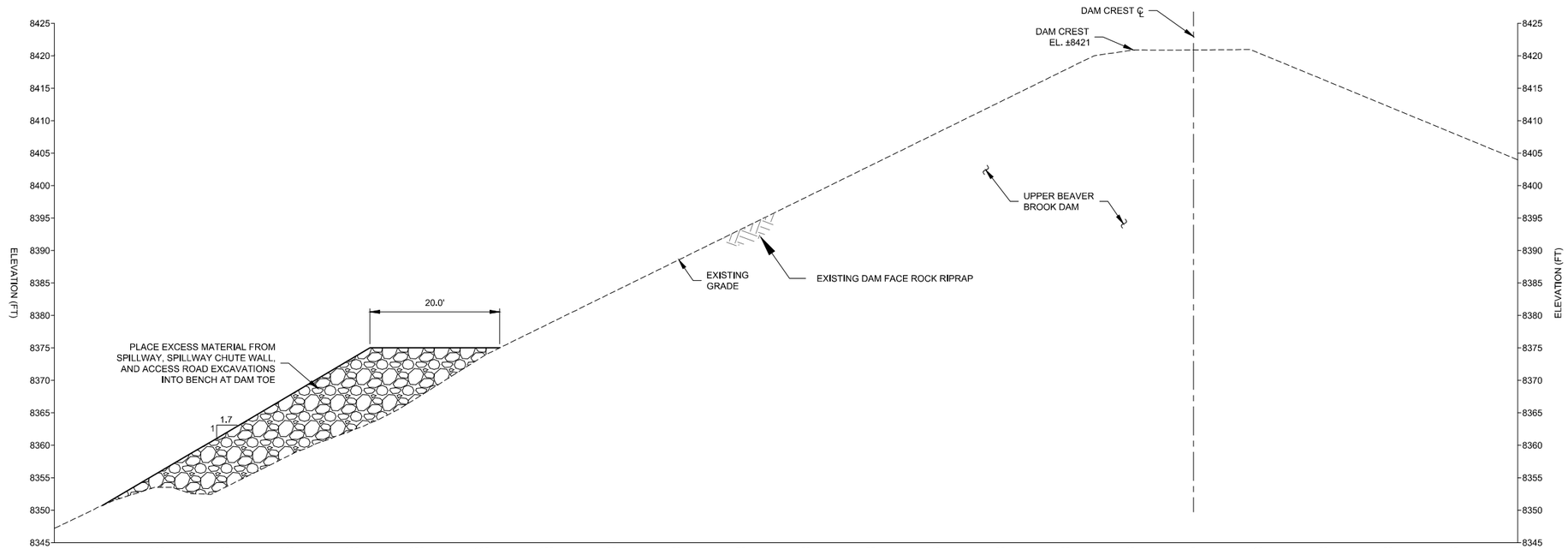
DWG. NO. C-04

SHEET NO. 10 of X



SECTION A
STA. 4+00
G-05

SCALE, FEET: 0 10 20



SECTION B
STA. 6+00
G-05

SCALE, FEET: 0 10 20

90% DESIGN DRAWINGS

Attention:

0 1"

If this scale bar does not measure 1" then drawing is not original scale.

NO.	DATE	ISSUE/REVISION	APP
1	09/11/2015	90% DESIGN DRAWINGS	CMM
0	02/09/15	60% DESIGN DRAWINGS	CMM

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Approval Date: DATE

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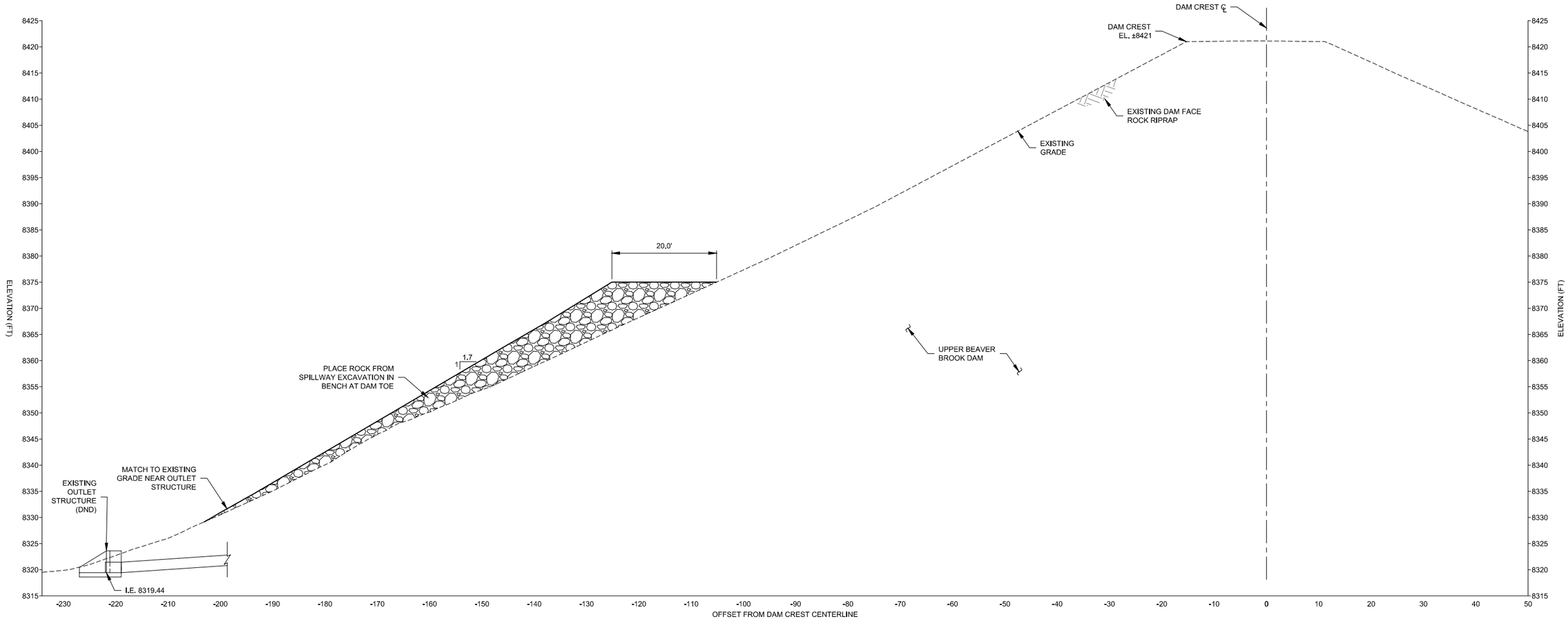
GEI Project 1327820

Upper Beaver Brook Spillway Improvements Project

DOWNSTREAM DAM TOE BENCH SECTIONS (1 OF 2)

DWG. NO. C-05

SHEET NO. 11 of X



0 10 20
SCALE, FEET

SECTION C
STA. 5+13
G-05

90% DESIGN DRAWINGS

Attention:	NO.	DATE	ISSUE/REVISION	APP
0 1"	1	09/11/2015	90% DESIGN DRAWINGS	CMM
If this scale bar does not measure 1" then drawing is not original scale.	0	02/09/15	60% DESIGN DRAWINGS	CMM

DRAFT

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Approval Date: DATE

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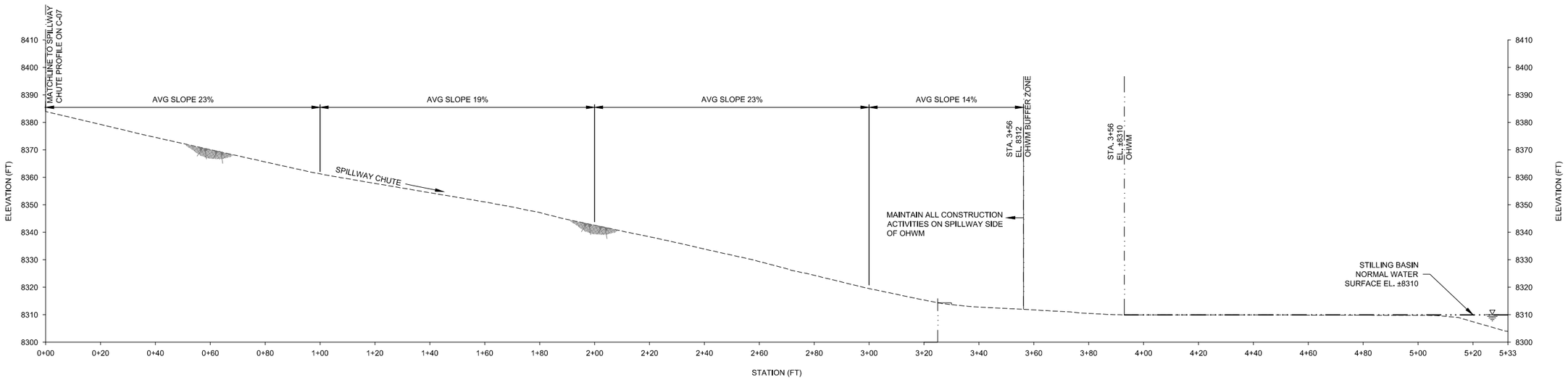
Upper Beaver Brook Spillway Improvements Project

DOWNSTREAM DAM TOE BENCH SECTIONS (2 OF 2)

DWG. NO. C-06

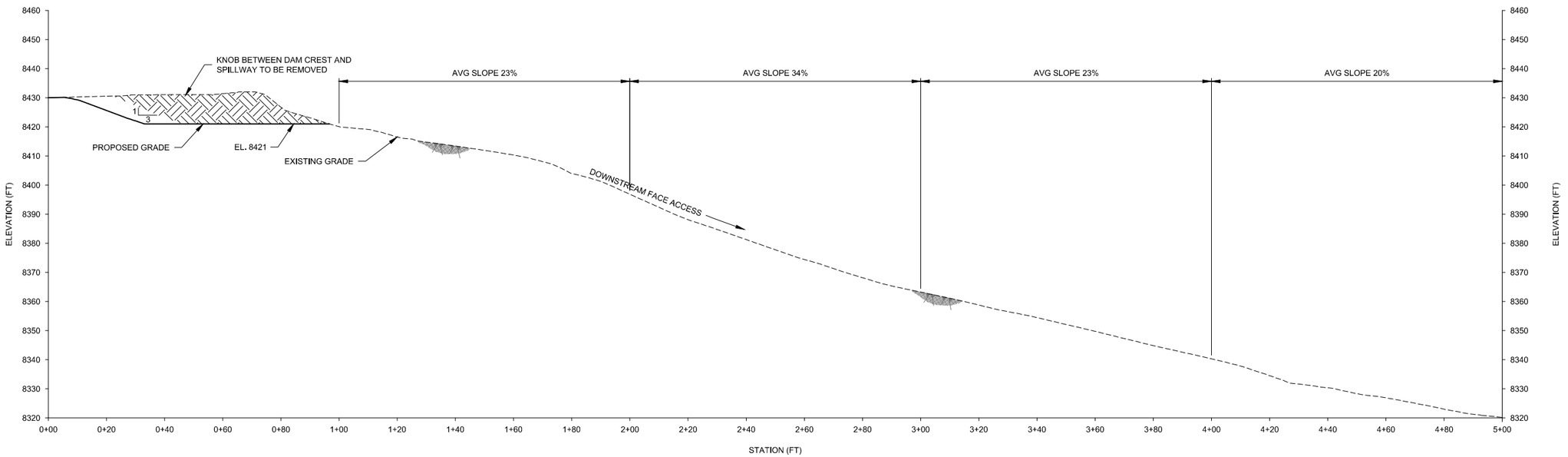
SHEET NO. 12 of X

P:\1327820 - Upper Beaver Brook\Civil\Production Drawings\Working Drawings\ C-06 - Downstream Toe Bench (2 of 2).dwg Sep 08, 2015 kprice



PROFILE
SPILLWAY CHUTE

0 20 40
SCALE, FEET



PROFILE
DOWNSTREAM ACCESS

0 20 40
SCALE, FEET

90% DESIGN DRAWINGS

Attention:

0 1"

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NO.	DATE	ISSUE/REVISION	APP
1	09/11/2015	90% DESIGN DRAWINGS	CMM
0	02/09/15	60% DESIGN DRAWINGS	CMM

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Drawn:
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Approval Date: DATE

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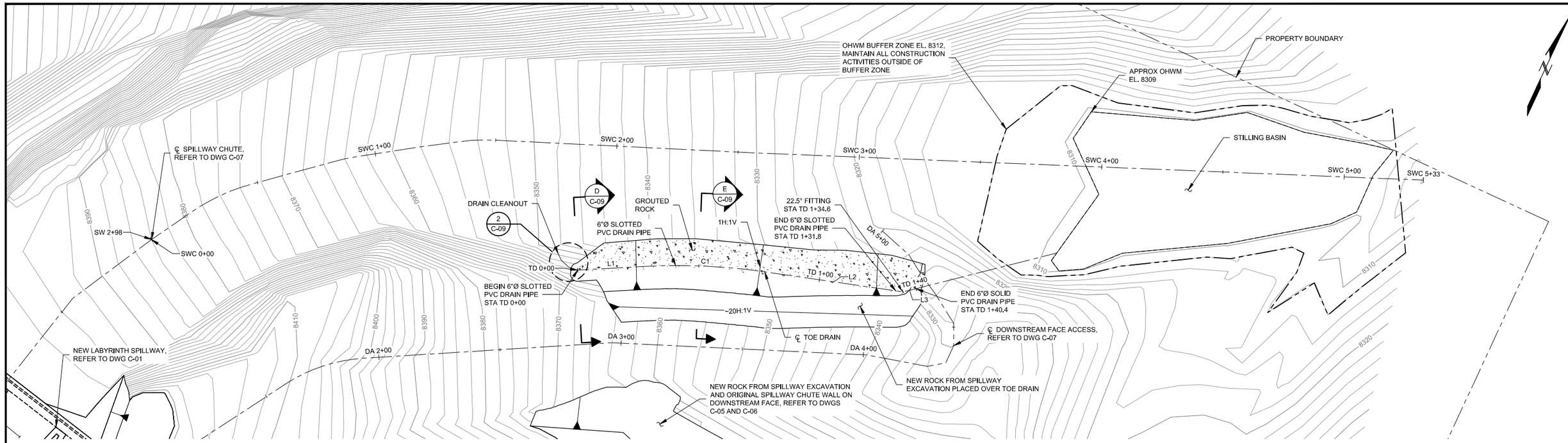
Upper Beaver Brook Spillway Improvements Project

SPILLWAY CHUTE AND DOWNSTREAM ACCESS PROFILES

DWG. NO. C-07

SHEET NO. 13 of X

P:\1327820 - Upper Beaver Brook\Civil\Production Drawings\Working Drawings\ C-07 - Spillway Chute and Downstream Access Profiles.dwg Sep 09, 2015 kprice



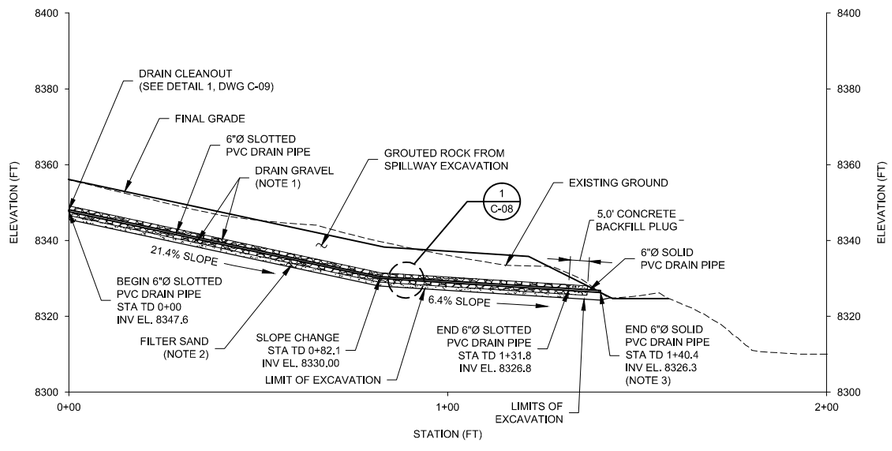
PLAN
TOE DRAIN AND SPILLWAY CHUTE WALL FILL

0 20 40
SCALE, FEET

Toe Drain CL					
Number	Start Northing	Start Easting	Length	Line/Chord Direction	Radius
L1	2493.39	4825.09	27.46'	N62°01'52"E	
C1	2506.27	4849.35	49.82'	N67° 44' 23.67"E	250.00'
L2	2525.11	4895.38	57.63'	N73°26'55"E	
L3	2541.52	4950.62	5.44'	N50°58'08"E	

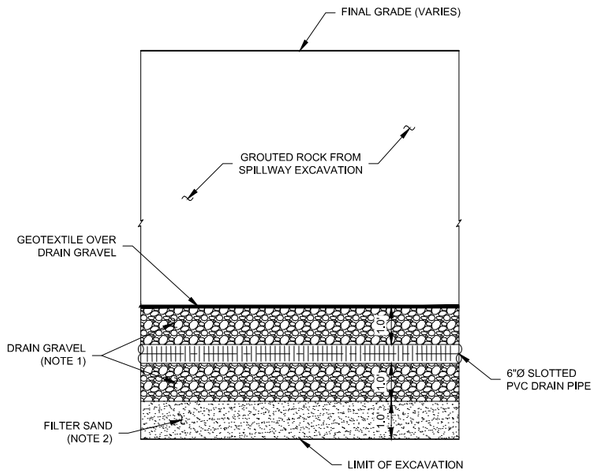
NOTES:

1. MINIMUM 1-INCH-THICK DRAIN GRAVEL SHALL SURROUND THE PVC DRAIN PIPE ON ALL SIDES.
2. MINIMUM 1-INCH-THICK SAND FILTER SHALL BE PLACED BELOW THE DRAIN GRAVEL IF THE DRAIN GRAVEL DOES NOT REST ON BEDROCK.
3. ADD SCREEN AT PIPE OUTFALL TO KEEP OUT SMALL RODENTS.



PROFILE
TOE DRAIN

0 20 40
SCALE, FEET



DETAIL 1 C-08
TOE DRAIN

0 2 4
SCALE, FEET

90% DESIGN DRAWINGS

NO.	DATE	ISSUE/REVISION	APP
0	02/09/15	60% DESIGN DRAWNINGS	CMM

Attention: 0 1" — If this scale bar does not measure 1" then drawing is not original scale.

DRAFT

Designed: J. HEITLAND
Checked: NAME
Drawn: J. HEITLAND
Approved By: C. MASCHING
Approval Date: DATE

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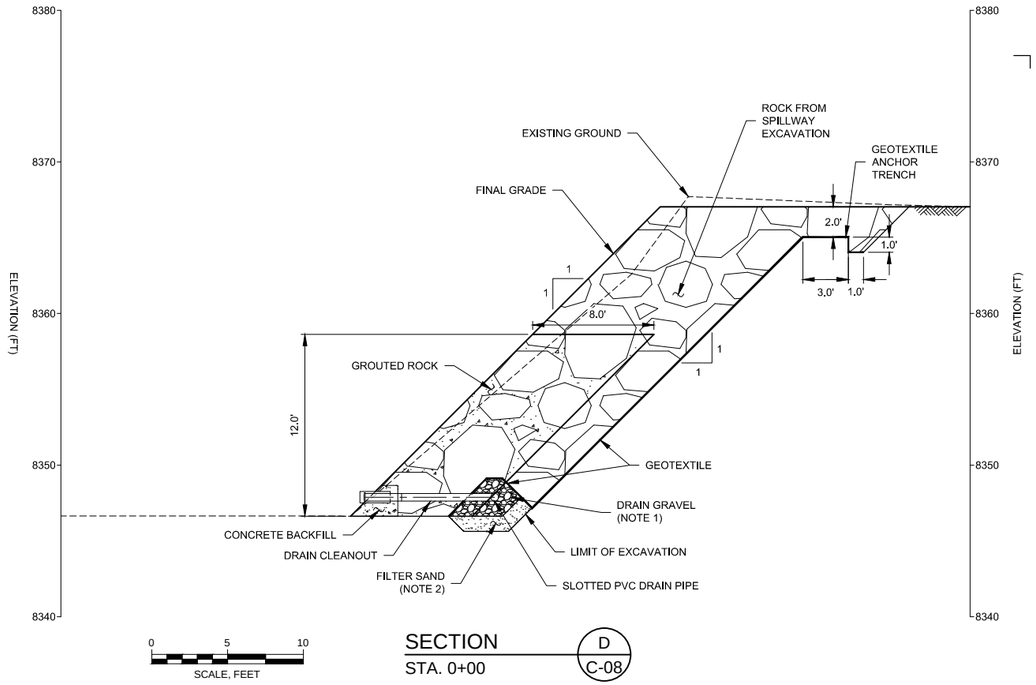
Upper Beaver Brook Spillway Improvements Project

TOE DRAIN PLAN AND PROFILE

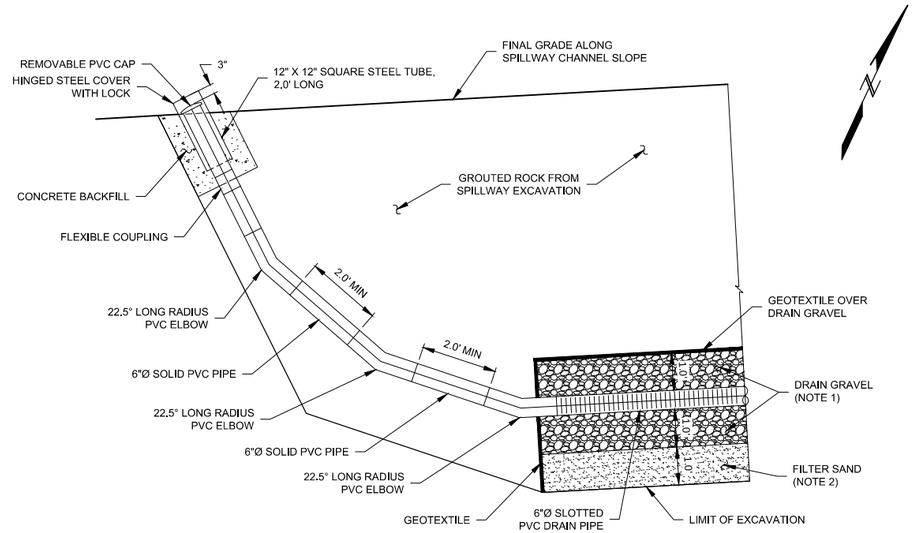
DWG. NO. C-08

SHEET NO. 14 of X

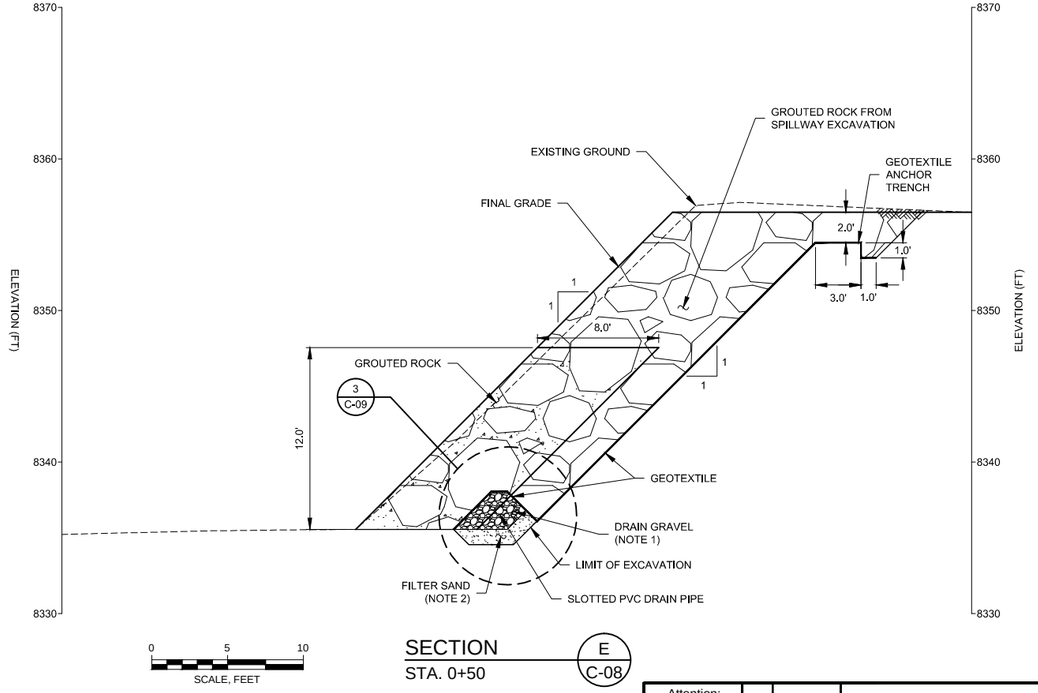
P:\1327820 - Upper Beaver Brook\Civil\Production Drawings\Working Drawings\C-08 - Toe Drain Plan and Profile.dwg Sep 18, 2015 kprice



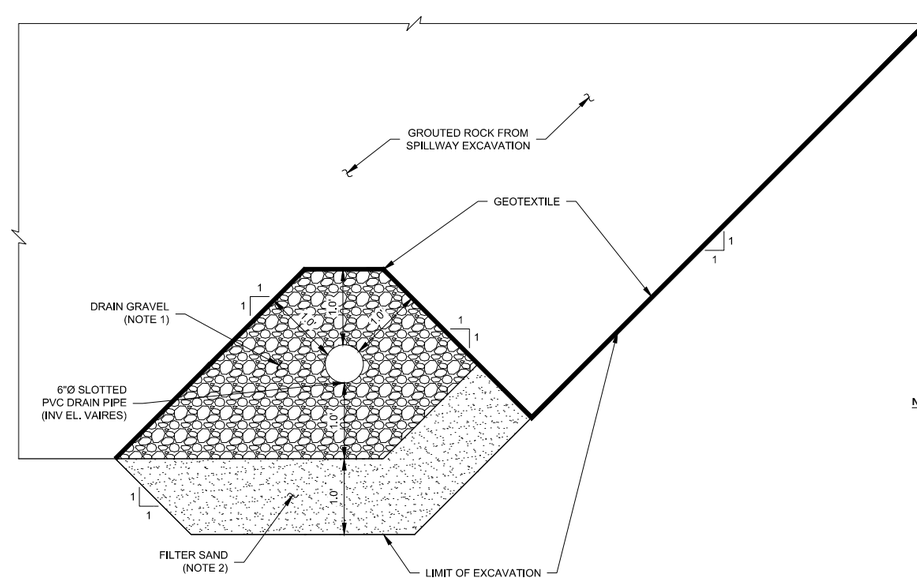
SECTION D / C-08
STA. 0+00



DETAIL 2 / C-08
DRAIN CLEANOUT



SECTION E / C-08
STA. 0+50



DETAIL 3 / C-09
TOE DRAIN TRENCH

NOTES:

1. MINIMUM 1-INCH-THICK DRAIN GRAVEL SHALL SURROUND THE PVC DRAIN PIPE ON ALL SIDES.
2. MINIMUM 1-INCH-THICK SAND FILTER SHALL BE PLACED BELOW THE DRAIN GRAVEL IF THE DRAIN GRAVEL DOES NOT REST ON BEDROCK.

90% DESIGN DRAWINGS

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NO.	DATE	ISSUE/REVISION	APP
0	02/09/15	60% DESIGN DRAWNINGS	CMM

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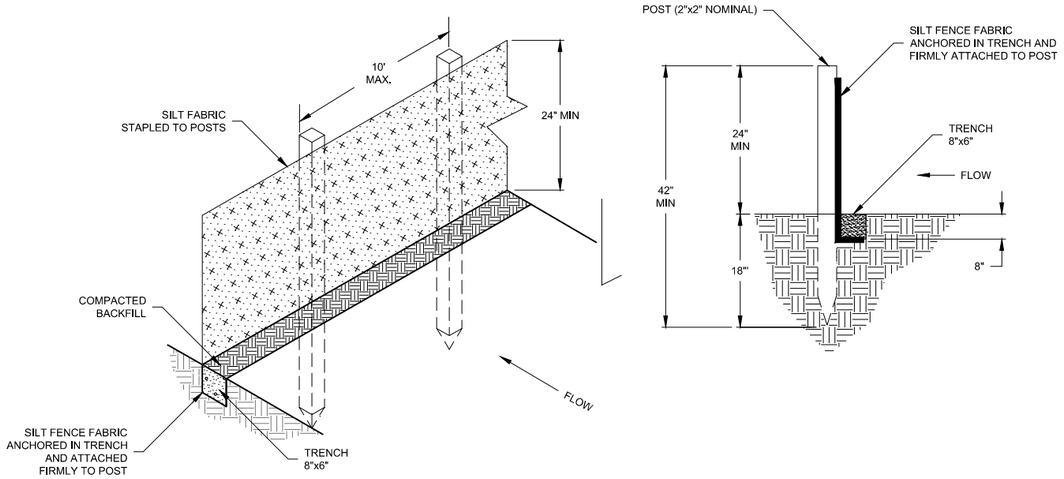
Upper Beaver Brook Spillway Improvements Project

TOE DRAIN SECTIONS AND DETAILS

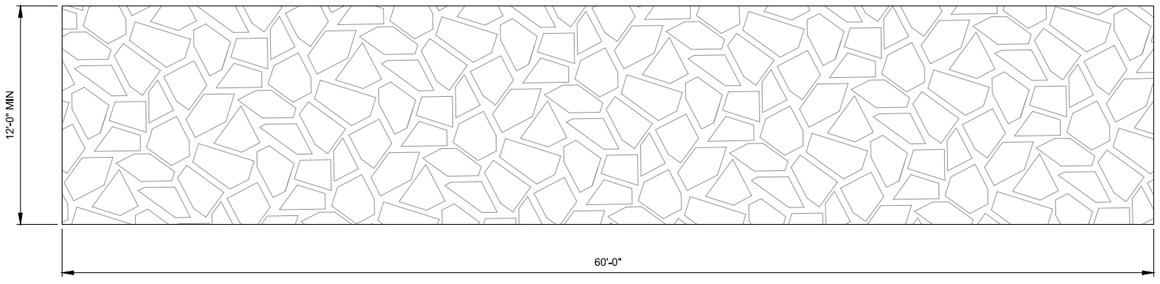
DWG. NO. C-09

SHEET NO. 15 of X



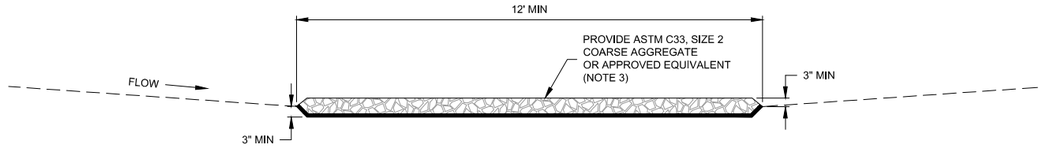
DETAIL

SILT FENCE
NTS



PLAN

STABILIZED CONSTRUCTION ENTRANCE
(NOTE 3)
NTS



SECTION

STABILIZED CONSTRUCTION ENTRANCE
(NOTE 3)
NTS

NOTES:

1. SEE DWG G-04 FOR TEMPORARY CONTROLS PLAN.
2. REFER TO SPECIFICATION SECTION 02254 - TEMPORARY EROSION CONTROL.
3. STABILIZED CONSTRUCTION ENTRANCE TO BE 60' LONG OR AS REQUIRED BY CONTRACTING OFFICER.

90% DESIGN DRAWINGS

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0	02/09/15	60% DESIGN DRAWINGS	CMM

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GEI Project 1327820

Upper Beaver Brook Spillway Improvements Project

TEMPORARY CONTROL DETAILS

DWG. NO. C-10

SHEET NO. X of X

CONCRETE NOTES

1. GENERAL:
- 1.1. ALL WORK SHALL CONFORM WITH ACI 301, LATEST EDITION, UNLESS NOTED OTHERWISE IN DRAWINGS OR PROJECT SPECIFICATIONS.
- 1.2. DETAIL BARS IN ACCORDANCE WITH THE LATEST EDITIONS OF PUBLICATION SP-66: "ACI DETAILING MANUAL" WITH ADDED REQUIREMENTS OF THE PROJECT SPECIFICATION AND ACI 318: "BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE."

2. DIMENSIONS:
- 2.1. DIMENSIONS ARE TO THE CENTERLINES OF THE BARS UNLESS OTHERWISE SHOWN. CLEAR COVER DIMENSIONS ARE MARKED "CLR" ALL DIMENSIONS TO A JOINT ARE TO THE CENTERLINE OF THE JOINT. BEAMS, COLUMNS, AND WALLS ARE CENTERED ON REFERENCED LINES.
- 2.2. THICKNESS SHOWN FOR WALLS AND SLABS ADJACENT TO UNDISTURBED SOIL OR ROCK ARE MINIMUM DIMENSIONS.

3. STRUCTURAL CONCRETE MIX REQUIREMENTS:
- 3.1. SEE SECTION 03 05 00
  - 3.1.1 LABYRINTH WALL: F'c = 6,000 PSI @ 28 DAYS
  - 3.1.2 MUD MAT: F'c = 2,000 PSI @ 28 DAYS
  - 3.1.3 ALL ELSE: F'c = 4,500 PSI @ 28 DAYS

4. NON-SHRINK GROUT:
- 4.1. CONFORM TO ASTM C1107, GRADES B, OR C.
- 4.2. ACHIEVE 6000 PSI COMPRESSIVE STRENGTH AT 28 DAYS.

5. FINISHING AND CONCRETE TOLERANCES:
- 5.1. REFER TO SPECIFICATIONS FOR REQUIREMENTS AND CONSTRUCTION TOLERANCES FOR HYDRAULIC STRUCTURES.
- 5.2. FINISH SURFACES FOR ALL SLABS, WALLS, CONSTRUCTION AND CONTROL JOINTS SHALL BE PROVIDED IN ACCORDANCE WITH THE SPECIFICATIONS.
- 5.3. UNLESS OTHERWISE INDICATED, CHAMFER EDGES OF ALL PERMANENTLY EXPOSED CONCRETE SURFACES WITH A 45 DEGREE BEVEL, 3/4 INCH X 3/4 INCH. CHAMFER STRIP MAY NOT BE SHOWN ON THE DESIGN DRAWINGS.

6. CONSTRUCTION/CONTROL JOINTS:
- 6.1. SUBMIT DRAWINGS SHOWING CONSTRUCTION AND CONTROL JOINT LOCATIONS ALONG WITH THE SEQUENCE OF POURS. CONSTRUCTION JOINT LOCATIONS AND CASTING SEQUENCE SHALL BE ARRANGED TO MINIMIZE THE EFFECTS OF ELASTIC AND LONG-TERM SHORTENING/SHRINKAGE. NO OTHER JOINTS SHALL BE INTRODUCED UNLESS APPROVED BY THE ENGINEER BEFORE CONCRETE IS PLACED.
- 6.2. CONSTRUCTION JOINT LOCATION AND CASTING SEQUENCE SHOWN ON THE DRAWINGS IS SUGGESTED AND HAS BEEN ARRANGED TO MINIMIZE THE EFFECTS OF ELASTIC AND LONG-TERM SHORTENING. SUBMIT DRAWINGS SHOWING PROPOSED CONSTRUCTION JOINT LOCATION AND CASTING SEQUENCE.
- 6.3. CONSTRUCTION JOINTS IN SLABS SHALL BE LOCATED TO ACCOMMODATE THE MAXIMUM LENGTH AND AREA THE CONTRACTOR CAN REASONABLY POUR, FINISH, AND JOINT IN THE SAME DAY, BUT SHALL NOT EXCEED A LENGTH OF 150 FEET WITH A MAXIMUM AREA OF 15,000 SQUARE FEET UNLESS APPROVED BY THE ENGINEER.
- 6.4. SHEAR FRICTION JOINTS: WHERE CONSTRUCTION JOINTS ARE LABELED AS "ROUGHENED" ON THE DRAWINGS, THE ENTIRE JOINT SURFACE SHALL BE MECHANICALLY ROUGHENED TO A 1/4" AMPLITUDE AND THOROUGHLY CLEANED. EXPOSE THE COURSE AGGREGATE IN THE HARDENED CONCRETE AND REMOVE ALL LOOSE MATERIAL.

7. PLAIN DOWELS:
- 7.1. DOWELS INDICATED ON THE DRAWING SUCH AS #8 (P.D.), ACROSS CONTROL JOINTS SHALL BE PLAIN REINFORCING BARS OF THE BAR DIAMETER INDICATED. PLAIN DOWELS SHALL BE A MINIMUM OF 36 INCHES LONG WITH EQUAL LENGTH EXTENDING ON EITHER SIDE OF THE CONTROL JOINT. IMMEDIATELY BEFORE THE SECOND CONCRETE PLACEMENT, THE PROJECTING HALF OF THE DOWEL SHALL BE GREASED TO PREVENT BOND TO THE CONCRETE.

8. DETAILING:
- 8.1. UNLESS OTHERWISE SHOWN, FOLLOW THE RECOMMENDATIONS OF ACI 315. NO CHANGES SHALL BE MADE WITHOUT PRIOR APPROVAL.

9. REINFORCING FABRICATION:
- 9.1. EMBEDMENT AND SPLICE LENGTHS:
  - 9.1.1. NO SPLICING OF REINFORCEMENT PERMITTED EXCEPT AS NOTED ON DRAWINGS. MAKE BARS CONTINUOUS AROUND CORNERS. WHERE PERMITTED, SPLICES MAY BE MADE BY CONTACT LAPS OR MECHANICAL CONNECTORS.
  - 9.1.2. SPLICES ARE TO BE MADE SO THAT GIVEN CLEAR DISTANCES TO THE FACE OF CONCRETE WILL BE MAINTAINED.
  - 9.1.3. UNLESS OTHERWISE SHOWN ON THE DRAWINGS, THE MINIMUM LENGTHS FOR EMBEDMENT AND LAP SPLICES FOR PARALLEL BARS SHALL BE AS GIVEN IN THE SCHEDULE.
  - 9.1.4. SEE 'LAP SPLICE AND DEVELOPMENT LENGTH SCHEDULE' FOR LAP AND EMBEDMENT LENGTHS.
- 9.2. MISCELLANEOUS REINFORCING REQUIREMENTS:
  - 9.2.1. PROVIDE ADDITIONAL BARS OR STIRRUPS REQUIRED TO SECURE REINFORCING IN PLACE DURING CONCRETE PLACEMENT.
  - 9.2.2. MAKE ALL REINFORCING BAR BENDS IN THE FABRICATOR'S SHOP UNLESS NOTED.
  - 9.2.3. NO WELDING OF REINFORCING PERMITTED UNLESS NOTED ON DRAWINGS. WHERE PERMITTED, PERFORM WELDING IN ACCORDANCE WITH AWS D1.4, LATEST EDITION.
  - 9.2.4. PROVIDE ADDED REINFORCING TO TRIM ALL OPENINGS, NOTCHES, AND REENTRANT CORNERS AS NOTED IN TYPICAL DETAILS.

10. SPACING:
- 10.1. THE FIRST AND LAST BARS IN SLABS AND WALLS, AND STIRRUPS IN BEAMS ARE TO START AND END AT A MAXIMUM OF ONE HALF THE ADJACENT BAR SPACING. ALL REINFORCING TO BE EQUALLY SPACED UNLESS OTHERWISE SHOWN ON THE DRAWINGS.

11. REINFORCING MATERIALS:
- 11.1. SEE SECTION 03 20 00.
- 11.2. PLACE REINFORCEMENT IN ACCORDANCE WITH APPROVED REINFORCEMENT SHOP DRAWINGS. IN THE EVENT OF A CONFLICT BETWEEN THESE DRAWINGS AND THE APPROVED SHOP DRAWINGS, THE APPROVED SHOP DRAWINGS SHALL GOVERN.
- 11.3. REINFORCEMENT PROTECTION:
  - 11.3.1. SEE "REINFORCING STEEL REINFORCING COVER SCHEDULE" FOR REINFORCING COVER.
  - 11.3.2. SEE ACI 318-11 7.5 AND ACI 301, SECTION 6.3 FOR REINFORCEMENT PLACING TOLERANCES AND ACI 117 FOR ADDITIONAL REQUIREMENTS
- 11.4. PROVIDE ACCESSORIES NECESSARY TO PROPERLY SUPPORT REINFORCING AND WELDED WIRE FABRIC AT POSITIONS SHOWN ON PLANS. THE RECOMMENDATIONS OF ACI 315 (DETAILING MANUAL) SHALL BE USED IN SELECTING ACCESSORIES.
- 11.5. ALL REINFORCING, DOWELS, BOLTS, AND EMBEDDED PLATES SHALL BE SET AND TIED IN PLACE BEFORE THE CONCRETE IS POURED. "STABBING" INTO PREVIOUSLY PLACED CONCRETE IS NOT PERMITTED.
- 11.6. BEFORE PLACING CONCRETE, CHECK ALL APPLICABLE DRAWINGS RELEASED AS SUITABLE FOR CONSTRUCTION INCLUDING MANUFACTURER'S DRAWINGS TO VERIFY THE PRESENCE OF ALL EMBEDDED MATERIAL REQUIRED IN THE PLACEMENT.
- 11.7. REINFORCEMENT MAY BE ADJUSTED IN THE FIELD TO CLEAR FORM TIES AND ANCHOR BARS. IN SUCH CASES, RELOCATION OF THE EMBEDDED MATERIALS MUST BE CONSIDERED. IN NO CASE SHOULD BARS BE BENT IN THE FIELD.
- 11.8. WHERE POSSIBLE, REINFORCEMENT SHALL BE PLACED TO MAINTAIN A CLEAR DISTANCE OF AT LEAST 1 INCH BETWEEN OTHER REINFORCEMENT, ANCHOR BOLTS, FORM TIES, OR OTHER EMBEDDED METALWORK. REINFORCEMENT PARALLEL TO ANCHOR BOLTS OR OTHER EMBEDDED METAL WORKS SHALL BE PLACED TO MAINTAIN A CLEAR DISTANCE OF AT LEAST 1-1/3 TIMES THE MAXIMUM SIZE AGGREGATE TO BE USED.

12. REINFORCEMENT SYMBOLS:

○—— AN OPEN CIRCLE AT THE END OF A BAR INDICATES A BEND WITH THE BAR TURNED FROM THE OBSERVER.

●—— AN OPEN CIRCLE AT THE END OF A BAR INDICATES A BEND WITH THE BAR TURNED FROM THE OBSERVER.

SPLICES SHOW THUS —‖— INDICATE A LAPPED SPLICE, NOT A BEND IN THE BAR.

TYPICAL REINFORCING INFORMATION

LAP SPLICE AND DEVELOPMENT LENGTH SHCEDULE (INCHES)

BAR SIZE (US)	BAR DIAMETER	F'c = 4500 PSI							F'c = 6000 PSI						
		COMP		TENSION					COMP		TENSION				
		LCE	LCS	LDH	LTE TOP	LTE	LTS TOP	LTS	LCE	LCS	LDH	LTE TOP	LTE	LTS TOP	LTS
#3	0.375	8	12	6	17	13	23	17	8	12	6	15	12	20	16
#4	0.500	9	15	6	23	17	30	23	9	15	6	20	15	26	20
#5	0.625	11	18	8	29	22	38	29	11	18	7	25	19	33	25
#6	0.750	13	22	9	34	26	45	35	13	22	8	30	23	39	30
#7	0.875	15	26	11	50	39	66	51	15	26	9	43	33	57	44
#8	1.000	18	30	13	58	44	76	58	18	30	11	50	38	65	50
#9	1.128	20	33	14	65	50	85	66	20	33	12	56	43	74	57
#10	1.270	22	38	16	73	56	96	74	22	38	14	63	49	83	64
#11	1.410	25	42	18	82	63	107	82	25	42	15	70	54	92	71

GENERAL NOTES:
1. 'LCE' COMPRESSION EMBEDMENT LENGTH, 'LCS' = COMPRESSION LAP SPLICE LENGTH,'LDH' = HOOK DEVELOPMENT LENGTH, 'LTE' = TENSION EMBEDMENT LENGTH, 'LTS' TENSION LAP SPLICE LENGTH
2. 'TOP' BARS ARE HORIZONTAL BARS PLACED WITH MORE THAN 12 INCHES OF FRESH CONCRETE IS CAST BELOW THE BAR
3. UNLESS NOTED OTHERWISE, ALL HOOK BARS EXTEND TO THE FAR FACE (LESS COVER)

LAP SPLICE NOTES:
1. ALL SPLICES SHALL BE WIRED IN CONTACT AND STACKED VERTICALLY
2. ALL SPLICE ARE 'LTS' UNLESS NOTED OTHERWISE
3. SMALLER BAR LAP LENGTH SHALL BE USED WHEN SPLICING DIFFERENT SIZED BARS
4. LAP LENGTHS SPECIFICALLY DETAILED ON DRAWINGS SHALL GOVERN IN LIEU OF LAP LENGTHS SCHEDULE
5. BUNDLED BAR SPLICES:
   - 5.1. INDIVIDUAL BAR SPLICES WITHIN THE BUNDLE SHALL BE STAGGERED
   - 5.2. INCREASE LAP LENGTH 20% FOR A 3 BAR BUNDLE
   - 5.3. INCREASE LAP LENGTH 33% FOR A 4 BAR BUNDLE

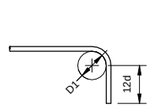
ADJUSTMENTS FOR GIVEN LAP LENGTHS:
1. SCHEDULED LAP LENGTHS ASSUME:
   - 1.1. CLEAR COVER IS GREATER THAN BAR DIAMETER, AND NOT LESS THAN 3/4"
   - 1.2. CLEAR SPACING BETWEEN BARS IS GREATER THAN 2 BAR DIAMETERS
   - 1.3. IF EITHER CONDITION 1.1. OR 1.2. IS NOT MET FOR A GIVEN BAR, INCREASE LENGTHS BY 50%
2. SPLICE LENGTHS NOTED BASED ON Fy = 60,000 PSI. FOR OTHER YIELD STRENGTHS, MULTIPLY SPLICE LENGTHS NOTED BY Fy/60,000

HOOK EMBEDMENT NOTES:
1. SCHEDULED HOOK EMBEDMENT LENGTHS ASSUME:
   - 1.1. SIDE COVER IS 2 1/2 INCHES OR GREATER
   - 1.2. COVER BEYOND IS 2 INCHES OR GREATER
2. IF SIDE COVER IS LESS THAN 2 1/2 INCHES, INCREASE LENGTHS BY 40%

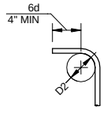
STEEL REINFORCING COVER SCHEDULE

CONCRETE SECTION	MINIMUM CLEAR COVER
UNIFORM SURFACE IN CONTACT WITH FOUNDATION	4 INCHES
FORMED SURFACES SUCH AS SPILLWAY SLAB AND WALL	
≥ 24 INCH THICKNESS	4 INCHES
> 12 INCHES AND < 24 INCHES IN THICKNESS	3 INCHES
≤ 12 INCHES IN THICKNESS CAST AGAINST AND PERMANENTLY EXPOSED TO EARTH	3 INCHES
≤ 12 INCHES CONCRETE EXPOSED EARTH AND WEATHER	
#6 THROUGH #18 BARS	2 INCHES
#3 THROUGH #5	1 1/2 INCHES

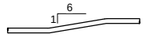
TYPICAL REINFORCING BENDS



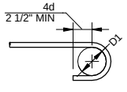
PRINCIPAL REINFORCING 90° HOOK



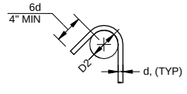
#3-#5 90° HOOK STIRRUPS ONLY



MAX OFFSET BEND



PRINCIPAL REINFORCING 180° HOOK



#3-#8 135° HOOK TIE OR STIRRUPS

D1		D2	
#3 - #8	6d	#3 - #5	4d
#9 - #11	8d	#6 - #8	6d
		#9 - #11	8d

NOTES:
1. ALL BENDS SHALL BE MADE COLD

ROCK ANCHOR NOTES

1. GENERAL:
- 1.1. FINAL ANCHOR DETAILS, INCLUDING HOLE DIAMETER, BEARING PLATE, AND STEEL SLEEVE SHALL BE CONTRACTOR'S RESPONSIBILITY IN ACCORDANCE WITH SPECIFICATION 31 52 00.
- 1.2. ROCK ANCHORS MAY BE RELOCATED UP TO 1'-0" IN ANY DIRECTION TO EASE WALL AND SLAB CONSTRUCTION AT CONTRACTOR'S OPTION.

90% DESIGN DRAWINGS

NO.	DATE	ISSUE/REVISION	APP
0	12/31/14	60% DESIGN DRAWNINGS	CMM

Attention:

0 1"

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DRAFT

Designed: MLK & RLP
Checked: S. ELVER
Drawn: R. PRICE
Approved By: C. MASCHING
Approval Date: 12/31/2014

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GEI PROJECT: 1327820

Upper Beaver Brook Spillway Improvement Projects

DWG. NO. S-01

CONCRETE AND REINFORCING NOTES

SHEET NO.

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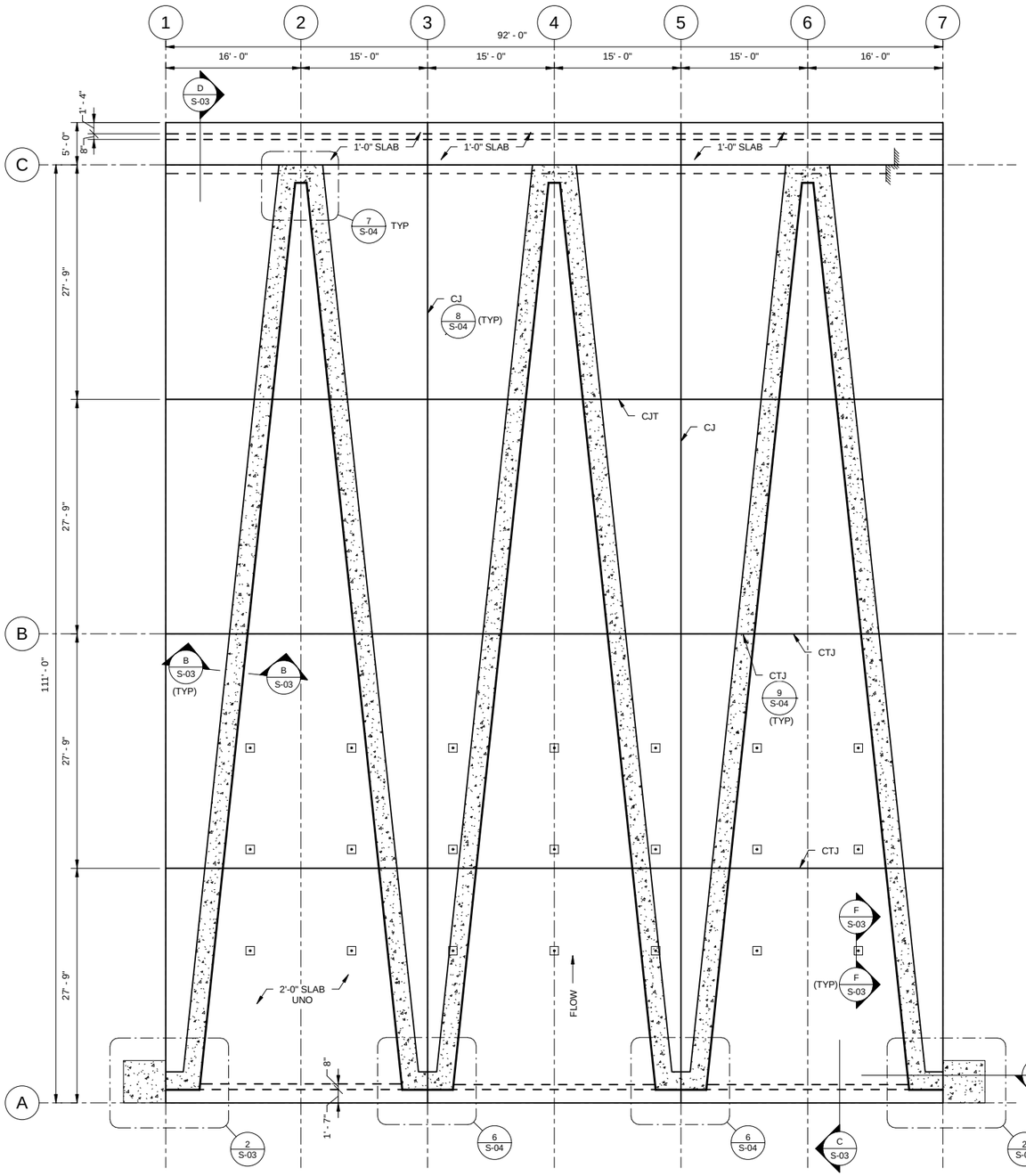
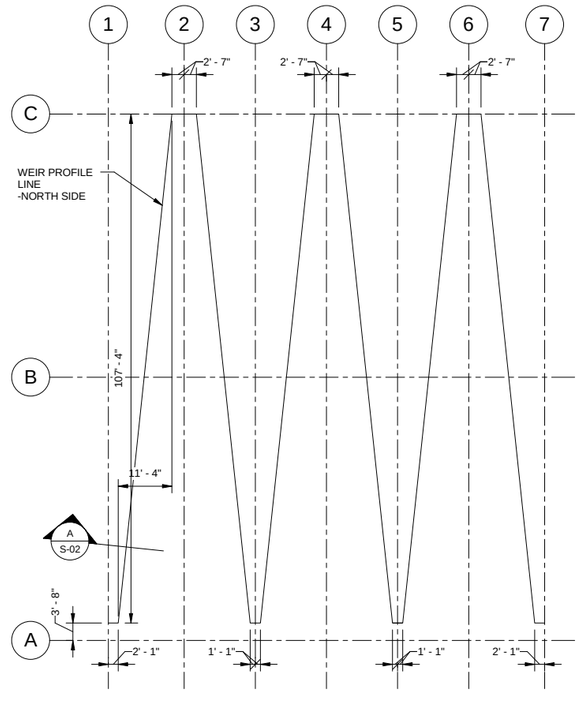


PLAN

SPILLWAY PLAN

0 4 8 16

1/8" = 1'-0"

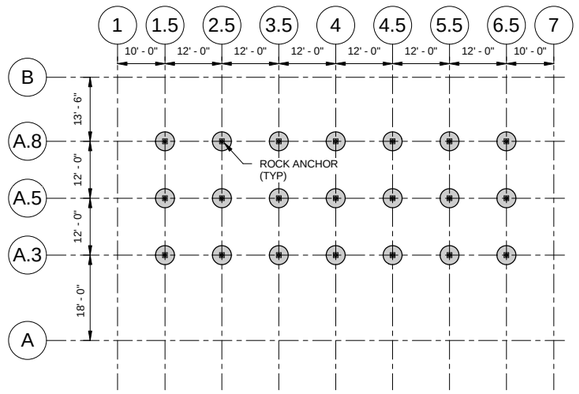


PLAN

WIER LAYOUT

0 8 16 32

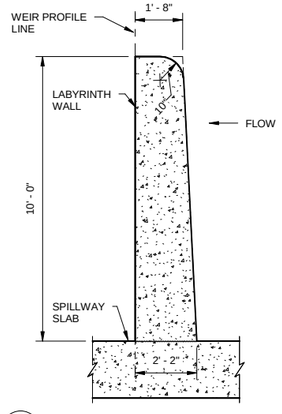
1/16" = 1'-0"



PLAN

ROCK ANCHOR LAYOUT

NOT TO SCALE



TYPICAL

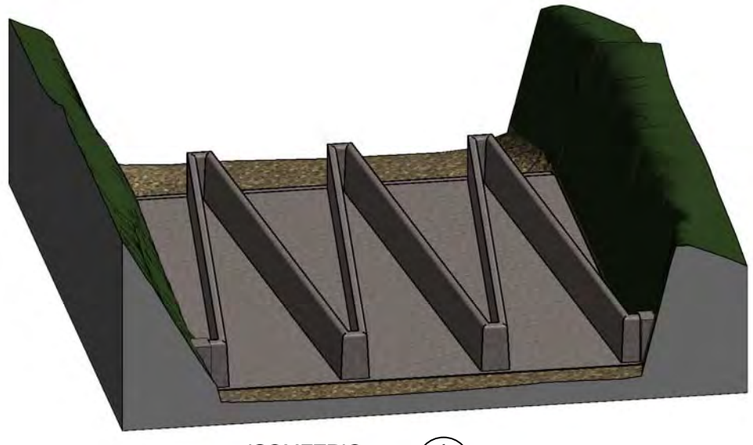
SECTION

LABYRINTH WALL PROFILE

A
S-02

0 2 4 8

3/8" = 1'-0"



ISOMETRIC

WIER ISOMETRIC

1
S-02

90% DESIGN DRAWINGS

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0	12/31/14	60% DESIGN DRAWNINGS	CMM

Attention:

0 1"

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DRAFT

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Checked: S. ELVER
Drawn: R. PRICE
Approved By: C. MASCHING
Approval Date: 12/31/2014

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GEI PROJECT: 1327820

Upper Beaver Brook Spillway Improvement Projects

DWG. NO. S-02

SPILLWAY PLANS

SHEET NO.

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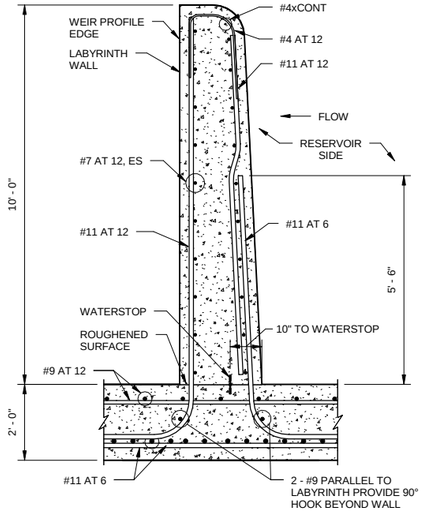
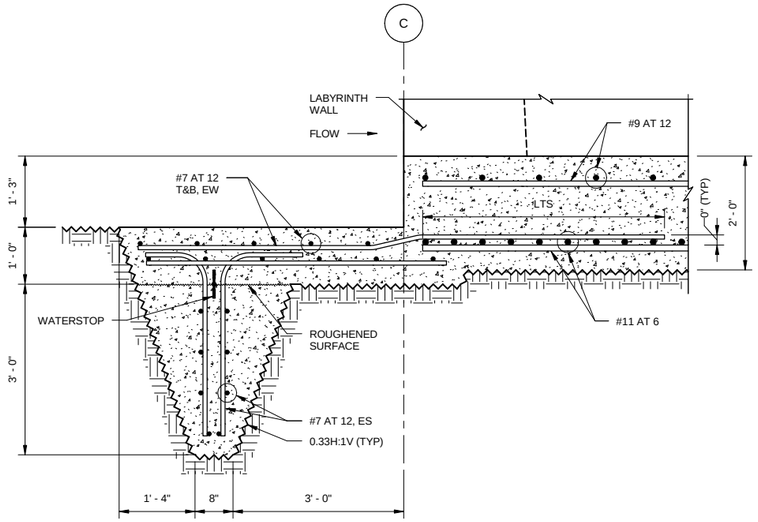


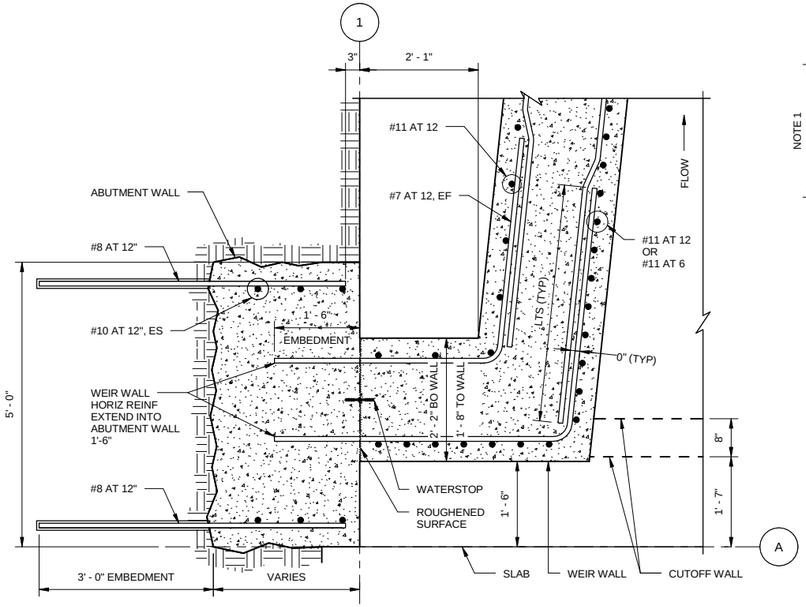
SECTION
TYP WALL AND SLAB REINFORCING
B
S-02

0 1 2 4
1/2" = 1'-0"



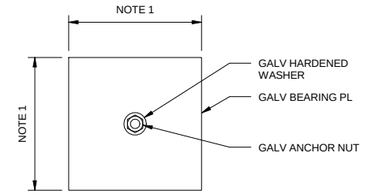
SECTION
DOWNSTREAM SLAB EDGE
D
S-02

0 1 2 4
3/4" = 1'-0"



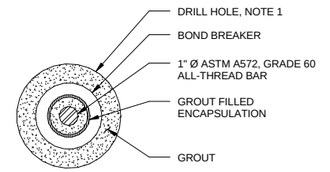
DETAIL
WEIR TO ROCK WALL CONNECTION 2
2
S-02

0 1 2 4
3/4" = 1'-0"



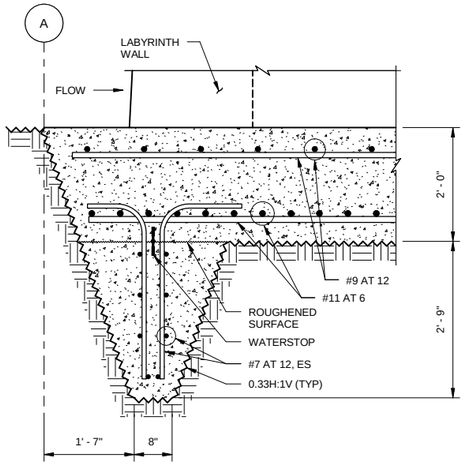
DETAIL
BEARING PLATE
3
S-03

0 1/2 1 2
1 1/2" = 1'-0"



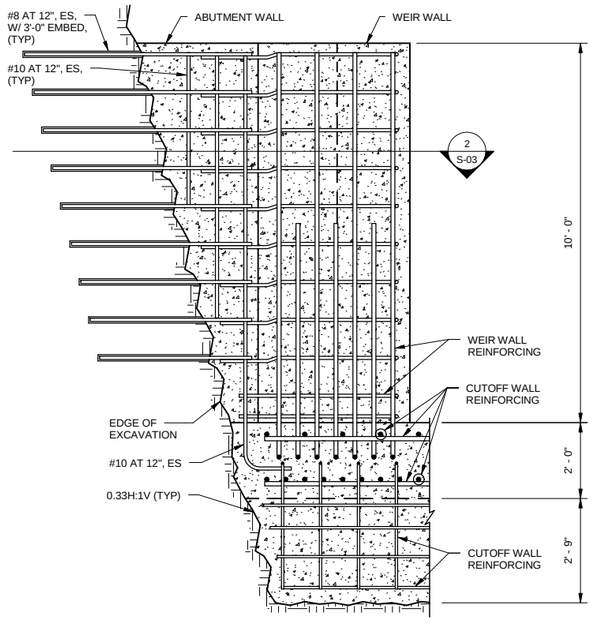
DETAIL
FREE STRESS LENGTH
4
S-03

0 1/4 1/2 1
3" = 1'-0"



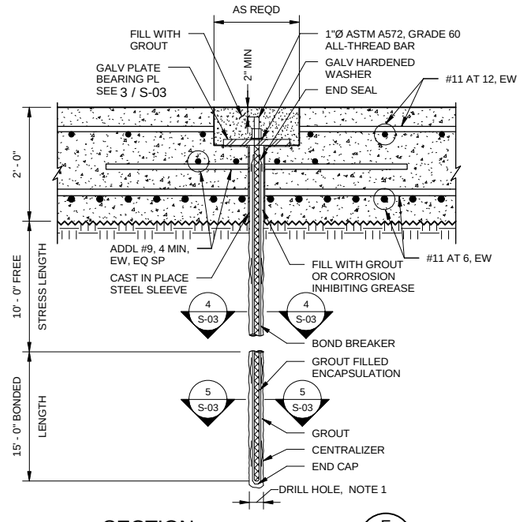
SECTION
UPSTREAM SLAB EDGE
C
S-02

0 1 2 4
3/4" = 1'-0"



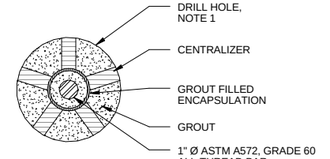
SECTION
WEIR TO ROCK WALL CONNECTION
E
S-02

0 1 2 4
1/2" = 1'-0"



SECTION
TYPICAL ROCK ANCHOR
F
S-02

0 1 2 4
3/4" = 1'-0"



DETAIL
BONDED LENGTH
5
S-03

0 1/4 1/2 1
3" = 1'-0"

NOTES:

1. FINAL ANCHOR DETAILS, INCLUDING HOLE DIAMTER, BEARING PLATE, AND STEEL SLEEVE SHALL BE CONTRACTOR RESPONSIBILITY IN ACCORDANCE WITH SPECIFICATION 31 52 00: ROCK ANCHOR.

90% DESIGN DRAWINGS

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GEI PROJECT: 1327820

Upper Beaver Brook Spillway Improvement Projects

DWG. NO. S-03

SPILLWAY SECTION AND DETAILS

SHEET NO.

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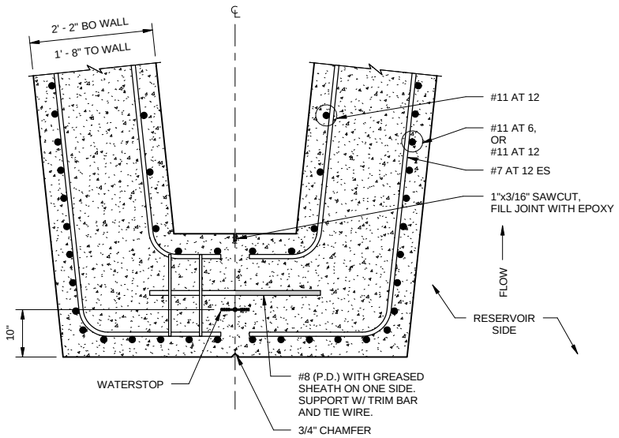
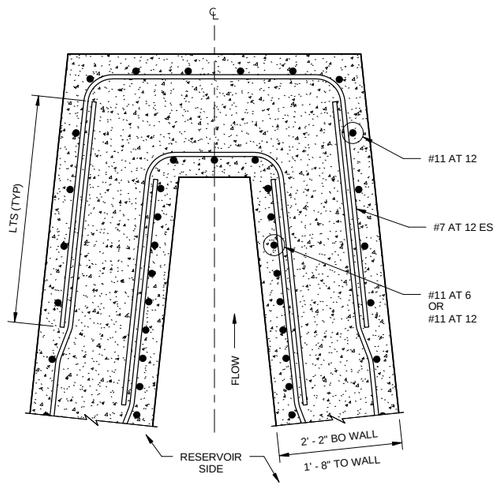


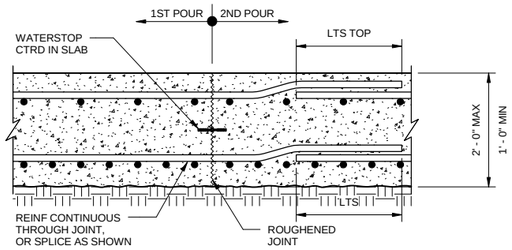
DETAIL 6 / S-02
UPSTREAM WALL REINFORCING AND CONTROL JOINT

0 1 2 4
3/4" = 1'-0"

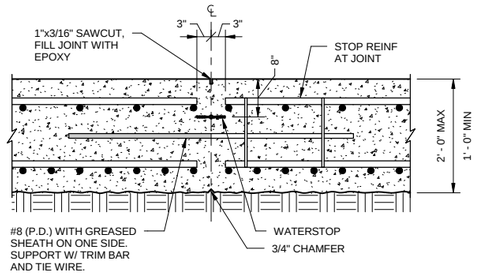


DETAIL 7 / S-02
DOWNSTREAM WALL REINFORCING

0 1 2 4
3/4" = 1'-0"



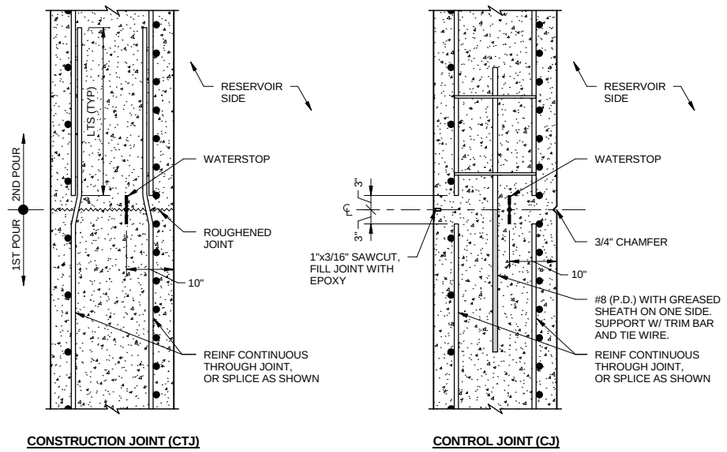
CONSTRUCTION JOINT (CTJ)



CONTROL JOINT (CJ)

DETAIL 8 / S-02
CONCRETE SLAB JOINTS

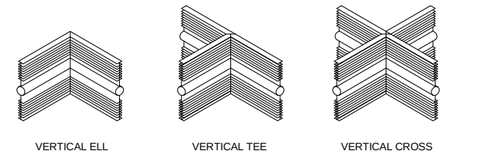
NOT TO SCALE



CONSTRUCTION JOINT (CTJ) **CONTROL JOINT (CJ)**

DETAIL 9 / S-02
CONCRETE CONTROL JOINT - WALL

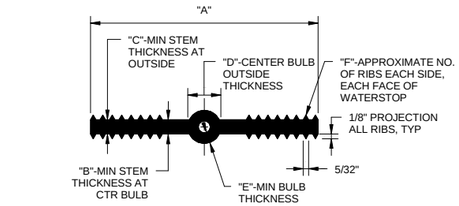
NOT TO SCALE



NOTES:
1. ALL FIELD WELDS SHALL BE MADE PER WATERSTOP MANUFACTURER'S RECOMMENDATIONS. ENGINEER SHALL INSPECT ALL FIELD WELDS FOR ACCEPTANCE PRIOR TO CONCRETE PLACEMENT OR WALL FORM PLACEMENT.
2. USE 6 INCH WATERSTOPS IN ALL CONSTRUCTION JOINTS UNLESS SPECIFICALLY SHOWN OTHERWISE.
3. FOR WALLS WITH SINGLE MAT OF REINFORCING LOCATE WATERSTOP ON LIQUID FACE 1" CLEAR OF REINFORCEMENT.

DETAIL 10 / S-04
PCV WATERSTOPS JOINTS

NOT TO SCALE



TYPE	SIZE	"A"	"B"	"C"	"D"	"E"	"F"
1	6" x 3/8"	6"	3/8"	3/8"	7/8"	1/4"	6

WATERSTOP NOTES:
1. NON-ROUND CENTER BULBS SHALL HAVE A MINIMUM OUTSIDE DIMENSION OF 'D'.
2. BULB TYPE WATERSTOP SHOWN IS REQUIRED FOR EXPANSION AND CONTROL JOINTS. SIMILAR WATERSTOPS WITHOUT CENTER BULB MAY BE SUBSTITUTED AT CONSTRUCTION JOINTS.
3. USE 6 INCH WATERSTOPS IN ALL CONSTRUCTION JOINTS UNLESS SPECIFICALLY SHOWN OTHERWISE.
4. FOR WALLS WITH SINGLE MAT OF REINFORCING LOCATE WATERSTOP ON LIQUID FACE 1" CLEAR OF REINFORCEMENT.

DETAIL 11 / S-04
WATERSTOP

NOT TO SCALE

90% DESIGN DRAWINGS

NO.	DATE	ISSUE/REVISION	APP
0	12/31/14	60% DESIGN DRAWNINGS	CMM

Attention: If this scale bar does not measure 1" then drawing is not original scale. (0 – 1")

DRAFT

Designed: MLK & RLP
Checked: S. ELVER
Drawn: R. PRICE
Approved By: C. MASCHING
Approval Date: 12/31/2014

GEI Consultants
4601 DTC Boulevard
Denver, Colorado 80237
303-662-0100

Lookout Mountain Water District
25958 Genesee Trail Road #514
Golden, Colorado 80401

GEI PROJECT: 1327820

Upper Beaver Brook Spillway Improvement Projects

SPILLWAY SECTION AND DETAILS

DWG. NO. S-04

SHEET NO.

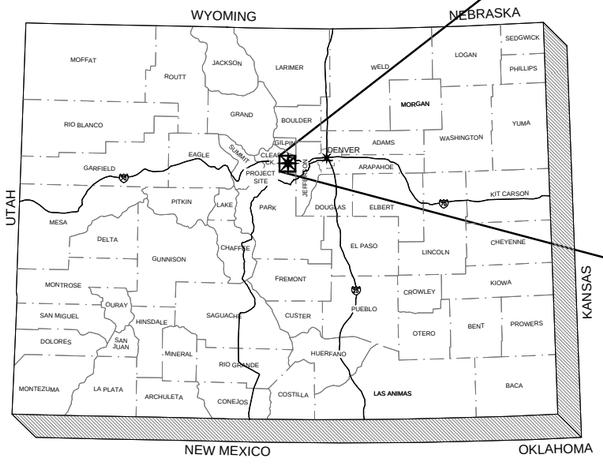
P:\1327820 - Upper Beaver Brook\Civil\Production Drawings\Working Drawings\UBB 90.rvt

Appendix D Outlet Works Rehabilitation 90% Design Drawings

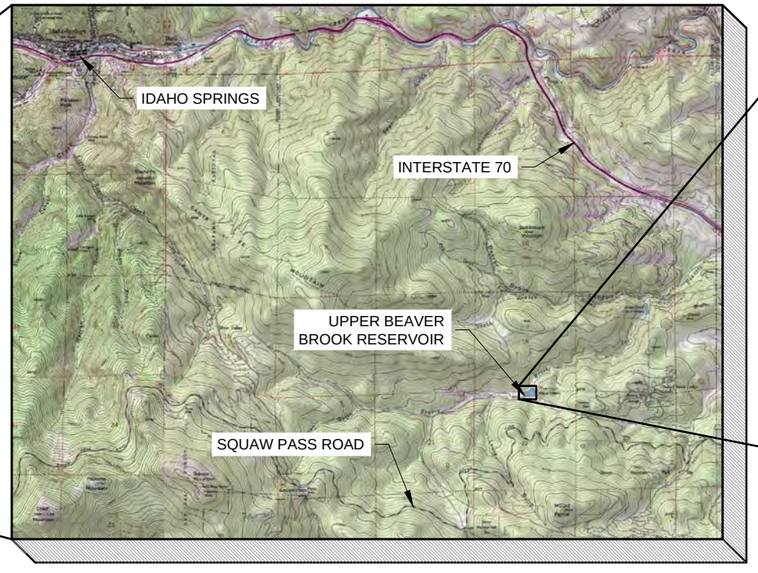
DESIGN DRAWINGS FOR

UPPER BEAVER BROOK OUTLET WORKS REHABILIATION PROJECT

LOOKOUT MOUNTAIN WATER DISTRICT
CLEAR CREEK COUNTY, COLORADO
WATER DIVISION 1, WATER DISTRICT 7
DAMID 070103



PROJECT LOCATION MAP
(NOT TO SCALE)



SITE LOCATION MAP
(NOT TO SCALE)

SITE VICINITY MAP
(NOT TO SCALE)

I HEREBY CERTIFY THAT THESE PLANS FOR THE CONSTRUCTION OF THE UPPER BEAVER BROOK OUTLET WORKS REHABILITATION PROJECT WERE PREPARED BY ME (OR UNDER MY DIRECT SUPERVISION).

CHAD M. MASCHING, P.E. COLORADO P.E. #39806
REGISTERED ENGINEER
GEI CONSULTANTS, INC.

APPROVED ON THE _____ DAY OF _____ 20____

STATE ENGINEER

WILLIAM T. MCCORMICK III, CO P.E. #29127
CHIEF - DAM SAFETY BRANCH

THESE PLANS MAY NOT BE MATERIALLY CHANGED, EXCEPT WITH THE PRIOR WRITTEN CONSENT OF THE STATE ENGINEER.

PREPARED FOR

LOOKOUT MOUNTAIN WATER DISTRICT
25958 GENESEE TRAIL ROAD #514
GOLDEN, COLORADO 80401

GOLDEN ● COLORADO

PREPARED BY

GEI Consultants
DENVER ● COLORADO

DWG. NO. G-01

SHEET NO. 1 of 6

90% DESIGN DRAWINGS

DRAWING LIST

SHEET NO.	DWG. NO.	TITLE
G-01	1	COVER SHEET
G-02	2	DRAWING LIST, GENERAL NOTES, LEGEND, AND ABBREVIATIONS
G-03	3	SITE PLAN
C-01	4	EXISTING OUTLET WORKS PLAN AND PROFILE
C-02	5	MODIFIED OUTLET WORKS PLAN AND PROFILE
C-03	6	OUTLET WORKS SECTIONS AND DETAILS

ABBREVIATIONS

AB	= ANCHOR BOLT	FH	= FLAT HEAD	O.C.	= ON CENTER
ALT	= ALTERNATE	FLG	= FLANGE	OD	= OUTSIDE DIAMETER
APPROX	= APPROXIMATE	FR	= FAR ROW	OHWM	= ORDINARY HIGH WATER MARK
BF	= BOTTOM FACE	FS	= FAR SIDE	PC	= POINT OF CURVATURE
BH	= BORE HOLE	FT	= FEET OR FOOT	PD	= PLAIN DOWELS
BL	= BOTTOM LAYER	FTG	= FOOTING	PE	= POLYETHYLENE
BOC	= BOTTOM OF CONCRETE	GALV	= GALVANIZED	PI	= POINT OF INTERSECTION
BOH	= BOTTOM OF HOLE	GR	= GRADE	P	= PLATE
BOT	= BOTTOM	HK	= HOOK	PT	= POINT OF TANGENCY
BR	= BOTTOM ROW	HM	= HOLLOW METAL	PVC	= POLYVINYL CHLORIDE
BRG	= BEARING	HORIZ	= HORIZONTAL	PL	= PROPERTY LINE
CFS	= CUBIC FEET PER SECOND	HR	= HANDRAIL	RA	= RADIUS
CJ C	= CONSTRUCTION JOINT	HS	= HIGH STRENGTH	REINF	= REINFORCEMENT
CL, L	= CENTERLINE	HSS	= HOLLOW STRUCTURAL STEEL	REQ'D	= REQUIRED
CLR	= CLEAR	HYD	= HYDRAULIC	R.O.W.	= RIGHT OF WAY
CMP	= CORRUGATED METAL PIPE	ID	= INSIDE DIAMETER	S	= SLOPE
CNTR	= CENTER	IE	= INVERT ELEVATION	SCH	= SCHEDULE
CONC	= CONCRETE	I.F.	= INSIDE FACE	SIM	= SIMILAR
CONT	= CONTINUOUS	INV	= INVERT	SPC, SPCS	= SPACE OR SPACES
CT J	= CONTRACTION JOINT	IR	= INSIDE ROW	SS	= STAINLESS STEEL
Δ	= DELTA	JT	= JOINT	SSP	= STEEL SHEETPILE
DIA, Ø	= DIAMETER	L	= CURVE LENGTH	STA	= STATION OR SPILLWAY STATION
DIAG	= DIAGONAL	LG	= LONG	STL	= STEEL
DWG, DWGS	= DRAWING OR DRAWINGS	LMWD	= LOOKOUT MOUNTAIN WATER DISTRICT	SQ	= SQUARE
DWL	= DOWEL	LP	= LOW POINT	SYM	= SYMMETRICAL
E	= EAST OR EASTING	MAX	= MAXIMUM	T&B	= TOP & BOTTOM
EA	= EACH	MIN	= MINIMUM	TBD	= TO BE DETERMINED
EC	= EACH CORNER	MH	= MANHOLE	TH	= TEST HOLE
EF	= EACH FACE	MNFR, MFR	= MANUFACTURER	THK	= THICK
EJ	= EXPANSION JOINT	NAD	= NORTH AMERICAN DATUM	T.O.	= TOP OF
EL., ELEV	= ELEVATION	NAVD	= NORTH AMERICAN VERTICAL DATUM	T.O.C.	= TOP OF CONCRETE
EQ SPC	= EQUALLY SPACED OR EQUAL SPACES	N	= NORTH OR NORTHING	T.O.W.	= TOP OF WALL
ER	= EACH ROW	NF	= NEAR FACE	TYP	= TYPICAL
ES	= EACH SIDE	NGS	= NATIONAL GEODETIC SURVEY	UBB	= UPPER BEAVER BROOK
EW	= EACH WAY	NGVD	= NATIONAL GEODETIC VERTICAL DATUM	UNC	= UNIFIED NATIONAL COARSE THREAD
EXST	= EXISTING	NO	= NUMBER	U.N.O.	= UNLESS NOTED OTHERWISE
EXT	= EXTENSION	NR	= NEAR ROW	USGS	= UNITED STATES GEOLOGICAL SURVEY
EXP	= EXPANSION	NS	= NEAR SIDE	VERT	= VERTICAL
FDN	= FOUNDATION	NTS	= NOT TO SCALE	WS	= WATER SURFACE
FF	= FAR FACE	NWS	= NORMAL WATER SURFACE	YR	= YEAR

GENERAL NOTES

1. CONSTRUCTION IS SUBJECT TO THE RULES AND REGULATIONS OF THE COLORADO STATE ENGINEER'S OFFICE (SEO). SUBSTANTIVE CHANGES TO THE APPROVED DRAWINGS AND SPECIFICATIONS MAY REQUIRE SEO APPROVAL.
2. BASIS OF PROJECT MAPPING: HORIZONTAL: _____. PROJECTION:_____. VERTICAL: _____.
3. PRIMARY SITE ACCESS TO THE DAM IS PROVIDED FROM SQUAW PASS ROAD. FROM THE INTERSECTION OF THE EVERGREEN PARKWAY AND SQUAW PASS ROAD, TRAVEL WEST ON SQUAW PASS ROAD FOR 3.6 MILES. THE TURNOFF IS ON THE RIGHT WITH PARKING AND GATE IMMEDIATELY FOLLOWING. KEYS TO THE GATE MAY BE OBTAINED FROM _____. THE RESERVOIR IS LOCATED ABOUT 0.5 MILES FROM THE SITE ENTRANCE.
4. CONTRACTOR IS RESPONSIBLE FOR DEVELOPING AND IMPLEMENTING A SEQUENCE AND SCHEDULE FOR COMPLETION OF THE WORK IN ACCORDANCE WITH APPLICABLE PROVISIONS OF THE CONTRACT DOCUMENTS.

RESERVOIR OPERATIONS

1. PROTECT THE RESERVOIR FROM SPILLS OR OTHER CONTAMINATION THROUGHOUT CONSTRUCTION. REFER TO SPECIFICATION SECTIONS____ AND _____ FOR ADDITIONAL WATER QUALITY PROTECTION REQUIREMENTS.
2. OWNER WILL MAINTAIN THE RESERVOIR WATER SURFACE ELEVATION AT A NORMAL LEVEL DURING THE CONSTRUCTION PERIOD. THE RESERVOIR WILL NOT BE LOWERED SPECIFICALLY TO FACILITATE REHABILITATION OF THE OUTLET WORKS. PLAN WORK TO BE ACCOMPLISHED WITH WATER SURFACE ELEVATIONS AS HIGH AS EL. 8399.

COORDINATION

1. SCHEDULE, COORDINATE, AND PERFORM THE WORK TO ALLOW NORMAL FACILITY OPERATIONS, INCLUDING OWNER ACTIVITIES RELATED TO OPERATION, MAINTENANCE, MONITORING, AND INSPECTION.
2. COORDINATE WITH THE OWNER FOR DESIGNATION OF SPECIFIC WORK AREAS FOR RESTRICTED ACCESS DURING PARTICULAR PERIODS OF THE WORK, AS WELL AS NEED FOR FENCING, SIGNAGE, AND OTHER MEASURES NECESSARY TO PROTECT THE PUBLIC, COMPLETED WORK, WORK IN PROGRESS, AND CONTRACTOR'S EQUIPMENT AND PROPERTY ON SITE.
3. MAINTAIN FULL AND COMPLETE ACCESS TO WORK TO OWNER, ENGINEER, AND REGULATORY PERSONNEL.

PERMITTING AND ENVIRONMENTAL

1. COMPLY WITH ALL REQUIREMENTS OF OWNER-OBTAINED PROJECT PERMITS. REFER TO SPECIFICATION SECTION _____ AND THE SPECIAL CONDITIONS FOR REQUIREMENTS OF OWNER-OBTAINED PERMITS. CONTRACTOR SHALL OBTAIN ALL OTHER PERMITS NECESSARY FOR CONSTRUCTION OF THE WORK.
2. REMOVAL OF OR DISTURBANCE TO TREES ON FOREST SERVICE PROPERTY SHALL NOT BE PERMITTED.

HATCH LEGEND:

STEEL

STRUCTURAL CONCRETE

RIPRAP

UNDISTURBED SOIL

EXISTING WETLANDS

GENERAL LEGEND:

B-1 — BORING LOCATION AND NUMBER

SURVEY CONTROL POINT

CONSTRUCTION CONTROL POINT

PLAN

DAM MODIFICATIONS — MAIN TITLE

0 10 20 — SCALE, FEET — DRAWING SCALE IN UNITS SPECIFIED

SITE ACCESS ROUTE

PROPERTY LINE

— x — x — x — FENCE

WATER SURFACE

34 — STATE HIGHWAY

COUNTY ROAD

LIMITS OF CONTRACTOR WORK AREA

DETAIL — OUTLET STRUCTURE — 1 / C-02 — DETAIL TITLE. THE NUMBER "1" REFERS TO THE DETAIL DESIGNATION. THE NUMBER "G-02" REFERS TO THE DRAWING NUMBER WHERE THE DETAIL IS CALLED OUT.

SECTION — STA. 0+00 — A / C-02 — SECTION TITLE. THE LETTER "A" REFERS TO THE SECTION DESIGNATION. THE NUMBER "G-02" REFERS TO THE DRAWING NUMBER WHERE THE SECTION IS CALLED OUT.

A / C-02 — SECTION LOCATION. THE LETTER "A" REFERS TO THE SECTION DESIGNATION. THE NUMBER "G-02" REFERS TO THE DRAWING NUMBER WHERE THE SECTION IS SHOWN.

3 / G-02 — DETAIL LOCATION. THE NUMBER "3" REFERS TO THE DETAIL DESIGNATION. THE NUMBER "G-02" REFERS TO THE DRAWING NUMBER WHERE THE DETAIL IS SHOWN.

90% DESIGN DRAWINGS

E:\1327820 - Upper Beaver\01-CAD\ G-02 - General Notes.dwg Sep 21, 2015 pegyers

Attention: 0 1" — If this scale bar does not measure 1" then drawing is not original scale.

NO.	DATE	ISSUE/REVISION	APP
0	09/25/15	90% DESIGN DRAWINGS	CMM

DRAFT

Designed: P. EGGERS
Checked: NAME
Drawn: P. EGGERS
Approved By: C. MASCHING
Approval Date: 09/25/2015

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4601 DTC Boulevard
Denver, Colorado 80237
303-662-0100

Lookout Mountain Water District
25958 Genesee Trail Road #514
Golden, Colorado 80401

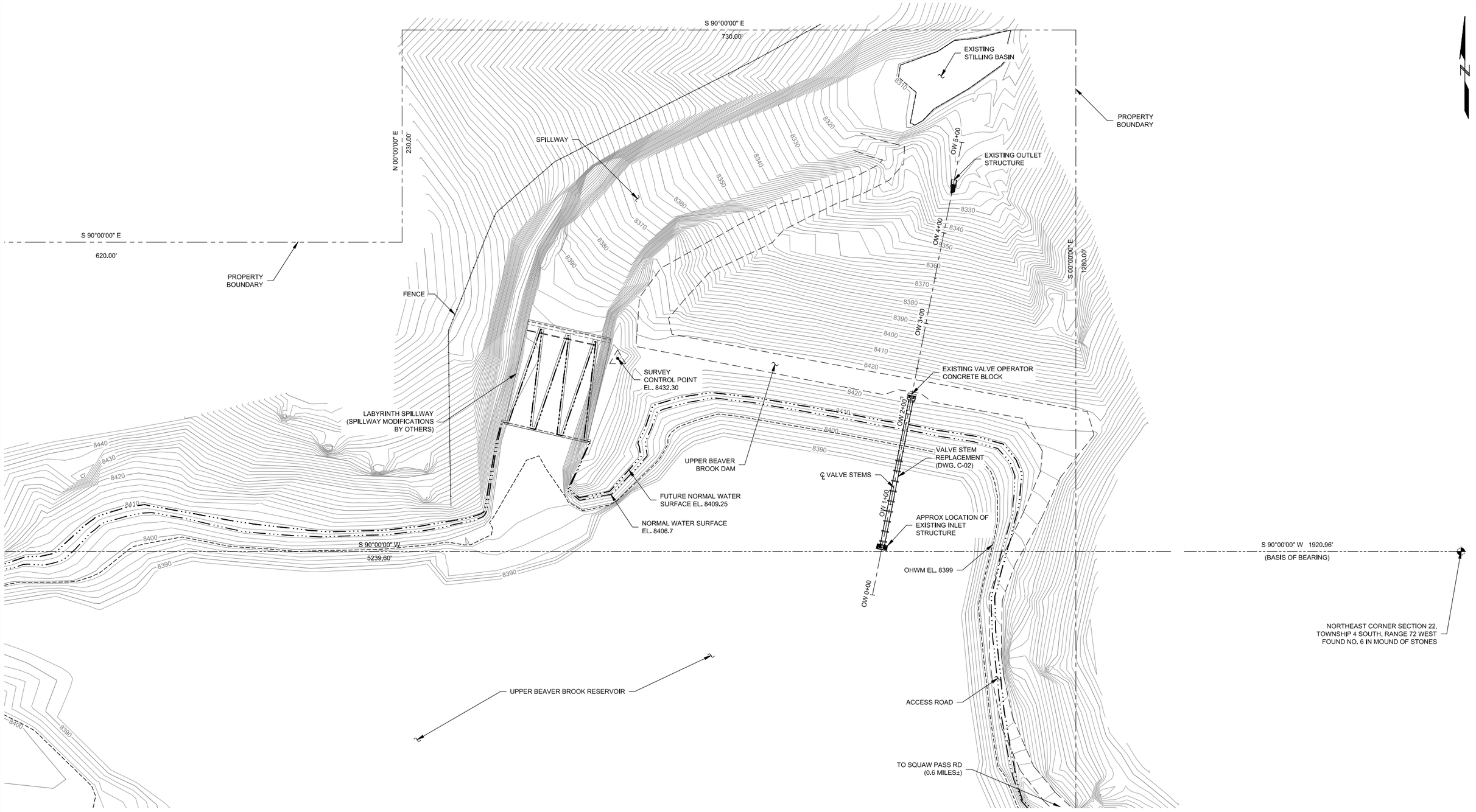
GEI Project 1327820

Upper Beaver Brook Outlet Works Rehabilitation Project

DRAWING LIST, GENERAL NOTES, LEGENDS, AND ABBREVIATIONS

DWG. NO. G-02

SHEET NO. 2 of 6



90% DESIGN DRAWINGS

0 50 100
SCALE, FEET

Attention:

0 1"

If this scale bar does not measure 1" then drawing is not original scale.

NO.	DATE	ISSUE/REVISION	APP
0	09/25/15	90% DESIGN DRAWINGS	CMM

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Approved By: C. MASCHING
Approval Date: 09/25/2015

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Golden, Colorado 80401

GEI Project 1327820

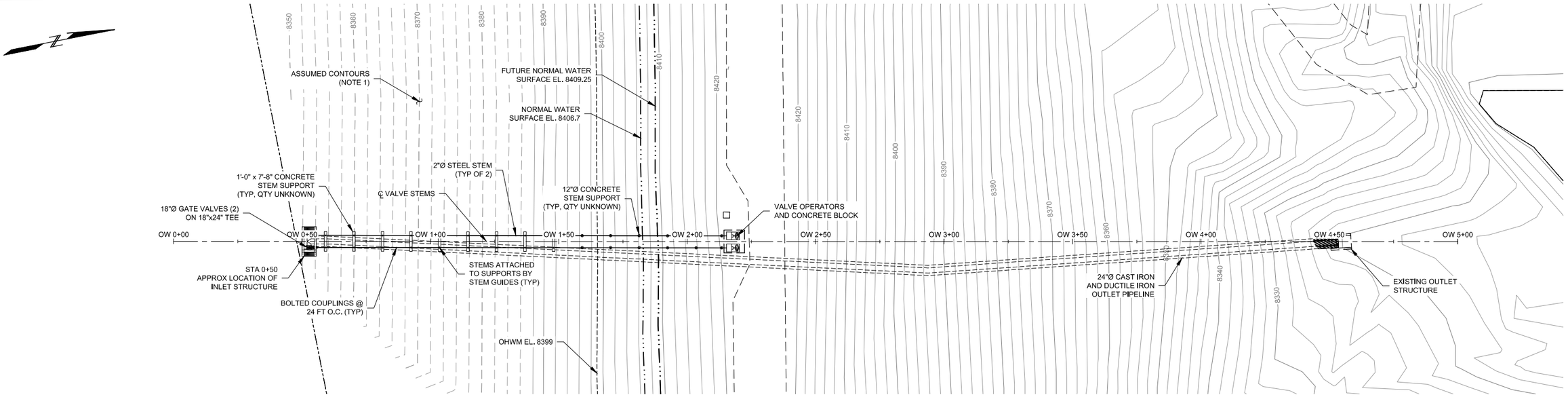
Upper Beaver Brook Outlet Works Rehabilitation Project

SITE PLAN

DWG. NO. G-03

SHEET NO. 3 of 6

E:\1327820 - Upper Beaver\01-CAD\ G-03 - Site Plan.dwg Sep 21, 2015 peggers

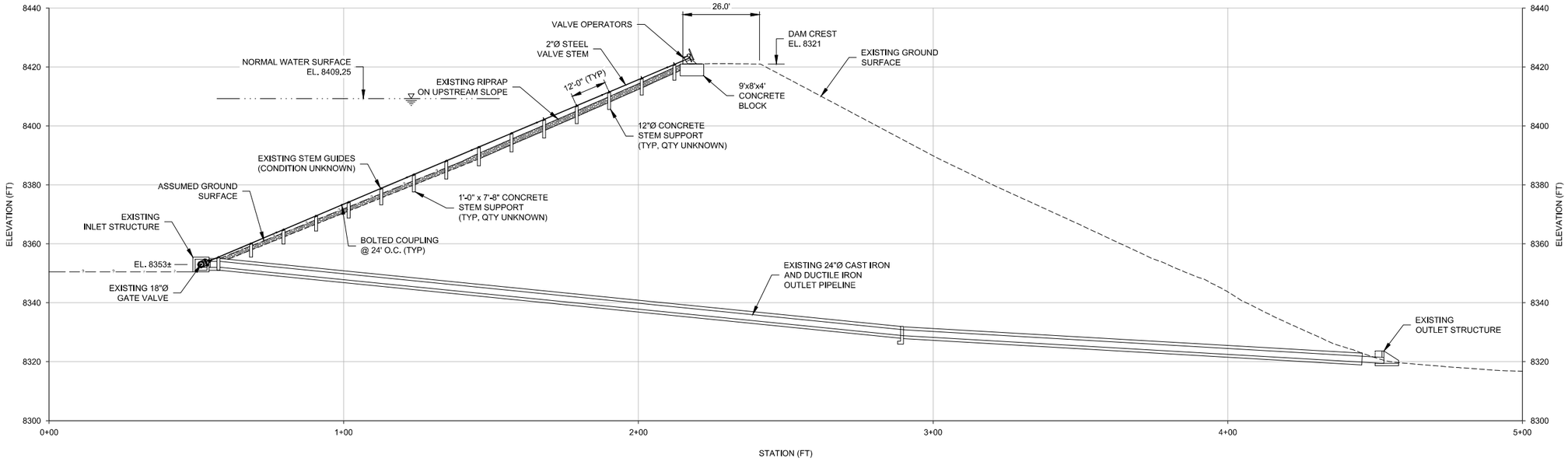


PLAN

EXISTING OUTLET WORKS

0 20 40

SCALE, FEET



PROFILE

EXISTING OUTLET WORKS

0 20 40

SCALE, FEET

NOTE:
1. ASSUMED CONTOURS ARE SHOWN FOR ILLUSTRATION ONLY AND REFLECT 2.5H:1V SLOPES BELOW THE WATER LEVEL AT THE TIME SURVEY WAS CONDUCTED.

90% DESIGN DRAWINGS

Attention: 0 1" — If this scale bar does not measure 1" then drawing is not original scale.					DRAFT	Designed: P. EGGERS Checked: NAME Drawn: P. EGGERS Approved By: C. MASCHING Approval Date: 09/25/2015
	0	09/25/15	90% DESIGN DRAWINGS	CMM		
	NO.	DATE	ISSUE/REVISION	APP		

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Denver, Colorado 80237
303-662-0100

Lookout Mountain Water District
25958 Genesee Trail Road #514
Golden, Colorado 80401

GEI Project 1327820

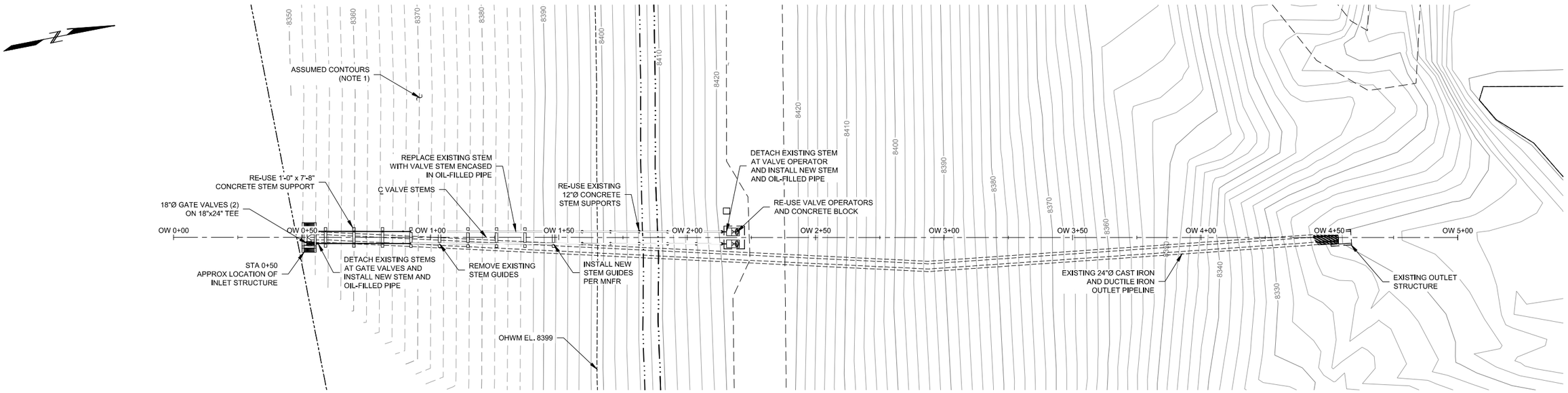
Upper Beaver Brook Outlet Works Rehabilitation Project

DWG. NO. C-01

EXISTING OUTLET WORKS PLAN AND PROFILE

SHEET NO. 4 of 6

E:\1327820 - Upper Beaver\01-CAD\ C-01 - Existing Outlet Works Plan and Profile.dwg Sep 21, 2015 peppers

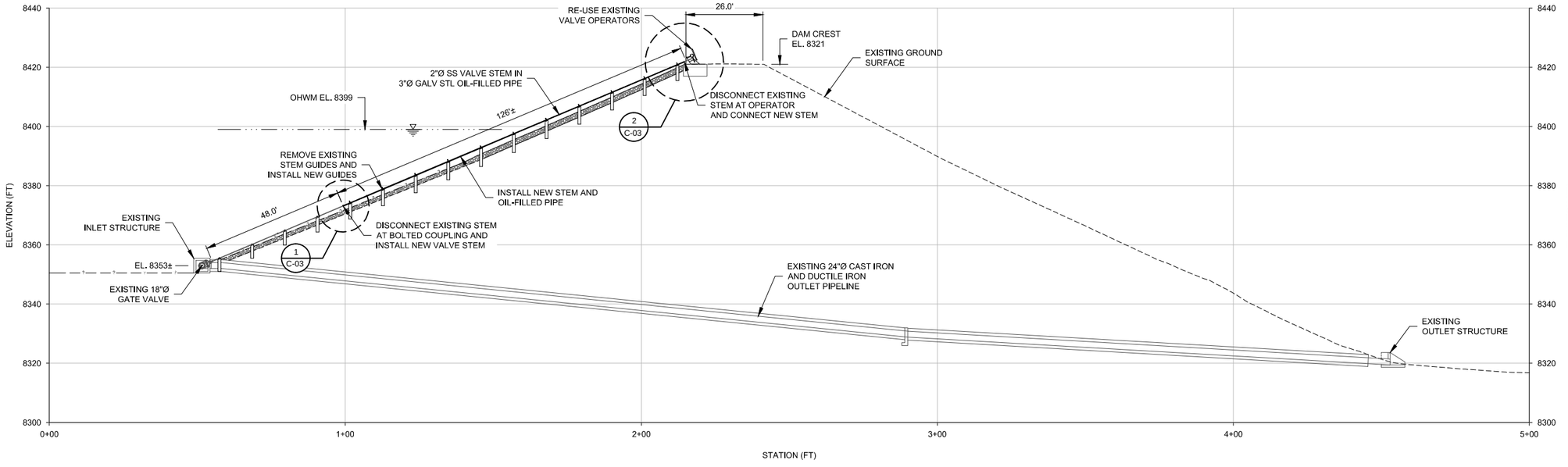


PLAN

EXISTING OUTLET WORKS

0 20 40

SCALE, FEET



PROFILE

EXISTING OUTLET WORKS

0 20 40

SCALE, FEET

NOTE:
1. ASSUMED CONTOURS ARE SHOWN FOR ILLUSTRATION ONLY AND REFLECT 2.5H:1V SLOPES BELOW THE WATER LEVEL AT THE TIME SURVEY WAS CONDUCTED.

90% DESIGN DRAWINGS

Attention:

0 1"

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NO.	DATE	ISSUE/REVISION	APP
0	09/25/15	90% DESIGN DRAWINGS	CMM

DRAFT

Designed: P. EGGERS
Checked: NAME
Drawn: P. EGGERS
Approved By: C. MASCHING
Approval Date: 09/25/2015

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25958 Genesee Trail Road #514
Golden, Colorado 80401

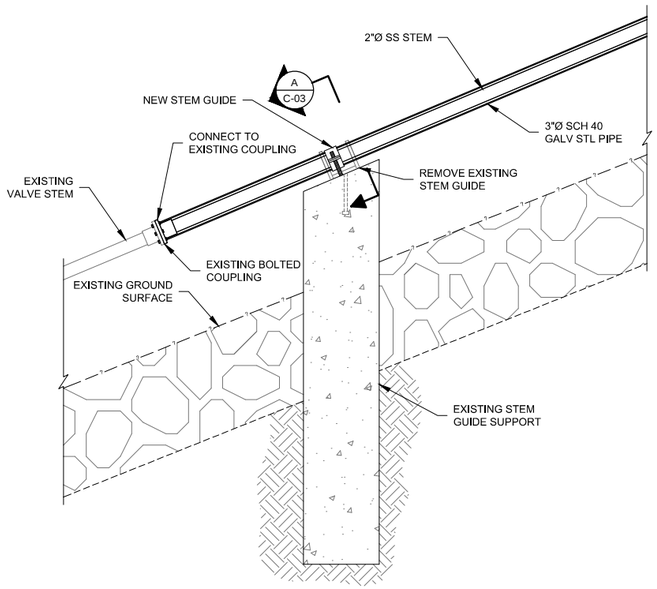
GEI Project 1327820

Upper Beaver Brook Outlet Works Rehabilitation Project

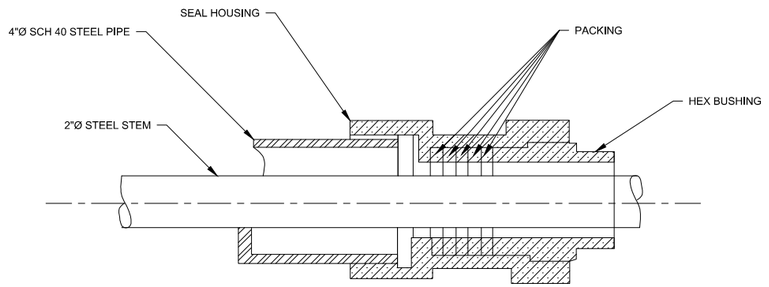
PROPOSED OUTLET WORKS PLAN AND PROFILE

DWG. NO. C-02

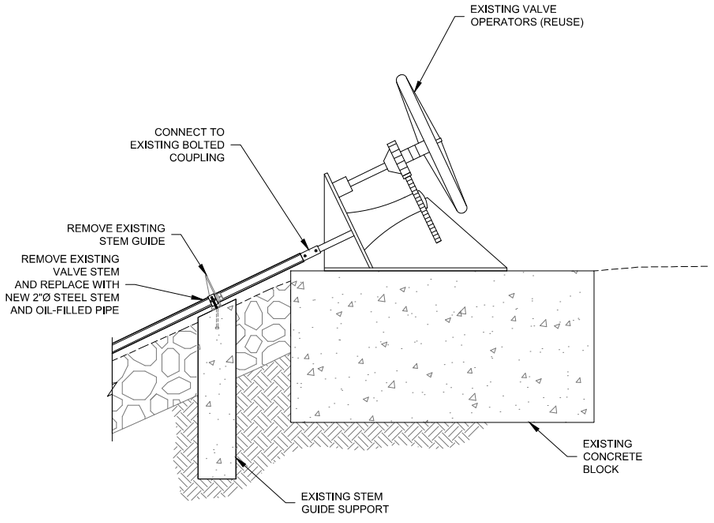
SHEET NO. 5 of 6



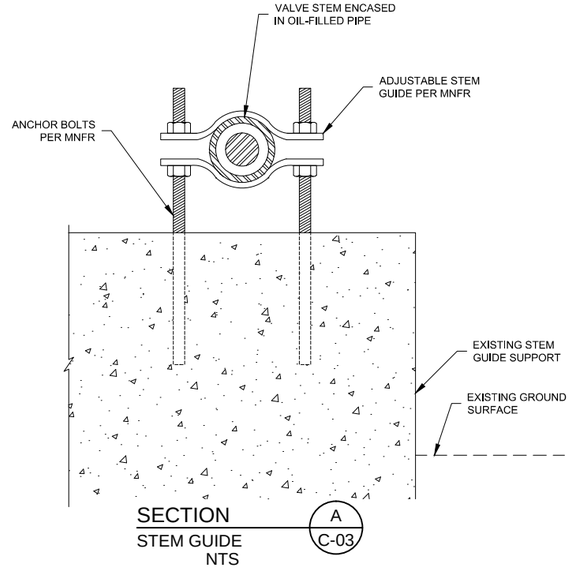
LOWER STEM CONNECTION (1 / C-02)
NTS



OIL SEAL ASSEMBLY (TYP / --)
NTS



UPPER STEM CONNECTION (2 / C-02)
NTS



SECTION (A / C-03)
STEM GUIDE
NTS

90% DESIGN DRAWINGS

Attention:	NO.	DATE	ISSUE/REVISION	APP
0 1" — If this scale bar does not measure 1" then drawing is not original scale.	0	09/25/15	90% DESIGN DRAWINGS	CMM

DRAFT

Designed: P. EGGERS
Checked: NAME
Drawn: P. EGGERS
Approved By: C. MASCHING
Approval Date: 09/25/2015

GEI Consultants
4601 DTC Boulevard
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303-662-0100

Lookout Mountain Water District
25958 Genesee Trail Road #514
Golden, Colorado 80401

GEI Project 1327820

Upper Beaver Brook Outlet Works Rehabilitation Project

OUTLET WORKS
SECTIONS AND DETAILS

DWG. NO. C-03

SHEET NO. 6 of 6

E:\1327820 - Upper Beaver\01-CAD\ C-03 - Outlet Works Sections and Details.dwg Sep 21, 2015 peggers

Appendix E LMWD Annual Reports

All LMWD annual reports can be found at:

http://www.lookoutmountainwaterdistrict.org/

A copy of the current annual transparency notice is below:

SPECIAL DISTRICT TRANSPARENCY NOTICE – 2014-2015
Pursuant to section 32-1-809, Colorado Revised Statutes

This information must be provided to the eligible electors of the district between November 16, 2014 and January 15, 2015.

Name of special district	Lookout Mountain Water District	
Address and telephone number of district's principal business office	1202 Bergen Parkway #215 (Mailing) 1202 Bergen Parkway #200 (Office) Evergreen, CO 80439 303-526-2025	
Name and telephone number of manager or other primary contact person for district	Christina B. Shea (Administrator/Secretary to the Board) 303-526-2025 Telephone 303-688-7072 Emergency 303-526-1257 Fax	
Time and place designated for regular board meetings	Second Mondays, 8:30 a.m. 317 S. Lookout Mountain Road, Golden 80401 (Highland Rescue Team Station Training and Meeting Room)	
Posting place designated for meeting notice (as per §24-6-402(2)(c), C.R.S.)	Lookout Mountain Water District Office Highland Rescue Team Ambulance District Office Foothills Fire Protection District Office	
District mill levy	17.700 mills, for levy in year 2011, 2012, 2013, 2014, 2015	
Total ad valorem tax revenue received by district during 2014 (Note if unaudited or otherwise incomplete.)	2014 year to date as of adoption of 2015 Budget: $442,084 received (2015 Budget: $435,036)	
Names of board members and terms	(1) Dean A. Snyder This office is on the **May 2016** ballot. **Two-year term**	(2) Barbara B. Nevins This office is on the **May 2018** ballot. **Four-year term**
	(3) Robert M. Heine This office will be on the **May 2016** ballot. **Four-year term**	(4) Donald E. Ranta This office will be on the **May 2016** ballot. **Four-year term**
	(5) M. Robert "Bob" Gray II This office is on the **May 2016** ballot. **Two-year term**	

Date of next regular election	Tuesday, May 3, 2016 *(preliminary)*
Self-nomination forms to be a candidate for district board member may be obtained from	Name: Christina Shea, Designated Election Official *(preliminary)* 1202 Bergen Parkway #200 - 215 Evergreen, CO 80439
Self-nomination forms to be a candidate for district board member should be returned to	Name: Christina Shea, Designated Election Official *(preliminary)* 1202 Bergen Parkway #200 - 215 Evergreen, CO 80439
Completed self-nomination forms must be received by the district by	Friday, February 28, 2016 *(preliminary)*

District election results will be posted on these websites:	Secretary of State www.sos.state.co.us	District or other website: www.lookoutmountainwaterdistrict.org
Applications to request permanent mail-in voter status (Enter county or counties in which the district is wholly or partially located.)	may be obtained from: Jefferson County Clerk and Recorder or online from Secretary of State: www.elections.colorado.gov	and may be returned to: Jefferson County Clerk and Recorder
Notice completed by:	Name: Christina Shea Title: Administrator E-mail: csbis@msn.com	Notice Dated: January 1, 2015 Some information herein may be subject to change.

File copy of this Notice with:

- Clerk and Recorder of each county in which district is wholly or partially located;
- Division of Local Government; and
- District's principal business office (make available for public inspection).

Appendix F CWCB Prequalification/Application

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street, Room 721
Denver, CO 80203

RECEIVED
JUL 27 2015
By

July 17,2015

Mr. Donald Ranta, Board President
Lookout Mountain Water District
1202 Bergen Parkway, Suite 200
Evergreen, CO 80439

Re: CWCB Prequalified Project List
Lookout Mountain Water District - Upper Beaver Brook Dam Spillway Improvement Project

Dear Mr. Ranta:

I am pleased to inform you that on July 15, 2015 the Colorado Water Conservation Board (CWCB) placed the Lookout Mountain Water District - Upper Beaver Brook Dam Spillway Improvement Project on the Prequalified Project List. Projects on this list fit the initial criteria of the Water Project Loan Program; however, this list does not constitute loan approval. In order to receive a loan, the Company must submit a completed Loan Feasibility Study for review by CWCB staff. That information will then be presented at a future CWCB meeting for Board approval of the loan.

Feasibility Studies for loans under $10 million are accepted at any time. Please allow 4-5 months from application date until funds are available. Loan Feasibility Studies received by July 31, 2015 will be scheduled for approval in September 2015, with funds available around December 2015. (The next deadline will be October 1 for loan approval in November 2015.)

Sincerely,

Anna Mauss, P.E.
Finance Section
Colorado Water Conservation Board

E-mail Copy: Kirk Russell, P.E. CWCB Finance Section Chief

P 303.866.3441 F 303.866.4474 www.cwcb.state.co.us
John W. Hickenlooper, Governor | Mike King, DNR Director | James Eklund, CWCB Director

COLORADO
Colorado Water Conservation Board

Water Project Loan Program

Application Type

☒ Prequalification *(Attach 3 years of financial statements)* ☐ Loan Approval *(Attach Loan Feasibility Study)*

Agency/Company Information

Company / Borrower Name: LOOKOUT MOUNTAIN WATER DISTRICT	
Authorized Agent &Title: DONALD RANTA, BOARD PRESIDENT	
Address: 1202 BERGEN PARKWAY, SUITE 200, EVERGREEN, CO 80439	
Phone: (303) 526-2025	Email: deranta@comcast.net
Organization Type: ☐ Ditch Co, ☒ District, ☐ Municipality ☐ other:_____	Incorporated? ☐ YES ☒ NO
County: JEFFERSON	Number of Shares/Taps: 565 Taps
Water District: APPLICANT	Avg. Water Diverted/Year: 175 acre-feet
Number of Shareholders/Customers Served: 1,600	Current Assessment per Share $____N/A___ (Ditch Co)
	Average monthly water bill $ ____40.00_____ (Municipality)

Contact Information

Project Representative: CHRISTINA SHEA, ADMINISTRATOR	
Phone: (303) 526-2025	Email: CSBIS@MSN.COM
Engineer: GEI Consultants, Inc.	
Phone: (303) 264-1080	Email: cmasching@geiconsultants.com
Attorney: Toussaint & Coaty, P.C.	
Phone: (303) 674-0800	Email: rtoussaint@tnclaw.com

Project Information

Project Name: Upper Beaver Brook Dam Spillway Improvement Project

Brief Description of Project: (Attach separate sheets if needed)

The project goal for the Upper Beaver Brook Dam Spillway Improvement Project is to provide an additional 140 acre-feet of storage in the reservoir. To provide the additional storage, GEI will design a new labyrinth spillway structure to raise the normal pool elevation at Upper Beaver Brook Dam. The new spillway will be designed to accommodate the project PMF, per SEO regulations for a high hazard dam. The design process will include review of the project design with LMWD and the SEO at key design stages to ensure the project meets LMWD's goals and SEO design requirements. GEI will work directly with the special committee or the entire Board at LMWD's direction. The design of the Upper Beaver Brook Dam Spillway Improvement Project will include geotechnical field investigations and laboratory testing, wetlands surveying and mitigation plans, engineering design and analyses, final design report, plans and technical specifications, opinion of probable construction costs (OPCC), and construction support services.

General Location: (Attach Map of Area)	
Estimated Engineering Costs: $390,000	Estimated Construction Costs: $3,019,735
Other Costs (Describe Above):	Estimated Total Project Costs: $3,409,735
Requested Loan Amount: $3,068,000 (*Limit 90% of Total Project Costs*)	Project Start Date(s) Design: September 2013/Construction: August 2016

Signature

Donald E Ranta President 6/8/15 Signature / Title Date	Return to: Finance Section Attn: Anna Mauss 1313 Sherman St #718 Denver, CO 80203 Ph. 303/866.3449 e-mail: anna.mauss@state.co.us

Appendix G Cesare Alternatives Study

LOOKOUT MOUNTAIN WATER DISTRICT

UPPER BEAVER BROOK MODIFICATION OPTIONS STUDY

PREPARED BY:

FUTURE ENGINEERING TECHNOLOGY GROUP

AND CESARE, INC.

CESARE, INC.
Geotechnical Engineers & Construction Materials Consultants

OCTOBER 8, 2012

UPPER BEAVER BROOK MODIFICATION OPTIONS DESCRIPTIONS

OPTION NUMBER	WATER STORAGE MODIFICATION OPTION DESCRIPTION
1	NEW REINFORCED CONCRETE LABYRINTH WEIR SPILLWAY (WEIR CREST EL. 8407.5)
2	DREDGING WITH NEW LABYRINTH WEIR SPILLWAY (WEIR CREST LOWERED TO EL. 8406.5)
3A	NEW RCC DAM AT SITE A (83' DAM HEIGHT WITH 350' LENGTH WITH 102 ACRE-FEET STORAGE)
3B	NEW RCC DAM AT SITE B (68' DAM HEIGHT WITH 400' LENGTH WITH 102 ACRE-FEET STORAGE)

FIGURE 1 – OPTIONS 1 AND 2 PLAN

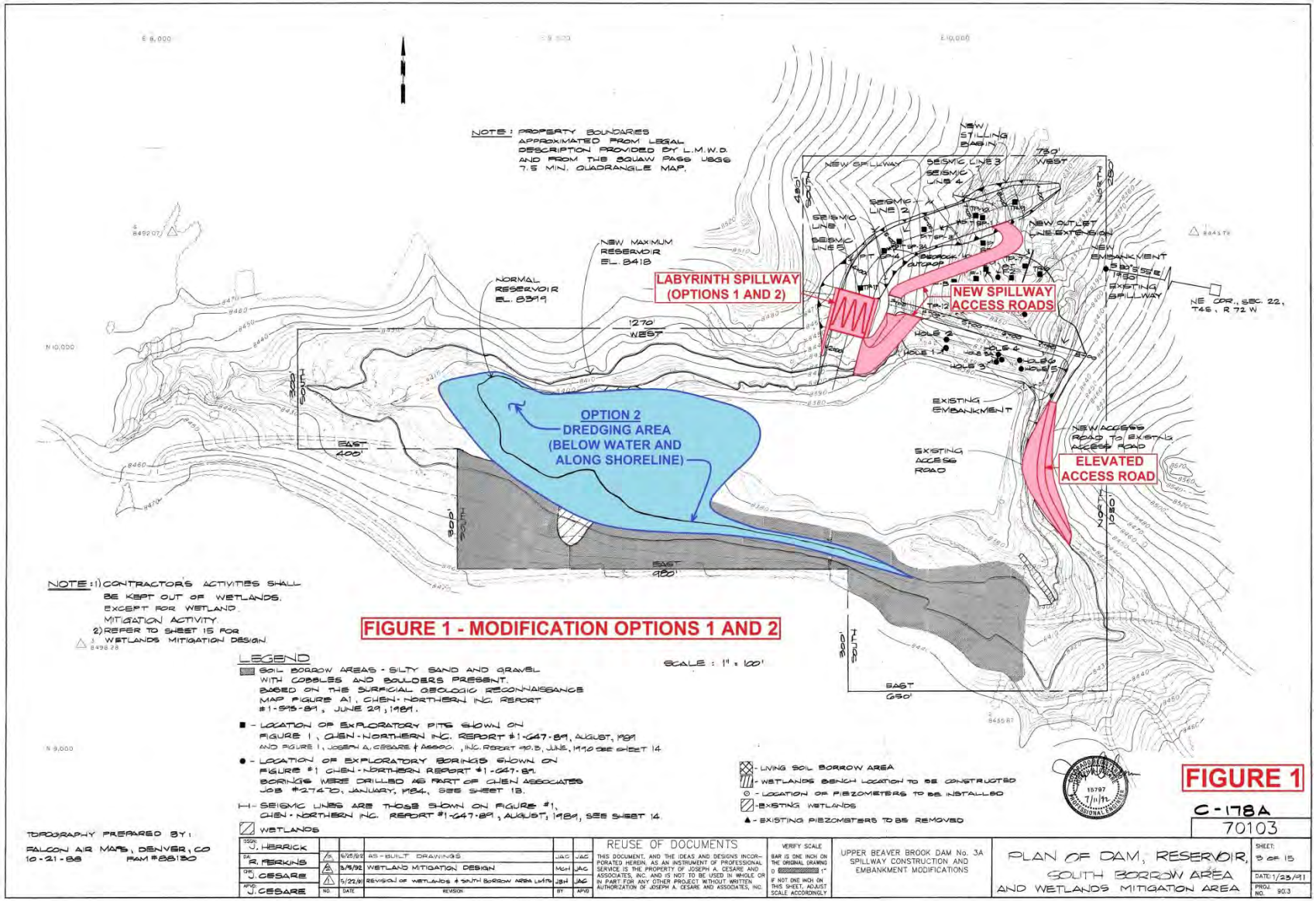


FIGURE 2 – OPTIONS 1 AND 2 DAM SITE PLAN

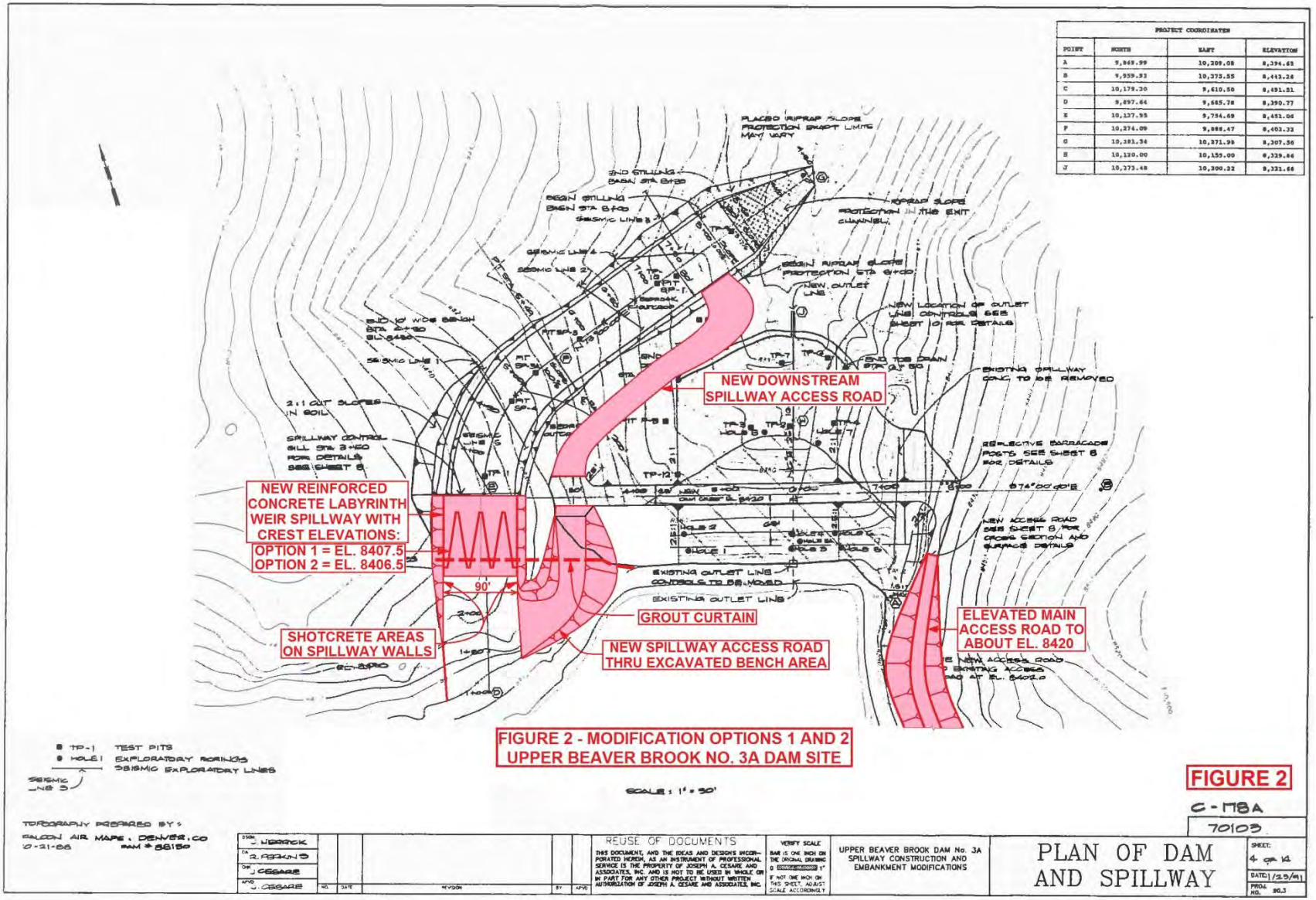


FIGURE 3 – OPTIONS 3A AND 3B PLAN

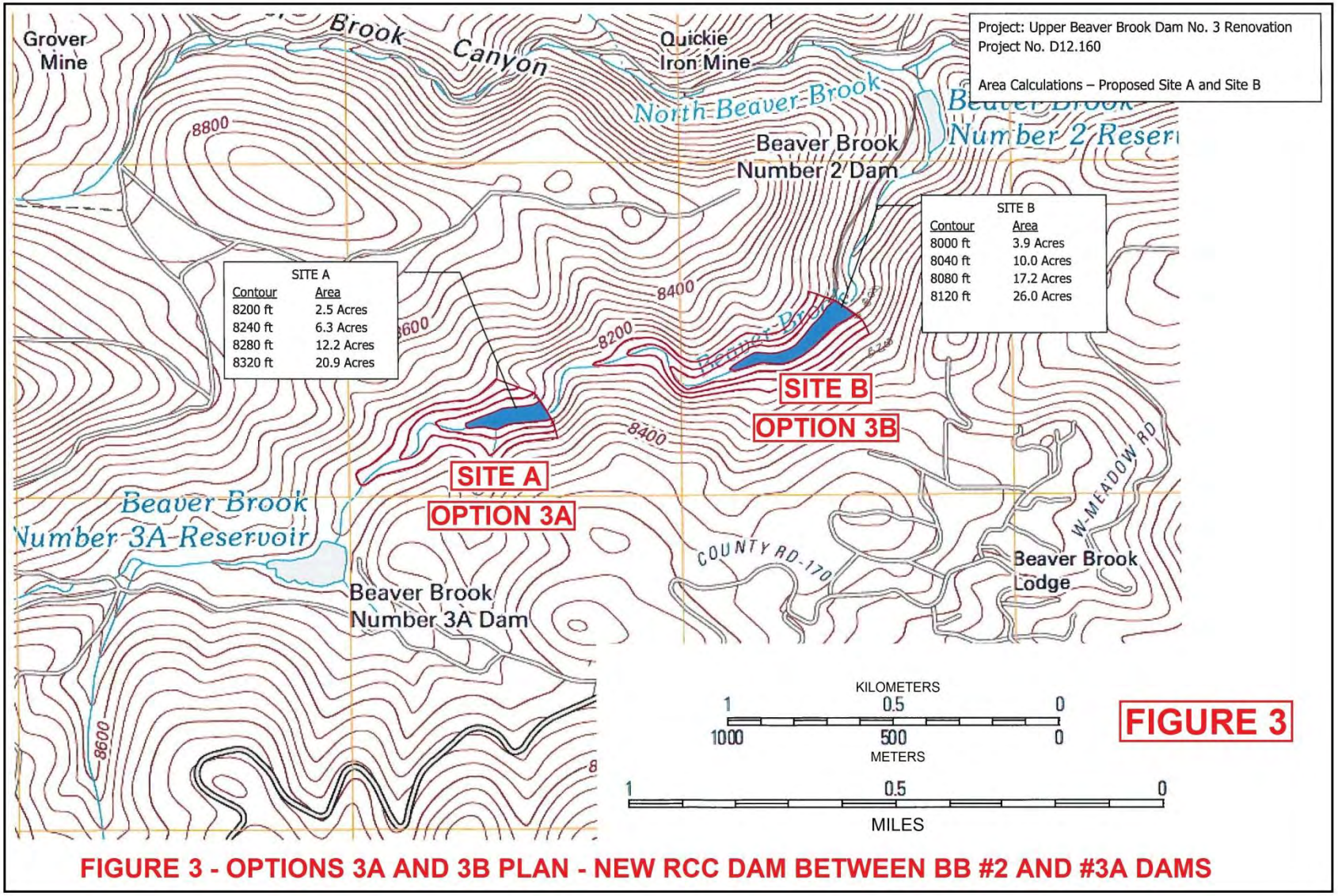
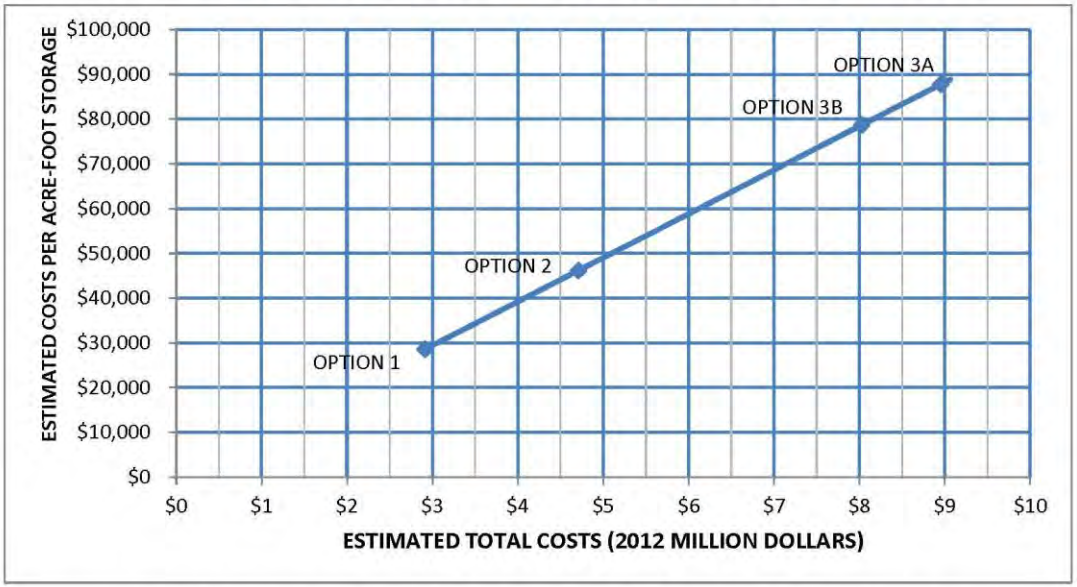


FIGURE 3 - OPTIONS 3A AND 3B PLAN - NEW RCC DAM BETWEEN BB #2 AND #3A DAMS

LOOKOUT MOUNTAIN WATER DISTRICT

UPPER BEAVER BROOK MODIFICATION OPTIONS COSTS

SUMMARY COMPARISON OF 2012 OPTIONS TOTAL COSTS



ESTIMATED TOTAL MODIFICATION COSTS SUMMARY:

OPTION 1 (LABYRINTH WEIR ONLY) * =	$2,914,000
OPTION 2 (DREDGING + LABYRINTH WEIR) =	$4,709,000
OPTION 3A (NEW RCC DAM AT SITE A) =	$8,953,000
OPTION 3A (NEW RCC DAM AT SITE B) =	$8,026,000

* ***OPTION 1*** ***- USING THE LABYRINTH WEIR WITH 3 CYCLES AND WEIR CREST EL. 8407.5 IS THE RECOMMENDED OPTION FOR FINAL DESIGNS AND CONSTRUCTION SELECTION***

CESARE, INC.
Geotechnical Engineers & Construction Materials Consultants

ESTIMATED TOTAL COSTS SUMMARY

ESTIMATED COSTS INCLUDE DESIGN AND CAPITAL CONSTRUCTION COSTS (2012)

MODIFICATION OPTIONS COMPARISON SUMMARY

LOOKOUT MOUNTAIN WATER DISTRICT

UPPER BEAVER BROOK SYSTEM MODIFICATION OPTIONS

102 ACRE-FEET (AF) WATER STORAGE VOLUME ENLARGEMENT COMPARISONS

OPTION NUMBER	WATER STORAGE OPTION DESCRIPTION	ACCESS ROADS REQUIRED (LINEAL FEET)	VOLUME OF CONCRETE REQUIRED (CUBIC YARDS)	VOLUME OF DREDGING REQUIRED (CUBIC YARDS)	NEW LAND PROPERTY REQUIRED (ACRES)	WETLANDS MITIGATION REQUIRED (ACRES)	EXPECTED SERVICE LIFE (YEARS)	ESTIMATED TOTAL SYSTEM COSTS (2012 DOLLARS)*	ANNUAL CAPITAL COSTS PER AF WATER STORAGE**	OPTION OVERALL RANKING	OPTION COMMENTS
1	NEW LABYRINTH WEIR SPILLWAY (WEIR CREST EL. 8407.5)	900	1,420	0	0	3	75	$2,914,000	$380.92	1	TOP SELECTION
2	DREDGING AND NEW LABYRINTH WEIR SPILLWAY (CREST EL. 8406.5)	900	1,360	23,000	0	7	75	$4,709,000	$615.56	2	DREDGING HIGH IMPACTS
3A	NEW RCC DAM AT SITE A (83' DAM HEIGHT WITH 350' LENGTH)	5,000	24,000	0	25	15	100	$8,953,000	$877.75	4	CAPITAL COSTS TOO HIGH
3B	NEW RCC DAM AT SITE B (68' DAM HEIGHT WITH 400' LENGTH)	2,600	19,000	0	30	20	100	$8,026,000	$786.86	3	CAPITAL COSTS TOO HIGH

* ESTIMATED SYSTEM COSTS INCLUDE 30% COST CONTINGENCIES AND 25% ENGINEERING & OBSERVATION COSTS FOR DESIGNS AND CONSTRUCTION

** ESTIMATED ANNUAL CAPITAL COSTS PER AF WATER STORAGE = ESTIMATED TOTAL SYSTEM COSTS / EXPECTED SERVICE LIFE / 102 AF ADDED STORAGE

COMPARISON OF MODIFICATION OPTIONS

HIGHER RANKING PRIORITY WAS GIVEN FOR SYSTEMS WITH LOWER CAPITAL COSTS

BEST - OPTION 1: *RECOMMENDED TOP SELECTION - USING 3-CYCLE LABYRINTH WEIR SPILLWAY WITH CREST EL. 8407.5*

GOOD - OPTION 2: *BETTER USING 3-CYCLE LABYRINTH WEIR SPILLWAY WITH CREST EL. 8406.5 AND MINIMAL DREDGING*

FAIR - OPTION 3B: *REDUCE DAM SIZE WITH LIMITED ADDED STORAGE AT EXISTING 3A RESERVOIR-BUT STILL TOO COSTLY*

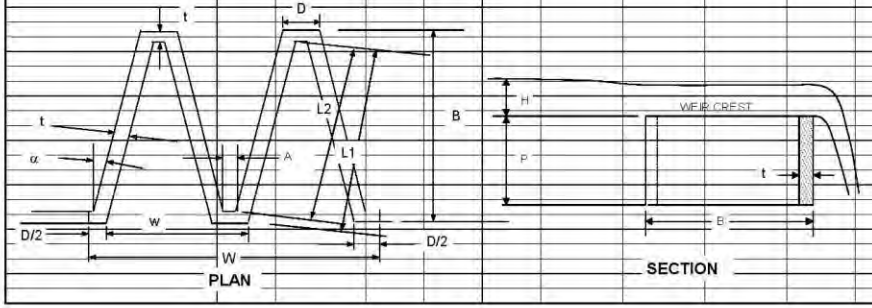
POOR - OPTION 3A: *REDUCE DAM SIZE WITH LIMITED ADDED STORAGE AT EXISTING 3A RESERVOIR-BUT STILL TOO COSTLY*

UPPER BEAVER BROOK DAM

LABYRINTH WEIR SPILLWAY DESIGN AND ESTIMATED COSTS - OPTION 1

Parameter	Symbol	Value	Units	Source/Equation/Notes				
Maximum Flow	Q_{max}	18,990	ft^3/s	Input		Input Cells		
Max Reservoir EL	res	8418.00	ft	Input				
Approach Channel EL	-	8398.00	ft	Input				
Labyrinth Weir Crest EL	El	8407.50	ft	Input				
Total Head	H_t	9.724	ft	H_t = res-crest-loss				
Approach Channel Depth		20.000	ft					
Approach Channel Bottom Width		90.0	ft	Input				
Approach Channel Side Slopes X:H,1:V		0.25		Input				
Approach Channel Length		120.0	ft	Input				
Approach Channel Area		1,900	ft^2					
Average Approach Velocity		9.99	fps					
Inlet Head Loss at Maximum Flow	Loss	0.78	ft	Set to zero or estimated from preliminary calcs				
Angle of Approach Flow	β	0	deg	Negligible				
Number of Cycles	N	3	-	Select to keep w/P ~ 3 to 4				
Crest Height	P	10.0	ft	Set P ~ 1.4 H_t				
Angle of Side Legs	α	8.00	deg	Normally 8°-12°				
Thickness of Wall	t	1.67	ft	t = P/6				
Inside Width at Apex	A	2.92	ft	Select between t and 2t - larger decreases spillway capacity				
Outside Width at Apex	D	5.81	ft	D = A + 2t *tan(45 - α/2)				
Total Head/Crest Height	H_t/P	0.972	-	OK	H_t/P < 0.9 in order to maintain the effectiveness of the weir			
Crest Coefficient	C_d	0.270	-	C_d from 1995 Tullis paper		0.196	0.270	0.333
Crest Coefficient	C_{df}	1.444		Cd*(2g)^0.5/1.5		1.050	1.444	1.784
Effective Crest Length	L	433.58	ft	$1.5Q_{max}/[(C_d*H_t^{1.5})*(2g)^{0.5}]$				
Length of Apron	B	74.66	ft	B = [L/(2N) + t*tan(45-α/2)]cos(α) + t				
Actual Length of Side Leg	L_1	73.71	ft	L_1 = (B-t)/cos(α)				
Effective Length of Side Leg	L_2	72.26	ft	L_2 = L_1 - t*tan(45 - α/2)				
Total Length of Walls	L_3	468.47	ft	L_3 = N(2L_1 + D + A)				
Distance Between Cycles	w	29.25	ft	w = 2L_1*sin(α) + A + D				
Width of Labyrinth	W	87.7	ft	W = N*w				
Distance Between Cycles/Crest Ht	w/P	2.92	-	OK	Normally between 3 and 4			
Wall Concrete Volume		569	yd^3		**Estimated Total Costs =**		**$1,026,395**	
Apron Thickness		2.0	ft		**(without grouting costs)**			
Apron Concrete Volume		843	yd^3					
Total Concrete Volume		1,412	yd^3					
Concrete Cost ($)		$958,939	$					
Approach Channel Volume		800	yd^3					
Excavation for structure		701	yd^3					
Approach Channel Costs ($)		$60,048	$					
Riprap Volume		148	yd^3					
Riprap Costs		$7,407	$					
Total Costs		**$1,026,395**	$					

Based on Paper From "Journal of Hydraulic Engineering, March 1995, Vol 121, No. 3", Entitled "Design of Labyrinth Spillways", J. Paul Tullis, Nosratollah Amanian, & David Waldron-Utah State University



PROPOSED OPTION 1

PRELIMINARY DESIGN DETAILS AND COSTS

REINFORCED CONCRETE LABYRINTH WEIR SPILLWAY-TOTAL SPILLWAY STRUCTURE AREA OF 90' WIDE x 100' LONG (3-CYCLES WITH 30' x 75' LONG CYCLE AREAS WITH 6 TOTAL WEIR WALLS AT 18" THICK x 10' HIGH)

ESTIMATED 2012 CONSTRUCTION-ONLY COSTS = $1,027,000 (FOR SPILLWAY STRUCTURE ONLY)

LOOKOUT MOUNTAIN WATER DISTRICT

UPPER BEAVER BROOK MODIFICATION OPTIONS STUDY

QUESTIONS AND ANSWERS

CESARE, INC.
Geotechnical Engineers & Construction Materials Consultants

OCTOBER 8, 2012

Future Engineering Technology Group, Inc.
9650 W. La Salle Avenue Lakewood, CO 80227
Phone: (303) 432-1957 Fax: (303) 432-1958
fetg@comcast.net www.exactflowlogic.com

November 22, 2012

Mr. Mark Mancini
Lookout Mountain Water District
25958 Genesee Trail Road #514
Golden, CO 80401

Subject: Upper Beaver Brook Modification Options Study
Lookout Mountain Water District
Clear Creek County, Colorado

Dear Mr. Mancini:

This letter report summarizes the findings and conclusions from the Upper Beaver Brook (UBB) Modification Options Study completed by Mr. Joe Cesare of Cesare, Inc. and myself for your review. The study proposal was authorized by the Lookout Mountain Water District approval and we were given the Notice to Proceed by email on August 14, 2012 to be completed within 60 days. This letter report includes the Modification Options study results and comparisons, PowerPoint slide presentation, Option Plan figures, cost estimates, hand calculations, and Technical Memorandum (TM) by Mr. Joe Cesare dated September 26, 2012. This study will recommend which is the best Modification Option selection to continue into the preliminary and final design phases.

BACKGROUND

The Upper Beaver Brook Dam 3A nominal crest elevation was raised from Elevation (El.) 8394 by 26 feet up to El. 8420 (existing dam crest) with J.A. Cesare and Associates, Inc. as the enlargement modification designer during 1991-1992 dam enlargement construction. The reservoir storage was increased 170 acre feet (AF) up to about 257 AF maximum storage volumes with the 80-foot wide concrete control sill El. 8399 within the excavated rock channel spillway. The maximum reservoir water surface area at El. 8399 is estimated to be about 11.9 acres. The routed Probable Maximum Flood (PMF) was determined by Futura Engineering in 1990 as 18,990 cubic feet per second (cfs) maximum flood flow. Mr. Joe Cesare and I performed a Site Visit to the UBB Dam 3A and surrounding areas on August 30, 2012 with several people from the Board and operators to properly assess the Project storage options. In recent discussions with Mr. Greg Hammer of the State of Colorado, Division of Water Resources Dam Safety Branch; it was determined that the new lower flood hydrology flows developed by the State may not be acceptable for the reduction of the final design flood levels. Therefore, the design PMF of 18,990 cfs was used in this Options study. Mr. Hammer recommended that improvements to the

piezometer well monitoring and seepage drain flow measurements are required for the existing UBB Dam 3A facilities, as it is considered a “High Hazard” dam by the State of Colorado.

The previous dam enlargement work performed in 1991-1992 indicated that the hardness of the rock material will likely preclude efficient ripper, backhoe or hoe ram excavation. Excavation of rock materials around the UBB Dam 3A facilities will require blasting in a few areas, but should be minimized during the construction of any required spillway or water storage improvements. During the previous construction work, blasting was used for the entire spillway excavation and dam raise with no issues to our knowledge. Blasting for any new construction work will have to be monitored with accelerometers and piezometer wells with observations of leakage before and after each blast. Liquefaction of the dam embankment is the concern with blast induced vibrations. The dam rock shells and embankment are not prone to liquefaction during seismic events, which include multiple cycles of shaking in a short duration. Blasting will be an event that will have one impulse that can be limited by allowable ground velocities and duration before the next blasting event. As a minimum precaution, weighted distance methods should be employed to evaluate any new blasting consistent with guidelines presented in the Oil and Public Safety Guidelines produced by the State of Colorado. The piezometer well levels should be checked between the blasting events to observe if any pore pressures are developing in the dam. If pore pressures are developed during blasting, then the duration between blasts and the powder factors should be adjusted for subsequent blasts or alternative methods of excavation will need to be followed. Another method of excavation would be the use of expansive non-blasting demolition agents. Any required blasting excavation is achievable by using controlled blasting methods and should be investigated to a greater degree during preliminary and final designs.

INTRODUCTION

This Upper Beaver Brook (UBB) Modification Options Study investigated several options for potential water storage enlargement of an additional 102 acre feet (AF) water volume with expansion of Upper Beaver Brook Dam 3A reservoir or stored at downstream dam sites. This 102 AF volume increase would increase the UBB Dam 3A total reservoir storage to about 359 AF volume with a maximum water surface area of about 14.3 acres at an approximate maximum water surface near El. 8407. The simplest possible option would involve increasing the height of the existing control weir (crest sill El. 8399) with a new straight 80-foot long reinforced concrete spillway weir with maximum weir crest set at about El. 8401 (only two feet high). The maximum two-foot high weir crest raise is limited by having to accommodate the design flood flow of 18,990 cfs through the spillway with one foot of freeboard on the existing enlarged dam. This straight weir option would provide no more than about 25 AF additional storage, which is only about one fourth of the required 102 AF volume increase required for viable options to be considered within the scope of this study. Therefore, this simple straight weir option was not considered as a potential option, because of the

other major and costly dam modifications required. The feasible Modification Options included within this study are the following options as requested at the July Board of Directors meeting (held on July 9, 2012):

A. **Option 1** – provide a new reinforced concrete labyrinth weir spillway within the existing rock cut spillway at UBB Dam 3A to enlarge the existing reservoir by 102 AF to about 359 AF total water storage capacity
B. **Option 2** – provide dredging within UBB Dam 3A area from below the water and near the reservoir shoreline to enlarge the existing reservoir storage volume and possibly include a new reinforced concrete labyrinth weir spillway within the existing rock cut spillway at UBB Dam 3A to enlarge the total storage capacity to about 359 AF volume
C. **Option 3A** – provide a new Roller Compacted Concrete (RCC) dam downstream of UBB Dam 3A located about 2,500 feet downstream on Beaver Brook to store the additional 102 AF water storage volume required
D. **Option 3B** - provide a new RCC dam downstream of UBB Dam 3A located about 6,000 feet downstream on Beaver Brook to store the additional 102 AF water storage volume required

MODIFICATION OPTIONS EVALUATIONS

Mr. Joe Cesare performed many calculations and evaluations of the Modification Options, which are within the Cesare TM included in the Main Appendix. Many of Cesare data values and estimates were used and summarized in the evaluations. The following assumptions, analyses, and design estimates were performed for each Modification Option as part of this study as summarized below:

- **OPTION 1** – The proposed layout Plan of the Option 1 facilities are shown in red colors on Figures 1 and 2 (see Main Appendix). It was determined that the estimated maximum water surface required to achieve the 359 AF total storage capacity within the UBB Dam 3A reservoir was approximately El. 8407.5. The El. 8407.5 was used as the labyrinth weir crest elevation for the new reinforced concrete spillway. Using the design PMF discharge of 18,990 cfs, Table 1 (see Main Appendix) shows the designs and estimated construction costs for the 3-cycle labyrinth weir spillway structure to be constructed within the existing rock spillway, as shown in Figure 2. The existing rock spillway channel will be cleared, excavated, and widened from 80 feet to 90 feet wide for the 90-foot wide by 100-foot long spillway structure. The 470-foot length of 18-inch thick by 10-foot high reinforced concrete weir walls comprise the labyrinth weir. The labyrinth weir spillway has a maximum discharge flow capacity of 18,990 cfs at water surface El. 8418, which provides a 2-foot freeboard during the PMF flows. The 2-foot thick reinforced concrete base slab will be anchored into the excavated rock channel bottom. Parallel 18-inch thick by 24-foot high reinforced concrete side walls will be installed to above the dam crest (El. 8420). The estimate 2012 reinforced concrete unit prices

used are $500 per CY for slab concrete and $800 per CY for wall concrete costs. Table 1 indicates that about 1,420 cubic yards (CY) of reinforced concrete will be required for the labyrinth weir spillway structure for an estimated 2012 construction cost of about $1,027,000.

A grout curtain will be installed below the spillway and dam surface to provide a proper cutoff of seepage flows through the area between the spillway and dam embankment. The excavated spillway rock walls will be covered with shotcrete to provide further seepage protection, as shown on Figure 2. New spillway access roads will be required on both the upstream and downstream ends of the existing spillway to be excavated (rock cut and fill on the upstream side of dam) and regraded (downstream side of dam). The main access road located about 300 feet south of the dam must be raised to about El. 8420 and cut into the existing hillside to provide proper access to the dam during flood conditions, as shown on Figure 2. There would be impacts of about 3 acres to wetland areas, which would likely be mitigated through a wetlands exchange program at about $50,000 per acre. Relocation of the existing wetlands flume and areas further to the west would be required.

- **OPTION 2** – The proposed areas of dredging below the water and along the reservoir shoreline are shown in blue colors on Figure 1 (see Main Appendix). However, since the depth and quantity of material available for dredging is unknown at this time only rough estimates can be made at this time. No dredging material can be removed from within 300 feet of the dam or spillway area for seepage reasons and much of the side slopes are rock materials, this produces very limited areas available for dredging. A rough estimate of minimal dredging material that can be removed is about 23,000 CY (or about 14 AF) total volume. This volume is only about one foot of reservoir storage depth or about 14% of the total 102 AF required. Therefore, a labyrinth weir spillway must be provided along with the dredging volume to provide the total 102 AF required.

  As shown in Table 2 (see Main Appendix), this reinforced concrete labyrinth weir spillway will be similar to the one provided in Option 1, but with a weir crest El. 8406.5 (lowered by one foot from dredging). The volume of reinforced concrete required is about 1,360 CY for the lowered labyrinth weir spillway structure for an estimated 2012 construction cost of about $992,000, as shown in Table 2. All other required dam modification features will be similar to those described in Option 1, including all the access road modifications. The impacts to wetland areas would be greater than Option 1 with about 7 acres affected, because of the shoreline areas used for dredging.

- **OPTION 3A** – The proposed location of the new RCC dam Site A, which is about 2,500 feet downstream from the existing UBB Dam 3A is placed on Beaver Brook, as shown on Figure 3. The estimated dimensions of the new RCC dam are about 83-foot maximum height with about 350-foot long

crest length with an RCC overflow spillway. The dam crest width is 20 feet with vertical upstream face and a downstream face having 0.8 Horizontal to 1 Vertical distance steep slope. The new dam will be equipped with a vertical intake tower and outlet works for required water releases. The estimated RCC concrete volume is about 24,000 CY with an estimated 2012 RCC-only construction cost of about $2,400,000 at $100 per cubic yard. A new 5,000-foot long access road with land property purchase for the road and dam site would require about 25 acres at about $20,000 per acre purchase for about $500,000 land purchase costs. About 15 acres of wetlands areas would be impacted and probably resolved through a wetlands mitigation exchange program at about $50,000 per acre for about $750,000 costs. The construction costs and schedule duration required for the new RCC dam construction would be much greater than the new labyrinth weir spillway construction with much more environmental impacts to the local community.

- **OPTION 3B** – The proposed location of the new RCC dam Site B, which is about 6,000 feet downstream from the existing UBB Dam 3A is placed on Beaver Brook, as shown on Figure 3. The Option 3B dam will have similar features as the Option 3A dam described above. The estimated dimensions of the new RCC dam are about 68-foot maximum height with about 400-foot long crest length with an RCC overflow spillway. The estimated RCC concrete volume is about 19,000 CY with an estimated 2012 RCC-only construction cost of about $1,900,000. A new 2,600-foot long access road with land property purchase for the road and dam site would require about 30 acres for about $600,000 land purchase costs. About 20 acres of wetlands areas would be impacted and probably resolved through a wetlands mitigation exchange program for about $1,000,000 exchange costs. The construction costs and schedule duration required for the new RCC dam construction would be much greater than the new labyrinth weir spillway construction with much more environmental impacts to the local community.

ESTIMATED MODIFICATION OPTION TOTAL COSTS

The estimated total capital costs, including design and construction costs, were estimated for all the Modification Options. The total capital costs include a 30% cost contingency amount to account for many unknown cost impacts at this study estimate level. Typically, for this level of study the following engineering and observation cost items are individually estimated as a percentage of the estimated construction costs as follows:

- 1%-5% for permitting and funding work
- 1%-3% for environmental, hydrology, surveying, and O&M coordination issues
- 8%-12% for geotechnical and design engineering for developing construction contract documents
- 7%-10% for engineering observation during construction
- 1%-2% for completion reporting

The above total engineering and observation costs for all analyses, designs, contract documents, and oversight during construction are included at an average 25% total amount of the estimated total construction costs for this study.

The estimated total 2012 capital costs summary, including all estimated construction and engineering costs, for each option are shown in following summary chart and associated itemized Tables (included in Main Appendix):

ESTIMATED TOTAL MODIFICATION COSTS SUMMARY

OPTION NUMBER	ESTIMATED TOTAL 2012 CAPITAL COSTS	ITEMIZED COSTS TABLE
1	$2,914,000	TABLE 3
2	$4,709,000	TABLE 4
3A	$8,953,000	TABLE 5
3B	$8,026,000	TABLE 6

These cost estimates are summarized on Table 7 (included in Main Appendix), which clearly indicate that Option 1 has the lowest estimated capital costs.

MODIFICATION OPTIONS COMPARISONS

The comparisons of the Modification Options place an emphasis on having the lower capital costs, however, other option system features and impacts must also be considered. The required access roads, volumes of concrete and dredging, required land purchases, impacts to wetland areas, and expected option service life also must be considered. The summary comparison of these option features, impacts, and estimated capital costs are shown on Table 8 (included in Main Appendix). The summary results are as follows:

MODIFICATION OPTIONS COMPARISON SUMMARY

OPTION NUMBER	ANNUAL CAPITAL COSTS PER AF WATER STORAGE*	OPTION OVERALL RANKING
1	$381	***1 – BEST***
2	$616	*2 – GOOD*
3A	$878	*4 – POOR*
3B	$787	*3 – FAIR*

***** Annual Costs Value = Total Capital Costs / Service Life / 102 AF Added Storage

RECOMMENDATIONS

The clearly best top selection with the highest ranking was Option 1 to use the reinforced concrete 3-cycle labyrinth weir spillway with crest El. 8407.5 and 470-foot long by 18-inch thick by 10-foot high labyrinth weir wall to provide for the required 102 AF additional water storage. The labyrinth weir spillway structure reinforced concrete base slab would be about 2 feet thick by 90 feet wide by 100

feet long with cutoff walls and anchored into the rock spillway channel. Detailed dimensions of the proposed labyrinth weir spillway are shown on Table 1. The recommended new labyrinth weir spillway and access road locations and modifications are shown on Figure 1. Major engineering and construction costs savings for Option 1 are produced by using the labyrinth weir proven technologies and construction techniques to provide maximum spillway flows and minimize impacts and modifications required to the existing dam. Option 1 requires minimal construction earthwork and materials to be used with minimal environmental and wetlands impacts.

The recommended top selection is clearly Modification Option 1 to continue into the preliminary and final design phases and ultimately the construction phase. The additional requirements to progress into the preliminary and final design aspects of Option 1 include: the detailed survey of the dam and reservoir areas, updated hydrology and geotechnical studies, dam stability analyses, blasting and excavation evaluations, design feasibility assessments, and Project permitting and funding issues. Final designs should evaluate the options for blasting excavation and development of specifications to limit the probability of excavation induced problems. Subsurface exploration in the form of core holes that are currently planned and possible in-situ seismic wave velocities will be helpful in these blasting evaluations. Blasting will likely be required for the raising of the access road south of the right abutment of the dam and within the existing spillway area near the left abutment. The steepness of the slopes below these blasting areas and the existence of the reservoir water make the possibility of construction of fills or retained earth options impractical. The existing reservoir water level could be lowered so that any required construction could be done in the dry to build up the access road with constructed fills or retained earth methods. The road fill has more flexibility in the acceptable types of excavation than does the excavation options for the left abutment spillway area. The required excavation within the left abutment spillway should be controlled, limited to the minimum necessary and performed in such a manner that the final rock slope geometry is suitable for long term hydraulic purposes and dam stability.

Please contact me if you have any questions or need additional information. We desire to continue to work with you and the Board on this important Project!

Sincerely,

Daniel J. Brauer

Daniel J. Brauer, P.E.

Lookout Mountain Water District
Upper Beaver Brook

MODIFICATION
OPTIONS STUDY

OCTOBER 3, 2012

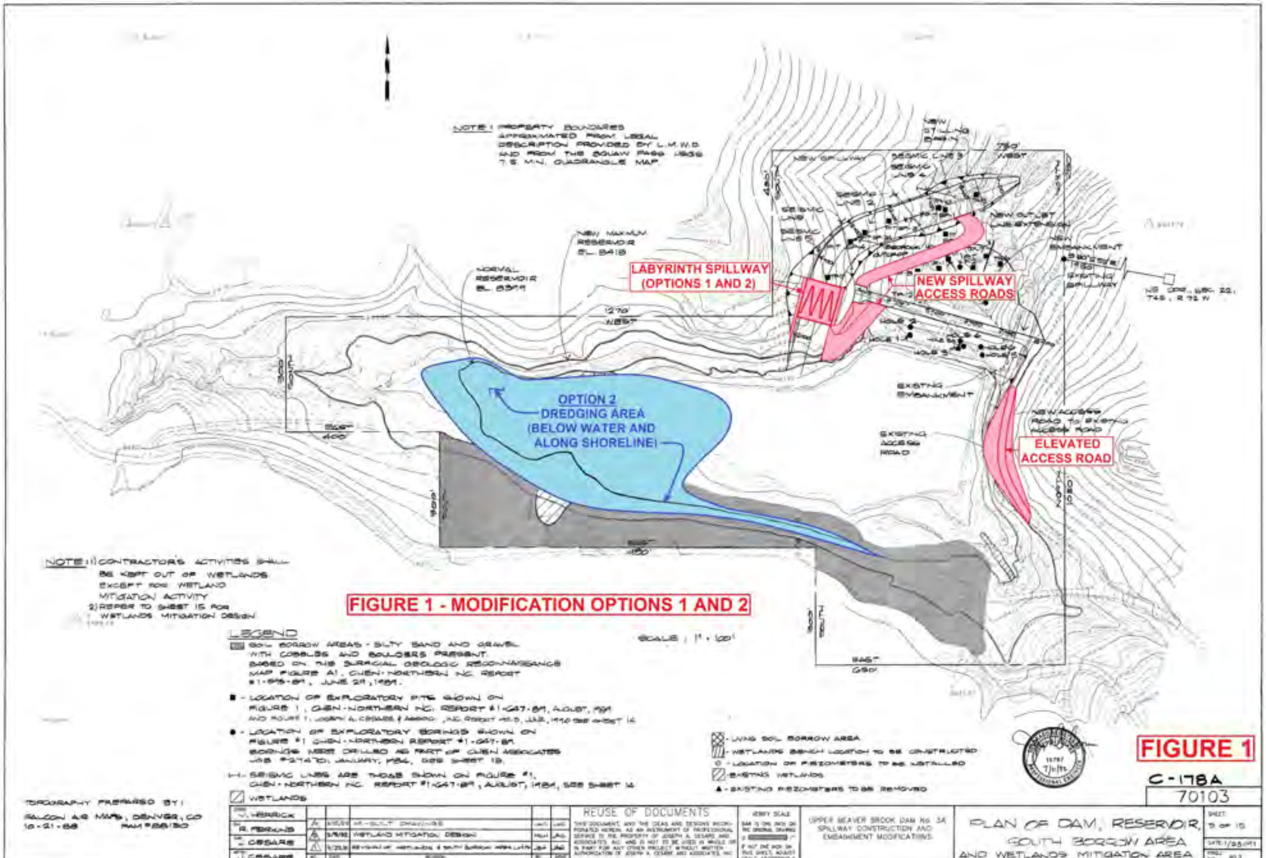
MAIN APPENDIX

Lookout Mountain Water District
Upper Beaver Brook

MODIFICATION
OPTIONS STUDY

OCTOBER 3, 2012

MAIN FIGURES
(3 TOTAL)


LABYRINTH SPILLWAY
(OPTIONS 1 AND 2)
NEW SPILLWAY
ACCESS ROADS
OPTION 2
DREDGING AREA
(BELOW WATER AND
ALONG SHORELINE)
ELEVATED
ACCESS ROAD
FIGURE 1 - MODIFICATION OPTIONS 1 AND 2
FIGURE 1
C-178A
70103
REUSE OF DOCUMENTS
UPPER BEAVER BROOK DAM No. 3A
SPILLWAY CONSTRUCTION AND
EMBANKMENT MODIFICATIONS
PLAN OF DAM, RESERVOIR,
SOUTH BORROW AREA
AND WETLANDS MITIGATION AREA

PROJECT COORDINATES			
POINT	NORTH	EAST	ELEVATION
A	9,865.99	10,209.08	8,394.65
B	9,959.93	10,375.55	8,443.26
C	10,179.30	9,610.50	8,491.51
D	9,897.64	9,685.78	8,390.77
E	10,137.95	9,754.69	8,451.06
F	10,274.09	9,888.47	8,402.32
G	10,381.34	10,271.98	8,307.56
H	10,120.00	10,155.00	8,329.86
J	10,273.48	10,300.22	8,321.66

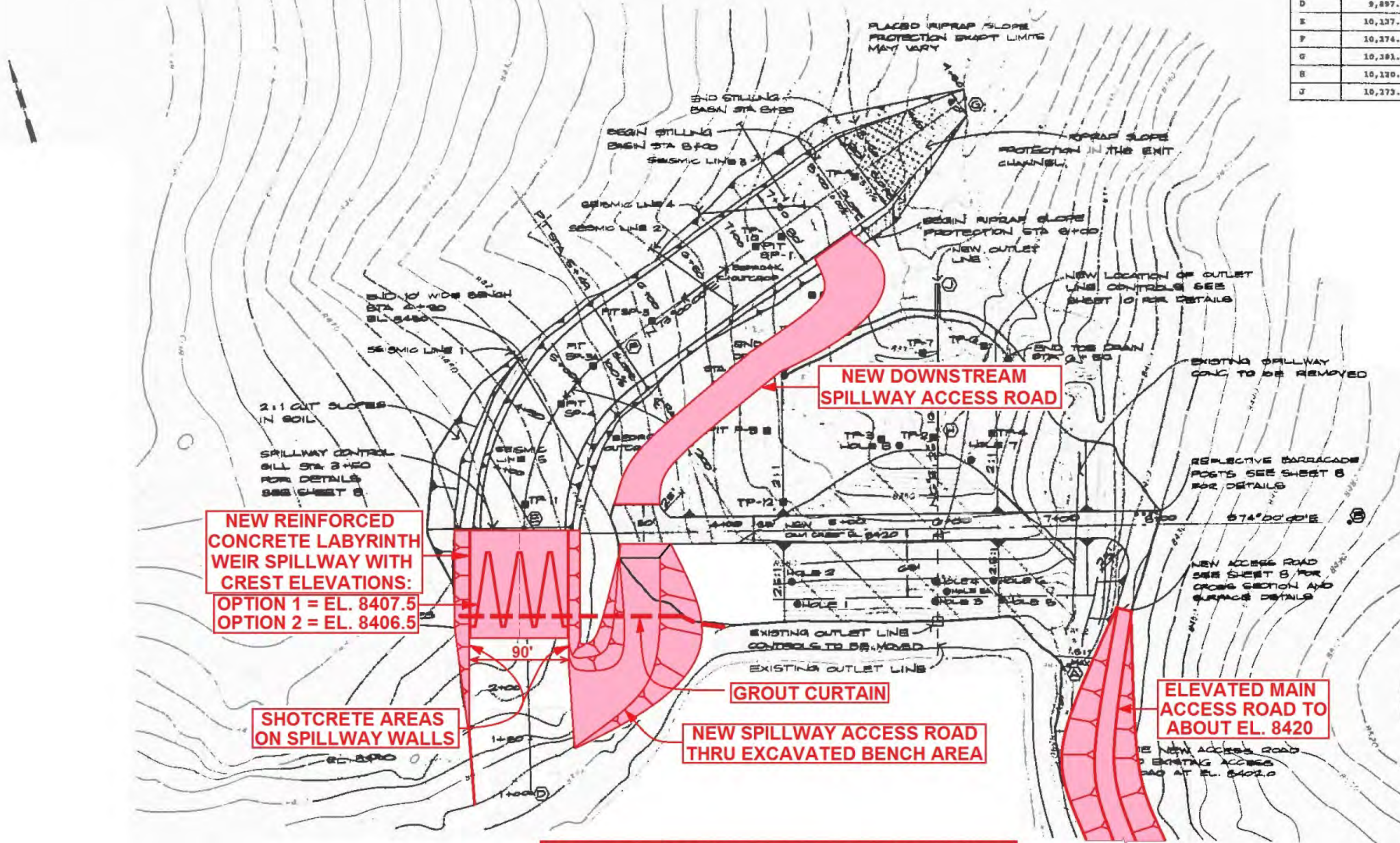


FIGURE 2 - MODIFICATION OPTIONS 1 AND 2
UPPER BEAVER BROOK NO. 3A DAM SITE

● TP-1 TEST PITS
● HOLE 1 EXPLORATORY BORINGS
SEISMIC LINE 3 SEISMIC EXPLORATORY LINES

SCALE: 1" = 30'

FIGURE 2

C-178A

70103

TOPOGRAPHY PREPARED BY:
FALCON AIR MAPS, DENVER, CO
10-21-88 JAM # 88150

DSGN: J. HERRICK
DR: R. PERKINS
CHK: J. CESARE
APVD: J. CESARE

NO. | DATE | REVISION | BY | APVD

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VERIFY SCALE
BAR IS ONE INCH ON THE ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALE ACCORDINGLY

UPPER BEAVER BROOK DAM No. 3A
SPILLWAY CONSTRUCTION AND EMBANKMENT MODIFICATIONS

PLAN OF DAM AND SPILLWAY

SHEET: 4 OF 14
DATE: 1/25/91
PROJ. NO. 90.3

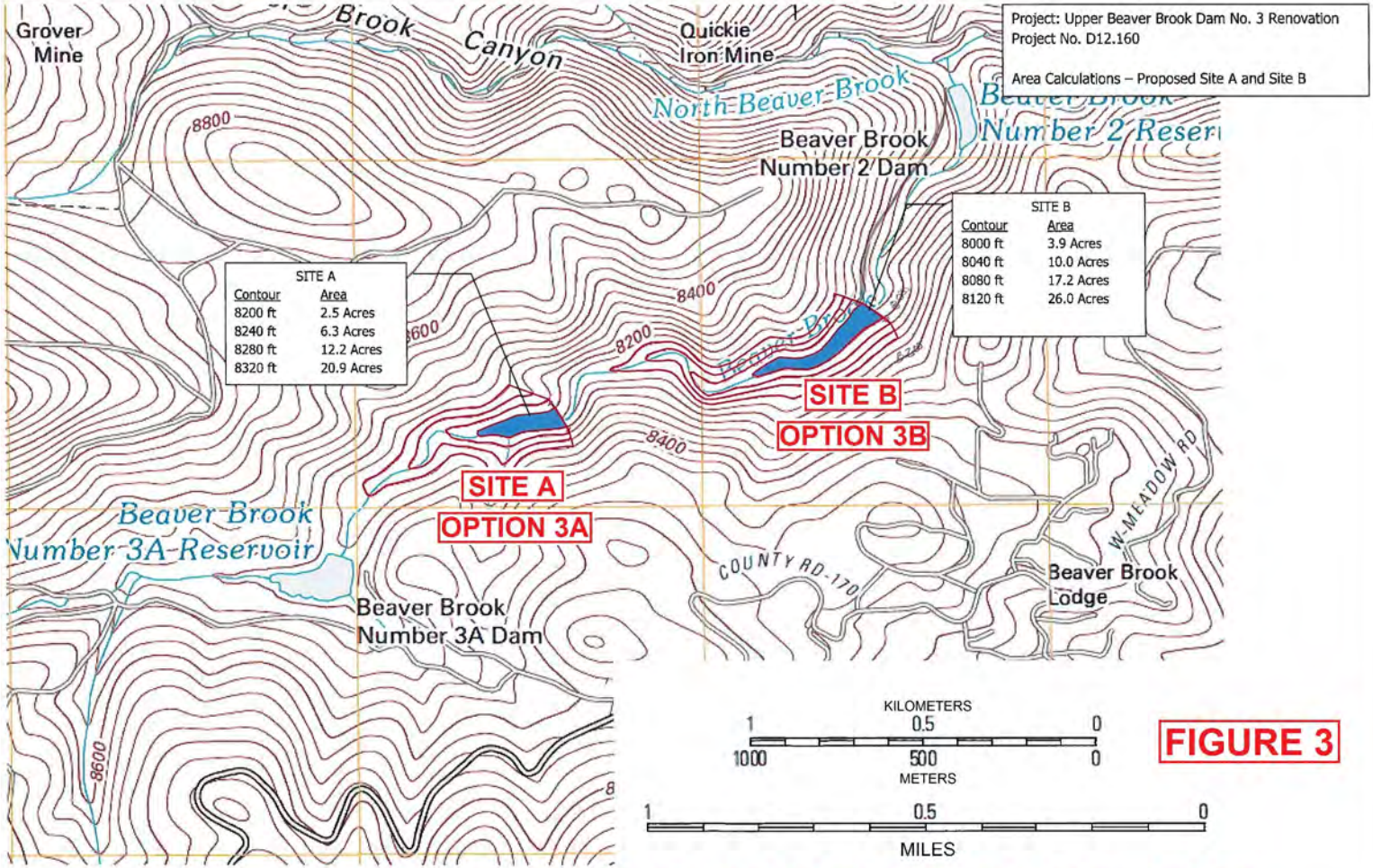


FIGURE 3 - OPTIONS 3A AND 3B PLAN - NEW RCC DAM BETWEEN BB #2 AND #3A DAMS

Lookout Mountain Water District
Upper Beaver Brook

MODIFICATION
OPTIONS STUDY

OCTOBER 3, 2012

REPORT TABLES

10/3/2012

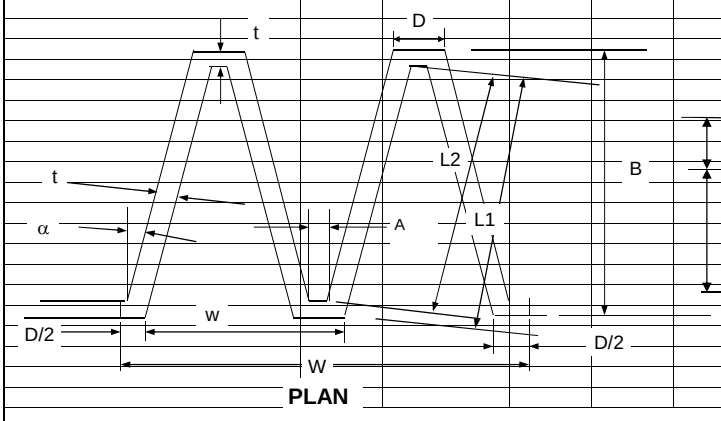
UPPER BEAVER BROOK DAM

LABYRINTH WEIR SPILLWAY DESIGN AND ESTIMATED COSTS - OPTION 1

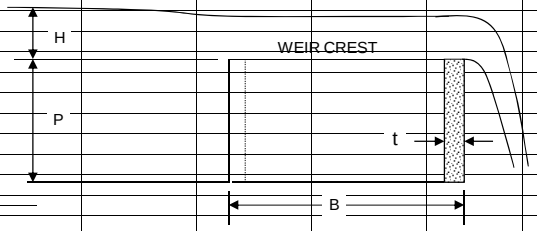
Parameter	Symbol	Value	Units	Source/Equation/Notes						
Maximum Flow	Q_{max}	18,990	ft^3/s	Input		Input Cells				
Max Reservoir EL	**res**	8418.00	ft	Input						
Approach Channel EL	**-**	8398.00	ft	Input						
Labyrinth Weir Crest EL	**El**	8407.50	ft	Input						
Total Head	H_t	9.724	ft	H_t = res-crest-loss						
Approach Channel Depth		20.000	ft							
Approach Channel Bottom Width		90.0	ft	Input						
Approach Channel Side Slopes **X**H:1V		0.25		Input						
Approach Channel Length		120.0	ft	Input						
Approach Channel Area		1,900	ft^2							
Average Approach Velocity		9.99	fps							
Inlet Head Loss at Maximum Flow	**Loss**	0.78	ft	Set to zero or estimated from preliminary calcs						
Angle of Approach Flow	**β**	0	deg	Negligible						
Number of Cycles	**N**	3	-	Select to keep w/P ~ 3 to 4						
Crest Height	**P**	10.0	ft	Set P ~ 1.4 H_t						
Angle of Side Legs	**α**	8.00	deg	Normally 8^o-12^o						
Thickness of Wall	**t**	1.67	ft	t = P/6						
Inside Width at Apex	**A**	2.92	ft	Select between t and 2t - larger decreases spillway capacity						
Outside Width at Apex	**D**	5.81	ft	D = A + 2t * tan(45 - α/2)						
Total Head/Crest Height	**H_t/P**	0.972	-	**OK**	H_t/P < 0.9 in order to maintain the effectiveness of the weir					
Crest Coefficient	C_d	0.270	-	C_d from 1995 Tullis paper			0.196	0.270	0.333	
Crest Coefficient	$C_{d'}$	1.444		Cd*(2g)^0.5/1.5			1.050	1.444	1.784	
Effective Crest Length	**L**	433.58	ft	$1.5Q_{max}/[(C_d*H_t^{1.5})*(2g)^{0.5}]$						
Length of Apron	**B**	74.66	ft	B = [L/(2N) + t*tan(45-α/2)]cos(α) + t						
Actual Length of Side Leg	L_1	73.71	ft	L_1 = (B-t)/cos(α)						
Effective Length of Side Leg	L_2	72.26	ft	$L_2 = L_1$ - t*tan(45 - α/2)						
Total Length of Walls	L_3	468.47	ft	$L_3 = N(2L_1 + D + A)$						
Distance Between Cycles	**w**	29.25	ft	$w = 2L_1*sin(α) + A + D$						
Width of Labyrinth	**W**	87.7	ft	W = N*w						
Distance Between Cycles/Crest Ht	**w/P**	2.92	-	**OK**	Normally between 3 and 4					

Wall Concrete Volume		569	yd^3	**Estimated Total Costs =**		**$1,026,395**	
Apron Thickness		2.0	ft	**(without grouting costs)**			
Apron Concrete Volume		843	yd^3				
Total Concrete Volume		1,412	yd^3				
Concrete Cost ($)		$958,939	$				
Approach Channel Volume		800	yd^3				
Excavation for structure		701	yd^3				
Approach Channel Costs ($)		$60,048	$				
Riprap Volume		148	yd^3				
Riprap Costs		$7,407	$				
Total Costs		**$1,026,395**	$				

Based on Paper From "Journal of Hydraulic Engineering, March 1995, Vol 121, No. 3", Entitled "Design of Labyrinth Spillways", J. Paul Tullis, Nosratollah Amanian, & David Waldron-Utah State University



PLAN



SECTION

TABLE 1

10/3/2012

UPPER BEAVER BROOK DAM

LABYRINTH WEIR SPILLWAY DESIGN AND ESTIMATED COSTS - OPTION 2

Parameter	Symbol	Value	Units	Source/Equation/Notes						
Maximum Flow	Q_{max}	18,990	ft^3/s	Input		Input Cells				
Max Reservoir EL	**res**	8417.00	ft	Input						
Approach Channel EL	**-**	8398.00	ft	Input						
Labyrinth Weir Crest EL	**El**	8406.50	ft	Input						
Total Head	H_t	9.636	ft	H_t = res-crest-loss						
Approach Channel Depth		19.000	ft							
Approach Channel Bottom Width		90.0	ft	Input						
Approach Channel Side Slopes **X**H:1V		0.25		Input						
Approach Channel Length		120.0	ft	Input						
Approach Channel Area		1,800	ft^2							
Average Approach Velocity		10.55	fps							
Inlet Head Loss at Maximum Flow	**Loss**	0.86	ft	Set to zero or estimated from preliminary calcs						
Angle of Approach Flow	**β**	0	deg	Negligible						
Number of Cycles	**N**	3	-	Select to keep w/P ~ 3 to 4						
Crest Height	**P**	10.0	ft	Set P ~ 1.4 H_t						
Angle of Side Legs	**α**	8.00	deg	Normally 8^o-12^o						
Thickness of Wall	**t**	1.50	ft	t = P/6						
Inside Width at Apex	**A**	2.63	ft	Select between t and 2t - larger decreases spillway capacity						
Outside Width at Apex	**D**	5.23	ft	D = A + 2t * tan(45 - α/2)						
Total Head/Crest Height	H_t**/P**	0.964	-	**OK**	H_t/P < 0.9 in order to maintain the effectiveness of the weir					
Crest Coefficient	C_d	0.273	-	C_d from 1995 Tullis paper			0.198	0.273	0.334	
Crest Coefficient	$C_{d'}$	1.459		Cd*(2g)^0.5/1.5			1.059	1.459	1.788	
Effective Crest Length	**L**	435.24	ft	$1.5Q_{max}/[(C_d*H_t^{1.5})*(2g)^{0.5}]$						
Length of Apron	**B**	74.62	ft	B = [L/(2N) + t*tan(45-α/2)]cos(α) + t						
Actual Length of Side Leg	L_1	73.84	ft	L_1 = (B-t)/cos(α)						
Effective Length of Side Leg	L_2	72.54	ft	$L_2 = L_1$ - t*tan(45 - α/2)						
Total Length of Walls	L_3	466.63	ft	$L_3 = N(2L_1 + D + A)$						
Distance Between Cycles	**w**	28.41	ft	$w = 2L_1*\sin(\alpha) + A + D$						
Width of Labyrinth	**W**	85.2	ft	W = N*w						
Distance Between Cycles/Crest Ht	**w/P**	2.84	-	**NG**	Normally between 3 and 4					

Wall Concrete Volume		539	yd^3	**Estimated Total Costs =**		**$991,898**
Apron Thickness		2.0	ft	**(without grouting costs)**		
Apron Concrete Volume		818	yd^3			
Total Concrete Volume		1,358	yd^3			
Concrete Cost ($)		$924,454	$			
Approach Channel Volume		800	yd^3			
Excavation for structure		701	yd^3			
Approach Channel Costs ($)		$60,037	$			
Riprap Volume		148	yd^3			
Riprap Costs		$7,407	$			
Total Costs		**$991,898**	$			

Based on Paper From "Journal of Hydraulic Engineering, March 1995, Vol 121, No. 3", Entitled "Design of Labyrinth Spillways", J. Paul Tullis, Nosratollah Amanian, & David Waldron-Utah State University

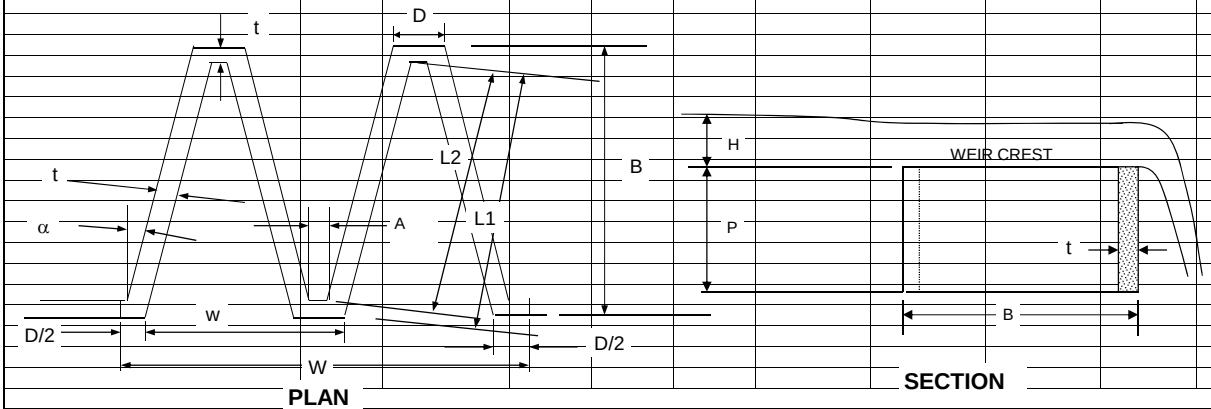


TABLE 2

UPPER BEAVER BROOK MODIFICATIONS - OPTION 1

LABYRINTH WEIR - 3 WEIR CYCLES - CREST EL. 8407.5

ESTIMATED TOTAL DESIGN AND CONSTRUCTION COSTS

BASED ON 2012 CONSTRUCTION COSTS

Item	Description	Quantity	Unit	Rate	Amount
1	Mobilization and Preparation work		LUMP SUM		$100,000
2	Care of Water		LUMP SUM		150,000
3	Rehabilitation of Existing Outlet Works:				
	Outlet Gate and Hoist Modifications		LUMP SUM		50,000
	Outlet Pipe Structure Improvements		LUMP SUM		20,000
4	Spillway Structure Modifications:				
	Reinforced Concrete Labyrinth Weir		LUMP SUM		1,027,000
	Shotcrete and Grouting		LUMP SUM		170,000
	Spillway Access Roads		LUMP SUM		24,000
5	Modification of Existing Access Road:				
	Excavation and Backfill		LUMP SUM		45,000
	Riprap Protection	200	cu.yd.	$30.00	6,000
	Gravel Surfacing	50	cu.yd.	$20.00	1,000
6	Miscellaneous Items:				
	Wetlands Area Improvements		LUMP SUM		20,000
	Wetlands Mitigation Exchange	3	ac.	$50,000	150,000
	Required Landscaping Work		LUMP SUM		30,000
	SUBTOTAL CONSTRUCTION COSTS =				$1,793,000
	COST CONTINGENCIES @ 30% =				$538,000
	ENGINEERING AND OBSERVATION @ 25% =				$583,000
	ESTIMATED TOTAL CONSTRUCTION COSTS =				**$2,914,000**

TABLE 3

10/3/2012

UPPER BEAVER BROOK MODIFICATIONS - OPTION 2

DREDGING AND LABYRINTH WEIR - CREST EL. 8406.5

ESTIMATED TOTAL DESIGN AND CONSTRUCTION COSTS

BASED ON 2012 CONSTRUCTION COSTS

Item	Description	Quantity	Unit	Rate	Amount
1	Mobilization and Preparation work		LUMP SUM		$150,000
2	Care of Water		LUMP SUM		150,000
3	Rehabilitation of Existing Outlet Works:				
	Outlet Gate and Hoist Modifications		LUMP SUM		50,000
	Outlet Pipe Structure Improvements		LUMP SUM		20,000
4	Dredging Operations and Modifications:				
	Dredging Operations-Below Water	17,000	cu.yd.	$30.00	510,000
	Dredging Operations-Along Shoreline	6,000	cu.yd.	$20.00	120,000
	Disposal Area Care/Modifications	23,000	cu.yd.	$10.00	230,000
5	Spillway Structure Modifications:				
	Reinforced Concrete Labyrinth Weir		LUMP SUM		992,000
	Shotcrete and Grouting		LUMP SUM		170,000
	Spillway Access Roads		LUMP SUM		24,000
6	Modification of Existing Access Road:				
	Excavation and Backfill		LUMP SUM		45,000
	Riprap Protection	200	cu.yd.	$30.00	6,000
	Gravel Surfacing	50	cu.yd.	$20.00	1,000
7	Miscellaneous Items:				
	Wetlands Area Improvements		LUMP SUM		50,000
	Wetlands Mitigation Exchange	7	ac.	$50,000	350,000
	Required Landscaping Work		LUMP SUM		30,000
	SUBTOTAL CONSTRUCTION COSTS =				$2,898,000
	COST CONTINGENCIES @ 30% =				$869,000
	ENGINEERING AND OBSERVATION @ 25% =				$942,000
	ESTIMATED TOTAL CONSTRUCTION COSTS =				**$4,709,000**

TABLE 4

10/3/2012

UPPER BEAVER BROOK MODIFICATIONS - OPTION 3A

NEW RCC DAM AND ACCESS ROAD - SITE A

ESTIMATED TOTAL DESIGN AND CONSTRUCTION COSTS

BASED ON 2012 CONSTRUCTION COSTS

Item	Description	Quantity	Unit	Rate	Amount
1	Mobilization and Preparation work		LUMP SUM		$200,000
2	Care of Water		LUMP SUM		150,000
3	Rehabilitation of Existing Outlet Works:				
	Outlet Gate and Hoist Modifications		LUMP SUM		50,000
	Outlet Pipe Structure Improvements		LUMP SUM		20,000
4	Modification of Existing Access Road:				
	Excavation and Backfill		LUMP SUM		10,000
	Riprap Protection	100	cu.yd.	$30.00	3,000
	Gravel Surfacing	50	cu.yd.	$20.00	1,000
5	New RCC Dam at Site A:				
	Land Purchase for Road and Dam	25	ac.	$20,000	500,000
	New Access Road	5,000	lin.ft.	$75.00	375,000
	Reservoir Site Clearing and Prep		LUMP SUM		100,000
	Dam Excavation and Cutoff Trench	8,000	cu.yd.	$25.00	200,000
	Dam Foundation and Grouting		LUMP SUM		200,000
	RCC Dam and Spillway Construction	24,000	cu.yd.	$100.00	2,400,000
	Dam Tower and Outlet Works		LUMP SUM		250,000
	Miscellaneous Dam Features		LUMP SUM		100,000
6	Miscellaneous Items:				
	Wetlands Area Improvements		LUMP SUM		100,000
	Wetlands Mitigation Exchange	15	ac.	$50,000	750,000
	Required Landscaping Work		LUMP SUM		100,000
	SUBTOTAL CONSTRUCTION COSTS =				$5,509,000
	COST CONTINGENCIES @ 30% =				$1,653,000
	ENGINEERING AND OBSERVATION @ 25% =				$1,791,000
	ESTIMATED TOTAL CONSTRUCTION COSTS =				**$8,953,000**

TABLE 5

10/3/2012

UPPER BEAVER BROOK MODIFICATIONS - OPTION 3B

NEW RCC DAM AND ACCESS ROAD - SITE B

ESTIMATED TOTAL DESIGN AND CONSTRUCTION COSTS

BASED ON 2012 CONSTRUCTION COSTS

Item	Description	Quantity	Unit	Rate	Amount
1	Mobilization and Preparation work		LUMP SUM		$200,000
2	Care of Water		LUMP SUM		150,000
3	Rehabilitation of Existing Outlet Works:				
	Outlet Gate and Hoist Modifications		LUMP SUM		50,000
	Outlet Pipe Structure Improvements		LUMP SUM		20,000
4	Modification of Existing Access Road:				
	Excavation and Backfill		LUMP SUM		10,000
	Riprap Protection	100	cu.yd.	$30.00	3,000
	Gravel Surfacing	50	cu.yd.	$20.00	1,000
5	New RCC Dam at Site B:				
	Land Purchase for Road and Dam	28	ac.	$20,000	560,000
	New Access Road	2,600	lin.ft.	$75.00	195,000
	Reservoir Site Clearing and Prep		LUMP SUM		100,000
	Dam Excavation and Cutoff Trench	6,000	cu.yd.	$25.00	150,000
	Dam Foundation and Grouting		LUMP SUM		200,000
	RCC Dam and Spillway Construction	19,000	cu.yd.	$100.00	1,900,000
	Dam Tower and Outlet Works		LUMP SUM		200,000
	Miscellaneous Dam Features		LUMP SUM		100,000
6	Miscellaneous Items:				
	Wetlands Area Improvements		LUMP SUM		100,000
	Wetlands Mitigation Exchange	18	ac.	$50,000	900,000
	Required Landscaping Work		LUMP SUM		100,000
	SUBTOTAL CONSTRUCTION COSTS =				$4,939,000
	COST CONTINGENCIES @ 30% =				$1,482,000
	ENGINEERING AND OBSERVATION @ 25% =				$1,605,000
	ESTIMATED TOTAL CONSTRUCTION COSTS =				**$8,026,000**

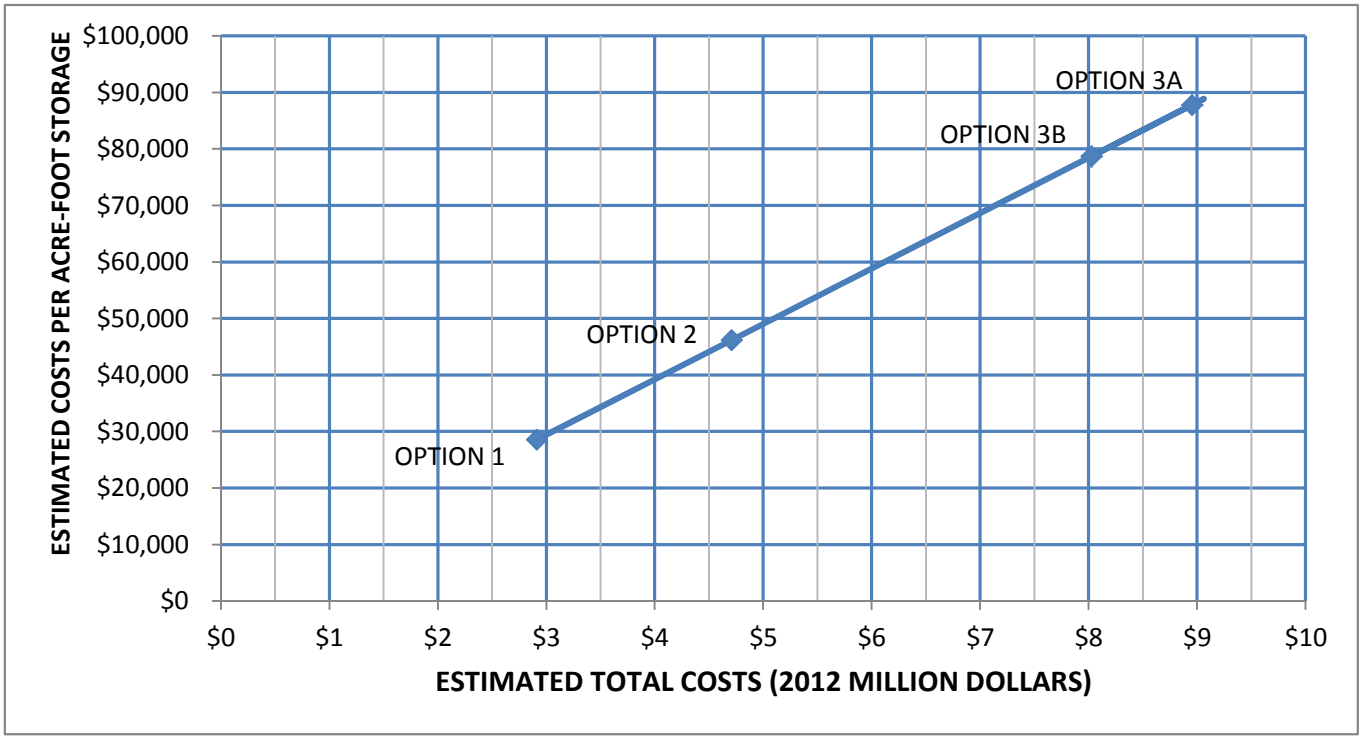
TABLE 6

10/3/2012

LOOKOUT MOUNTAIN WATER DISTRICT

UPPER BEAVER BROOK MODIFICATION OPTIONS COSTS

SUMMARY COMPARISON OF 2012 OPTIONS TOTAL COSTS



ESTIMATED TOTAL MODIFICATION COSTS SUMMARY:

OPTION 1 (LABYRINTH WEIR ONLY) * =	**$2,914,000**
OPTION 2 (DREDGING + LABYRINTH WEIR) =	**$4,709,000**
OPTION 3A (NEW RCC DAM AT SITE A) =	**$8,953,000**
OPTION 3A (NEW RCC DAM AT SITE B) =	**$8,026,000**

* ***OPTION 1 - USING THE LABYRINTH WEIR WITH 3 CYCLES AND WEIR CREST EL. 8407.5 IS THE RECOMMENDED OPTION FOR FINAL DESIGNS AND CONSTRUCTION SELECTION***

CESARE, INC.
Geotechnical Engineers & Construction Materials Consultants

TABLE 7

LOOKOUT MOUNTAIN WATER DISTRICT

UPPER BEAVER BROOK SYSTEM MODIFICATION OPTIONS

102 ACRE-FEET (AF) WATER STORAGE VOLUME ENLARGEMENT COMPARISONS

OPTION NUMBER	WATER STORAGE OPTION DESCRIPTION	ACCESS ROADS REQUIRED (LINEAL FEET)	VOLUME OF CONCRETE REQUIRED (CUBIC YARDS)	VOLUME OF DREDGING REQUIRED (CUBIC YARDS)	NEW LAND PROPERTY REQUIRED (ACRES)	WETLANDS MITIGATION REQUIRED (ACRES)	EXPECTED SERVICE LIFE (YEARS)	ESTIMATED TOTAL SYSTEM COSTS (2012 DOLLARS)*	ANNUAL CAPITAL COSTS PER AF WATER STORAGE**	OPTION OVERALL RANKING	OPTION COMMENTS
1	NEW LABYRINTH WEIR SPILLWAY (WEIR CREST EL. 8407.5)	900	1,420	0	0	3	75	$2,914,000	$380.92	1	TOP SELECTION
2	DREDGING AND NEW LABYRINTH WEIR SPILLWAY (CREST EL. 8406.5)	900	1,360	23,000	0	7	75	$4,709,000	$615.56	2	DREDGING HIGH IMPACTS
3A	NEW RCC DAM AT SITE A (83' DAM HEIGHT WITH 350' LENGTH)	5,000	24,000	0	25	15	100	$8,953,000	$877.75	4	CAPITAL COSTS TOO HIGH
3B	NEW RCC DAM AT SITE B (68' DAM HEIGHT WITH 400' LENGTH)	2,600	19,000	0	30	20	100	$8,026,000	$786.86	3	CAPITAL COSTS TOO HIGH

* ESTIMATED SYSTEM COSTS INCLUDE 30% COST CONTINGENCIES AND 25% ENGINEERING & OBSERVATION COSTS FOR DESIGNS AND CONSTRUCTION

** ESTIMATED ANNUAL CAPITAL COSTS PER AF WATER STORAGE = ESTIMATED TOTAL SYSTEM COSTS / EXPECTED SERVICE LIFE / 102 AF ADDED STORAGE

COMPARISON OF MODIFICATION OPTIONS

HIGHER RANKING PRIORITY WAS GIVEN FOR SYSTEMS WITH LOWER CAPITAL COSTS

BEST - OPTION 1: *RECOMMENDED TOP SELECTION - USING 3-CYCLE LABYRINTH WEIR SPILLWAY WITH CREST EL. 8407.5*

GOOD - OPTION 2: *BETTER USING 3-CYCLE LABYRINTH WEIR SPILLWAY WITH CREST EL. 8406.5 AND MINIMAL DREDGING*

FAIR - OPTION 3B: *REDUCE DAM SIZE WITH LIMITED ADDED STORAGE AT EXISTING 3A RESERVOIR-BUT STILL TOO COSTLY*

POOR - OPTION 3A: *REDUCE DAM SIZE WITH LIMITED ADDED STORAGE AT EXISTING 3A RESERVOIR-BUT STILL TOO COSTLY*

TABLE 8

Lookout Mountain Water District
Upper Beaver Brook

MODIFICATION
OPTIONS STUDY

OCTOBER 3, 2012

CALCULATIONS
AND CESARE
TECHNICAL MEMO

Project 12-014 Page 1 OF 1
Date 10/2/12 By DJBrown
Client Lookout Mtn. Water District Checked _____ By _____
Subject UBB Modification Options Approved 10/2/12 By DJB

Upper Beaver Brook Dam 3A Modifications Study

- Modification Options - (Using JACesare TM dated 9/26/12) -
  Option 1 - New labyrinth weir spillway to store additional 102 AF
  Option 2 - Dredging with new lower labyrinth weir spillway
  Option 3A - New RCC Dam located at Site A (102 AF water storage)
  Option 3B - New RCC Dam located at Site B (102 AF water storage)

- OPTION 1 - The design and estimated 2012 construction costs for the proposed labyrinth weir spillway are shown on Table 1 using weir crest El. 8407.5. The total costs of Option 1 are $2,914,000 as shown on Table 3.

- OPTION 2 - Rough estimate of dredging material quantities:
  Below water ≅ 200' x 450' x 5' depth / 27 ≅ 17,000 CY (Below)
  Shoreline ≅ 1000' x [(20'x5'depth) + 10'(10')/2] / 27 ≅ 6,000 CY (Shoreline)
  Dredging ≅ 23,000 CY (14 AF) or 14% of 102 AF required
  - Must combine with labyrinth weir spillway storage with lowered weir crest at El. 8406.5. The total costs of Option 2 are $4,709,000 as shown on Table 4.

- OPTION 3A - New RCC dam located at Site A, about 2,500' downstream of UBB 3A - 83' Max. high x 350' long
  RCC volume ≅ 24,000 CY (JAC calcs)
  New land purchase ≅ 25 acres @ $20K/acre
  Wetlands mitigation ≅ 15 acres @ $50K/acre
  - Total costs of Option 3A are about $ 8,953,000, as shown on Table 5.

- OPTION 3B - New RCC dam located at Site B, about 6,000' downstream of UBB 3A - 68' Max. high x 400' long
  RCC Volume ≅ 19,000 CY (JAC calcs)
  New land purchase ≅ 30 acres
  Wetlands Mitigation ≅ 20 acres
  - Total costs of Option 3B are about $8,026,000, as shown on Tables 6 and 7.

- Options Comparisons are shown on Table 8 and indicate the best Option selection as:

  * OPTION 1 - Recommend Top Selection to proceed with into Preliminary and Final Designs

CESARE, INC.
Geotechnical Engineers & Construction Materials Consultants

TECHNICAL MEMO

PROJECT NAME: Upper Beaver Brook Dam
PROJECT NO.: 12.160
FROM: Joseph A. Cesare, P.E.
DATE: September 26, 2012 (Revised by DJ Brauer on 10/2/2012)

This document summarizes our geotechnical analysis of aspects associated with the feasibility study for modifications to Upper Beaver Brook Dam 3A. The existing reservoir holds approximately 256 acre-feet of water and was raised from an initial crest elevation of 8,394 to a crest elevation of 8,420 between 1991 and 1992. Joseph A. Cesare and Associates, Inc. designed the modifications for initial raise. That raise was done by construction of a rock cut open spillway to pass the probable maximum flood of approximately 19,000 cfs. Rock from the excavation was used to raise the downstream shell. Soil from borrow excavations along the south upstream area of the reservoir was used to raise the relatively impervious core. Rock from the spillway cut was crushed and screened for filter, drain, riprap bedding, and riprap.

To our knowledge, the dam has operated satisfactorily since its construction in 1992. The purpose of this study is to look at increasing the reservoir size to accommodate an additional 102 acre-feet of storage. Based on the existing storage area curve from the 1991 design drawings, it appears that at elevation 8,407 there is a surface area of 14.25 acres and a storage increase of approximately 102 acre-feet.

As part of the scope of work, we looked at three categories.

1. Add storage by construction of a labyrinth weir spillway.
2. Add storage by dredging in the lake with possible lower labyrinth weir spillway.
3. Add storage at alternative dam sites downstream of Upper Beaver Brook Dam 3A.

The following report summarizes our findings.

LABYRINTH SPILLWAY

The labyrinth spillway hydraulics, size, and cost estimate are being developed by Future Engineering Technology Group. The labyrinth spillway will allow the design flood to pass with less head over the spillway lip. This will allow an increase in the normal pool of the reservoir and hence, more active storage without having to raise the dam. Geotechnical issues that need to be addressed with this concern with this spillway are

- its location,
- seepage control at the spillway,
- raising of the access road, and
- effects of increased reservoir level on the existing dam.

It's our opinion at this time that shotcreting should be considered from the control lip of the spillway back to the spillway entrance. As part of the shotcrete, slope protection/remediation would need to be addressed along the west abutment of the spillway because of existing rock falls in that area. It's our understanding that the labyrinth weir will have an approximately 50 to 60 foot apron that will continue upstream from the existing control sill. This should put the labyrinth weir in relatively good quality rock consistent with what was observed in our field exploration and upstream of the centerline of the existing dam.

In addition to the shotcrete on both sides of the spillway, we would recommend a grout curtain be constructed underneath, along centerline of the labyrinth weir. The labyrinth weir, as part of the construction, should have a thickened plynth block section through which the foundation grouting can be conducted. The grout curtain would extend to the east at a slight angle from the labyrinth weir on a line to the existing normal pool level. Depth of the grout curtain should go to approximate elevation 8,370.

The purpose of the shotcrete and a grout curtain would be to channel seepage through the potentially fractured rocks so that the majority of it would have to encounter the relatively impervious upstream shell of the dam and be filtered through the filter media. There is an area that will not be covered by this grout curtain, but, because of the existence of the grout curtain will still result in a reduction of head and seepage pressure.

As part of the labyrinth weir study, access should be developed to both the upstream and downstream end of the spillway for future maintenance. Access to the downstream end is assumed to be done by bulldozer and would involve regrading existing material in this area. Upstream access could be provided by removing the existing rock above the existing dam crest between the existing dam and the spillway be cut. This material can be placed into the upstream portion of the labyrinth weir for access, or, to augment the access at the lower end of the spillway.

We estimated the shotcrete to cover approximately 8,000 square feet at a cost of $10 per square foot for an estimated cost of $80,000. We have estimated grouting to require 45 grout holes at $2,000 per hole for an estimated cost of $90,000.

Regrading was estimated at approximately 800 cubic yards of rock excavation at $25 per cubic yard for an estimated cost of $20,000. Grading at the lower end of the spillway was estimated at two days of bulldozer work at $2,000 per day for an estimated cost of $4,000.

DREDGING

Additional storage could be generated by dredging material that exists below and adjacent to the water line of the reservoir. There are limitations to dredging. As a minimum, dredging should not be allowed to occur within a distance of 300 feet of the upstream toe of the existing dam. Excavation in this area could open seepage paths that could increase seepage through the dam. Increase seepage could result in issues of piping and overall dam stability concerns.

Limiting the potential dredging area limits the amount of material that can be removed from the reservoir. We have delineated an area 300 feet from the existing reservoir to the proposed new reservoir level as a location inside which dredging should not occur. This proposed dredging area is shown in Figure 1. There are two major components to evaluate for dredging. First, is there a meaningful volume of material that's excavatable inside the reservoir? We do not know this at the current time. A bathymetric survey and some form of subsurface exploration inside the reservoir is necessary to answer this question. Geologically, the area does not look as though it has a deep alluvial deposition, so, from a cursory standpoint, the amount of volume that could exist within the reservoir that is readily dredgeable is questionable.

The overburden material (soil) on-site is derived from glaciation and subsequent water transport from high energy stream flows. This means that large rocks and cobbles are contained in this material which would prove difficult for conventional floating dredge operations. The other alternative would be dragline excavation. This would require lowering the water level for access.

Once the material is removed from dredging, the second component is disposal of the materials. If a floating dredge is used, the material is pumped from the dredge and disposed as a slurry and allowed to drain. If a dragline is used, the material is deposited near the dragline and hauled away. The most readily available area for disposal is the area upstream above the proposed water level to the west. This area was previously modified to add wetlands that the 1991 raise removed. At that time, the wetlands had to be replaced at a rate of 1.6 acres for every acre taken out. This resulted in the construction of approximately 1.6 acres of wetlands. As the existing reservoir level is raised by this proposed modification, this area will be inundated. That means not only will that area not be available to dispose of dredge material, but that area will be removed. Therefore, it's intuitive that as a minimum the wetlands area would need to be reclaimed at possibly at a greater area than removed. This essentially eliminates this area to dispose of dredge tailings.

Without doing any calculations on the amount of material to be dredged, once the wetlands are removed, it's very probable that the only amount of area left to reasonably reclaim for wetlands is approximately 1.4 acres. The 1.4 acres is less than what would be removed. It appears there may be issues with having enough area to reclaim as wetlands. Also, the area slopes more than the originally reclaimed area and would require regarding to put it within required water table depth. Additionally, the inflow to the reservoir and a parshall flume is in this area that would need to be maintained or moved. These issues still do not address where the dredge tailings would be placed, but do raise the question of wetlands remediation.

Unless dredge tailings are to be pumped from the reservoir area, it would appear from this cursory evaluation that dredging is not feasible. Should dredging be conducted, however, the available area in the reservoir to dredge is approximately 9 acres. This area would need to be excavated to approximately 11 feet deep in order to achieve the 100 acre-feet of storage. Not only does this seem to be difficult to achieve with the geologic environment and soil types in the area, it would also result in a need to dispose over 100 acre-feet of dredged tailings which is over 160,000 cubic yards of material. Just using similar areas would require a 9 acre area to be raised 11 feet. We are not aware of such an area in close proximity to the reservoir.

It is our initial opinion that due to potential wetlands issues, limited disposal area, and probable lack of readily dredgeable material, that the option for dredging does not appear to be feasible, unless accompanied with a labyrinth weir spillway structure and lowered weir crest elevation.

ALTERNATIVE RESERVOIR SITES

Two reservoir sites between Upper Beaver Brook Dam 3A and Beaver Brook Dam 2A were investigated. No sites below Beaver Brook Dam 2 were investigated even though one already does exist that belongs to LMWD. The existing reservoir, or reservoir sites, that exist below Beaver Brook Dam 2 are below the water treatment system and would require installation of pipelines and pumping to put the water back into the system. Therefore, reservoir sites below Beaver Brook Dam 2 do not appear feasible.

Two sites are designated site A and B and are located and are shown on Figure 3. These reservoir sites exist in relatively rugged terrain between the two reservoirs 3A and 2 with no existing access to either site. We assume that access would be via road from Beaver Brook Dam No. 2 to the south. We used existing hydrology from Upper Beaver Brook Dam 3A to crudely size these reservoirs to allow for passage of the PMF storm and maintain 100 acre-feet of storage. Site A would have a dam with a crest length of approximately 350 feet and a height of approximately 83 feet high. Site B required a dam of 68 feet high with a 400 foot crest length.

It is probable that there is a lack of construction materials for an earthfill dam at these sites. We have assumed the most probable dam type because of the location and geology of these sites would be roller compacting concrete dams.

Calculating volumes for these dams resulted in a roller compacted concrete volumes of 23,250 cubic yards at site A and 18,365 cubic yards at site B. Construction of these dams and reservoirs would be difficult because of access. Both would require all aggregates to be trucked to site unless a quarry is opened. The spillway excavation was used as a quarry for Upper Beaver Brook Dam 3A aggregate material and it encountered larger quantities of waste than anticipated. It would be our opinion that opening of a quarry for this site not only would be risky but could have environmental issues that the neighbors may not be willing to accommodate. Regardless of whether a quarry is opened on-site or materials trucked in, an access road of approximately one mile would need to be constructed in order to access site A and 0.5 miles to access site B. Based on dam volume and access road length, site B would be the more favorable of the two.

Based on estimates of $75 per foot for the access road and $100 per cubic yard for roller compacted concrete and with 50 percent contingency for construction and engineering resulted in an estimated construction cost of approximately $3 million. This analysis does not take into account any kind of environmental issues or land acquisitions.

ACCESS ROAD

Access will need to be improved to the dam. The access road that enters from the east and turns to the north to access the right abutment of the dam is currently has an elevation of approximately

8,402 at its lowest point which is 3 feet above current normal pool that allows for access to the dam crest during the 100-year storm.

Proposed elevation for the new reservoir will be approximately 8,407. This means that the road should be raised to at least elevation 8,410. To be conservative we estimated the elevation to be 8,413. Because of the existing reservoir and the width of the road it doesn't appear feasible to raise area by constructing a fill. At this time two options of either a cut into the rock at this location and constructing the raise by cut and fill, or, construction of an MSE wall. We estimate this rock cut to be approximately 1,800 cubic yards at a cost of $25 per cubic yard for a total estimated price of $45,000. An MSE wall would have a length of 300 feet and an estimated average height of 6 feet. This resulted in a wall with a 1,800 square foot surface area at an estimated cost of $35 per square foot. The total estimated MSE cost was $63,000. Figure 2 shows the areas for shotcrete, grouting, spillway access, and access road raising.

SUMMARY OF ESTIMATED COST

The following table presents a summary of our estimated costs. Realize these are feasibility level estimates based on judgment, experience, and conversation with a contractor experienced with your site. These should not in any way be considered valid or assured, but are presented to give a relative evaluation of options for this study. Final prices can only be determined after completion of final design and prices are proposed by qualified contractors.

TABLE 1. Summary of Estimated Costs

1. Dredging	Not estimated, not feasible
2. Site B RCC Dam and Access Road [(1)]	$3 million+
3. Labryinth Weir [(2)]	
Shotcreting	$80,000
Grouting	$90,000
Spillway Access	$24,000
Access Road Modification	
Cut and Fill	$45,000
MSE Wall	$63,000

(1) A 50% contingency has been assumed.

(2) No contingencies have been assumed.

DAM STABILITY

The proposed raising of the reservoir to approximately elevation 8,410 was briefly reviewed based on the original design report of June, 1990. Based on that report, the stability analysis showed a long term steady state seepage factor of safety of 1.68 for the reservoir with a normal pool at 8,399 and a factor of safety of 1.44 with the reservoir at the PMF flood elevation of 8,419. By comparison of factors of safety versus elevation, it would appear that the factor of safety for the water at elevation 8,410 for long term steady state seepage is approximately 1.55, which is acceptable. If the water elevation is 8,407 the factor of safety is approximately 1.60.

Similarly, the seismic stability analysis for the original dam showed a factor of safety of 1.29 with the water at normal pool of 8,399. There was no analysis done with water at a higher height because that would be considered an extremely conservative analysis. Intuitively, the factor of safety will be less. However, based on our experience and literature that dams with factors of safety 1.5 or over for long term steady state seepage typically have seismic stability factors of greater than 1.0 for horizontal accelerations of typically 0.1 to 0.15g which would apply to this reservoir.

Additionally, the deformation analysis done back in 1990 indicated that the probability of liquefaction was low and if deformation did occur during seismic events, the calculated deformation was estimated to be between 2 to 6 inches, which would be within the free board even during the PMF flood. It would appear based on this preliminary analysis that stability of the existing reservoir for the probable reservoir level increase raise would be acceptable. This should be evaluated at greater detail during preliminary and final design.

SEEPAGE

As the reservoir level is raised, the current seepage will increase. The 1990 design report calculated seepage at 0.13 cubic feet per second (cfs) based on a ratio of length of seepage path and head. For an increase of the reservoir level to 8,410 this seepage is calculated to increase approximately 13 percent to a flow of 0.15 cfs, or approximately 65 gallons per minute. If the reservoir is raised to 8,407 the seepage value would decrease slightly. We do not know the current seepage rate on the dam and recommend review of the existing safety inspection records and piezometer readings during preliminary and final design.

At this time, no additional subsurface investigation is being anticipated other than more detailed field mapping. This will be developed as the feasibility design develops. As part of the grouting, in situ Packer testing should be done to better define depths and lengths of grouting.

CALCULATIONS

Calculations have been included in Appendix A.

APPENDIX A

CESARE, INC.
Geotechnical Engineers & Construction Materials Consultants

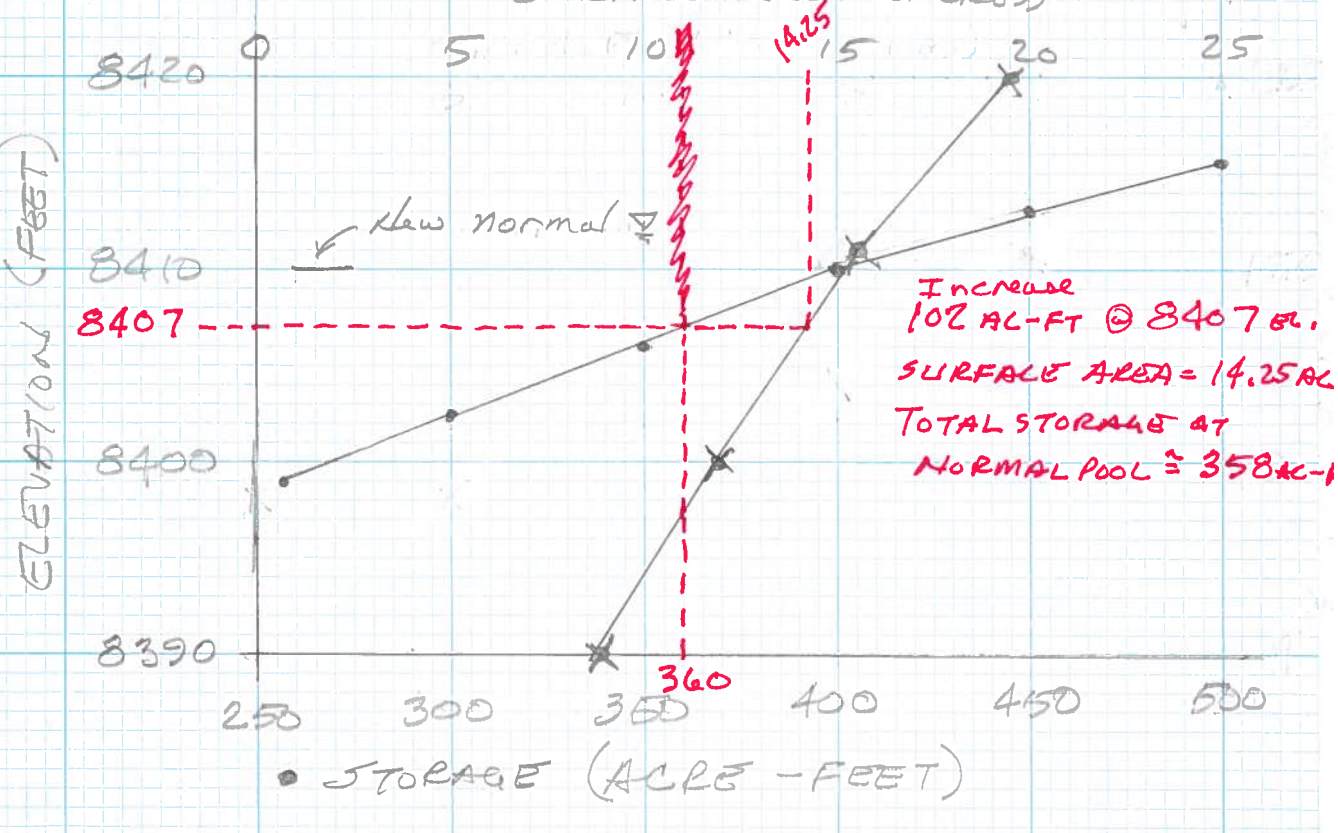
PROJECT NO. D12.160 SHEET 1/12
PROJECT Upper Beaver Brook Dam 3A CALC JAC DATE 9/5/12
SUBJECT Enlargement Options CHKD _____ DATE _____

Purpose: Evaluate probable methods of increasing storage (LMWD) for Lookout Mountain Water District. Areas to investigate a) dredging
b) new reservoir between dam 3A and 2
c) Labyrinth Spillway addition

Current drawing by LMWD has the new normal pool at 8410. Based on storage area curve (interpolated from original plans) storage volume at 8410 is approximately 400 AC-FT for and increase of 154 AC-FT above curret storage of 256 AC-FT.

* 9/5/12 - Desired volume increase is 102 AC-FT to 358 AC-FT - use 360

From Storage Area Curve: Sheet 2 of 14 orig. dwgs.



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PROJECT NO. D12.1620 SHEET 2 of 2
PROJECT Upper Beaver Brook Dam 3A CALC JAC DATE 9/5/12
SUBJECT CHKD DATE

Dredging: Feasibility of Dredging to increase storage:

1) Cannot excavate near dam; dredging has a high probability of increased seepage. Because of nature of metamorphic rock comprising the foundation and previous seepage issues are of dredging should be limited. Area to be a minimum of 300' from reservoir toe.

Low storage area current 8407 surface area = 14.25 AC.

Area available to dredge - outside of the 300' zone is estimated at approx. 8.9 acres (see attached sheet)

Of this volume the wetlands will need to be replaced - assuming just similar replacement which is not conservative - area ≅ 1.6 acres. use 2 acres assuming an increased requirement.

Look at area for disposal - assuming disposal in general reservoir area within property bounds - only approx 200' x 300' exist below elevation 8420 in relatively flat ground. Even in this area is the inflow and parshall flume - area is 1.4 acres - no room for disposal and possible issues w/ wetland replacement if required.

Should consideration be to pump to the east on LMWD property relatively level ground would be desired - if 5' could be dredged for appx 9 acres this would yield 45 acre-feet of additional storage. Disposal similarly would

require a similar area w/fill 5' high. Lesser areas would have smaller height and vica-versa-

Conclusion: Dredging not feasible in general area of reservoir. Additional land would need to be required (acquired?) and spoils pumped. Costs would be a function of production rates and equipment used. Cobbles could cause problems with smaller floating dredges. Draglines would limit areas to be dredged and would increase material handling costs.

Alternate Reservoir Sites: Feasibility of constructing a reservoir between 3A and 2.

Look at recent topographic mapping.

Topographic difference ≅ 540 feet from toe of 3A to mid. res. 2 - distance ≅ 8000' - slope = 540/8000 ≅ 7%

Located two sites from topographic map and Google Earth. Areas appeared the "flatter" areas which should result in lower dam.

Using Google Earth a storage area curve was approximated for an embankment up to 120' high.

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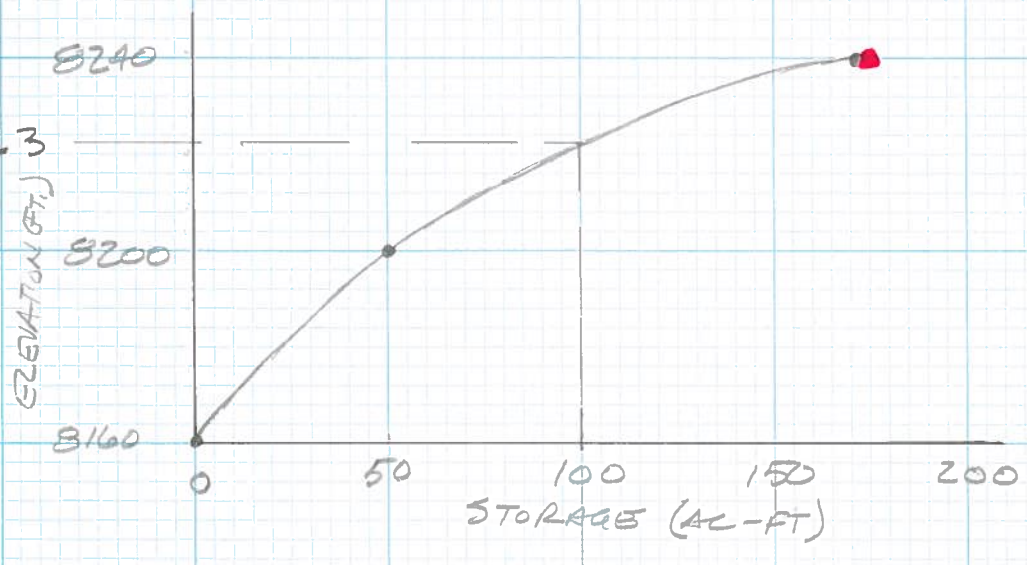
PROJECT NO. D12160 SHEET 4/12
PROJECT
CALC JAC DATE 9/10/12
SUBJECT
CHKD DATE

SITE A

Elevation (FT)	Δ	Area (AC)	AVG.	Vol. (AC-FT)
8160		0		
	40'		1.25	50
8200		2.5	4.40 ~~4.30~~	176 ~~172~~
	40'	~~6.1~~ 6.3		
8240			9.25 ~~9.0~~	370 ~~360~~
	40'	12.2 ~~11.9~~		
8280			16.5 ~~16.1~~	662
	40'	20.9 ~~20.3~~		
8320				



EMBANKMENT ≅ 8223 for 100 AC-FT STORAGE

If earth embankment assume 20' freeboard same as 3A

height = (8223+20) − 8160 = 83 feet high.

Crest length approx. 350' scaled.

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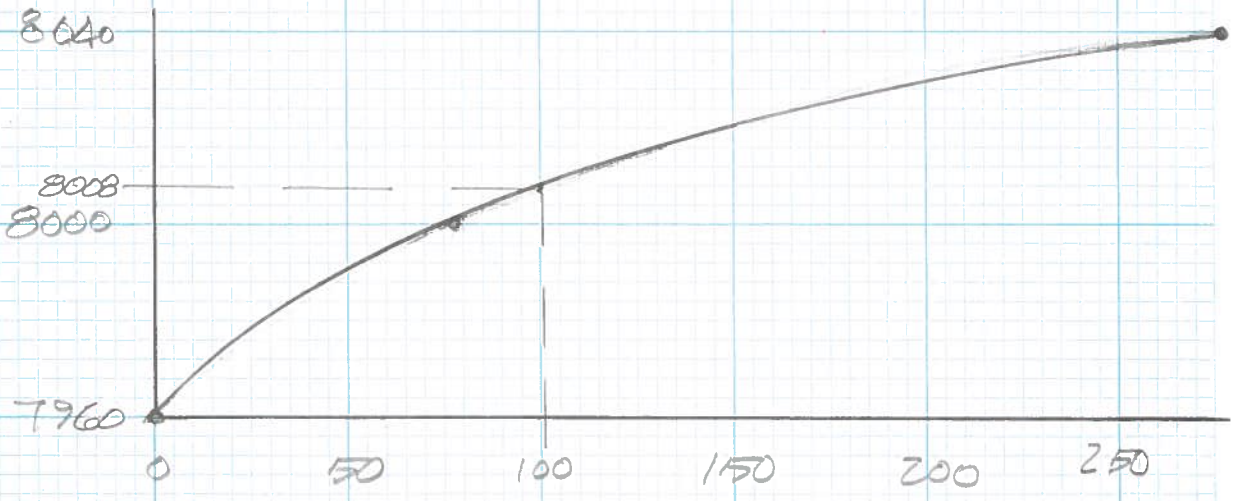
PROJECT NO. D2160 SHEET 5/12

PROJECT _____ CALC HC DATE 9/10/12

SUBJECT _____ CHKD _____ DATE _____

SITE B

Elevation (FT)	Δ	Area (AC)	AVG.	Vol. (AC-FT)
				0
7960		0		
	40		1.95	78.0
8000		3.9		
	40		6.95	278.0
8040		10.0		
	40		13.6	
8080		17.2		



WATER LEVEL @ 8008 for 100 AC-FT. storage –

Assume 20' for freeboard (8008+20) – 7960 = 68'

Dam 68' high

Crest length ≅ 400' scaled

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PROJECT NO. D12.1160 SHEET 6/12
PROJECT _____ CALC HAC DATE 9/10/12
SUBJECT _____ CHKD _____ DATE _____

Estimate Quantities for dams - from figures 10.1 – 10.3; Roller Compacted Concrete Dams by Hansen & Reinhardt 1991

RCC volumes:

$$V = \frac{(SH)^2(L_t + 2L_b) + 3T_c^2 L_t}{162S}$$

where V = vol in CY
S = slope of d.s. face
H = height of max section + 5' over ex.
L_t = X sectional length of dam at crest + 15 feet exc. at each abut
L_b = base of dam
T_c = thickness (uplift) of crest (Ft)

assume 20' crest width
0.8:1 d.s. slope

Site A: assume base is 100'

$$V = \frac{(0.8 \times 83)^2((350+15+15) + 2(100)) + 3(20)^2(350+15+15)}{162(0.8)}$$

$$\cong 23{,}250 \text{ CY}$$

SITE B

$$V = \frac{(0.8 \times 68)^2((400+15+15) + 2(100)) + 3(20)^2(400+15+15)}{162(0.8)}$$

$$V \cong 18{,}365 \text{ CY}$$

Site B has smaller dam volume; use it for further analysis.

Dam would require access road:
Road from Beaver Brook 2 to Site B; approx 0.5 miles
assume 100'/day w/ bulldozer, loader & grader @ $750/hr,
for equipment = 750 × 10 hr/day = 7500/day per 100' = $75/ft.
5280(0.5)(75) = $198,000 – say $200,000

RCC @ $100/cy = 18,365(100) = $1,836,500

assume 35% contingency and 15% for engineering

(1,836,500 + 200,000) 1.50 = $ 3,054,750

Development of lowest reservoir not feasible as it is for augmentation water and below the treatment plant. Would require >10 miles of pipeline and pumping.

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PROJECT NO. D12.160 SHEET 8/12

PROJECT _____ CALC JAE DATE 9/14/12

SUBJECT _____ CHKD _____ DATE _____

LABYRINTH SPILLWAY

— Cost and hydraulics by FETC —

Geotechnically:

1) Locate in existing spillway upstream of existing control sill. Will require 50'-60' apron. Use existing control sill as d.s. limit of spillway.

2) From field visit

FETC a) slope protection on left abutment from existing and potential future rock falls

b) Moving upstream provides better rock for abutments

JAE c) Consider as a minimum shotcreting of side slopes to 8421 u.s. of weir to 8399 and d.s. tapering at the control sill to 2' above flow depth.

JAE d) Consider grout curtain to force increased ½ and seepage into d.s. shell of dam. From left abutment of weir to current normal pool u.s. of sta 3+00+/-

JAE 3) Need access to u.s. and d.s. of weir for surveying to 8370

JAE 4) Need to raise road at least above 100 yr. level on right abutment of dam.

5) Evaluate increased seepage based on initial study

6) Evaluate dam stability based on initial study.

7) Review past safety inspections.

8) Consider coring & packer testing one hole in spillway and right abutment of spillway. Could be done during grouting.

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PROJECT NO. D12160 SHEET 9/12
PROJECT _____ CALC JAC DATE 9/14/12
SUBJECT _____ CHKD _____ DATE _____

Shotcrete area - assume rt. abutment excavated to 8420 w/access to U.S. entrance to spillway -

Area Right abutment: 150' x (8420-8399) = 3150 □'

Left Abutment - assume to 8421 from 8399 for 225'

225 (8420-8399) = 4725 □'

Total area = 7,875 □'

Grouting: Assume spillway width (plinth block part of spillway)

depth - to elevation 8370 -

80(8399-8370) = 2,320 □'

Right abutment - 8420-8399(90') = 1890 □'

Total Area = 4,210 □'

or look at grouting - say holes 4'o-c over 170'

= 170/4 ≈ 42.5 - say 45 holes

ESTIMATED COSTS -

Shotcrete - ≈ 8000 SF @ $10/FT² = 80,000

Grouting - 45 holes @ $2000/hole = 90,000

Total = $170,000

Regrading: At entrance and exit from spillway -

Upper Access: ~~Assume~~ a prism – 200' long, max 25' high
max 25' width

Volume = $\frac{1}{3}\left[\frac{1}{2}(200)(25)(25)\right]/27$ = 772 cy – say 800

assume $25/cy rock ex. & placement

800(25) = $20,000

* 772 / (80(100)/27) ≅ 2.6' dep
say 3' deep

* (waste u.s. in spillway area)

Lower Access:

Dozer work to regrade –
say 2 days @ 8hr./day × $250/hr

2(8)(250) = $4,000

Road Construction – Current road at 8402 passes the 100 yr. storm above 8399 –
use the same number – 3' above assumed spillway elevation of 8410 –
is 8413 –
Need to raise road 8413 – 8402 = 11'

Due to existing reservoir not practical to construct fill – either excavate back into slope or build MSE –
Assume cut/fill for road –

volume to raise road – say 300'long, 15' wide 11' high
should be conservative – 300 × 15 × 11/27 ≅ 1833 cy say 1800

cut tapers to 0 at each end – 1800($25/cy) = $45,000

MSE – Wall – assume 300' long and an average height of 6 feet.

MSE WALL – @ $35/SF. = 35(300)(6) = $63,000

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PROJECT NO. D121600 SHEET 11/12

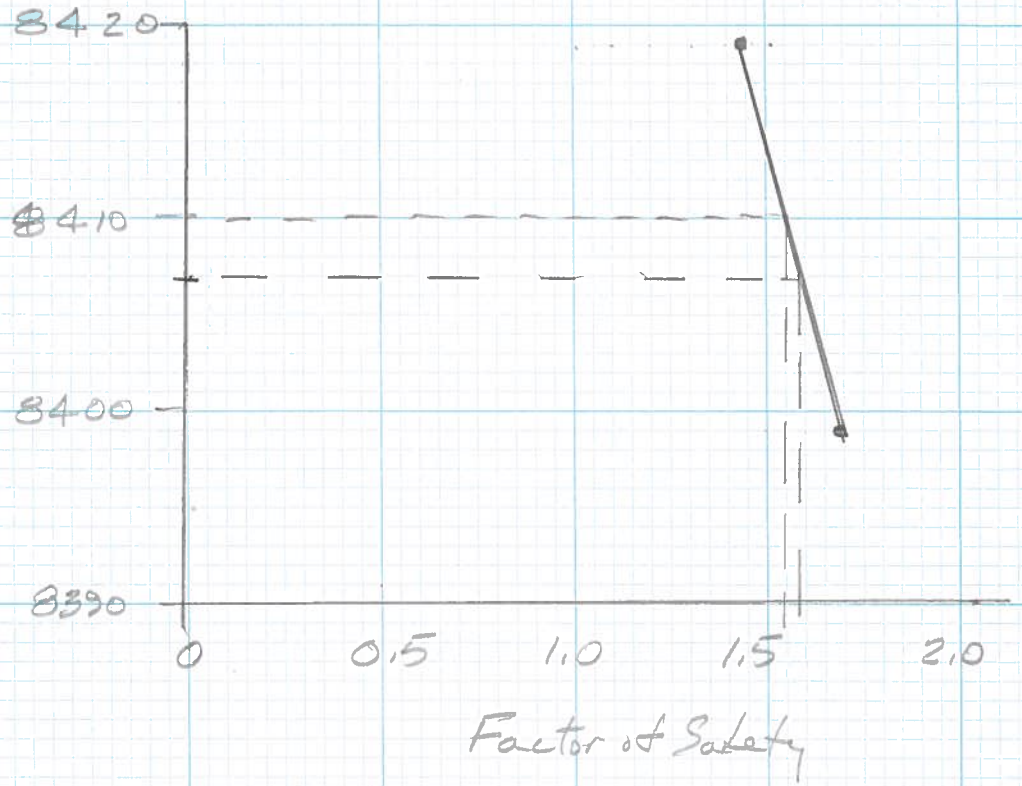
PROJECT _____ CALC JAC DATE 9/14/12

SUBJECT _____ CHKD _____ DATE _____

Look at Stability Based on Prev. Work —

—— stability analyses showed F.S. = 1.44 for long term steady state w/ ▽ @ PMF & 8419, F.S. = 1.68 for long term S.S. @ ▽ = 8399

Using these as data points



Assumed ▽ @ 8410 yield F.S. = 1.55 — OK —

F.S. for seismic only analyzed w/ ▽ @ 8399 — needs to be addressed — F.S. = 1.29; literature and exp. has shown for F.S. = 1.5 or greater, pseudo static analyses generally are > 1.0, say OK at this point. needs to be further evaluated.

previous analyses indicated liquefaction unlikely. Deformation analysis indicated 2" to 6" deformation which is within free board even at PMF.

CESARE, INC.
Geotechnical Engineers & Construction Materials Consultants

PROJECT NO. D12,160 SHEET 12/12
PROJECT
CALC DJC DATE 9/14/12
SUBJECT
CHKD DATE

Seepage: Seepage will increase and should be analyzed in greater detail in design.

Based on existing analyses:

maximum head in initial design was nominally 8400 to 8330 or 70'-

head now will be 8410 to 8330 or 80'-

For initial evaluation assume seepage is linear and a function of $i = \frac{\Delta h}{\Delta L}$

at max. section i was $\frac{70}{310} = 0.23$

now $\frac{80}{310} = 0.26$

$0.26/0.23 = 1.13$ - say 13% increase -

should review inspection records for seepage rates and piezo. readings. Based on previous design seepage should be: $0.13(1.13) = 0.15$ cfs or 67 gpm

Appendix H Burns & McDonnell Rate Study Draft

Pending Approval and Adoption by Board of Directors

Water Financial Planning and Rate Study

Lookout Mountain Water District, Colorado

Water Rate Study
Project No. 86249

Draft Report
9/30/2015

Water Financial Planning and Rate Study

prepared for

Lookout Mountain Water District, Colorado
Water Rate Study
Evergreen, Colorado

Project No. 86249

Draft Report
9/30/2015

prepared by

Burns & McDonnell Engineering Company, Inc.

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LIST OF ABBREVIATIONS

Abbreviation	Term/Phrase/Name
AWWA	American Water Works Association
BMcD	Burns & McDonnell
Ccf	Hundred cubic feet
CIP	Capital Improvement Program
CWCB	Colorado Water Conservation Board
CPI	Consumer Price Index
FY	Fiscal Year
LMWD	Lookout Mountain Water District
O&M	Operation & Maintenance Expense
Study	Lookout Mountain Water District Rate Study
The District	Lookout Mountain Water District

1.0 EXECUTIVE SUMMARY

1.1 Project Background

Burns & McDonnell (BMcD) was engaged by the Lookout Mountain Water District (the District) to perform a financial planning and water rate study (Study) that (i) evaluates the financial planning implications of the recommended capital improvements, and (ii) proposes rates to adequately recover costs for the District. This Executive Summary and Report presents the major findings of the rate study.

1.2 Financial Planning

Comprehensive financial planning conducted for the District indicates that revenues under existing rates are not adequate to meet the projected cash obligations of the District over the five-year study period. The need for revenue adjustments are influenced by the following factors:

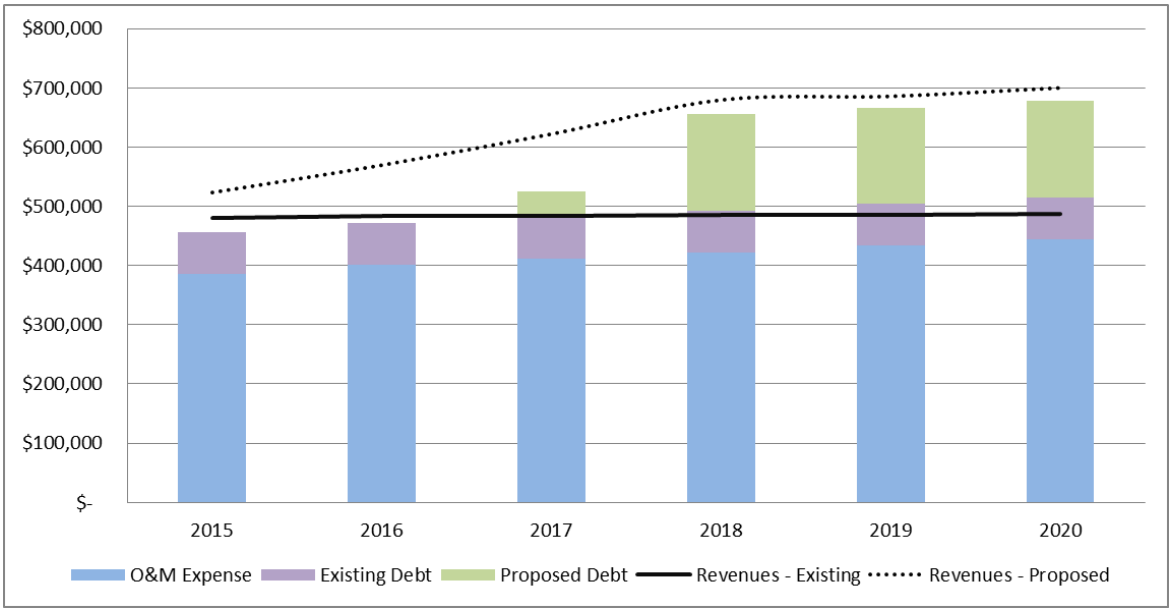
- Funding the Upper Beaver Brook Reservoir improvement project and the related debt service
- Providing adequate debt service coverage to satisfy debt covenant requirements
- Providing adequate reserves for fluctuating economic conditions and hydrologic or water cycle

Several financial planning scenarios were evaluated to fund the operating and capital needs of the system. After discussions with the District, BMcD proceeded with a levelized rate increase over three years. This scenario is recommended based on its ability to meet the following guiding principles:

1. Provide a stable series of revenue adjustments rather than a sudden, more substantial change in revenues
2. Achieve debt service coverage that exceeds the minimum requirement of 1.05 times
3. Maintain minimum operating reserves of approximately $500,000 annually for the enterprise fund

The financial plan is illustrated below in the Figure 1-1, which compares the major cash obligations shown in the bars to the revenues, with and without proposed revenue adjustments, shown in lines. The proposed revenue adjustments are sufficient to meet projected obligations.

Figure 1-1: Comparison of Enterprise Fund Operating Revenues and Expenses



1.3 Impact of Proposed Rates

The existing rate structure includes a minimum charge and an inclining volumetric rate for usage exceeding 3,000 gallons per month. This structure was maintained and a proportionate increase is proposed to be implemented across all user charges. A comparison of 2016 total monthly user charges under existing and proposed rates was completed for usage levels of 3,000 gallons and 5,000 gallons. The results are shown in Table 1-1.

A comparison of Residential charges among other regional water utilities under their existing rates was also conducted. The comparisons shown in Figure 1-2 and Figure 1-3 indicate the proposed revenue adjustment does not change the District's position relative to the sampled water utilities. Additionally, it is likely that water rates for the other surveyed communities will be trending upward over time.

Table 1-1: Total Usage Charge Comparison for 2015-2020

	Taxable Property			Tax Exempt Property		
	Monthly	Difference		Monthly	Difference	
Year	Charge	$	%	Charge	$	%
Usage of 3,000 Gallons Per Month						
2015	30.00	n/a	n/a	100.00	n/a	n/a
2016	32.93	2.93	9.75%	109.75	16.58	9.75%
2017	36.14	3.21	9.75%	120.45	18.19	9.75%
2018	39.66	3.52	9.75%	132.19	19.96	9.75%
2019	39.66	0.00	0.00%	132.19	0.00	0.00%
2020	40.45	0.79	2.00%	134.84	4.49	2.00%
Usage of 5,000 Gallons Per Month						
2015	65.00	n/a	n/a	170.00	n/a	n/a
2016	71.34	6.34	9.75%	186.58	16.58	9.75%
2017	78.29	6.96	9.75%	204.77	18.19	9.75%
2018	85.93	7.63	9.75%	224.73	19.96	9.75%
2019	85.93	0.00	0.00%	224.73	0.00	0.00%
2020	87.64	1.72	2.00%	229.23	4.49	2.00%

Figure 1-2: Total User Charge Comparison at 3,000 Gallons

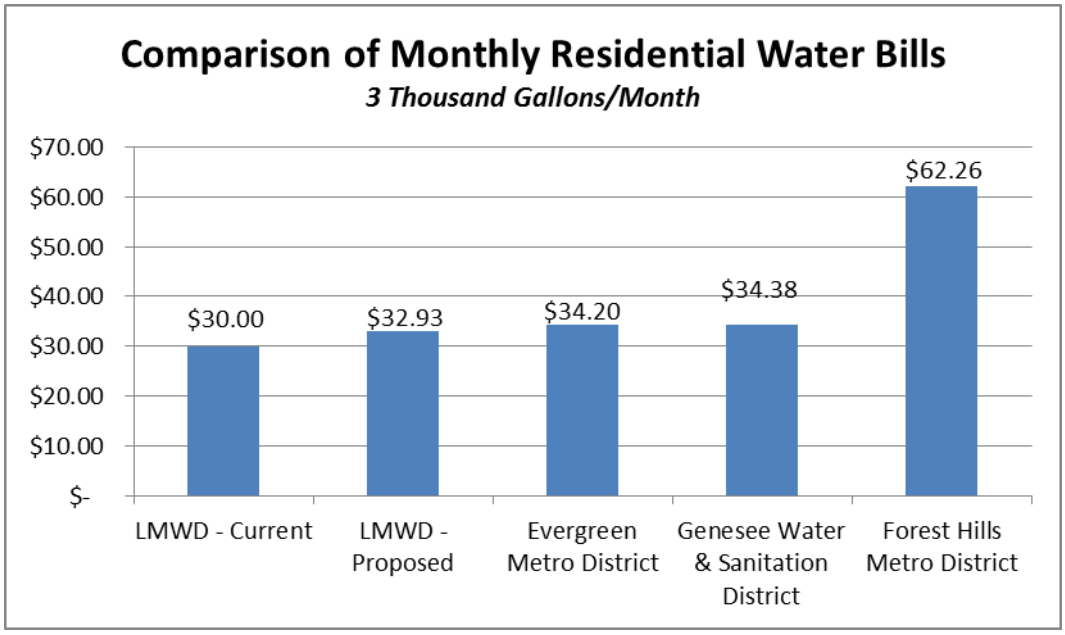
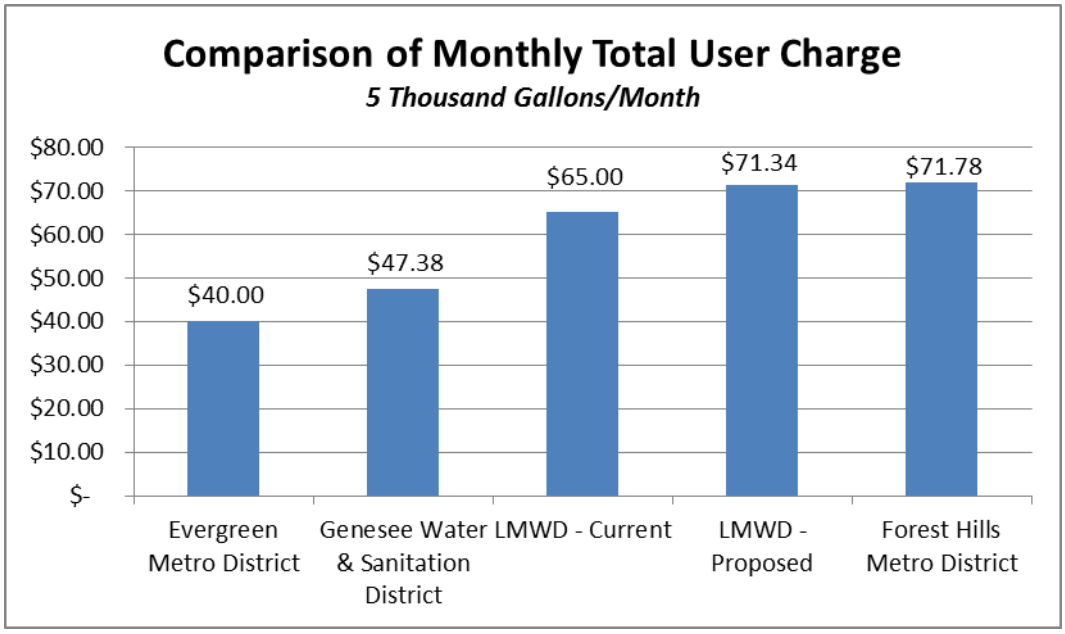


Figure 1-3: Total User Charge Comparison at 5,000 Gallons



2.0 INTRODUCTION

2.1 Project Background

Burns & McDonnell (BMcD) was engaged by the Lookout Mountain Water District (the District) to perform a financial planning and water rate study (Study) that (i) evaluates the financial planning implications of the recommended capital improvements, and (ii) proposes rates to adequately recover costs for the District. The Study establishes a five-year financial plan, and evaluates potential changes to existing rate levels to sufficiently recover costs. The District is facing the following financial challenges:

- Funding for the Upper Beaver Brook Reservoir project and the related debt service
- Providing adequate debt service coverage to satisfy debt covenant requirements
- Providing adequate reserves for fluctuating economic and hydrologic or water cycle

The financial plan presented herein for the District is designed to increase revenues to sufficiently fund operating and capital requirements, to achieve necessary debt service coverage levels, and to maintain utility reserves at a reasonable level. This report presents the findings of the Study.

2.2 Project Approach

To meet the project objectives identified by the District, BMcD conducted a comprehensive financial planning assessment to determine the overall degree of increase necessary to accomplish funding objectives. Proposed rates were then developed under the existing rate structure to produce the indicated revenues. A comparison of typical residential charges was also performed.

2.3 Statement of Limitations

In preparation of the Study, Burns & McDonnell relied upon information provided by the District. The information included various analyses, computer-generated information and reports, audited financial reports, and other financial and statistical information, as well as other documents such as operating budgets and current retail water rate schedules. In addition, input to key assumptions regarding expected timing of loan reimbursements, payments, and future levels of revenue, sales, and expenditures was provided to Burns & McDonnell. While Burns & McDonnell has no reason to believe that the information provided, and upon which Burns & McDonnell has relied, is inaccurate or incomplete in any material respect, Burns & McDonnell has not independently verified such information and cannot guarantee its accuracy or completeness.

Estimates and projections prepared by Burns & McDonnell relating to financial forecasting and costs are based on Burns & McDonnell's experience, qualifications, and judgment as a professional consultant.

Since Burns & McDonnell has no control over weather, cost and availability of labor, material and equipment, labor productivity, contractors' procedures and methods, unavoidable delays, economic conditions, government regulations and laws (including interpretation thereof), competitive bidding, and market conditions or other factors affecting such estimates or projections, Burns & McDonnell does not guarantee the accuracy of its estimates or predictions

3.0 FINANCIAL PLANNING ANALYSIS

The primary issue addressed in the Financial Planning Analysis is revenue adequacy. The results of the Financial Planning Analysis answer the questions:

- "Are the existing rates adequate?"
- "If not, what level of overall revenue increase is needed?"

To determine if the existing schedule of rates can be expected to generate revenues sufficient to meet the District's operating and capital costs, BMcD prepared a five-year financial projection of revenues and expenditures for the District. A comparison of projected revenues and expenditures provides insight into the adequacy of overall revenue levels.

Our approach to Financial Planning involves the following basic steps:

1. Project revenues under existing rates.
2. Project District operating and capital expenditures.
3. Develop five-year financial plan, including the budget year and a five-year forecast period.

The planning period includes the current fiscal year, 2015, as a budget year and a five-year forecast period, fiscal year (FY) 2016 to FY 2020. The District utilizes a twelve-month fiscal year beginning January 1 and ending December 31. The Financial Plan Analysis recognizes and references the same fiscal year in the five-year budget and planning period.

The District maintains two distinct funds, the enterprise fund and the general fund. The enterprise fund receives user charge revenue and funds the direct operating expenses and debt service associated with the District water supply and distribution system. The general fund receives tax-based revenues and funds the indirect operating expenses and debt service associated with the District. A projected cash flow was developed for each fund using similar forecasting techniques, and as appropriate these assumptions are discussed in this report. However, proposed adjustments to user charges are applicable only to the enterprise fund. As such, the focus of the financial planning discussed herein is the enterprise flow of funds. Cash flow projections for the general fund and the combined enterprise and general fund may be found in the appendices of this report.

3.1 District Revenues Under Existing Rates

The first step in the Financial Plan Analysis was to project revenues under the existing schedule of rates. Completing this effort required an analysis of customers, volumes, and revenues.

3.1.1 Historical Projected Customers

Table 3-1 presents the historical water customers served by the District from 2012 to 2014 and the projection of customers for the 2015 to 2020 planning period. In recent years, the District has experienced slight growth in the number of accounts due to activating existing taps. Based on discussion with District staff, the projection of accounts reflects activation of taps for 2016 through 2020.

3.1.2 Historical and Projected Volumes

Table 3-1 also presents the historical water volumes, based on applicable water sales for 2012 to 2014, and the projection of volumes for the 2015 to 2020 planning period. The District has experienced fluctuations in billed volumes due primarily to weather and hydrologic cycle. Annual water volumes were set based on recent historical average water sales per account. In conjunction with the modest increase in accounts, volume is anticipated to increase slightly over the study period.

Table 3-1: Historical and Projected Accounts and Volume

Line		Historical			Budget	Forecast				
No.	Description	2012	2013	2014	2015	2016	2017	2018	2019	2020
	Accounts									
1	Taxable	499	500	500	500	503	504	505	506	508
2	Tax Exempt	14	14	14	14	14	14	14	14	14
3	Total Accounts	513	514	514	514	517	518	519	520	522
	Billed Volume ***(1,000 Gallons)***									
4	Taxable	54,123	41,011	40,351	40,680	40,930	41,010	41,090	41,170	41,330
5	Tax Exempt	3,168	2,980	1,851	2,420	2,420	2,420	2,420	2,420	2,420
6	Total Billed Volume	57,291	43,991	42,202	43,100	43,350	43,430	43,510	43,590	43,750
7	User Charge Revenues under Existing Rates	$ 325,746	$ 313,453	$ 495,893	$ 480,000	$ 482,900	$ 483,900	$ 484,800	$ 485,800	$ 487,700

3.1.3 Existing Water Rates

The current water rate schedule is shown in Table 3-2 and features a minimum monthly usage charge including up to 3,000 gallons, and an inclining block volumetric rate for usage in excess of 3,000 gallons. User rates are distinguished between two classes, taxable and tax exempt. The current rates were effective as of June 25, 2014.

3.1.4 User Charge Revenues Under Existing Rates

Table 3-1 presents historical enterprise fund user revenues for 2012 to 2014 and a projection of user revenues under existing rates for the 2015 to 2024 planning period. The projection of user revenues was estimated based on the forecasted accounts and volumes factored by the existing schedule of water rates.

Historical water user revenues ranged from $325,746 in 2012 to $495,893 in 2014. Forecasted user revenues reflect the generally stable levels of anticipated customers and volumes previously presented and the existing rates implemented in 2014. Overall, water user revenues under existing rates are projected to grow slightly from $480,000 in 2015 to $487,700 by the end of the study period in 2020.

Table 3-2: Existing Water Rates

	Existing Rates	
Usage (1,000 Gallons)	Taxable Properties	Tax Exempt Properties
0-3	$ 30.00	$ 100.00
4	$ 15.00	$ 30.00
5	$ 20.00	$ 40.00
6	$ 25.00	$ 50.00
7	$ 30.00	$ 60.00
8	$ 35.00	$ 70.00
9	$ 40.00	$ 70.00
10	$ 45.00	$ 70.00
11	$ 50.00	$ 70.00
12	$ 55.00	$ 70.00
13	$ 60.00	$ 70.00
14	$ 65.00	$ 70.00
15	$ 70.00	$ 70.00
16	$ 70.00	$ 70.00
17	$ 70.00	$ 70.00
18	$ 70.00	$ 70.00
19	$ 70.00	$ 70.00
20	$ 70.00	$ 70.00
21	$ 70.00	$ 70.00
22	$ 70.00	$ 70.00

3.1.5 Other Revenues

Revenues related to factors other than user charges were also forecasted. Table 3-3 shows other revenues for both the enterprise and general funds. Enterprise fund revenues increased in 2013 and 2014 as a result of grant and insurance proceeds. Forecasted enterprise fund other revenues are based on 2015 budgeted

levels and primarily include inactive tap fees and pass through revenues associated with Subdistrict A debt service payments.

General fund revenues are included in other revenues for the purpose of the rate study, as those revenues are not related to user charges and will not change based on adjustments to future user charges. These revenues are primarily tax-based revenue streams.

Table 3-3: Other Revenues

Line No.	Description	Historical 2012	Historical 2013	Historical 2014	Budget 2015	Forecast 2016	Forecast 2017	Forecast 2018	Forecast 2019	Forecast 2020
	Fund									
1	Enterprise Fund	$ 57,477	$ 62,489	$ 174,518	$ 43,496	$ 43,500	$ 43,500	$ 43,500	$ 43,500	$ 43,500
	General Fund									
2	Real property taxes	$ 455,530	$ 454,460	$ 440,312	$ 435,036	$ 435,000	$ 435,000	$ 435,000	$ 435,000	$ 435,000
3	Specific ownership taxes	$ 32,063	$ 33,835	$ 34,165	$ 32,000	$ 32,000	$ 32,000	$ 32,000	$ 32,000	$ 32,000
4	Rebate/Refund of real property taxes	$ -	$ -	$ -	$ (500)	$ (500)	$ (500)	$ (500)	$ (500)	$ (500)
5	Proceeds from lease funds	$ -	$ 200,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -
6	Inclusion fees	$ -	$ -	$ 18,500	$ 18,500	$ 18,500	$ 18,500	$ 18,500	$ 18,500	$ 18,500
7	Other non-operating income	$ 800	$ 4,196	$ -	$ -	$ -	$ -	$ -	$ -	$ -
8	Interest income, incl delinquent taxes	$ 976	$ 974	$ 858	$ 500	$ 500	$ 500	$ 500	$ 500	$ 500
9	Total General Fund Revenue	$ 489,369	$ 693,465	$ 493,835	$ 485,536	$ 485,500	$ 485,500	$ 485,500	$ 485,500	$ 485,500
10	**Total Other Revenue**	$ 546,846	$ 755,954	$ 668,353	$ 529,032	$ 529,000	$ 529,000	$ 529,000	$ 529,000	$ 529,000

3.2 District Expenditures

The District's primary enterprise fund cash expenditures include the following direct operating and capital costs:

- Operation and Maintenance (O&M) Expenses
- Capital Improvement Program Expenditures
- Debt Service Principal and Interest Payments

3.2.1 O&M Expenses

Table 3-4 presents the recent O&M expense history and the projection of District O&M expenses through the 2020 planning period. Expenses summarized on Table 3-4 reflect operating costs associated with the enterprise and general fund. Costs related to capital projects are excluded from Table 3-4 and will be discussed later in this report.

Enterprise fund O&M expenses ranged from $419,200 in 2013 to $273,900 in 2014. O&M costs for 2015 are based on the approved budget of approximately $386,400. Projected O&M expenses in general are escalated from budgeted 2015 amounts based on inflationary assumptions of 2.5 percent annually.

Expenses with variable costs and timing have been included the forecast with the guidance of District staff.

The general fund O&M was similarly forecasted, reflecting an inflation adjustment of 2.5 percent annually above budgeted 2015 expenditure levels.

Table 3-4: Historical and Projected Operation and Maintenance Expenses

Line		Historical			Budget	Forecast				
No.	Description	2012	2013	2014	2015	2016	2017	2018	2019	2020
	Enterprise Fund									
1	Contract services	$ -	$ 123,100	$ 121,500	$ 125,700	$ 128,800	$ 132,000	$ 135,300	$ 138,700	$ 142,200
2	Testing and analysis, supplies	$ -	$ 2,400	$ 2,300	$ 2,400	$ 2,500	$ 2,600	$ 2,700	$ 2,800	$ 2,900
3	Testing and analysis, lab fees	$ -	$ 12,400	$ 3,100	$ 10,800	$ 11,100	$ 11,400	$ 11,700	$ 12,000	$ 12,300
4	SDWA Sampling Upgrade	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
5	Locater service	$ -	$ 800	$ 900	$ 3,000	$ 3,100	$ 3,200	$ 3,300	$ 3,400	$ 3,500
6	Sludge removal & extra backwashes	$ -	$ 900	$ 400	$ 3,000	$ 3,100	$ 3,200	$ 3,300	$ 3,400	$ 3,500
7	Trash removal	$ -	$ 900	$ 800	$ 900	$ 900	$ 900	$ 900	$ 900	$ 900
8	Snow removal and road maint.	$ -	$ 10,200	$ 10,000	$ 12,000	$ 12,300	$ 12,600	$ 12,900	$ 13,200	$ 13,500
9	Repair & Maintenance	$ -	$ 34,600	$ 40,700	$ 71,800	$ 79,000	$ 81,000	$ 83,000	$ 85,100	$ 87,200
10	Locate curb stop project	$ -	$ 13,900	$ 1,700	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000
11	Electricity	$ -	$ 26,600	$ 25,400	$ 29,900	$ 30,700	$ 31,500	$ 32,300	$ 33,100	$ 33,900
12	Gas, treatment plant	$ -	$ 3,300	$ 4,300	$ 4,000	$ 4,100	$ 4,200	$ 4,300	$ 4,400	$ 4,500
13	Fuel, emergency generator	$ -	$ 300	$ 500	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000
14	Chemicals	$ -	$ 30,600	$ 35,500	$ 36,000	$ 36,900	$ 37,800	$ 38,700	$ 39,700	$ 40,700
15	Other maintenance supplies	$ -	$ 1,500	$ 500	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500
16	Tools	$ -	$ -	$ -	$ 500	$ 500	$ 500	$ 500	$ 500	$ 500
17	Equipment rental	$ -	$ -	$ -	$ 2,000	$ 2,100	$ 2,200	$ 2,300	$ 2,400	$ 2,500
18	Telephone/DSL	$ -	$ 3,500	$ 2,900	$ 2,400	$ 2,500	$ 2,600	$ 2,700	$ 2,800	$ 2,900
19	Telemetry--wireless service	$ -	$ 5,500	$ 1,800	$ 2,100	$ 2,200	$ 2,300	$ 2,400	$ 2,500	$ 2,600
20	Security service	$ -	$ 3,600	$ 2,200	$ 3,000	$ 3,100	$ 3,200	$ 3,300	$ 3,400	$ 3,500
21	Other operation & maintenance	$ -	$ 2,000	$ 800	$ 2,000	$ 2,100	$ 2,200	$ 2,300	$ 2,400	$ 2,500
22	Water purchases or leases	$ -	$ 73,500	$ -	$ 40,000	$ 41,000	$ 42,000	$ 43,100	$ 44,200	$ 45,300
23	Maintenance, watershed	$ -	$ -	$ 1,000	$ 3,000	$ 3,100	$ 3,200	$ 3,300	$ 3,400	$ 3,500
24	Water rights maintenance & operations	$ -	$ 21,000	$ 12,500	$ 17,900	$ 18,300	$ 18,800	$ 19,300	$ 19,800	$ 20,300
25	Contingency/Flood damage	$ -	$ 48,600	$ 5,100	$ 10,500	$ 10,800	$ 11,100	$ 11,400	$ 11,700	$ 12,000
26	Enterprise Fund Total	$ -	$ 419,200	$ 273,900	$ 386,400	$ 401,700	$ 412,000	$ 422,500	$ 433,300	$ 444,200
	General Fund									
27	Accounting	$ -	$ 12,200	$ 12,000	$ 12,000	$ 12,300	$ 12,600	$ 12,900	$ 13,200	$ 13,500
28	Auditing	$ -	$ 4,600	$ 4,900	$ 5,000	$ 5,100	$ 5,200	$ 5,300	$ 5,400	$ 5,500
29	Directors' fees	$ -	$ 6,000	$ 5,500	$ 6,500	$ 6,500	$ 6,500	$ 6,500	$ 6,500	$ 6,500
30	Payroll taxes	$ -	$ 500	$ 400	$ 500	$ 500	$ 500	$ 500	$ 500	$ 500
31	Consulting, water rights	$ -	$ 33,100	$ 21,500	$ 24,000	$ 24,600	$ 25,200	$ 25,800	$ 26,400	$ 27,100
32	Legal	$ -	$ 55,500	$ 69,900	$ 69,600	$ 81,300	$ 73,000	$ 84,900	$ 76,800	$ 88,800
33	Contract services, administration & billing	$ -	$ 63,000	$ 73,700	$ 72,000	$ 73,800	$ 75,600	$ 77,500	$ 79,400	$ 81,400
34	Rent, storage, office, PO box	$ -	$ 4,300	$ 4,300	$ 5,100	$ 5,200	$ 5,300	$ 5,400	$ 5,500	$ 5,600
35	Insurance	$ -	$ 9,400	$ 9,800	$ 10,600	$ 10,800	$ 11,100	$ 11,400	$ 11,700	$ 12,000
36	Travel & meals	$ -	$ 1,200	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500
37	Seminars & meetings	$ -	$ 2,000	$ 900	$ 2,000	$ 2,100	$ 2,200	$ 2,300	$ 2,400	$ 2,500
38	Dues & publications incl SPWRAP	$ -	$ 900	$ 1,100	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500
39	Election expenses	$ -	$ -	$ -	$ -	$ 10,000	$ -	$ 10,000	$ -	$ 10,000
40	Telephone/communications	$ -	$ 1,500	$ 1,600	$ 1,800	$ 1,800	$ 1,800	$ 1,800	$ 1,800	$ 1,800
41	Post office box, moved above	$ -	$ 500	$ -	$ 300	$ 300	$ 300	$ 300	$ 300	$ 300
42	Postage	$ -	$ 2,600	$ 4,100	$ 4,200	$ 4,300	$ 4,400	$ 4,500	$ 4,600	$ 4,700
43	Mailing & collation, moved to contract	$ -	$ 700	$ -	$ -	$ -	$ -	$ -	$ -	$ -
44	Printing, billing stock, multifunction	$ -	$ 2,900	$ 2,200	$ 3,900	$ 4,000	$ 4,100	$ 4,200	$ 4,300	$ 4,400
45	Office supplies	$ -	$ 600	$ 600	$ 400	$ 400	$ 400	$ 400	$ 400	$ 400
46	Information tech, website, billing software	$ -	$ 8,000	$ 4,700	$ 7,500	$ 7,700	$ 7,900	$ 8,100	$ 8,300	$ 8,500
47	Other administratrive (fees, permits, maps, etc.)	$ -	$ 1,300	$ 300	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500	$ 1,500
48	Bank charges	$ -	$ 800	$ 1,100	$ 1,200	$ 1,200	$ 1,200	$ 1,200	$ 1,200	$ 1,200
49	Uncollected taxes, other	$ -	$ 1,100	$ -	$ 700	$ 700	$ 700	$ 700	$ 700	$ 700
50	County treasurer's fees	$ -	$ 6,800	$ 6,600	$ 6,500	$ 6,500	$ 6,500	$ 6,500	$ 6,500	$ 6,500
51	General Fund Total	$ -	$ 219,500	$ 226,700	$ 238,300	$ 263,600	$ 249,000	$ 274,700	$ 260,400	$ 286,400
	Total O&M	**$ -**	**$ 638,700**	**$ 500,600**	**$ 624,700**	**$ 665,300**	**$ 661,000**	**$ 697,200**	**$ 693,700**	**$ 730,600**

3.2.2 Projected Capital Improvement Expenditures

Table 3-5 shows the projected capital improvement program (CIP) expenditures for the 2016 to 2020 planning period. All CIP is associated with the enterprise fund, and the most substantial initiative includes the Upper Beaver Brook Reservoir expansion.

As shown in Table 3-5, the specifically identified projects in the current CIP peak in 2016 resulting from the Upper Beaver Brook project. The District assumes the Upper Beaver Brook Reservoir Expansion project will be financed through the Colorado Water Conservation Board (CWCB) loan program, while all other projects will be funded with pay as you go cash balances. The table below shows the projected CIP costs per year associated with individual projects.

Table 3-5: Capital Improvement Program

Line No.	Description	Budget 2015	Projected 2016	2017	2018	2019	2020
	Enterprise Fund						
1	LBB Dam & Spillway Improvement	$ -	$ -	$ -	$ -	$ -	$ 50,000
2	Upper Beaver Brook Reservoir Expansion	$ -	$ 3,224,400	$ -	$ -	$ -	$ -
3	Dam Seepage Project	$ -	$ 10,000	$ -	$ -	$ -	$ -
4	Main Waterline Upgrades	$ -	$ 10,000	$ -	$ 10,000	$ -	$ -
5	JDTF improvements	$ 8,000	$ -	$ -	$ -	$ -	$ -
6	Meters & valves	$ 10,000	$ 5,000	$ -	$ 10,000	$ -	$ 10,000
7	Reservoirs, dams and flumes	$ 175,000	$ 5,000	$ -	$ -	$ -	$ -
8	Contingency (Rate Study - 2015)	$ 17,000	$ -	$ -	$ -	$ -	$ -
9	**Total CIP**	**$ 210,000**	**$ 3,254,400**	**$ -**	**$ 20,000**	**$ -**	**$ 60,000**

3.2.3 Existing and Proposed Debt Service Requirements

Table 3-6 presents both the existing and proposed debt service requirements for the District. As shown on Table 3-6, existing debt is distinguished between debt funded by the enterprise fund and debt funded by the general fund. In general, existing enterprise fund debt is backed by the pledged revenues of the enterprise fund, while general fund debt is not. Enterprise fund debt includes debt issued through the CWCB and the Subdistrict A debt service. Together these two debt obligations amount to about $70,300 annually. Proposed debt is necessary to fund the Upper Beaver Brook Reservoir expansion project and is also a CWCB debt instrument. Terms are assumed to include an interest only payment in 2017 due at the approximate time of closing, followed by annual principal and interest payments based on a 30 year term and a 3.25 percent interest rate.

Debt applicable to the general fund is related to equipment lease obligations. These existing obligations are all projected to retire within the next five years.

Table 3-6: Existing and Proposed Debt Service

Line No.	Description	Projected 2015	2016	2017	2018	2019	2020
	Existing Debt						
	Enterprise Fund						
1	1992 Issuance	$ 39,031	$ 39,031	$ 39,031	$ 39,031	$ 39,031	$ 39,031
2	2004 Issuance (Subdistrict A)	$ 31,696	$ 31,696	$ 31,696	$ 31,696	$ 31,696	$ 31,696
3	Total Proposed Debt (a)	$ -	$ -	$ 43,139	$ 162,500	$ 162,500	$ 162,500
4	Total Enterprise Fund Debt	$ 70,727	$ 70,727	$ 113,866	$ 233,227	$ 233,227	$ 233,227
	General Fund						
5	2007 Issuance	$ 132,700	$ 132,700	$ 132,700	$ 132,700	$ 132,700	
6	2010 Issuance	$ 46,253					
7	2013 Issuance	$ 42,625	$ 42,625	$ 7,104	$ -		
8	Total General Fund Debt	$ 221,578	$ 175,325	$ 139,804	$ 132,700	$ 132,700	$ -
9	**Total Debt**	**$ 292,305**	**$ 246,052**	**$ 253,670**	**$ 365,927**	**$ 365,927**	**$ 233,227**

(a) Proposed debt issuance of $3.099 million assuming a term of 30 years, an interest rate of 3.25%, and issuance cost of 1% of gross bond proceeds. Payments are estimated to begin 2 years after initial draw

3.3 District Financial Plan

Based on the information developed for this report, a financial plan has been assembled. This financial plan aggregates the revenues and expenses forecasted and described previously to assess the adequacy of revenues to meet all operating and capital requirements. The cash flow analysis identifies the overall increase in revenues needed to meet the District's overall financial objectives.

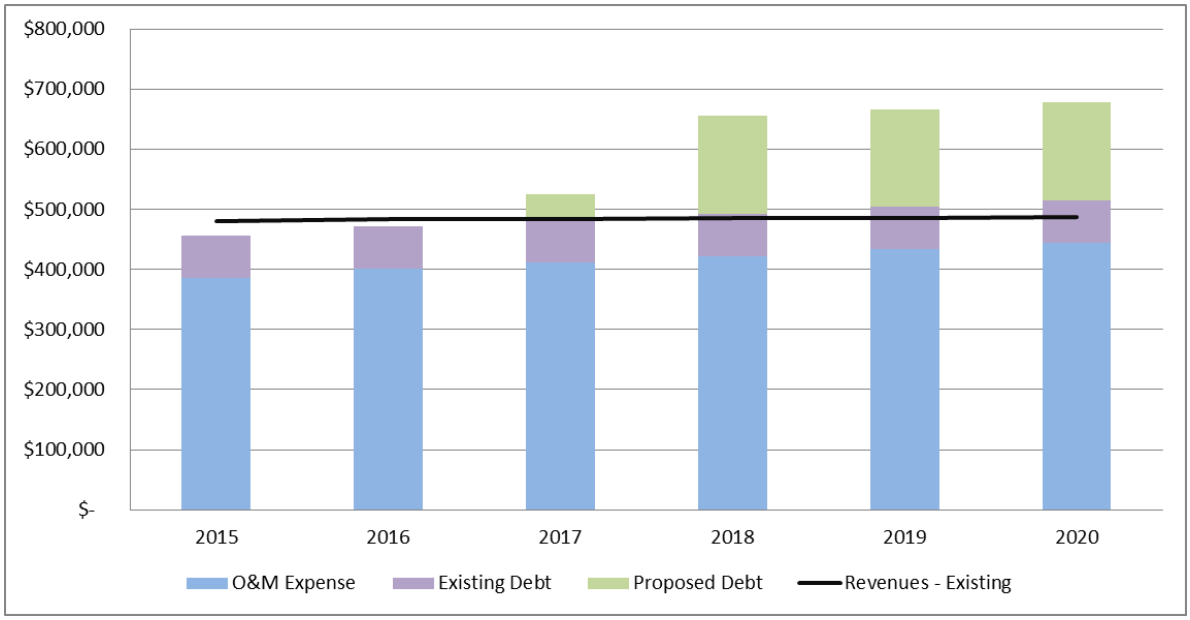
3.3.1 Water System Operating Flow of Funds

Figure 3-1 demonstrates the relationship between enterprise fund operating revenues under existing rates and the projected revenue requirements for the District. As indicated in Figure 3-1, beginning in 2018 revenues are not sufficient to meet the forecasted enterprise fund O&M and debt service expenses. This operating forecast is not sustainable; if forecasted revenues and costs are realized at the projected levels, enterprise fund reserve balances will be exhausted in 2020.

Additionally, based on the debt covenants associated with existing CWCB debt, the District is required to maintain a debt service coverage level of at least 1.00 annually. Debt service coverage is the relationship between net pledged revenues divided by annual debt service, where net pledged revenues equal enterprise fund revenues less enterprise fund operating expenses. A 1.00 threshold indicates that, after O&M expenses are paid, revenues amounting to the annual debt service must be available. Furthermore, to issue additional debt, debt service coverage must be achieved at a level of 1.05 times the maximum future debt service of the District. In light of the debt service requirements associated with the Upper

Beaver Brook Reservoir project, without a revenue increase, these debt service coverage thresholds are not attainable.

Figure 3-1: Enterprise Fund Operating Cash Flow under Existing Rates



The following revenue increases are proposed to appropriately meet the funding requirements of the District, maintain reasonable reserves, and achieve required debt service coverage thresholds.

Table 3-7: Proposed Water Revenue Increases

Year	Proposed Revenue Increase
2016	9.75%
2017	9.75%
2018	9.75%
2019	0.00%
2020	2.00%

These adjustments will address the projected operating deficits over time and provide needed capital funding to implement the CIP. A detailed cash flow illustrating the impact of these adjustments is presented in Table 3-8.

Line 1 of Table 3-8 shows user revenues under existing rates, as shown previously on Line 7 of Table 3-1. Lines 2 through 7 of Table 3-8 present the proposed revenue increases needed to finance the District's operating and capital costs for the planning period. Total enterprise fund user charge revenues are

summarized on Line 8 of Table 3-8. Other revenues are shown on Lines 9 through 18. Forecasts of Other Water Fund Revenue are projected to remain constant during the study period at $43,500. The sum of Lines 8 and 18 produce the total enterprise fund revenue as shown on Line 19.

Revenue requirements are outlined on Lines 21-25 with the total in Line 26. Line 21 is the sum of the O&M expenses related to the enterprise fund as shown previously on Line 26 of Table 3-4. Lines 22 through 24 of Table 3-8 represent the existing and proposed debt service.

Debt service coverage is calculated on Line 28 of Table 3-8. This value represents the net pledged revenues (Line 19 less Line 21), divided by enterprise fund debt service on Line 24. As noted earlier, this ratio must exceed 1.00 annually. In order to issue additional bonds, a ratio of 1.05 must be achieved using the maximum annual debt service rather than annual debt service as the denominator. For financial planning purposes, the proposed revenue adjustments were designed to achieve annual debt service coverage above the 1.00 minimum annual threshold, which is intended to allow the District some margin for variance in future results in both the annual debt service coverage and the additional bonds debt service coverage requirements.

3.3.2 Water System Capital Flow of Funds

The capital flow of funds is shown in Table 3-8 on Lines 29 through 36.

Potential sources of funds include transfers from operations, issuance of debt and CWCB reimbursement. Uses of capital funds include the CIP program expenditures shown previously in Table 3-5. Additionally, expenses associated with the issuance of the CIP debt in 2016 are estimated to be approximately 1.0 percent based on information provided by the CWCB.

Line 36 of Table 3-8 shows the District's annual capital balance. Negative amounts shown on Line 36 are funded through the use of reserves.

3.3.3 Total Enterprise Fund Cash Flow Results

Total enterprise fund operating and capital sources of funds are aggregated over the Study period and are summarized on Line 37 of Table 3-8. These revenues are compared to the total costs which are summarized on Line 38. The total annual balance for the enterprise fund is represented on Line 39. Negative annual balances will draw down the utility's cash reserves, while positive annual balances will contribute to reserves.

Table 3-8: Enterprise Fund Statement of Cash Flows

Line No.				Projected					
				2015	2016	2017	2018	2019	2020
	Operating Flow of Funds								
1	**Revenue Under Existing Rates**			$ 480,000	$ 482,900	$ 483,900	$ 484,800	$ 485,800	$ 487,700
	Proposed Revenue Adjustments								
	Year	Month	Increase						
2	2016	2	9.75%		43,200	47,200	47,300	47,400	47,600
3	2017	2	9.75%			47,500	51,900	52,000	52,200
4	2018	2	9.75%				52,200	57,100	57,300
5	2019	2	0.0%					-	-
6	2020	2	2.0%						11,800
7	Total Proposed Additional Revenue			$ -	$ 43,200	$ 94,700	$ 151,400	$ 156,500	$ 168,900
8	Total Water User Charge Revenue			$ 480,000	$ 526,100	$ 578,600	$ 636,200	$ 642,300	$ 656,600
	Enterprise Fund Revenue			$ -	$ -	$ -	$ -	$ -	$ -
9	(Allowances)			$ (7,200)	$ (7,200)	$ (7,200)	$ (7,200)	$ (7,200)	$ (7,200)
10	Late payment fees			$ 900	$ 900	$ 900	$ 900	$ 900	$ 900
11	Inspection fees			$ 500	$ 500	$ 500	$ 500	$ 500	$ 500
12	Transfer fees			$ 600	$ 600	$ 600	$ 600	$ 600	$ 600
13	Inactive tap fees			$ 14,000	$ 14,000	$ 14,000	$ 14,000	$ 14,000	$ 14,000
14	Miscellaneous operating income and fees			$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000	$ 1,000
15	Interest income, Subdistrict A			$ -	$ -	$ -	$ -	$ -	$ -
16	Grants or insurance proceeds			$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000	$ 2,000
17	Subdistrict A - collections for debt service			$ 31,700	$ 31,700	$ 31,700	$ 31,700	$ 31,700	$ 31,700
18	Other Enterprise Fund Revenue			$ 43,500	$ 43,500	$ 43,500	$ 43,500	$ 43,500	$ 43,500
19	**Total Enterprise Revenue**			**$ 523,500**	**$ 569,600**	**$ 622,100**	**$ 679,700**	**$ 685,800**	**$ 700,100**
20	(Excluding Capital)			$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements								
21	Operation and Maintenance Expense			$ 386,300	$ 401,700	$ 412,000	$ 422,500	$ 433,300	$ 444,200
	Debt Service								
22	Existing Debt			$ 70,700	$ 70,700	$ 70,700	$ 70,700	$ 70,700	$ 70,700
23	Proposed Debt & IDC			$ -	$ -	$ 43,139	$ 162,500	$ 162,500	$ 162,500
24	Total Debt Service			$ 70,700	$ 70,700	$ 113,839	$ 233,200	$ 233,200	$ 233,200
25	Other			$ -	$ -	$ -	$ -	$ -	$ -
26	**Total Revenue Requirements**			**$ 457,000**	**$ 472,400**	**$ 525,839**	**$ 655,700**	**$ 666,500**	**$ 677,400**
27	**Annual Operating Balance**			**$ 66,500**	**$ 97,200**	**$ 96,261**	**$ 24,000**	**$ 19,300**	**$ 22,700**
28	**Enterprise Fund Debt Service Coverage**			1.94	2.37	1.85	1.10	1.08	1.10
	Capital Flow of Funds								
	Sources								
29	Transfer from Operations			$ -	$ -	$ -	$ -	$ -	$ -
30	Debt Issuance			$ -	$ 3,099,145	$ -	$ -	$ -	$ -
31	CWCB Reimbursement			$ -	$ 351,000	$ -	$ -	$ -	$ -
32	Total Sources			-	3,450,145	-	-	-	-
	Uses								
33	CIP			$ 210,000	$ 3,254,400	$ -	$ 20,000	$ -	$ 60,000
34	Bond Issuance Expense			$ -	$ 31,000	$ -	$ -	$ -	$ -
35	Total Capital Uses			210,000	3,285,400	-	20,000	-	60,000
36	**Ending Balance**			**(210,000)**	**164,745**	**-**	**(20,000)**	**-**	**(60,000)**
	Consolidated Cash Flow Results								
37	Total Sources of Funds			$ 523,500	$ 4,019,745	$ 622,100	$ 679,700	$ 685,800	$ 700,100
38	Total Uses of Funds			$ 667,000	$ 3,757,800	$ 525,839	$ 675,700	$ 666,500	$ 737,400
39	Annual Balance			$ (143,500)	$ 261,945	$ 96,261	$ 4,000	$ 19,300	$ (37,300)
40	Beginning Balance			$ 335,800	192,300	454,245	550,505	554,505	573,805
41	Annual Balance			$ (143,500)	$ 261,945	$ 96,261	$ 4,000	$ 19,300	$ (37,300)
42	Ending Balance			$ 192,300	$ 454,245	$ 550,505	$ 554,505	$ 573,805	$ 536,505
	Reserve Targets								
43	Operating (Days)	180		$ 190,500	$ 198,100	$ 203,200	$ 208,400	$ 213,700	$ 219,100
44	Capital			$ 300,000	$ 300,000	$ 300,000	$ 300,000	$ 300,000	$ 300,000
45	Total			$ 490,500	$ 498,100	$ 503,200	$ 508,400	$ 513,700	$ 519,100

The beginning balance available to the District is shown on Line 40 and is estimated to be $335,800 beginning January 1, 2015. The available balance is projected to grow to reach reserve targets as outlined in Lines 43 through 45.

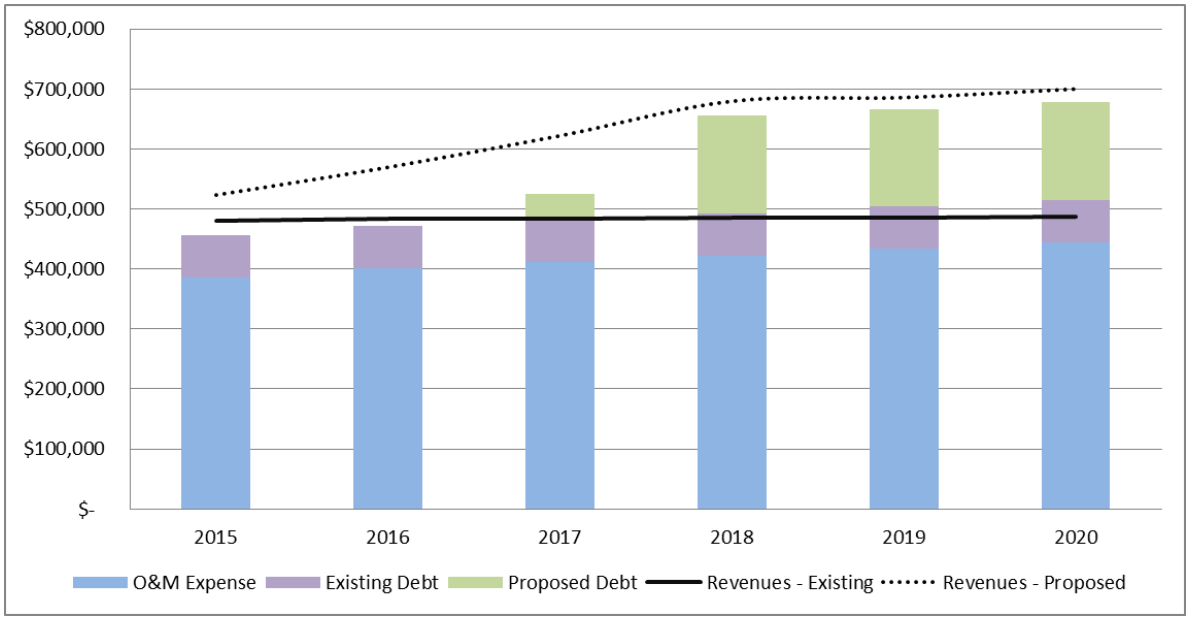
A targeted minimum balance has been developed and is shown on Line 43. This amount is comprised of 180 days of operation and maintenance expenses, plus an additional $300,000 for a capital projects reserve. The targeted minimum balance was developed to provide reasonable financial flexibility through working capital liquidity and an emergency reserve to provide some protection against potential volatility in revenues and costs.

Revenue fluctuations are typical in an industry dependent on weather and the hydrologic cycle. Demand by water consumers is greatly influenced by factors such as air temperature, natural precipitation, seepage/groundwater, and consumer perception. Consumer perception may result in more or less water consumption that is not always predictable. Natural precipitation, including the location, duration, frequency and rate of delivery all impact a consumer's demand for water. The District's water rate structure is primarily based on consumption levels and timing, which can vary and result in substantial revenue fluctuations.

Emergency reserves are not only needed for unforeseen events, but they are also needed for expected but unpredictable events. A drought is not unforeseen; however, it is unpredictable in terms of timing and duration and can have economic impacts to both suppliers and consumers. External factors, such as a changing regulatory environment or a legal finding in a water court case can have long-lasting impacts. Volatility in commodity costs such as chemical and power can also have adverse impacts on costs. Asset failure resulting from factors such as age, level of use, maintenance, natural disaster, and other variables can cause utilities to incur replacement costs sooner than anticipated. It is difficult to plan for or to entirely mitigate these kinds of risks, but having sufficient reserves in order to respond effectively is the District's fiduciary responsibility.

Figure 3-2 illustrates the impact of the proposed revenue adjustments. As shown in Figure 3-2, revenues under proposed rates are sufficient to fund anticipated operating and capital costs.

Figure 3-2: Enterprise Fund Operating Cash Flow under Existing and Proposed Rates



3.4 Summary

The proposed revenue adjustments as shown in Table 3-7 will allow the District to operate in accordance with the debt service coverage requirements, maintain adequate reserves, and fund operating and capital costs. The forecasted cash flow as shown for the enterprise fund in Table 3-8 was aggregated for the general fund. Additionally, a combined enterprise and general fund flow of funds was also developed. These tables can be found in Appendix A and B respectively.

4.0 PROPOSED RATE DESIGN

4.1 Introduction

The primary focus of rate design is the examination of revenue recovery. Generally speaking, the objective is to design rates for the District to generate adequate revenues to meet the projected operating and capital costs, while maintaining sound financial performance.

4.2 Existing Water Rates

The existing schedule of water rates, which was shown previously in Table 1-2 features a minimum monthly usage charge including up to 3,000 gallons, and an inclining block volumetric rate for usage in excess of 3,000 gallons. User rates are distinguished between two classes, taxable and tax exempt.

4.3 Proposed Water Rates

The existing rate structure was considered to be serving the District reasonably well based on the following considerations.

- **Revenue stability**: The base fee/minimum bill provides a reliable revenue source, especially in consideration of the climate variability from year to year in the service area.
- **Fixed cost coverage**: The majority of District's costs are fixed, meaning they do not vary proportionately with the volume of water produced. The potential issuance of additional debt, for the major CIP coming, will add to the fixed cost nature of the District's cost structure. Having a basic minimum charge helps provide revenue stability and a degree of fixed cost coverage.
- **Ease of explanation**: The existing rate structure has been in effect for a considerable amount of time and is familiar to both customers and District staff.

Based on these considerations no changes are proposed to the existing rate structure. Proposed water rates are shown in Table 4-1 and are assumed to be effective on January 1 of each indicated year. Proposed rates reflect an across-the-board adjustment, meaning each rate component increases at the same percentage as the system-wide increase summarized in Table 3-7.

Table 4-1: Existing and Proposed Rates

	Existing Rates		2016 Rates		2017 Rates		2018 - 2019 Rates		2020 Rates	
Usage (1,000 Gallons)	Taxable Properties	Tax Exempt Properties	Taxable Properties	Tax Exempt Properties	Taxable Properties	Tax Exempt Properties	Taxable Properties	Tax Exempt Properties	Taxable Properties	Tax Exempt Properties
0-3	$ 30.00	$ 100.00	$ 32.93	$ 109.75	$ 36.14	$ 120.45	$ 39.66	$ 132.19	$ 40.45	$ 134.84
4	$ 15.00	$ 30.00	$ 16.46	$ 32.93	$ 18.07	$ 36.14	$ 19.83	$ 39.66	$ 20.23	$ 40.45
5	$ 20.00	$ 40.00	$ 21.95	$ 43.90	$ 24.09	$ 48.18	$ 26.44	$ 52.88	$ 26.97	$ 53.94
6	$ 25.00	$ 50.00	$ 27.44	$ 54.88	$ 30.11	$ 60.23	$ 33.05	$ 66.10	$ 33.71	$ 67.42
7	$ 30.00	$ 60.00	$ 32.93	$ 65.85	$ 36.14	$ 72.27	$ 39.66	$ 79.32	$ 40.45	$ 80.90
8	$ 35.00	$ 70.00	$ 38.41	$ 76.83	$ 42.16	$ 84.32	$ 46.27	$ 92.54	$ 47.19	$ 94.39
9	$ 40.00	$ 70.00	$ 43.90	$ 76.83	$ 48.18	$ 84.32	$ 52.88	$ 92.54	$ 53.94	$ 94.39
10	$ 45.00	$ 70.00	$ 49.39	$ 76.83	$ 54.20	$ 84.32	$ 59.49	$ 92.54	$ 60.68	$ 94.39
11	$ 50.00	$ 70.00	$ 54.88	$ 76.83	$ 60.23	$ 84.32	$ 66.10	$ 92.54	$ 67.42	$ 94.39
12	$ 55.00	$ 70.00	$ 60.36	$ 76.83	$ 66.25	$ 84.32	$ 72.71	$ 92.54	$ 74.16	$ 94.39
13	$ 60.00	$ 70.00	$ 65.85	$ 76.83	$ 72.27	$ 84.32	$ 79.32	$ 92.54	$ 80.90	$ 94.39
14	$ 65.00	$ 70.00	$ 71.34	$ 76.83	$ 78.29	$ 84.32	$ 85.93	$ 92.54	$ 87.64	$ 94.39
15	$ 70.00	$ 70.00	$ 76.83	$ 76.83	$ 84.32	$ 84.32	$ 92.54	$ 92.54	$ 94.39	$ 94.39
16	$ 70.00	$ 70.00	$ 76.83	$ 76.83	$ 84.32	$ 84.32	$ 92.54	$ 92.54	$ 94.39	$ 94.39
17	$ 70.00	$ 70.00	$ 76.83	$ 76.83	$ 84.32	$ 84.32	$ 92.54	$ 92.54	$ 94.39	$ 94.39
18	$ 70.00	$ 70.00	$ 76.83	$ 76.83	$ 84.32	$ 84.32	$ 92.54	$ 92.54	$ 94.39	$ 94.39
19	$ 70.00	$ 70.00	$ 76.83	$ 76.83	$ 84.32	$ 84.32	$ 92.54	$ 92.54	$ 94.39	$ 94.39
20	$ 70.00	$ 70.00	$ 76.83	$ 76.83	$ 84.32	$ 84.32	$ 92.54	$ 92.54	$ 94.39	$ 94.39
21	$ 70.00	$ 70.00	$ 76.83	$ 76.83	$ 84.32	$ 84.32	$ 92.54	$ 92.54	$ 94.39	$ 94.39
22	$ 70.00	$ 70.00	$ 76.83	$ 76.83	$ 84.32	$ 84.32	$ 92.54	$ 92.54	$ 94.39	$ 94.39

4.4 Existing and Proposed Total User Charges per Month

Table 4-2 shows common monthly usage levels and the impact that the proposed rates will have on total usage charges. This was calculated for each class and a usage level of 3,000 and 5,000 gallons per month.

Figures 4-1 and 4-2 show regional comparisons of total user charges at frequent usage District monthly consumption levels under both existing and proposed 2016 rates. Among communities surveyed, the average total user charge at 3,000 gallons per month was $40.21 with a median of $34.20. Average total user charge at 5,000 gallons per month was $56.04, and a median of $65.00. As shown in Figure 4-1, overall District water rates are in the middle of the communities surveyed. Additionally, it is likely that water rates for other communities will be trending upward over time.

Table 4-2: Representative Total User Charges under Existing and Proposed Rates

	Taxable Property			Tax Exempt Property		
	Monthly	Difference		Monthly	Difference	
Year	Charge	$	%	Charge	$	%
Usage of 3,000 Gallons Per Month						
2015	30.00	n/a	n/a	100.00	n/a	n/a
2016	32.93	2.93	9.75%	109.75	16.58	9.75%
2017	36.14	3.21	9.75%	120.45	18.19	9.75%
2018	39.66	3.52	9.75%	132.19	19.96	9.75%
2019	39.66	0.00	0.00%	132.19	0.00	0.00%
2020	40.45	0.79	2.00%	134.84	4.49	2.00%
Usage of 5,000 Gallons Per Month						
2015	65.00	n/a	n/a	170.00	n/a	n/a
2016	71.34	6.34	9.75%	186.58	16.58	9.75%
2017	78.29	6.96	9.75%	204.77	18.19	9.75%
2018	85.93	7.63	9.75%	224.73	19.96	9.75%
2019	85.93	0.00	0.00%	224.73	0.00	0.00%
2020	87.64	1.72	2.00%	229.23	4.49	2.00%

Figure 4-1: Total User Charge Comparison at 3,000 Gallons

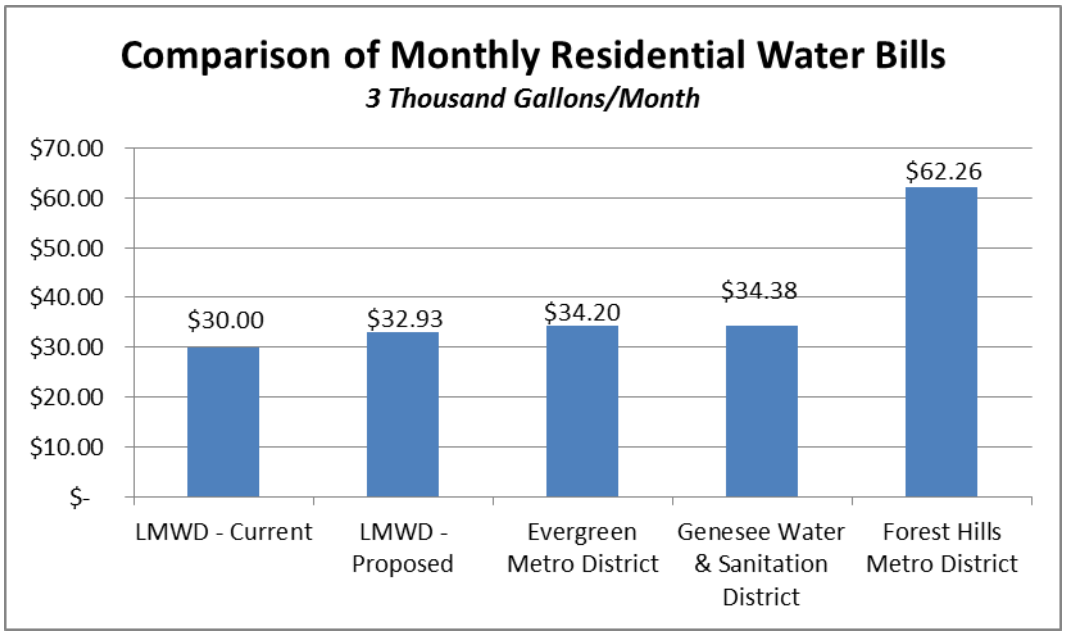
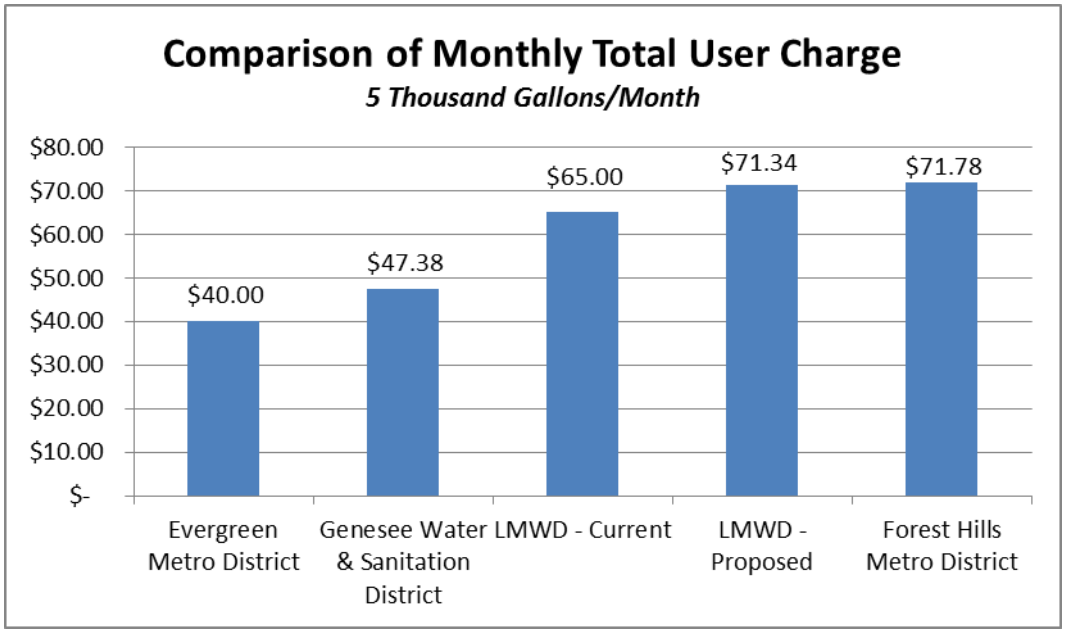


Figure 4-2: Total User Charge Comparison at 5,000 Gallons



APPENDIX A GENERAL FUND STATEMENT OF CASH FLOWS

General Fund Statement of Cash Flows

Line No.		Projected 2015	2016	2017	2018	2019	2020
	Operating Flow of Funds						
1	Revenue Under Taxes	$ 435,036	$ 435,000	$ 435,000	$ 435,000	$ 435,000	$ 435,000
	Proposed Revenue Adjustments						
	Year Month Increase						
2	2016 2 0.0%		-	-	-	-	-
3	2017 2 0.0%			-	-	-	-
4	2018 2 0.0%				-	-	-
5	2019 2 0.0%					-	-
6	2020 2 0.0%						-
7	Total Proposed Additional Revenue	-	-	-	-	-	-
8	Total Water User Charge Revenue	$ 435,000	$ 435,000	$ 435,000	$ 435,000	$ 435,000	$ 435,000
	General Fund Revenue						
9	Specific ownership taxes	$ 32,000	$ 32,000	$ 32,000	$ 32,000	$ 32,000	$ 32,000
10	Rebate/Refund of real property taxes	$ (500)	$ (500)	$ (500)	$ (500)	$ (500)	$ (500)
11	Proceeds from lease funds	$ -	$ -	$ -	$ -	$ -	$ -
12	Inclusion fees	$ 18,500	$ 18,500	$ 18,500	$ 18,500	$ 18,500	$ 18,500
13	Other non-operating income, Gain (loss) on assets	$ -	$ -	$ -	$ -	$ -	$ -
14	Other	$ -	$ -	$ -	$ -	$ -	$ -
15	Other	$ -	$ -	$ -	$ -	$ -	$ -
16	Other	$ -	$ -	$ -	$ -	$ -	$ -
17	Interest income, incl delinquent taxes	$ 500	$ 500	$ 500	$ 500	$ 500	$ 500
18	Total Miscellaneous Revenue	$ 50,500	$ 50,500	$ 50,500	$ 50,500	$ 50,500	$ 50,500
	Total General Fund Revenue	**$ 485,500**	**$ 485,500**	**$ 485,500**	**$ 485,500**	**$ 485,500**	**$ 485,500**
19	(Excluding Capital)	$ -	$ -	$ -	$ -	$ -	$ -
	Revenue Requirements						
20	Operation and Maintenance Expense	$ 238,300	$ 263,600	$ 249,000	$ 274,700	$ 260,400	$ 286,400
21	Debt Service						
22	Existing Debt	$ 221,600	$ 175,300	$ 139,800	$ 132,700	$ 132,700	$ -
23	Proposed Debt	$ -	$ -	$ -	$ -	$ -	$ -
24	Total Debt Service	$ 221,600	$ 175,300	$ 139,800	$ 132,700	$ 132,700	$ -
25	Transfer to Capital	$ -	$ -	$ -	$ -	$ -	$ -
26	**Total Revenue Requirements**	$ 459,900	$ 438,900	$ 388,800	$ 407,400	$ 393,100	$ 286,400
27	**Annual Operating Balance**	**$ 25,600**	**$ 46,600**	**$ 96,700**	**$ 78,100**	**$ 92,400**	**$ 199,100**
28	**General Fund Debt Svc Coverage**	1.12	1.27	1.69	1.59	1.70	-
	Capital Flow of Funds						
	Sources						
29	Transfer from Operations	$ -	$ -	$ -	$ -	$ -	$ -
30	Debt Issuance	$ -	$ -	$ -	$ -	$ -	$ -
31	CWCB Reimbursement	$ -	$ -	$ -	$ -	$ -	$ -
32	Total Sources	-	-	-	-	-	-
	Uses						
33	CIP	$ -	$ -	$ -	$ -	$ -	$ -
34	Bond Issuance Expense	$ -	$ -	$ -	$ -	$ -	$ -
35	Total Capital Uses	$ -	$ -	$ -	$ -	$ -	$ -
36	**Ending Capital Balance**	-	-	-	-	-	-
	Consolidated Cash Flow Results						
37	Total Sources of Funds	$ 485,500	$ 485,500	$ 485,500	$ 485,500	$ 485,500	$ 485,500
38	Total Uses of Funds	$ 459,900	$ 438,900	$ 388,800	$ 407,400	$ 393,100	$ 286,400
39	Annual Balance	$ 25,600	$ 46,600	$ 96,700	$ 78,100	$ 92,400	$ 199,100
40	Beginning Balance	$ 11,600	$ 37,200	$ 83,800	$ 180,500	$ 258,600	$ 351,000
41	Annual Operating Balance	$ 25,600	$ 46,600	$ 96,700	$ 78,100	$ 92,400	$ 199,100
42	Ending Balance	$ 37,200	$ 83,800	$ 180,500	$ 258,600	$ 351,000	$ 550,100
	Reserve Targets						
43	Operating (Days 90	$ 58,800	$ 65,000	$ 61,400	$ 67,700	$ 64,200	$ 70,600
44	Capital	$ -	$ -	$ -	$ -	$ -	$ -
45	Total	$ 58,800	$ 65,000	$ 61,400	$ 67,700	$ 64,200	$ 70,600

APPENDIX B CONSOLIDATED STATEMENT OF CASH FLOWS

Combined Statement of Cash Flows

Line No.		Projected 2015	2016	2017	2018	2019	2020
	Operating Flow of Funds						
1	Revenue Under Existing Rates	$ 480,000	$ 482,900	$ 483,900	$ 484,800	$ 485,800	$ 487,700
	Proposed Revenue Adjustments						
	Year Month Increase						
2	2016 2 9.75%		$ 43,200	$ 47,200	$ 47,300	$ 47,400	$ 47,600
3	2017 2 9.75%			$ 47,500	$ 51,900	$ 52,000	$ 52,200
4	2018 2 9.75%				$ 52,200	$ 57,100	$ 57,300
5	2019 2 0.00%					$ -	$ -
6	2020 2 2.00%						$ 11,800
7	Total Proposed Additional Revenue	$ -	$ 43,200	$ 94,700	$ 151,400	$ 156,500	$ 168,900
8	Total Water User Charge Revenue	$ 480,000	$ 526,100	$ 578,600	$ 636,200	$ 642,300	$ 656,600
	Other Enterprise Fund Revenue						
9	Miscellaneous Revenue	$ 11,800	$ 11,800	$ 11,800	$ 11,800	$ 11,800	$ 11,800
10	Subdistrict A - collections for debt service	$ 31,700	$ 31,700	$ 31,700	$ 31,700	$ 31,700	$ 31,700
11	Total Other Enterprise Fund Revenue	$ 43,500	$ 43,500	$ 43,500	$ 43,500	$ 43,500	$ 43,500
	General Fund Revenue						
12	Taxes	$ 466,500	$ 466,500	$ 466,500	$ 466,500	$ 466,500	$ 466,500
13	Other non-operating income	$ 19,000	$ 19,000	$ 19,000	$ 19,000	$ 19,000	$ 19,000
14	Total General Fund Revenue	$ 485,500	$ 485,500	$ 485,500	$ 485,500	$ 485,500	$ 485,500
15	**Grand Total Water Revenue**	**$ 1,009,000**	**$ 1,055,100**	**$ 1,107,600**	**$ 1,165,200**	**$ 1,171,300**	**$ 1,185,600**
	Revenue Requirements						
	Operation & Maintenance Expense						
16	Enterprise Fund O&M	$ 386,300	$ 401,700	$ 412,000	$ 422,500	$ 433,300	$ 444,200
17	Gen. Fund O&M	$ 238,300	$ 263,600	$ 249,000	$ 274,700	$ 260,400	$ 286,400
18	Total O&M	$ 624,600	$ 665,300	$ 661,000	$ 697,200	$ 693,700	$ 730,600
	Debt Service						
19	Existing Enterprise Fund Debt	$ 70,700	$ 70,700	$ 70,700	$ 70,700	$ 70,700	$ 70,700
20	Proposed Enterprise Fund Debt	$ -	$ -	$ 43,139	$ 162,500	$ 162,500	$ 162,500
21	Existing Gen. Fund Debt	$ 221,600	$ 175,300	$ 139,800	$ 132,700	$ 132,700	$ -
22	Total Debt Service	$ 292,300	$ 246,000	$ 253,639	$ 365,900	$ 365,900	$ 233,200
23	Other	$ -	$ -	$ -	$ -	$ -	$ -
24	**Total Revenue Requirements**	**$ 916,900**	**$ 911,300**	**$ 914,639**	**$ 1,063,100**	**$ 1,059,600**	**$ 963,800**
25	**Annual Operating Balance**	**$ 92,100**	**$ 143,800**	**$ 192,961**	**$ 102,100**	**$ 111,700**	**$ 221,800**
26	Enterprise Net Revenue (Lines 8 + 9 - 16)	137,200	167,900	210,100	257,200	252,500	255,900
27	Enterprise Debt Service (Lines 19 + 20)	70,700	70,700	113,839	233,200	233,200	233,200
28	**Enterprise Fund Debt Service Coverage**	**1.94**	**2.37**	**1.85**	**1.10**	**1.08**	**1.10**
	Capital Flow of Funds						
	Sources						
29	Transfer from Operations	$ -	$ -	$ -	$ -	$ -	$ -
30	Debt Issuance	$ -	$ 3,099,145	$ -	$ -	$ -	$ -
31	CWCB Reimbursement	$ -	$ 351,000	$ -	$ -	$ -	$ -
32	Total Sources	$ -	$ 3,450,145	$ -	$ -	$ -	$ -
	Uses						
33	CIP	$ 210,000	$ 3,254,400	$ -	$ 20,000	$ -	$ 60,000
34	Bond Issuance Expense	$ -	$ 31,000	$ -	$ -	$ -	$ -
35	Total Capital Uses	$ 210,000	$ 3,285,400	$ -	$ 20,000	$ -	$ 60,000
36	**Annual Capital Balance**	**$ (210,000)**	**$ 164,745**	**$ -**	**$ (20,000)**	**$ -**	**$ (60,000)**
	Consolidated Cash Flows						
37	Total Sources of Funds	$ 1,009,000	$ 4,505,245	$ 1,107,600	$ 1,165,200	$ 1,171,300	$ 1,185,600
38	Total Uses of Funds	$ 1,126,900	$ 4,196,700	$ 914,639	$ 1,083,100	$ 1,059,600	$ 1,023,800
39	Annual Balance	$ (117,900)	$ 308,545	$ 192,961	$ 82,100	$ 111,700	$ 161,800
40	Beginning Balance	$ 347,400	$ 229,500	$ 538,045	$ 731,005	$ 813,105	$ 924,805
41	Annual Operating Balance	$ (117,900)	$ 308,545	$ 192,961	$ 82,100	$ 111,700	$ 161,800
42	**Ending Balance**	**$ 229,500**	**$ 538,045**	**$ 731,005**	**$ 813,105**	**$ 924,805**	**$ 1,086,605**
	Reserve Targets						
43	Operating (Days) 180	$ 308,000	$ 328,100	$ 326,000	$ 343,800	$ 342,100	$ 360,300
44	Capital	$ 200,000	$ 200,000	$ 200,000	$ 200,000	$ 200,000	$ 200,000
45	Total	$ 508,000	$ 528,100	$ 526,000	$ 543,800	$ 542,100	$ 560,300

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