Appendix E –Preliminary Design Report

SOMERSET DIVERSION
PRELIMINARY DESIGN REPORT

PREPARED FOR:

DELTA CONSERVATION DISTRICT

COLORADO REGISTERED
AARON KEITH ASQUITH
36602
1/13/15
PROFESSIONAL ENGINEER

Prepared by:

MERRICK® & COMPANY
McLaughlin Water Engineers
A Division of Merrick & Company

Aaron Asquith, Colorado P.E. 36602

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SOMERSET DIVERSION

PRELIMINARY DESIGN REPORT

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1.0 INTRODUCTION

Merrick & Company has completed preliminary designs for modifications to the Somerset Diversion. Objectives for the design identified by the Delta Conservation District and Project Stakeholders are as follow:

1. Ensure full diversion of water rights at all flow levels,
2. Ensure fish and boater passage through/around diversion,
3. Reduce sediment loading in diverted water before pumping,
4. Reduce long-term maintenance,
5. Survive 100-yr flood,
6. Minimize impact to surrounding floodplain, and
7. Optimize pumping operations from pump station to water tank.

The Project Stakeholders include:

1. Oxbow LLC – Elk Creek Mine
2. Somerset Domestic Waterworks District
3. Gunnison Basin Roundtable
4. Colorado River Water Conservation District
5. Colorado Division of Parks and Wildlife
6. Trout Unlimited
7. Gunnison County
8. Delta Conservation District
9. Western Slope Conservation District

1.1 KICKOFF MEETING

A project kickoff meeting was held on July 22, 2014 to discuss project schedule and scope as well as refine project objectives. Primary discussion points included the following:

1. The Waterworks District would like to eliminate the initial pumping (river to wet well) with the proposed design.
2. The group would like the final configuration to equally benefit fishing and boating recreation with boating/passage improvements to encourage low hazard normal river use and not necessarily provide a destination park and play experience.
3. Where possible, the group would like to introduce natural elements into the design, minimizing straight lines or obvious man made elements where possible.
4. The project area is currently on private property. Development of access will not be initiated until this analysis/design is completed.

1.2 PRELIMINARY DESIGN REVIEW MEETING

A draft preliminary design report was provided to the Integrated Project Team on September 29, 2014. Design Alternatives were presented and discussed on October 6, 2014. Primary discussion points included the following:

1. The costs presented did not include on shore (land) work. The cost for that work should be included in the final report.
2. Most group member preferred the single thread river option.
3. River velocities and depths for fish passage were preferred for Alternative 2.
4. The group would like to explore a third alternative that blends small drops and a single thread for restoration of the river.
5. Follow up with the County is needed to further define needed floodplain development permitting for the site.
6. The team would like an estimate of construction duration included in the report.
7. There is concern that construction of the diversion at the proposed location may cause the need to apply for a change in point of diversion.

2.0 SCOPE

The scope of this project is further divided into tasks as follow:

1. Kick-off meeting
2. Site Inspection and Survey
3. Draft Preliminary Design
4. Draft Preliminary Design Review
5. Preliminary Design Iteration
6. Preliminary Design and Report Review

3.0 BACKGROUND

The Somerset Diversion is located on the North Fork of the Gunnison River approximately 0.6 miles upstream of Somerset, CO in Gunnison County. In the 1960's, an infiltration gallery was constructed to provide a reliable groundwater source for coal mining operations and potable water supply to mine workers and the Town of Somerset. The Oxbow Mine maintains the responsibility of supplying potable water to the Town's residents. The water supply system has been periodically improved since the original infiltration gallery construction. The original gallery, consisting of a 6-feet diameter, 20-feet long vertical corrugated metal pipe and 4-feet diameter, 100-feet long horizontal pipe was expanded with the addition of two 4-feet diameter 40-feet long perpendicular pipes at the eastern end of the gallery. An existing pump station housing twin 50 hp vertical turbine pumps delivers water via a 6" water line to a 200,000 gallon water storage tank located near the main mine surface buildings. A second 200,000 gallon water storage tank was constructed by the mine in 2002 to address the long wall mining process at the Elk Creek Mine.

Mining has ceased and significantly reduced water demand. In addition, the existing infiltration gallery has deteriorated and can no longer adequately flood the wet well to allow pumping at the decreed diversion rate of 1.8 cfs for sustained periods. As a result, the mine is currently operating two trash pumps that sit in the river. One discharges into the infiltration gallery and the other one discharges directly to the wet well during periods of high demand. The result is the diversion and pumping of sediment laden water to the raw water storage tank. While the sediment laden water is not reported to have caused damage to the vertical turbine pumps, it does cause sediment buildup in the tank, leading to regular maintenance cleanings. In addition, during periods of turbid river flow, additional backwash cycles are required at the water treatment plant.

The Fire Mountain Ditch Company has been working with the USBR to address sedimentation of Paonia Reservoir upstream. Since completed, the reservoir capacity has been steadily decreasing due to sediment inflow from its tributaries. It is our understanding that sediment is being discharged from the reservoir to the North Fork equal to the rate of sediment inflow to preserve current storage volume. Although there are currently other sources of sediment load to the Gunnison River, most notably Coal and Anthracite Creeks, this discharge has increased sediment in the river at the Somerset Diversion.

3.1 EVALUATION OF EXISTING SITE AND DIVERSION

Merrick & Company completed a topographic and bathymetric survey of the site and river bottom from July 22 through July 24, 2014. Surveying was completed using a Leica Total Station. Monuments or other control points on established datums, such as NAVD 88 and NGS 83 could not be located in the immediate project area. As a result, the survey was tied to the vertical datum used by the Oxbow Mine, LLC. Full topographic survey extended downstream of the pump station 500 feet and upstream 1000 feet. River cross sections were also collected 1,000 feet upstream and 2,000 feet downstream of the pump station. The most downstream cross section corresponds to Cross Section Z, as identified in the Flood Insurance Study, Gunnison County, Colorado and Incorporated Areas, FIS Number 08051CV000A, May 16, 2013. The measured hydraulic drop in the North Fork from the east entrance road to the west entrance road at the time of surveying was 9.9 feet with an overall channel slope 0.83%.

Based on conversations with the project team, multiple loose rock sills were constructed in the river to raise local groundwater and aide with infiltration gallery production. Since construction, the sills have gradually lost shape during high flows from saltation and local scour processes. In the current state, water is spread out across the sills, resulting in shallow flow in spaces between boulders. The shallow nature of the flow and numerous small gaps limits boat passage through the diversion site at low flows. In addition, local scour around the larger boulders allows underflow through voids that are foot entrapment hazards for fisherman and waders. At intermediate boating flows, less than 1,000 cfs, gaps between boulders are a pinning hazards for boaters. It was also noted that banks on both sides of the river have degraded to a near vertical condition as a result of the unstable condition of the reach. It is opined that this vertical condition is the result of a combination of channel degradation due to sediment stripping by Paoina reservoir and higher flows being directed into banks by the series of installed sills. The resulting condition is near vertical banks that can no longer support riparian habitat or wetland vegetation needed to keep topsoil in place and provide shaded shelter for fish and other aquatic species.

4.0 ALTERNATIVE DEVELOPMENT

Two initial alternative concepts were developed for in river improvements. Following the preliminary design report review, a third alternative was developed for the site. Alternative 1 provides a surface intake to supply pump station water and restores the reach with a combination of drops and pools. Alternative 1 is based on restoring and reinforcing the series of sills previously constructed that are currently in a disorganized state. Alternative 2 provides a similar surface intake to supply pump station water but restores the reach to a continuous single-thread riffle through the project reach. Alternative 3 provides a hybrid of Alternatives 1 and 2. Alternative 3 promotes a new intake and single thread river, but relies on small drops and pools in lieu of a continuous riffle to restore the river. The three alternatives are further described below and are depicted on Drawings 1, 2 and 3, attached in Appendix A.

4.1 ALTERNATIVE NO. 1 – DROP POOL RIVER RESTORATION

Alternative No. 1 restores and reinforces the multiple sill project previous constructed to locally raise groundwater at the diversion location. This alternative provides a combination of small drops and pools to distribute the grade in the reach. The alternative is depicted on the attached Drawing 1. The surface water diversion occurs at the upper drop structure. A combination roughened fish passage/boat chute (low flows) and a roughened step dam that is activated during higher flows is integrated with the diversion. The proposed diversion is a lateral takeout with a sediment sluice channel. A bar rack is proposed to protect the intake from debris and large cobbles while the sluice channel, combined with a fine screen, would reduce diversion of granular sediment.

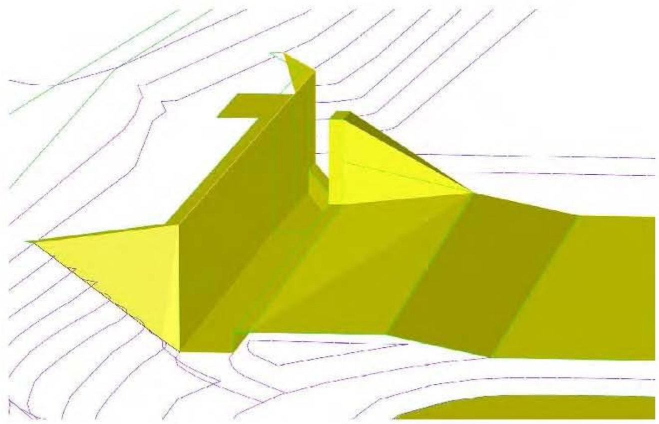

Figure 1: Isometric View of Lateral Diversion and Sluice Channel

The existing bifurcated channel through the bend remains intact and is reinforced by reconstructed sills. On the inside path, three drops of approximately 1 foot each provide navigable drops, passable by upstream migrating trout, and intermediate resting pools. Along the outside bank, one larger 1.5 feet drop is coupled with a 200 feet long riffle to distribute the grade in the reach. The two channels are combined just upstream of the pump station at a counter weir with 0.5 feet of hydraulic drop. The counter weir provides a dual function, including distributing a portion of the existing drop as well as providing protection of the improvements from additional head cutting downstream of the reach.

The following are short descriptions of the design elements included in Alternative No. 1:

- ***Intake/Diversion Orientation*** – *The intake/diversion structure is proposed on the outside of a bend, parallel to the river bank and oriented to provide sweeping flow across the intake bar rack to reduce pinning of floating debris.*
- ***Bar Rack*** – *New sloped bar rack along intake structure for exclusion of large floating debris.*
- ***Sluice Channel with Overshot Gate*** – *A concrete channel, parallel to river flow is proposed to sluice sediment downstream while allowing lateral intake of water. An overshot gate within the channel can be raised during periods of low flow and drought to ensure a pool for water diversion. During high flow, the gate will be lowered to promote sediment sluicing.*

- ***Existing and New Sills*** *– Boulders from the existing loose rock sills will be reused. New sills will be constructed at similar elevation to existing sills, however, the new sills will include appropriate cutoffs and grout for stability during a 100-yr design flood.*
- ***Fish Passage*** *– A roughened channel (rock ramp) using boulders to provide fish passage at the grouted boulder diversion structure. Other sills will use a combination of boulders and low drops to allow upstream fish passage.*
- ***Stepped Dam*** *– Grouted boulder steps at the dam will improve stability and reduce hazards along the toe of the dam.*
- ***Jetties*** *– Boulder jetties upstream, downstream, and within the project reach will be constructed to turn the river flow, provide a take-out for river users, and protect the bank.*
- ***Portage Trail*** *– A trail and signage to encourage portage around the intake and diversion dam is included on the north bank.*

4.2 ALTERNATIVE NO. 2 – RIFFLE AND TERRACE RESTORATION

Alternative 2 represents a return of the river reach to a single thread, matching the overall river gradient and mimicking the river width and riparian and wetland terraces bordering the river upstream and downstream of the project site. This alternative uses a combination of a single drop/sill and constructed riffle to distribute the drop within the reach. Similar to Alternative 1, a combination fish ramp/boat passage and lateral diversion structure is proposed at the upstream end of the project reach. The drop is reduced to 2 feet in this alternative to further promote fish passage and low hazard boat passage. In lieu of multiple sills, a series of jetties on the outside of the river bend shift the river north and provide an opportunity to re-establish the outside bend terrace that has long since vanished as a result of sediment transport and scour. It is anticipated that existing boulders will be reused for the project and native river bed material will be stripped, stockpiled and replaced after grading to reform a natural armoring layer in the extended riffle.

Photo 1: Riffle River Section Upstream of Project Reach

Note that one primary goal of Alternative 2, depicted on Drawing 2, is to restore the river to a more natural condition, prior to loose boulder sill installation and subsequent destabilization of the reach. Similar to reaches upstream and downstream, it is planned to add large individual boulders or boulder clusters to provide variability in the riffle, and feeding/resting zones for fish.

The following are short descriptions of the design elements included in Alternative No. 2:

- ***Intake/Diversion Orientation*** *– The intake/diversion structure is proposed on the outside of a bend, parallel to the river bank and oriented to provide sweeping flow across the intake bar rack to reduce pinning of floating debris.*
- ***Bar Rack*** *– New sloped bar rack along intake structure for exclusion of large floating debris.*
- ***Sluice Channel with Overshot Gate*** *– A concrete channel, parallel to river flow is proposed to sluice sediment downstream while allowing lateral intake of water. An overshot gate within the channel can be raised during periods of low flow and drought to ensure a pool for water diversion. During high flow, the gate will be lowered to promote sediment sluicing.*
- ***Existing and New Sills*** *– Boulders from the existing loose rock sills will be reused. One new grouted boulder diversion sill will be constructed at the upstream end of the project reach. The new sill will be constructed at a similar elevation to the upper existing sill; however, it will include appropriate cutoffs and grout for stability during a 100-yr design flood.*
- ***Fish Passage*** *– A roughened channel (rock ramp) using boulders to provide fish passage at the grouted boulder diversion structure. The remainder of the reach will be restored with a continuous riffle, meeting fish passage criteria.*

- ***Jetties and Boulder Clusters*** – *Boulder jetties upstream, downstream and within the project reach will be constructed to turn the river flow, provide a take-out for river users, protect the bank and establish riparian/wetland terraces. In addition, large single boulders or boulder clusters are provided for intermediate resting and feeding areas within the riffle.*
- ***Portage Trail*** – *A trail and signage to encourage portage around the intake and diversion dam is included on the north bank.*

4.3 ALTERNATIVE NO. 3 – SINGLE THREAD DROP POOL RIVER RESTORATION

Alternative 3 also returns the river to a single thread. Three sills are proposed with crests at elevations to match the overall river gradient and mimick the river width upstream and downstream of the site. Similarly to Alternative 2, wetland and riparian terraces are provided through the restored reach. The upstream sill is a combination fish ramp/boat passage integrated with a lateral diversion structure. The two downstream sills provide small drops suitable for play boating for intermediate skill level users. Because sill crests are proposed to match the overall river gradient, the project relies on local scour to maintain small pools at the sills where standing waves or holes would form. This approach allows shoulders of the sills to be graded at shallow slopes, providing upstream roughened fish passage at either side of the hydraulic.

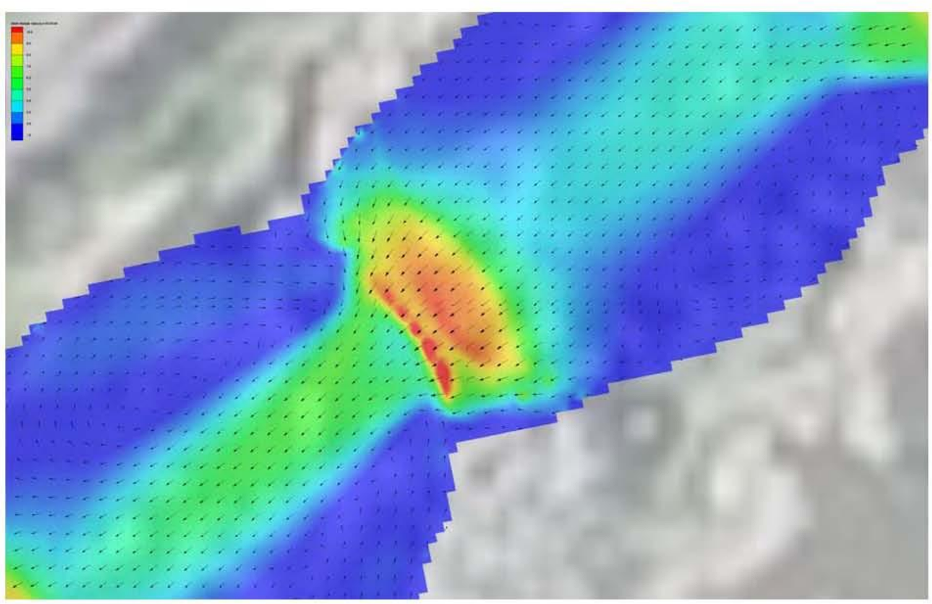

Figure 2: 2D Modeling of Low Drop Sill – Note Low velocities (1 – 5 FT/SEC) at Sides

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The following are short descriptions of the design elements included in Alternative No. 3:

- ***Intake/Diversion Orientation*** *– The intake/diversion structure is proposed on the outside of a bend, parallel to the river bank and oriented to provide sweeping flow across the intake bar rack to reduce pinning of floating debris.*
- ***Bar Rack*** *– New sloped bar rack along intake structure for exclusion of large floating debris.*
- ***Sluice Channel with Overshot Gate*** *– A concrete channel, parallel to river flow is proposed to sluice sediment downstream while allowing lateral intake of water. An overshot gate within the channel can be raised during periods of low flow and drought to ensure a pool for water diversion. During high flow, the gate will be lowered to promote sediment sluicing.*
- ***Existing and New Sills*** *– Boulders from the existing loose rock sills will be reused. New sills will be constructed with crests to match the overall river gradient. The new sills will include appropriate cutoffs and grout for stability during a 100-yr design flood.*
- ***Fish Passage*** *– A roughened channel (rock ramp) using boulders to provide fish passage at the grouted boulder diversion structure. Other sills will use a combination of boulders and low drops to allow upstream fish passage while providing a recreational experience.*
- ***Jetties and Boulder Clusters*** *– Boulder jetties upstream, downstream and within the project reach will be constructed to turn the river flow, provide a take-out for river users, protect the bank and establish riparian/wetland terraces. In addition, large single boulders or boulder clusters are provided for intermediate resting and feeding areas within the riffle.*
- ***Portage Trail*** *– A trail and signage to encourage portage around the intake and diversion dam is included on the north bank.*

5.0 HYDROLOGY

In preparation of this design, we obtained the Flood Insurance Study for the North Fork. The study, titled "Flood Insurance Study – Gunnison County, Colorado and Incorporated Areas" completed detailed floodplain mapping on the North Fork upstream to a cross section 2,000 feet west of the diversion pump station. The most upstream cross section was duplicated with the survey effort for this project; however, unavailable NGS bench marks in the area did not allow matching of the 2 datums. Review of the study indicates the following flood series flows for the North Fork at the Somerset Gage.

Event Frequency (Yrs)	Flow (cfs)
10	5,600
50	8,000
100	9,200
500	11,300

Table 1 – North Fork Gunnison River Flood Series from Flood Insurance Study

6.0 HYDRAULIC ANALYSIS

Mr. Mike Drake (Delta Conservation District) recorded water surface elevations at three locations within the project reach. Data was collected periodically from May 3, 2014 to July 2, 2014 during flows ranging from 586 cfs to 2,697 cfs. In addition, water surface elevations were measured at the time of survey (flow of 275 cfs). Initially, a one dimensional hydraulic model (HEC-RAS) was built for the project reach. Roughness values were selected based on field observations of the reach. Using measured water surface elevations, roughness values were adjusted to provide a best fit (modeled to measured data) over the range of flows. The resulting one dimensional model has a maximum difference from measured results of 0.27 feet, with an average difference of 0.12 feet. Note that differences in predicted values were both above and below the measured water surface elevations.

Results from the one-dimensional model were used to setup two-dimensional modeling. Existing conditions and Alternatives 1 and 2 were 2D modeled using TUFLOW with pre- and post-processing, using SMS v11.0. Two flows were evaluated in the existing proposed conditions 2D hydraulic models: 400 cfs and 1,000 cfs. In all models, the diverted flow to the pump station was ignored, as it represented a very small portion of the river flow (0.45% and 0.18%). The overshot gate was modeled in the down condition. Both alternatives provided promising intake conditions that would result in minimal floating debris accumulations and intake of sediment.

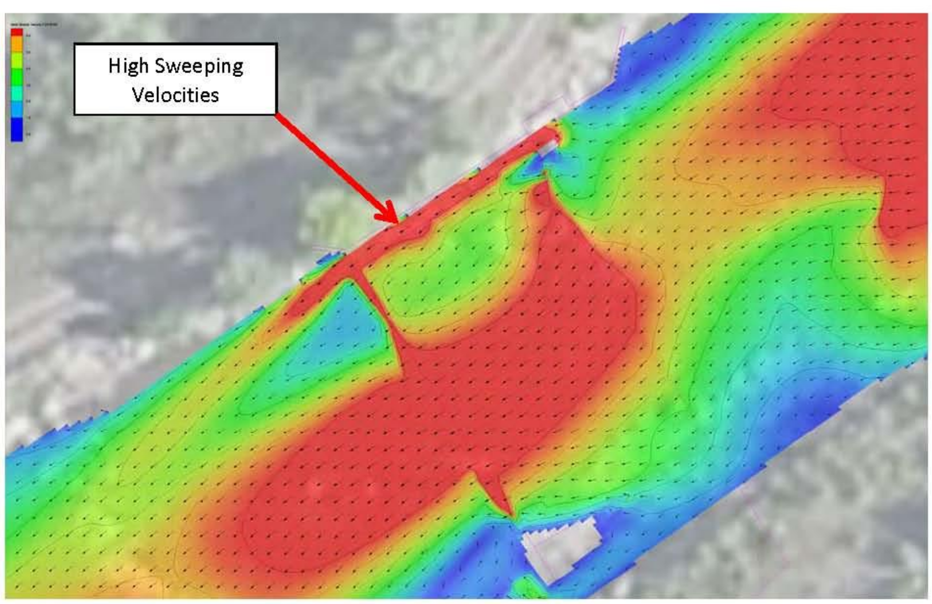

Figure 3: 2D Hydraulic Results at Intake – 1,000 cfs

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Results from the 2D modeling effort are provided in the attached Appendices. Appendix B includes results at 400 cfs and Appendix C includes results at 1,000 cfs.

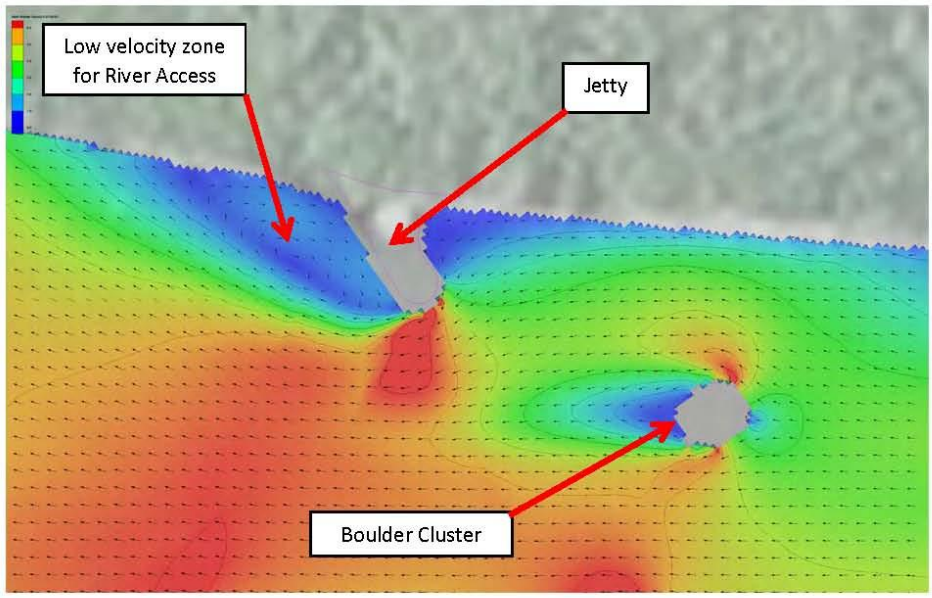


Figure 4: 2D Hydraulic Results at Jetty and Boulder Cluster

6.1 STABILITY

In-river structures must resist river forces. Riprap, loose boulders and grouted boulders will be used to resist tractive forces, shear stresses, and impact forces. Subsurface cutoffs are required to reduce piping and uplift pressures on structures. Scour protection using sloped grouted boulders and buried riprap is needed along the toe of the diversion structure and sills, and at the sediment trough. Grouted boulder jetty structures, riprap and vegetation will be used for bank/channel stabilization. Stability design including scour depths, channel degradation and aggradation, and armoring sizes/types was not completed for this phase but will be required during final design.

6.2 FLOOD CONVEYANCE

The Federal Emergency Management Agency (FEMA) has mapped the reach but not performed a detailed flood study of the project reach. Alternatives 1 and 2 have been modeled using HEC-RAS (1-Dimensional Model approved by FEMA) to determine impacts to the 100-yr water surface elevations in the reach. To determine impacts, a base model was created from collected cross section survey data. Drawing MO, attached in Appendix A, depicts the locations of cross sections used in the modeling effort. After an existing conditions model was completed it was then modified to represent proposed conditions for Alternatives 1 and 2. Water surface profiles from the modeling efforts are attached in Appendix A, following Drawing MO. Table 2 represents the existing conditions versus proposed conditions modeling results.

Cross Section	Existing Conditions Water Surface (Feet)	Alternative 1 Water Surface (Feet)	Water Surface Difference (Feet)	Alternative 2 Water Surface (Feet)	Eater Surface Difference (Feet)
145637.9	6038.32	6038.26	-0.06	6038.27	-0.05
145545.7	6038.61	6038.54	-0.07	6038.55	-0.06
145458.5	6037.07	6037.80	0.73	6037.81	0.74
145376.2	6036.54	6036.86	0.32	6036.86	0.32
145290.1	6035.81	6035.81	0.00	6035.85	0.04
145215.6	6034.87	6036.08	1.21	6034.29	-0.58
145129.3	6034.01	6034.73	0.72	6033.18	-0.83
145049.2	6033.13	6033.34	0.21	6032.40	-0.73
144988.6	6032.48	6032.80	0.32	6032.98	0.50
144948.2	6032.53	6032.97	0.44	6032.86	0.33
144855.6	6032.45	6032.60	0.15	6032.67	0.22
144777.7	6030.89	6031.33	0.44	6031.37	0.48
144688.7	6029.35	6030.28	0.93	6030.59	1.24
144613.2	6029.39	6030.27	0.88	6030.10	0.71
144544.0	6029.31	6029.18	-0.13	6029.18	-0.13
144459.6	6028.72	6028.72	0.00	6028.72	0.00
144391.8	6027.59	6027.59	0.00	6027.59	0.00
144320.1	6026.06	6026.06	0.00	6026.06	0.00
144245.6	6026.49	6026.49	0.00	6026.49	0.00
143645.0	6022.53	6022.53	0.00	6022.53	0.00
142740.0	6015.22	6015.55	0.33	6015.22	0.00

Table 2 – 100-yr Modeling Results - North Fork Existing Conditions and Alternatives 1 and 2

As can be seen from the table, the proposed alternatives modify the existing 100-yr water surface elevations by as much as 1.2 feet at some cross sections. In preparation of this report we have contacted Gunnison County Planning to determine required floodplain permitting associated with the project and the potential water surface increase as a result of the project. The project lies within Zone A of the Flood Insurance Rate Map (FIRM) and will be constructed in the floodplain and floodway. In development of final design, a standard floodplain development permit application (available on the County website) will be required. Currently, the County floodplain regulations limit the post project base flood elevation rise to 0.5 feet. We believe two approaches may be taken during final design development. These include:

1. Modification of design to achieve a 0.5 feet or less rise, followed by standard floodplain development permit application.
2. Request for a variance to the regulations as the only adjacent structure potentially impacted would be the existing pump station. Note that the pump station finished floor elevation is approximately 2 feet above the 100-yr water surface elevation.

The County reviews floodplain development applications on a case by case basis and does not have specific criteria related to diversion structures. As a result, the design engineer for the final project will need to prepare a report detailing the proposed impacts to the floodplain. It is highly recommended that an initial project meeting with the County is held to discuss options and requirements for the project.

6.3 FISH PASSAGE

Two applicable sources were identified by document research to determine fish passage criteria for target species, adult trout. *Washington Department of Fisheries and Wildlife (WADFW) Fish Passage Design at Road Culverts Design Manual* provides required hydraulic conditions, water depth and velocity, for passage of an adult Rainbow Trout (>6-inches). *The United States Army Corps of Engineers Fish Passage Development and Evaluation Program Fisheries Handbook* by Milo C. Bell (1991) lists swimming capabilities for many fish species including trout. Fish passage criteria from these sources are summarized below:

Fish Passage Criteria (WADFW)

- Minimum Depth: 0.8 feet
- Maximum Velocity: 4 feet/second

Brown Trout Swimming Capabilities (USACE – Milo Bell)

- Sustained Swim Speed: 7 feet/second
- Darting Swim Speed: 12 feet/second

Additionally, existing hydraulic conditions in the river upstream and downstream of the project reach were evaluated to determine current fish passage conditions. To demonstrate that a continual path from downstream to upstream was available for fish passage, the following criteria were applied to the 2D model results:

Existing Passage Conditions in River Upstream and Downstream of Reach (2D Model Results)

- Depth: 0.8 feet, and
- Velocity: < 7 feet/second

Based on document research and existing river conditions, Merrick used the following fish passage criteria for the preliminary design.

Fish Passage Criteria

- **Minimum Depth: 0.8 feet**
- **Maximum Velocity: 7 feet/second**
- **Fish Passage Flow Range: 400 cfs – 1000 cfs**

A roughened channel/rock ramp fishway design is proposed for the diversion structure. The channel is trapezoidal with a 15 foot wide bottom, 18-inches deep, 4:1 side slopes, and longitudinal slope of 6%. Boulders are placed in the channel invert and on side slopes to create hydraulic roughness and slower velocities. A conservative Manning's roughness value of 0.08 was used for hydraulic analysis in the two-dimensional modeling based on recommendations from *Reclamation Managing Water in the West Rock Ramp Design Guidelines, U.S. Department of the Interior Bureau of Reclamation, September 2007* and a HEC-RAS model analysis conducted by Merrick. Relative roughness due to boulder obstructions in the fishway was evaluated by developing two hydraulic models with the same geometries (cross section, slope, length) and boundary conditions. Boulders were added to the channel cross sections in one model. The channel roughness of the other model (without boulder obstructions) was increased until the energy grade lines were equal, representing a relative channel roughness that included boulder obstructions. Two channel slopes were evaluated; 2% low gradient and 10% high gradient. Results indicate channel roughness is sensitive to channel slope (see Figures Below).

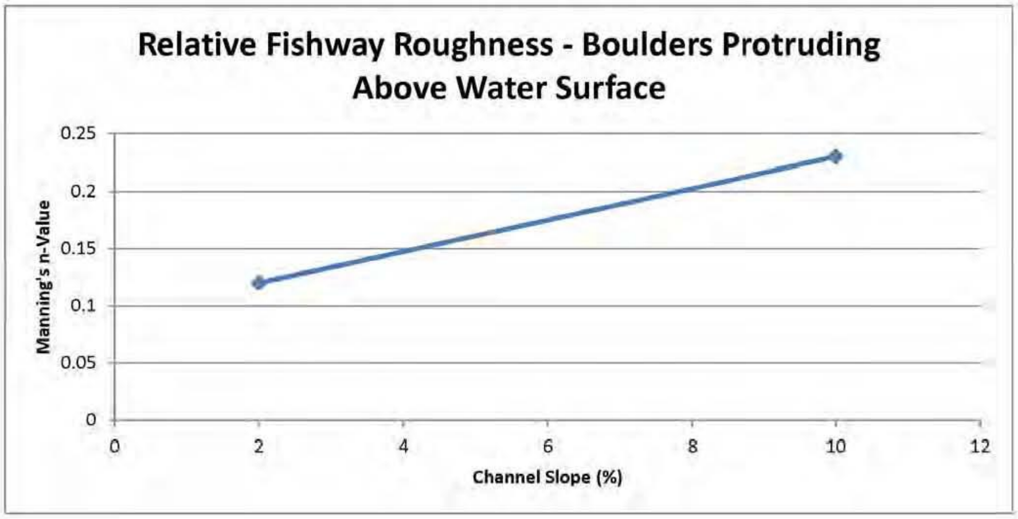


Figure 5 – Results of Merrick Analysis of Fishway Channel Roughness (HEC-RAS)

It is important to note that these roughness results are for hydraulic conditions where the boulders extend above the surface of the water. Lower roughness values are expected once overtopping occurs. In conclusion, the Manning's roughness value of 0.08 used for fishway design is within recommended ranges for rock ramps with boulder obstructions by the USBR and is slightly conservative according to the Merrick analysis.

7.0 SAFETY

Although the improvements for this project are not intended primarily for boating recreation use, Merrick recommends that in-river improvements be designed per the guidelines for recreational structures in the "Colorado Floodplain and Stormwater Criteria Manual" by the Colorado State Water Conservation Board (CWCB). This guideline states that the primary objective for planning, design and construction is *"structures be designed and constructed so that they are predictable and without hidden or unobvious hazards to* <u>*responsible*</u> *users"*. Low hazard design elements are included in the concept designs:

- Portage Trail – Ability for river users to exit the water upstream of the diversion and walk around or "scout" the structure,
- Dam Hazard Mitigation – Low slope or stepped dam face to reduce the "reverse roller" hydraulic that develops at the toe of the dam at some flows & boulder placement to reduce foot and hand entrapment hazards, and

- Signage – install signage upstream and at the dam site to provide the public with information on responsible usage, potential hazards and portage/access.

Merrick & Company recommends that the CWCB criteria be used as a basis for further development of the design.

8.0 INTAKE OPERATIONS

Sluicing is proposed to improve sediment and debris exclusion at the intake. An overshot gate at the dam crest will improve sweeping velocities across the bar rack and move large sediments such as cobbles downstream away from the intake. The proposed overshot gate is similar to an air bladder gate system as manufactured by Obermeyer Hydro, Inc. Summary of proposed sluicing operations follows:

- Overshot Gate Sluicing:
  - Operated in the fully Up or fully Down position
  - Open during higher river flows >400 cfs
  - Closed below river flows ≤ 400 cfs
  - Do not allow overtopping of gate for safety reasons

9.0 OVERSHOT GATE SYSTEM

An overshot gate is proposed for sluicing sediment at the intake diversion dam. The gate is connected to the river bottom by a hinge that allows a panel to be raised and lowered. Compressed air fills a reinforced rubber bladder under the gate panel to raise the gate. Conversely, air is released from the bladder to lower the gate panel. The gate is intended to be in the fully up or fully down position depending on sediment sluicing needs and river flow. Controls can be configured to automate the gate movement by water level, time, or other parameters.

Merrick has used a similar gate system on past projects. Obermeyer Hydro, Inc. of Fort Collins, Colorado is a leading manufacturer of these systems. They have been installed on small and large rivers all over the world and have been exposed to harsh river conditions including ice flows, large debris and high flood flows. The following figures are of a recent Merrick project on an irrigation diversion dam in Boise, Idaho.

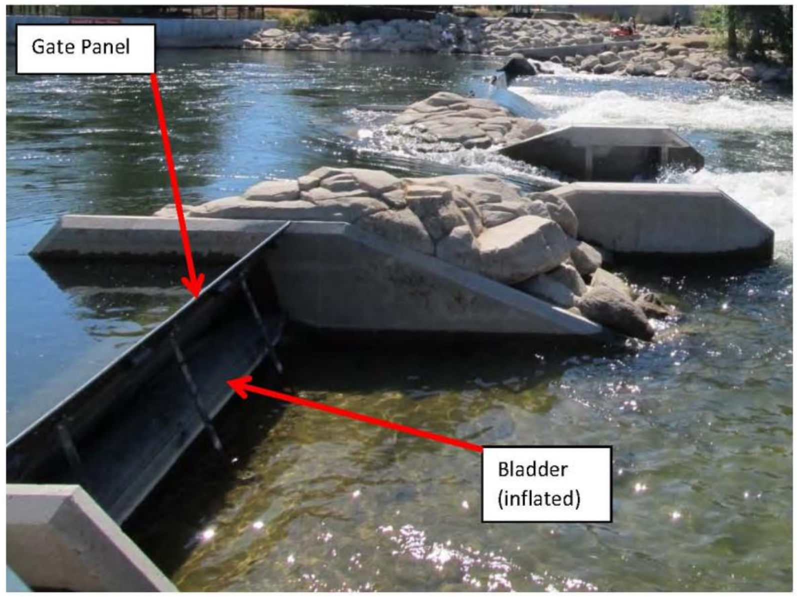


Figure 6 – Overshot Gate in "Up" Position at Thurman Mill Diversion Boise River, ID

These types of gates are generally low in maintenance over the project life. The gate incorporates a stainless steel hinge assembly with thick rubber hinge seal. Side seals are also constructed of a rubber j-bulb shape held in place with a removable – bolt-on plate. Gate panels are high density steel, treated to withstand corrosion and erosive forces of flowing sediment laden water. The bladder is a reinforced vulcanized rubber that is highly puncture resistant. At the proposed installation, stop logs would be included upstream of the gate to allow dewatering and full inspection on an annual basis. During inspection, seals along the bottom and sides should be inspected over the full length to determine if abnormal wear or tearing has occurred. In addition, the bladder would be inflated and observed for pressure loss or punctures. Seals can be replaced without gate removal if necessary although in this installation, minor leakage will not likely impact diversion operations. If installed correctly and without vandalism, it is likely that the gate system will last 10+ years without maintenance.

Figure 7 – Overshot Gate in "Down" Position at Thurman Mill Diversion Boise River, ID

10.0 POST-DIVERSION ALTERNATIVES (LAND WORK)

Based on discussions with project stakeholders the major concerns regarding pump station operation include:

1. Handling fine sediments (currently entrained by the river trash pump) that settle in the 200,000 raw water storage tank.
2. Inadequate water supply causing pump shut off when both pumps operate.

The proposed alternatives screen/remove sediments over 0.5 mm in diameter, which is a typical particle size passable by a vertical turbine pump without severe damage. The remaining granular sediment (< 0.5 mm) and colloidal sediment (clay particles) are much more difficult to remove.

Following diversion, water is routed to the existing pump station from where it is pumped to a 200,000 gallon raw water storage tank. Two alternatives to deliver water from the diversion to the pump station were evaluated as part of this project. Alternative A is a direct piping option from the diversion and is depicted on the Alternative 1 Site Plan. The alternative proposes to carry diverted water through a 12" or 18" pipe approximately 450 feet to a splitter structure. The splitter structure would be designed to maintain a constant water surface elevation and flooding of the wet well. From the splitter structure water would be piped directly to the pump station wet well, or if diversion rates are higher than the needed by the pump station, excess water would be returned via a constructed wetland channel to the river.

Alternative B provides the opportunity to settle fine sediments in a pond prior to pumping to the raw water tank. As shown in the Alternative 2 and 3 Site Plans, diverted water is carried for approximately 430 feet to a 5 feet deep settling pond. Diverted water would then pass over a weir structure and flow by gravity to the existing pump station wet well. The pond would be equipped with a spillway to allow flows in excess of pumping rates to be returned to the river via a constructed wetlands channel. This project offers the benefit of sediment removal near the diversion, in lieu of removal through period raw water tank cleaning. Either alternative is an improvement over the existing system as the need for double pumping (river to wet well and wet well to tank) is reduced.

11.0 LAND EASEMENTS AND OWNERSHIP

Proposed improvements are to be constructed on and adjacent to private property. Under all alternatives, proposed river restoration will improve the channel reach and improve fishing and boating recreation. In addition, it is prudent and appropriate to provide portage around in-river structures so they may be scouted or bypassed by in-river users. Determination of needed property and access for operation and maintenance of the diversion improvements is outside the scope of work for this project; however, it is recommended that development of access parallels further design development and funding requests for the project.

12.0 COSTS AND ESTIMATED CONSTRUCTION SCHEDULE

For cost estimation, quantities of work were estimated from the concept drawings and unit costs were estimated for this report. Unit costs were prepared from average unit costs of recent project bids with similar scope and from manufacturer supplied data. A breakdown of cost estimates is provided in Appendix D for Alternatives 1 through 3 (River Work) and Alternatives A and B (Land Work). A summary of estimates of probable construction costs is provided in Table 3.

River Work	**Estimated Cost**
Alternative 1 – Drop Pool River Restoration	$1,400,000
Alternative 2 – Riffle and Terrace Restoration	$990,000
Alternative 3 – Single Thread Drop Pool River Restoration	$1,350,000
Land Work	**Estimated Cost**
Alternative A – Direct Pipe Option	$130,000
Alternative B – Settling Pond Option	$160,000

Table 3 – Cost Estimates Summary

As can be seen from Table 3, the range of estimated costs for the project, river plus land work, is **$1,120,000** to **$1,560,000**.

A larger project, the Hartland Dam Modifications, was completed in Fall 2011/Winter 2012. The project was approximately twice the estimated cost of the proposed Somerset Diversion Project. The Hartland Project started in September and required 4.5 months for completion. Based on that schedule and similar project complexities, it is estimated that this project could be completed in 3 months and could start earlier, possibly August, as the required bypass flow rate is much less on the North Fork than the main stem of the Gunnison.

13.0 CONCLUSIONS AND RECOMMENDATIONS

Three alternative concepts were developed for this report and are presented herein. All concepts address primary design objectives including:

1. Ensure full diversion of water rights at all flow levels,
2. Ensure fish and boater passage through/around diversion,
3. Reduce sediment loading in diverted water before pumping,
4. Reduce long-term maintenance,
5. Survive 100-yr flood with improvements,
6. Minimize impact to surrounding floodplain, and
7. Optimize pumping operations from pump station to water tank.

The concepts, as developed, have been validated with preliminary design analysis and Alternatives 1 and 2 have been modeled using one-dimensional and two-dimensional modeling techniques. Based on 2D modeling, results indicate that some final design revisions and modeling will be required to ensure compliance with fish passage criteria. In addition, both designs modeled indicated a rise in the 100-yr water surface elevation in the project reach.

Alternatives 1 and 3 support multi-use recreational objectives for the project reach, maximizing benefits for both fisherman and boaters. Of the two, Alternative 3 is more desired by Project Stakeholders as it returns the river to a single thread and provides an opportunity for riparian terrace restoration. With Alternative 3, a local amenity will be provided that will benefit residents in the valley and encourage visitation, although on a small scale. For these reasons, Alternative 3 is the recommended as the basis for future design phases and funding requests. A rendering of Alternative 3 has been included in Appendix A. While the preliminary design appropriate to move forward has been completed, several key items, in addition to finalization of Contact Documents, will need to be considered in future phases of work. These include:

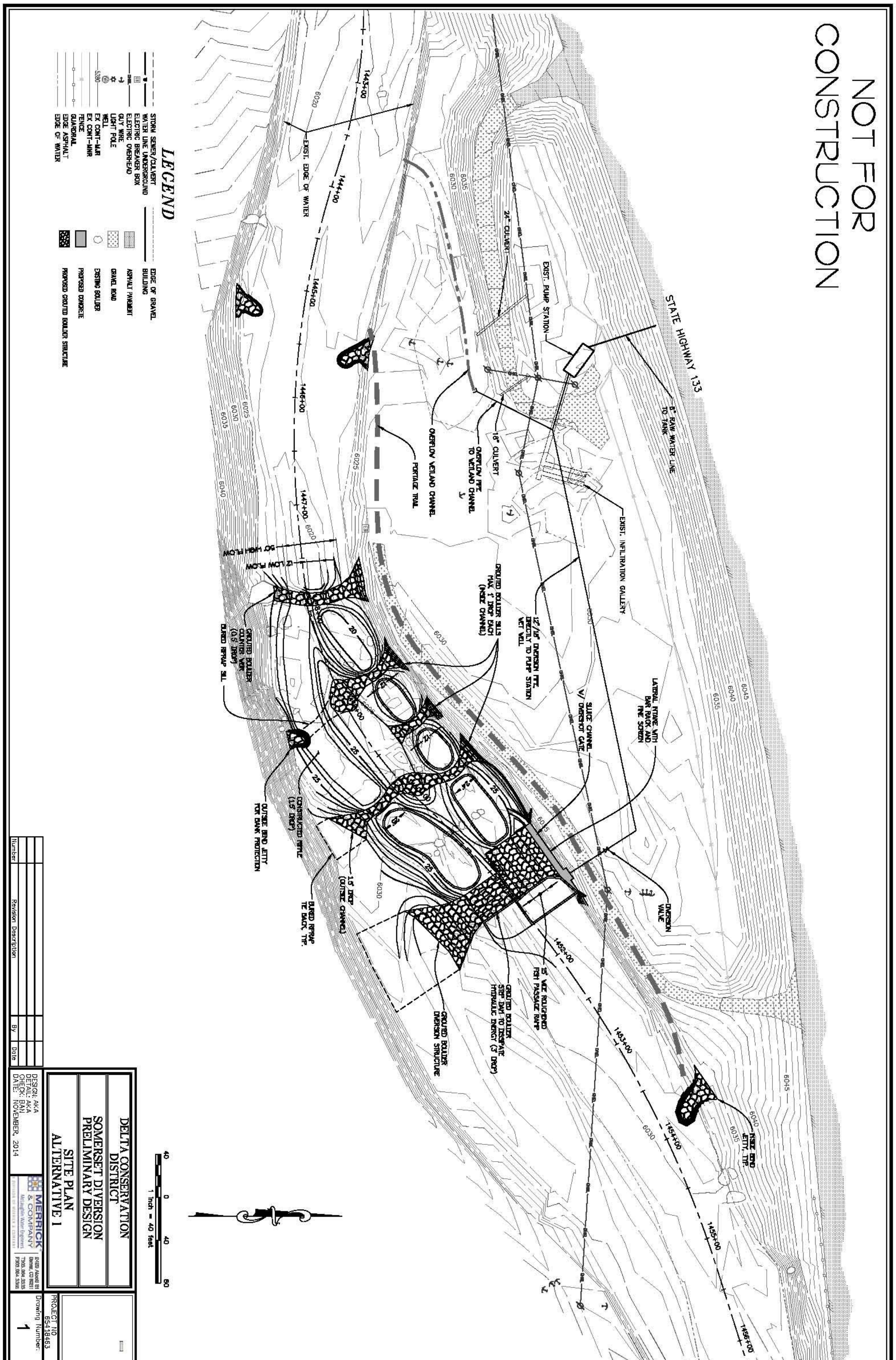
1. Property boundary surveying and development of land purchase agreements and/or easements for maintenance and operation.

2. Tie project survey to NAVD 88 (vertical datum) and NGS State Plane Coordinates (horizontal control).
3. Refine specific design items, including grouted boulder sill slopes and roughness elements, to achieve fish passage criteria.
4. Prepare and submit a floodplain development application to Gunnison County.
5. Evaluate the presence of wetland and Waters of the U.S. and submit a USACE 404 Permit Application prior to construction.

Appendix A

Preliminary Design Drawings, Rendering,

and 1D Modeling Figures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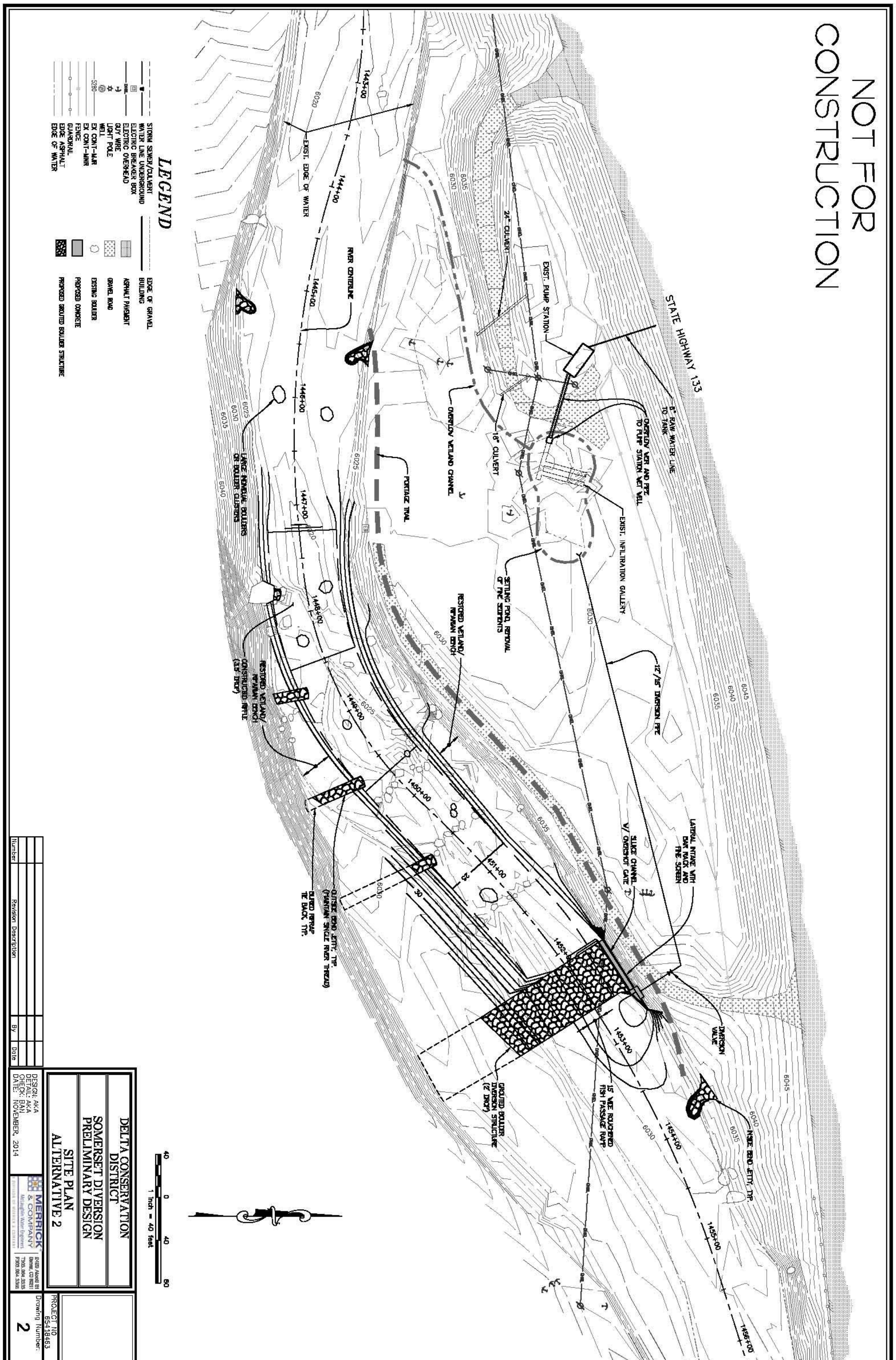
STATE HIGHWAY 133
LEGEND
STORM SEWER/CULVERT
WATER LINE UNDERGROUND
ELECTRIC LINE UNDERGROUND
ELECTRIC BREAKER BOX
ELECTRIC OVERHEAD
GUY WIRE
LIGHT POLE
WELL
EX CONT-MJR
EX CONT-MNR
FENCE
GUARDRAIL
EDGE ASPHALT
EDGE OF WATER
EDGE OF GRAVEL
BUILDING
ASPHALT PAVEMENT
GRAVEL ROAD
EXISTING BOULDER
PROPOSED CONCRETE
PROPOSED GROUTED BOULDER STRUCTURE
EXIST. EDGE OF WATER
EXIST. PUMP STATION
24" CULVERT
18" CULVERT
8" RAW WATER LINE TO TANK
OVERFLOW PIPE TO WETLAND CHANNEL
OVERFLOW WETLAND CHANNEL
PORTAGE TRAIL
EXIST. INFILTRATION GALLERY
LATERAL INTAKE WITH BAR RACK AND FINE SCREEN
SLUICE CHANNEL W/ OVERSHOT GATE
DIVERSION VALVE
GROUTED BOULDER SILLS MAX. 1' DROP EACH (INSIDE CHANNEL)
GROUTED BOULDER CULVERT SILL (0.5' DROP)
BURIED RIPRAP SILL
OUTSIDE BEND JETTY FOR BANK PROTECTION
CONSTRUCTED RIFFLE (1.5' DROP)
1.5' DROP (OUTSIDE CHANNEL)
BURIED RIPRAP TIE BACK, TYP.
GROUTED BOULDER DIVERSION STRUCTURE
GROUTED BOULDER STEP DAM TO DISSIPATE HYDRAULIC ENERGY (3' DROP)
15' WIDE ROUGHENED FISH PASSAGE RAMP
ROCK BEND JETTY, TYP.
50' HIGH FLOW
12' LOW FLOW
1443+00
1444+00
1445+00
1446+00
1447+00
1452+00
1453+00
1454+00
1455+00
1456+00
1 inch = 40 feet
DELTA CONSERVATION DISTRICT
SOMERSET DIVERSION PRELIMINARY DESIGN
SITE PLAN ALTERNATIVE 1
DESIGN: AKA
DETAIL: AKA
CHECK: RAH
DATE: NOVEMBER, 2014
MERRICK & COMPANY
PROJECT NO. 65416463
Drawing Number: 1
Number
Revision Description
By
Date



NOT FOR CONSTRUCTION
STATE HIGHWAY 133
LEGEND
STORM SEWER/CULVERT
WATER LINE UNDERGROUND
ELECTRIC BREAKER BOX
ELECTRIC OVERHEAD
GUY WIRE
LIGHT POLE
WELL
EX CONT-MJR
EX CONT-MNR
FENCE
GUARDRAIL
EDGE ASPHALT
EDGE OF WATER
EDGE OF GRAVEL
BUILDING
ASPHALT PAVEMENT
GRAVEL ROAD
EXISTING BOULDER
PROPOSED CONCRETE
PROPOSED GROUTED BOULDER STRUCTURE
EXIST. EDGE OF WATER
24" CULVERT
EXIST. PUMP STATION
RIVER CENTERLINE
OVERFLOW WETLAND CHANNEL
18" CULVERT
8" RAW WATER LINE TO TANK
OVERFLOW WEIR AND PIPE TO PUMP STATION WET WELL
EXIST. INFILTRATION GALLERY
PORTAGE TRAIL
SETTLING POND, REMOVAL OF FINE SEDIMENTS
LARGE INDIVIDUAL BOULDERS OR BOULDER CLUSTERS
RESTORED WETLAND/RIPARIAN BENCH
12"/15" DIVERSION PIPE
CONSTRUCTED RIFFLE
LATERAL INTAKE WITH BAR RACK AND FINE SCREEN
SLUICE CHANNEL W/ OVERSHOT GATE
OUTSIDE BEND JETTY, TYP. (MAINTAIN SINGLE RIVER THREAD)
BURIED RIPRAP TIE BACK, TYP.
DIVERSION VALVE
15' WIDE ROUGHENED FISH PASSAGE RAMP
GROUTED BOULDER DIVERSION STRUCTURE (2' DROP)
INSIDE BEND JETTY, TYP.
1443+00
1444+00
1445+00
1446+00
1447+00
1448+00
1449+00
1450+00
1451+00
1452+00
1453+00
1454+00
1455+00
1456+00
6020
6025
6030
6035
6040
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1 inch = 40 feet
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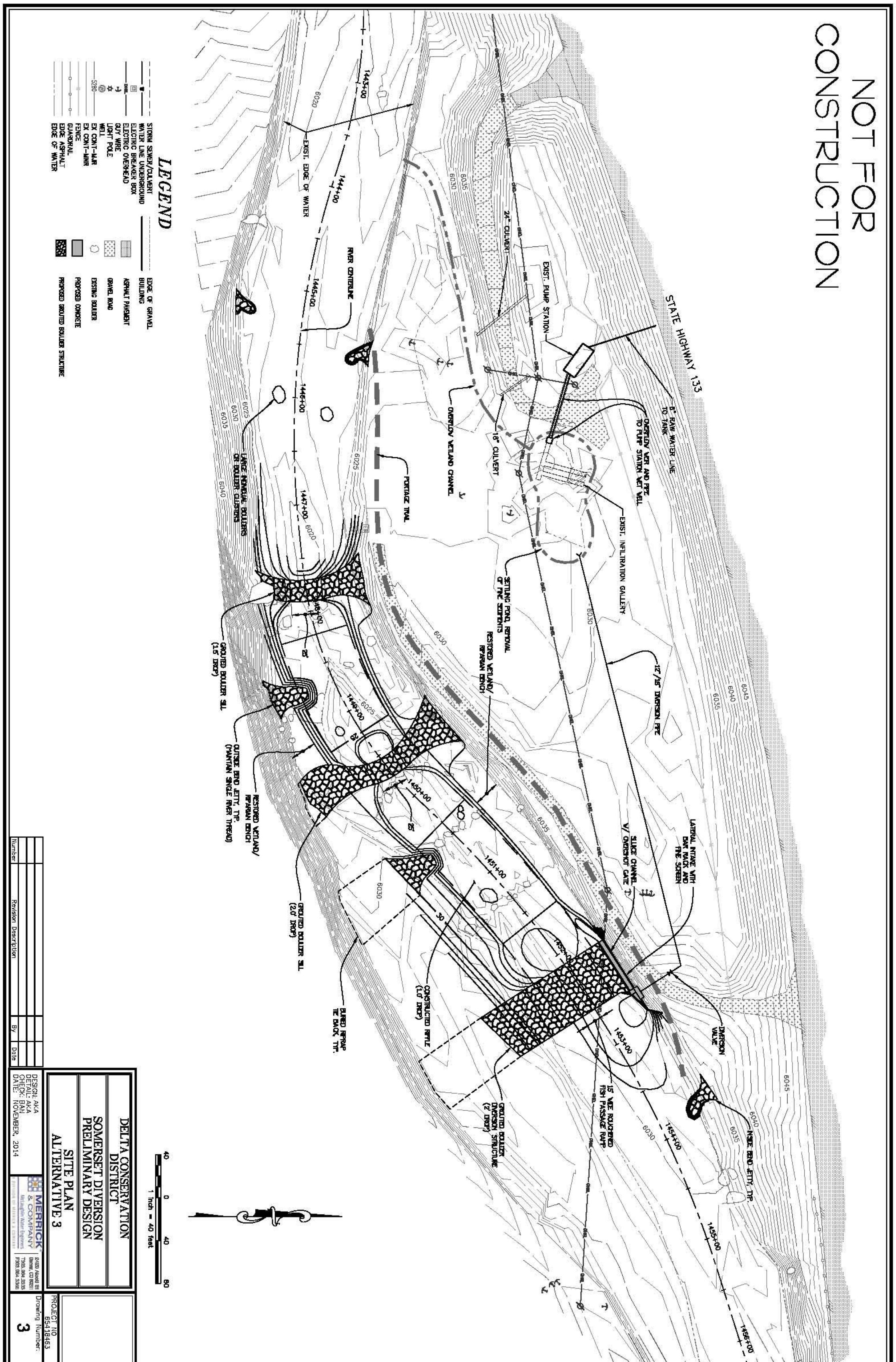
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STATE HIGHWAY 133
LEGEND
STORM SEWER/CULVERT
ELECTRIC OVERHEAD
GUY WIRE
LIGHT POLE
WELL
FENCE
GUARDRAIL
EDGE ASPHALT
EDGE OF WATER
EDGE OF GRAVEL
BUILDING
ASPHALT PAVEMENT
GRAVEL ROAD
EXISTING BOULDER
PROPOSED CONCRETE
PROPOSED GROUTED BOULDER STRUCTURE
EXIST. EDGE OF WATER
RIVER CENTERLINE
24" CULVERT
EXIST. PUMP STATION
18" CULVERT
OVERFLOW WETLAND CHANNEL
PORTAGE TRAIL
EXIST. INFILTRATION GALLERY
12"/15" DIVERSION PIPE
LATERAL INTAKE WITH TRASH RACK AND FINE SCREEN
SLUICE CHANNEL W/ OVERSHOT GATE
DIVERSION VALVE
INSIDE BEND JETTY, TYP.
15' WIDE ROUGHENED FISH PASSAGE RAMP
GROUTED BOULDER DIVERSION STRUCTURE (2' DROP)
CONSTRUCTED RIFFLE (1.0' DROP)
BURIED RIPRAP TIE BACK, TYP.
GROUTED BOULDER SILL (2.0' DROP)
RESTORED WETLAND/ RIPARIAN BENCH
OUTSIDE BEND JETTY, TYP. (MAINTAIN SINGLE RIVER THREAD)
GROUTED BOULDER SILL (1.5' DROP)
SETTLING POND, REMOVAL OF FINE SEDIMENTS
LARGE INDIVIDUAL BOULDERS OR BOULDER CLUSTERS
1 inch = 40 feet
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SOMERSET DIVERSION PRELIMINARY DESIGN
SITE PLAN ALTERNATIVE 3
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MERRICK & COMPANY
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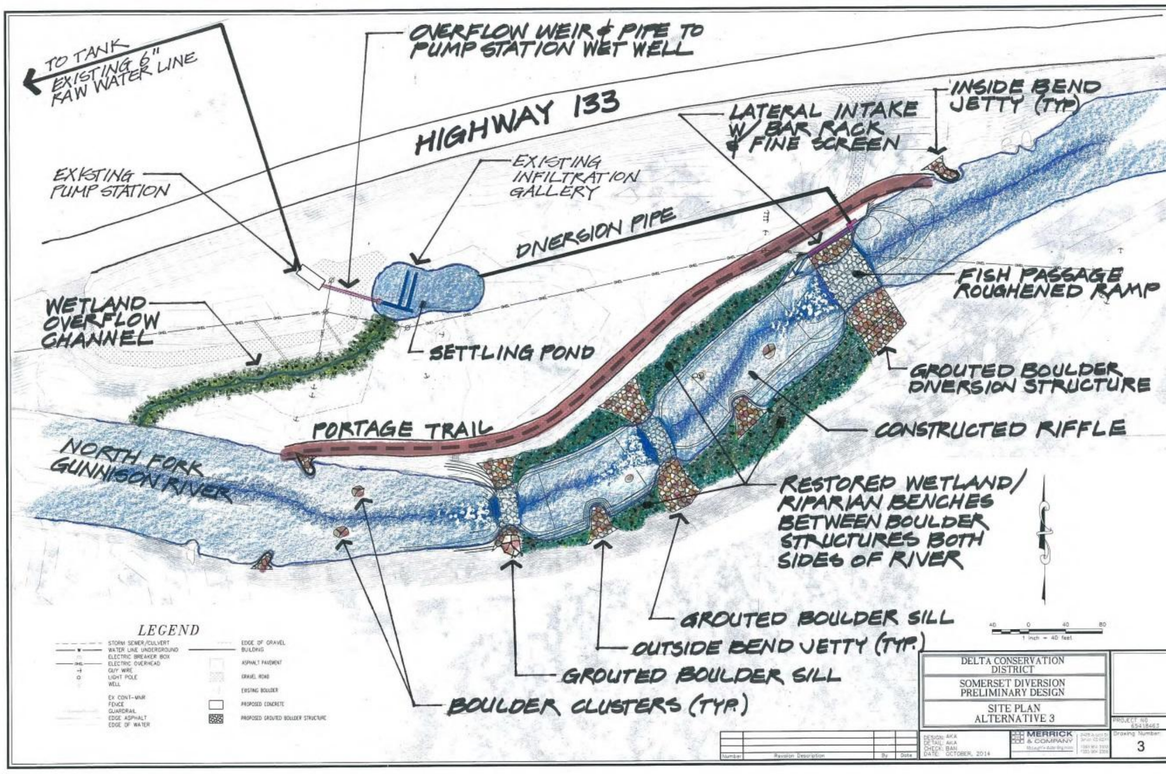

TO TANK
EXISTING 6" RAW WATER LINE
OVERFLOW WEIR & PIPE TO PUMP STATION WET WELL
HIGHWAY 133
LATERAL INTAKE W/ BAR RACK & FINE SCREEN
INSIDE BEND JETTY (TYP.)
EXISTING PUMP STATION
EXISTING INFILTRATION GALLERY
DIVERSION PIPE
FISH PASSAGE ROUGHENED RAMP
WETLAND OVERFLOW CHANNEL
SETTLING POND
GROUTED BOULDER DIVERSION STRUCTURE
CONSTRUCTED RIFFLE
PORTAGE TRAIL
NORTH FORK GUNNISON RIVER
RESTORED WETLAND/ RIPARIAN BENCHES BETWEEN BOULDER STRUCTURES BOTH SIDES OF RIVER
GROUTED BOULDER SILL
OUTSIDE BEND JETTY (TYP.)
GROUTED BOULDER SILL
BOULDER CLUSTERS (TYP.)
LEGEND
1 inch = 40 feet
DELTA CONSERVATION DISTRICT
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SITE PLAN ALTERNATIVE 3
PROJECT NO. 65418463
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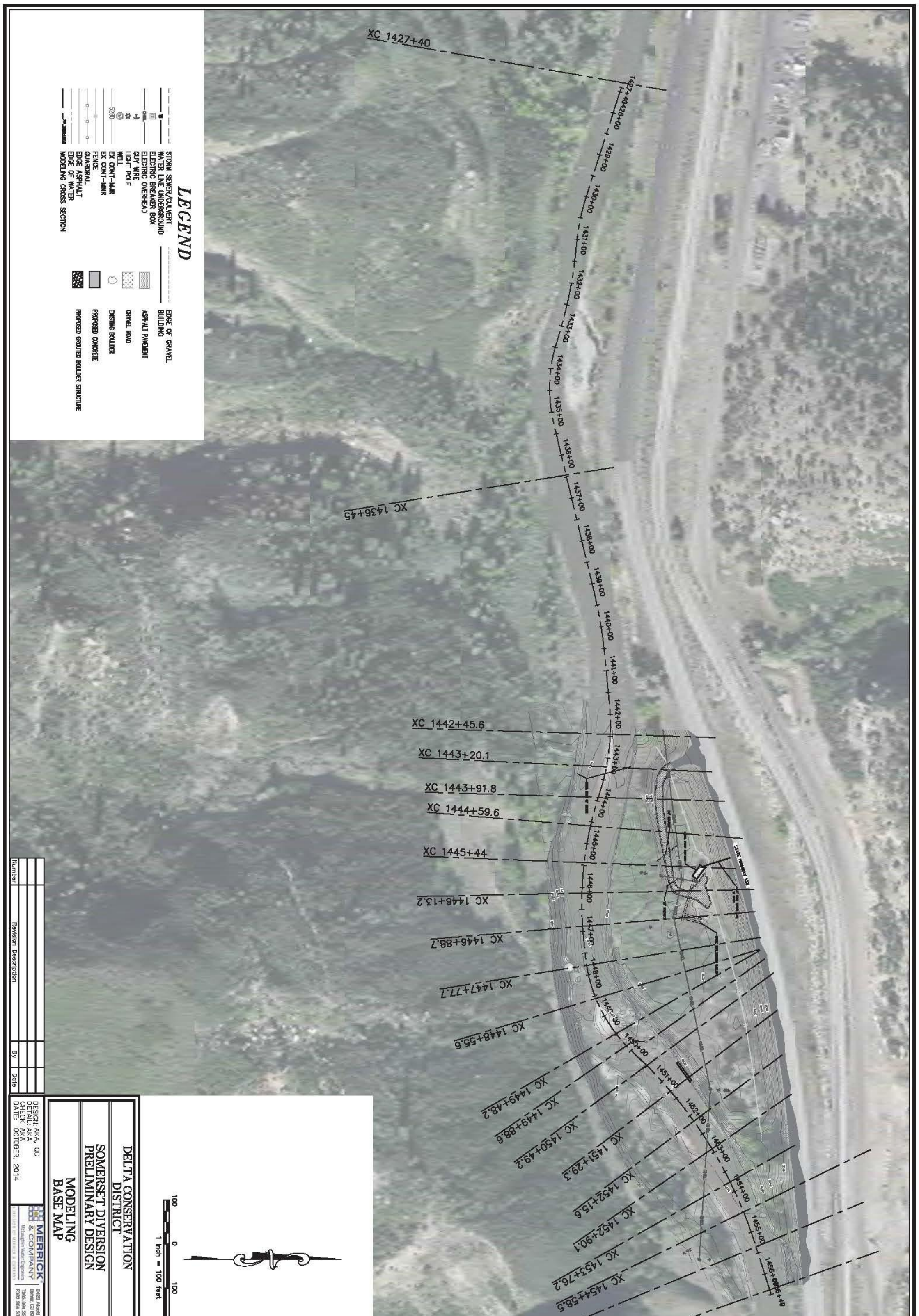
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STORM SEWER/CULVERT
WATER LINE UNDERGROUND
ELECTRIC BREAKER BOX
ELECTRIC OVERHEAD
GUY WIRE
LIGHT POLE
WELL
EX CONT-MAJOR
EX CONT-MINOR
FENCE
GUARDRAIL
EDGE ASPHALT
EDGE OF WATER
MODELING CROSS SECTION
EDGE OF GRAVEL
BUILDING
ASPHALT PAVEMENT
GRAVEL ROAD
EXISTING BOULDER
PROPOSED CONCRETE
PROPOSED GROUTED BOULDER STRUCTURE
XC 1427+40
XC 1436+45
XC 1442+45.6
XC 1443+20.1
XC 1443+91.8
XC 1444+59.6
XC 1445+44
XC 1446+13.2
XC 1446+88.7
XC 1447+77.7
XC 1448+55.6
XC 1449+48.2
XC 1449+88.6
XC 1450+49.2
XC 1451+29.3
XC 1452+15.6
XC 1452+90.1
XC 1453+76.2
XC 1454+58.5
XC 1455+45.7
XC 1456+37.9
1 inch = 100 feet
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SOMERSET DIVERSION PRELIMINARY DESIGN
MODELING BASE MAP
DESIGN: AKA, QC
DATE: OCTOBER, 2014
MERRICK & COMPANY
PROJECT NO
Drawing Number:
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Number
Revision Description
By
Date

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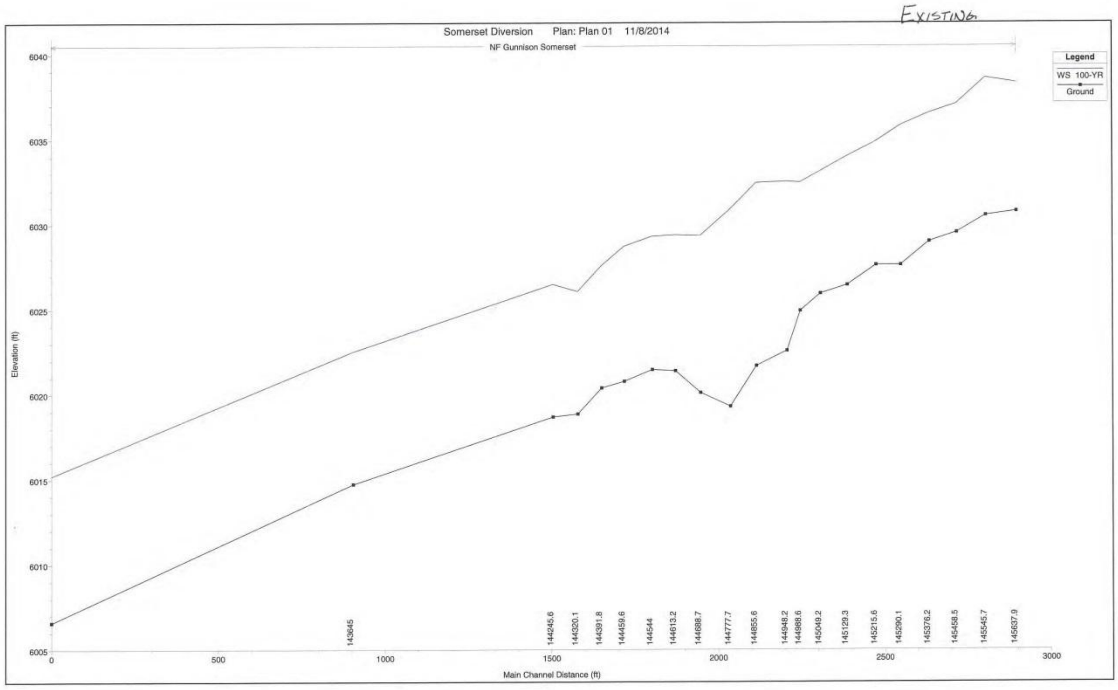

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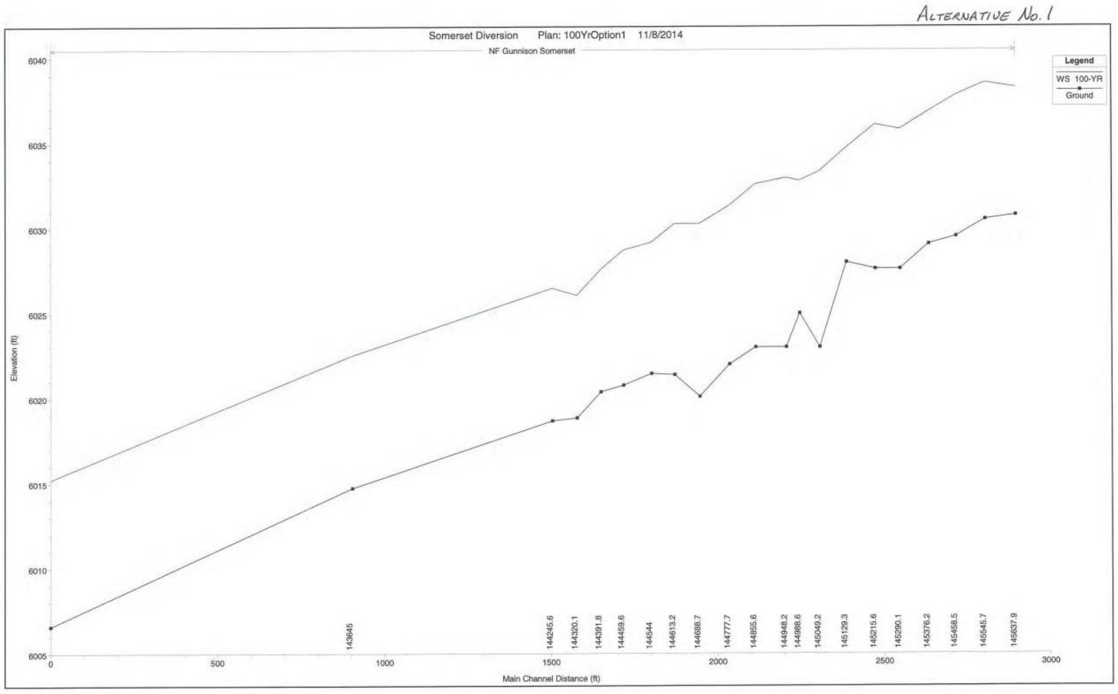

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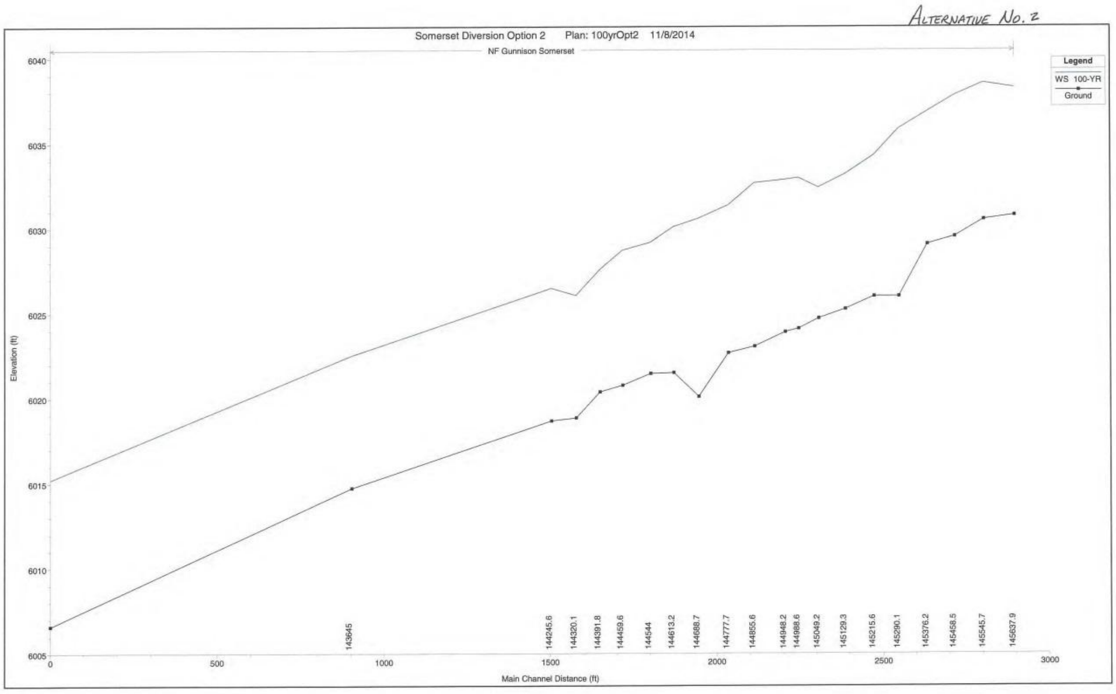

Appendix B

2D Modeling – 400 cfs

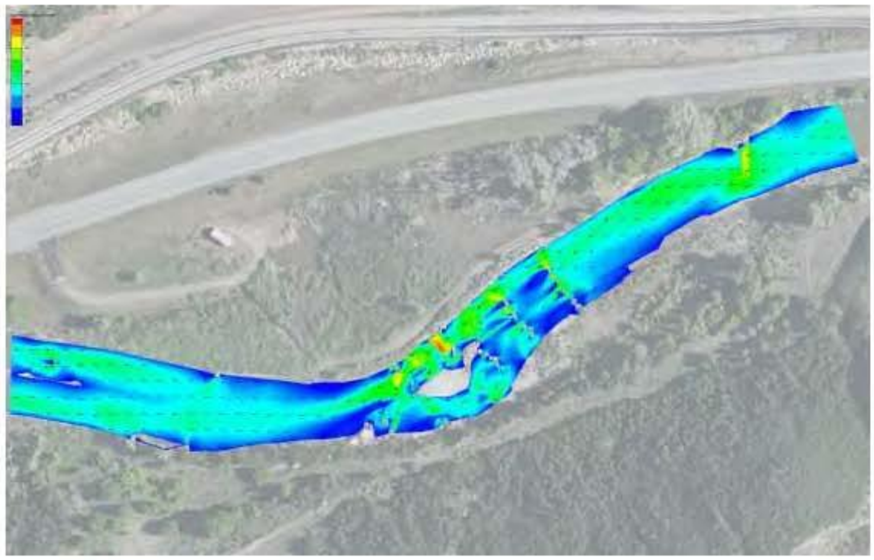

Figure B1: Existing Conditions – 400 cfs

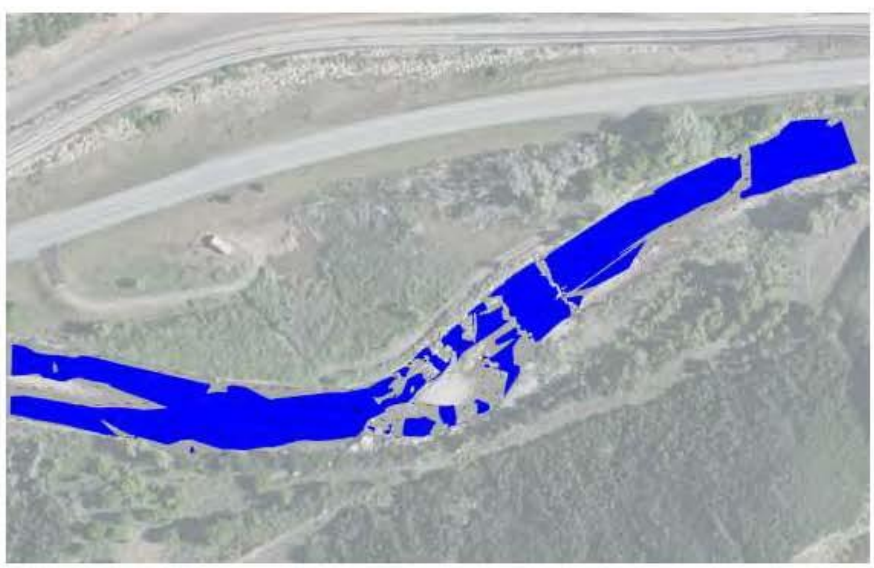

Figure B2: Fish Passage Routes - Existing Conditions – 400 cfs – Depth > 0.8, Velocity < 6.0

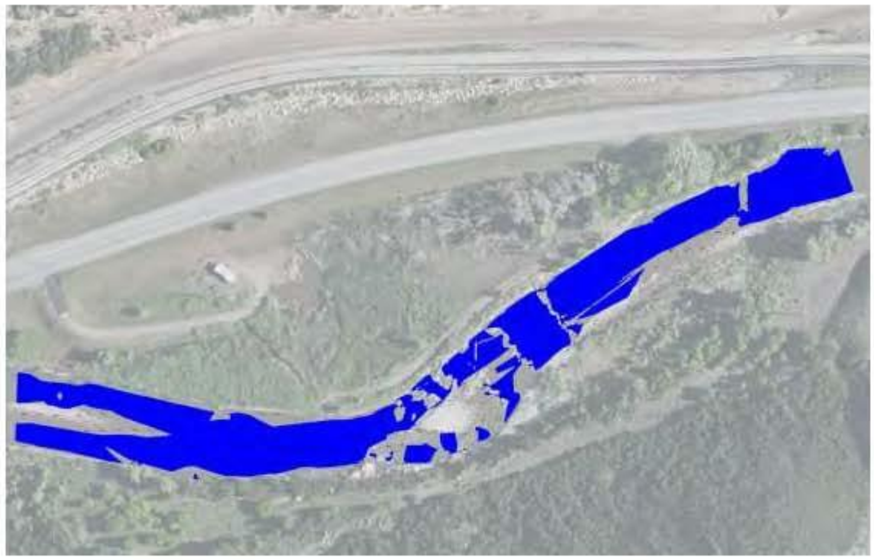

Figure B3: Fish Passage Routes – 400 cfs – Existing Conditions – Depth > 0.8, Velocity < 7.0

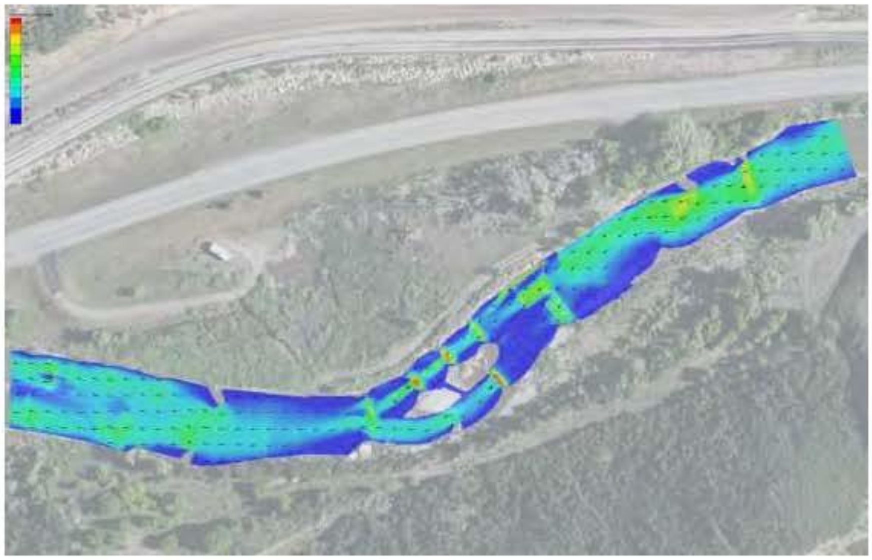

Figure B4: Alternative 1 – Proposed Conditions – 400 cfs

Figure B5: Fish Passage Routes - Alternative 1 – Proposed Conditions - 400 cfs

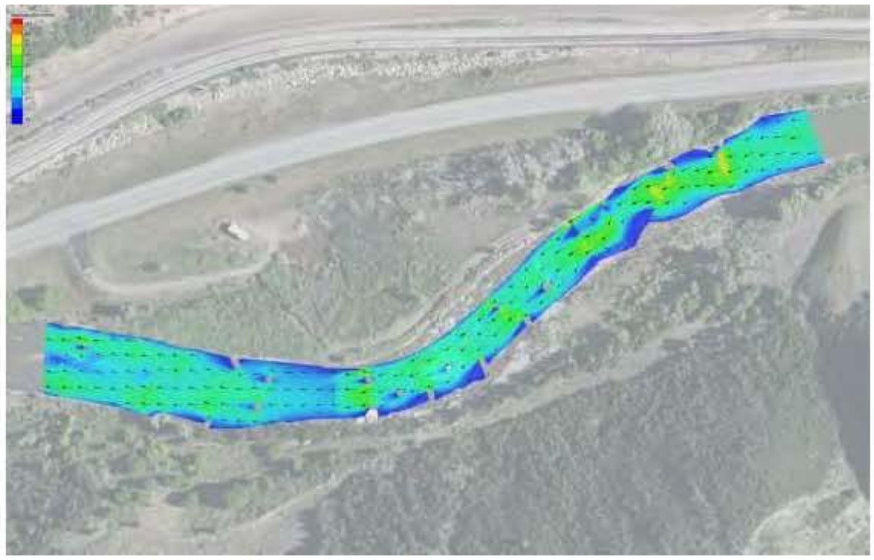

Figure B6: Alternative 2 – Proposed Conditions – 400 cfs

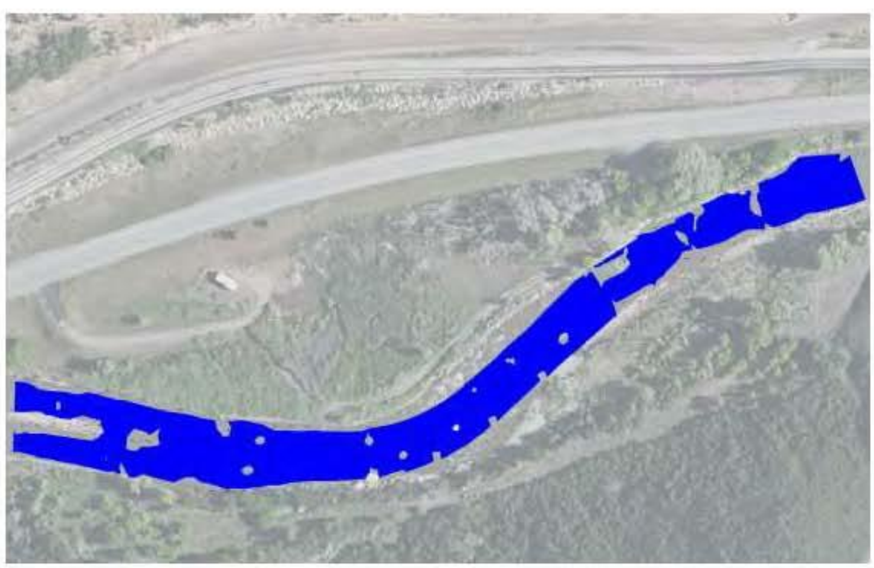

Figure B7: Fish Passage Routes – Alternative 2 - Proposed Conditions – 400 cfs

Appendix C

2D Figures – 1,000 cfs

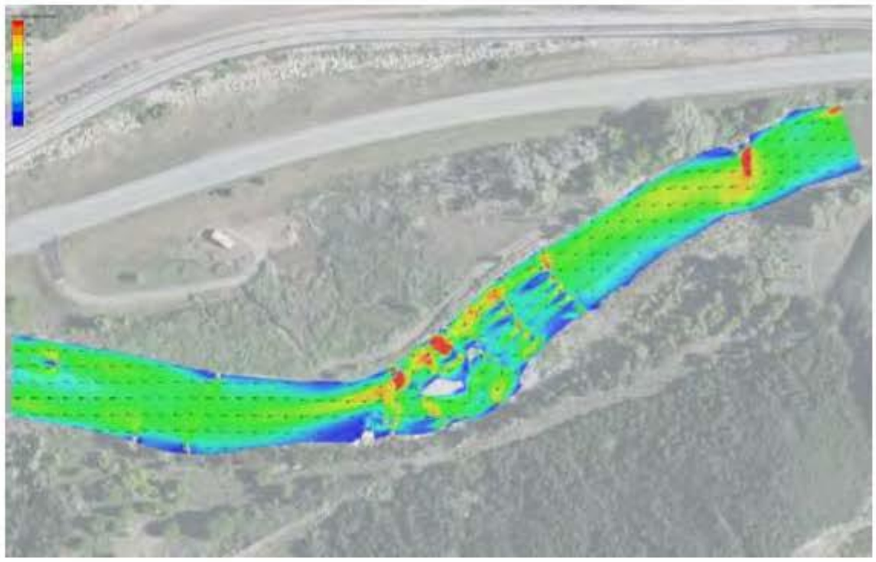

Figure C1: Existing Conditions – 1,000 cfs

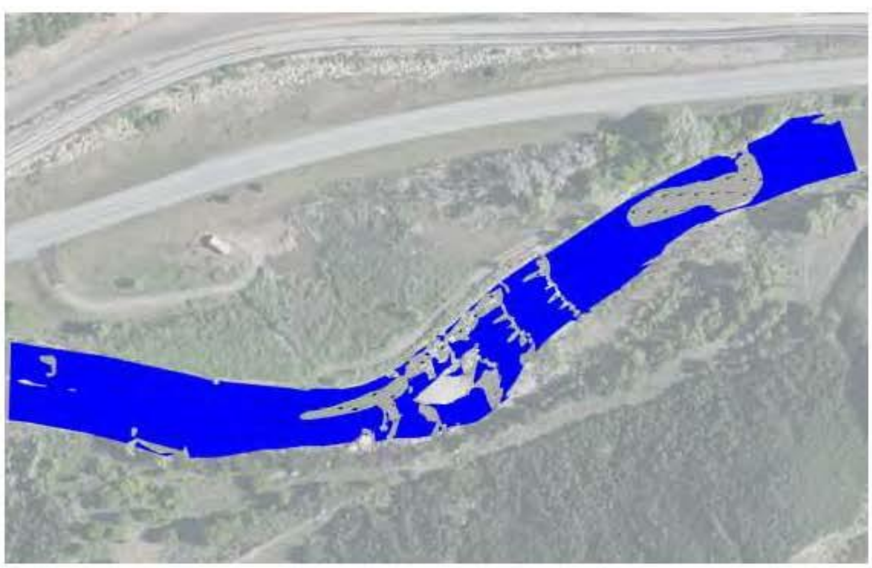

Figure C2: Fish Passage Routes– Existing Conditions – 1,000 cfs - Depth > 0.8, Velocity < 6.0

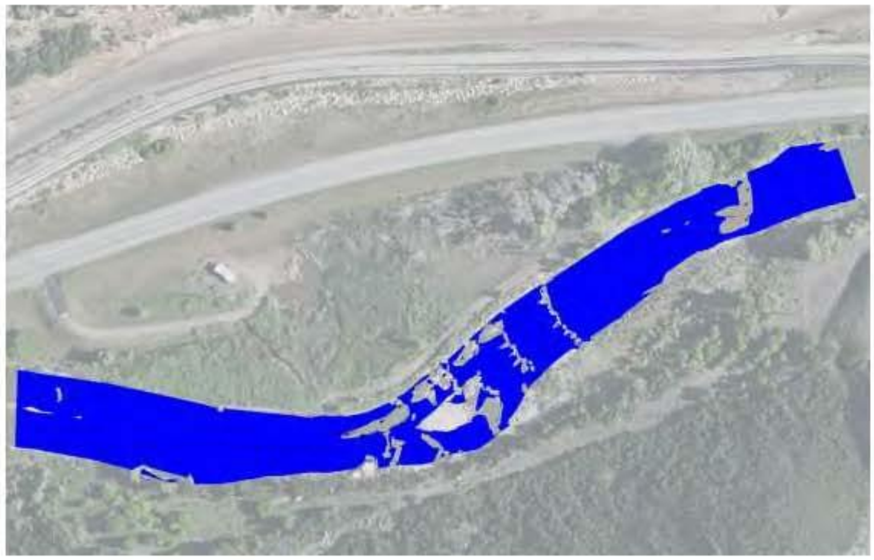

Figure C3: Fish Passage Routes – 1 Existing Conditions – 1,000 cfs - Depth > 0.8, Velocity < 7.0

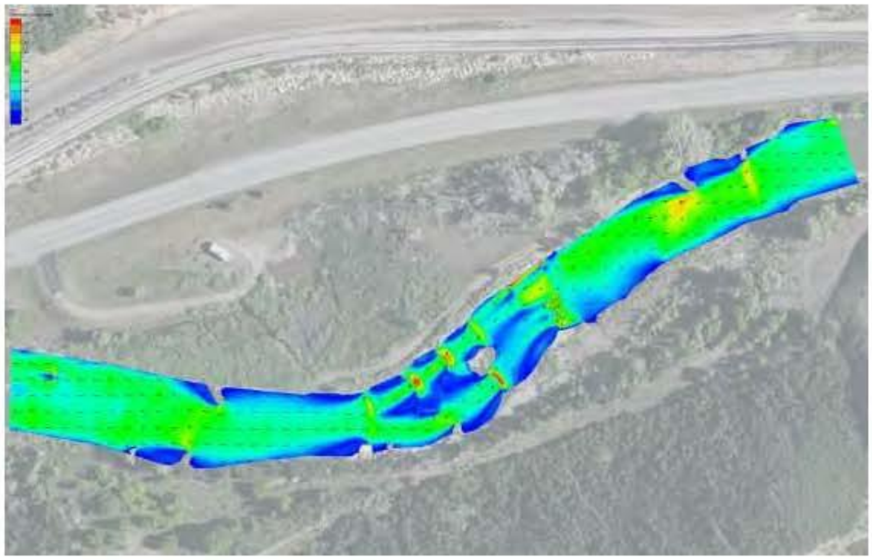

Figure C4: Alternative 1 – Proposed Conditions – 1,000 cfs

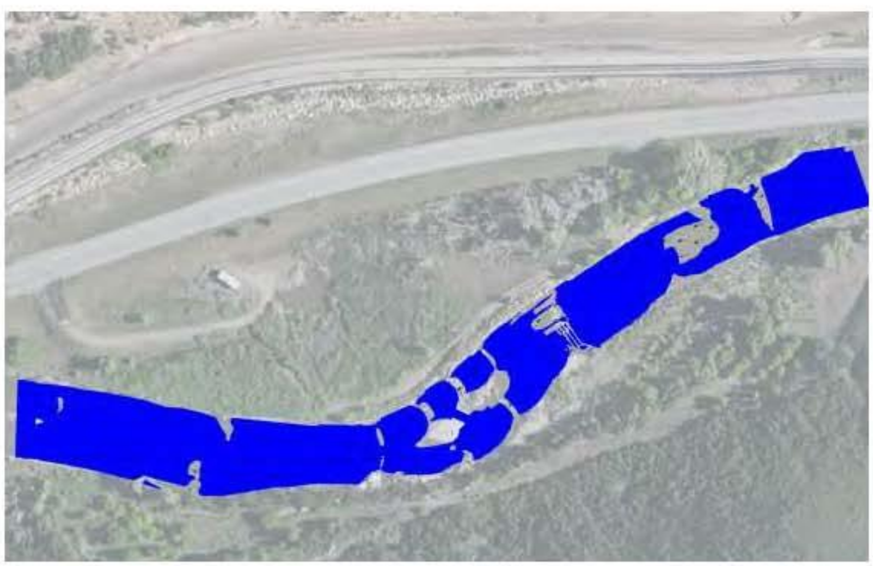

Figure C5: Alternative 1 - Fish Passage Routes – Proposed Conditions - 1,000 cfs

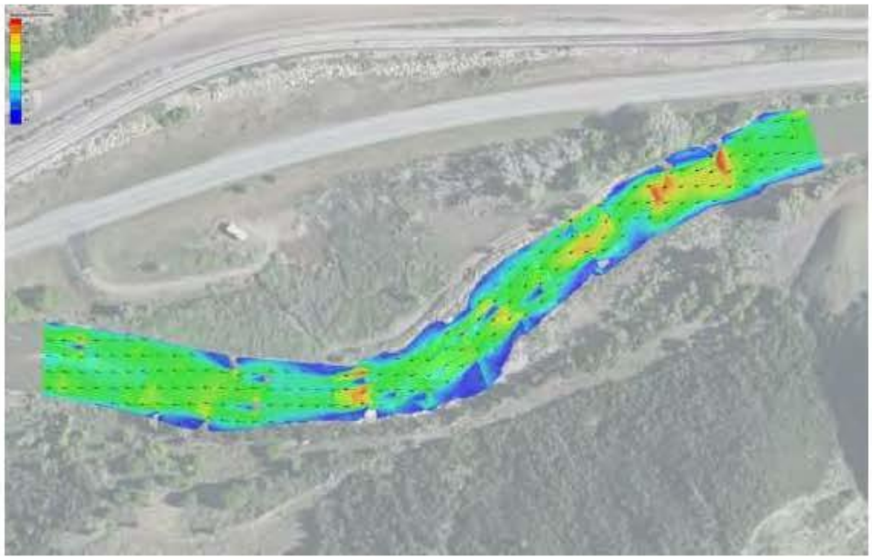

Figure C6: Alternative 2 – Proposed Conditions – 1,000 cfs

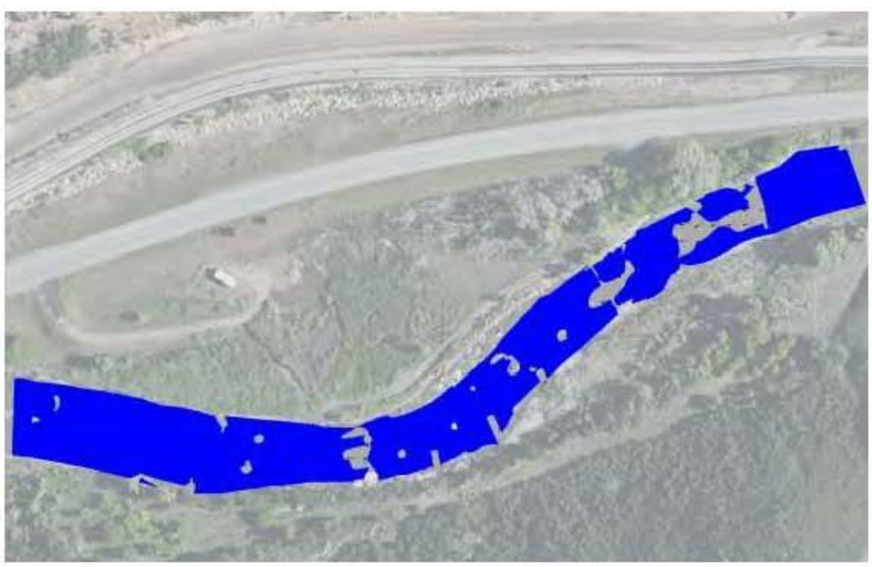

Figure C7: Alternative 2 - Fish Passage Routes – Proposed Conditions – 1,000 cfs

Appendix D

Detailed Cost Estimates

MERRICK & COMPANY

McLaughlin Water Engineers
A Division of Merrick & Company

Delta Conservation District
Somerset Diversion Preliminary Design
Engineer's Opinion of Probable Costs
ALTERNATIVE #1
November 2014

Item	Quantity	Unit	Cost($)/Unit	Cost ($)
General Site Costs				
Mobilization	1	LS	$50,000	$50,000
Dewatering	1	LS	$100,000	$100,000
Subtotal				$150,000
25% Contingency				$37,500
Subtotal				**$187,500**
Intake Structure				
Excavation and Backfill	50	c.y.	$13	$650
Concrete Walls and Slabs	85	c.y.	$800	$68,000
Bar Rack	140	s.f.	$20	$2,800
Fine Screen	20	s.f.	$50	$1,000
Overshot Gate	1	ea.	$15,000	$15,000
Subtotal				$87,450
25% Contingency				$21,863
Subtotal				**$110,000**
Jetties				
Imported and Placed Boulders (24" to 48")	210	c.y.	$125	$26,250
Grout	74	c.y.	$250	$18,500
Subtotal				$44,750
25% Contingency				$11,188
Subtotal				**$56,000**

Grouted Boulder Sills/Diversion

Imported and Placed Boulders (24" to 48")	1,665	c.y.	$125	$208,125
Reused On-site Boulders (24" to 48")	130	c.y.	$70	$9,100
Grout	630	c.y.	$250	$157,500
Cutoff Walls (assume 12 ft deep)	6,010	s.f.	$45	$270,450
Subtotal				$645,175
25% Contingency				$161,294
Subtotal				**$807,000**
Miscellaneous				
Portage Trail	300	l.f.	$12	$3,600
Riffle Construction	675	c.y.	$20	$13,500
Pool Excavation and Haul Off	800.0	c.y.	$20	$16,000
Seeding, Planting and Restoration	0.5	acre	$20,000	$10,000
Subtotal				$43,100
25% Contingency				$10,775
Subtotal				**$54,000**
Final Design Engineering (15%)				**$182,175**
TOTAL				***$1,397,000***

Assumptions

1. Prices shown are for budgetary planning purposes only.

MERRICK & COMPANY
McLaughlin Water Engineers
A Division of Merrick & Company

Delta Conservation District
Somerset Diversion Preliminary Design
Engineer's Opinion of Probable Costs
ALTERNATIVE #2
November 2014

Item	Quantity	Unit	Cost($)/Unit	Cost ($)
General Site Costs				
Mobilization	1	LS	$50,000	$50,000
Dewatering	1	LS	$100,000	$100,000
Subtotal				$150,000
25% Contingency				$37,500
Subtotal				**$187,500**
Intake Structure				
Excavation and Backfill	50	c.y.	$13	$650
Concrete Walls and Slabs	85	c.y.	$800	$68,000
Bar Rack	140	s.f.	$20	$2,800
Fine Screen	20	s.f.	$50	$1,000
Overshot Gate	1	ea.	$15,000	$15,000
Subtotal				$87,450
25% Contingency				$21,863
Subtotal				**$110,000**
Jetties				
Imported and Placed Boulders (24" to 48")	450	c.y.	$125	$56,250
Grout	160	c.y.	$250	$40,000
Subtotal				$96,250
25% Contingency				$24,063
Subtotal				**$121,000**

Grouted Boulder Sills/Diversion

Imported and Placed Boulders (24" to 48")	740	c.y.	$125	$92,500
Reused On-site Boulders (24" to 48")	130	c.y.	$70	$9,100
Grout	300	c.y.	$250	$75,000
Cutoff Walls (assume 12 ft deep)	1,440	s.f.	$45	$64,800
Subtotal				$241,400
25% Contingency				$60,350
Subtotal				**$302,000**
Miscellaneous				
Portage Trail	300	l.f.	$12	$3,600
Riffle Construction	2,940	c.y.	$20	$58,800
Import Topsoil	600.0	c.y.	$45	$27,000
Seeding, Planting and Restoration	0.5	acre	$40,000.0	$20,000
Subtotal				$109,400
25% Contingency				$27,350
Subtotal				**$137,000**
Final Design Engineering (15%)				**$128,625**
TOTAL				***$986,000***

Assumptions

1. Prices shown are for budgetary planning purposes only.

MERRICK & COMPANY

McLaughlin Water Engineers
A Division of Merrick & Company

Delta Conservation District
Somerset Diversion Preliminary Design
Engineer's Opinion of Probable Costs
ALTERNATIVE #3
November 2014

Item	Quantity	Unit	Cost($)/Unit	Cost ($)
General Site Costs				
Mobilization	1	LS	$50,000	$50,000
Dewatering	1	LS	$100,000	$100,000
Subtotal				$150,000
25% Contingency				$37,500
Subtotal				**$187,500**
Intake Structure				
Excavation and Backfill	50	c.y.	$13	$650
Concrete Walls and Slabs	85	c.y.	$800	$68,000
Bar Rack	140	s.f.	$20	$2,800
Fine Screen	20	s.f.	$50	$1,000
Overshot Gate	1	ea.	$15,000	$15,000
Subtotal				$87,450
25% Contingency				$21,863
Subtotal				**$110,000**
Jetties				
Imported and Placed Boulders (24" to 48")	232	c.y.	$125	$29,000
Grout	81	c.y.	$250	$20,250
Subtotal				$49,250
25% Contingency				$12,313
Subtotal				**$62,000**

Grouted Boulder Sills/Diversion

Imported and Placed Boulders (24" to 48")	1,789	c.y.	$125	$223,625
Reused On-site Boulders (24" to 48")	130	c.y.	$70	$9,100
Grout	670	c.y.	$250	$167,500
Cutoff Walls (assume 12 ft deep)	4,224	s.f.	$45	$190,080
Subtotal				$590,305
25% Contingency				$147,576
Subtotal				**$738,000**
Miscellaneous				
Portage Trail	300	l.f.	$12	$3,600
Riffle Construction	590	c.y.	$20	$11,800
Import Topsoil	600.0	c.y.	$45	$27,000
Seeding, Planting and Restoration	0.5	acre	$40,000.0	$20,000
Subtotal				$62,400
25% Contingency				$15,600
Subtotal				**$78,000**
Final Design Engineering (15%)				**$176,325**
TOTAL				***$1,352,000***

Assumptions

1. Prices shown are for budgetary planning purposes only.

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A Division of Merrick & Company

Delta Conservation District
Somerset Diversion Preliminary Design
Engineer's Opinion of Probable Costs
Land Work
November 2014

Direct Piping Option

Item	Quantity	Unit	Cost($)/Unit	Cost ($)
General Site Costs				
Mobilization	1	LS	$5,000	$5,000
Dewatering	1	LS	$10,000	$10,000
Subtotal				$15,000
25% Contingency				$3,750
Subtotal				**$18,750**
Piping Work				
12"/18" Pipe	585	l.f.	$75	$43,875
12"/18" Valve	1	ea.	$3,000	$3,000
Splitter Structure	1	LS	$5,000	$5,000
Connect to Exist. Pump Station	1	LS	$5,000	$5,000
Demo Interfering Gallery Pipes	1	LS	$10,000	$10,000
Construct Wetlands Channel	230	l.f.	$35	$8,050
Subtotal				$74,925
25% Contingency				$18,731
Subtotal				**$94,000**
Final Design Engineering (15%)				**$16,913**
TOTAL				***$130,000***

Settling Pond Option

Item	Quantity	Unit	Cost($)/Unit	Cost ($)
General Site Costs				
Mobilization	1	LS	$5,000	$5,000
Dewatering	1	LS	$10,000	$10,000
Subtotal				$15,000
25% Contingency				$3,750
Subtotal				**$18,750**
Piping/Pond Work				
12"/18" Pipe	430	l.f.	$75	$32,250
12"/18" Valve	1	ea.	$3,000	$3,000
Pond Excavation and Haul Off	1,100	c.y.	$25	$27,500
Weir Box	1	LS	$10,000	$10,000
Connect to Exist. Pump Station	1	LS	$5,000	$5,000
Demo Interfering Gallery Pipes	1	LS	$10,000	$10,000
Construct Wetlands Channel	230	l.f.	$35	$8,050
Subtotal				$95,800
25% Contingency				$23,950
Subtotal				**$120,000**
Final Design Engineering (15%)				**$20,813**
TOTAL				***$160,000***

Assumptions

1. Prices shown are for budgetary planning purposes only.

Appendix F – Alternative 2 Support Statement and Concerns

From a fisheries perspective, Alternative number 2 is by far the preferred alternative. It adequately meets the goals of this project by creating a functional water diversion structure that allows both boater and fish passage, while maintaining a channel that is reflective of the natural channel of the N. Fork Gunnison.

I am not enthusiastic about the three grouted drop structures that are proposed in Alternative number 3, as they will have detrimental impacts to the fishery in the N. Fork. These structures appear to have been added to allow for the addition of play boating, which I was not aware of having been a stated goal of the project. Such grouted structures are known to negatively impact riverine fisheries in three ways: they limit fish passage due to high velocities, they reduce the amount of inhabitable fish habitat within the altered reach, and they reduce the aquatic invertebrate production within the stretch of river.

The high velocities within the tongue of these types of structures typically exceed the swimming capabilities of fish, especially at low flows when the entire volume of the river is confined to the grouted drop structure. Although the proposed design describes the use of boulders to allow upstream fish passage and shows some low velocity zones adjacent to the drop structure, I am concerned that these boulders will not be accessible during low flow conditions where these types of grouted drop structures are most limiting to fish passage. We have seen issues with these types of designs throughout the state. Would it be possible to run the Merrick fish-passage analysis for Alternative number 3 at low flows to see what predicted fish passage would look like? In such an analysis, would the Manning's n value be adjusted to reflect the low roughness, grouted surface? If these structures are preferred, we would recommend making adjacent fish passage structures that would be inundated and passable at all flow conditions.

In multiple kayak parks throughout the state, CPW has observed significant declines in fish abundance and biomass. This is due to the high and variable flow conditions that result from the accelerated water that is produced as a necessity for creating play-waves. Essentially, the conditions within pools downstream of grouted drop structures are too tumultuous for fish to inhabit in normal numbers.

Finally, grouted drop structures reduce the aquatic invertebrate production from the section of stream in which they are installed. Aquatic invertebrates utilize the interstitial spaces between cobbles in the stream bed for habitat, and the highest zones of invertebrate densities are within riffles. Grouted drop structures eliminate these invertebrate production zones by changing the natural riffle drops in a river to grouted drops causing drastic reductions in overall biomass within the reach of river. The impacts of this reduced biomass can affect fish populations well downstream of the drop structures by eliminating inflows of invertebrates from upstream.

In summation, CPW does not support Alternative number 3. If this alternative is pursued, we would like to see the Merrick analysis for this design for the entire reach, and would recommend installing fish passage channels adjacent to the grouted drops.

We greatly prefer Alternative number 2. Thanks! Eric Gardunio; Area Aquatic Biologist