DRAFT DESIGN REPORT

FOR

BURKE CREEK HIGHWAY 50 CROSSING AND REALIGNMENT PROJECT, PHASE I

STATELINE, NEVADA

March 2016

*Approved by:*______________________________

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1.0 INTRODUCTION

PROJECT LOCATION

Burke Creek is a small stream in the Lake Tahoe Basin which passes just north of the intersection of Highway 50 and Kahle Drive in Stateline, NV. It has an approximately 4.5 square mile drainage area to Lake Tahoe. The Burke Creek Highway 50 crossing and Realignment Project (Project) area includes parking lots that infringe on the stream's floodplain and meadow. The Project extends from Highway 50 to approximately 1000 feet upstream of Highway 50, and is located on property owned by the USFS, private owners (Sierra Colina LCC. and Apartments 801 LCC.), Douglas County and NDOT.

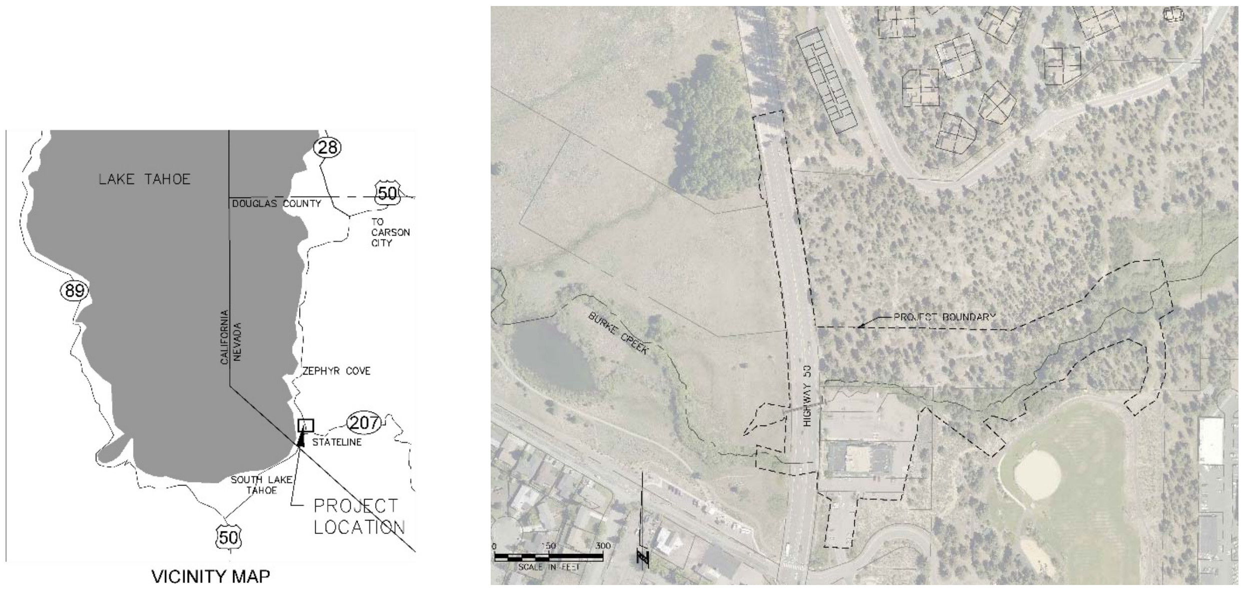


Figure 1.1 Project Area Location.

PROJECT NEED/DESCRIPTION

The Lake Tahoe Total Maximum Daily Load (TMDL) is based on reducing the transport of fine sediment and nutrients from upland, urban catchments. The breakdown of road traction material and road surfaces have been implicated in Fine Sediment Particle (FSP) generation which can be conveyed via stormwater routing to Burke Creek and thence to the Lake. A sediment pond, Jenning's Pond, on Burke Creek is present downstream of Highway 50. Sampling of the pond-bottom does not show FSP settling, suggesting transport of FSP to the Lake is very likely.

As Burke Creek approaches Highway 50 it is impacted by directly connected stormwater runoff from Highway 50, and some Douglas County property (part of Kahle recreation area). An undersized culvert under Highway 50 restricts proper stream function and has potential to back-water Highway 50 travel lanes according to HEC-RAS modeling and observed incidents. Stormwater runoff from private property is also routed to this undersized culvert. Separation of these flows is a part of this project. The proposed project will establish a functional stream crossing under Highway 50 to reduce the possibility of the creek overflowing and back-watering the highway; increase floodplain access; and disconnect untreated stormwater runoff to Burke Creek in the project area.

At the Apartment 801 LLC. Building (formerly Bluth and Tahoe Nugget Casino) entrance and Highway 50, a drop inlet delivers untreated stormwater directly to Burke Creek. Stormwater runoff from a part of the parking lot and

Highway 50 also discharges to Burke Creek via this drop inlet (Photo 1.1). In average water years Burke Creek is directly connected to the Lake (Photo 1.2).

Photo 1.1. Directly Connected Drop Inlet to Burke Creek

Photo 1.2. Burke Creek Connection to Lake Tahoe

Burke Creek has been historically modified and relocated to accommodate development including the former Tahoe Nugget Casino, Highway 50 and other commercial development. This includes parking lots that infringe on its floodplain. It flows through 5 property ownerships including USFS, two private owners, Douglas County and NDOT. The Burke Creek Highway 50 Crossing and Realignment Project generally consists of improving the Burke Creek crossing under Highway 50 (phase 1) and realigning and restoring the reach directly downstream of the crossing (phase 2). The project will improve channel morphology and function of an approximate 4.5 square miles drainage area to Lake Tahoe. The EIP numbers for this project is EIP #01.02.03.01. This document is concerned with Phase 1 of the project to be constructed in 2016. Phase 1 consists of the Highway 50 crossing, upstream creek improvements and Highway 50 drainage improvements.

GOALS AND OBJECTIVES

The goal of the Project is to construct a crossing for Burke Creek under Highway 50 that restores hydrologic and sediment transport continuity, restores wet meadow conditions to Rabe Meadow (Phase 2), and improves drainage on Highway 50. From these goals the following objectives were developed:

1. Realign the stream channel to a natural topographic depression and improve stream function of Burke Creek directly downstream of Highway 50;

2. Reduce the size of the upstream parking lot and relocate the stream through the former parking lot to increase floodplain access and stream function;
3. Treat stormwater in the project area before discharge to Burke Creek and gain Lake Clarity Credits for Douglas County and Nevada Department of Transportation (NDOT) for reducing pollutants of concern including FSP, nitrogen and phosphorus;
4. Develop a project that requires minimal Operations & Maintenance budget; and
5. Enhance stream and alluvial fan functions using geomorphic and hydrologic appropriate design elements

Project constraints including property boundaries and existing utility locations made a few of the original objectives unattainable including Reducing flooding frequency to the adjacent commercial parking lot, providing habitat continuity, and constructing a geomorphically appropriate crossing. The restrictions to completing these objectives are discussed in more detail in Appendix F.

PROJECT FUNDING

The project received funding from the Nevada Division of State Lands Water Quality and Erosion Control Grants Program, the US Forest Service Southern Nevada Public Land Management Act funds, and the Nevada Department of Transportation.

Table 1.1. Funding Sources and Amounts for the Burke Creek Highway 50 Crossing and Realignment Project**.**

Agency	Cash Funding	In Kind Funding	Total Funds
Nevada Division of State Lands Water Quality and Erosion Control Grants Program	$587,172		$587,172
Douglas County SEZ Mitigation Funds	$100,000		$100,000
US Forest Service Southern Nevada Public Land Management Act Funds	$957,896		$957,896
Nevada Department of Transportation	$525,000	$30,000.00	$550,000
TOTAL			**$2,200,068**

PROJECT PARTNERS

Nevada Tahoe Conservation District (NTCD) is the project sponsor and lead agency responsible for planning, designing, and implementation of the Burke Creek Highway 50 Crossing and Realignment Project. NTCD is working closely with project consultants Balance Hydrologics, Inc. and Wood Rodgers, Inc. to design and construct the best project possible. Additionally, a number of other important partners will continue to participate in the process to ensure successful project delivery. Project partners include:

1. Douglas County, Nevada
2. Nevada Division of Environmental Protection (NDEP)
3. Nevada Department of Transportation (NDOT)
4. Nevada Division of State Lands (NDSL)
5. Tahoe Regional Planning Agency (TRPA)
6. USDA – Forest Service, Lake Tahoe Basin Management Unit

BACKGROUND DOCUMENTS

The planning of this project has been ongoing for many years and has encountered several stops and starts. It should be noted that prior to 2009, a technical Advisory Committee (TAC) comprised of project partners was established for a Burke Creek restoration project. Conceptual plans were created for multiple alternatives and a preferred alternative was selected. The Burke Creek-Rabe Meadow Complex Master Plan Project TAC then selected a revised alternative that was advanced to a 50% design by Wood Rodgers Inc. The 50% plans were abandoned after the opportunity for a land swap was taken advantage of by Douglas County in 2014. The land swap allowed the Project to expand the floodplain upstream of the Highway 50 crossing. Current design plans reflect the larger project area made available by the land swap.

Many background documents and data are available. As many prior studies as possible have been utilized in the design of the Project. Below is a list of relevant documents used to inform design:

- Culvert Design Memorandum (Wood Rodgers, 2016) – included as Appendix E
- Design Basis Memorandum (Balance Hydrologics, 2016) – included as Appendix F
- Wood Rogers Burke Creek Highway 50 Crossing and Replacement Project Geotechnical Investigation Report (Carter, 2015) – Included as Appendix D
- Burke Creek Restoration Project Alternatives Analysis Report (Winzler and Kelly and Others, 2009)
- Burke Creek / Rabe Meadows Preliminary Restoration Plans (Wood Rogers, 2012)
- Burke Creek Highway 50 Crossing and Realignment Project Monitoring Plan (NTCD)
- Burke Creek Restoration Potential and Design Concepts (NHC, 2006)
- Burke Creek-Rabe Meadow Complex Master Plan Existing Conditions Report (Wood Rodgers, 2014)
- Burke Creek-Rabe Meadow Complex Master Plan CIP Alternatives Evaluation Report (Wood Rodgers, 2014)

Current Project planning utilizes a TAC with current project partners and gathers input from the TAC to shape design. Comments were received from TAC members and Sierra Colina LLC. On the 50% design. Response to comments is provided in Appendix A.

2.0 DRAINAGE AND HYDROLOGY

EXISTING CONDITIONS

The hydrology provided in the alternatives analysis report for the Burke Creek Restoration project completed in 2009 (Winzler & Kelly, 2009) was used as existing conditions hydrology for the Project. The average summer base flow in the creek is estimated to be 0.22 cfs. Estimated peak flows for Burke Creek during storm events are given in Table 1 below:

Table 2.1. Estimated Peak Flow for Burke Creek above Highway 50*

	Peak Flow for Indicated Return Period [cfs]					
	1.2 yr	**5 yr**	**10 yr**	**25 yr**	**50 yr**	**100 yr**
Burke Creek Above Highway 50	8	32	47	71	94	121

*peak flows given by Winzler & Kelly, 2009

Geomorphic setting, channel patterns, existing soil types, and hydrology are more thoroughly discussed in Balance Hydrologic's Design Basis Memorandum, attached as Appendix F.

LAND CAPABILITY

The U.S. Forest Service and TRPA developed the Bailey land capability system in the early 1970s based primarily on the official USDA soils maps for the Tahoe Region. Each soil type was assigned to a land capability class ranging from 1 to 7, with capability 1 being the most environmentally fragile and sensitive to development. Wherever land was found to be influenced by a stream or high groundwater, it was assigned to capability 1b, also known as "Stream Environment Zone" or SEZ.

The Project is located within TRPA land capabilities classes 1a, 1b, 2, 3, 4, 5 and 7. The Project will remove approximately 8,550 square feet of existing parking lot coverage on Douglas County property and restore to 1b, SEZ.

TOPOGRAPHY

Many topographic surveys have been utilized to inform the Project design including:

- Light detection and ranging (LiDAR) imagery and topographic information (USGS and TRPA, 2010)
- Topographic basemap and right-of way survey (Turner and Associates, 2007)
- Longitudinal Survey and Riparian Mapping (McBain & Trush, 2007)
- Basemap and parcel boundaries of commercial property (Lumos and Associates, 2013)
- Supplemental survey and cross sections (Atkins, 2013)
- Supplemental Survey of monitoring wells and existing infrastructure, (Wood Rodgers, 2015)
- Various utilities potholing by NDOT, NTCD, and Wood Rodgers

3.0 DESIGN

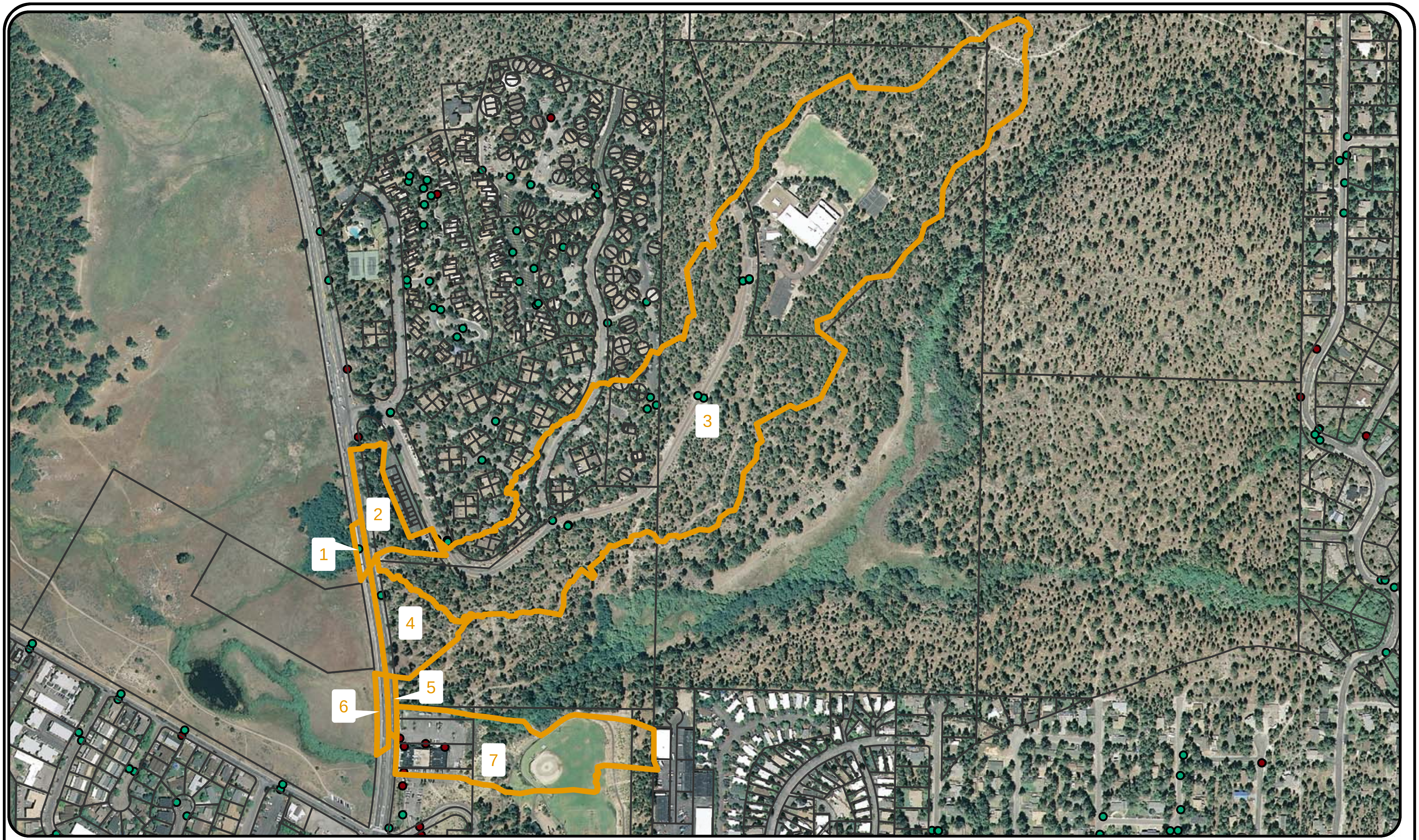
CULVERT DESIGN

The proposed culvert pipe will be a 38-inch by 57-inch corrugated metal pipe arch (CMPA). A CMPA material has a smaller wall thickness compared to a reinforced concrete pipe or box. The CMPA's shape maximizes flow capacities within the given vertical constraints compared to a circular pipe. The CMPA can convey up to 103.6 cfs before overtopping Highway 50, which is just over the 50-year peak flow. Wood Rodgers Inc. is responsible for the culvert design and has detailed design methods in culvert design documentation memorandum included in this report as Appendix E.

PEAK AND DESIGN FLOW

The 25 year storm was used as the design storm for conveyance as specified in the most current NDOT Drainage Manual (NDOT 2006) for interstate highways. Peak flow calculations were calculated by the rational method and are summarized in Table 3.1 below. See Appendix B: Highway Drainage Reference and Calculations for full rational method calculations.

Inputs to the rational method included physical drainage area characteristics. Areas and characteristics were determined using ArcGIS. See Figure 3.1: Drainage Improvement Design Subcatchments for the locations of each subcatchment related to table 3.1. Time of Concentration (Tc) was also calculated and determined storm duration as required by the rational method. Rainfall intensities were obtained using National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Precipitation Frequency Atlas of the Western United States, Nevada. See Appendix B: Highway Drainage Reference and Calculations.



Legend

- Design Subcatchments
- Parcel Boundaries
- SedimentTraps
- DrainageInlet

FIGURE 3.1
Drainage Improvement Design Subcatchments

0 245 490 980 1,470 1,960 Feet

1 in = 542 ft

N W E S

NV West State Plane NAD 83	horiz. units: feet
Prepared by NTCD	March 2016

Nevada Tahoe Conservation District

Table 3.1. Summary of Peak Flows Q5, Q25, and Q100

Design Subcatchment	Calculation/Improvement Type	Q5	Q25	Q100
1	Trench Drain	0.02	0.06	0.09
2	Trench Drain	0.17	0.31	0.68
3	Trench Drain	6.32	11.15	23.32
4	C&G	0.17	0.32	0.64
5	C&G	0.02	0.05	0.08
6	C&G	0.02	0.06	0.10
7	Existing Culvert Outlet	0.77	1.34	2.63

DRAINAGE DESIGN

PROPOSED TRENCH DRAIN CALCULATIONS

The 50% design planned to install a trench drain in design subcatchment 1 to separate Highway 50 run off from Folsom Spring. Unfortunately the location and type of existing water and sewer piping created a conflict with the trench drain design. Because installing the trench drain would require replacement of over 100 feet of both the existing water and sewer 10" asbestos cement lines, the proposed trench drain was deemed not cost effective and dropped from the 90% design. Conveying the water across the Highway and uphill to existing systems was also considered as an alternative but abandoned. The depth of pipe required to convey the small amount of run off is deeper than current infrastructure and would necessitate redesign and replacement of all storm drain structures, again making improvements not cost effective.

The trench drain associated with design subcatchments 2 and 3 is proposed to alleviate Highway 50 flooding in design subcatchment 2. A flooding problem in this area has been observed by NTCD staff on several occasions and, by visual inspection, has been determined to be caused by a low point on the shoulder. Although the size and associated peak flow of design subcatchment 2 is relatively small, shoulder infiltration alone is not enough to treat the run off. The low point does not allow highway drainage to enter the existing large drainage inlet (DI), which also conveys Lake Village run off. A trench drain was chosen over a DI to connect to the existing system at this location because the existing storm drain infrastructure is shallow and would not allow for a pipe retrofit.

The minimum design return frequency for roadway surface drainage facility design storm on NDOT interstate highways is 25 years. However, because the area in design subcatchment 2 is in sump, NDOT requires improvements to be sized with a 50% clogging factor, therefore doubling the size of the inlet (NDOT, 2006). The 100 year event must also be considered. The trench drain sizing was calculated using the manufacturer's design guide (ABT Inc., 2015). The sizing spreadsheet is included in Appendix B. The 70' long trench drain with a 6" grate and a 0.7% slope shown on the plans is capable of conveying 1.3 cfs, which is well above the 100 year peak flow for design subcatchment 2.

The capacity of the existing system was also considered. Total flows from design subcatchments 2, 3, and 4 were checked against existing pipe diameters and slopes. Calculations given in Appendix B show that the system can handle the additional flows that will be received post project from design subcatchment 2.

PROPOSED CURB AND GUTTER DI CALCULATIONS

The 50% design proposed curb and gutter in three locations. The location at design catchment 5 was dropped from the 90% design because the design depended on the ability to re-grade a driveway on private property. The private property owner did not desire to be a project partner and the curb and gutter could not be brought forward in the design process. The other two locations in design subcatchments 4 and 6 are proposed as drainage improvements.

The curb and gutter in design subcatchment 4 is meant to stabilize and protect an existing dirt shoulder, which shows signs of erosion. Vertical curb is proposed to match the existing curb. Rolled curb and gutter is proposed over the culvert crossing in design subcatchment 6 so that the shoulder may be accessed more easily for maintenance. This rolled curb and gutter is also proposed to stabilize and protect the existing shoulder, which shows signs of rilling. Both locations meet spread criteria for 0' in the roadway at the 25 year event.

Calculations were also preformed to size the DI grate for design subcatchment 6 improvements. A 2' wide by 2' long curved vane grate will be sufficient to capture the 25 year event. See Appendix B for calculations.

PROPOSED CONDITION FOR EXISTING CULVERT OUTLET CALCULATIONS

The existing Burke Creek Culvert will remain in place even though Burke Creek will be redirected into a new culvert. The remaining culvert will convey stormwater flows only, with peak flows of 1.46 cfs for the 25 year event and 2.80 cfs for the 100 year event. Grading is proposed in the remaining Burke Creek channel to disconnect stormwater flows from the proposed Burke Creek channel. These improvement are proposed for Phase 2 of the project.

LAKE CLARITY CREDIT SUMMARY

Lake Clarity Credits (LCC) are accrued by implementing and maintaining projects that reduce the loading of fine sediment particles (FSP). To achieve the greatest amount of LCC, the focus would be on areas that are directly connected or have the highest connectivity score (5). Because Burke Creek flows directly to Lake Tahoe, adjacent roads and properties are directly connected and likely to contribute sediment. Drainage work in the northern area of the project boundary is less connected since Folsom Spring ends in the meadow and does not result in many credits as a result.

The proposed stormwater improvements near the new creek alignment include curb and gutter, sediment traps, and a long vegetated treatment area with willow check dams in the area where Burke Creek used to flow downstream of Highway 50 (to be implemented in Phase 2). The long vegetated area occupying the existing creek's abandoned channel would effectively disconnect stormwater flow from Burke Creek. The size of the area was determined by using the natural topography and inputting the results into the Pollutant Load Reduction Model (PLRM). PLRM results are summarized in Table 3.2 and available in Appendix G.

Table 3.2. Summary of PLRM Results.

Entity	FSP reduction (lb/yr)	Potential Lake Clarity Credits
NDOT	864	4.3
Douglas County	1050	5.3

CHANNEL DESIGN

The new 194 foot channel section upstream of the culvert varies from an average slope of 11.8 percent to 4.6 percent. In order to create a stable channel with high grades, rock and log drop structures were utilized to achieve these slopes. Because the stream will see water almost immediately, rocks and logs are used to construct the entire channel since mature vegetation cannot provide stability for many years. Erosion Control Blanket will be used to provide stability on the banks and floodplain until vegetation takes root and matures. Balance Hydrologics Inc. was responsible for geomorphic design and hydrologic modeling and has detailed design methods in design basis memorandum included in this report as Appendix F. It is important to note that the HEC-RAS model used Reinforced Concrete Box (RCB) culvert from the 50 percent design and the model was not updated to include the new CMPA culvert that will be utilized for the final design. Although, the CMPA culvert has a reduced capacity and could cause additional backwatering, the floodplain and culvert will still be able to pass the 50 year storm and therefore will meet regulatory requirements and be an improvement from the existing conditions.

Using the results of the HEC-RAS model, NTCD sized the various types of stream material (Appendix C). Channel bed material was sized by Balance Hydrologics, Inc. and checked by NTCD. Channel bank material (rocks) were sized using a combination of methods and as recommended by the Washington Department of Fish and Wildlife, the largest diameter rock of the resulting gradation was chosen, 2 feet diameter. Logs were sized by estimating the various forces on each log and selecting appropriate rock and soil ballast which is also referred to as "keying in." Scour depths were calculated to account for the depth of rock needed to protect the channel bed from scour after each rock and log drop. Drops were placed at the intervals necessary to move the channel from its perched location to the proposed floodplain and culvert.

Upstream of the new channel, the existing channel has numerous head cuts and unstable areas. Due to existing vegetation, access using construction equipment is difficult in this area which dictated low impact hand work as the tool for restoration. Willow Debris Structures were designed as in stream grade control structures. The location of each was selected starting at the downstream end where evidence of a stable bed existed and working upstream using the extent of ponding from the downstream structure to select the spacing. Materials can be harvested nearby and installed completely by hand.

REVEGETATION

A seed mix of several native species was chosen to create a healthy and diverse floodplain that mimics the healthy floodplain downstream. Because the new channel will not have a seasoning period and the floodplain will be stabilized by erosion control fabric, shrubs will be installed for community aesthetics.

4.0 PROJECT PERMITTING

USFS SPECIAL USE PERMIT

A Special Use Permit is needed to construct improvements on USFS lands

USACE NWP 3

The US Army Corps of Engineers requires projects within Waters of the United States that are less than 0.1 acres to submit a Pre-Construction Notification (PCN) and obtain a Nationwide Permit 3 (NWP 3) which is for "Maintenance." The associated Jurisdictional Wetland Study can be found in Appendix C.

TRPA EIP PROJECT PERMIT

The TRPA EIP Project Review Application and Initial Environmental Checklist have been submitted to TRPA.

DOUGLAS COUNTY PERMITS

A Douglas County grading permits must be obtained prior to construction

STORMWATER POLLUTION PREVENTION PLAN (SWPPP)

The area of disturbance associated with the implementation of the project is expected to be greater than an acre in size, therefore, triggering a Stormwater Pollution Prevention Plan. A draft SWPPP will be authored by NTCD and the Contractor wil be required to revise the SWPPP prior it construction.

NDEP PERMITS

Two Nevada Division of Environmental Protection (NDEP) permits are required, a Temporary Working in Waterways Permit and a 401 Permit. NDEP will also need to approve the waterline relocation.

5.0 PROJECT MAINTENANCE

The NTCD, Douglas County and NDOT are responsible for maintaining the project for the next 20 years. The project is designed to be low maintenance.

IRRIGATION

Irrigation will be provided to establish the vegetation in the project area by the Contractor. The Contractor will maintain the irrigation for one to two growing seasons depending on plant establishment success and then remove temporary irrigation after plant establishment. Maintenance will include periodic checks to ensure proper functioning, coverage and water delivery of the irrigation system. Plants have been selected to be self-sufficient after establishment. More details are provided in the “Revegetation” section of the Special Technical Provisions.

CULVERT AND FLOODPLAIN

The proposed floodplain is designed to pass 100 year flow. The culvert is designed to be 10 percent bigger than the 50 year flood in order to pass upstream debris. NDOT will inspect the culvert annually for any major obstructions and remove them as necessary.

VEGETATION MANAGEMENT

Although the restoration has the potential to reduce the need for vegetation management, the willows and alders in the riparian corridor will need thinning every 5 years or less as deemed necessary by Douglas County. Willows and alders should be thinned so that five to fifteen foot gaps exist every thirty feet of stream channel. Willows and alders should also be cleared near the inlet and outlet of the culvert and in the proximity of any structure, such as the flow split structure.

6.0 REFERENCES

Douglas County Design Criteria and Improvement Standards. 2007.

Douglas County Design Criteria and Improvement Standards. DRAFT 2013.

Federal Highway Administration. August 2013. HEC-22. Hydraulic Engineering Circular No. 22, Third Edition. Urban Drainage Design Manual. Publication No. FHWA-NHI-10-009. September 2009 (Revised August 2013). U.S. Department of Transportation

Lindberg, Michael R. 2006. Civil Engineering Reference Manual for the PE Exam. 10th Edition. Professional Publications, Inc. Belmont, CA.

Nevada Department of Transportation (NDOT). December 2006. Drainage Manual, 2nd Edition. Prepared by Hydraulics Section. Jeff Fontaine, P.E., Director.

Nevada Department of Transportation (NDOT). Standard Details.

National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Precipitation Frequency Atlas of the Western United States, Nevada.

NTCD and Wood Rodgers. 2014. Burke Creek-Rabe Meadow complex master plan – existing conditions report: consulting report, 24 p. + appendices.

Winzler & Kelley, Michael Love & Associates, and McBain & Trush, Inc. 2009. Burke Creek restoration project alternatives analysis report, Burke Creek at Highway 50, Stateline, Nevada: report prepared for Tahoe Regional Planning Agency, 170 p. + appendices.

APPENDIX A: RESPONSES TO 50% COMMENTS

Comments on Burke Creek HWY 50 Crossing and Realignment Project				
			Commenter: Erik Nilssen P.E., Douglas County	**Responder: NTCD Engineering**
Comment #	Document	Page	Comment	Response
DC-1	50% Plans	ii	Douglas County will need a set of as-built plans as well.	Noted
DC-2	50% Plans	ii	Note seems like it does not apply. Plenty of work will take place outside of the NDOT ROW.	Irrelevant portion of note has been deleted
DC-3	50% Plans	G-1	"Potential Access to Upstream Work Via Existing Sierra Colina Road" needs to be clarified. Is this an access or not? Contractor needs to know for sure what they can use.	The access point from the Douglas County ball fields has been made the primary access point for upstream improvements on the 90% plans. For separate Sierra Colina mitigation work, the Contractor may choose to use the Sierra Colina access point.
DC-4	50% Plans	G-1	Show the existing Sierra Colina Fence. Maybe it can function as the construction fence in-lieu of the chain link fence. Not sure about putting chain link across the creek.	the fence has been shown on relevant sheets. Chain link fence has been changed to CLF in appropriate locations.
DC-5	50% Plans	G-1	This page needs to reference details. Details should be provided for the chain link fence and gravel entrance.	Details for temporary erosion control have been included in the 90% plans. chain link fence and gravel entrance are detailed in the specifications. Gravel entrance detail is on Sheet D-7 of plans.
DC-6	50% Plans	G-1	Do we have the temporary construction easements to place DI protection on Van Buskirk's property?	We do not have the construction easement to protect two of the inlets shown on the 50% plans. The inlet protection at these inlets have been removed from the 90% plan set.
DC-7	50% Plans	G-1	Show all easements including the temporary construction and access easements obtained from Mr. Bluth during the BLA.	Completed on 90% plans
DC-8	50% Plans	G-1	Right side of the page "Plan--Drainage Work"--label US 50. There should be some stationing or something to locate the work. This stretch of work is not identified and could be anywhere on the 50 from Sacramento to Maryland.	Alignment and labeling has been added to general sheets.
DC-9	50% Plans	G-2	"Proposed Tree Removal" table--DBH is an acronym used that is not in the legend. I don't know what it stands for.	Diameter at Breast Height has been added to the abbreviations list.
DC-10	50% Plans	G-2	Label road as US HWY 50.	Alignment and labeling has been added to general sheets.
DC-11	50% Plans	G-2	Remove "and/or plug" from the stormdrain removal note. Doesn't make sense to leave it. Also, call out the size, material, and length of stormdrain to be removed.	Call-outs have been adjusted.
DC-12	50% Plans	G-2	Note "remove existing lamp post." Are you returning to the property owner? Are you going to reinstall? It's private property.	The lamp post to be removed is on Douglas County Property. The Contractor will dispose of the lamp post.
DC-13	50% Plans	G-2	The removal line on the east landscape island should match Sheet 14. Adjust the line so that it does not remove any of the concrete from the landscape island.	A note has been added to the plans to fit the vertical curb to the existing island. The island concrete is in poor condition and may need to be replaced.
DC-14	50% Plans	G-2	Revise note to "Remove and Dispose of Curb, Sidewalk, and Landscaping." There should be a hatch to show the limits of removal. There is on Sheet 10, but is should be shown on this sheet as well.	Corrected on 90% plans
DC-15	50% Plans	G-2	Previously, Douglas County required sidewalk along US 50 to be replaced. I don't see that sidewalk replaced in the plan set.	The new sidewalk alignment is shown in the 90% Plans.

Comments on Burke Creek HWY 50 Crossing and Realignment Project				
			Commenter: Erik Nilssen P.E., Douglas County	**Responder: NTCD Engineering**
Comment #	Document	Page	Comment	Response
DC-16	50% Plans	CS-2	The proposed contours need to match the existing contours at the property lines.	The proposed 90% surface does match the existing surface at the property line. However, the vertical curb at the property boundary makes the proposed contours visually not line up exactly with the existing contours due to the 6" vertical difference.
DC-17	50% Plans	CS-2	Contour lines as shown are not constructible. There is no horizontal control to tell the contractor where to grade. The cross sections on Sheet 9 try to provide some horizontal control, they those stations are skewed at different angles and also not tied to anything.	The 90% plans show the existing NDOT highway alignment and select station/offset points. The control for the project is: Nevada department of transportation monument No. 424005M (LPN 907): Horizontal Datum NAD 83/94 State Plane Coordinate System Nevada; Vertical Datum NGVD 29 US feet. NTCD will be responsible for construction staking.
DC-18	50% Plans	CS-2	Need detail for new concrete to be poured against old.	A note has been added to the sidewalk detail.
DC-19	50% Plans	CS-2	Provide stationing for Log & Boulder Step Pools.	Stationing has been provided in the 90% details.
DC-20	50% Plans	CD-1	No stationing exists. I have no idea where this stretch of road is.	The existing NDOT highway alignment has been included with the 90% design.
DC-21	50% Plans	CD-2	Note "Construct Transition to Vertical Curb" provide detail for this transition.	This improvement was eliminated from the design.
DC-22	50% Plans	CD-2	Note "Regrade and Repave Driveway" why is this in the scope? If we do need to repave it, we need to callout the stationing for the removal limits. We also need to provide a detail that shows the thickness of pavement.	This improvement was eliminated from the design.
DC-23	50% Plans	CD-2	I am confused by the two small areas that call for pavement removal and revegetate. Won't the entire County parcel be revegetated? We should show the revegetate symbol across the whole parcel.	These areas were eliminated because the private property owner did not wish to be a project partner. Revegetation is called out on the Revegetation Plan and/or specified in the Special Provisions.
DC-24	50% Plans	CD-2	Note "Construct Vertical Curb" need detail.	Detail included with 90% design.
DC-25	50% Plans	CD-2	Note "construct A/C pavement in place of existing island" why are we removing this island? Seems they would like to have some landscaping. Not sure where TRPA is, but Douglas County requires landscape fingers every 8 parking spaces.	This improvement was eliminated from the design.
DC-26	50% Plans	CD-2	Why the callout to relocate the underground telephone lines? Seems like an unnecessary expense. Can't they leave them where they are?	Proposed grading will expose part of the telephone line. Also, the line would be completely inaccessible under the project flood control berm. Frontier Communications has expressed a desire to keep the lines accessible for maintenance.

APPENDIX B: HIGHWAY DRAINAGE CLACULATIONS AND REFERENCE

NOAA Atlas 14, Volume 1, Version 5
Location name: Zephyr Cove-Round Hill Village, Nevada, US*
Latitude: 38.9727°, Longitude: -119.9352°
Elevation: 6321 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.123** (0.108–0.142)	**0.153** (0.135–0.178)	**0.199** (0.173–0.231)	**0.242** (0.210–0.282)	**0.312** (0.262–0.363)	**0.374** (0.306–0.438)	**0.449** (0.355–0.532)	**0.539** (0.409–0.650)	**0.684** (0.489–0.843)	**0.819** (0.556–1.03)
10-min	**0.187** (0.164–0.216)	**0.233** (0.205–0.272)	**0.303** (0.264–0.352)	**0.369** (0.320–0.429)	**0.475** (0.399–0.553)	**0.570** (0.465–0.668)	**0.684** (0.541–0.810)	**0.821** (0.623–0.990)	**1.04** (0.744–1.28)	**1.25** (0.846–1.57)
15-min	**0.232** (0.204–0.268)	**0.289** (0.255–0.337)	**0.375** (0.327–0.436)	**0.457** (0.396–0.531)	**0.588** (0.494–0.685)	**0.706** (0.576–0.827)	**0.848** (0.670–1.00)	**1.02** (0.772–1.23)	**1.29** (0.923–1.59)	**1.55** (1.05–1.95)
30-min	**0.312** (0.274–0.362)	**0.389** (0.343–0.454)	**0.505** (0.441–0.588)	**0.615** (0.533–0.716)	**0.792** (0.666–0.923)	**0.951** (0.776–1.12)	**1.14** (0.902–1.35)	**1.37** (1.04–1.65)	**1.74** (1.24–2.14)	**2.08** (1.41–2.62)
60-min	**0.386** (0.339–0.447)	**0.481** (0.424–0.561)	**0.625** (0.545–0.727)	**0.762** (0.660–0.886)	**0.981** (0.824–1.14)	**1.18** (0.961–1.38)	**1.41** (1.12–1.67)	**1.70** (1.29–2.05)	**2.15** (1.54–2.65)	**2.58** (1.75–3.25)
2-hr	**0.547** (0.496–0.613)	**0.673** (0.609–0.755)	**0.835** (0.752–0.935)	**0.981** (0.877–1.10)	**1.19** (1.04–1.35)	**1.38** (1.18–1.57)	**1.59** (1.33–1.83)	**1.84** (1.49–2.15)	**2.27** (1.77–2.72)	**2.69** (2.03–3.29)
3-hr	**0.688** (0.628–0.755)	**0.849** (0.780–0.937)	**1.04** (0.944–1.14)	**1.19** (1.08–1.31)	**1.40** (1.26–1.56)	**1.58** (1.39–1.77)	**1.78** (1.54–2.00)	**2.02** (1.71–2.31)	**2.41** (1.99–2.82)	**2.82** (2.26–3.35)
6-hr	**1.06** (0.970–1.17)	**1.31** (1.20–1.45)	**1.59** (1.44–1.74)	**1.80** (1.63–1.97)	**2.08** (1.86–2.29)	**2.30** (2.03–2.54)	**2.50** (2.19–2.80)	**2.74** (2.36–3.10)	**3.05** (2.57–3.50)	**3.30** (2.73–3.86)
12-hr	**1.57** (1.41–1.74)	**1.95** (1.76–2.17)	**2.40** (2.16–2.67)	**2.76** (2.47–3.07)	**3.25** (2.87–3.64)	**3.61** (3.16–4.08)	**3.99** (3.44–4.54)	**4.37** (3.70–5.03)	**4.85** (4.02–5.70)	**5.22** (4.24–6.21)
24-hr	**2.14** (1.88–2.44)	**2.67** (2.36–3.05)	**3.33** (2.94–3.80)	**3.87** (3.40–4.40)	**4.60** (4.03–5.24)	**5.18** (4.52–5.89)	**5.79** (5.02–6.59)	**6.41** (5.53–7.31)	**7.26** (6.20–8.30)	**7.93** (6.71–9.10)
2-day	**2.74** (2.40–3.15)	**3.44** (3.02–3.97)	**4.40** (3.85–5.06)	**5.20** (4.54–5.98)	**6.35** (5.51–7.30)	**7.28** (6.27–8.38)	**8.29** (7.09–9.55)	**9.35** (7.93–10.8)	**10.9** (9.09–12.7)	**12.1** (10.0–14.2)
3-day	**3.09** (2.69–3.59)	**3.92** (3.40–4.54)	**5.08** (4.40–5.89)	**6.05** (5.23–6.99)	**7.43** (6.38–8.59)	**8.56** (7.30–9.90)	**9.78** (8.27–11.3)	**11.1** (9.29–12.8)	**12.9** (10.7–15.1)	**14.4** (11.8–16.9)
4-day	**3.45** (2.98–4.02)	**4.39** (3.79–5.11)	**5.76** (4.96–6.71)	**6.90** (5.92–8.00)	**8.52** (7.25–9.88)	**9.84** (8.34–11.4)	**11.3** (9.46–13.1)	**12.8** (10.6–14.9)	**15.0** (12.3–17.5)	**16.7** (13.6–19.7)
7-day	**4.18** (3.60–4.90)	**5.35** (4.60–6.28)	**7.07** (6.06–8.28)	**8.46** (7.23–9.90)	**10.4** (8.85–12.2)	**12.0** (10.1–14.0)	**13.7** (11.5–16.0)	**15.4** (12.9–18.1)	**17.9** (14.8–21.1)	**19.9** (16.3–23.6)
10-day	**4.86** (4.20–5.63)	**6.23** (5.38–7.21)	**8.19** (7.07–9.48)	**9.74** (8.39–11.3)	**11.9** (10.2–13.7)	**13.6** (11.6–15.7)	**15.3** (13.0–17.8)	**17.2** (14.5–19.9)	**19.8** (16.5–23.0)	**21.8** (18.0–25.5)
20-day	**6.64** (5.77–7.65)	**8.49** (7.38–9.79)	**11.0** (9.59–12.7)	**13.0** (11.2–15.0)	**15.6** (13.4–18.0)	**17.6** (15.1–20.3)	**19.6** (16.7–22.7)	**21.7** (18.4–25.1)	**24.5** (20.6–28.5)	**26.6** (22.1–31.1)
30-day	**8.01** (6.95–9.19)	**10.3** (8.91–11.8)	**13.4** (11.6–15.4)	**15.7** (13.6–18.1)	**18.9** (16.3–21.7)	**21.3** (18.3–24.5)	**23.8** (20.3–27.4)	**26.3** (22.3–30.3)	**29.7** (25.0–34.3)	**32.3** (27.0–37.5)
45-day	**9.87** (8.64–11.2)	**12.7** (11.1–14.4)	**16.5** (14.5–18.8)	**19.4** (16.9–22.1)	**23.2** (20.1–26.4)	**26.0** (22.5–29.7)	**28.9** (24.9–33.0)	**31.8** (27.3–36.4)	**35.6** (30.3–40.9)	**38.5** (32.5–44.5)
60-day	**11.4** (9.83–13.0)	**14.7** (12.7–16.8)	**19.1** (16.5–22.0)	**22.3** (19.3–25.6)	**26.4** (22.7–30.3)	**29.3** (25.2–33.7)	**32.2** (27.6–37.1)	**35.1** (29.9–40.4)	**38.7** (32.8–44.7)	**41.3** (34.9–48.0)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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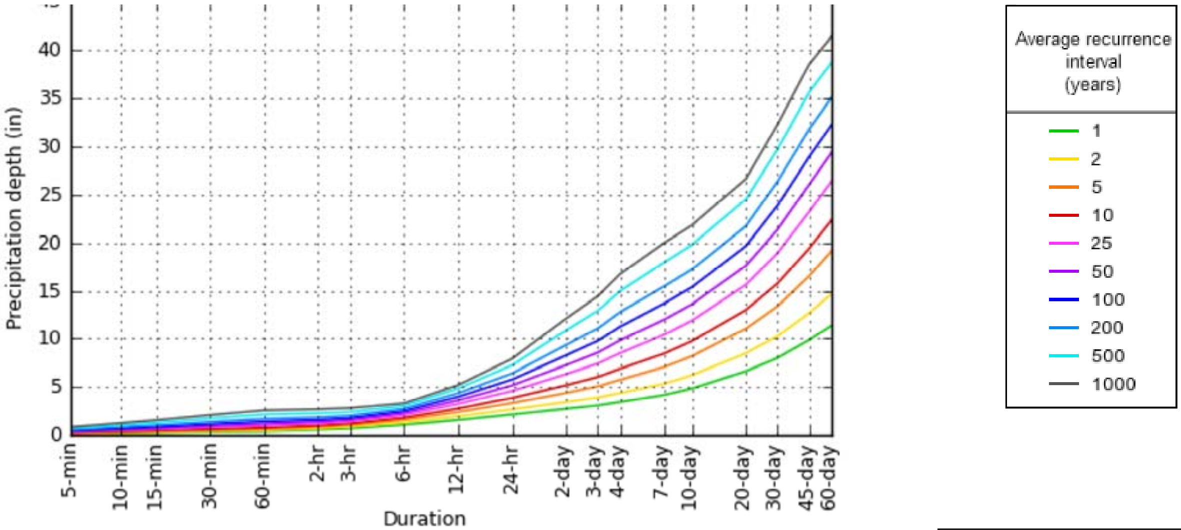
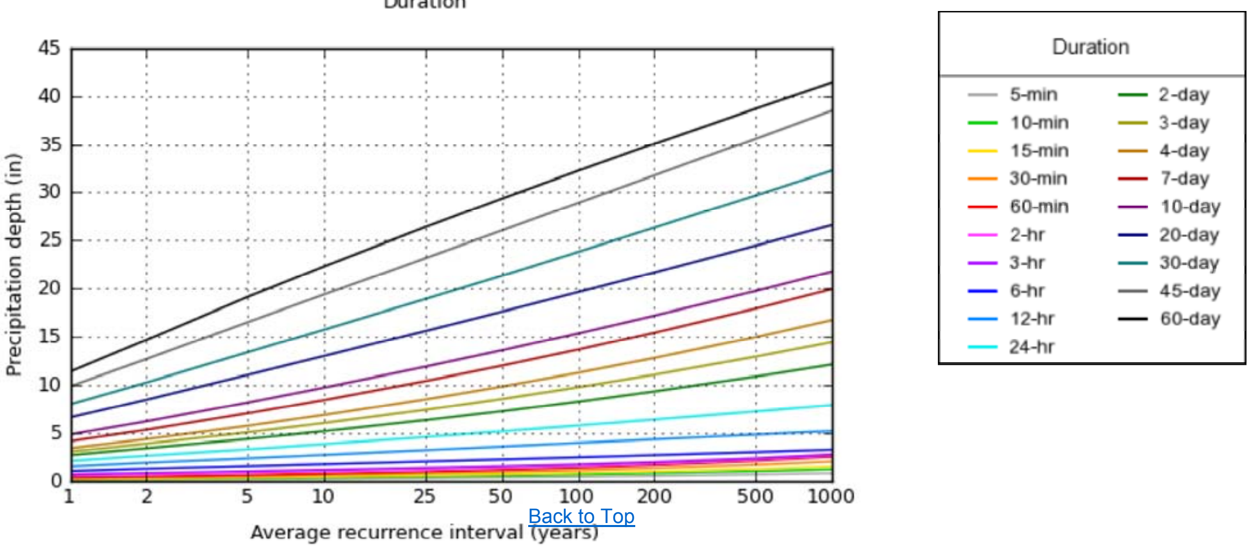
PF graphical





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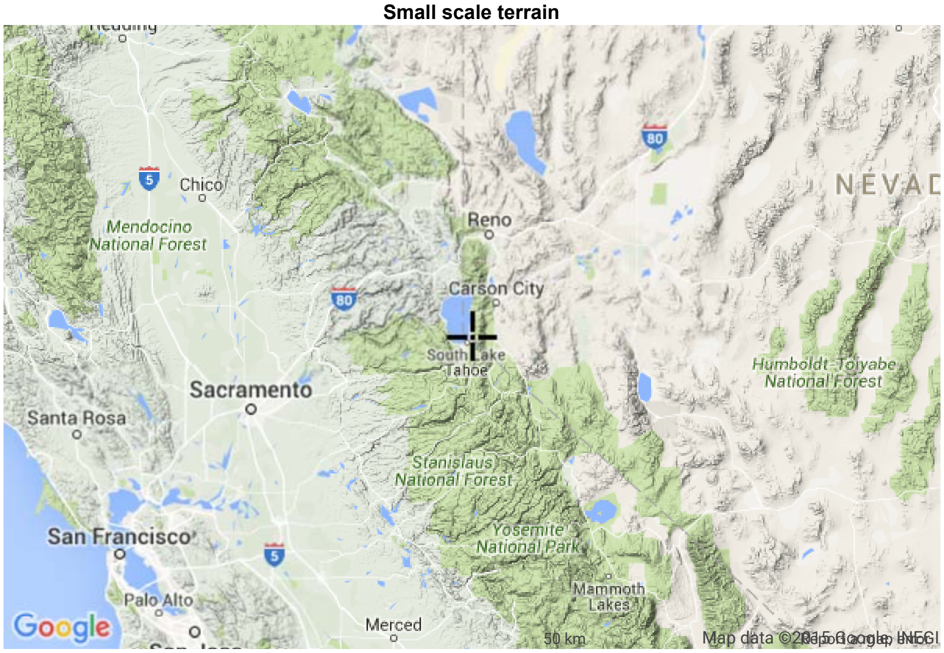
Maps & aerials

Small scale terrain



Rational Method Calculations

Variable	Description
A	Area
V	Velocity
S	Slope
L	Length
Tt	travel time in gutter
Ti	initial flow time
Tc	time of concentration
C	runoff coefficient (composite based on land use %)
tc check	this is a way to check tc calcs, use the minimum of the 2.

Equations

Tt=L/V

Tc =Ti+Tt

(check) Tc = L/180 +10

$$V = 20.3282\sqrt{S}$$

$$ti5 = \frac{1.8(1.1 - C5)\sqrt{L}}{S^{1/3}}$$

$$ti100 = \frac{1.8(1.1 - C100)\sqrt{L}}{S^{1/3}}$$

$$Q = CiA$$

NDOT minimum tc of 5 min for pavement, 10 for land and pavement

Design Sub-catchment	Description	Total A (sf)	Gutter/ Channel Slope (S) (%)[4]	Avg V (ft/s)[1]	Paved L (ft)	Travel time Tt (min)	Land S (%)[2]	Land L (Ft)	Composite C5	Ti5 (min)	Composite C25	Ti25 (min)	Composite C100	Ti100 (min)	Tc5 (min)	Tc25 (min)	Tc100 (min)	Total L (ft)	Tc check (min)	Final Tc5 (min)	i(5) (in/hr)	Final Tc25 (min)	i(25) (in/hr)[3]	Final Tc100 (min)	i(100) (in/hr)	Q5 (cfs)	Q25 (cfs)	Q100 (cfs)
1	North Area, west highway, trench drain by Folsom spring	8,930	0.30	1.11	89	1.33	2	20	0.88	1.4	0.9	1.3	0.93	1.1	2.7	2.6	2.4	109	10.6	2.7	0.119	2.6	0.312	2.4	0.449	0.02	0.06	0.09
2	North Area, east highway, trench drain to alleviate hwy flooding	75,100	0.30	1.11	454	6.80	8.3	252	0.27	11.7	0.3	11.2	0.47	9.0	18.5	17.9	15.8	706	13.9	13.9	0.375	13.9	0.588	13.9	0.848	0.17	0.31	0.68
3	North Area, east highway, to existing large DI	1,806,300	3.70	3.91	1652	0.00	6.8	2036	0.30	34.2	0.3	32.6	0.49	26.0	34.2	32.6	26.0	3688	30.5	30.5	0.505	30.5	0.792	26.0	1.14	6.32	11.15	23.32
4	North Area, east highway, additional C&G	98,490	1.00	2.03	100	0.82	14.9	355	0.20	12.5	0.2	11.8	0.41	9.5	13.3	12.7	10.3	455	12.5	12.5	0.375	12.5	0.588	10.3	0.684	0.17	0.32	0.64
5	Crossing, curb upstream of Van Buskirk Property	8,280	2.6	3.28	226	1.15	2	20	0.88	1.4	0.9	1.3	0.93	1.1	2.55	2.4	2.2	246	11.4	2.6	0.119	2.4	0.312	2.2	0.449	0.02	0.05	0.08
6	Crossing, added curb over proposed culvert, west side Hwy	9,920	2.6	3.28	313	1.59	2	20	0.88	1.4	0.9	1.3	0.93	1.1	3.00	2.9	2.7	333	11.9	3.0	0.119	2.9	0.312	2.7	0.449	0.02	0.06	0.10
7	Crossing, remaining flow to existing culvert	268,160	2.6	3.28	200	1.02	11	1043	0.33	20.0	0.4	19.1	0.50	15.6	21.02	20.1	16.6	1243	16.9	16.9	0.375	16.9	0.588	16.6	0.848	0.77	1.34	2.63

Notes:

1. V calcs best suited for flow paths > 100ft
2. Land slopes and lengths in pavement only areas are based on cross slopes
3. A duration of 5 minutes was used for all time of concentrations less than 5 minutes
4. NDOT minimum gutter slope of 0.3 was used in flat areas
5. Calculation methods based on 2009 Truckee Meadows Regional Drainage Manual

Rational Method Summary Table

Design Sub-catchment	Description	Total A (sf)	Composite C25	Composite C100	i(25) (in/hr)	i(100) (in/hr)	Q25 (cfs)	Q100 (cfs)
1	North Area, west highway, trench drain by Folsom spring	8,930	0.9	0.93	0.312	0.449	0.06	0.09
2	North Area, east highway, trench drain to alleviate hwy flooding	75,100	0.3	0.47	0.588	0.848	0.31	0.68
3	North Area, east highway, to existing large DI	1,806,300	0.3	0.49	0.792	1.14	11.15	23.32
4	North Area, east highway, additional C&G	98,490	0.2	0.41	0.588	0.684	0.32	0.64
5	Crossing, extended curb upstream of Van Buskirk Property	8,280	0.9	0.93	0.312	0.449	0.05	0.08
6	Crossing, added curb over proposed culvert, west side Hwy	9,920	0.9	0.93	0.312	0.449	0.06	0.10
7	Crossing, remaining flow to existing culvert	268,160	0.4	0.50	0.588	0.848	1.34	2.63

5+6+7	Total flow to existing culvert outlet	1.46	2.80
2+3+4	Total Flow through existing DI, outleting to private property	11.79	24.64

Composite Runoff Coefficient, C, Values										
		Land Use Area (sf)								
Area	**Description**	**Paved Road**	**Open Space: Park**	**Undeveloped Forest**	**Business/ Commercial: Downtown**	**Residential: Multi-Family**	**Total Area (sf)**	**Composite C5**	**Composite C25**	**Composite C100**
1	North Area, trench drain by Folsom spring	8,930	-	-	-	-	8,930	0.88	0.90	0.93
2	North Area, trench drain to alleviate hwy flooding	19,690	-	55,410	-	-	75,100	0.27	0.31	0.47
3	North Area, to existing large DI	170,200	79,000	1,090,520	258,740	207,840	1,806,300	0.30	0.34	0.49
4	North Area, additional C&G	17,290	-	81,200	-	-	98,490	0.20	0.24	0.41
5	Crossing, curb upstream of Van Buskirk Property	8,280	-	-	-	-	8,280	0.88	0.90	0.93
6	Crossing, added curb over proposed culvert, west side H	9,920	-	-	-	-	9,920	0.88	0.90	0.93
7	Crossing, remaining flow to existing culvert	-	102,140	66,910	99,110	-	268,160	0.33	0.37	0.50

Summary of C Values*			
Land Use	**C5**	**C25**	**C100**
Paved Road	0.88	0.90	0.93
Open Space: Park	0.05	0.10	0.30
Undeveloped Forest	0.05	0.10	0.30
Business/ Commercial: Downtown	0.82	0.83	0.85
Residential: Multi-Family	0.60	0.62	0.78

**Source: Table 701 of 2009 Truckee Meadows Regional Drainage Manual*

Post-Project Pipe Capacity Check

Question: Is existing pipe capacity for subcatchments 3 and 4 large enough to handle additional flows from subcatchment 2?
Assumptions: Full flow in the pipe, not under pressure.

Existing large DI (15.5'x4')to Highway DI -34"x22" oval RCP	**value**	**notes**
Q25 (cfs)- for 2 and 3	**11.47**	
Q100 (cfs)- for 2 and 3	**24.00**	
Length (ft)	138	from asbuilts
Upper Elevation (ft)	6317.13	from asbuilts
Lower Elevation (ft)	6316	from asbuilts
Slope (ft/ft)	0.82%	
Pipe Size	34"x22" oval RCP	
Manning's n	0.013	ave. value for concrete; Appendix 19.A, Lindeburgh: Civil Engineering Reference Manual, Tenth Edition
Shape	ellipse	
Bottom Width (ft)	n/a	
Side Slope (xH:1V)	n/a	
P= Wetted Perimeter [ft]	7.49	P =2*pi*(sqrt(.5*(a^2+b^2)))
A= Cross sectiona flow area [ft^2]	4.08	A= pi*a*b
R= Hydraulic Radius = A/P	0.54	
Velocity [ft/sec]	6.9	
Maximum existing Q [cfs]	**28.2**	exceeds required 25 and 100 year event frequency

Across Hwy 50 - 38"x 24" HE RCP	**value**	**notes**
Q25 (cfs)- for 2, 3, 4	**11.79**	
Q100 (cfs)- for 2 ,3, 4	**24.64**	
Length (ft)		
Upper Elevation (ft)		unknown (sediment and visual obstructions to field verification)
Lower Elevation (ft)		unknown
Slope (ft/ft)	0.30%	assume minimum
Pipe Size	38"x 24" HE RCP	
Manning's n	0.013	ave. value for concrete; Appendix 19.A, Lindeburgh: Civil Engineering Reference Manual, Tenth Edition
Shape	ellipse	
Bottom Width (ft)	n/a	
Side Slope (xH:1V)	n/a	
P= Wetted Perimeter [ft]	8.32	
A= Cross sectiona flow area [ft^2]	4.97	
R= Hydraulic Radius = A/P	0.60	
Velocity [ft/sec]	4.5	
Maximum existing Q [cfs]	**22.1**	exceeds required 25 year event frequency

C&G Spread

<u>Question:</u> How far does the 25 year storm spread from proposed C&G into the Highway?

<u>Assumptions:</u> The Highway 50 cross slope is assumed to be 2%, cross slope of proposed curb is used as Sx

Design Subatchment 4	value	notes
Q25 [cfs]	0.32	
longitudinal slope, Sl	1.65%	from CAD surface
cross slope, Sx	8.33%	from Type 1 detail 2" over 2'
Manning's, n	0.015	per NDOT, 2006
cub and gutter spread, T	**1.72**	equation 4-2 from HEC 22
T= [Q_{25}*n/(K*Sx^1.67*Sl^0.5)]^0.375		
Allowable spread = gutter width only [ft]	<= 2.0	OKAY!
check depth [ft]	0.14	d= T*Sx, <= 0.5

Design Subatchment 6	value	notes
Q25 [cfs]	0.06	
longitudinal slope, Sl	2.51%	from CAD surface
cross slope, Sx	8.33%	from Type 6 detail 2" over 2'
Manning's, n	0.015	per NDOT, 2006
cub and gutter spread, T	**0.87**	equation 4-2 from HEC 22
T= [Q_{25}*n/(K*Sx^1.67*Sl^0.5)]^0.375		
Allowable spread = gutter width only [ft]	<= 2.0	OKAY!
check depth [ft]	0.07	d= T*Sx, <= 0.25

Proposed DI Grate Size

<u>Assumptions:</u> Use 2' wide curved vane grate, no side flow interception because spread is contained within gutter. Q25 design storm assume wier flow for depressed inlet

Q = C*P*d^1.5, where...		equation 4-26 from HEC-22
Q= Flow to proposed inlet in cfs	0.06	
P = Perimeter of grate (disregarding the curb side of grate)		
C = 3.0 for English units	3.0	
d= average depth across grate = T*Sx	0.07	
P = Q/(C*(T*Sx)^1.5)	1.10	
L = P-2*W		assuming 2' width, 2'x2' grate is adequate

APPENDIX C: STREAM CHANNEL MATERIAL CALCULATIONS

Stream Material Sizing - bankfull

Project:	Burke Creek Crossing
Date:	11/24/2015
Calculated by:	MK

Steep Portion 1+38-2+00

1. Inputs

Proposed Channel Conditions - Steep Portion 1+38-2+00

Design Flow	5	cfs	bankfull flow
XS A	1.5	sq ft	
top W	2	ft	
q =	2.5	cu ft/sec ft	
Vavg	3.333333333	ft/sec	
g	32.2	ft/sec^2	
S	0.118	ft/ft	

2. Eqns to Calculate particle size

USACE Riprap Design		
developed for:	slope (2 to 20%)	
	low unit discharge?	
D30 = (1.95S^0.555(1.3q)^(2/3))/g^1/3		
D30 =	0.13	
D84 = 1.5D30		
D84 =	0.20	

Bathhurst (1987)		
developed for:	slope (0.23 to 9%)	
	particle dia. (0.35-11")	
D50 = 3.56q^2/3*S^3/4/g^1/3		
D50 =	0.415	ft

Robinson et al (1998)		
developed for:	slope (2 to 40%)	
	particle dia. (0.6-11")	
(Input q in m^3/s/m)		
q =	0.232376562	m^3/s/m
D50 = [q/(8.07x10^(-6)*S^-0.58)]^0.529		
D50 =	118.635	mm
D50 =	0.389	ft

Abt and Johnson (1991)		
developed for:	slope (1 to 20%)	
	particle dia. (1 to 6")	
D50 = .436q(sizing)^0.56*S^0.43		
q(sizing) =	q*sizing factor	
sizing factor =	1.35	
D50 =	0.344	ft

Choose D50 = 0.4

Downstream Portion 0-1+38

1. Inputs

Proposed Channel Conditions - Downstream Portion 0-1+38

Design Flow	5	cfs
XS A	1.5	ft
top W	2	
q =	2.5	cu ft/sec ft
V	3.333333	ft/sec
g	32.2	ft/sec^2
S	0.046	ft/ft

2. Eqns to Calculate particle size

USACE Riprap Design		
developed for:	slope (2 to 20%)	
	low unit discharge?	
D30 = (1.95S^0.555(1.3q)^(2/3))/g^1/3		
D30 =	0.08	
D84 = 1.5D30		
D84 =	0.12	

Bathhurst (1987)		
developed for:	slope (0.23 to 9%)	
	particle dia. (0.35-11")	
D50 = 3.56q^2/3*S^3/4/g^1/3		
D50 =	0.205	ft

Robinson et al (1998)		
developed for:	slope (2 to 40%)	
	particle dia. (0.6-11")	
(Input q in m^3/s/m)		
q =	0.232377	m^3/s/m
D50 = [q/(8.07x10^(-6)*S^-0.58)]^0.529		
D50 =	88.856	mm
D50 =	0.292	ft

Abt and Johnson (1991)		
developed for:	slope (1 to 20%)	
	particle dia. (1 to 6")	
D50 = .436q(sizing)^0.56*S^0.43		
q(sizing) =	q*sizing factor	
sizing factor =	1.35	
D50 =	0.229	ft

Choose D50 = 0.2

3. Develop Grain Size Distribution Utilizing Calculated D50

Washington Department of Fish and Wildlife Grain Size Distribution (WDFW, 2003)

D84/D100 =	0.4	D84/D100 =	0.4
D84/D50 =	2.5	D84/D50 =	2.5
D84/D16 =	8	D84/D16 =	8

WDFW Substrate Gradation		
D100 =	2.50	ft
D84 =	1.00	ft
D50 =	0.4	ft
D16 =	0.13	ft
D8 =	0.03	ft

WDFW Substrate Gradation		
D100 =	1.25	ft
D84 =	0.50	ft
D50 =	0.2	ft
D16 =	0.06	ft
D8 =	0.01	ft

Note: WDFW gradation above is based on wide variety of stream beds in different environments. The D84/D100 ratio of 0.4 may give too large of boulder size. Judgement should be made to adjust size to something reasonable for the site. ACOE EM 1110-2-1601 suggests using D100 = 2 x D50. If using ACOE steep slope methods to size substrate, then D84 - 1.5D30 (WDFS, 2003). The largest rock should not be greater in size than 1/4 of the active channel width.

Rock Structures: Use D84-D100

Stream Material: Use <D84

Bankline Rock: Use D50 to D84

Resulting Engineered Stream Material Gradation

Size Class	Particle Dia	
D100 =	2	ft
D84 =	1.5	ft
D50 =	0.8	ft
D16 =	4	in
D8 =	0.08	in

Justification: Choose largest size of ESM to be equal to the D84 calculated using the WDFW gradation. The size exceeds the ACOE recommendation of D100 = 2 x D50

4. ESM Thickness

Thickness greater or equal to max (1.5 x D50 or D100)(ACOE EM 1110-2-1601)

or if D100 is set to protrude above surface by 1/3 then use 0.67D100 (Flosi et al.)

T = 2 ft (choose D100>1.5 x D50

5. References

1) US Dept of the interior BOR. 2007. Rock Ramp Design Guidelines

2) WDFW, 2012. Stream Habitat Restoration Guidelines: http://wdfw.wa.gov/publications/01374/wdfw01374.pdf

3) USACE. 1994. Hydraulic Design for Flood Control Channels, EM-1110-2-1601

4) California Department of Fish and Game. 2009. Fish Passage Design and Implementation: Part XII of the California Salmonid Stream Habitat Restoration Manual. Sacramento, CA, CA Dept of Fish and Game

Stream Material Sizing - 100 year flow

Project: Burke Creek Crossing
Date: 11/24/2015
Calculated by MK

1. Inputs

Proposed Channel Conditions - max q from HEC RAS

Design Flow	71	cfs	25 yr flow
XS A	11.96	sq ft	
top W		ft	
q =	6.29	cu ft/sec ft	
V	5.94	ft/sec	
g	32.2	ft/sec^2	
S	0.1	ft/ft	

2. Eqns to Calculate particle size

USACE Riprap Design		USACE Riprap Tables (Plate 37)	
developed for slope (2 to 20%)		Use Depth <1 ft, V < 8ft/sec	
low unit discharge?		Choose D30 = 0.3 ft	
D30 =			
(1.95S^0.555(1.3q)^(2/3))/g^1/3		D50 = D30 (D85/D15)^1/3	
D30 =	0.22	D30 =	0.30
D84 = 1.5D30		D50 = 1.22 D30	
D84 =	0.34	D50	0.37

Bathhurst (1987)		
developed for	slope (0.23 to 9%)	
	particle dia. (0.35-11")	
D50 = 3.56q^2/3*S^3/4/g^1/3		
D50 =	0.678	ft

Robinson et al (1998)		
developed for	slope (2 to 40%)	
	particle dia. (0.6-11")	
(Input q in m^3/s/m)		
q =	0.5850616	m^3/s/m
D50 = [q/(8.07x10^(-6)*S^-0.58)]^0.529		
D50 =	183.778	mm
D50 =	0.603	ft

Abt and Johnson (1991)		
developed for	slope (1 to 20%)	
	particle dia. (1 to 6")	
D50 = .436q(sizing)^0.56*S^0.43		
q(sizing) =	q*sizing factor	
sizing factor =	1.35	
D50 =	0.537	ft

Choose D50 = 0.6

1. Inputs

Proposed Channel Conditions - Downstream Portion 0-1+38

Design Flow	121	cfs
XS A	18.7	ft
top W		ft
q =	8.71	cu ft/sec ft
V	6.47	ft/sec
g	32.2	ft/sec^2
s	0.1	ft/ft

2. Eqns to Calculate particle size

USACE Riprap Design	
developed for:	slope (2 to 20%)
	low unit discharge?
D30 = (1.95S^0.555(1.3q)^(2/3))/g^1/3	
D30 =	0.28
D84 = 1.5D30	
D84 =	0.42

Bathhurst (1987)		
developed for:	slope (0.23 to 9%)	
	particle dia. (0.35-11")	
D50 = 3.56q^2/3*S^3/4/g^1/3		
D50 =	0.842	ft

Robinson et al (1998)		
developed for:	slope (2 to 40%)	
	particle dia. (0.6-11")	
(Input q in m^3/s/m)		
q =	0.809721	m^3/s/m
D50 = [q/(8.07x10^(-6)*S^-0.58)]^0.529		
D50 =	218.250	mm
D50 =	0.716	ft

Abt and Johnson (1991)		
developed for:	slope (1 to 20%)	
	particle dia. (1 to 6")	
D50 = .436q(sizing)^0.56*S^0.43		
q(sizing) =	q*sizing factor	
sizing factor =	1.35	
D50 =	0.644	ft

Choose D50 = 0.7

3. Develop Grain Size Distribution Utilizing Calculated D50

Washington Department of Fish and Wildlife Grain Size Distribution (WDFW, 2003)

D84/D100 =	0.4		D84/D100 =	0.4	
D84/D50 =	2.5		D84/D50 =	2.5	
D84/D16 =	8		D84/D16 =	8	

WDFW Substrate Gradation		
D100 =	3.75	ft
D84 =	1.50	ft
D50 =	0.6	ft
D16 =	0.19	ft
D8 =	0.04	ft

WDFW Substrate Gradation		
D100 =	4.38	ft
D84 =	1.75	ft
D50 =	0.7	ft
D16 =	0.22	ft
D8 =	0.05	ft

Note: WDFS gradation above is based on wide variety of stream beds in different environments. The D84/D100 ratio of 0.4 may give too large of boulder size. Judgement should be made to adjust size to something reasonable for the site. ACOE EM 1110-2-1601 suggests using D100 = 2 x D50. If using ACOE steep slope methods to size substrate, then D84 - 1.5D30 (WDFS, 2003). The largest rock should not be greater in size than 1/4 of the active channel width.

Rock Step Pool

Project:	Burke Creek Crossing
Date:	12/2/2015
Calculated by:	MK

1. Inputs

Proposed Channel Conditions - 100 year

Design Flow	121	cfs
XS A	18.7	sq ft
q =	8.71	cu ft/sec ft
V	6.47	ft/sec
g	32.2	ft/sec^2
s	0.118	ft/ft

2. Eqns to Calculate particle size

USACE Riprap Design		
developed for:	slope (2 to 20%)	
	low unit discharge?	
D30 = (1.95S^0.555(1.3q)^(2/3))/g^1/3		
D30 =	0.31	
D50 = 1.22D50 =	0.37	
D84 = 1.5D30		
D84 =	0.46	

Costa (1983)		
empirical, CO front range streams		
Dmin = (Vavg/9.571)^2.05		
Dmin =	0.45	ft

CalTrans, App N, Rock Weir (2009)		
W = 0.00002*V^6*SG/(0.207*(SG-1)^3)		
V = 1.33Vmax for impinging flow conditions		
V =	8.605882353	ft/sec
SG = rock spec gravity, assume 2.65		
W =	14	lbs
should have a higher Vmax		

NRCS, 2001	
D50weir = 2 x D50riprap	
D100weir = 2 x D50weir	
D50min-weir = 0.75 x D50riprap	
D50weir =	0.75
D100weir =	1.49
D50min-weir =	0.56

Isbash (1936)		
rounded stones in running water		
Dmin = V^2/(1.479g((SGs-SGw)/SQw))		
SG (spec gravity)	2.65	
Dmin =	0.53	ft

3. Cross check with previous sheet

Dmin from Isbash = 1.35 ft

Rock Structures: Use D84-D100

Resulting Engineered Stream Material Gradation

Size Class	Particle Dia	
D100 =	2	ft
D84 =	1.5	ft
D50 =	0.8	ft
D16 =	4	in
D8 =	0.08	in

Choose to use D84-100 as weir material

4. References

1) Natural Resources Conservation Service. 2001. Design of Rock Weirs. Technical Notes - Engineering - No. 13, U.S. Department of Agriculture, Boise, ID. 6 pp.
2) WDFW, 2012. Stream Habitat Restoration Guidelines: http://wdfw.wa.gov/publications/01374/wdfw01374.pdf
3) USACE. 1994. Hydraulic Design for Flood Control Channels, EM-1110-2-1601
4) California Department of Fish and Game. 2009. Fish Passage Design and Implementation: Part XII
of the California Salmonid Stream Habitat Restoration Manual. Sacramento, CA, CA Dept of Fish and Game

Log Step Pool

Project:	Burke Creek Crossing
Date:	12/3/2015
Calculated by:	MK

1. Inputs

Proposed Channel Conditions - 100 year

Design Flow	121	cfs
XS A	18.7	sq ft
q =	8.71	cu ft/sec ft
V	6.47	ft/sec
g	32.2	ft/sec^2
s	0.118	ft/ft
SG, yellow pine	0.38	
SG, white fir	0.37	

Forces to consider: Buoyancy, sliding, , ballast, scour

2. calculations

Buoyancy		
F_B = (pi()*D^2*L)/4)*density water*g*(1-SG_L)*N_L		
D (tree diameter)	1.00	ft
L (length of tree)	6	
SG_L (spec grav of log)	varies	
N_L (number of logs)	1	
Fb (pine) =	5,870.48	lb
Fb (fir) =	5,965.16	lb
Fb (aspen) =	#REF!	lb
Fb (willow) =	#REF!	lb

Rock Ballast		
SG (boulders)	2.65	granite
D_B	1	ft
N_B, Number of boulders submerged	**1**	
Nu_B, Number of boulders above water	1	
W' = effective weight of submerged boulders		
W' = pi()*D^3/6*p_w*g*(S_s-1)		
1735.893304	lbs	

Soil Ballast		
SG soil	2.65	
Soil DD min	90	lbs/ft3
Soil DD max	115	lbs/ft3
Relative D (Dr)	0.9	
Unit wt of dry soil	111.8918919	
Void ratio	0.48	
porosity	0.32	
saturation below water	100%	

wt of pore water		18.03	
sat unit wt of soil backfil		129.92	
buoyant unit wt		67.52	
nominal footprint		3	
depth below water		1	
depth above water		0	
W' =	203	lbs	
W =	390	lbs	
Buoyancy FS		3.028413293	choose 3

Sliding				
XS area	A =	1.50		sq ft
obstructed area	A =	1.00		sq ft
Drag Coeff.	C_D =	1		
max stream V V			6.47	ft/sec
	Φ =	**38**	degrees for cobble	
Apparent Drag Coef	9			
Horiz Force Drag	11756.6782	lbs		
Streambed Resistance (tan Φ)	0.781285627			
Force of friction	-3072.022706	lbs		
FS sliding	-3.827015398			

Choose 18" diameter logs, based on rock sizing. To meet FS required from buoyancy and sliding forces, key in 3*1.5 = 4.5 feet min

Min Log Diameter (m)	Bankfull Width 0 to 5m	Bankfull Width 5 to 10m	Bankfull Width 10 to 15m	Bankfull Width 15 to 20m
	Minimum Length (m)			
0.5	6	13	31	---
0.55	5	11	26	---
0.6	4	9	22	32
0.65	3	8	19	28
0.7	3	7	19	24
0.75	3	6	14	21
Min Volume (m3)	1	2.5	6	9

Smaller streams (<10m wide): Single or multiple pieces of wood can be effectively used to create habitat, stabilize the channel, dissipate energy, and store sediment. Logs most often lie perpendicular or are angled downstream to flow, but any orientation is feasible. They may span the channel or intrude partway into the channel. Logs in small streams may be used to create step pools (i.e. plunge pools). Because small streams generally have less energy to move LW, a greater variety of LW locations and orientations can be employed without excess risk.

4. References

1) WDFW, 2012. Stream Habitat Restoration Guidelines: http://wdfw.wa.gov/publications/01374/wdfw01374.pdf
2) 1999. Wood handbook: wood as an engineering material. General Technical Report, FPL-GTR-113
3) Alden, H.A. 1995. *Hardwoods of North America* . General Technical Report FPL-GTR-83
4) Alden, H.A. 1997. *Softwoods of North America* . General Technical Report FPL-GTR-102

Scour Calculations

Project:	Burke Creek Crossing
Date:	12/2/2015
Calculated by:	MK

1. Inputs

Proposed Channel Conditions

Design Flow	121	cfs	100 year
q =	8.71	cu ft/sec ft	
V	6.47	ft/sec	
g	32.2	ft/sec^2	
s	0.118	ft/ft	

2. Eqns to Calculate particle size

Isbash (1936)		
rounded stones in running water		
Dmin = (V^2)/(2gC^2Gs^-1)		
C (Isbash Coeff) =	0.86	high turbulence
	1.2	low turbulence (in pools)
SG (spec gravity)	2.65	
D =	2.33	ft
D =	1.20	ft
ok to use low turbulence in scour pool		

3. Calc thickness

T = 2*D50 or 1.5*D100, whichever is greater

T =	2.39	ft
Scour Depth from next sheet =	2.788267	
thickness of rock =	2.59	ft

APPENDIX D: GEOTECHNICAL REPORT

Geotechnical Investigation

Burke Creek Highway 50 Crossing and Realignment Project

Stateline, Douglas County, Nevada

Mr. Michael Pook
NEVADA TAHOE CONSERVATION DISTRICT
400 Dorla Court Box 915
Zephyr Cove, NV 89448

Project No.: 8484.002

April 22, 2015

PROFESSIONAL ENGINEER - STATE OF NEVADA
MISCHELLE J. SMITH
EXP: 6-30-16
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4-22-15

Mischelle J. Smith, PE
PE Number – 6972

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EXECUTIVE SUMMARY

The project is located about 500 feet north of the intersection of US 50 and Kahle Drive in Stateline, Douglas County, Nevada, and consists of the realignment of Burke Creek. Improvements to be constructed include a new highway waterway crossing, realignment of the creek channel, and installation of stormwater treatment basins.

The soils in the stream realignment zone mainly consist of granular alluvium deposits generally classified as non-plastic, poorly-graded sand to silty sands. Similar subsurface soils were encountered near the proposed highway crossing, although this area appears to have been elevated with an embankment fill and is expected to include utility trenches. An appreciable increase in soil/rock stiffness was encountered at a depth near fifteen feet at each exploration location.

Perched or ponding groundwater was encountered at shallow depths in exploratory borings. It appears that the underlying weathered bedrock zone is acting as a very low permeability layer in localized areas. Wet alluvium was observed above the bedrock, and drive samples from within the weathered bedrock zone presented much lower moisture contents. At the highway crossing location, although encountered at 6+/- feet, groundwater did not daylight nor was observed in the embankment face towards the meadow. This presents the possibility that utility trenches parallel to the highway may be acting as a conduit for groundwater. During our exploration Burke Creek was active, which may have also contributed to our groundwater observations.

The TRPA Code of Ordinances' groundwater interception policies allow for the exception to groundwater interception if drainage structures are necessary to protect the structural integrity of an existing structure, or it is a necessary measure for the protection or improvement of water quality. Care shall be taken during construction to protect the environment against significant adverse effects from grading.

Sloughing soils and the need to dewater should be anticipated for the bulk of the project area. Removal of large root balls and existing vegetation may also present some grading issues. Additional slope stabilization above and beyond OSHA requirements may be warranted due to soil and groundwater conditions; especially since sandy soils have a tendency to slough or cave in the presence of groundwater.

1.0 INTRODUCTION

Presented herein are the results of Wood Rodgers' geotechnical exploration, laboratory testing, and associated geotechnical recommendations for the proposed Burke Creek Restoration and US 50 Crossing Project located in Stateline, Douglas County, Nevada. These recommendations are based on surface and subsurface conditions encountered in our explorations and on details of the proposed project as described in this report. The objectives of this study were to:

1. Determine general groundwater and soil conditions, including estimation of hydraulic conductivity, pertaining to design and construction of the proposed improvements.

2. Provide grading and excavation recommendations associated with channel restoration and culverts as related to these geotechnical conditions.

The area covered by this report is shown on Plate A-1 (Site Plan & Approximate Exploration Locations) in Appendix A. Our study included field exploration, laboratory testing, and engineering analyses to identify the physical and mechanical properties of the earth materials. Results of our field exploration and testing programs are included in this report and form the basis for all conclusions and recommendations.

2.0 PROJECT DESCRIPTION

This project consists of the realignment of Burke Creek stream channel both upstream and downstream of US 50. Phase I will include: culvert replacement across US 50, parking lot abandonment, and stream restoration upstream of the highway. Phase II includes stream channel realignment downstream of US 50 and installation of stormwater treatment basins. The limits of this geotechnical report are specific to the highway crossing and the upstream realignment of the stream channel.

The improvement areas are generally located within NDOT right-of-way, United States Forest Service (USFS) parcels, and Douglas County property. Proposed improvement depths typically extend to eight to ten feet below existing grade; however, deeper facilities, existing or proposed, may exist. All highway improvement construction shall meet the Standard Specifications for Road and Bridge Construction (2014 Silver Book, NDOT).

3.0 SITE CONDITIONS

The site is situated at the base of the northwestern flank of East Peak Mountain within the transition from granitic mountain slopes to depositional lands. Topography in the study corridor varies from moderately steep to slight, ranging from about 2 to 10 percent slopes extending downard toward lake terraces, meadow, and Lake Tahoe. Vegetation is variable within the proposed improvement area and ranges from native grasses, brush; pine and aspen trees surrounding the existing parking lot. Light wood debris and charred bark were encountered beneath the existing parking lot at a depth of four feet.

A significant portion of the stream channel improvements will be situated in the northern half of the existing parking lot. In this area, the pavement is badly deteriorated with many cracks and potholes. The pavement is bound by concrete curbing which is also badly deteriorated, broken, and lifted in areas. Surface drainage is generally directed to the south and east. During our investigation, we encountered a pavement section with an overall thickness of about six inches. From the surface downward, the pavement section is composed of:

- An 1 ½" overlay of asphaltic concrete (AC) with a paving fabric as a stress aborbing membrane interlayer;
- Two to three inches of aggregate base;
- Another 1 ½" layer of AC; directly overlying
- Native alluvium or fill.

The proposed US 50 culvert crossing is positioned directly to the west of the center of the northern portion of the parking lot. At this crossing, US 50 is a five-lane highway presenting an asphaltic concrete pavement surface. The east side of the highway surface is bound by concrete curb and gutter; the west side is confined by a granular shoulder fill and is elevated above the meadow to the west. The elevation difference on the west side of the highway is believed to be attributed to historic grading of the meadow area and limited embankment fills for the highway; based on our observations, the difference between meadow and highway surface is currently on the order of six to ten feet. The highway buffer zone to the parking lot is currently covered by various landscape sections including: landscape rock, concrete sidewalk, a few small trees, and grass; this area also includes the existing concrete pipe culvert which runs parallel to the highway for about 200 feet before the highway culvert is directed to the west.

Underground Service Alert (USA) was notified of our subsurface investigation, and provided locating services of underground utilities in the area. Public underground utiilities that were identified are mainly located parallel to and in the shoulder area on the west side of the highway, and include but are not limited to communications and dry utilities. Private utilities should be expected in the parking lot, and at least include power lines to light poles. No underground utilities were encountered in either of our subsurface explorations.

4.0 FIELD EXPLORATION

The project was explored on March 26, 2015 by advancing two exploratory borings using a CME-75 drill rig. The approximate locations of the test locations are shown on Plate A-1 – Site Plan and Approximate Exploration Locations. To be consistent with the limits of the planned improvement depths, the maximum depth of bore hole advance was 20 feet below the existing ground surface. Soil samples for index testing were collected from the bore holes at specific depths in the soil horizon.

Wood Rodgers' personnel examined and classified all soils in the field in general accordance with ASTM D 2488 (Description and Identification of Soils). During exploration, representative samples were placed in sealed plastic bags and returned to our Reno, Nevada laboratory for testing. Additional soil identification including Munsell soil color, as well as verification of the field classifications, were subsequently performed in accordance with ASTM 2487 (Unified Soil Classification System [USCS]) upon completion of laboratory testing. Descriptive logs of the exploratory borings are presented as Plate A-2a and A-2b in Appendix A. A USCS chart has been included as Plate A-3 - Unified Soil Classification and Key to Soil Descriptions.

The exploration was supplemented with a Refraction Microtremor (ReMi®) geophysical survey in the existing parking lot along the proposed stream realignment. ReMi measured the shear-wave and compression-wave velocities of the subsurface profile to the targeted depth of 35 feet below existing grade. The resulting two-dimensional profiles are presented as Plate A-5, and may be used to identify: depths to more competent units, indications as to excavation characteristics, and development of in-situ soil properties. The compression (P-wave) profile, shown in Figure 1 below, shows the location of boring B-2 relative to the geophysical survey. In general, the profile shows a ten to twenty foot thick layer of saturated soils (4,400 to 5,000 ft/s) overlying a competent zone of weathered rock exhibiting an average subsurface gradient about nine percent downward to the west. A deeper zone of weaker material was detected from about 35 feet to 60 feet along the survey alignment.

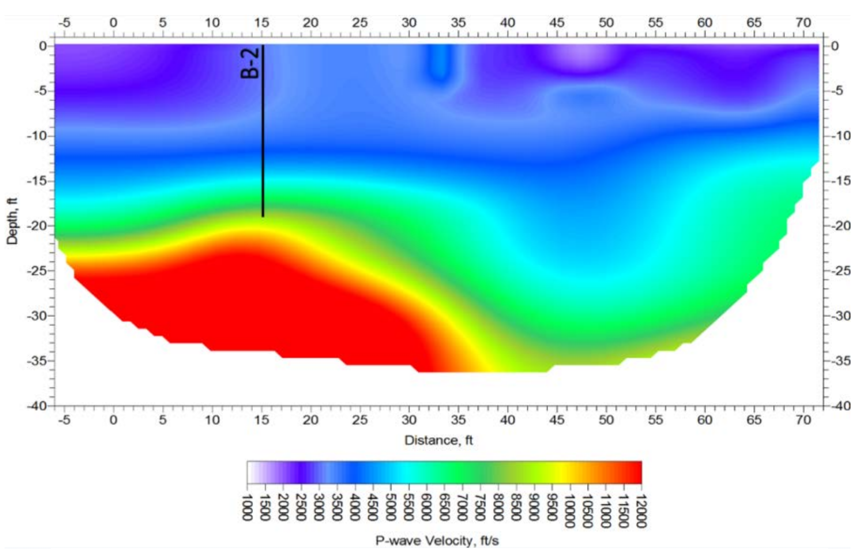

Figure 1 – Two-Dimensional Compression P-wave Profile

5.0 LABORATORY TESTING

All soil testing performed in the Wood Rodgers' laboratory is conducted in accordance with the standards and methods described in Volume 4.08 (Soil and Rock; Dimension Stone; Geosynthetics) of the ASTM Standards. Samples of significant soil types were analyzed to determine their in-situ moisture contents (ASTM D 2216), grain size distributions (ASTM D 6913), and plasticity indices (ASTM D 4318). Results of these tests are shown on Plate A-4a and A-4b – Summaries of Test Data. The test results were used to classify the soils according the USCS (ASTM D 2487) and to verify the field logs, which were then updated.

Table 1: Summary of Laboratory Test Results

	D 2487	D 6913				D 4318		
Sample ID	Soil Type	D_{10} (mm)	D_{60} (mm)	D_{100} (mm)	- #200 (%)	Liquid Limit	Plastic Limit	Plastic Index
B-1 5.0	SM	*0.01	0.29	4.75	28.6	36	31	5
B-1 10.0	SP-SM	0.105	1.65	19	7.1	NP	NP	NP
B-1 15.0	SP-SM	0.119	1.39	9.5	6.0	NP	NP	NP
B-2 2.5	SM	*0.01	0.26	19	30.3	NP	NP	NP
B-2 15.0	SP-SM	0.119	1.39	9.5	6.0	NP	NP	NP

*Extrapolated value developed for K_{sat} correlation.

6.0 GEOLOGIC AND GENERAL SOIL AND GROUNDWATER CONDITIONS

Based on the Geologic Map of the Lake Tahoe Basin published by the California Geological Survey (Figure 2), the site is mapped in area of geologic transition from Granodiorite of East Peak (Keg) to Lacustrine terrace deposits (Qlt) and Alluvium (Q). The soil units encountered in our explorations typically consisted of silty sand with varying amounts of gravel, sand, and silt. Consistent with our borings and geophysical measurements, soil/rock stiffness and competency increases at depths approaching 15 feet.

The bedrock that lies underneath the meadows and forests of Burke Creek is a slightly to moderately weathered granodiorite, which is among the oldest rock in the Tahoe area. The granodiorite formed in a large batholith intrusion during the Cretaceous period; slow even cooling in the batholith allowed medium to coarse grained phaneritic crystals to form. These crystals include (in order of highest to lowest percentage) plagioclase, quartz, microcline, biotite, pyrite, and mafics.

Overlying the bedrock is the Burke Creek fluvial system, occurring as a saturated wet meadow. The wet meadow consists predominantly of granular alluvial deposits which have undergone redoximorphic color reduction. This is likely a result of the creek having a low gradient and the flows mainly transporting fine sands. The shallow gradient of the wet meadow also causes the surrounding area to become saturated which contributes to an anaerobic environment allowing for reduction of the iron in the soil. With the granodiorite being the primary source rock for the soils in the wet meadow, the potential for reduction of the soil is likely enhanced due to the considerable pyrite content. Pyrite is an iron sulfide; when sulfates are released from decomposing pyrite and combined with water, sulfuric acid is formed. This is known as acid rock drainage and may act as a reducing fluid within the wet meadow soils. The potential for this condition is bolstered by a measured pH of 5.0 for soils in the upper four feet of the profile.

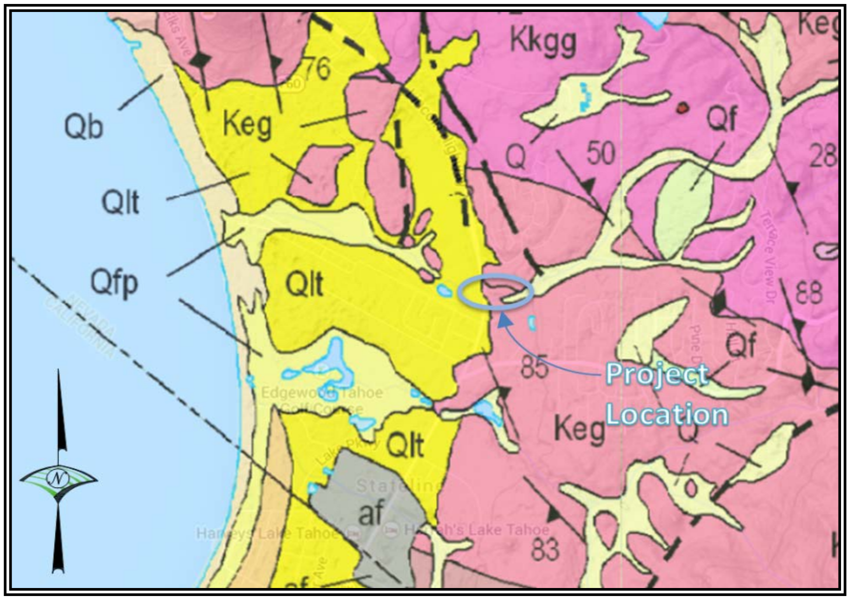

Figure 2 – Geologic Map of Burke Creek Area

Perched or ponding groundwater was encountered at depths of six and three feet below ground surface in exploratory borings B-1 and B-2, respectively. It appears that the underlying weathered bedrock zone is acting as a practically impervious layer in localized areas, as wet alluvium was observed above the bedrock, and drive samples from within the weathered bedrock zone presented much lower moisture contents. At the highway crossing location, no daylight of groundwater was observed towards the embankment and meadow. This indicates the possibility that utility trenches parallel to the highway may be acting as a conduit for groundwater. During our exploration Burke Creek was active, which may have also contributed to our groundwater observations.

7.0 DISCUSSION AND RECOMMENDATIONS

The recommendations provided herein along with proper design and construction of the planned improvements, work together as a system to improve overall performance. If any aspect of this system is ignored or poorly implemented, the performance of the project will suffer. Any evaluation of the site for the presence of surface or subsurface hazardous substances is beyond the scope of this study. When suspected hazardous substances are encountered during routine geotechnical investigations, they are noted in the exploration logs and reported to the client. No such substances were identified during our exploration.

7.1 Excavations and Trenching

Based on the results of our exploration, it is our opinion that the site soils appear to be predominantly OSHA Soil Type C, although variations exist. Areas with very loose, poorly-graded, wet sand and silty sand were encountered, and due to their cohesionless and saturated condition, are expected to possess a low unconfined compressive strength. Therefore, additional slope stabilization above and beyond OSHA requirements may be warranted. Bank stability is the responsibility of the contractor, who is present at the site, able to observe changes in ground conditions and has control over personnel and equipment.

7.2 Highway Creek Crossing

The waterway opening for the highway creek crossing is currently in the preliminary design phase with two options being discussed; an open-bottom archway or a pipe culvert. With either option, invert elevations are expected to be on the order of eight to ten feet below the roadway surface. Based on the subsurface soil profile encountered in exploratory boring B-1, the foundation materials at this elevation excavated as dense sandy soils which should allow for the use of shallow foundations or trenching, as needed.

7.2.1 Foundations

An allowable bearing capacity of the foundation soils at a depth of ten feet may be estimated at 4,000 pounds per square foot, provided NDOT Silver Book Structure Excavation and Backfill specifications are adhered to. This preliminary estimate is based on a continuous footing, a minimum of two feet wide, bearing on cohesionless soils. Hydraulic design considerations, including scour potential, should account for the protection of foundation elements by means of erosion protection, flow control, and regular maintenance of the channel and culvert inlet.

7.2.2 Lateral Earth Pressure

Lateral loads, such as wind or seismic, may be resisted by passive soil pressure and friction on the bottom of the footing. The recommended coefficient of base friction is 0.4 and has been reduced by a factor of 1.5 on the ultimate soil strength. Lateral earth pressures imposed on retaining walls are dependent on the relative rigidity and movement of the structure, soil type, and moisture conditions behind the wall. Recommended lateral earth pressures are presented in Table 1 – Lateral Earth Pressures.

Table 2 – Lateral Earth Pressures

Wall Type	Lateral Earth Pressure (psf/f)
Restrained Wall resisting At-Rest Pressure	55
Rotation of wall face to allow full development of Static Active Pressure	38
Static Passive Pressure	375
Combined Static & Dynamic – Driving Wedge	90
Combined Static & Dynamic – Resisting Wedge	250

Wall backfill shall be granular material meeting the specification of NDOT Silver Book (704.03.11). Excessive pressures can be developed due to heavy compaction equipment during backfill placement. Therefore, all backfill behind any retaining structures should be screened to 3" minus and shall be compacted to not less than 90 percent relative compaction. Due care must be exercised during compaction to avoid build-up of excessive pressures. The values presented in Table 2 do not take into account hydrostatic pressures. French drains, a drainage backfill geotextile such as Mirafi 140 N, or a pre-manufactured drain system such as Tensor® DC1200 may be used if hydrostatic pressure buildup is possible.

7.2.3 Soil Corrosivity

Chemical soil screening was performed on a composite soil sample obtained from exploratory boring B-1. The results are presented on Plate A-6. Based on American Concrete Institute exposure categories, the sulfate exposure may be considered negligible; however, the pH value indicates an acidity level near the NDOT specification for concrete culverts and below the specification range for steel culverts. This may require an import backfill be used in the zone surrounding the proposed culvert. The NDOT Specification for granular backfill is presented in Table 3:

Table 3 – NDOT Specification 704.03.11 for Granular Backfill

Sieve Size	Percent Passing by Mass		
75 mm (3 in.)	100		
4.75 mm (No. 4)	35 - 100		
600 µm (No. 30)	20 - 100		
75 µm (No. 200)	0 - 12		
Project Control Tests	**Test Method**	**Requirements**	
Sieve Analysis	Nev. T206	Above	
Sampling Aggregate	Nev. T200	-	
Liquid Limit	Nev. T210	35 Max.	
Plasticity Index	Nev. T212	10 Max	
Source Requirement Tests	**Test Method**	**Culverts and Structures (Concrete) Culverts (Aluminum & Plastic) Requirements**	**Culverts (Steel) Requirements**
pH Value	AASHTO T289	5.0 to 9.5	6.0 to 9.0
Resistivity	AASHTO T288	1000 ohm*cm Min.	2000 ohm*cm Min.

7.3 Hydraulic Conductivity Predictions

A variety of empirical methods have been developed to predict saturated hydraulic conductivity of soils based on grain-size analysis, laboratory tests, and field tests. One of the most simple and commonly used approaches is the Hazen equation which utilizes the results from grain-size analysis to estimate saturated hydraulic conductivity[1]. The grain-size method will give an order-of-magnitude estimate for soils that are relatively coarse-grained, i.e. sands and some silty sands; however, judgement must be used to account for in-situ conditions such as: soil texture, soil consistency, depth to groundwater and/or bedrock, or other geologic conditions. The non-plastic silty sands beneath the parking lot are very loose to loose; therefore, the soil matrix presents good drainage conditions. Using the Hazen equation, the coefficient of permeability for these sands may be estimated to be on the order of 10^{-2} centimeters per second (cm/s). Based on NRCS Web Soil Survey research, the minor site soils and individual layers may present saturated hydraulic conductivity values as quick as 10^{-1} cm/s; however overall, the soils in the upper five feet are expected to present a rating of 10^{-2} to 10^{-3} cm/s.

The bedrock underlying the site appears to present a low permeability below the extent of weathering. Although the bedrock may prove to be excavatable, the in-situ coefficient of permeability[2] may be estimated to be on the order of 10^{-6} to 10^{-7} cm/s. These values are intended to provide a general k_{sat} estimate based on the conditions observed; subsurface variations and percolation losses caused by sediment deposition over time will influence these values. If a more refined approach is necessary for hydraulic modelling, field data should be collected for representative in-situ percolation or steady-state infiltration rates per the applicable

[1] Hazen Equation: k_{sat} (cm/s) = $(D_{10})^2$; where D_{10} is in mm.
[2] Bureau of Reclamation, Earth Manual.

standard test methods. The Guelph permeameter is an instrument typically used to measure in-situ hydraulic conductivity and is supported by the standard ASTM D5126.

8.0 STANDARD LIMITATION CLAUSE

This report has been prepared in accordance with generally accepted local geotechnical practices. Test results, analyses, and recommendations submitted are based upon field exploration performed and the conditions encountered as discussed in our report. This report does not reflect soil variations that may become evident during the construction period, at which time re-evaluation of the recommendations or additional testing may be necessary. We recommend our firm be retained to perform construction observation in all phases of the project related to geotechnical factors to document compliance with construction standards and our recommendations.

This report was prepared by Wood Rodgers, Inc. for the benefit of Nevada Tahoe Conservation District. The material in it reflects Wood Rodgers' best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Wood Rodgers' accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

9.0 REFERENCES

American Society for Testing and Materials (ASTM), 1993, *Soil and Rock; Dimension Stone; Geosynthetics,* Volume 4.08.

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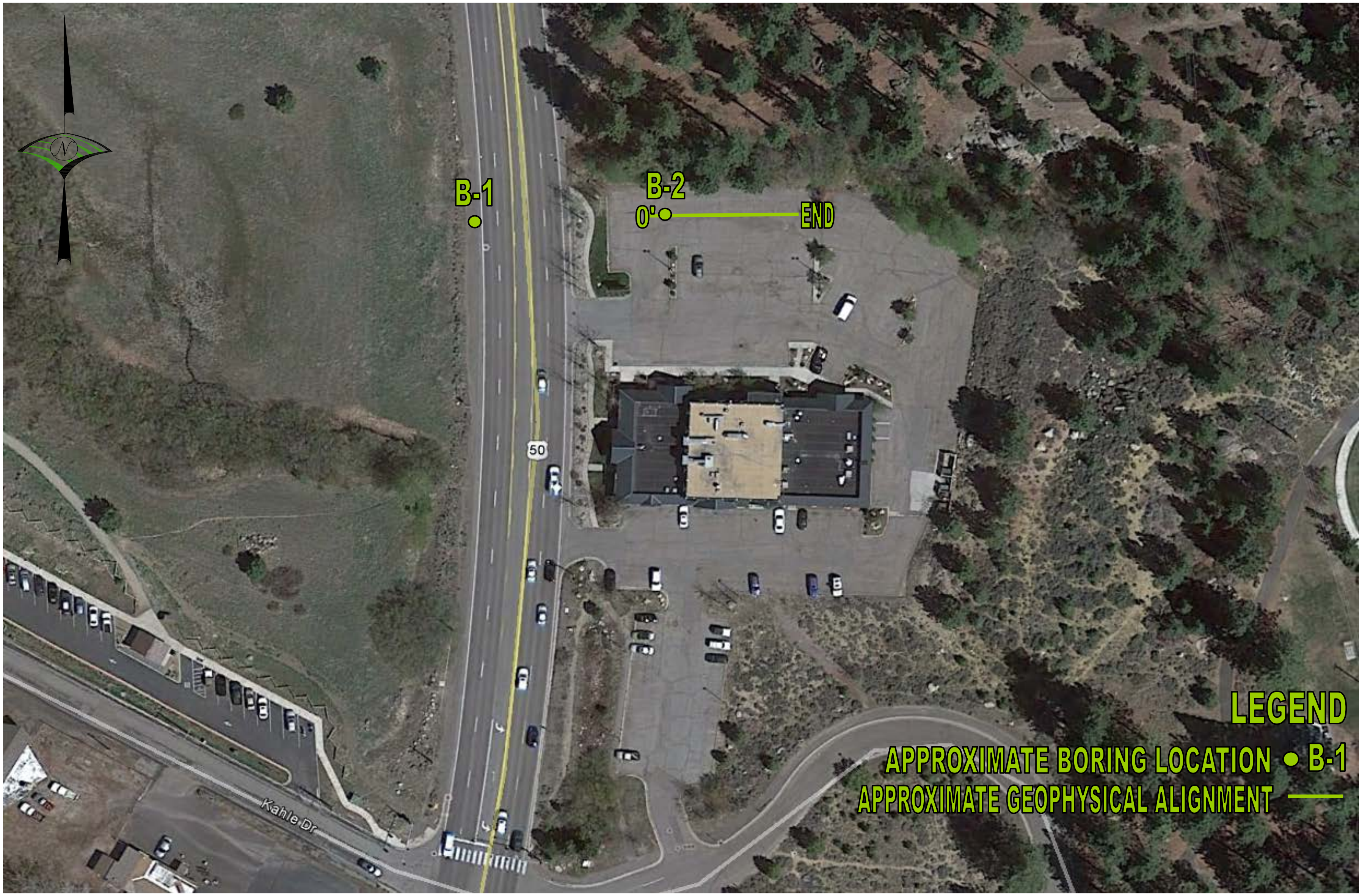

Reference: Google Earth Imagery, date 4/2014.

WOOD RODGERS

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SITE PLAN AND APPROXIMATE EXPLORATION LOCATIONS

Geotechnical Investigation
BURKE CREEK HIGHWAY 50 CROSSING and REALIGNMENT
STATELINE, NEVADA

Project No.: 8484.001

Date: 04/09/15

PLATE A-1

Wood Rodgers, Inc.
5440 Reno Corporate Drive
Reno, NV 89511
Telephone: 775-823-4068
Fax: 775-823-4066

BORING NUMBER B-1

CLIENT Nevada Tahoe Conservation District
PROJECT NAME Burke Creek Highway 50 Crossing and Realignment Project
PROJECT NUMBER 8484.002
PROJECT LOCATION Stateline, Nevada
DATE STARTED 3/26/15 **COMPLETED** 3/26/15
GROUND ELEVATION Shoulder **HOLE SIZE** 4 inches
DRILLING CONTRACTOR PC Exploration
GROUND WATER LEVELS:
DRILLING METHOD CME 75
▽ **AT TIME OF DRILLING** 6.0 ft
LOGGED BY Blake Carter **CHECKED BY** Blake Carter
▼ **AT END OF DRILLING** 6.0 ft
NOTES: Backfilled with cuttings
▼ **AFTER DRILLING** 6.0 ft

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	R-VALUE	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		FILL - GRAVEL SHOULDER - POORLY GRADED SAND WITH GRAVEL, (SP) medium dense to dense, dry, grayish brown										
		SILTY SAND, (SM) very loose to loose, moist to wet, grayish black, (Gley 1 / 2.5 / N)	SPT 1A		7-4-4 (8)							
5		▼ Reddish gray (2.5Y 5/1)	SPT 1B		3-3-3 (6)		105	30.6	36	31	5	28.6
			SPT 1C		2-2-2 (4)							
10		POORLY GRADED SAND WITH SILT, (SP-SM) dense, wet to moist, light brown (7.5YR 5/6)	SPT 1D		21-15-21 (36)		105	12.0	NP	NP	NP	7.1
15		BEDROCK, GRANODIORITE, slightly to moderately weathered, weak to moderately strong increasing with depth, intensely fractured; excavates as a Poorly Graded Sand with Silt (SP-SM), very dense, moist, gray (Gley / 6 / N)	SPT 1E		13-25-50 (75)		130	12.0	NP	NP	NP	6.0
20												

Bottom of Borehole at 20.0 Feet.

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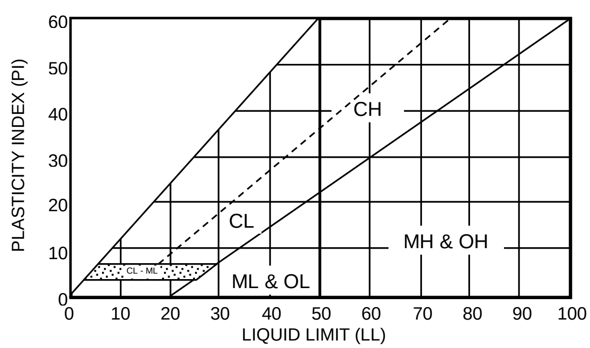
BORING NUMBER B-2

CLIENT Nevada Tahoe Conservation District
PROJECT NAME Burke Creek Highway 50 Crossing and Realignment Project
PROJECT NUMBER 8484.002
PROJECT LOCATION Stateline, Nevada
DATE STARTED 3/26/15 **COMPLETED** 3/26/15
GROUND ELEVATION Lot **HOLE SIZE** 4 inches
DRILLING CONTRACTOR PC Exploration
GROUND WATER LEVELS:
DRILLING METHOD CME 75
AT TIME OF DRILLING 3.0 ft
LOGGED BY Blake Carter **CHECKED BY** Blake Carter
AT END OF DRILLING 3.0 ft
NOTES: Backfilled with cuttings, sealed w/grout
AFTER DRILLING 3.0 ft

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	R-VALUE	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0		ASPHALT CONCRETE										
		SILTY SAND WITH GRAVEL, (SM) medium dense, wet, dark gray, (Gley 1 / 4 / 1)										
			SPT 2A		7-11-18 (29)		105	16.6	NP	NP	NP	30.3
5		SILTY SAND, (SM) very loose to loose, moist to wet, very dark gray, (Gley 1 / 3/ N)										
			SPT 2B		6-8-12 (20)							
			SPT 2C		2-2-2 (4)							
10			SPT 2D		3-10-19 (29)							
			SPT 2E		17-20-24 (44)		105		NP	NP	NP	
15		BEDROCK, GRANODIORITE, slightly to moderately weathered, weak to moderately strong increasing with depth, intensely fractured; excavates as a Poorly Graded Sand with Silt (SP-SM), very dense, moist, gray (Gley / 6 / N)	SPT 2F		21-30-50 (80)		130	12.0	NP	NP	NP	6.0
20												

Bottom of Borehole at 20.0 Feet.

MAJOR DIVISION					TYPICAL NAMES
COARSED-GRAINED SOILS MORE THAN HALF IS COARSER THAN NO. 200 SIEVE	**GRAVEL** MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN SANDS WITH LITTLE OR NO FINES		GW	WELL GRADED GRAVELS WITH OR WITHOUT SAND, LITTLE OR NO FINES
				GP	POORLY GRADED GRAVELS WITH OR WITHOUT SAND, LITTLE OR NO FINES
		GRAVELS WITH OVER 12% FINES		GM	SILTY GRAVELS, SILTY GRAVELS WITH SAND
				GC	CLAYEY GRAVELS, CLAYEY GRAVELS WITH SAND
	SAND MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS WITH LITTLE OR NO FINES		SW	WELL GRADED SANDS WITH OR WITHOUT GRAVEL, LITTLE OR NO FINES
				SP	POORLY GRADED SAND WITH OR WITHOUT GRAVEL, LITTLE OR NO FINES
		SANDS WITH OVER 12% FINES		SM	SILTY SANDS WITH OR WITHOUT GRAVEL
				SC	CLAYEY SANDS WITH OR WITHOUT GRAVEL
FINE-GRAINED SOILS MORE THAN HALF IS FINER THAN NO. 200 SIEVE	**SILT AND CLAY** LIQUID LIMIT 50% OR LESS			ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTS WITH SANDS AND GRAVELS
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY CLAYS WITH SANDS AND GRAVELS, LEAN CLAYS
				OL	ORGANIC SILTS OR CLAYS OF LOW PLASTICITY
	SILT AND CLAY LIQUID LIMIT GREATER THAN 50%			MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOLID, ELASTIC SILTS
				CH	INORGANIC CLAYS OR HIGH PLASTICITY, FAT CLAYS
				OH	ORGANIC SILTS OR CLAYS MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS



CONSISTENCY		RELATIVE DENSITY	
SILTS & CLAYS	SPT BLOW* COUNTS (N)	SANDS & GRAVELS	SPT BLOW* COUNTS (N)
VERY SOFT	0 - 2	VERY LOOSE	0 - 4
SOFT	3 - 4	LOOSE	5 - 10
MEDIUM STIFF	5 - 8	MEDIUM DENSE	11 - 30
STIFF	9 - 15	DENSE	31 - 50
VERY STIFF	16 - 30	VERY DENSE	50 +
HARD	30 +		

* The Standard Penetration Resistance (N) In blows per foot is obtained by the ASTM D1585 procedure using 2" O.D., 1 3/8" I.D. samplers.

DESCRIPTION OF ESTIMATED PERCENTAGES OF GRAVEL, SAND, AND FINES	
TRACE	Particles are present but est. < 5%
FEW	5% - 10%
LITTLE	15% - 20%
SOME	30% - 45%
MOSTLY	50% - 100%

NOTE: Percentages are presented within soil description for soil horizon with laboratory tested soil samples.

DEFINITIONS OF SOIL FRACTIONS	
SOIL COMPONENT	PARTICLE SIZE RANGE
COBBLES	ABOVE 3 INCHES
GRAVEL	3 IN. TO NO. 4 SIEVE
COARSE GRAVEL	3 IN. TO 3/4 IN.
FINE GRAVEL	3/4 IN. TO NO. 4 SIEVE
SAND	NO. 4 TO NO. 200
COARSE SAND	NO. 4 TO NO. 10
MEDIUM SAND	NO. 10 TO NO. 40
FINE SAND	NO. 40 TO NO. 200
FINES (SILT OR CLAY)	MINUS NO. 200 SIEVE

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UNIFIED SOIL CLASSIFICATION AND KEY TO SOIL DESCRIPTIONS

Geotechnical Investigation

BURKE CREEK HIGHWAY 50 CROSSING and REALIGNMENT STATELINE, NEVADA

Project No.: 8484.001
Date: 04/09/15

PLATE A-3

Wood Rodgers, Inc.
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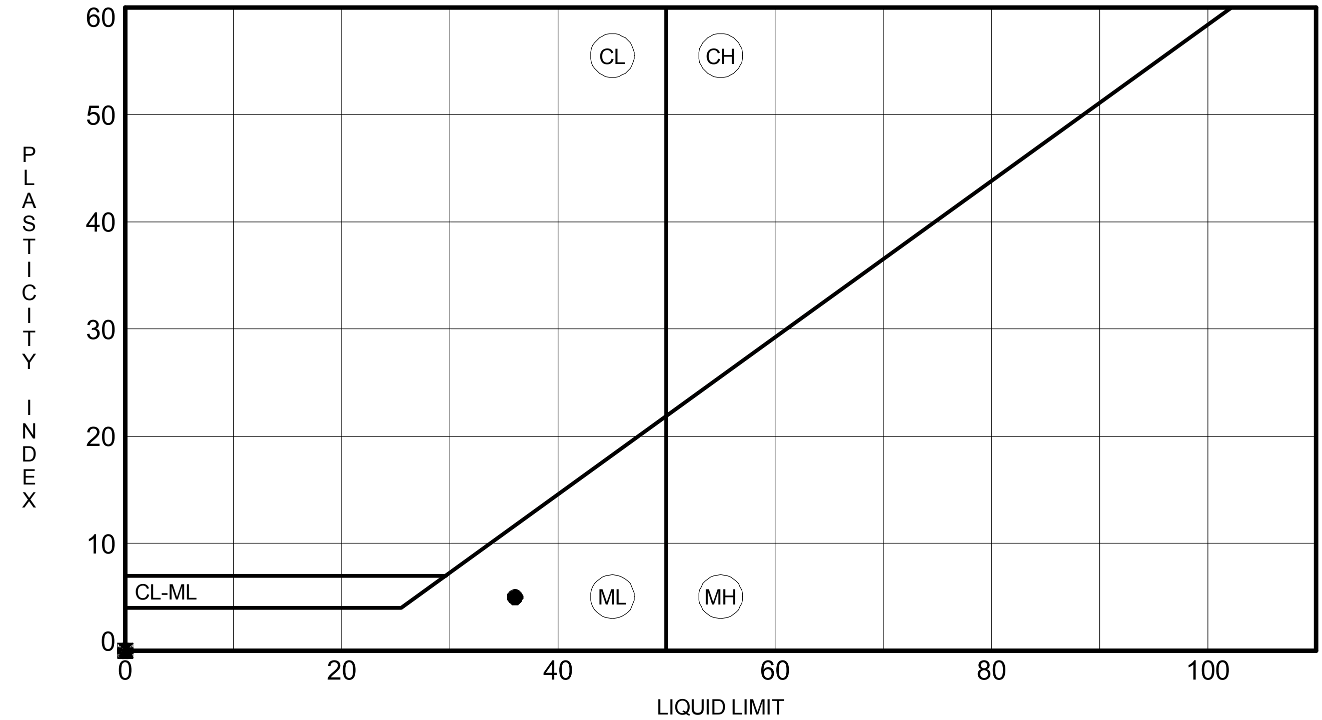
ATTERBERG LIMITS' RESULTS

CLIENT Nevada Tahoe Conservation District
PROJECT NAME Burke Creek Highway 50 Crossing and Realignment Project
PROJECT NUMBER 8484.002
PROJECT LOCATION Stateline, Nevada



	TEST PIT	DEPTH	LL	PL	PI	Fines	Classification
●	**B-1**	**5.0**	**36**	**31**	**5**	**29**	**SILTY SAND(SM)**
⧗	**B-1**	**10.0**	**NP**	**NP**	**NP**	**7**	**POORLY GRADED SAND with SILT(SP-SM)**
▲	**B-1**	**15.0**	**NP**	**NP**	**NP**	**6**	**POORLY GRADED SAND with SILT(SP-SM)**
★	**B-2**	**2.5**	**NP**	**NP**	**NP**	**30**	**SILTY SAND(SM)**
⊙	**B-2**	**12.5**	**NP**	**NP**	**NP**		**SILTY SAND(SM)**
✪	**B-2**	**15.0**	**NP**	**NP**	**NP**	**6**	**POORLY GRADED SAND with SILT(SP-SM)**

ATTERBERG LIMITS - GINT STD US LAB.GDT - 4/14/15 12:48 - C:\USERS\PUBLIC\DOCUMENTS\BENTLEY\GINT\PROJECTS\NEVADA TAHOE CONSERVATION DISTRICT.GPJ

Wood Rodgers, Inc.
5440 Reno Corporate Drive
Reno, NV 89511
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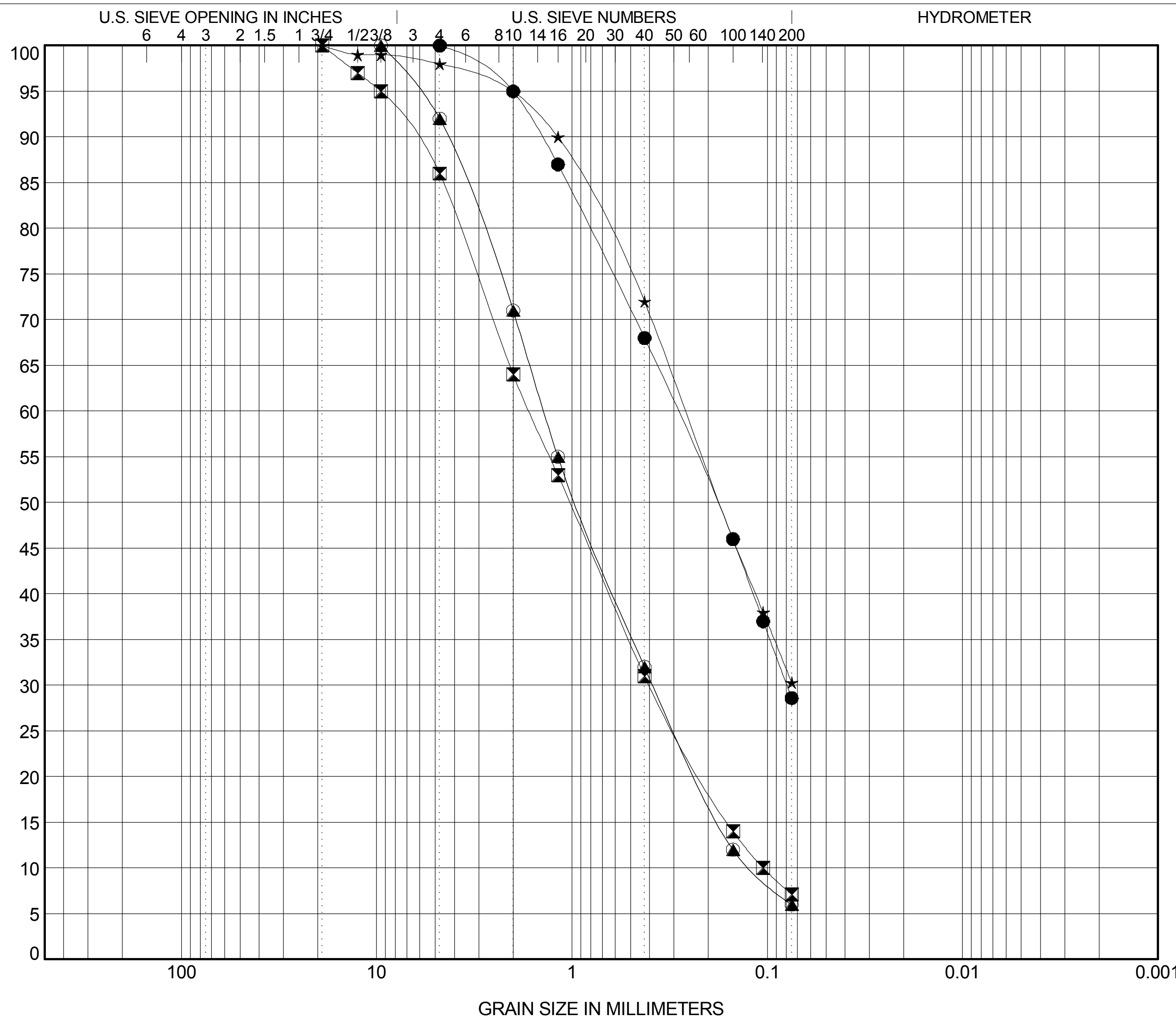
Fax: 775-823-4066

GRAIN SIZE DISTRIBUTION

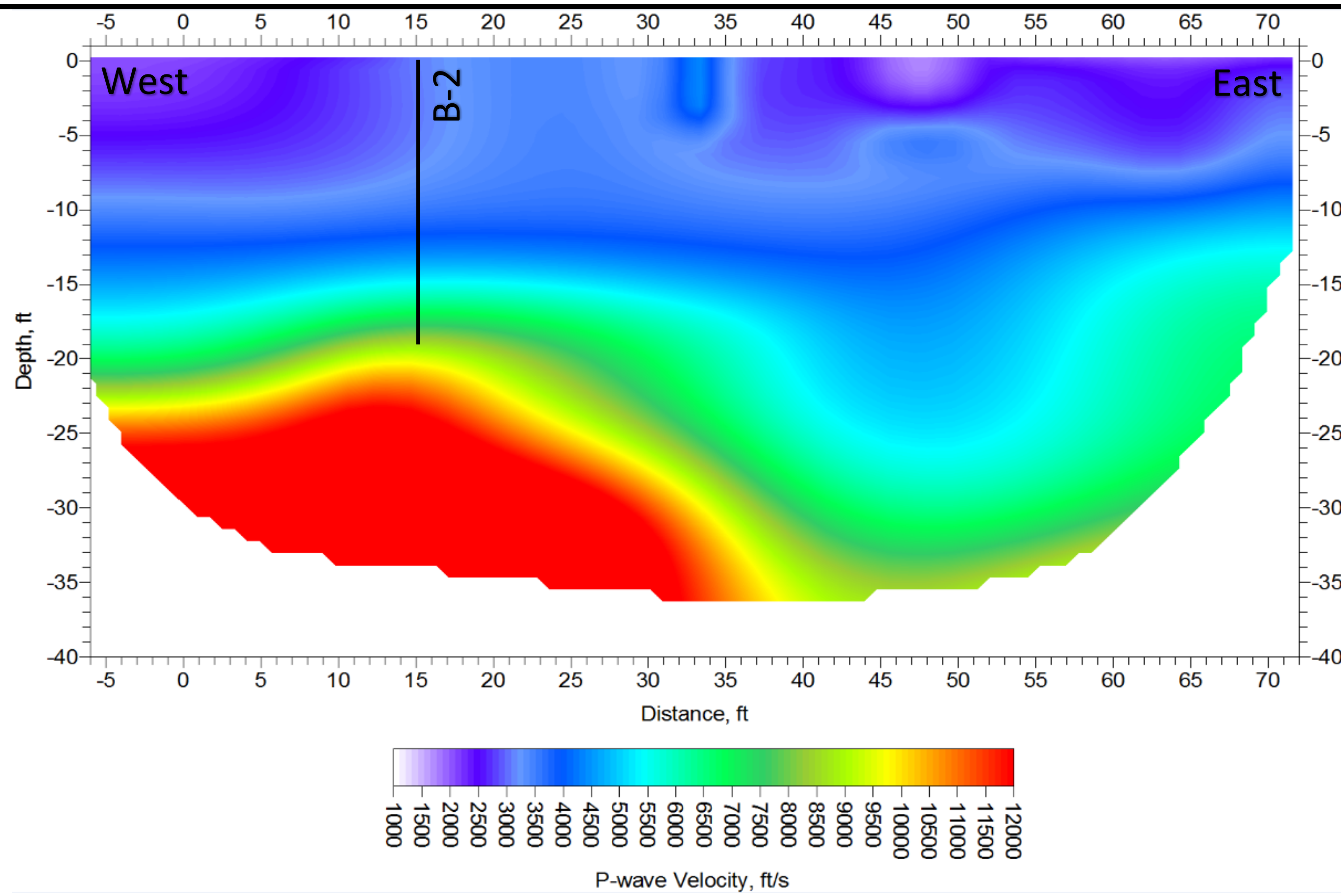
CLIENT Nevada Tahoe Conservation District
PROJECT NAME Burke Creek Highway 50 Crossing and Realignment Project
PROJECT NUMBER 8484.002
PROJECT LOCATION Stateline, Nevada

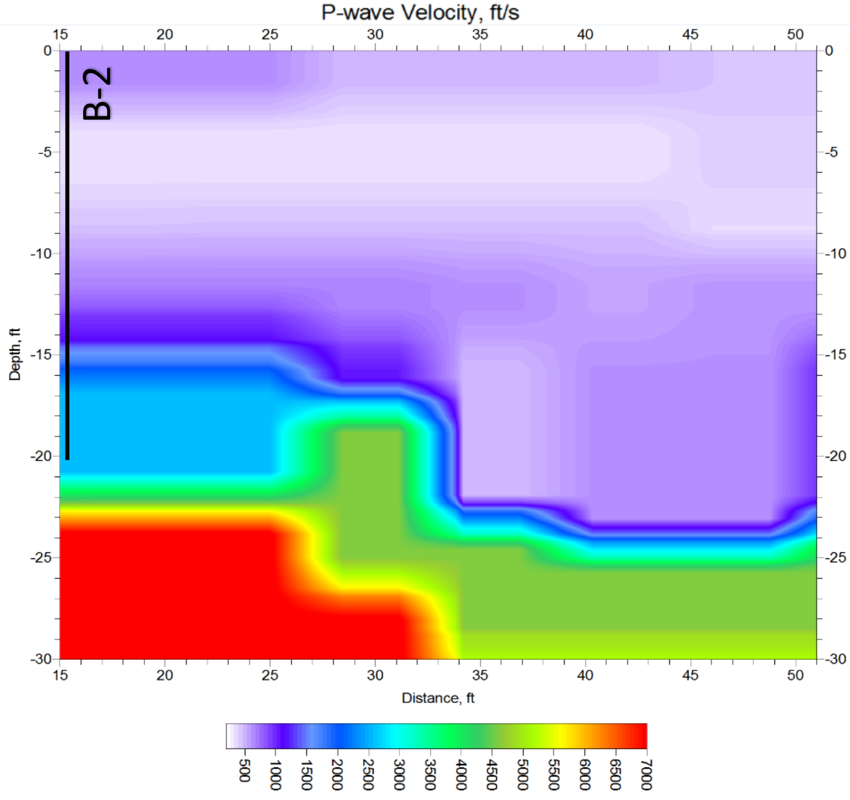


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	B-1	5.0	**SILTY SAND(SM)**	36	31	5		
⧗	B-1	10.0	**POORLY GRADED SAND with SILT(SP-SM)**	NP	NP	NP	0.92	15.72
▲	B-1	15.0	**POORLY GRADED SAND with SILT(SP-SM)**	NP	NP	NP	0.89	11.69
★	B-2	2.5	**SILTY SAND(SM)**	NP	NP	NP		
⊙	B-2	15.0	**POORLY GRADED SAND with SILT(SP-SM)**	NP	NP	NP	0.89	11.69

	BORING	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt / %Clay
●	B-1	5.0	4.75	0.291	0.079		0.0	71.4	28.6
⧗	B-1	10.0	19	1.651	0.4	0.105	14.0	78.9	7.1
▲	B-1	15.0	9.5	1.392	0.383	0.119	8.0	86.0	6.0
★	B-2	2.5	19	0.263			2.0	67.7	30.3
⊙	B-2	15.0	9.5	1.392	0.383	0.119	8.0	86.0	6.0





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2-D GEOPHYSICAL PROFILES

Geotechnical Investigation
BURKE CREEK HIGHWAY 50 CROSSING and REALIGNMENT
STATELINE, NEVADA

Project No.: 8484.001
Date: 04/09/15

PLATE A-5

SilverState Analytical Laboratories

LABORATORY REPORT

DATE: April 07, 2015

LABORATORY NO: R15-0151

CLIENT: Wood Rodgers
5440 Reno Corporate Drive
Reno, NV 89511

PAGE: 1 of 1

CLIENT PROJECT: Burke Creek

CLIENT PO #: 8484.001

Sampled By: B. Carter
Date Sampled: ---
Time Sampled: ---

Submitted by: ---
Date Received: 04/03/15
Time Received: 1240

Report Attention: B. Carter

Sample ID	Parameter	Result	Unit	MRL	Method	Date Analyzed	Analyst
B-1 3'-4'	Sodium	0.01	%	0.01	ASTM D2791A	04/06/15	LB
	Sulfate	<0.01	%	0.01	SM4500E	04/06/15	LB
	Sodium Sulfate	<0.01	%	0.01	Calculation	04/06/15	LB
	pH	4.99	S.U.	---	EPA9045D	04/06/15	LB
	Chloride	88.02	mg/kg	10	SM4500ClD	04/06/15	LB

ND: Non Detect
MRL: Method Reporting Limit
EPA Flags: None

Note: The results for each constituent denote the percentage (%) for that particular element which is soluble in a 1:5 (soil to water) extraction ratio and corrected for dilution

REVIEWED BY: [signature] signing for
John Sloan
Laboratory Director
EPA: NV00931 (SSAL-Reno)
EPA: NV00930 (SSAL-LV)

3638 East Sunset Road, Suite 100 • Las Vegas, NV 89120 • Tel: 702-873-4478 Fax: 702-873-7967
4587 Longley Lane, No. 2 • Reno, NV 89502 • Tel: 775-825-1127 Fax: 775-825-1167
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Memo

WOOD RODGERS
DEVELOPING INNOVATIVE DESIGN SOLUTIONS

Job No.: 8484.002

☐ **URGENT!**
☐ Meeting/Phone Summary
☒ For Your Information
☒ Geotechnical Addendum

To: Monica Grammenos, P.E.
Meghan Kelly, P.E.

From: Blake Carter, P.E.
Date: 12/1/2015

Re: **Burke Creek Highway 50 Crossing and Realignment Project**
Ref: **50% Design Plans, 6/24/15**

This memo is in response to our phone conversation on November 19, 2015 regarding geotechnical considerations for an earthen berm detail and a split flow detail planned for the upstream diversion. These recommendations may be considered an addendum to our geotechnical investigation report dated April 22, 2015, and are specific to the explored soil conditions.

7.4 Earthen Berm

The proposed grading for the upstream creek realignment will create a floodplain within the existing parking lot and be bordered by an earthen berm along the southern limits. Based on the proposed cross sections, the cuts and fills are limited to about 5 feet and include earthwork quantities of 658 cubic yards (cy) of cut, 315 cy of fill, for a net 343 cy of cut. Based on exploratory boring B-2 within the parking lot, the soil profile consists of about 4 to 6 inches of asphalt directly overlying a medium dense layer of silty sand with limited amounts of gravel and a fines content near 30 percent. The silty sand layer extended to a depth of fifteen feet beneath the asphalt before encountering bedrock.

7.4.1 Site Preparation

All debris, pavement, and concrete should be removed from the site; recycled materials are not recommended for use within the earthen berm fills. Because the site has previously been developed, care must be exercised during grading to locate and identify any existing buried improvements that require removal and replacement. Aggregate base or bedding sand encountered during the removal of improvements may be sufficiently blended with the native silty sands and stockpiled for re-use provided it meets the requirements for fill. The contractor shall have fill materials, including those generated on site, sampled, tested, and approved by the engineer prior to placement and compaction.

7.4.2 Grading and Filling

Once the asphalt, debris, and vegetation are removed from areas to receive fill, the existing subgrade should be scarified for a depth of 12-inches, moisture conditioned to within 3 percent of optimum and compacted to at least 90 percent relative compaction (ASTM D1557). Any soft or wet zones may require stabilization such as over-excavation or dewatering prior to final grading. Do not place fill materials on surfaces that are muddy, frozen, or contain frost or ice.

The soils removed from beneath the parking area are generally suitable as berm fill materials. If due care is not exercised and the resulting stockpile is compromised with coarse particles such as cobbles or asphalt, the oversized (ie. Greater than 4-inch diameter) should be removed, or import fill will be required and should meet the requirements specified in Table 1.

Table 1 - Guideline Specification for Imported Fill

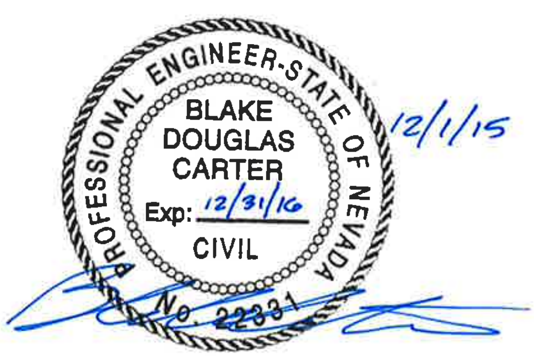
Sieve Size	Percent by Weight Passing
4 Inch	100
¾ Inch	70 - 100
No. 40	15 - 80
No. 200	5 - 40
Maximum Liquid Limit	40
Maximum Plasticity Index	10

Fill should be placed in in maximum 8-inch loose lifts and densified to at least 90 percent relative compaction or 95 percent relative compaction where fill depth is greater than 2 feet (ASTM D1557). Soils should have moisture contents within 3 percent of optimum. Higher moisture contents are acceptable if the soil lift is stable and required relative compaction is attained. Field density testing should be performed on each lift of fill.

Based on the anticipated soil types, the compacted fill material may be estimated to present a coefficient of permeability on the order of 10^{-4} to 10^{-5} centimeters per second (Bureau of Reclamation, Earth Manual). If a more refined approach is necessary for hydraulic modelling, field testing should be performed to develop representative in-situ percolation or steady-state infiltration rates.

7.5 Log Flow Diversion

The proposed diversion structure is composed of one log weir connected to two wing logs with rebar, and is protected on the downstream side by cobbles. The diversion is located on a hillside at the cut/fill transition and will require some minor earthwork to facilitate flow. The exposed native subgrade surfaces, as well as fill material, should be compacted to at least 90 percent relative compaction (ASTM D1557). Logs should be sufficiently embedded into soil for stability as indicated on Sheet D-4.



APPENDIX E: CULVERT DESIGN MEMO

TECHNICAL MEMORANDUM

TO: Meghan Kelly, PE, *Senior Project Engineer*/Nevada Tahoe Conservation District
Monica Grammenos, PE, *Project Engineer*/Nevada Tahoe Conservation District

FROM: Mark Rayback, PE, *Project Manager*/Wood Rodgers, Inc.
Allan Laca, PE (CA), QSD, *Project Engineer*/Wood Rodgers, Inc.

SUBJECT: Burke Creek Highway 50 Crossing and Realignment Project – Culvert Design Documentation

DATE: January 29, 2016

INTRODUCTION

This technical memorandum supports the design of the proposed culvert crossing for the Burke Creek Highway 50 Crossing and Realignment Project. Burke Creek will be realigned upstream and downstream of Highway 50 and there is a proposed crossing at Highway 50. The existing culvert crossing will be removed and capped.

HYDROLOGY

In support of Balance Hydrologics creating a HEC-RAS model for the Burke Creek Highway 50 Crossing and Realignment Project, the design team utilized the flow calculations presented in the Alternatives Analysis Report by Winzler & Kelly (Winzler & Kelly Report). The flows in the Winzler & Kelly Report were derived using standard frequency analysis of five U.S. Geological Survey (USGS) gages located on the southeast shore of Lake Tahoe. This was done because Burke Creek does not have a USGS gauge. From their analysis, the 50-year peak flow for Burke Creek in the project area is 94 cubic feet per second (cfs). The results from the Winzler & Kelly Report have been included in Attachment 1. To confirm these flows were reasonable, Wood Rodgers used the USGS Region 1 Regression Equation for the Burke Creek watershed to develop flows. Flows from the Region 1 Regression Equation and the Winzler & Kelly Report were compared and are shown in Attachment 2. Flows from the Winzler & Kelly Report are within reasonable tolerance with the Regression equation flows.

Per the Tahoe Regional Planning Authority (TRPA) Code, 60.4.6.D, drainage conveyances through a Stream Environment Zone (SEZ) "…shall be designed for a minimum of a 50-year storm," which is more conservative than NDOT guidelines, which recommends using the 25-year peak flows for design. Based on previous TAC discussions about the flows in Burke Creek, the 50-year flow from the Winzler & Kelly Report were utilized for the sizing of the proposed culvert crossing at Highway 50.

PROPOSED GEOMETRY

The proposed culvert pipe will be a 38-inch by 57-inch corrugated metal pipe arch (CMPA). A CMPA material has a smaller wall thickness compared to a reinforced concrete pipe or box. The CMPA's shape maximizes flow capacities within the given vertical constraints compared to a circular pipe.

The CMPA was modeled in the culvert analysis software HY-8 (developed by Aquaveo) to determine headwater and elevations. The CMPA can convey up to 103.6 cfs before overtopping Highway 50, which is just over the 50-year peak flow. The result from the HY-8 model has been included in Attachment 3.

The total cover over the pipe ranges from 2.4 feet (at the edge of pavement) to 3.5 feet (at the crown of the roadway).

Due to pH levels, the CMPA will need to be lined with a cured-in-place-pipe (CIPP) liner.

UTILITY CONFLICTS

There is approximately two (2) feet of separation between the 10" Sanitary Sewer Main and the bottom of the culvert and approximately one (1) foot of separation between the 10" Water Main. With this proposed design, a number of communication lines, a 6-inch gas line, and potentially a fiber optic line will need to be relocated. An existing communications vault is located north of the proposed culvert crossing. A field visit to the communications vault on the westbound side of Highway 50 was performed and the dimensions of the vault was determine to be 4.2-feet wide (from east to west) by 8.5-feet long (from north to south) by 8.1-feet deep (manhole rim to bottom of vault). Based on these dimensions, there is a minimum 2-foot horizontal clearance between the communications vault and the proposed culvert. Turner and Associates performed a survey in the project area and the top of the communications vault manhole was determined to be at an elevation of 6,314.81 feet. Based on the dimensions, the bottom of the communication vault is at an elevation of 6,306.71. At the point where the proposed culvert crossing is closest to the communications vault, the bottom of the culvert is at 6,308.72, which is slightly higher than the bottom of the vault. To avoid vertical conflicts, the communication lines will be relocated three (3) feet lower to cross under the proposed culvert. It is anticipated that this box will need to be stabilized during construction.

ATTACHMENTS

Attachment 1 – Winzler & Kelly Flows
Attachment 2 – USGS Region 1 Regression Equation Comparison
Attachment 3 – HY-8 Results

Attachments

Attachment 1 – Winzler & Kelly Flows

4.4.1 High Flows

Flows used to estimate culvert and channel capacity were determined using a standard flood frequency analysis of five USGS stream gages located along the southeast shore of Lake Tahoe. All five are within close proximity to Burke Creek and have similar aspect ratios. A Log Pierson Type III distribution was applied to the annual maximum peak flow record for each gaging station using procedures outlined in Bulletin 17B (USGS, 1982) (see Table 4). The peak flow analysis for each gage is provided in Appendix G.

The predicted peak flows associated with various return periods were scaled by unit drainage area, and the average of the five sites was calculated. The average return flow per unit area was then scaled to the drainage area of Burke Creek at Highway 50. For the purpose of culvert sizing and evaluation of flood capacity, the 100-year return flow for Burke Creek was determined to be 120 cfs.

Table 4: Peak flow estimates for USGS gaging stations on small tributaries to Lake Tahoe within close proximity to Burke Creek.

USGS Stream Gaging Station	Period of Record	Drainage Area (mi2)	Peak Flow for Indicated Return Period (cfs) 1.2-year	5-year	10-year	25-year	50-year	100-year
10336760 Edgewood Ck at Stateline, NV	1993-2006	5.61	17	73	109	169	228	300
103367585 Edgewood Ck at Palisade Drive Nr Kingsbury, NV	1991-2001	3.13	8	34	50	77	102	133
10336735 North Logan House Ck at Hwy 50 Nr Glenbrook, NV	1991-2000	1.08	2	12	18	26	33	41
10336725 Glenbrook Ck at Old Hwy 50 Nr Glenbrook NV	1991-2000	3.75	8	37	55	87	117	153
10336730 Glenbrook Ck At Glenbrook, NV	1988-2006	4.11	19	60	84	125	164	212
Average flow per square mile (cfs/mi^2)			**3**	**12**	**17**	**27**	**35**	**45**
Estimated flood frequency determined from average unit discharge LPIII distribution of annual maximum flows.								
Burke Creek above Highway 50		**2.67**	**8**	**32**	**47**	**71**	**94**	**121**

4.4.2 Low Flows

Based on field visits, cross section analysis, and discussions with Tahoe Regional Planning Agency (TRPA) and US Forest Service personnel, it appears that peak flows in Burke Creek are uncharacteristically low relative to adjacent streams given its drainage area. This supposition is based on bankfull channel dimensions and flow data collected in Burke Creek.

The NTCD established a short-term streamflow gaging station on Burke Creek immediately upstream of the Highway 50 crossing. The station was in operation from April 26, 2006 through July 19, 2007 and recorded stage every 30 minutes. The gaging captured two years of spring snowmelt and baseflow over one complete summer (Figure 11). A stage-discharge rating curve was established by NTCD to relate stage to streamflow and a flow hydrograph was developed. This hydrograph is shown with flow records from three USGS gaged streams on Figure 12.

Attachment 2 – USGS Region 1 Regression Equation Comparison

Regression Equations Methods

Regional regression equations are outlined in the USGS National Flood-Frequency Program (USGS 1999). Watersheds in the South Lake Tahoe region with mean elevations greater than approximately 7,500 feet AMSL, areas from 0.6 to 200 square miles (384 to 128,000 acres) and mean annual precipitation from 11 to 43 inches are within Region 1. All the subbasins with areas greater than 384 acres draining to the project area meet these criteria, so the equation for Region 1 was utilized. Mean annual precipitation was obtained from US Army Corps of Engineers data (USACE 2005).

Region 1 Input

Area (sq. Mi.)	2.417359
Precip	25

Region 1	
Q2	27
Q5	47
Q10	62
Q25	83
Q50	98
Q100	113

Winzler Kelly	
Q2	--
Q5	32
Q10	47
Q25	71
Q50	94
Q100	121

http://pubs.usgs.gov/fs/fs-123-98/#us_weather

J:\Gis\DataSources\US_Federal\USFS LTBMU\LTBMU_GIS_Library.mdb\Water\precipitation

Attachment 3 – HY-8 Results

HY-8 Culvert Analysis Report

Table 1 - Summary of Culvert Flows at Crossing: Arch

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1_UseMe Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6314.93	71.00	71.00	0.00	1
6315.14	76.00	76.00	0.00	1
6315.35	81.00	81.00	0.00	1
6315.58	86.00	86.00	0.00	1
6315.83	91.00	91.00	0.00	1
6315.98	94.00	94.00	0.00	1
6316.35	101.00	101.00	0.00	1
6316.61	106.00	105.47	0.51	5
6316.79	111.00	108.62	2.35	4
6316.96	116.00	111.33	4.66	4
6317.11	121.00	113.79	7.21	4
6316.50	103.64	103.64	0.00	Overtopping

Rating Curve Plot for Crossing: Arch

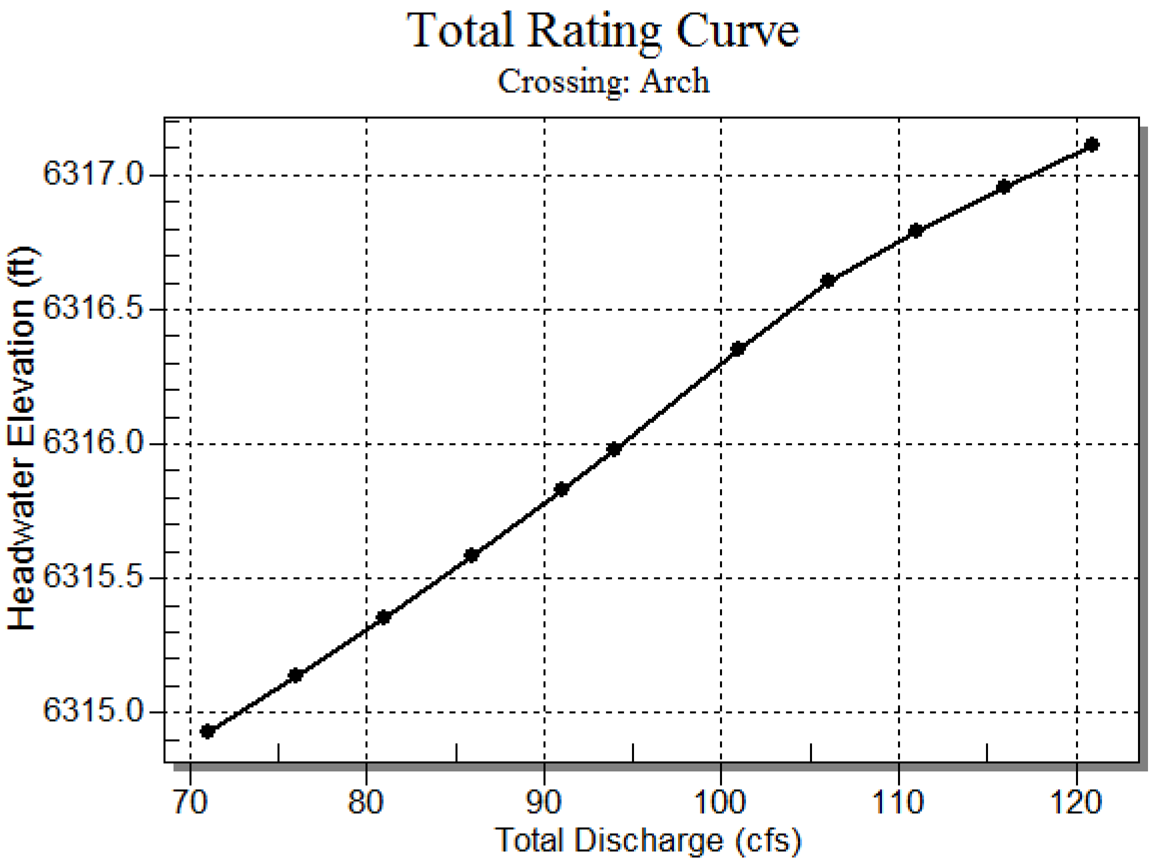


Table 2 - Culvert Summary Table: Culvert 1_UseMe

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
71.00	71.00	6314.93	3.429	0.0*	5-S2n	0.833	2.029	0.839	1.226	18.161	4.825
76.00	76.00	6315.14	3.636	0.0*	5-S2n	0.864	2.110	0.920	1.281	17.100	4.943
81.00	81.00	6315.35	3.854	0.0*	5-S2n	0.894	2.191	0.906	1.335	18.606	5.056
86.00	86.00	6315.58	4.083	0.0*	5-S2n	0.924	2.262	1.017	1.388	18.064	5.164
91.00	91.00	6315.83	4.326	0.0*	5-S2n	0.957	2.329	1.129	1.440	18.351	5.267
94.00	94.00	6315.98	4.478	0.0*	5-S2n	0.985	2.369	1.199	1.471	18.494	5.327
101.00	101.00	6316.35	4.852	0.0*	5-S2n	1.049	2.463	1.317	1.541	19.091	5.461
106.00	105.47	6316.61	5.105	0.0*	5-S2n	1.090	2.523	1.353	1.591	18.845	5.554
111.00	108.62	6316.79	5.292	0.0*	5-S2n	1.119	2.555	1.383	1.639	18.935	5.642
116.00	111.33	6316.96	5.456	0.0*	5-S2n	1.144	2.580	1.407	1.687	19.040	5.728
121.00	113.79	6317.11	5.610	0.0*	5-S2n	1.167	2.603	1.429	1.735	19.133	5.811

* theoretical depth is impractical. Depth reported is corrected.

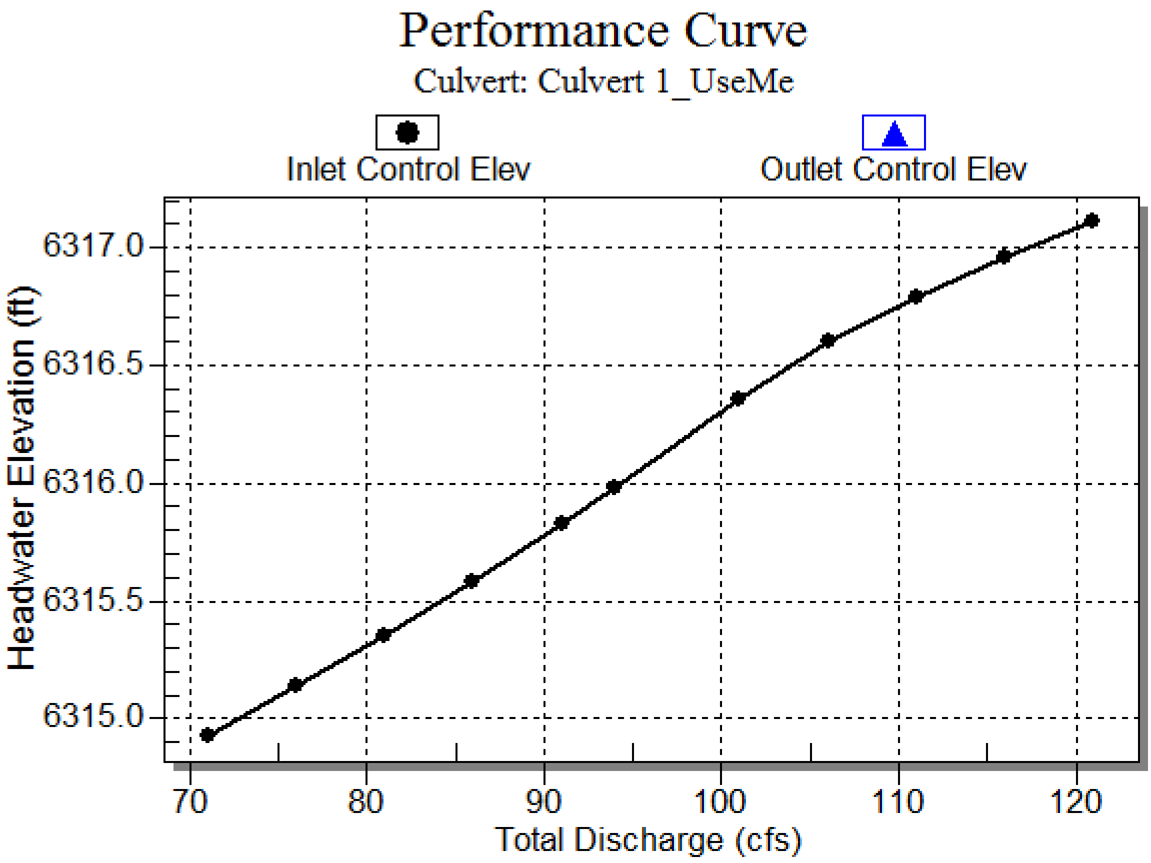
****

Inlet Elevation (invert): 6311.50 ft,   Outlet Elevation (invert): 6307.00 ft

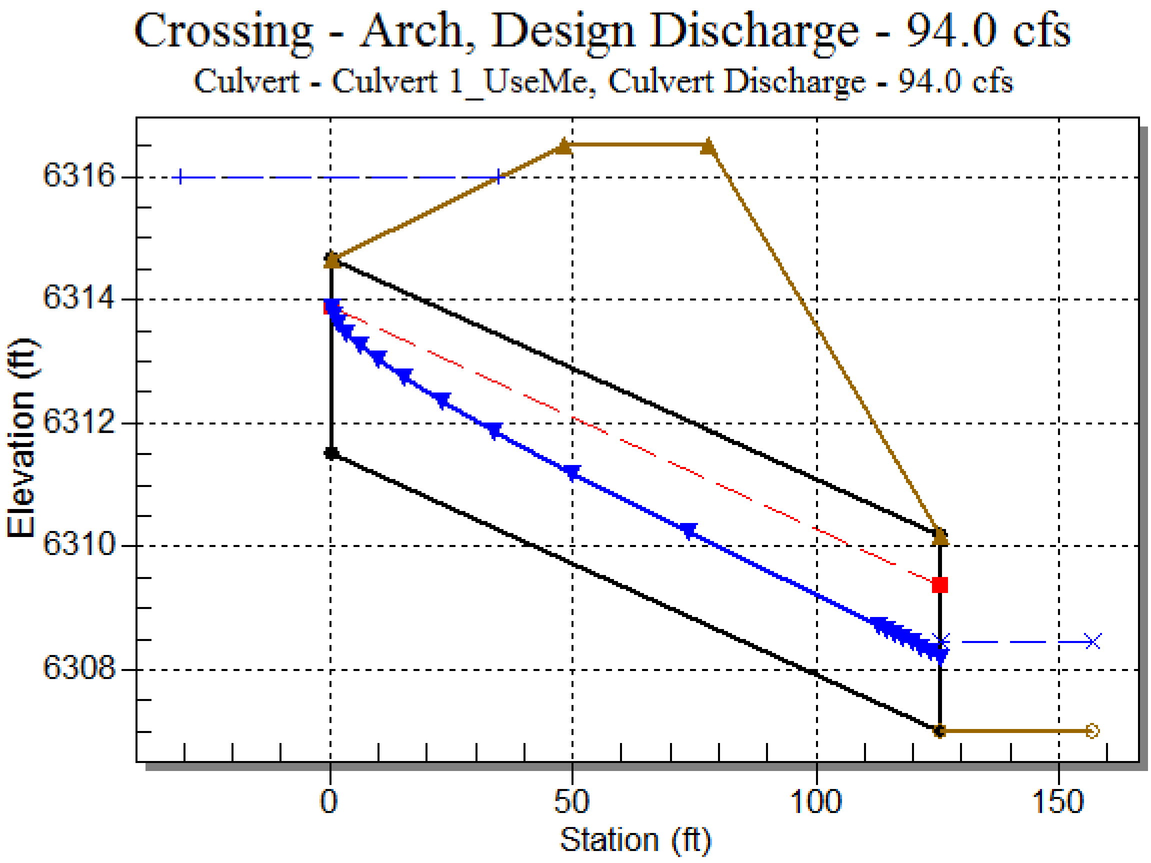
Culvert Length: 125.08 ft,   Culvert Slope: 0.0360

****

Culvert Performance Curve Plot: Culvert 1_UseMe



Water Surface Profile Plot for Culvert: Culvert 1_UseMe



Site Data - Culvert 1_UseMe

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 6311.50 ft

Outlet Station: 125.00 ft

Outlet Elevation: 6307.00 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1_UseMe

Barrel Shape: Pipe Arch

Barrel Span: 57.00 in

Barrel Rise: 38.00 in

Barrel Material: Steel or Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0105

Inlet Type: Conventional

Inlet Edge Condition: Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Arch)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
71.00	6308.23	1.23	4.82	3.75	0.77
76.00	6308.28	1.28	4.94	3.92	0.77
81.00	6308.34	1.34	5.06	4.08	0.77
86.00	6308.39	1.39	5.16	4.24	0.77
91.00	6308.44	1.44	5.27	4.40	0.77
94.00	6308.47	1.47	5.33	4.50	0.77
101.00	6308.54	1.54	5.46	4.71	0.78
106.00	6308.59	1.59	5.55	4.86	0.78
111.00	6308.64	1.64	5.64	5.01	0.78
116.00	6308.69	1.69	5.73	5.16	0.78
121.00	6308.74	1.74	5.81	5.31	0.78

Tailwater Channel Data - Arch

Tailwater Channel Option: Rectangular Channel

Bottom Width: 12.00 ft

Channel Slope: 0.0490

Channel Manning's n: 0.0690

Channel Invert Elevation: 6307.00 ft

Roadway Data for Crossing: Arch

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 5.00 ft

Crest Elevation: 6316.50 ft

Roadway Surface: Paved

Roadway Top Width: 30.00 ft

APPENDIX F: BALANCE HYDROLOGICS DESIGN BASIS MEMO

Memo

To: Michael Pook, Nevada Tahoe Conservation District

From: Peter Kulchawik, P.E. and David Shaw, P.G.

Date: March 9, 2016

Cc: Stephanie Heller, U.S. Forest Service

Subject: Feasibility Assessment and Limited Design Basis for Burke Creek Restoration and Drainage Enhancement Design, Douglas County, Nevada

PURPOSE OF THIS MEMO

This memo accompanies the 50-percent restoration design for Burke Creek at US Route 50 (referred to as US 50 herein) in Douglas County Nevada, near Stateline, Nevada (Appendix A). The designs and design guidelines presented herein are focused on restoring alluvial fan processes and floodplain functions and values to Burke Creek and Rabe Meadow, while addressing streamflow drainage issues on US 50 near Kahle Drive. The project is proceeding in two phases: Phase 1 includes gully stabilization, channel realignment, floodplain restoration, and culvert replacement upstream of and under US 50, and Phase 2 includes channel re-alignment and floodplain and alluvial fan restoration downstream of US 50 (see Figure 1). Phase 1 has been designed by NTCD with input from Balance Hydrologics, and Phase 2 design has been designed by Balance Hydrologics with input from NTCD and the US Forest Service Tahoe Basin Management Unit.

The purpose of this memo is as follows:

- Outline the project goals and objectives,
- Provide a summary of previously completed studies and background information,
- Characterize existing conditions as they pertain to the restoration design,
- Describe project constraints and opportunities,
- Summarize analyses completed to inform the design, including:
  - A review of groundwater data collected for the Phase 2 portion of the project, and
  - Development and refinement of a hydraulic model of the site,
- Document the design basis for the proposed restoration features, and
- Provide:
  - channel alignment and design parameters for the Phase 1 portion of the project (upstream of US 50),
  - channel and meadow restoration designs for the Phase 2 portion of the project (downstream of US 50),
  - recommendations for spot treatment of channel incision upstream of the Phase 1 portion of the project, and
  - recommendations for design of the replacement culvert under US 50.

The design parameters and attached plans are suitable for presentation to and discussion among the Technical Advisory Committee (TAC); however, this memo should always accompany the design and design parameters when they are distributed.

PROJECT GOALS AND OBJECTIVES

Our work on this effort focuses on establishing geomorphic, hydrologic, and hydraulic design parameters for the restoration elements of the project, and developing an engineering plan set for the Phase 2 portion of the project. The project also includes stormwater drainage and culvert designs that are being completed by NTCD and Wood Rodgers Engineers and Geotechnical Specialists. Phase 1 restoration design is being completed by NTCD staff, while soil rehabilitation and revegetation strategies are being provided by Integrated Environmental Restoration Services (IERS).

We have developed design parameters and designs that focus on the following goals and objectives:

Goals

- Restore hydrologic and sediment transport continuity;
- Restore wet meadow conditions to Rabe Meadow; and
- Improve drainage on US 50.

Objectives

- Realign the stream channel to a natural topographic depression and improve stream function of Burke Creek directly downstream of US 50;
- Reduce the size of the commercial development parking lot in order to reroute the stream, and increase floodplain access and stream function;
- Treat stormwater in the project area before discharge to Burke Creek and gain Lake Clarity Credits for Douglas County and Nevada Department of Transportation (NDOT) for reducing pollutants of concern including Fine Sediment Particles (FSP), nitrogen, and phosphorous;
- Develop a project that requires minimal maintenance;
- Move or modify historical features or watershed disturbances that have re-routed dominant streamflow patterns;
- Enhance stream and alluvial fan functions using geomorphic and hydrologic-appropriate design elements.

It should be noted that two of the originally stated objectives for this project discussed among the TAC and in our scope of work are constrained by property boundaries and utility infrastructure:

- **Reduce the frequency of flooding on US 50 and in the adjacent commercial parking lot.** Prior investigators and hydraulic modeling indicates that the channel frequently spills onto the parking lot at a number of locations, one of which is upstream of the project property boundary. Significant work would need to be conducted on privatelyowned property to address channel overflow at all locations where it occurs. The project addresses the flooding at US 50, but only mildly alleviates—and does not eliminate—flooding to the commercial parking lot.

- **Construct a geomorphically-appropriate crossing of Burke Creek under US 50.** Utility lines running underneath US 50 require the culvert to be placed with a minimum outlet invert of 6307.0 feet (see Sheet CS-5). As a result, the longitudinal profile continuity cannot be maintained without significant placement of fill on the Phase 2 portion of the project. The design therefore includes an approximately 6-foot-high cascade at the proposed US 50 culvert outlet, and a culvert slope that is lower than that of the Phase 1 channel slope.
- **Provide habitat continuity along Burke Creek across US 50.** Due to the number of constraints imposed by property boundaries, existing utilities, and regulatory criteria, it is not possible to design the project to both improve geomorphic processes and restore longitudinal connectivity for fish passage. Significant utility relocation along US 50, cooperation with land owners and/or land acquisition, and complex geotechnical engineering would be required to dually improve geomorphic processes and provide fish passage at a wide range of flows.

AVAILABLE DATA/REPORTS REVIEWED

The following data, reports, and/or information were reviewed for this project:

- Light detection and ranging (LiDAR) imagery and topographic information (USGS and TRPA, 2010)
- Topographic basemaps provided by NTCD (Turner and Associates, 2007; Atkins, 2013; Lumos and Associates, 2013)
- Groundwater monitoring data collected by NTCD beginning in March 2015
- Geologic Map of the Lake Tahoe Basin (Saucedo, 2005)
- Burke Creek Restoration Project Alternatives Analysis Report (Winzler and Kelly and others, 2009)
- Burke Creek / Rabe Meadows Preliminary Restoration Plans (Wood Rogers, 2012)
- Wood Rogers Burke Creek Highway 50 Crossing and Replacement Project Geotechnical Investigation Report (Carter, 2015)
- Burke Creek Highway 50 Crossing and Realignment Project Monitoring Plan (prepared by NTCD)
- Burke Creek Restoration Potential and Design Concepts (NHC, 2006)
- Burke Creek-Rabe Meadow Complex Master Plan Existing Conditions Report (Wood Rodgers, 2014)
- Burke Creek-Rabe Meadow Complex Master Plan CIP Alternatives Evaluation Report (Wood Rodgers, 2014)

COMPLETED TECHNICAL STUDIES

Balance has completed the following studies for this project:

- Channel reconnaissance (December 18, 2014, July 8, 2015, and November 6, 2015)

- Groundwater monitoring implementation assistance and data review
- Hydraulic modeling of existing and proposed conditions

EXISTING CONDITIONS

Geomorphic Setting

A general overview map of the Burke Creek project area is provided in Figure 1. Burke Creek is tributary to Lake Tahoe, which ultimately discharges to the Truckee River at Tahoe City. The watershed above the project site drains an approximate 2.46–square-mile area that is mostly underlain by Cretaceous-age granitic rocks (Saucedo, 2005; Figure 2). Weathering and erosion of these materials tend to develop relatively young, coarse-textured, and well-drained sandy soils. This basement rock is locally capped in the upper watershed by late Triassic-early Jurassic meta-volcanic rocks. Quaternary alluvial deposits are present in lower-gradient meadow reaches.

Extensional normal faults are present and roughly coincide with the alignment of US 50 at this location, with an uplifted block to the east of the highway and the down-dropped block to the west. Fine-grained lacustrine sediments are mapped along the perimeter of Lake Tahoe above the current lake elevation, extending as far east and as high as US 50. These sediments were deposited during higher lake level stands associated with various glaciation episodes and damming of the lake outlet by glaciers and glacial deposits, and are overlain by a thin veneer of floodplain deposits mapped along lower reaches of the creek.

Upstream of US 50, the Burke Creek channel is largely confined by a steep, forested canyon reach and, to a minor extent, fill material associated with construction of the athletic fields immediately south of the stream. The stream corridor opens as it enters the parking lot and the US 50 area, where it historically has formed an alluvial fan, or during higher lake level stands, a delta. The proposed project is in this transitional zone at the apex of the alluvial fan, with project elements extending from the mouth of the canyon (near the ball fields at Kahle Community Center) to upper Rabe Meadow (upstream of the pond along Kahle Drive).

Alluvial fans serve as transfer systems for materials eroded from mountain masses and destined for deposition in adjacent basins or valleys. They are storage sites for erosion debris. A characteristic of active alluvial fans is active channel widening and channel migration. Historical aerial photographs presented by Winzler and Kelley (2009) indicate that the Burke Creek channel historically deposited material to form a meadow at this location, and associated channel movement or migration has occurred for roughly the past 100,000 years. Sediment deposits in the parking lot and soils investigations suggest debris flows or episodic sediment delivery events still occur in this subwatershed at times, with a tendency toward active sediment aggradation and alluvial fan development under modern conditions.

Channel Patterns

Winzler and Kelley (2009) analyzed USGS topographic maps from 1891 and 1893, which showed Burke Creek as a blue line stream terminating in a marshy area (roughly the location of the current pond within Rabe Meadow); it was unclear whether there was a defined channel between the marshy area and Lake Tahoe as of that time. Winzler and Kelly (2009) also analyzed a series of historical aerial photographs throughout the 1900s. The photos showed that as of 1940 Burke Creek flowed across the footprint of the existing commercial development on the east side of US 50, and continued due west through the current footprint of residential areas along Kahle Drive. Between 1940 and 1969 Kahle Drive and the commercial center to the east of US 50 were constructed, and the channel was rerouted to the north to approximately its current alignment. Channel adjustments have been negligible after 1969, as the channel migration has been limited by infrastructure and mature vegetation. In the late 1970s, a portion of the Phase 2 footprint was graded and foundations installed (some of which remain buried today) for a casino project; the project was abandoned in the early 1980s and the land purchased by the USFS (NTCD, 2014). Although there is no evidence that the casino project affected channel patterns, the grading has altered overland and groundwater flow paths.

The channel morphology of Burke Creek varies throughout the project footprint since it spans a transition from steep canyon to low-gradient meadow. The steep canyon portion of Burke Creek (upstream of US 50) is dominated by step pools formed by wood and reinforced by cobbles. Burke Creek within the gully stabilization portion of the project (see Figure 1) has a sinuosity of 1.2 and the riparian corridor has been only mildly impinged on by development. The channel has vertically incised in places, and has limited connectivity to the floodplain at these locations. Channel widening is less prevalent, and appears to be limited by woody vegetation, bedrock, and possibly remnants of former stream crossings.

Downstream from the gully stabilization portion of the project the Phase 1 portion of Burke Creek was rerouted to accommodate the commercial center resulting in a very straight channel planform, with a sinuosity of nearly one. Here, the channel is confined by steep hillsides and bedrock along the right bank, and with a constructed berm along the left bank. The slope is 2.5 percent along the north property boundary of the commercial development, and steepens to more than 12 percent as the channel approaches the existing US 50 culvert.

The slope of the low-gradient meadow portion of Burke Creek (downstream of US 50) ranges from 2 to 4 percent. The sinuosity of the existing channel is similar to the upstream reach (roughly 1.2), however, this metric should not be used as a design parameter for Phase 2 because the channel planform has been impacted by infrastructure and an abandoned casino project. An undisturbed channel planform through the meadow could not be discerned from historical aerial photographs. Burke Creek is perched slightly above the surrounding meadow; riparian vegetation and a comparatively low channel slope appear to have been effective in causing high sediment loads from the canyon to deposit in the channel and immediately overbank. As such, channel avulsion is prevalent in this reach, along with frequent overbank flows and flooding along Kahle Drive in the vicinity of the US Forest Service's recently constructed Lam Watah Trailhead parking lot.

Hydrology

Burke Creek is a snowmelt-dominated perennial channel. At its crossing with US 50, Burke Creek has a watershed area of 2.46 square miles (Figure 3). Watershed elevations range from roughly 6,315 feet near US 50 to more than 8,400 feet along the crest of the Carson Range (also the eastern boundary of the Lake Tahoe Basin). Annual floods typically occur between March and June and coincident with peak snowmelt runoff with occasional flash flooding generated by summer thunderstorms. Mid-winter rain-on-snow events are also common and can generate measurable runoff and sediment transport exceeding that of the annual snowmelt runoff peak.

The only gaging data for Burke Creek is from a streamflow monitoring program by NTCD and TRPA from April 2006 to July 2007. The peak snowmelt runoff from water year 2006 was estimated as 2.2 cfs on May 2, 2006 (NTCD and TRPA, as cited by Winzler and Kelley, 2009). This event was roughly a 1.2-year event in many of the local USGS gaging records and had similar timing to the Burke Creek peak flow. As such it is reasonable say 2.2 cfs is a 1.2-year event for Burke Creek.

Flows for higher return periods were estimated by (1) scaling USGS streamflow data from nearby gaged systems by watershed area (Winzler and Kelley, 2009), (2) modeling per methods outlined in the Nevada Department of Transportation (NDOT) Drainage Manual (NTCD and Wood Rodgers, 2014), and (3) regional regression equations for rural Nevada (USGS, 1999). Flows for each of the three methods are summarized as follows:

Return Period	**Watershed Scaling**	**NDOT Modeling**	**Regression Equations**
year	*cfs*	*cfs*	*cfs*
2	5	9.4	27
10	47	n/a	62
25	71	152	83
50	94	363	98
100	121	668	113

The flow estimates by the watershed scaling and regression equation approaches agree (with the exception of the 2-year flow), which is logical since the regression equations are based on USGS gaging data. The design flow estimates by NDOT modeling methods are typically used to size stormwater infrastructure, as such, they are conservative and tend to overestimate flow. For example, the NDOT model estimated the 2-year flow as 9.4 cfs which is unreasonable given field observations by Balance staff and others who have previously studied the system in detail. For this reason—along with the fact that statistical analyses of real data inherently provide more realistic peak flow estimates—we adopted watershed scaling estimates for the restoration design.

Soils

Soils in the Burke Creek watershed range from very well-drained, gravelly soils along the rim of the Tahoe Basin to poorly-drained, silty-loamy soils near Lake Tahoe (see Figure 4). Granodiorite is the parent material for most soils in the Burke Creek system. The highest portions of the watershed (roughly 7,800 feet and above) are dominated by the Dagget complex. These soils are very well-drained (hydrologic soil group A), and are composed of a gravel-sand-loam mixture. From US 50 (approximately 6,300 feet) up to 7,800 feet the soils are of the Cassenai-Cagwin complex. These soils are well-drained (hydrologic soil groups A or B) and are composed of a coarse sand-loam mixture. Cassenai soils tend to form on north aspects and are deeper due to dense vegetation cover, whereas Cagwin soils tend to form on south aspects and are shallower due to mostly shrub vegetation. In the meadow downsteam of US 50, soils are mostly of the Tahoe complex. These soils are poorly-drained (hydrologic soil groups C and D) and are composed of a sand-loam-silt mixture (USGS and NRCS, 2007). The Tahoe complex (as well as the Cassenai-Cagwin complex) is listed in the NRCS database as a potentially hydric soil, however, none have been field-verified as such.

PROPOSED CONDITIONS

The following sections describe the restoration design for Phase 1 and Phase 2. Emphasis is given to how the design meets project goals and objectives, and how it fits within the context of the existing conditions as characterized above. We begin by describing the design concept in a general sense, then elaborate on how the design was molded by constraints, opportunities, technical analyses, and background studies. We conclude with our final recommendations for Phase 1, along with describing the design basis for Phase 2.

Design Components

The main feature of Phase 1 is realigning Burke Creek through a widened floodplain and riparian corridor. The slope of the channel and floodplain is steep to account for the site's existing topography and to maximize sediment delivery under US 50 and toward Rabe Meadow and the Phase 2 portion of the project. Several boulder and log step-pool structures stabilize the steep slope of Phase 1. A berm separates the Phase 1 floodplain from the commercial development to the south in order to contain flood flows. A portion of the existing Burke Creek channel—and its riparian vegetation—will be preserved as a side channel that will be activated during moderate flows. A log flow split structure at the upstream end of Phase 1 will divide the total flow between the side channel and realigned Burke Creek. The side channel and realigned Burke Creek rejoin before entering a newly constructed culvert beneath US 50. Lastly, Phase 1 will also include gully stabilization measures along Burke Creek upstream of the widened floodplain area.

The culvert outlet defines the upstream end of Phase 2. A boulder cascade will be built immediately downstream of the outlet to bring flow down to the meadow elevation. The cascade flows into a stilling pool constructed of logs and boulders, and from there flow to the meadow will be equally divided between two small distributary channels by low weirs. One channel will rejoin existing Burke Creek after a short distance and the other will follow the natural topography of the meadow to rejoin existing Burke Creek further downstream. Grade control logs and log step pools throughout the meadow will prevent incision of the meadow and encourage diffuse flow.

Design Constraints

Identification of site-specific constraints is a critical step to help establish restoration feasibility and a basis for design. Based on available background information described above and a site reconnaissance we identified the following site constraints. Our proposed Phase 1 design recommendations and Phase 2 design attempt to incorporate elements that avoid, minimize, or mitigate these constraints, but it should be noted that not all constraints can be avoided.

1. *Hydrology*

   a) Burke Creek does not have a long-term streamflow gaging record. Therefore, the hydrologic characteristics of the watershed have not been directly measured;
   b) Historical land use and construction of US 50, Kahle Drive, and commercial development has altered Burke Creek along the project reach. In addition to channel encroachment, the highway has increased impervious surface and runoff;
   c) Existing wetlands and riparian areas are somewhat functional; designs should minimize or avoid direct and indirect impacts to existing functional habitat.
   d) The groundwater data suggest streamflow is the primary hydrologic support for riparian vegetation downstream of US 50; since a portion of the channel is proposed to be abandoned, potential impacts to vegetation along the channel should be considered.

2. *Geomorphology*

   a) The project area is located on an active alluvial fan. Erosion, aggradation and channel migration are natural processes on an alluvial fan;
   b) The watershed above the project site is confined by steep topography and offers limited storage for excessive sediment that may originate from debris flows as the result of a rain-on-snow events or post-wildfire runoff. Such an event could directly alter the future channel morphology/patterns and hydrology in the project area;

3. *Infrastructure*

   a) A gravity sewer line and other utilities along US 50 limit the slope and alignment of the proposed culvert.
   b) Implementation of the proposed culvert will involve working around and under US 50. During construction, traffic control and lane closures will be required.
   c) Buried concrete footings are present in the Phase 2 portion of the project site. Their precise locations and burial depths are unknown. Construction may require removal of concrete footings should they be encountered during excavation.

4. *Property Ownership*

   a) Burke Creek traverses a patchwork of public and private land, particularly Phase 1. The property boundary for the commercial development limits the extent of the widened floodplain corridor. Construction will require close coordination and notification of business owners within the commercial development.

5. *Phasing*

   a) Project funding and USFS construction crew scheduling constraints have led to the project being implemented in two phases over the course of two years. The site configuration in the interim between Phase 1 and Phase 2 must be carefully weighed for flooding and other safety and logistical concerns from a partially complete project.

b) Since the culvert will be built under Phase 1, we recommend the culvert outlet structure (originally part of Phase 2) be constructed at the same time. The outlet structure includes energy dissipation and flow dispersal features that will allow for diffuse overland through the meadow. The existing topography is such that the overland flow will rejoin with Burke Creek, and be directed toward the pond.

Design Opportunities

Similar to design constraints, we find it helpful to identify site opportunities where design elements may serve multiple objectives or facilitate restoration of stream and meadow functions. Based on our assessment, we have identified the following opportunities:

1. *Ease of construction access*

   The project is proximate to roads and trails, as such, construction access will require only minimal disturbance to the natural landscape.

2. *Meadow sod*

   During clearing and grubbing for Phase 2, sod is available for harvest and temporary storage to become part of the revegetation plan. The USFS is responsible for the Phase 2 revegetation plan, as such, revegetation is not discussed in detail herein. We recommend the USFS evaluate the suitability for sod for reuse prior to including it in the revegetation plan.

3. *Proximity to materials or reuse needed for construction*

   The proposed alternatives include both cut and fill volumes. Cut materials are likely suitable for fill or design elements (e.g., rock for riffle or grade control structures). Excavated material for may be able to be reused for fill, however, balancing the earthwork—particularly for Phase 1—is improbable. Because Phase 2 is on USFS land, there may be opportunities to reuse logs and boulders salvaged from other USFS projects.

Analyses Conducted

Groundwater

Eleven piezometers were installed in 2015 downstream of US 50 to evaluate existing groundwater levels in the vicinity of the existing and proposed channels in the Phase 2 portion of the project. NTCD staff collected data (depth to groundwater measurements) bi-weekly throughout the spring, and monthly after June. The piezometer locations are shown in Figure 5 and a summary of the data is included in Appendix B.

Based on the data collected between spring and fall 2015, it appears that groundwater levels are nearest to the ground surface and highest in elevation near the existing channel. This leads us to believe that the stream is the primary source of shallow groundwater levels, and that other groundwater sources are limited. Therefore, if the channel is moved, groundwater levels along the dewatered portion of the existing riparian corridor are expected to drop, with an associated potential impact to existing riparian vegetation along the channel.

Hydraulics

The US Army Corp of Engineers Hydrologic Engineering Center's River Analysis System (HEC-RAS) version 4.1, along with its geospatial extension for ArcGIS, HEC-GeoRAS version 10.1, was used to model Burke Creek under existing conditions and as proposed in the Phase 1 and Phase 2 areas, from a point roughly 500 feet upstream of its crossing at Highway 50 to the pond adjacent to Kahle Drive. A digital terrain model (DTM) in the ArcInfo TIN format was developed from the proposed Phase 1 grading plan developed in Civil3D. The grading plan was overlain on the existing conditions survey completed for this study[1] to create a seamless surface of Phase 1 of the project and the surrounding area. The data were reviewed for quality control in preparation for subsequent steps.

Cross sections were cut from the DTM in GeoRAS, and additional cross sections were interpolated in HEC-RAS to improve model stability. The final average cross section spacing was roughly 50 feet. Manning's *n* values used to represent roughness within the channel banks varied based on channel form, substrate size, and vegetation. Lateral weirs were included in the model to account for spillage over the left bank along existing Burke Creek, where floodwaters have been documented to flow toward the commercial development upstream of US 50. See Figure 6 for cross section locations, and Appendix C for existing conditions model output.

Three steady state flows were run in the model: 5 cfs (an approximately 2-year event), 71 cfs (25-year event), and 121 cfs (100-year event). The magnitudes of all events were based on Winzler & Kelley and others (2009).

During the 100-year flood (121 cfs) the model predicts that the existing 24" culvert under US 50 only conveys 18 cfs, and the remainder of the flow either spills over the banks into the commercial development or into the northbound lanes of US 50. The most significant spillage occurs along the left bank, just upstream of the Phase 1 grading limit, where during the 25-year event 16 cfs of the total 71 cfs spills over the left bank prior to reaching the upstream end of Phase 1; during the 100-year event 43 cfs of the total 121 cfs spills. Due to the simplified 1-dimensional modeling approach, flow leaving Burke Creek was not simulated once it spilled overbank, however the topographic data suggest overbank flows would concentrate at the intersection of US 50 and Kahle Drive, then flow along Kahle Drive toward Lake Tahoe.

The same one-dimensional hydraulic model used to characterize the existing flood conditions was adapted to the Phase 1 design to test the design against the following objectives:

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[1] The existing conditions survey consisted of a LiDAR survey (USGS, 2010) supplemented by ground-based surveys by Turner and Associates (2007), McBain & Trush (2007), Atkins (2013), and Lumos and Associates (2013). These surveys were combined by NTCD staff to create the existing conditions topographic surface.

a) Verify the 100-year event is contained within the proposed berms with sufficient freeboard;
b) Verify the proposed culvert can convey the 100-year event without flooding Highway 50 or adjacent properties;
c) Inform the design of the flow split structure which will direct flow into both the existing channel and the newly created channel;
d) Estimate average channel velocities for rock, boulder, and log sizing calculations; and
e) Confirm the low flow channel is sized such that the floodplain will be inundated by the 2-year flow.

See Figure 7 for cross section locations, and Appendix D for model output.

A digital terrain model (DTM) in the ArcInfo TIN format was developed from the proposed Phase 1 grading plan developed in Civil3D. The grading plan was overlain on the existing conditions survey completed for this study to create a seamless surface of Phase 1 of the project and the surrounding area. Cross sections were cut from the DTM in GeoRAS, and additional cross sections were interpolated in HEC-RAS to improve model stability. The final average cross section spacing was between 5 and 10 feet (including interpolated cross sections). The same lateral weirs as used in the existing conditions model were included in the Phase 1 model to simulated overbank spillage upstream of Phase 1. An additional lateral weir was added to represent the split flow structure at the upstream end of Phase 1.

As in the existing conditions hydraulic model, the Phase 1 model suggests significant overbank spillage from the left bank upstream of the Phase 1 grading limit during the 25- and 100-year events. As discussed earlier, grading at the most severe overflow points is not practicable due to project boundary constraints, so the magnitude of overbank spillage toward the commercial development at this location will be the same as existing conditions.

We offer the follow results and inferences from the hydraulic model corresponding to the objectives above:

a) The 100-year flood is contained within the proposed berms with at least one foot of freeboard except between cross sections 963 to 989 and at cross section 1104; the least amount of freeboard at these locations is 0.4 feet. To increase the amount of freeboard, it appears feasible to either flatten the floodplain grading (i.e. decrease the transverse slope) in these areas or increase the height of the berm. Having one foot of freeboard is not necessarily a regulatory requirement, rather it is a means of accounting for uncertainty in the model and realistic grading tolerances.

b) The culvert contains the 100-year event without flooding Highway 50, although the flow is only 78 cfs at the culvert since the remainder of the 100-year event spills from the channel upstream of Phase 1, leaving the system and bypassing the culvert. The model suggests the flow through the culvert is inlet controlled, and the inlet becomes submerged by roughly 0.3 feet during the 100-year event. This is a relatively minor amount of submergence, and depth of backwater is not anticipated to flood Highway 50 or surrounding properties.

c) The crest of the log directing flow to the southwest and into the proposed Burke Creek channel should be 6325.2 feet, and the crest of the log directing flow to the west and into existing Burke Creek should be 6326.0. These elevations were estimated such that existing Burke Creek channel is activated just below the 2-year flow. Both logs of the flow split structure were modeled as having a 1-foot wide notch; the recommended elevations represent the inverts of the notches.

d) Velocity output for Phase 1 for the 25- and 100-year events is summarized in the attached table in Appendix D. Average velocities are calculated to be on the order of 3 to 6.5 ft/s. We have provided this information so NTCD may adequately size the logs and boulders.

e) The model suggests that 2-year flow just begins to inundate the newly graded floodplain at most cross section locations in Phase 1. The 2-year flow will provide periodic inundation of the Phase 1 floodplain to support riparian vegetation, as well as to modulate sediment loads.

Design Criteria

Gully stabilization

The portion of Burke Creek where gully stabilization work is proposed appears to be moderately stable and functional; however, headcuts and clear signs of moderate downcutting of the channel bed have been observed at certain locations. There is general agreement among the project design team that the importance of protecting healthy, functioning sections of the channel and riparian corridor should be weighed heavily against construction access impacts in this area, and that "overengineering" of the channel should be avoided. We therefore recommend that any gully stabilization work upstream of the Phase 1 portion of the project should be centered on low-impact work that can be done either by hand or very light equipment.

Channel slope

Since US 50 approximately marks the transition in Burke Creek from a steep canyon to a flat meadow, an overarching consideration of the restoration design was to maintain a steep slope for the Phase 1 portion (upstream of US 50) and a mild slope for the Phase 2 portion (downstream of US 50). By doing so Phase 1 will be dominated by sediment transport, and Phase 2 will be dominated by sediment deposition thereby restoring key alluvial fan processes in the system to meadow areas and avoiding sediment deposition and channel avulsion upstream of US 50.

Channel morphology

Channel characteristics of the restoration design should be based on those of a nearby, geomorphically stable reference channel. The reference reach for the Phase 1 design was chosen to be a relatively steep portion of Burke Creek, roughly 200 feet upstream from the eastern end of the parking lot and the Phase 1 reach (see Figure 8). The reference reach is dominated by step pools formed by wood, as is typical of channels with slopes between 3% and 8%. The radius of meander curvature is from 8 to 12 feet, the slope is 5 to 7 percent, and the sinuosity is approximately 1.2. The channel bottom width varies between 1 and 2 feet, and the channel banks are generally less than 1-foot high. The Phase 1 design should utilize similar dimensions in an effort to maintain sediment transport across Phase 1 and through the culvert.

Step-pool morphology

Much of the research on step-pool morphology presents the geometry of step-pools in terms of three variables: crest-to-crest spacing (L), step height (H, measured from the crest to the bottom of the next pool downstream), and average bed slope (S). A literature review by Chin and others (2008) summarized that the ratio of mean steepness (H/L) to average bed slope typically ranges between 1 and 2. This principle was applied to the step-pool design of Phase 1 with the following constraints:

- Minimum crest spacing = 8 feet (based on our experience with construction feasibility)
- Minimum crest drop[2] = 0.5 feet (based on our experience with realistic construction tolerances)
- Maximum crest drop = 1.5 feet (a maximum value from a dataset of natural systems; see Chartrand and others, 2011)

Flood control and maintenance of water surface elevations

The project must increase capacity under US 50 to eliminate the periodic channel overtopping caused by the existing 24-inch CMP. Eliminating spillage into the commercial development, however, is precluded by constraints upstream of the Phase 1 work. Specifically, the property boundary for the commercial development does not allow the widened floodplain corridor of Phase 1 to be maintained all the way to the Douglas County property to the east. The design team evaluated alternatives to decrease overbank spillage concluded that only a highly engineered and unnatural solution could address the problem within the limits of the project boundary, which would conflict with other project goals and carry a high cost-benefit ratio.

Fish passage criteria

Winzler and Kelley (2009) identified Lahontan Cutthroat Trout (LCT) as the target species for fish passage, and established that hydraulic parameters typically used for juvenile and adult rainbow trout were reasonable surrogates for LCT given their physiological similarities. In order to achieve the target channels slope with an appropriate channel form, most of the drops in the log and boulder step-pool structures of Phase 1 and Phase 2 are greater than the maximum water surface drop of 0.5 feet for juveniles and 0.67 feet for adults. Modifying the design to add more step-pool structures with smaller drops would reduce the length of pools between drops to the point of being too small and/or shallow to provide sufficient resting space and room to accelerate prior to jumping; moreover, the smaller pools would not be consistent with published geometrical relationships for naturally-occurring step pools. Furthermore, to provide fish passage, Phase 2 would need to be constructed entirely on fill which mean a much larger construction disturbance area, and would carry a higher risk of failure. For these reasons—and

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[2] Crest drop is not the same as step height. Crest drop is the difference in elevation between two consecutive step-pool crests.

because only a modest amount of habitat would be gained—the restoration design is not anticipated to provide fish passage according to the criteria presented by Winzler and Kelly (2009).

<u>*Hydrologic support for existing riparian and meadow habitat*</u>

Relocation of the US 50 culvert will alter the location where Burke Creek enters Rabe Meadow, and is anticipated to affect the hydrologic support for existing riparian vegetation for a portion of the existing channel. This portion of Burke Creek will continue to receive localized runoff, but vegetation may be affected by lowered groundwater levels. We recommend that the design limit the length of the channel that is abandoned to the extent practicable.

Phase 1 Design Recommendations

Sheets CS-1 through CS-5 of the 50% design plans (dated June 24, 2015) show the locations of the Phase 1 proposed treatments and restoration elements. The restoration design relies heavily on the use of natural materials (logs, boulders, and plantings), as consistent with natural channels found in this setting.

<u>*Gully stabilization*</u>

The recommendations for gully stabilization treatments are based on existing woody debris jams present along Burke Creek between Phase 1 and the upper meadow. By strategically placing woody debris in the channel, sediment deposition upstream of the jams will be enhanced, thereby gradually raising the bed elevation and decreasing the severity of incision. The jams should be composed of woody vegetation harvested from nearby willows and alders on Douglas County and USFS property. Jams should be anchored by embedding ends of logs into the banks and bed, then weaving smaller wood and branches against and between the logs. Where possible, the debris jams should be positioned where large trees have already fallen into the channel; the trees will be used to help anchor the jams. We recommend that the jams be spaced based on the channel slope, with elevations established so that one jam backwaters the toe of the next jam upstream.

<u>*Step-pools*</u>

Phase 1 relies heavily on the use of step-pool structures to maintain a steep, stable slope. Step-pools are typical to natural systems having slopes between three and eight percent; the existing Burke Creek channel upstream of US 50 and the proposed Burke Creek Phase 1 channel both have slopes of roughly seven percent so step-pools are recommended as a geomorphically-appropriate feature for the project.

We recommend that the step-pool geometry be based on the design criteria presented above. Crest spacing and step heights were varied so all step-pools are not uniform and do not appear to be engineered. The mixed use of log and boulders step-pools also enhances the variability in the design. We recommend that steps composed of boulders have their crest boulders staggered (i.e. not placed at same elevations) with lateral spacing between boulders not exceeding the D90 of the channel bed material. Doing so will allow the system to self-organize over time; the crest boulders will act as keystones, and smaller boulders and cobbles will lodge themselves between the crest boulder, creating a tightly interlocked structure (Knighton, 1998).

For step-pool sequences having large crest-to-crest spacing (more than 15 feet) we anticipate a short section of riffle to form between the pool and next crest downstream. We recommend the slope of the riffle section to be constructed to be no greater than two percent, based on typical slopes for stable riffles (Knighton, 1998).

Flow split structure

The Phase 1 design proposes to preserve a portion of the existing Burke Creek channel to be used as a high flow side channel. At the upstream end of Phase 1, a log flow split structure is proposed that will divert all flow up the 1.5-year event (3 cfs) to the new channel. Above 3 cfs, the total flow will be split between the new channel and the existing Burke Creek channel. The existing Burke Creek channel was designed to become active at the 1.5-year flow to maintain regular hydrologic support for existing, healthy vegetation along the channel. To achieve this objective, the hydraulic model suggests the crest of the log directing flow to the southwest and into the proposed Burke Creek channel should be 6325.2 feet, and the crest of the log directing flow to the west and into existing Burke Creek should be 6326.0.

Downstream of the flow split structure on the existing Burke Creek channel, only minor grading is proposed except where it rejoins the newly realigned Burke Creek channel. Since the capacity of the existing Burke Creek channel will not increase, the hydraulic model suggests that it will overtop at high flows, however, the overtopping will be directed toward the widened floodplain and will be entirely contained by the berm. The model suggests the existing Burke Creek channel will begin to overtop as described during the 25-year flow. The log flow split structure diverts only 10 cfs of the total 25-year flow to the existing Burke Creek channel which is enough to begin overtopping the left bank. The model suggests the overtopping is short-lived spatially, and only occurs immediately downstream of the flow split structure.

Channel and floodplain

The reference reach for Phase 1 is a relatively steep portion of Burke Creek, roughly 200 feet upstream from the eastern end of the commercial development's parking lot. The reference reach is dominated by step-pools formed by cobbles and wood. The radius of curvature ranges from 8 to 12 feet. These same parameters are recommended for the Phase 1 design in an effort to maintain sediment transport across the Phase 1 reach and through the culvert.

The recommended dimensions of the low flow channel for Phase 1 are based on characteristics of the reference reach as well. The low flow channel should be variable, but with an average bottom width of 1 foot, an average depth of 1 foot, and steep side slopes supported by cobbles, boulders, and large wood. By mimicking the dimensions and features found in the reference reach, we anticipate the floodplain will be inundated at a similar frequency. The hydraulic model suggests that floodplain begins to become inundated at 5 cfs (2-year flow). If post-project monitoring indicates that this is less frequent than desired for maintenance of floodplain vegetation, adaptive placement of wood and plantings can be employed to cause more frequent and dynamic overbank flooding.

Channel bed material

We recommend that channel bed material for Phase 1 be composed of sub-angular to rounded granitic rock, and have the following gradation, by weight:

D90 = 180 mm
D50 = 45 mm
D10 = 8 mm
D0 = 4mm (i.e. no material smaller than 4 mm)

The gradation is skewed toward coarser material because the watershed currently provides sand and gravels to the project reach.

Culvert

We have recommended that the culvert be as steep as the Phase 1 channel gradient, in order to promote the transport of as much sediment as possible under US 50 to the Phase 2 portion of the project, where sediment deposition, channel aggradation, channel avulsion, and alluvial fan restoration can take place. We understand, however, that existing utility alignments (in particular, a gravity sewer line) prevent this, however, and as a result, the slope of the culvert has been set at 3.6 percent, half of the Phase 1 reach-average slope (7.2%). Occasional deposition on the Phase 1 side of the culvert is therefore anticipated due to this slope break.

Because the culvert could not be made as steep as desired, the culvert outlet elevation is roughly 6 feet higher than the meadow surface at the toe of the US 50 embankment. Given the culvert outlet elevation, there were two plausible ways to design the Phase 2 portion of the project. Either (a) raise the elevation of the entire meadow and build Phase 2 on fill material, or (b) bring the channel down over a short distance to the existing meadow elevation with a steep cascade just downstream of the culvert outlet. Ultimately, we chose the latter option because building Phase 2 on fill would increase the reach-average slope for Phase 2 and reduce the likelihood of sediment deposition in the targeted area. Furthermore, placing non-native fill material in a dynamic, alluvial fan reach introduces undue risk to the project in terms of the material washing out during a major flood before vegetation has established to stabilize the area. Lastly, building Phase 2 on fill would not allow existing, high-quality portions of the meadow to be preserved.

Summary of Phase 1 recommended design parameters

Average bed slope	3 to 8 percent
Sinuosity	1.2
Meander radius of curvature	8 to 12 feet
Minimum culvert slope	3.6 percent
Channel width	1 to 2 feet
Channel depth	1 foot max
Step-pool crest spacing	8 feet min
Step-pool crest drop	0.5 to 1.5 feet

Phase 2 Design Elements

Sheets CS-6 and CS-7 of the 50% design plans (dated June 24, 2015) show the locations of the Phase 2 proposed treatments and restoration elements. The Phase 2 restoration design similarly relies heavily on the use of natural materials.

Culvert outlet protection/flow dissipater

As discussed above, the culvert outlet will require a steep cascade channel to bring Burke Creek down to the elevation of the existing meadow. Having a steep slope immediately downstream of the culvert will increase sediment transport to the meadow, and prevent deposition at the outlet. The designed cascade is roughly 50 feet long and has a slope of 11 percent. The cascade includes several large (greater than 3-foot diameter) boulders to stabilize the steep slope and roughen the channel. The boulders will be embedded into the banks of the low flow channel, alternating on the left and right sides. This will effectively decrease the slope of the low flow channel through the cascade by forcing it to “zig-zag” between the alternating boulders. During high flows the boulders will become mostly submerged, decrease velocities, and allow for energy dissipation. To add additional roughness and further stabilize the slope, willow pole cuttings are proposed along the overbank areas.

The cascade channel terminates in a pool to further reduce velocities before flow is released to the meadow via two outlets: one for the realigned mainstem of Burke Creek and one for the breakout channel. Several embedded logs and boulders will form the downstream side of the pool, and will maintain the thalweg elevation of Burke Creek and the breakout channel (the elevation for either will be approximately equal to evenly divide flow between both channels). The pool will be lined with a well-graded mixture of sub-angular rock to protect against scour, and the surrounding area will be planted following construction to ensure long-term stability.

Though downstream of US 50—the demarcation between Phases 1 and 2—we recommend the culvert outlet work will be done as part of Phase 1 in order to protect the steep outlet slope against erosion in the year between constructing the two phases. Flow will travel overland toward the pond during this period, and no temporary diversion channel is proposed.

Breakout channel

Distributary channels are common in alluvial fan environments, as such a breakout channel was included in the Phase 2 design because a multi-thread planform is an appropriate morphology for Burke Creek given its geomorphic setting. Furthermore, the breakout channel provides an opportunity to maintain hydrologic support for existing, healthy riparian vegetation that would otherwise be bypassed by realigning Burke Creek, and distributes flow throughout the meadow to restore wet meadow conditions. We recommend that the willow and alders growing adjacent to the abandoned portion of Burke Creek be thinned to remove half of the trees for re-use in the re-aligned channel corridor, where appropriate. Only removing half the trees will allow the existing trees to survive in case the groundwater decline is limited and is anticipate to be more aesthetically pleasing that complete removal of the riparian corridor. Moreover, there may be habitat value associated with the dead and dying trees.

Grade control and bank logs

The design for both the realigned Phase 2 channels includes grade control logs and bank logs. The grade control logs are oriented perpendicular to the channel and are buried so only the top one to two inches of the logs are exposed at the thalweg. Their purpose is to maintain the slope of the channel and to prevent reach-wide vertical incision by stopping headcuts, should they form. By taking this measure to prevent incision, the potential for longevity of wet meadow conditions is greatly increased. The bank logs are oriented parallel to the channel and are placed at the outsides of meander bends to prevent lateral erosion of the banks that would introduce sediment to the system and potentially flank the grade control logs.

Log step pools

Further downstream in Phase 2 the slope of the meadow steepens to a point where it is likely the channel would incise through the native meadow soils. To reduce the risk of incision, the Phase 2 design include a series of log step-pool structures, similar to those of Phase 1. Again, preventing incision is critical in maintaining the shallow groundwater needed to restore wet meadow conditions and limiting sediment generation and delivery to downstream.

LIMITATIONS

This report was prepared in general accordance with the accepted standard of practice in surface-water and groundwater hydrology existing in Western Nevada and the Sierra Nevada for projects of similar scale at the time the investigations were performed. No other warranties, expressed or implied, are made.

As is customary, we note that readers should recognize that interpretation and evaluation of subsurface conditions and physical factors affecting the hydrologic context of any site is a difficult and inexact art. Judgments leading to conclusions and recommendations are generally made with an incomplete knowledge of the conditions present. More extensive or extended studies, including additional hydrologic and sediment transport baseline monitoring, can reduce the inherent uncertainties associated with such studies. We note, in particular, that many factors affect local and regional hydrology and hydraulics levels. If the client wishes to further reduce the uncertainty beyond the level associated with this study, Balance should be notified for additional consultation.

We have used standard environmental information such as precipitation, hydrology, topographic mapping, and soil mapping, and work by previous investigators in our analyses and approaches without verification or modification, in conformance with local custom. New information or changes in regulatory guidance could influence the plans or recommendations, perhaps fundamentally. As updated information becomes available, the interpretations and recommendations contained in this report may warrant change. To aid in revisions, we ask that readers or reviewers advise us of new plans, conditions, or data of which they are aware.

Concepts, findings and interpretations contained in this report are intended for the exclusive use of the Nevada Tahoe Conservation District under the conditions presently prevailing except where noted otherwise. Their use beyond the boundaries of the site could lead to environmental or structural damage, and/or to noncompliance with water-quality policies, regulations or permits. Data developed or used in this report were collected and interpreted solely for developing an understanding of the hydrologic context at the site as an aid to conceptual planning and channel and wetland restoration design. They should not be used for other purposes without great care, updating, review of sampling and analytical methods used, and consultation with Balance staff familiar with the site. In particular, Balance Hydrologics, Inc. should be consulted prior to applying the contents of this report to geotechnical or facility design, routine wetland management, sale or exchange of land, or for other purposes not specifically cited in this report.

Finally, we ask once again that readers who have additional pertinent information, who observed changed conditions, or who may note material errors should contact us with their findings at the earliest possible date, so that timely changes may be made.

Figures

Appendices

References

Chartrand, S.M., Jellinek, M., and others, 2011, Geometric scaling of step-pools in mountain streams – observations and implication: Geomorphology, vol. 129, p. 141 – 151.

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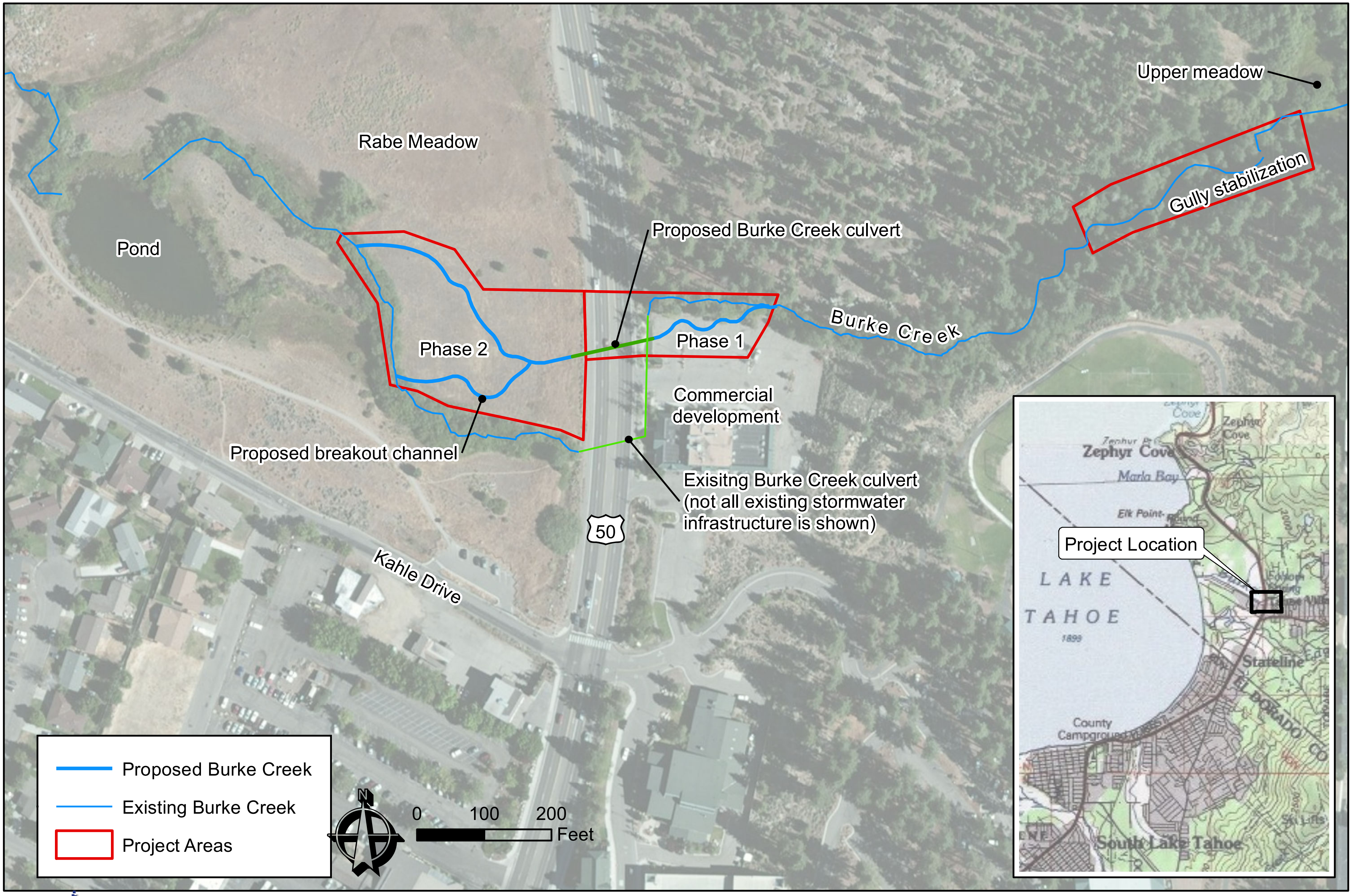
FIGURES

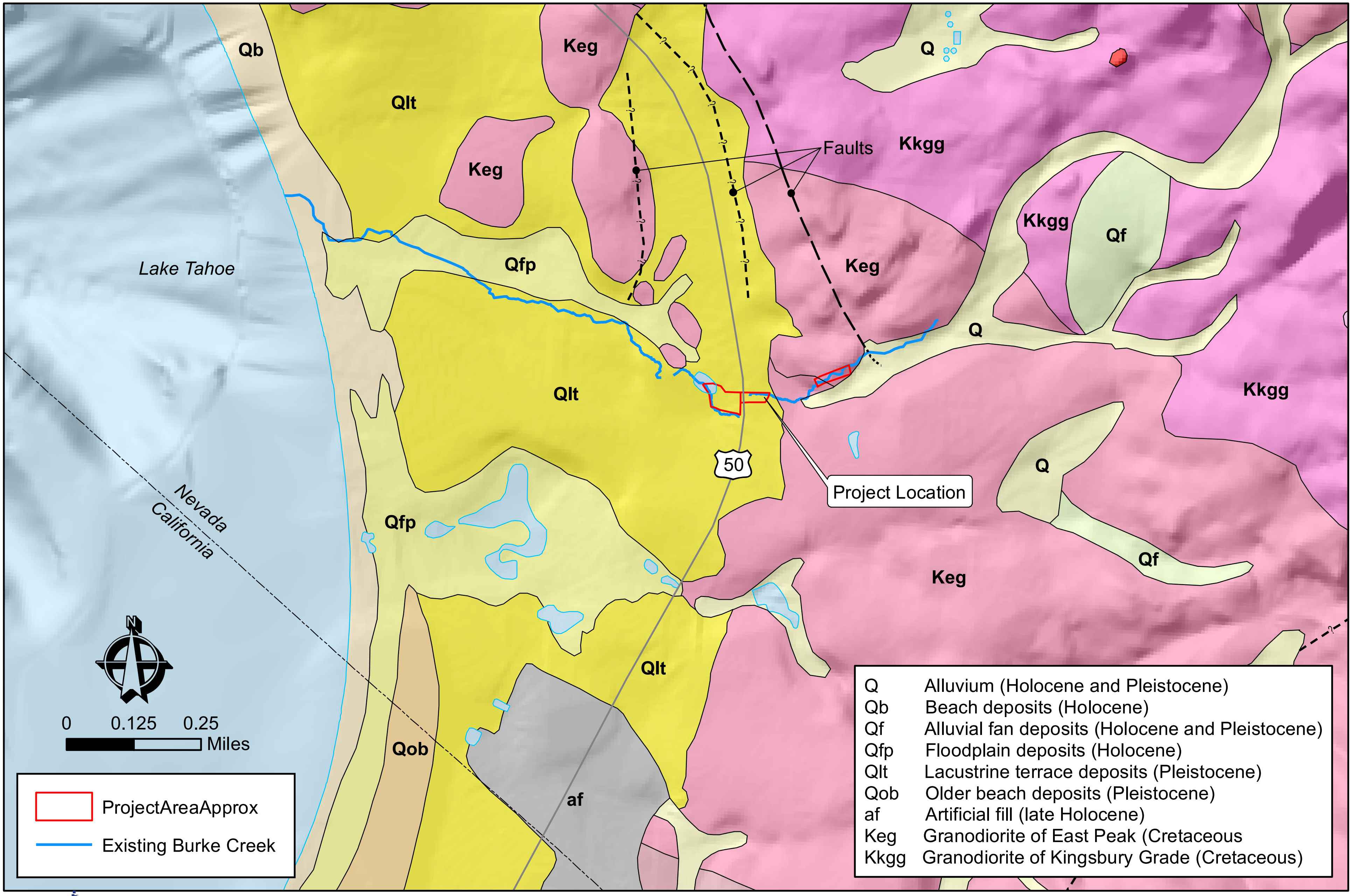


Balance Hydrologics, Inc.

Figure 1. Burke Creek restoration project overview, Douglas County, Nevada

Source: ESRI ArcGIS Online and data partners including USGS

Y:\GIS\Projects\214156 Burke Creek Restoration\Figures\214156 Fig1 Overview.mxd



Balance Hydrologics, Inc.

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Figure 2. Geology map showing the location of the Burke Creek restoration project, Douglas County, Nevada

Source: Saucedo (2008)

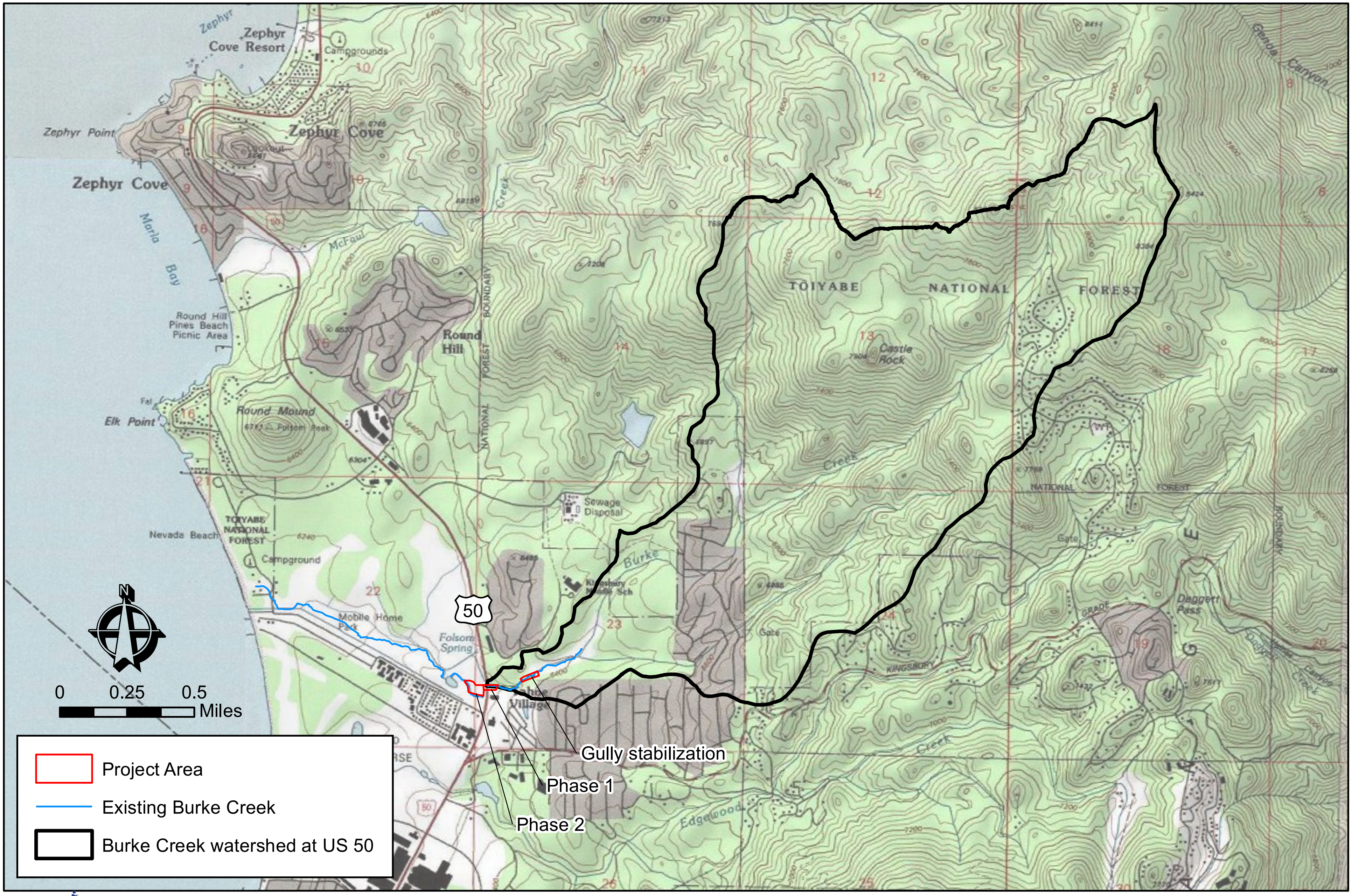

Figure 3. Burke Creek watershed, Douglas County, Nevada

Source: Wood Rodgers; USGS

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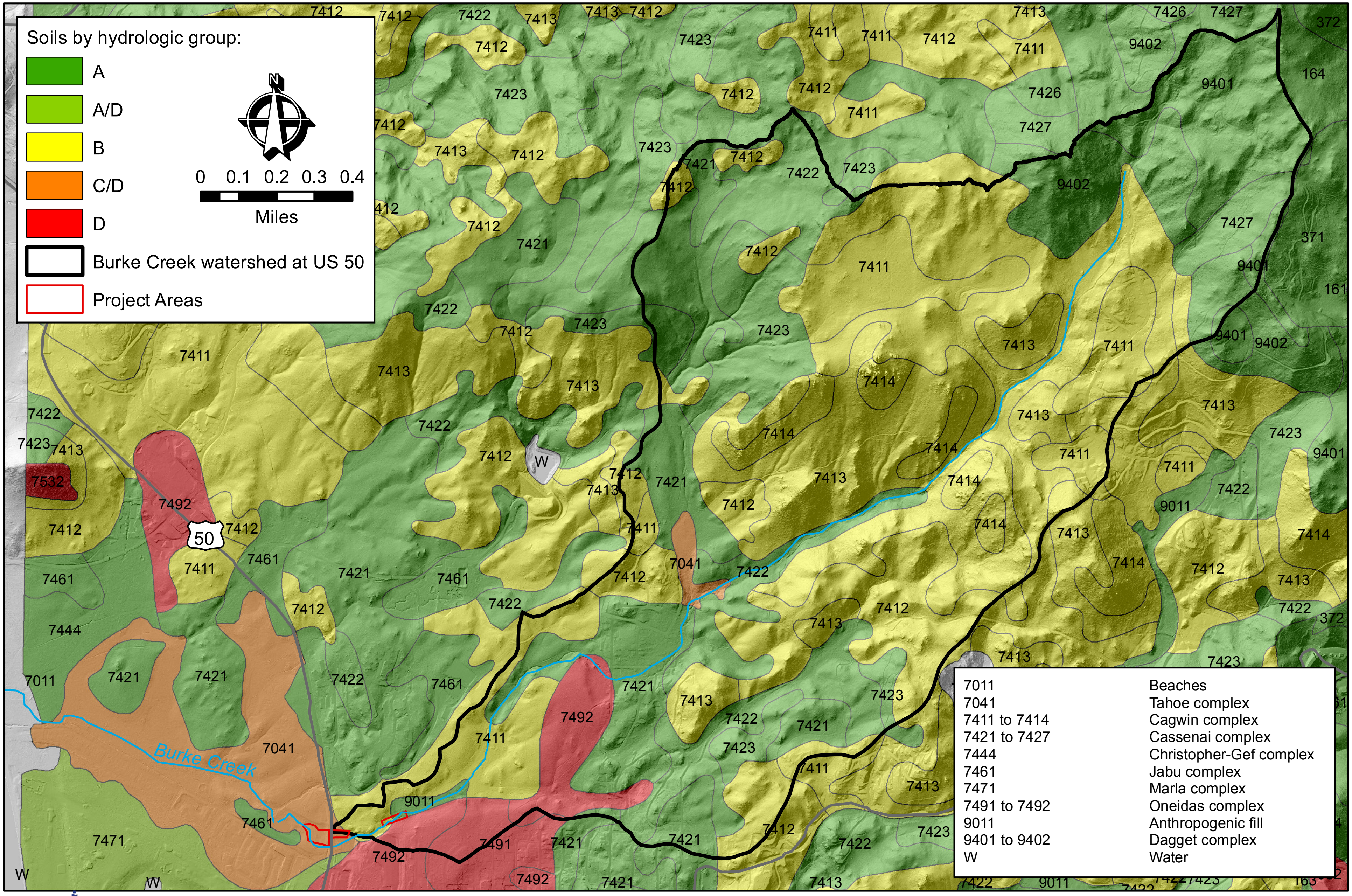

Balance Hydrologics, Inc.

Figure 4. Soils map for Burke Creek watershed, Douglas County, Nevada

Sources: NRCS, TRPA, USGS, NHD

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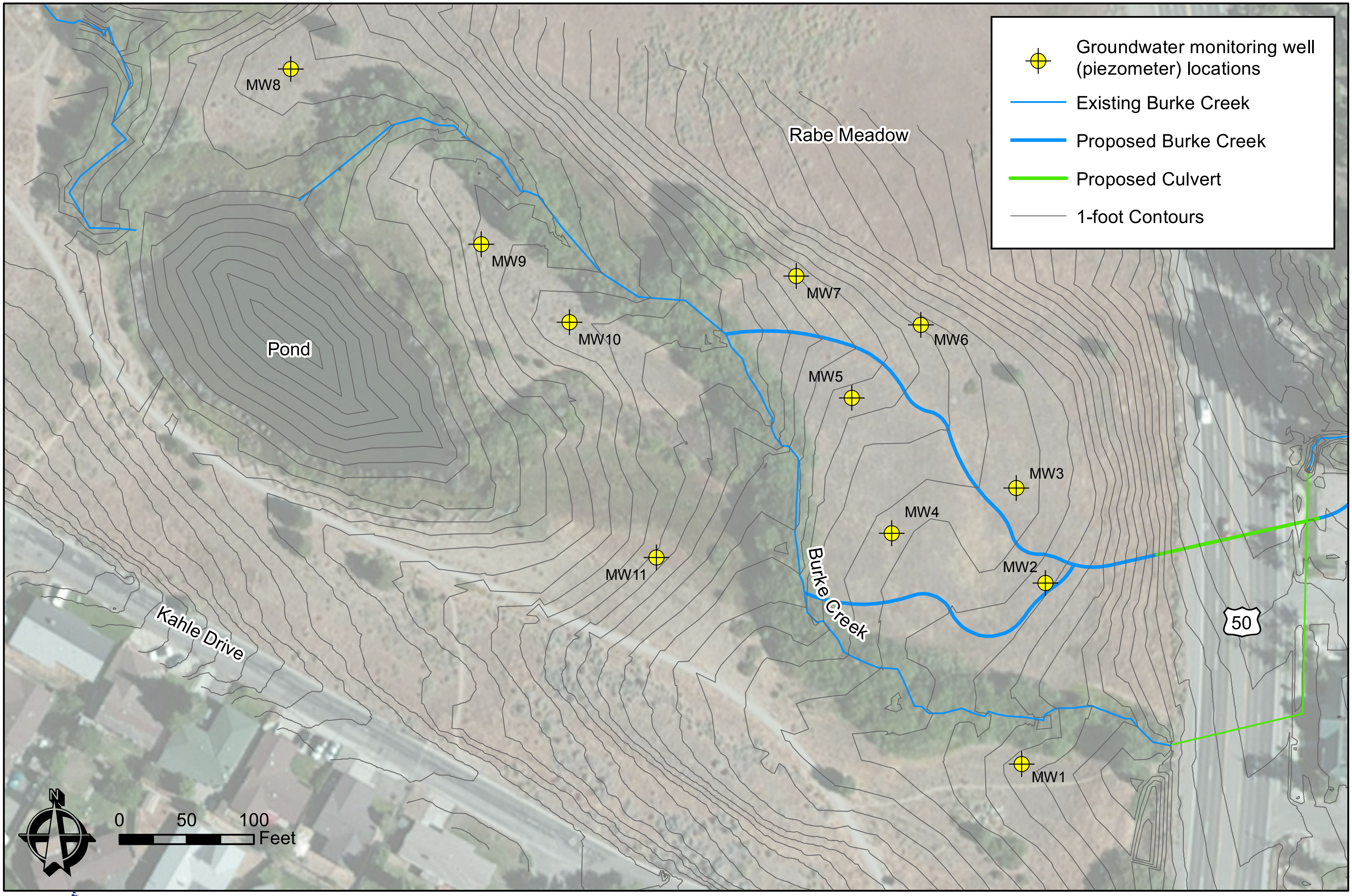

Balance Hydrologics, Inc.

Figure 5. Burke Creek groundwater monitoring well locations, Douglas County, Nevada

Sources: ESRI ArcGIS Online and data partners including USGS, well locations provided by NTCD

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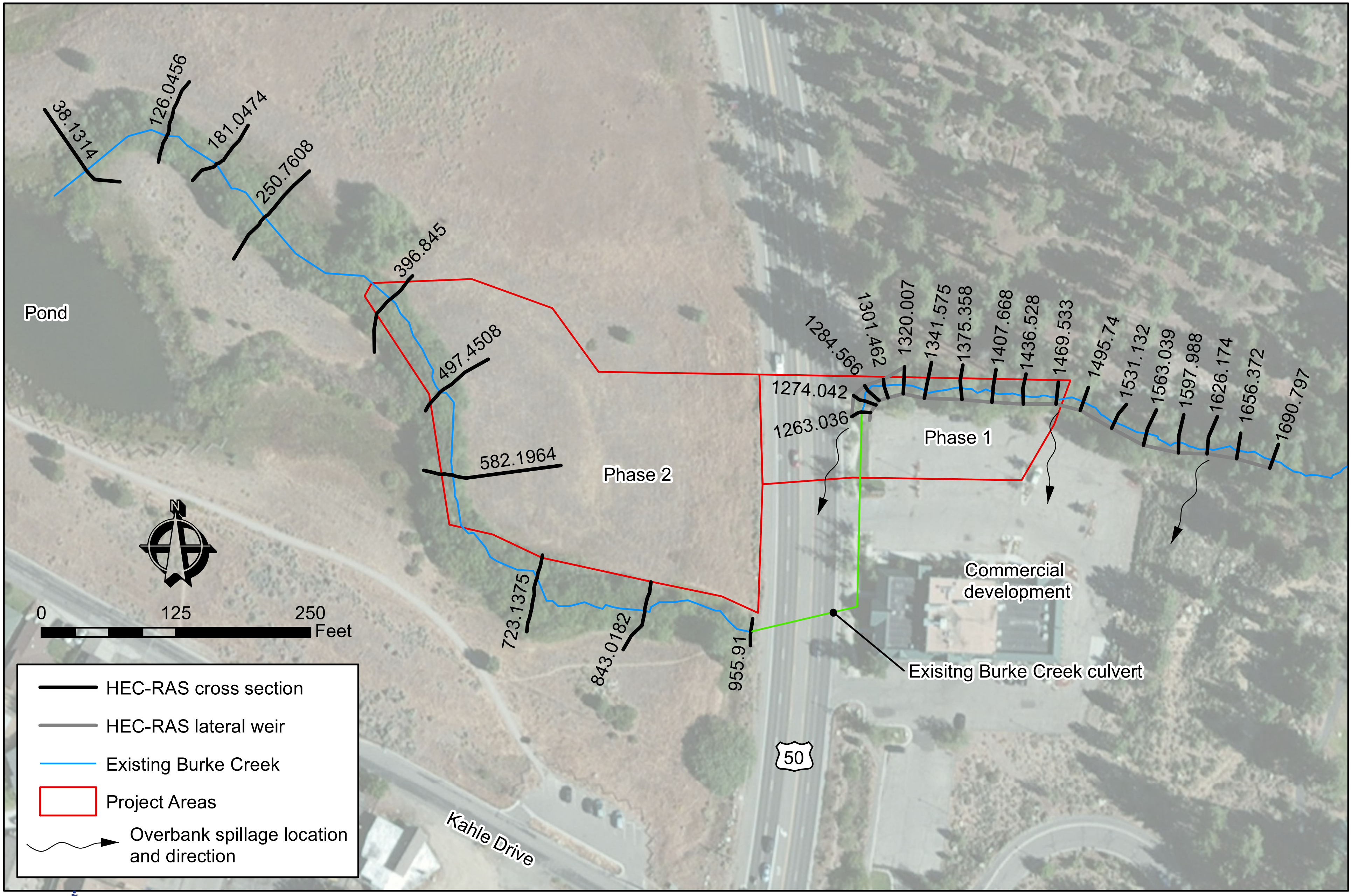

Balance Hydrologics, Inc.

Figure 6. Existing HEC-RAS cross section locations, Douglas County, Nevada

Source: ESRI ArcGIS Online and data partners including USGS

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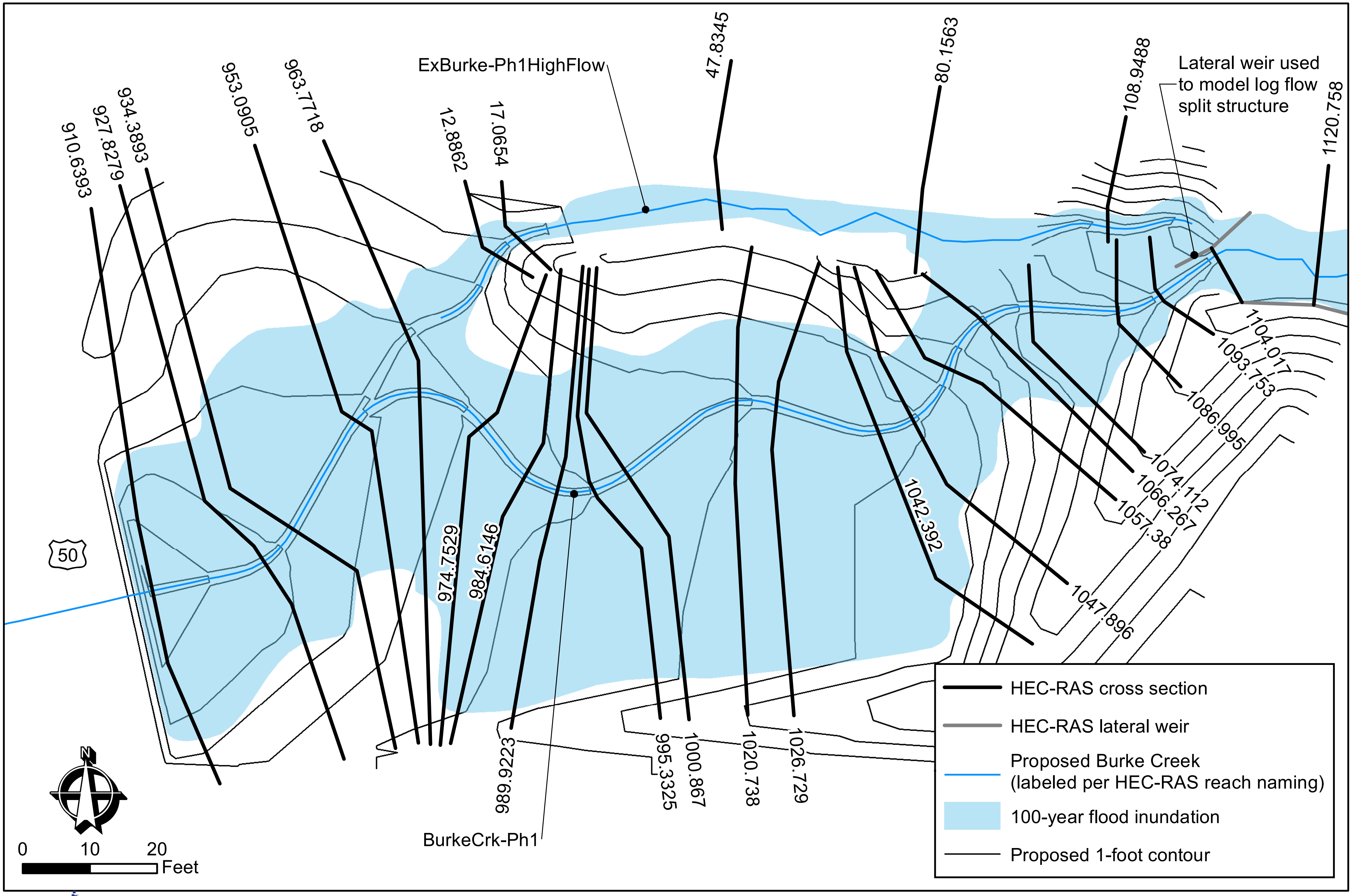

Balance Hydrologics, Inc.

Figure 7. Proposed HEC-RAS cross section locations, Burke Creek Restoration, Phase 1 Douglas County, Nevada

Source: NTCD (proposed topography)

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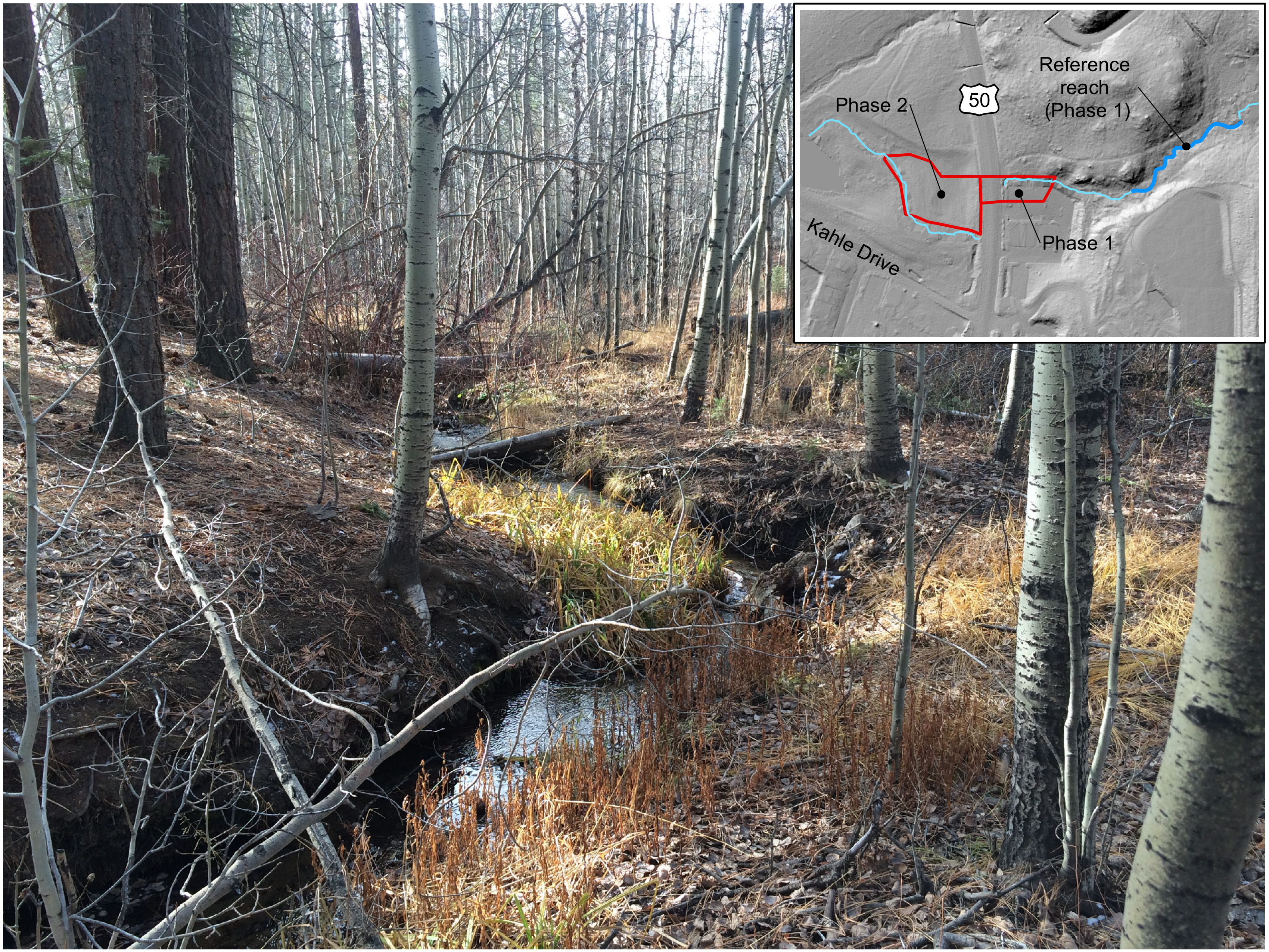

Balance Hydrologics, Inc.

Figure 8. Burke Creek Phase 1 reference reach, Douglas County, Nevada

Source: USGS

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APPENDIX A:
PHASE 1 AND PHASE 2 50 PERCENT DESIGN

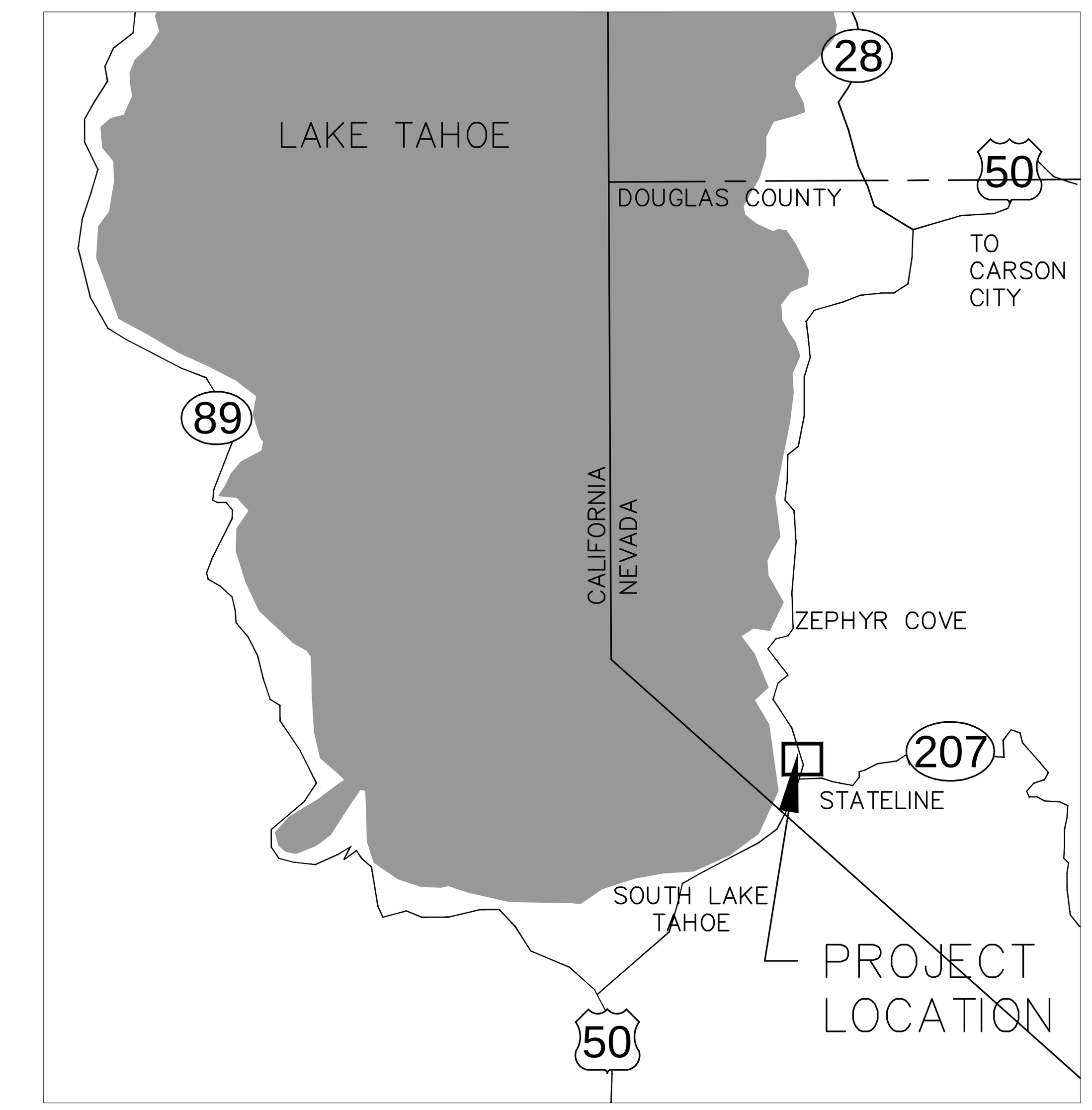
NEVADA TAHOE CONSERVATION DISTRICT

BURKE CREEK HIGHWAY 50 CROSSING AND REALIGNMENT PROJECT

IN THE COUNTY OF DOUGLAS

PLAN
SCALE: 1" = 150'

SHEET INDEX



VICINITY MAP
NOT TO SCALE

ENGINEER:

MEGHAN C. KELLY, P.E.
REGISTERED CIVIL ENGINEER
STATE OF NEVADA, NO. 20851
NEVADA TAHOE CONSERVATION DISTRICT
400 DORLA CT.
ZEPHYR COVE, NV 89448
(775) 586-1610

DATE

APPROVAL:

ERIK NILSSEN, P.E.
DOUGLAS COUNTY ENGINEER

DATE

USFS?

DATE

NDOT?

DATE

50% DESIGN PLANS
NOT FOR CONSTRUCTION

Nevada Tahoe Conservation District

TITLE
BURKE CREEK HWY 50 CROSSING AND REALIGNMENT PROJECT

DESIGNED/DRAWN	MK/MK
CHECKED	MG
DATE	6/24/2015
SCALE	AS SHOWN
PROJECT	BCC
SHEET	*i*

GENERAL NOTES

1. ALL IMPROVEMENTS SHALL BE ACCOMPLISHED UNDER THE APPROVAL, INSPECTION, AND TO THE SATISFACTION OF NEVADA TAHOE CONSERVATION DISTRICT (NTCD) & THE NEVADA DEPARTMENT OF TRANSPORTATION (NDOT). IMPROVEMENT CONSTRUCTION SHALL COMPLY WITH THESE PLANS AND THE MOST RECENT STANDARD SPECIFICATIONS & PLANS FOR ROAD & BRIDGE CONSTRUCTION ("STANDARD SPECIFICATIONS"). AND CONSTRUCTION NOT SPECIFIED IN THESE PLANS SHALL CONFORM TO THE REQUIREMENTS OF THE STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION. THE CONTRACTOR IS OBLIGATED TO BE FAMILIAR WITH APPLICABLE SECTIONS OF THE STANDARD SPECIFICATIONS NOT DISCUSSED IN THE GENERAL NOTES. THE CONTRACT SPECIAL TECHNICAL PROVISIONS SHALL SUPERSEDE THOSE OF THE STANDARD SPECIFICATIONS WHERE DISCREPANCIES OCCUR.
2. CONTRACTOR SHALL MAINTAIN A SET OF PLANS ON SITE SHOWING "AS CONSTRUCTED" CHANGES. UPON COMPLETION, CONTRACTOR SHALL SUPPLY NDOT AND NTCD A SET OF "AS BUILT" PLANS.
3. MOBILIZATION AREAS ARE TO BE SECURED BY THE CONTRACTOR AND APPROVED BY TRPA. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTENANCE OF MOBILIZATION SITES, INCLUDING PLACEMENT AND MAINTENANCE OF BMPS.
4. PRIOR TO STARTING WORK, THE CONTRACTOR SHALL INSTALL TEMPORARY BMP MEASURES AT LOCATIONS WHERE NEEDED TO CONTROL EROSION AND WATER POLLUTION DURING THE CONSTRUCTION OF THE PROJECT. THE BMP MEASURES SHALL REMAIN IN PLACE AND SHALL BE MAINTAINED IN A FUNCTIONAL CONDITION FOR THE DURATION OF THE CONSTRUCTION. SILT FENCE IS REQUIRED AT ALL CROSS DRAIN OUTLETS. SILT FENCE OR SEDIMENT LOGS WILL BE REQUIRED AT OTHER LOCATIONS AS SHOWN ON THE DRAWINGS OR STAKED IN THE FIELD BY THE ENGINEER. ALL EROSION CONTROL MEASURES SHALL MEET OR EXCEED TRPA REQUIREMENTS.
5. ALL EXISTING VEGETATION SHALL BE PRESERVED UNLESS SPECIFICALLY IDENTIFIED BY THE ENGINEER FOR REMOVAL. BMP'S TO PROTECT VEGETATION SHALL BE INSTALLED BY THE CONTRACTOR IF REQUIRED BY TRPA. CONTRACTOR TO REVEGETATE ANY AREAS OUTSIDE THE DISTURBED AREA SHOWN ON THE PLANS WITH PLANTS APPROVED BY TRPA AT THEIR OWN EXPENSE.
6. NTCD WILL PROVIDE ONE SET OF CONSTRUCTION STAKES AT NTCD'S EXPENSE. ADDITIONAL CONSTRUCTION STAKES WILL BE PROVIDED AT THE CONTRACTOR'S EXPENSE. LIMITS FOR ALL ITEMS OF WORK SHALL BE STAKED IN THE FIELD BY THE ENGINEER. THESE LIMITS AND THE RESULTING TREATMENT LENGTH/AREAS MAY VARY FROM THOSE SHOWN ON THE DRAWINGS. PAYMENT FOR ITEMS OF WORK WILL BE MADE FOR THE AMOUNT AUTHORIZED BY THESE FIELD STAKED LIMITS AND THE SPECIAL TECHNICAL PROVISIONS.
7. UTILITY LOCATIONS SHOWN ON THE DRAWINGS ARE APPROXIMATE. WHERE EXCAVATION IS NECESSARY, THE CONTRACTOR SHALL CONTACT UNDERGROUND SERVICE ALERT (USA) AND ALL AFFECTED UTILITY COMPANIES TO LOCATE ALL BURIED UTILITIES AT LEAST 48 HOURS PRIOR TO EXCAVATION. THE CONTRACTOR SHALL COORDINATE WITH UTILITY COMPANIES FOR RELOCATION OF UTILITIES AS REQUIRED BY THE WORK. WHENEVER CONNECTIONS TO OR CLEARANCE FROM ANY UTILITY IS REQUIRED, THE CONTRACTOR SHALL POTHOLE TO VERIFY THE LOCATION, SIZE AND MATERIAL OF THE UTILITY PRIOR TO CONSTRUCTION.
8. ASPHALT REPLACEMENT SHALL INCORPORATE A 4% ±1% CROSS SLOPE BETWEEN THE SAWCUT AND THE NEW ROADSIDE TREATMENT. NEW ROADSIDE FLOW CONVEYANCES SHALL INCORPORATE SUCH GRADE AS NECESSARY TO GUARANTEE WATER CONTINUES TO FLOW IN THE PRESENT DIRECTION, WITHOUT PONDING OR BREAKOUTS.
9. ALL WORK SHALL BE DONE WITHIN THE NDOT RIGHT-OF-WAY UNLESS EASEMENT OR CONSTRUCTION PERMIT HAS BEEN ACQUIRED BY NDOT, IN WHICH CASE THE LIMITS OF WORK ARE AS SPECIFIED ON THE DRAWINGS. ANY DAMAGE DONE BY THE CONTRACTOR OR HIS SUBCONTRACTORS TO PRIVATE PROPERTY AND/OR OUTSIDE OF THE NOTED LIMITS OF WORK IS SOLELY THE RESPONSIBILITY OF THE CONTRACTOR AND/OR HIS SUBCONTRACTORS.
10. NTCD WILL PROVIDE INITIAL TESTING AND INSPECTION OF WORK AND MATERIAL AT NTCD'S EXPENSE. THE COST OF REMOVAL AND/OR REPLACEMENT OF ANY DEFECTIVE WORK OR MATERIAL IS THE RESPONSIBILITY OF THE CONTRACTOR. THE COST OF RETESTING AND/OR INSPECTING OF REPLACED WORK AND MATERIAL IS ALSO THE RESPONSIBILITY OF THE CONTRACTOR. SUCH COSTS WILL BE DEDUCTED FROM ANY MONEYS DUE OR WHICH MAY BECOME DUE TO THE CONTRACTOR.
11. STANDARD WORK DAYS SHALL BE MONDAY THROUGH FRIDAY. SATURDAY AND SUNDAY MAY BE WORKED ON OCCASION ONLY TO MAKE UP FOR WEATHER DELAYS OR OTHER SCHEDULE DELAYS. NOISE GENERATING ACTIVITIES WILL BE LIMITED TO THE HOURS OF 8:00 AM TO 6:30 PM.
12. NOISE SHALL BE REDUCED BY THE MANDATORY USE OF MUFFLERS ON ALL CONSTRUCTION VEHICLES AND EQUIPMENT. WHERE FEASIBLE, SOLENOIDAL PAVEMENT BREAKERS WILL BE USED IN LIEU OF AIR POWERED JACK HAMMERS. NOISE GENERATING ACTIVITIES WILL BE LIMITED TO THE HOURS OF 8:00 AM TO 6:30 PM.
13. THE CONTRACTOR SHALL PROVIDE A WATER TRUCK TO WATER AREAS AS NECESSARY TO CONTROL DUST. THE CONTRACTOR WILL PROVIDE SWEEPING AT THE END OF EACH DAY.
14. ALL TREES AND NATURAL VEGETATION TO REMAIN ON THE SITE SHALL BE PROTECTED PER TRPA.
15. SOIL AND CONSTRUCTION MATERIAL SHALL NOT BE TRACKED OFF THE CONSTRUCTION SITE. GRADING OPERATIONS SHALL CEASE IN THE EVENT THAT A DANGER OF VIOLATING THIS CONDITION EXISTS.
16. DURING CONSTRUCTION ENVIRONMENTAL PROTECTION DEVICES, SUCH AS EROSION CONTROL, DUST CONTROL, AND VEGETATION PROTECTION DEVICES SHALL BE MAINTAINED AT ALL TIMES.
17. LOOSE SOIL MOUNDS OR SURFACES SHALL BE PROTECTED FROM WIND OR WATER EROSION BY BEING APPROPRIATELY COVERED WHEN CONSTRUCTION IS NOT IN ACTIVE PROGRESS OR WHEN REQUIRED BY TRPA.
18. EXCAVATED MATERIAL SHALL BE STORED UPGRADE FROM THE EXCAVATED AREA WHENEVER POSSIBLE. NO MATERIAL SHALL BE STORED IN ANY STREAM ENVIRONMENT ZONE (SEZ) OR WET AREA.
19. ONLY EQUIPMENT OF A SIZE AND TYPE THAT WILL DO THE LEAST AMOUNT OF DAMAGE, UNDER PREVAILING SITE CONDITIONS, AND CONSIDERING THE NATURE OF THE WORK TO BE PERFORMED, WILL BE USED. ALL HEAVY MACHINERY WORK SHALL BE PERFORMED FROM PAVED SURFACES TO AVOID SOIL COMPACTION.
20. NO WASHING OF VEHICLES OR HEAVY EQUIPMENT, INCLUDING CEMENT MIXERS, SHALL BE PERMITTED ANYWHERE ON THE SUBJECT PROPERTY UNLESS AUTHORIZED BY TRPA IN WRITING.
21. NO VEHICLE OR HEAVY EQUIPMENT SHALL BE ALLOWED IN A STREAM ENVIRONMENT ZONE OR WET AREA EXCEPT AS AUTHORIZED BY TRPA.
22. ALL CONSTRUCTION SHALL BE WINTERIZED BY OCTOBER 15 TO REDUCE THE WATER QUALITY IMPACTS ASSOCIATED WITH WINTER WEATHER.
23. THE CONTRACTOR AND/OR THEIR AUTHORIZED AGENTS SHALL EACH DAY REMOVE ALL SEDIMENT, MUD, CONSTRUCTION DEBRIS, OR OTHER POTENTIAL POLLUTANTS THAT MAY HAVE BEEN DISCHARGED TO, OR ACCUMULATE IN, THE NDOT RIGHT-OF-WAYS AS A RESULT OF CONSTRUCTION ACTIVITIES ASSOCIATED WITH THIS SITE DEVELOPMENT OR CONSTRUCTION PROJECT. SUCH MATERIALS SHALL BE PREVENTED FROM ENTERING THE STORM SYSTEM.
24. ADDITIONAL CONSTRUCTION SITE DISCHARGE BEST MANAGEMENT PRACTICES MAY BE REQUIRED OF THE OWNER AND HIS OR HER AGENTS DUE TO UNFORESEEN EROSION PROBLEMS OR IF THE SUBMITTED PLAN DOES NOT MEET THE PERFORMANCE STANDARDS SPECIFIED IN THE TRUCKEE MEADOWS CONSTRUCTION SITE BEST MANAGEMENT PRACTICE HANDBOOK.
25. TEMPORARY OR PERMANENT STABILIZATION PRACTICES WILL BE INSTALLED ON DISTURBED AREAS AS SOON AS PRACTICABLE AND NO LONGER THEN 24 HOURS AFTER THE CONSTRUCTION ACTIVITY IN THAT PORTION OF THE SITE HAS BEEN TEMPORARILY OR PERMANENTLY CEASED.
26. AT A MINIMUM, THE CONTRACTOR OR HIS AGENT SHALL INSPECT ALL DISTURBED AREAS, AREAS USED FOR STORAGE OF MATERIALS AND EQUIPMENT THAT ARE EXPOSED TO PRECIPITATION, VEHICLE ENTRANCE AND EXIT LOCATIONS, AND ALL BMP'S WEEKLY, PRIOR TO A FORECASTED RAIN EVENT AND WITHIN 24 HOURS AFTER ANY ACTUAL RAIN EVENT. SOME EXCEPTIONS TO WEEKLY INSPECTIONS MAY APPLY, SUCH AS FROZEN GROUND CONDITIONS OR SUSPENSION OF LAND DISTURBANCE ACTIVITIES. REFER TO STORM WATER GENERAL PERMIT NVR100000, SECTION 1.B.1.g.
27. TRAFFIC CONTROL AND LANE CLOSURES WILL BE PER NDOT STANDARD SPECIFICATIONS.
28. ACCESS TO BUSINESSES SHALL BE MAINTAINED THROUGHOUT THE DURATION OF CONSTRUCTION

ABBREVIATIONS

NOT ALL ABBREVIATIONS LISTED ARE USED IN THESE PLANS

A.B.	AGGREGATE BASE	MDD	MAXIMUM DRY DENSITY
AC.	ACRE	MJ	MECHANICAL JOINT
A.C.	ASPHALT CONCRETE	MI.	MILE
@	AT	MIN.	MINIMUM
APPROX.	APPROXIMATE	MISC.	MISCELLANEOUS
AVG.	AVERAGE	N	NORTH
AWWA	AMERICAN WATER WORKS ASSOCIATION	N.I.C.	NOT IN CONTRACT
BC	BEGIN CURVE	NDOT	NEVADA DEPT OF TRANSPORTATION
C&G	CURB AND GUTTER	NTCD	NEVADA TAHOE CONSERVATION DISTRICT
CATV	CABLE TELEVISION	N.T.S.	NOT TO SCALE
C.B.	CATCH BASIN	NO.	NUMBER
CL	CENTERLINE	OC	ON CENTER
CLR.	CLEAR	OG	ORIGINAL GRADE
CO.	CLEAN OUT	OH(E/T)	OVERHEAD ELECTRIC OR TELEPHONE LINES
CONST.	CONSTRUCT	±	PLUS OR MINUS
CF	CUBIC FEET	PT.	POINT
CMP	CORRIGATED METAL PIPE	PCC	POINT OF COMPOUND CURVE, PORTLAND CEMENT CONCRETE
CY	CUBIC YARD	PC	POINT OF CURVATURE
D.G.	DECOMPOSED GRANITE	PI	POINT OF INFLECTION
DEG	DEGREE(S)	PIP	PROTECT IN PLACE
DI	DROP INLET	PVC	POLYVINYL CHLORIDE
DIA.	DIAMETER	PVMT	PAVEMENT
DR	DIMENSION RATIO	POC	POINT ON CURVE
DWG	DRAWING	POS	POSITIVE
DW, DWY	DRIVEWAY	PRC	POINT OF REVERSE CURVE
EA.	EACH	PSI	POUNDS PER SQUARE INCH
EASE.	EASEMENT	PL	PROPERTY LINE
EG	EXISTING GRADE	PO	PUSH ON
ELEC	ELECTRIC	PUE	PUBLIC UTILITY EASEMENT
EP	EDGE OF PAVEMENT	R	RADIUS
ELEV.	ELEVATION	RCP	REINFORCED CONCRETE PIPE
EC	END CURVE	REVEG	REVEGATATION
EX.	EXISTING	RLC	ROCK LINED CHANNEL
FG	FINISH GRADE	RT,R	RIGHT
FH	FIRE HYDRANT	R/W, ROW	RIGHT-OF-WAY
FCA	FLANGE COUPLER ADAPTER	SS	SANITARY SEWER, STAINLESS STEEL
FES	FLARED END SECTION (METAL)	SSCO.	SANITARY SEWER CLEAN OUT
FL	FLOWLINE	SSMH	SANITARY SEWER MANHOLE
FLG	FLANGED	S	SLOPE
FT.	FOOT, FEET	S	SOUTH
FTG	FOOTING	SF	SQUARE FOOT/FEET
FV	FLUSH VALVE	SHT	SHEET
°	DEGREE	STD	STANDARD
G	GAS	SDR	STANDARD DIMENSION RATIO
GV	GATE VALVE	SSPWC	STANDARD SPECIFICATIONS FOR PUBLIC WORKS
GB	GRADE BREAK	STA	STATION
HDPE	HIGH DENSITY POLYETHYLENE	SD	STORM DRAIN
HDPE-NP	NON-PERFORATED HIGH DENSITY POLYETHYLENE	SDMH	STORM DRAIN MANHOLE
HDPE-P	PERFORATED HIGH DENSITY POLYETHYLENE	TBC	TOP BACK OF CURB
HP	HIGH POINT	TOC	TOP OF CURB
HOR., HORIZ.	HORIZONTAL	TRPA	TAHOE REGIONAL PLANNING AGENCY
IN.	INCH	TW	TOP OF WALL
IE	INVERT ELEVATION	TYP	TYPICAL
IRR.	IRRIGATION	UGE	UNDERGROUND ELECTRIC LINES
IVGID	INCLINE VILLAGE GENERAL IMPROVEMENT DISTRICT	UGT	UNDERGROUND TELEPHONE LINES
L	LEFT	VC	VERTICAL CURVE
LEN.	LENGTH	VG	VALLEY GUTTER
LF	LINEAR FEET	VPC	VERTICAL POINT OF CURVATURE
LID	LOW IMPACT DEVELOPMENT	VPI	VERTICAL POINT OF INFLECTION
LP	LOW POINT	VPT	VERTICAL POINT OF TANGENT
LS	LUMP SUM	W	WATER
MH	MANHOLE	WL	WATERLINE
MAX.	MAXIMUM	W	WEST
		W/	WITH
		WM	WATER METER

UTILITIES

CABLE TELEVISION	CHARTER COMMUNICATIONS, (775) 588-1077
NATURAL GAS	SOUTHWEST GAS, (877) 860-6022
ELECTRIC	NV ENERGY, (775) 834-4444
STORM DRAIN	DOUGLAS COUNTY PUBLIC WORKS (775) 782-9989
SEWER	DOUGLAS COUNTY SEWER IMPROVEMENT DISTRICT (775) 588-3558
WATER	KINGSBURY GID, (775) 588-3548
PHONE	ATT, (800) 288-2020
USA DIGS	(800) 642-2444 OR 811

LEGEND

NOTE: LEGENDS PROVIDED ON INDIVIDUAL PLAN SHEETS OVERRIDES THIS LEGEND

EXISTING

- MAJOR CONTOUR
- MINOR CONTOUR
- 6695 — EXISTING MAJOR CONTOUR LABEL
- 5+00 — EXISTING ALIGNMENT
- EXISTING GRADE (SECTION VIEW)
- PROPERTY LINE
- EXISTING FENCE
- OR PAVEMENT
- SD — STORM DRAIN LINE
- CATCH BASIN
- STORM DRAIN MANHOLE
- W — WATER LINE
- WM — WATER METER/ VALVE
- SS — SANITARY SEWER LINE
- SS — SANITARY SEWER MANHOLE
- OH E — OVERHEAD ELECTRIC LINE
- POWER POLE
- UG T — UNDER GROUND TELEPHONE LINES
- OH T — OVERHEAD TELEPHONE LINES
- UG FO — UNDERGROUND FIBER OPTIC LINES
- GAS — UNDERGROUND GAS LINES
- DRAINAGE
- TREE
- FIRE HYDRANT
- CURB
- OR CONCRETE
- CONTROL POINT
- BUILDING
- PRIVATE DRIVEWAY
- SIGN
- ROCK LINED CHANNEL
- EXISTING ROCK WALL
- 125-382-13 — ASSESSOR PARCEL NUMBER
- 958 TYNER ST. — PHYSICAL ADDRESS (PRIVATE LOT)

PROPOSED

- MAJOR CONTOUR
- MINOR CONTOUR
- 6694 — PROPOSED MAJOR CONTOUR LABEL
- 5+00 — PROPOSED ALIGNMENT(ROAD CENTERLINE)
- GRADING DAYLIGHT LINE
- GRADING LINE/FEATURE LINE
- PROPOSED GRADE (SECTION VIEW)
- CLF — CONSTRUCTION LIMIT FENCE
- FF — FILTER FENCE
- SEDIMENT ROLL
- EROSION CONTROL BLANKET
- STAGING AREA
- PROPOSED PIPE
- PROPOSED CONCRETE
- PROPOSED VEGETATION/WILLOW
- ROCK LINED CHANNEL (PLAN VIEW)
- SEDIMENT REMOVAL
- ROCK (SECTION VIEW)
- ROCK DISSIPATER
- PROJECT BOUNDARY

3 / D-5 — SECTION OR DETAIL IDENTIFICATION; NUMBER OF SHEET ON WHICH SECTION OR DETAIL IS DRAWN

3 / – — SECTION OR DETAIL IDENTIFICATION; SYMBOL FOR DETAIL ON THE SAME SHEET

HORIZONTAL AND VERTICAL PROJECTION

VERTICAL CONTROL IS DATUMN NGVD 29 US FEET;
HORIZONTAL CONTROL IS NDOT CONTROL LINE LPN 907 HORIZONTAL DATUMN NAD 83/94 (aka NAD 83HARN) STATE PLANE COORDINATED SYSTEM NEVADA ZONE WEST (U.S. FEET) AND MODIFIED TO GROUND COMBINED SCALE FACTOR OF 0.9997370692

50% DESIGN PLANS
NOT FOR CONSTRUCTION

Nevada Tahoe Conservation District

NOTES
BURKE CREEK HWY 50 CROSSING AND REALIGNMENT PROJECT

DESIGNED/DRAWN	MK/MK
CHECKED	MG
DATE	6/24/2015
SCALE	AS SHOWN
PROJECT	BCC
SHEET	ii

Nevada Tahoe Conservation District

INDEX
BURKE CREEK HWY 50 CROSSING AND REALIGNMENT PROJECT

DESIGNED/DRAWN	MK/MK
CHECKED	MG
DATE	6/24/2015
SCALE	AS SHOWN
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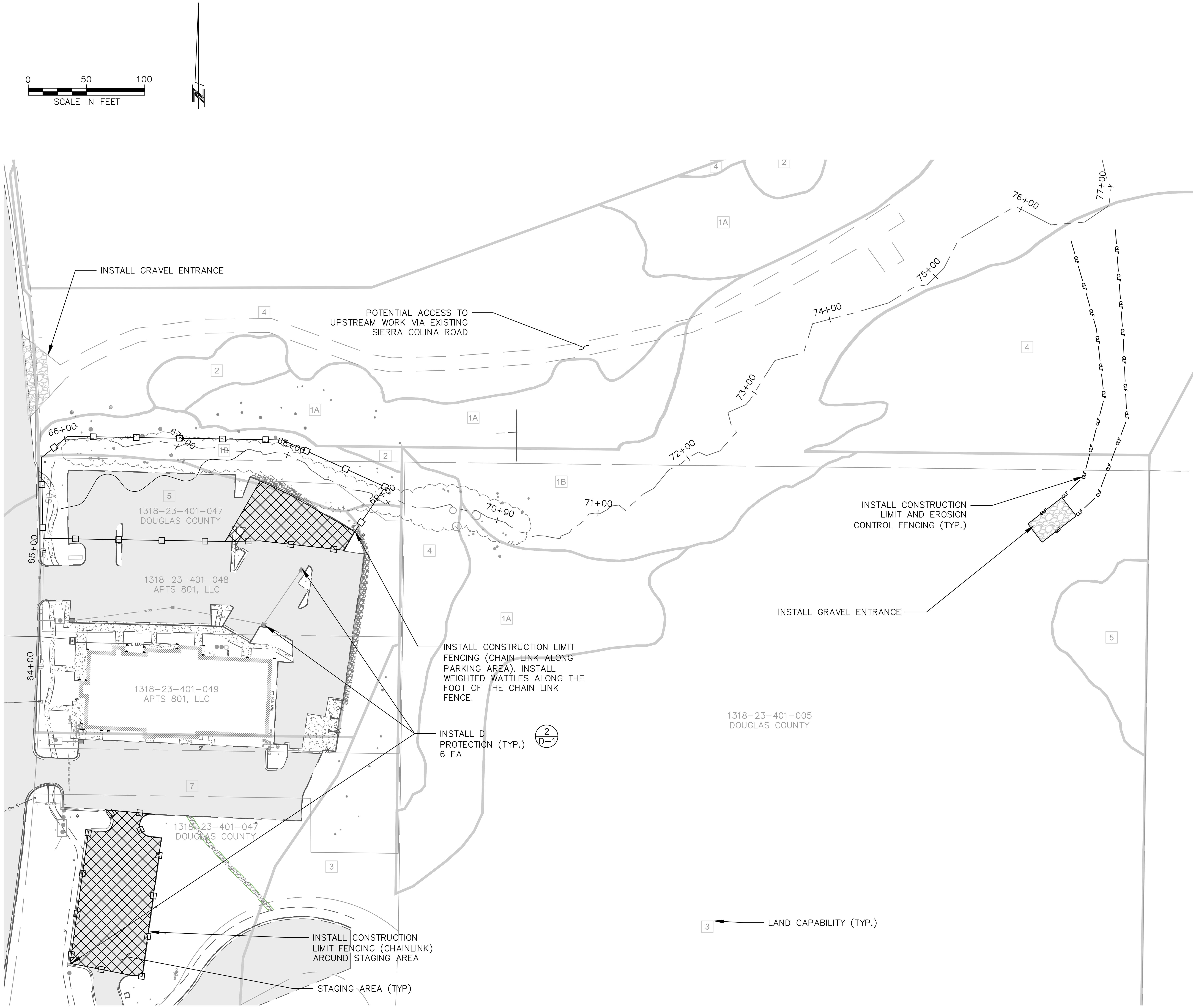
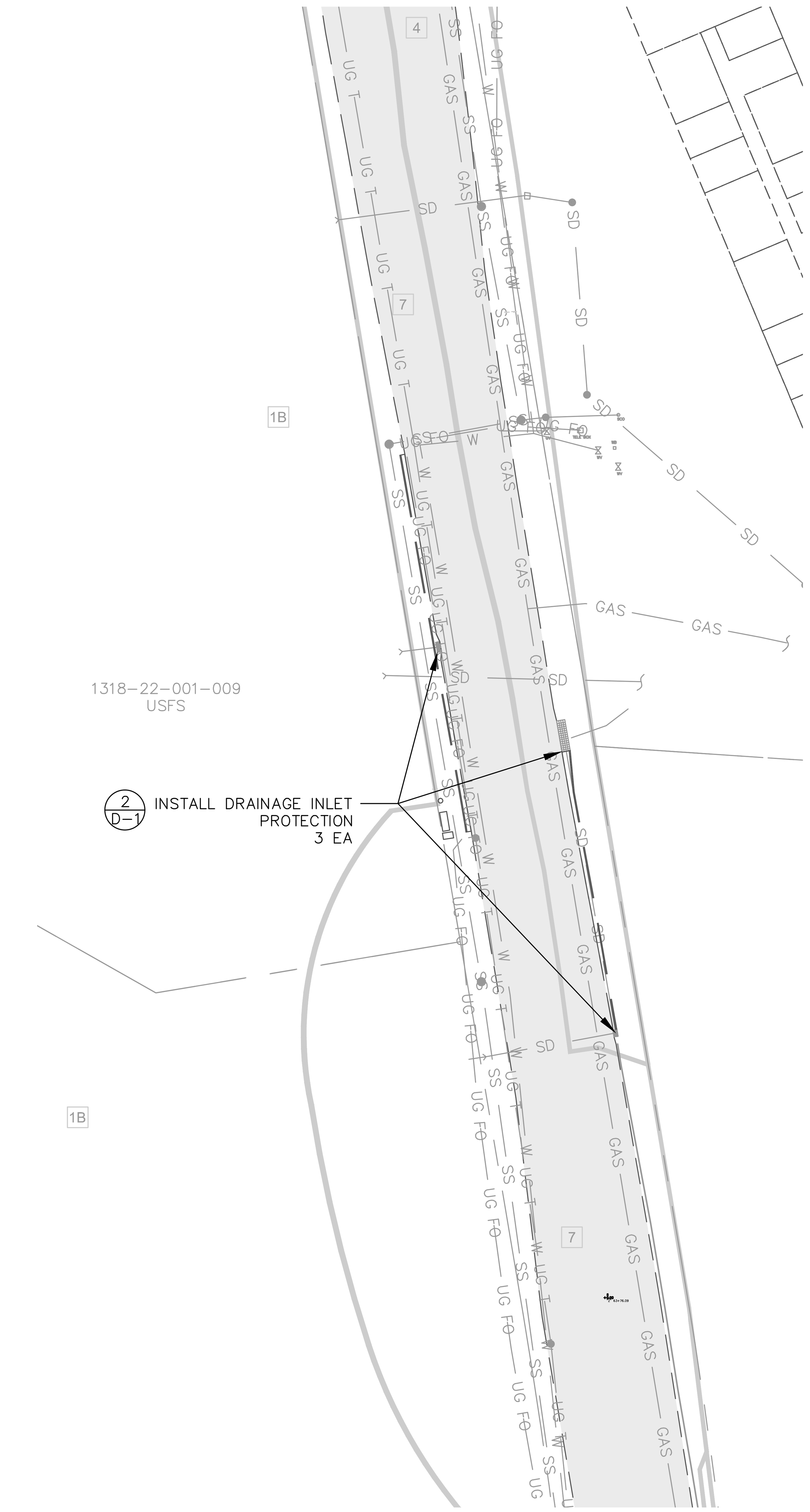
3 of 19



PLAN - STREAM WORK

SCALE: 1" = 50'



PLAN - DRAINAGE WORK

SCALE: 1" = 50'

50% DESIGN PLANS
NOT FOR CONSTRUCTION

Nevada Tahoe Conservation District

EROSION CONTROL AND STAGING
BURKE CREEK HWY 50 CROSSING AND
REALIGNMENT PROJECT
PHASE 1

DESIGNED/DRAWN	MK/MK
CHECKED	MG
DATE	6/24/2015
SCALE	AS SHOWN
PROJECT	BCC
SHEET	G-1

NOTES:
1. REMOVED TREES AND VEGETATION TO BE SALVAGED FOR STREAM WORK.

PROPOSED TREE REMOVAL

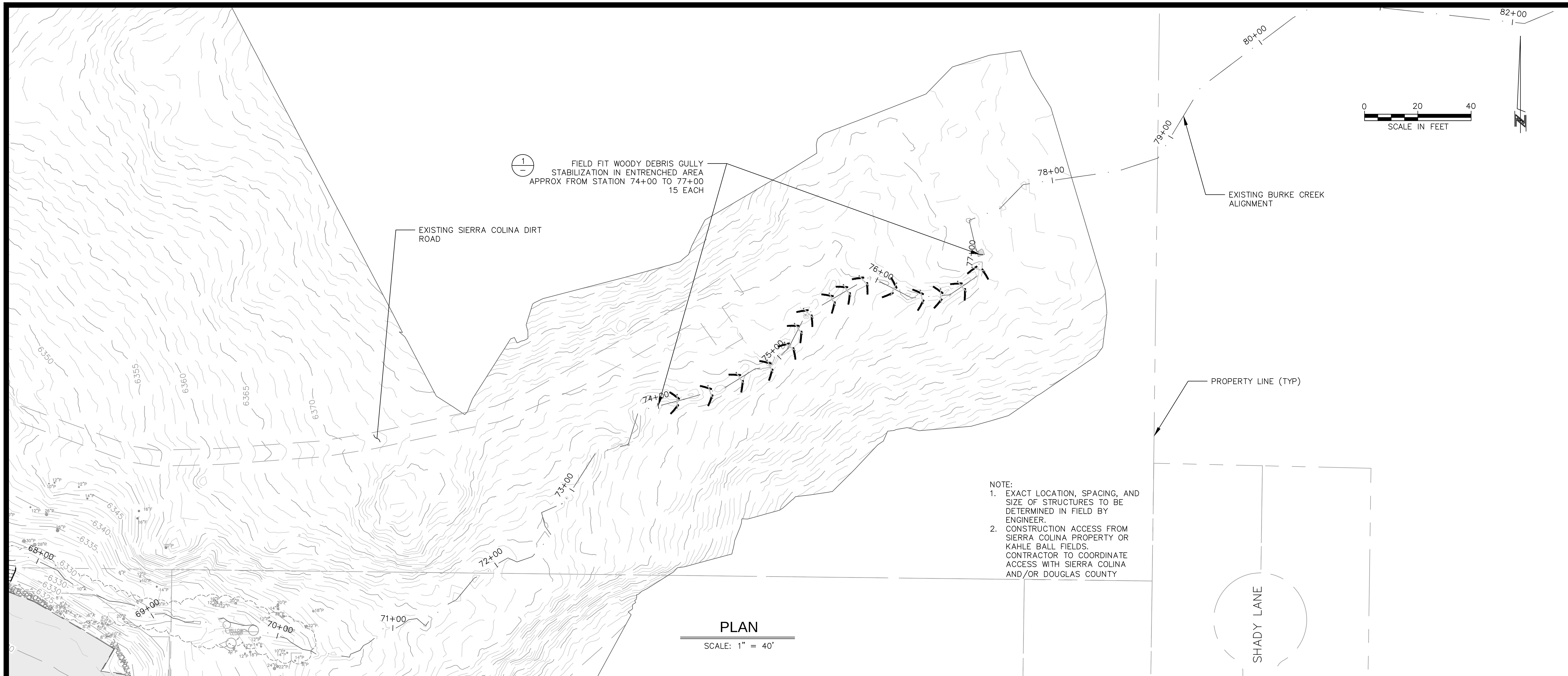
6"-14" DBH	9
15"-22" DBH	6
23" -29" DBH	1
30" OR GREATER	0

50% DESIGN PLANS
NOT FOR CONSTRUCTION

Nevada Tahoe Conservation District

DEMOLITION
BURKE CREEK HWY 50 CROSSING AND REALIGNMENT PROJECT
PHASE 1

DESIGNED/DRAWN MK/MK
CHECKED MG
DATE 6/24/2015
SCALE AS SHOWN
PROJECT BCC
SHEET G-2

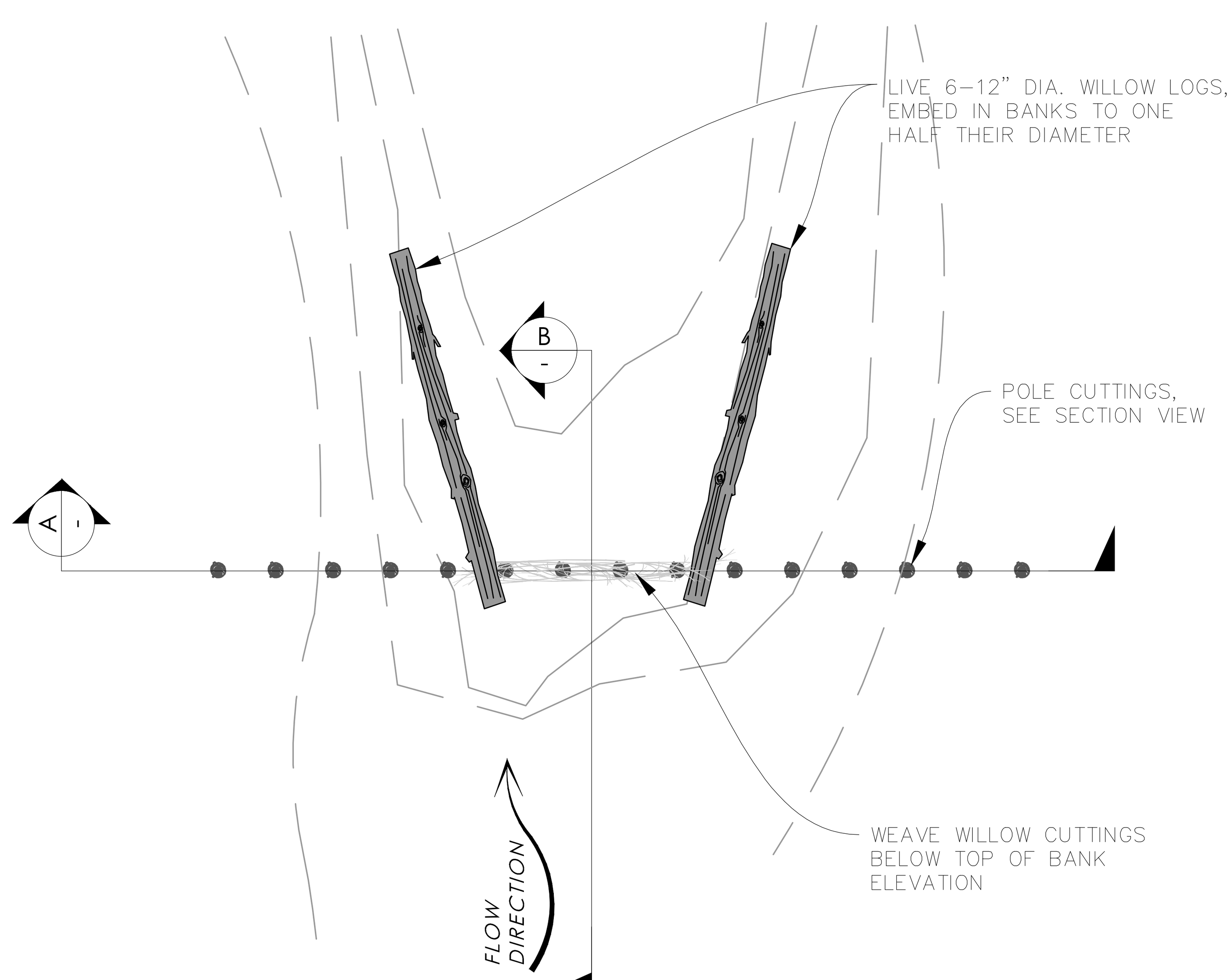


PLAN

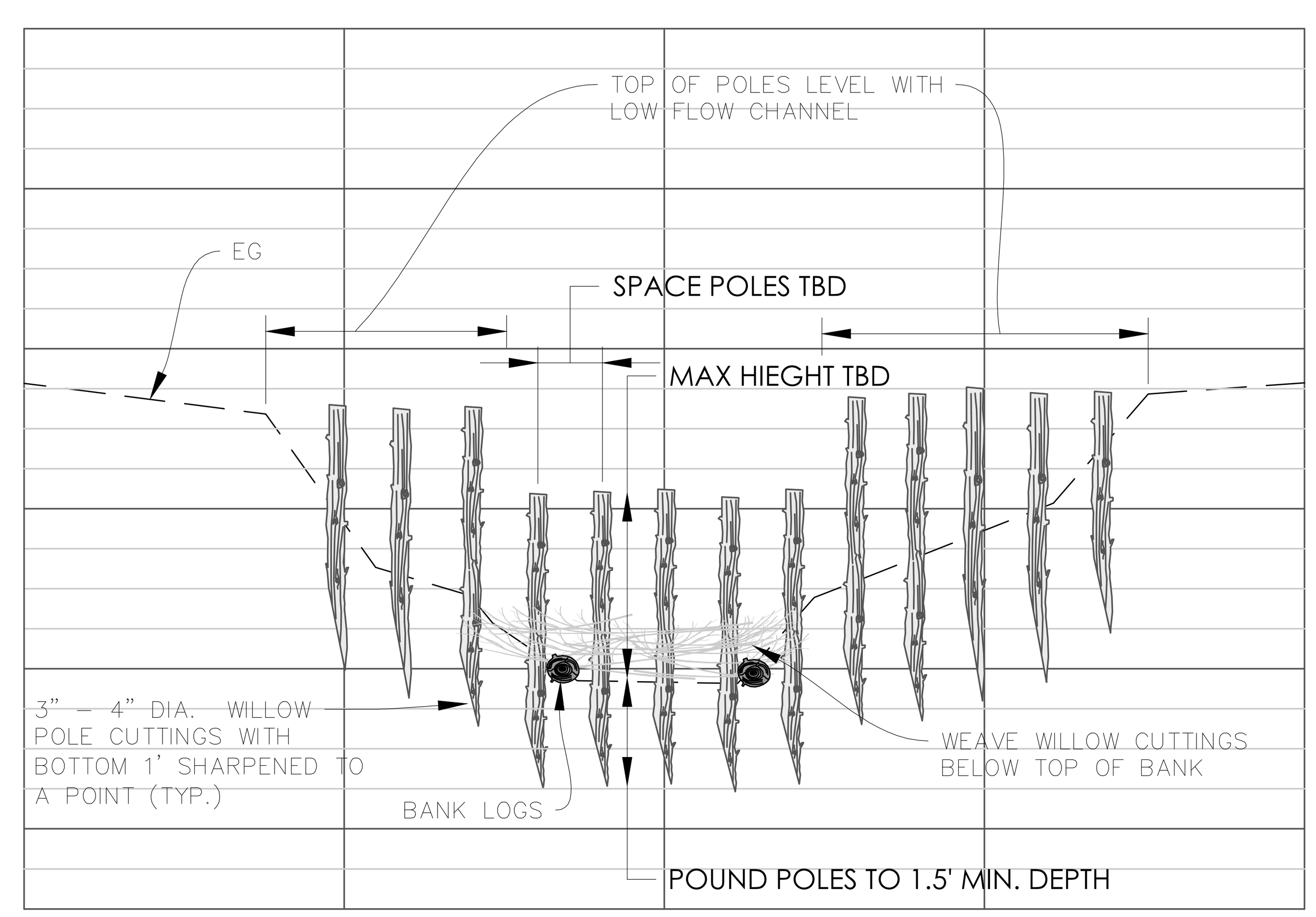
SCALE: 1" = 40'

NOTE:
1. EXACT LOCATION, SPACING, AND SIZE OF STRUCTURES TO BE DETERMINED IN FIELD BY ENGINEER.
2. CONSTRUCTION ACCESS FROM SIERRA COLINA PROPERTY OR KAHLE BALL FIELDS. CONTRACTOR TO COORDINATE ACCESS WITH SIERRA COLINA AND/OR DOUGLAS COUNTY

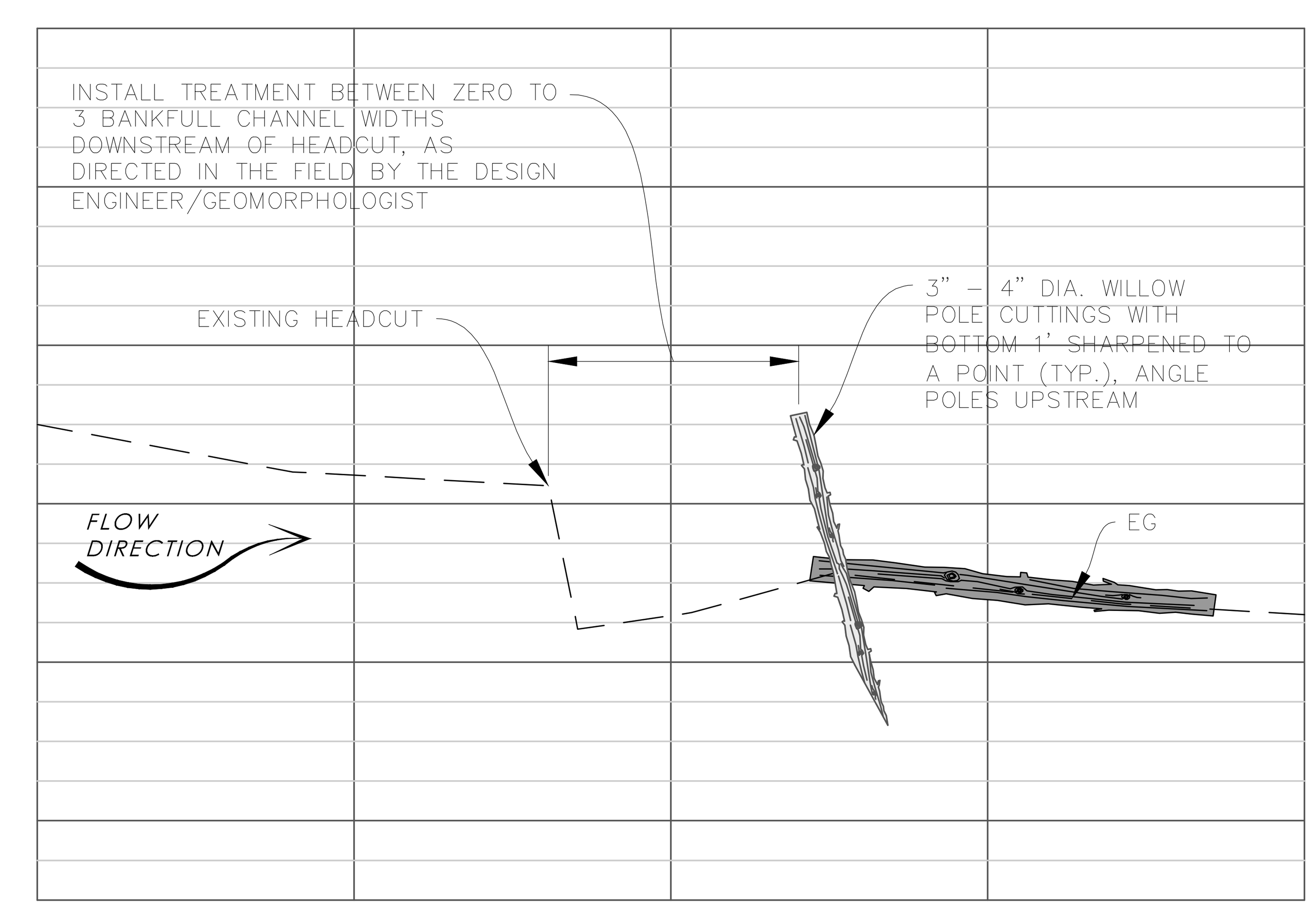
50% DESIGN PLANS
NOT FOR CONSTRUCTION



1 WOODY DEBRIS GULLY STABILIZATION
PLAN VIEW NTS



WOODY DEBRIS GULLY STABILIZATION A
ELEVATION VIEW NTS

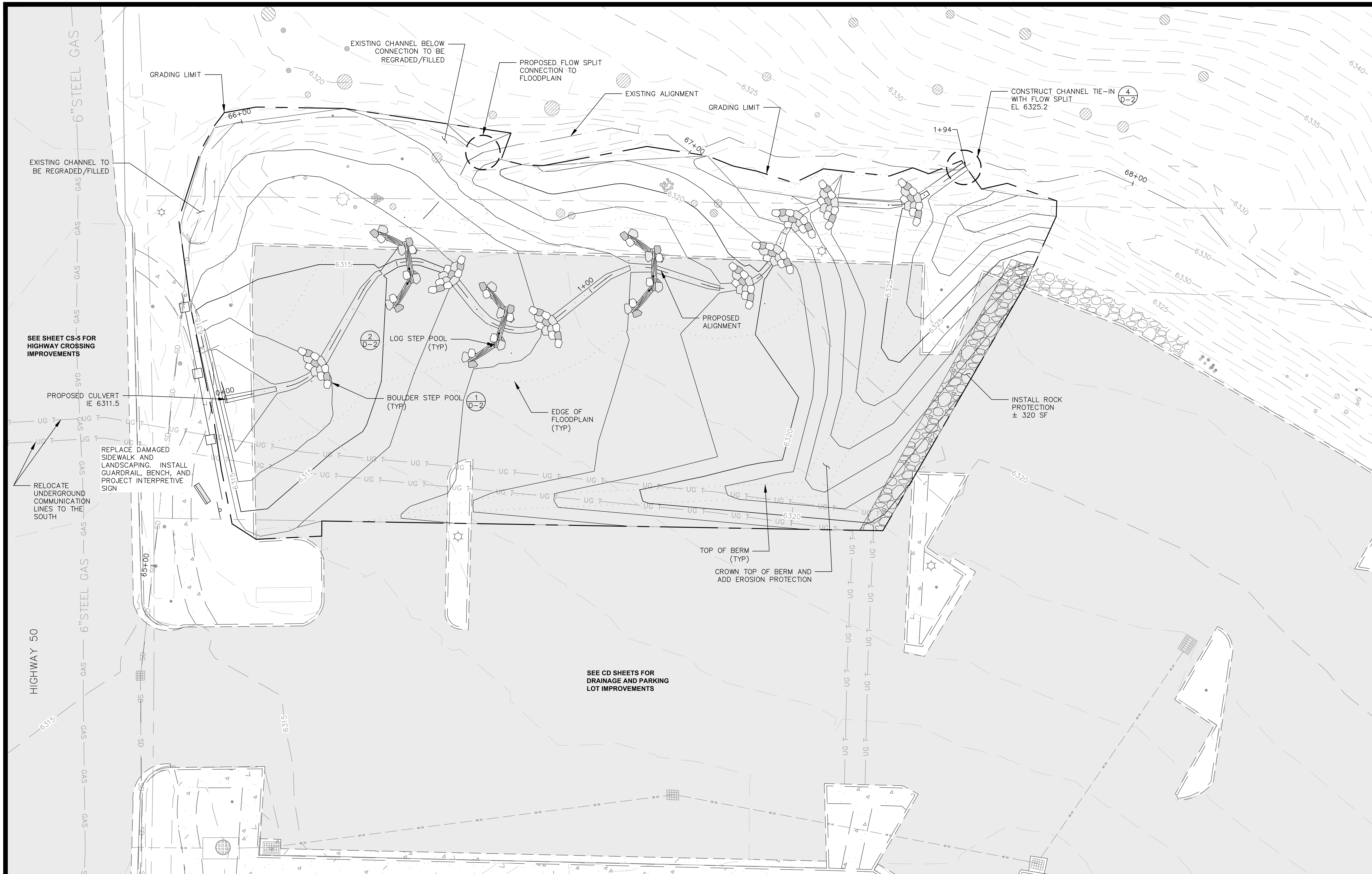


WOODY DEBRIS GULLY STABILIZATION B
PROFILE VIEW NTS

Nevada Tahoe Conservation District

EXISTING STA 74+00 TO 77+00 PLAN AND DETAIL
BURKE CREEK HWY 50 CROSSING AND REALIGNMENT PROJECT
PHASE 1

DESIGNED/DRAWN DS/MBG
CHECKED MCK
DATE 06/24/2015
SCALE AS SHOWN
PROJECT BCC
SHEET CS-1
6 OF 19



EARTHWORK TABLE

CUT	658 CY
FILL	315 CY
NET	343 CY CUT

0 10 20
SCALE IN FEET

50% DESIGN PLANS
NOT FOR CONSTRUCTION

Nevada Tahoe Conservation District

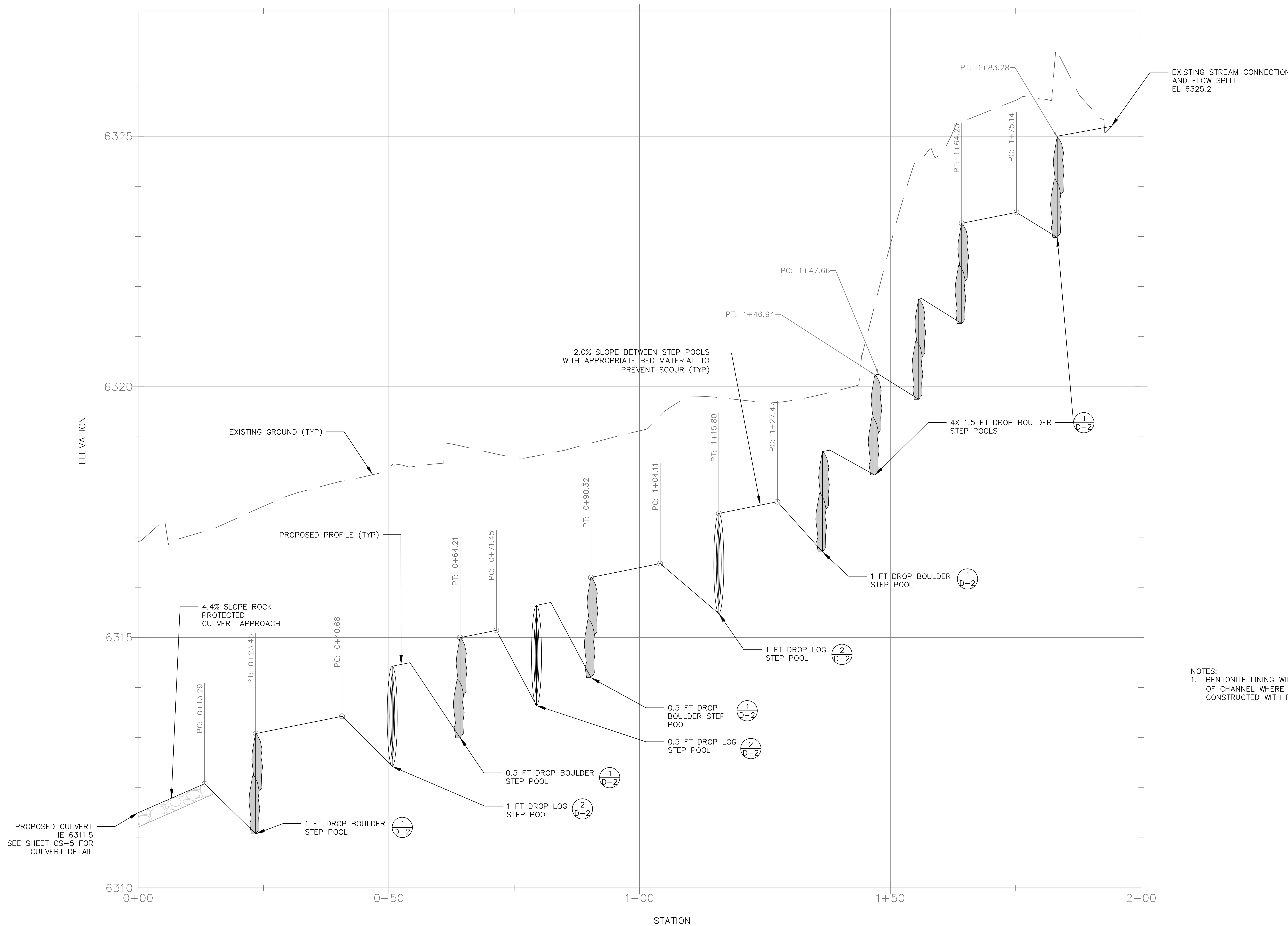
UPSTREAM OF HIGHWAY CREEK PLAN
BURKE CREEK HWY 50 CROSSING AND REALIGNMENT PROJECT
PHASE 1

DESIGNED/DRAWN	DS/MBG
CHECKED	MCK
DATE	06/24/2015
SCALE	AS SHOWN
PROJECT	BCC
SHEET	CS-2

50% DESIGN PLANS
NOT FOR CONSTRUCTION

PROPOSED BURKE CREEK PROFILE
UPSTREAM OF HIGHWAY 50

SCALE: HORIZ: 1" = 10'; VERT: 1" = 1'



NOTES:
1. BENTONITE LINING WILL BE USED ON PORTIONS OF CHANNEL WHERE BANKS/FLOODPLAIN ARE CONSTRUCTED WITH FILL

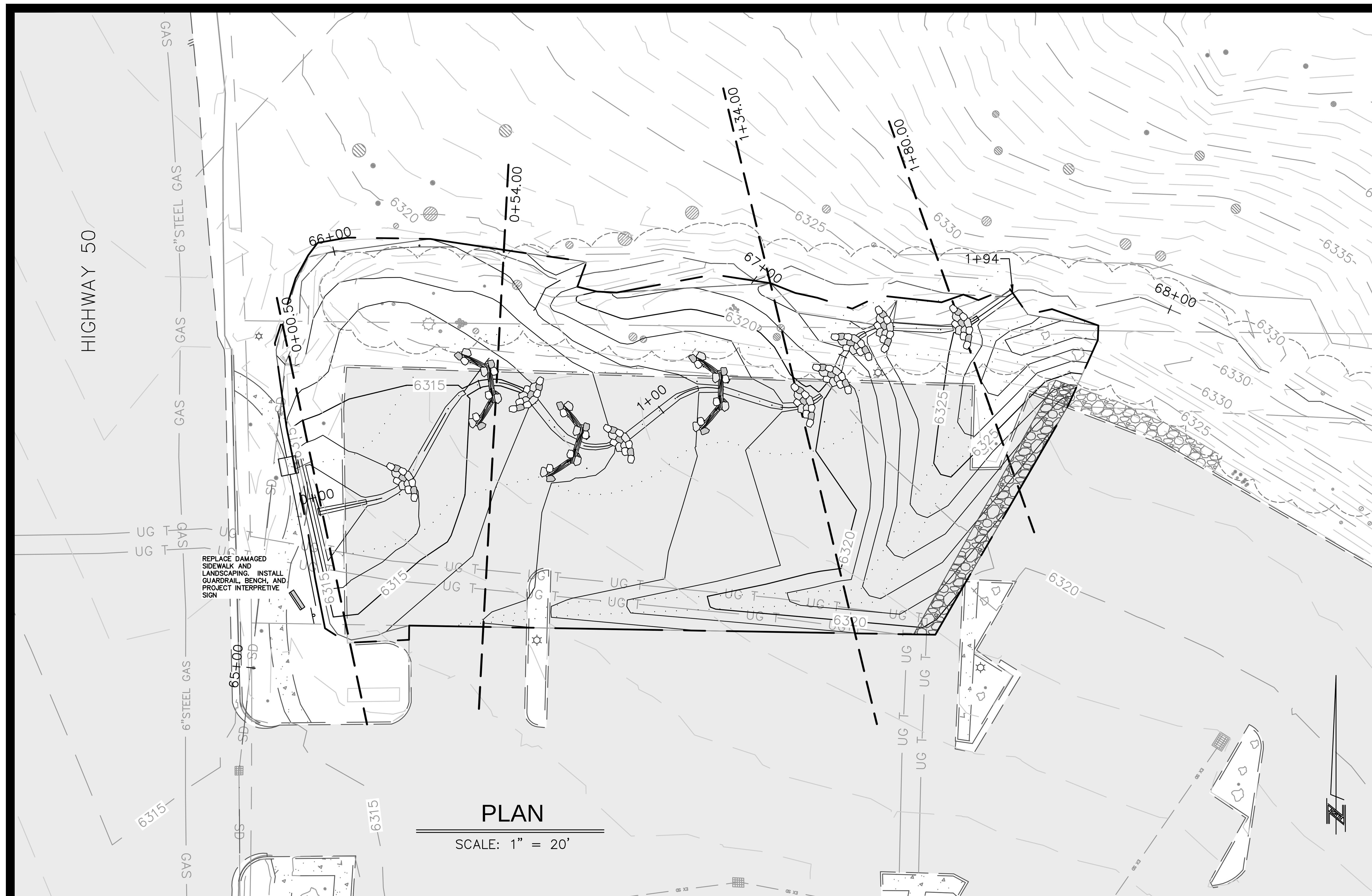
0 10 20
SCALE IN FEET
1H:10V

Nevada Tahoe Conservation District

UPSTREAM OF HIGHWAY CREEK PROFILE
BURKE CREEK HWY 50 CROSSING AND REALIGNMENT PROJECT
PHASE 1

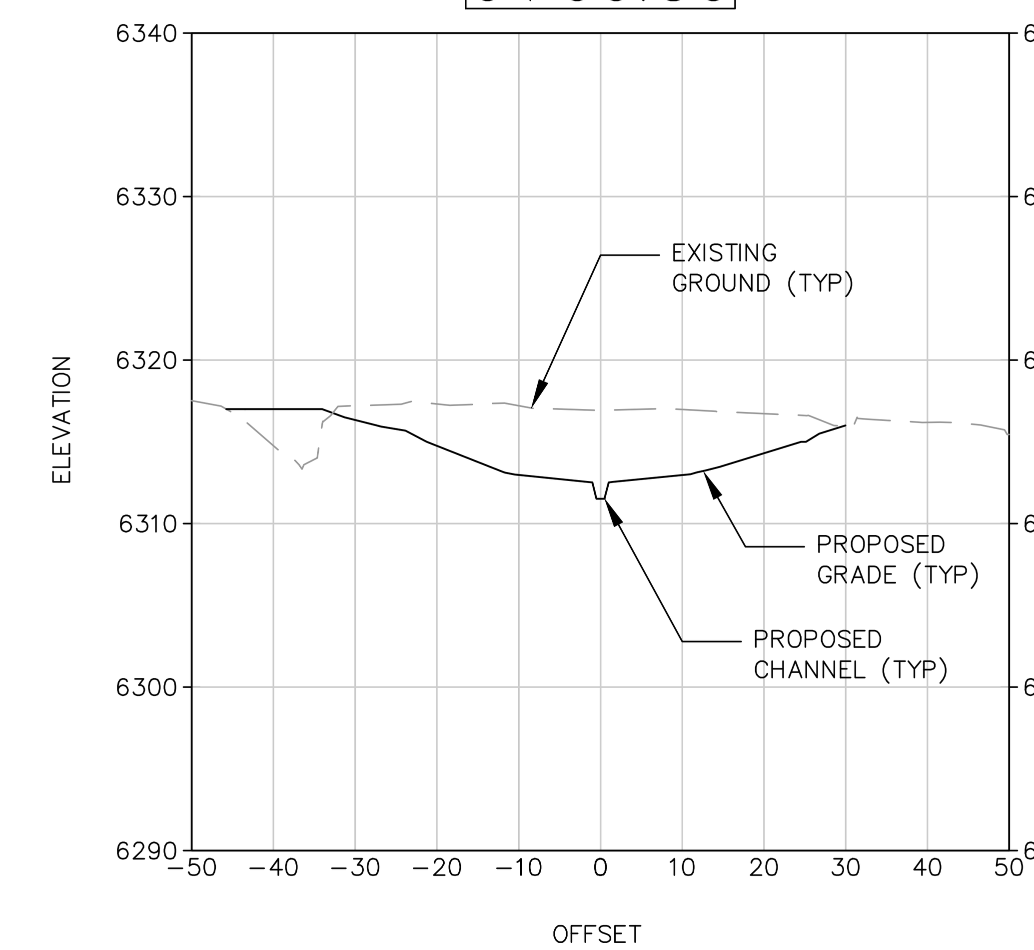
DESIGNED/DRAWN	DS/MBG
CHECKED	MCK
DATE	06/24/2015
SCALE	AS SHOWN
PROJECT	BCC

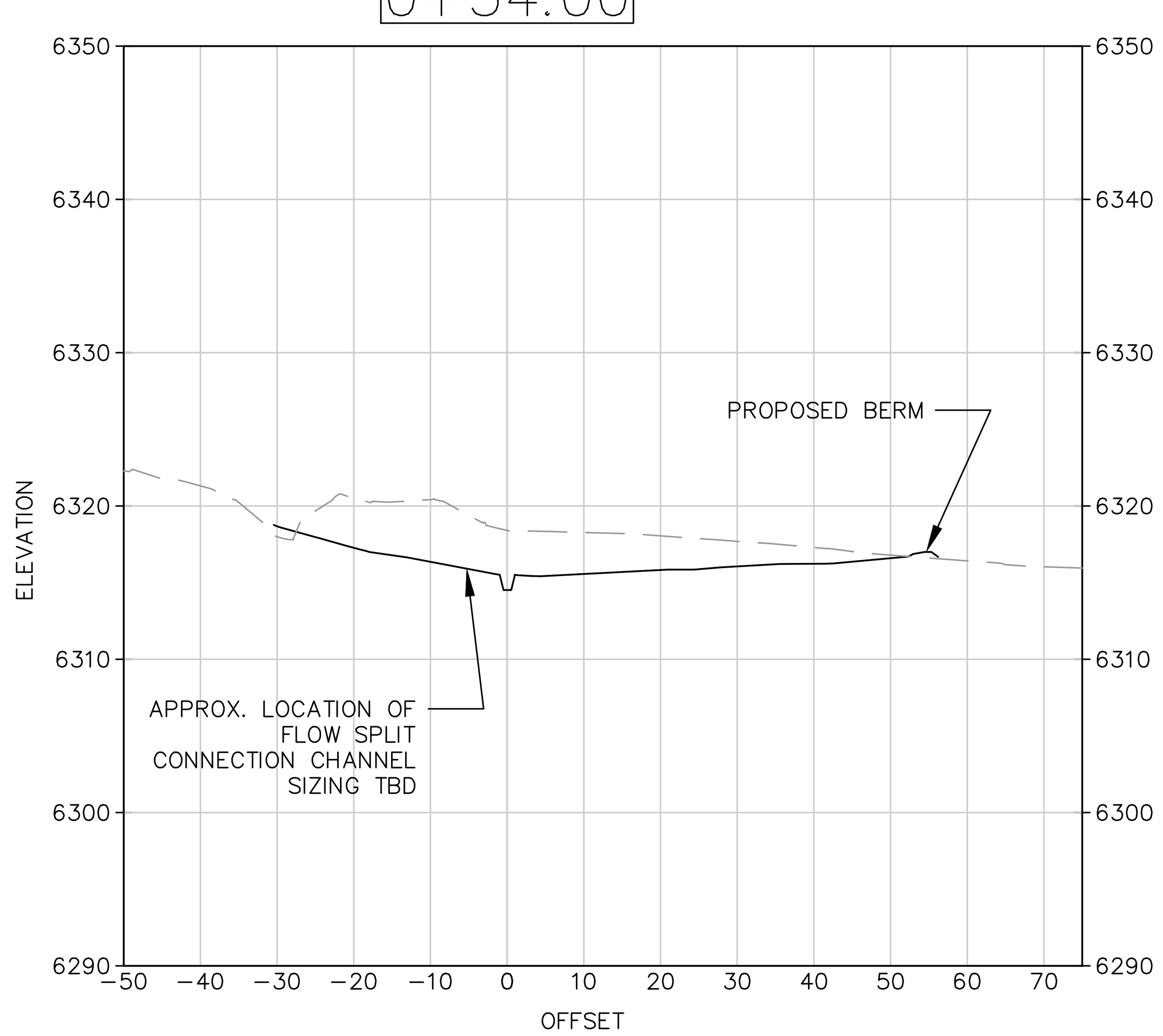
SHEET
CS-3
8 OF 19

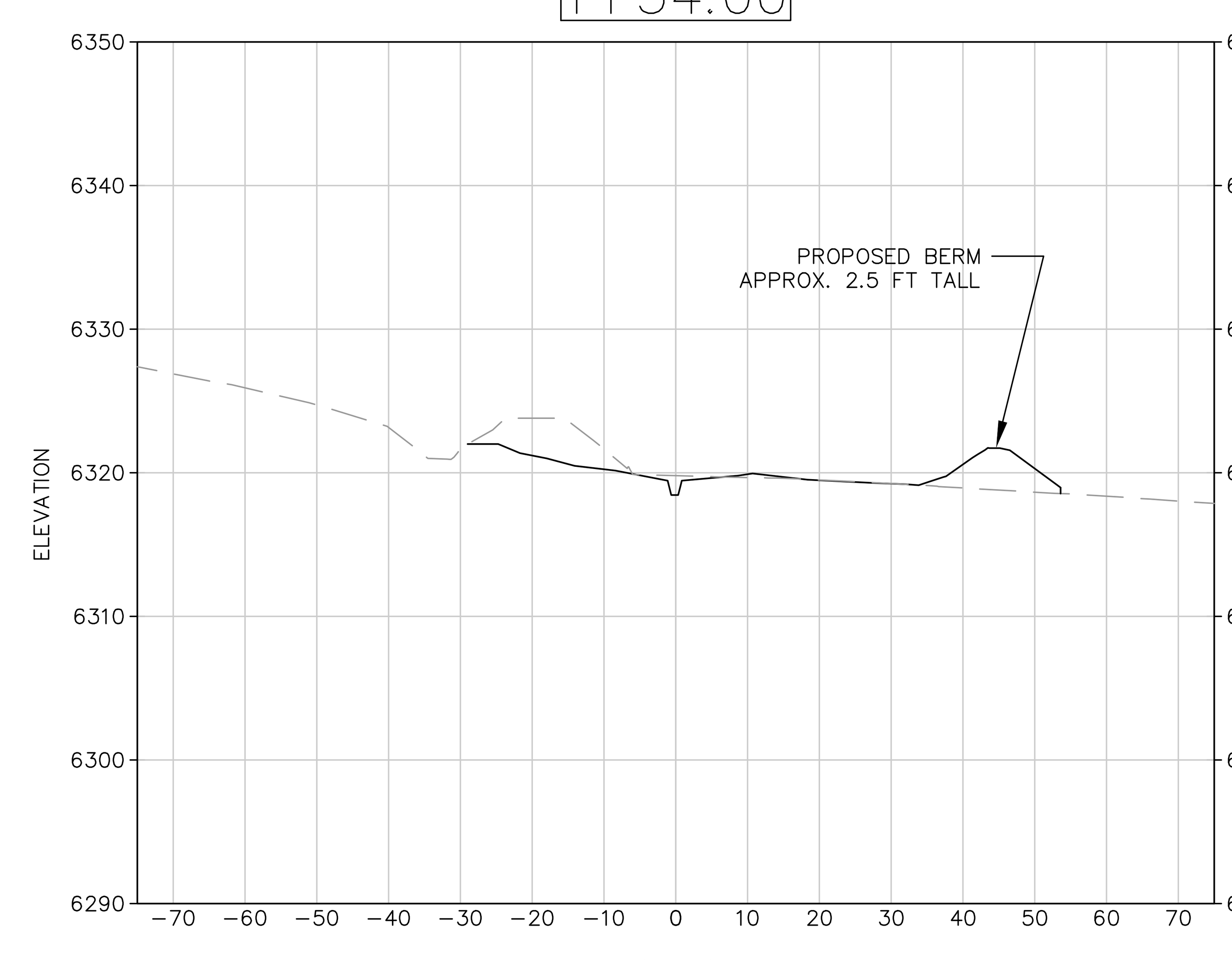


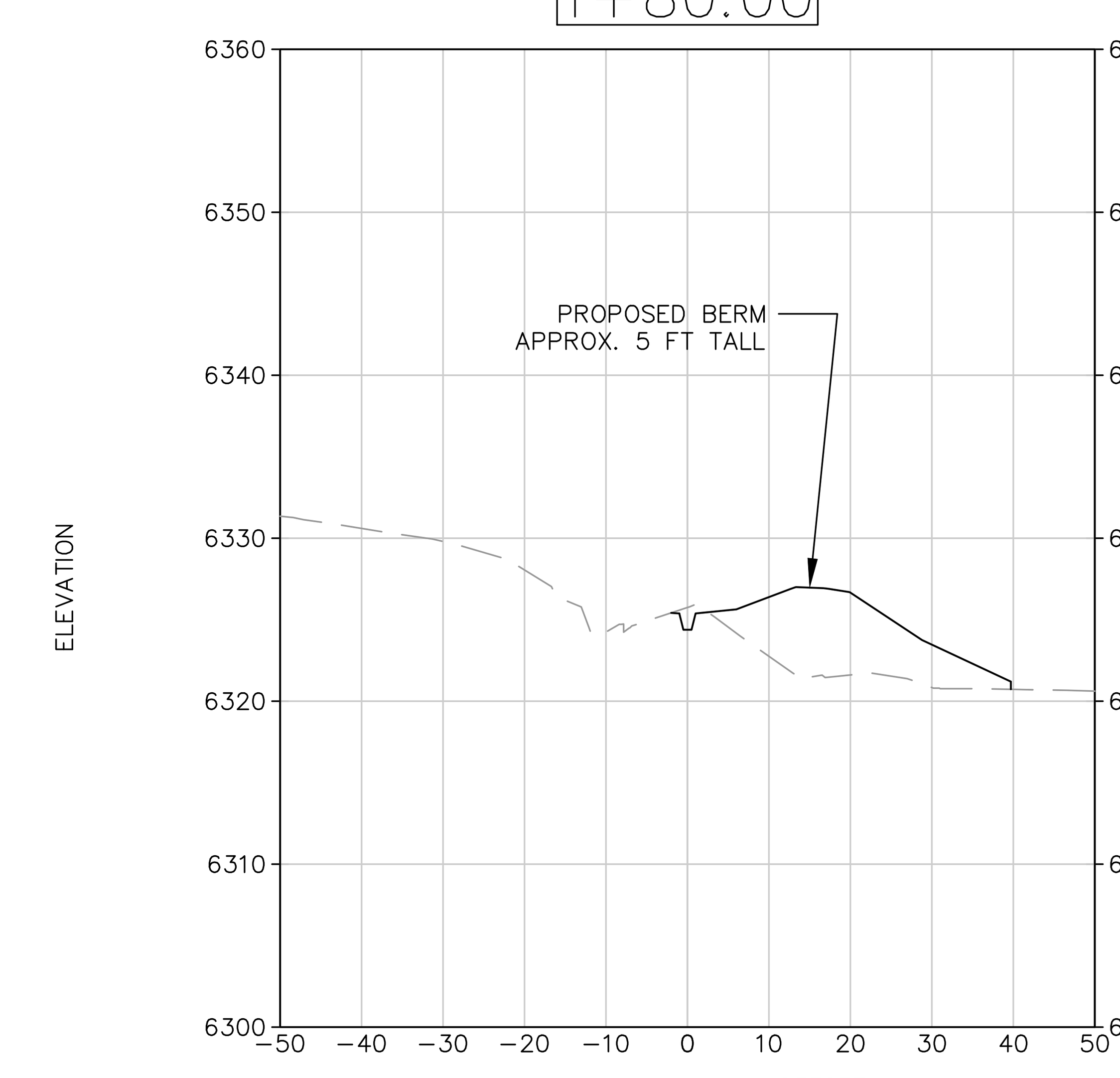
PLAN

SCALE: 1" = 20'









FLOODPLAIN CROSS SECTIONS
UPSTREAM OF HIGHWAY 50

SCALE: HORIZ: 1" = 20'; VERT: 1" = 10'

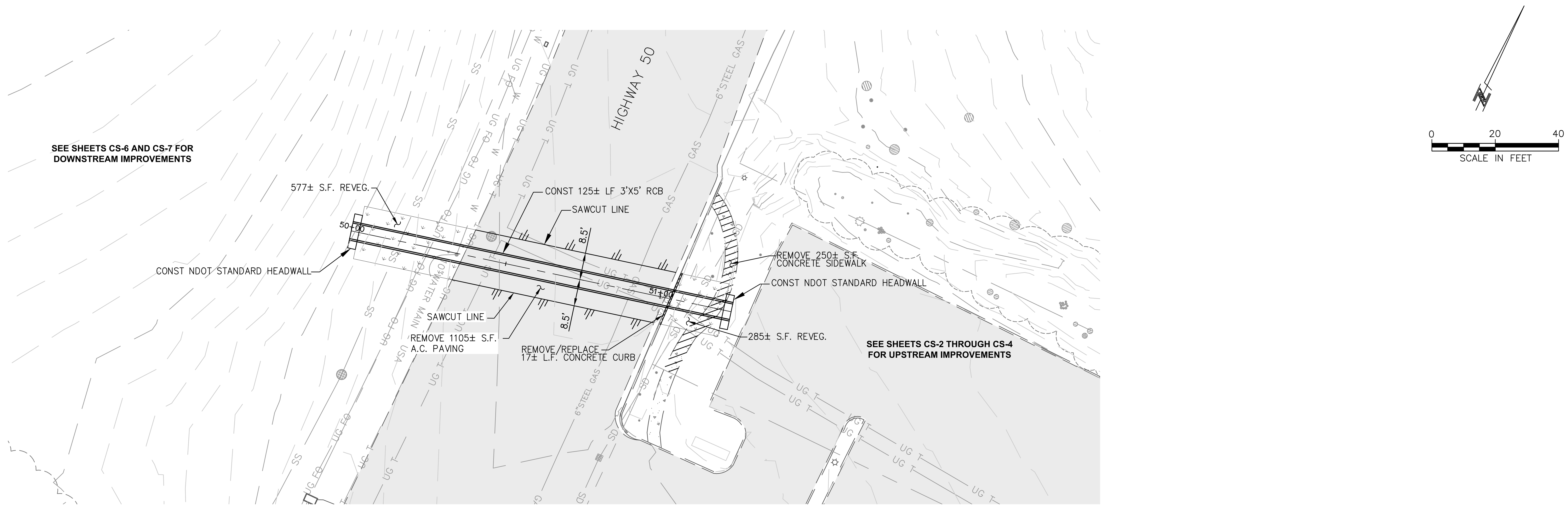
0 20 40
SCALE IN FEET
1H: 2V

50% DESIGN PLANS
NOT FOR CONSTRUCTION

Nevada Tahoe Conservation District

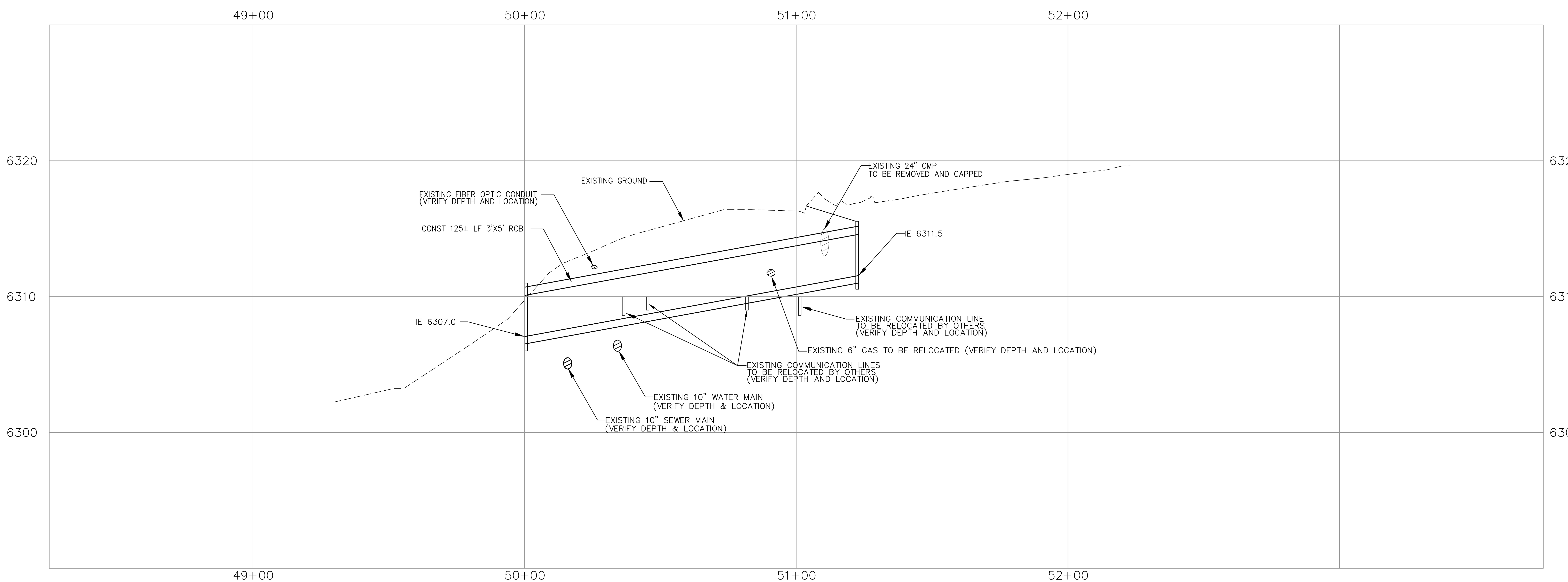
UPSTREAM OF HIGHWAY SECTIONS
BURKE CREEK HWY 50 CROSSING AND REALIGNMENT PROJECT
PHASE 1

DESIGNED/DRAWN	MBG/MBG
CHECKED	MCK
DATE	06/24/2015
SCALE	AS SHOWN
PROJECT	BCC
SHEET	CS-4



PLAN

SCALE: 1" = 20'



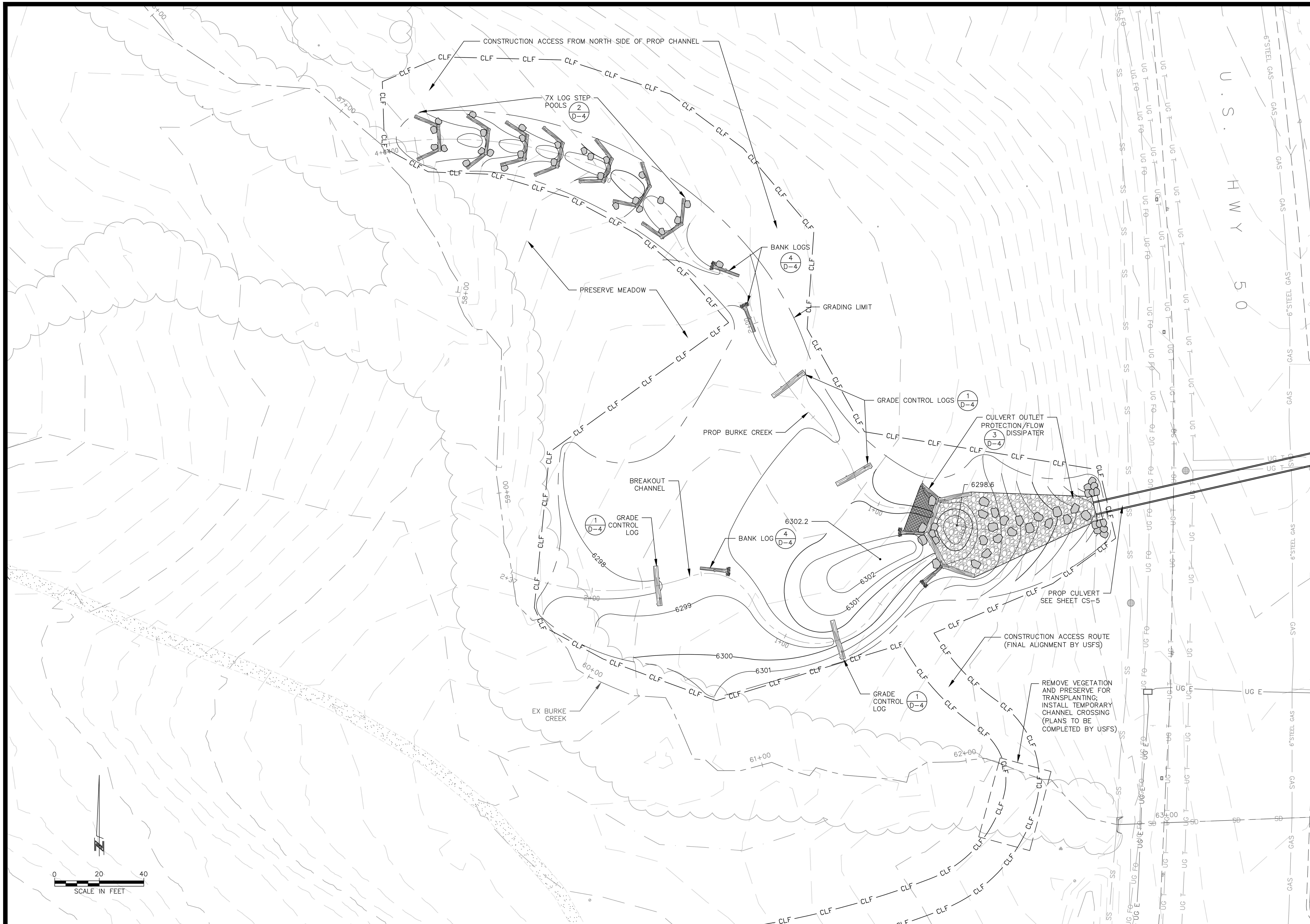
PROFILE

SCALE: HORIZ: 1" = 20', VERT: 1" = 4'

Nevada Tahoe Conservation District

HWY 50 CULVERT PLAN AND PROFILE
BURKE CREEK HWY 50 CROSSING AND REALIGNMENT PROJECT
PHASE 1

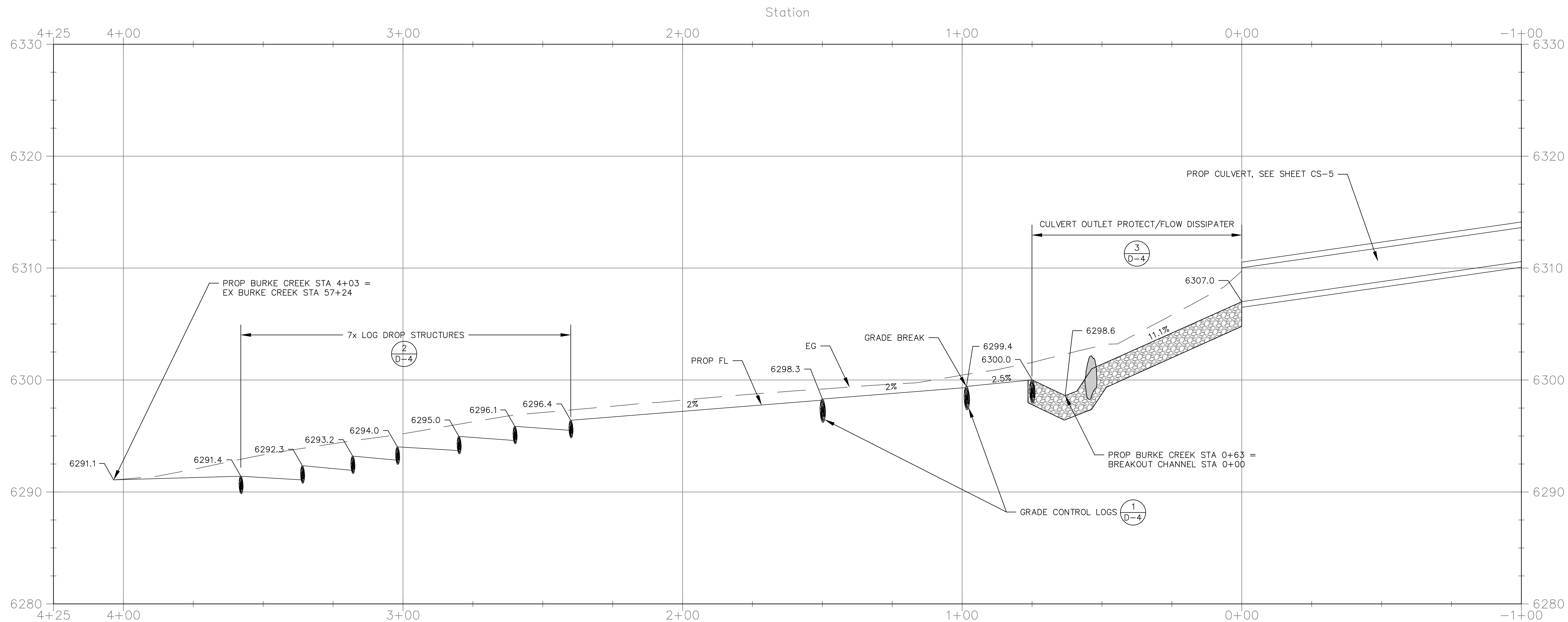
DESIGNED/DRAWN	AT
CHECKED	MG/MK
DATE	6/24/2015
SCALE	1"=20' H, 1"=4' V
PROJECT	BCC
SHEET	CS-5



Nevada Tahoe Conservation District

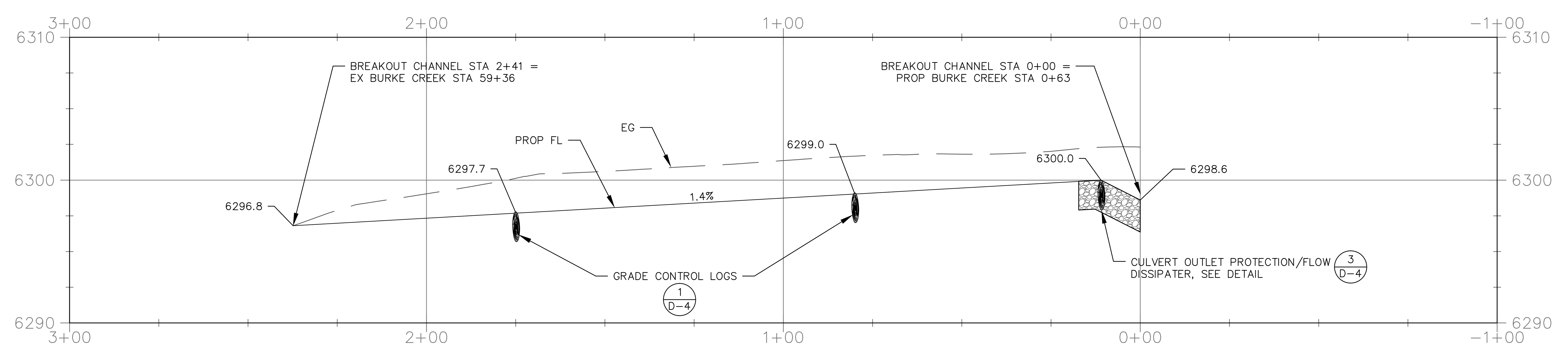
DOWNSTREAM OF HIGHWAY PLAN
BURKE CREEK HWY 50 CROSSING AND REALIGNMENT PROJECT
PHASE 2

DESIGNED/DRAWN	DS/PK
CHECKED	MK/MG
DATE	6/24/2015
SCALE	1" = 20'
PROJECT	BCC
SHEET	CS-6



PROP BURKE CREEK PROFILE

VERT SCALE: 1" = 5' (4X)



BREAKOUT CHANNEL PROFILE

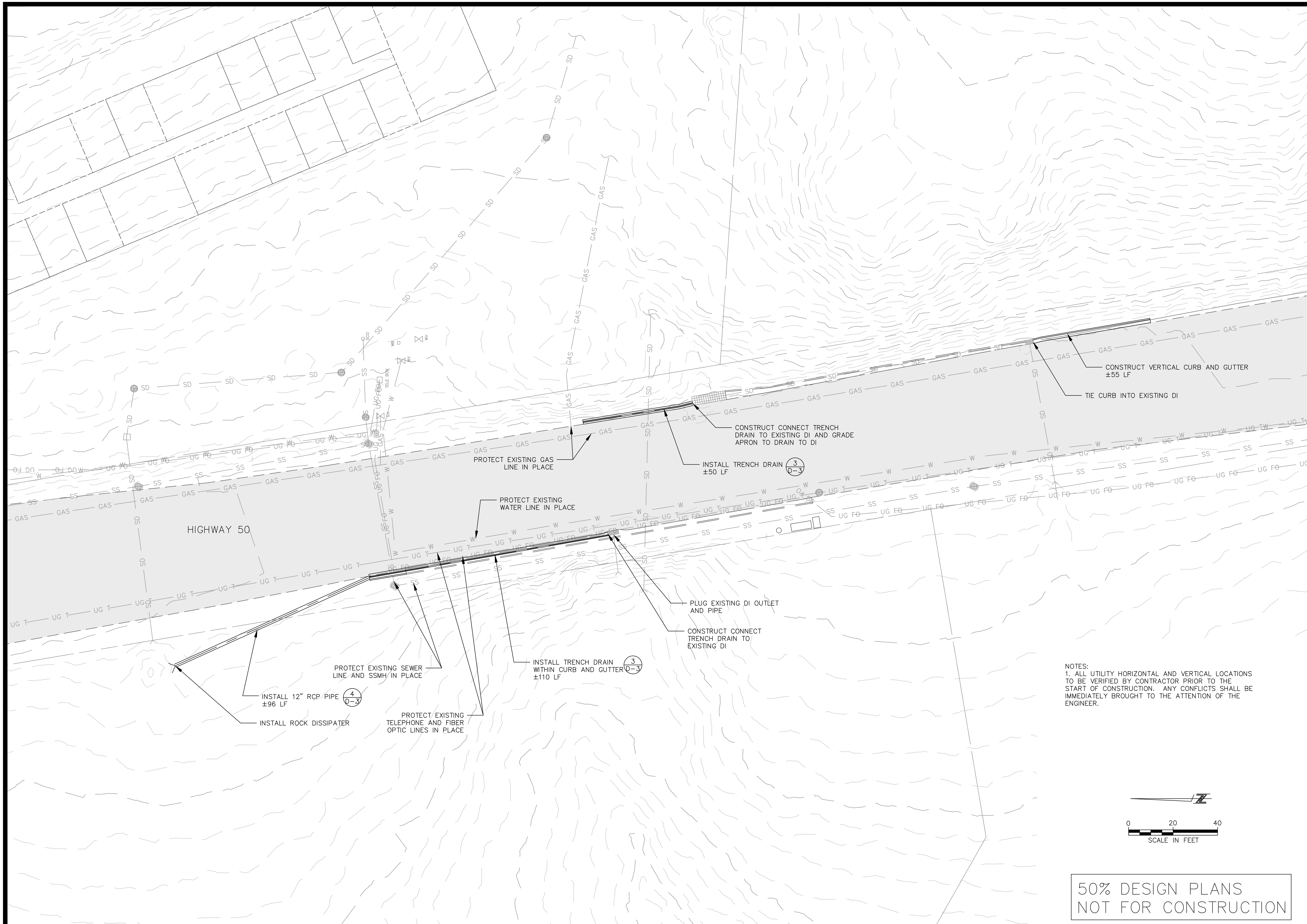
VERT SCALE: 1" = 5' (4X)

0 20 40
HORIZONTAL SCALE IN FEET

Nevada Tahoe Conservation District

DOWNSTREAM OF HIGHWAY PROFILES
BURKE CREEK HWY 50 CROSSING AND
REALIGNMENT PROJECT
PHASE 2

DESIGNED/DRAWN	DS/PK
CHECKED	MK/MG
DATE	6/24/2015
SCALE	AS SHOWN
PROJECT	BCC
SHEET	CS-7



NOTES:
1. ALL UTILITY HORIZONTAL AND VERTICAL LOCATIONS TO BE VERIFIED BY CONTRACTOR PRIOR TO THE START OF CONSTRUCTION. ANY CONFLICTS SHALL BE IMMEDIATELY BROUGHT TO THE ATTENTION OF THE ENGINEER.

50% DESIGN PLANS
NOT FOR CONSTRUCTION

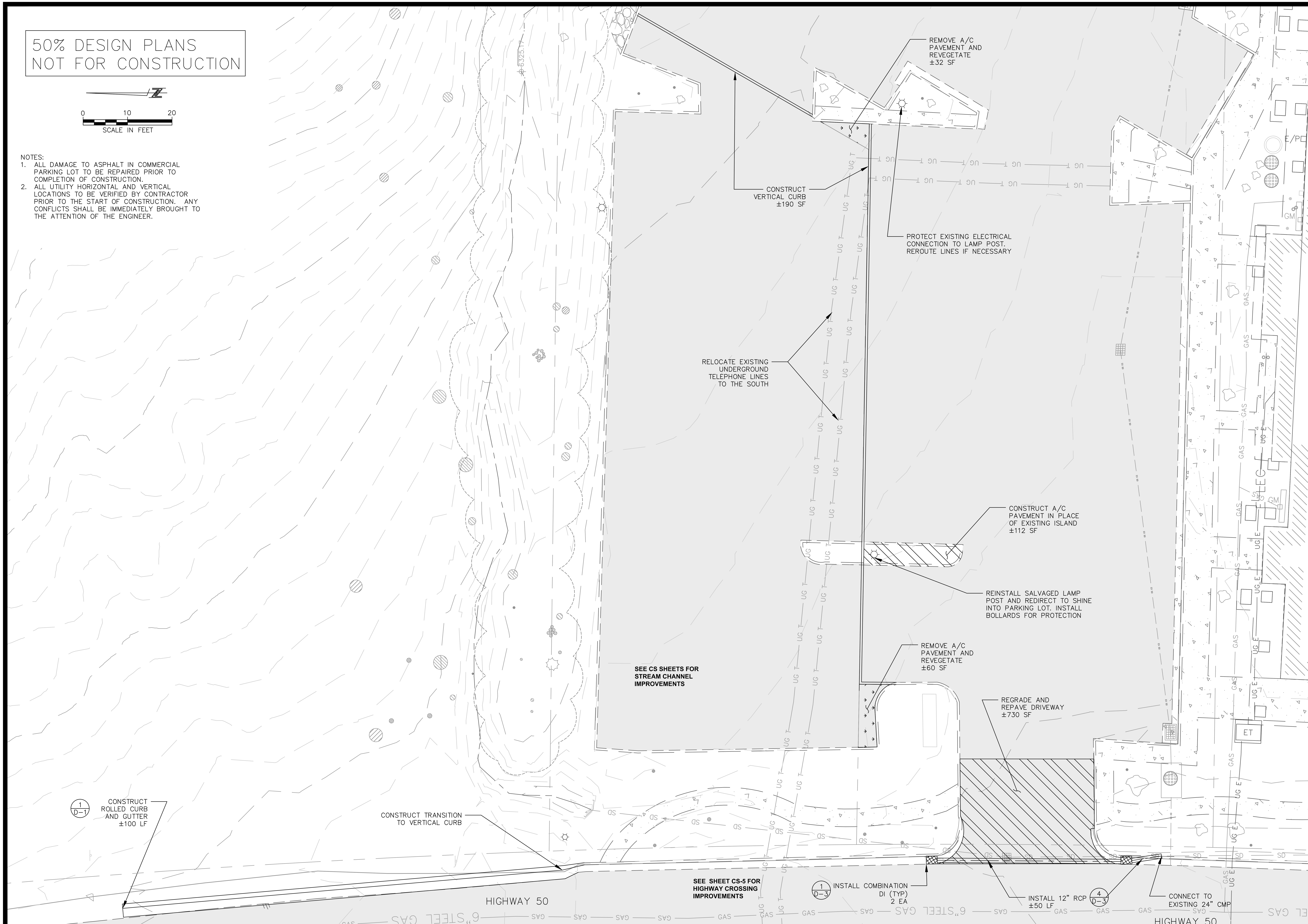
Nevada Tahoe Conservation District

DRAINAGE PLAN NORTH
BURKE CREEK HWY 50 CROSSING AND
REALIGNMENT PROJECT
PHASE 1

DESIGNED/DRAWN
MBG/MBG
CHECKED
MCK
DATE
06/24/2015
SCALE
AS SHOWN
PROJECT
BCC
SHEET
CD-1

50% DESIGN PLANS
NOT FOR CONSTRUCTION

NOTES:
1. ALL DAMAGE TO ASPHALT IN COMMERCIAL PARKING LOT TO BE REPAIRED PRIOR TO COMPLETION OF CONSTRUCTION.
2. ALL UTILITY HORIZONTAL AND VERTICAL LOCATIONS TO BE VERIFIED BY CONTRACTOR PRIOR TO THE START OF CONSTRUCTION. ANY CONFLICTS SHALL BE IMMEDIATELY BROUGHT TO THE ATTENTION OF THE ENGINEER.

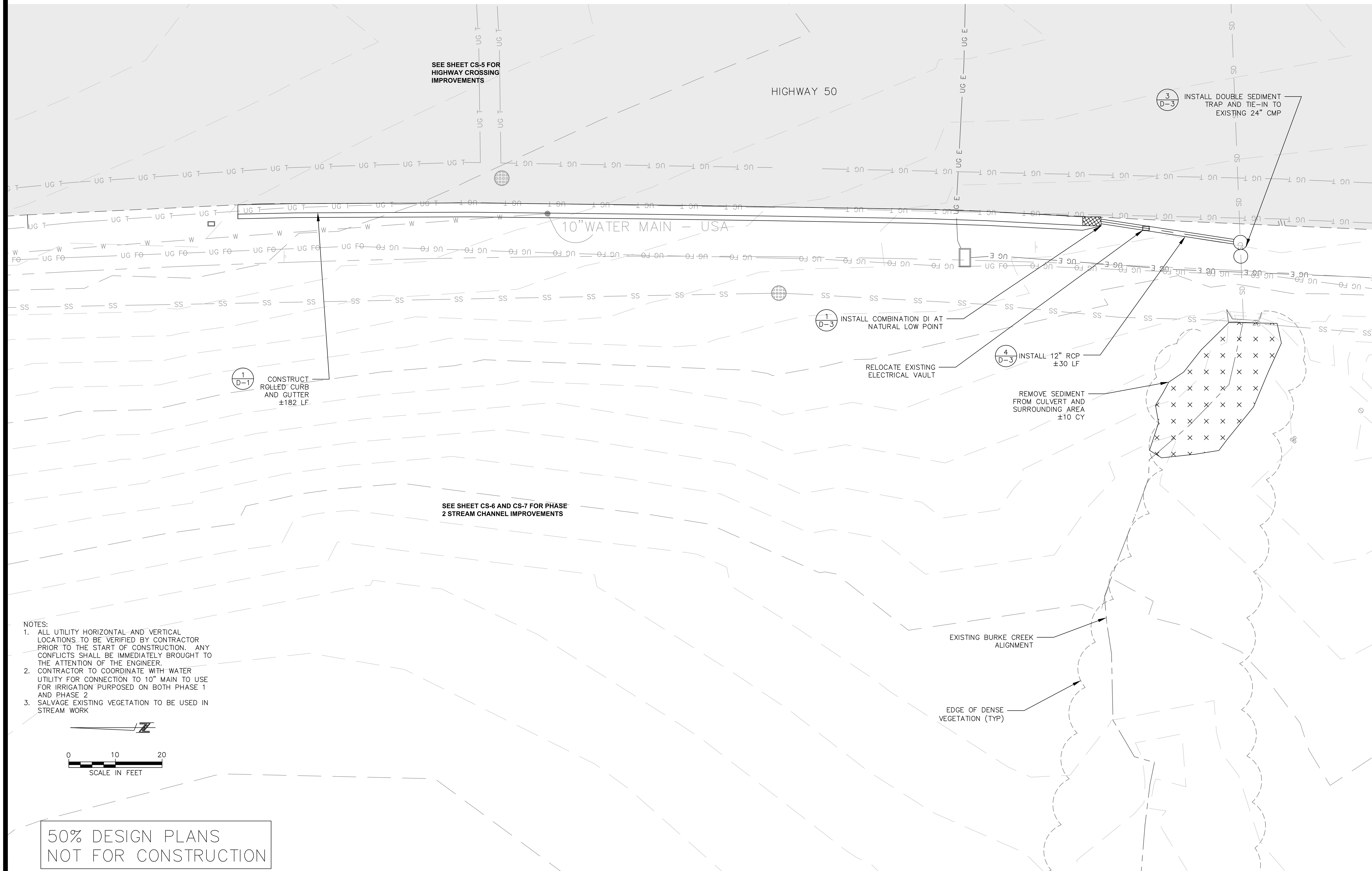


Nevada Tahoe Conservation District

DRAINAGE PLAN SOUTH 1
BURKE CREEK HWY 50 CROSSING AND REALIGNMENT PROJECT
PHASE 1

DESIGNED/DRAWN	MBG/MBG
CHECKED	MCK
DATE	06/24/2015
SCALE	AS SHOWN
PROJECT	BCC
SHEET	CD-2

14 OF 19



NOTES:
1. ALL UTILITY HORIZONTAL AND VERTICAL LOCATIONS TO BE VERIFIED BY CONTRACTOR PRIOR TO THE START OF CONSTRUCTION. ANY CONFLICTS SHALL BE IMMEDIATELY BROUGHT TO THE ATTENTION OF THE ENGINEER.
2. CONTRACTOR TO COORDINATE WITH WATER UTILITY FOR CONNECTION TO 10" MAIN TO USE FOR IRRIGATION PURPOSED ON BOTH PHASE 1 AND PHASE 2
3. SALVAGE EXISTING VEGETATION TO BE USED IN STREAM WORK

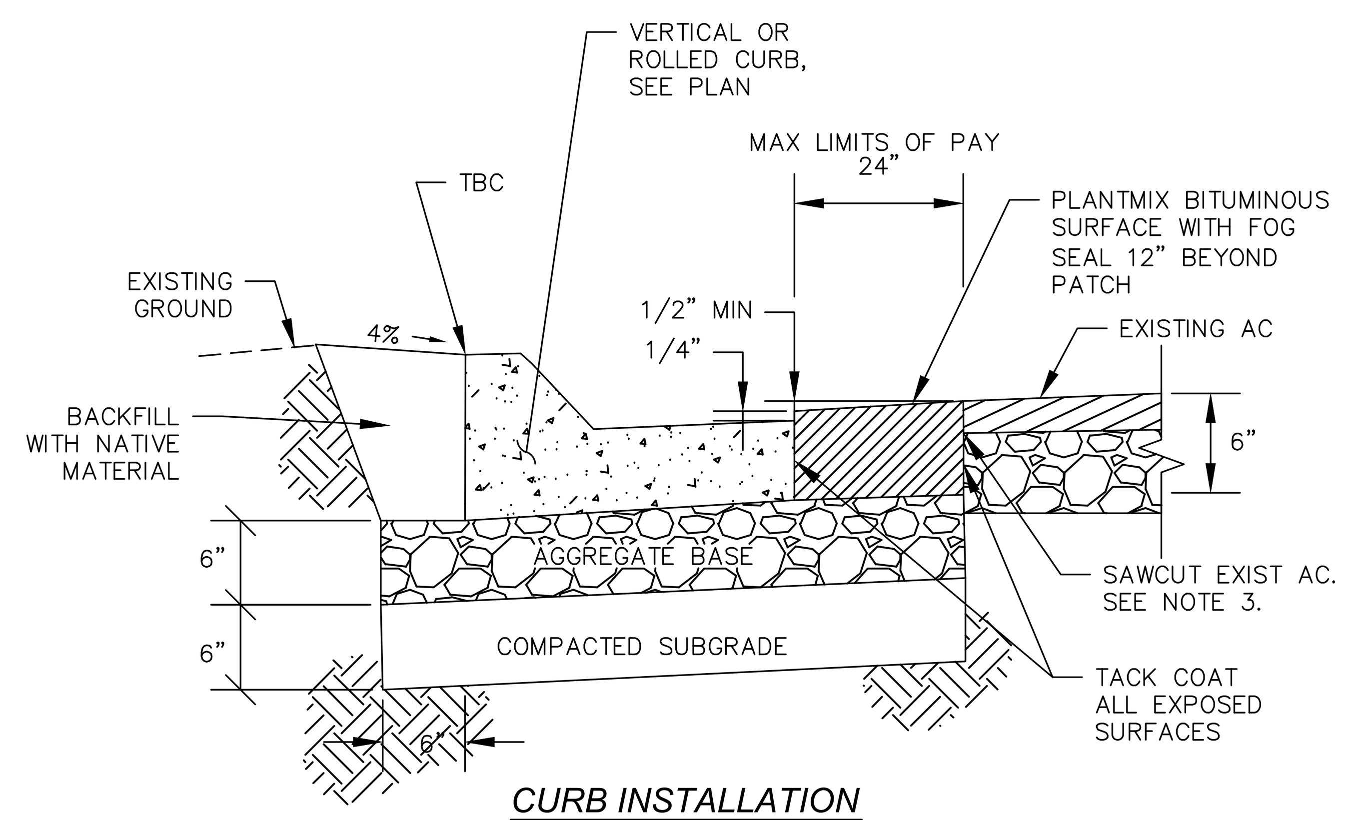
50% DESIGN PLANS
NOT FOR CONSTRUCTION

Nevada Tahoe Conservation District

DRAINAGE PLAN SOUTH 2
BURKE CREEK HWY 50 CROSSING AND REALIGNMENT PROJECT
PHASE 1

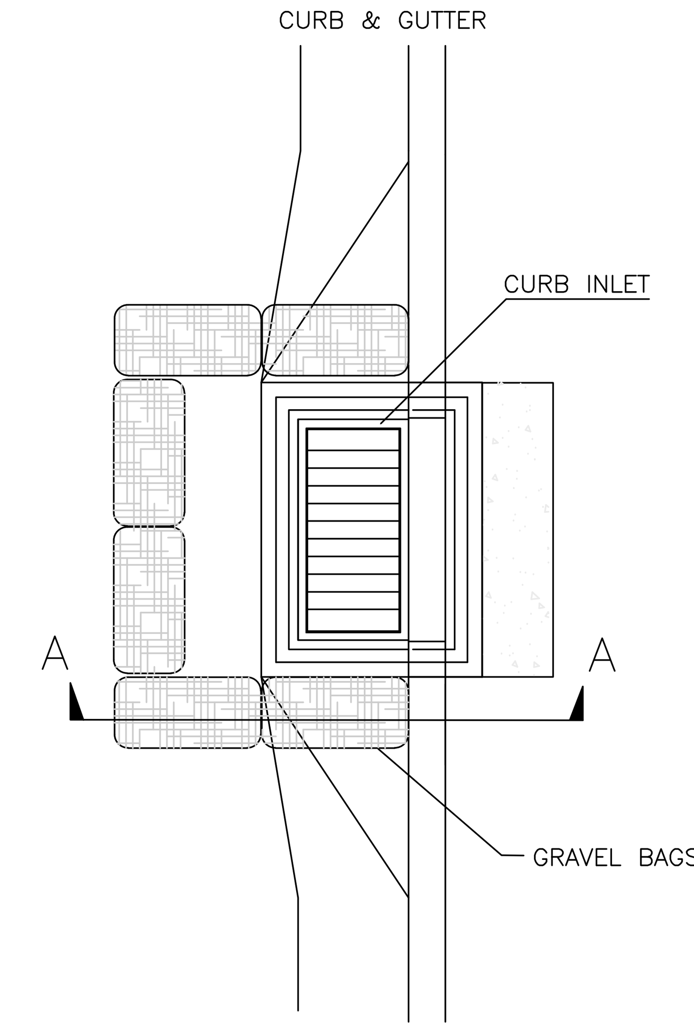
DESIGNED/DRAWN	MBG/MBG
CHECKED	MCK
DATE	06/24/2015
SCALE	AS SHOWN
PROJECT	BCC
SHEET	CD-3

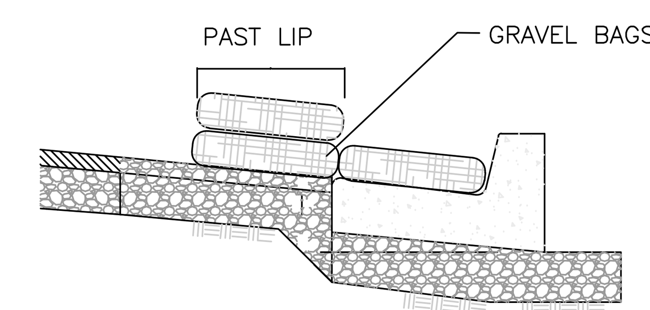
CURB INSTALLATION



NOTES:
1. CURB TYPE PER PLAN.
2. SAW CUT ALONG STRAIGHT LINES. NO SAW CUTS WITHIN WHEEL PATH
3. SURFACE TOLERANCES FOR AC PAVEMENT REPAIR SHALL CONFORM TO THE CURRENT EDITION OF THE STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION (ORANGE BOOK)
4. ASPHALT CONCRETE MATERIALS AND TESTING SHALL CONFORM THE THE CURRENT EDITION OF THE ORANGE BOOK.
5. AGGREGATE BASE SHALL BE TYPE 2 CLASS B COMPACTED TO 95% MDD.
6. COMPACTED SUBGRADE SHALL BE CLASS A OR CLASS E (NATIVE) BACKFILL COMPACTED TO 90% MDD
7. TACKCOAT ALL EXPOSED SURFACES SS–1h, 0.07–0.13 GAL/SY
8. PORTLAND CEMENT SHALL CONFORM TO SECTION 337.10.01.01 OF THE STANDARD SPECIFICATIONS (ORANGE BOOK) FOR CONCRETE EXPOSED TO FREEZE–THAW ENVIRONMENTS.

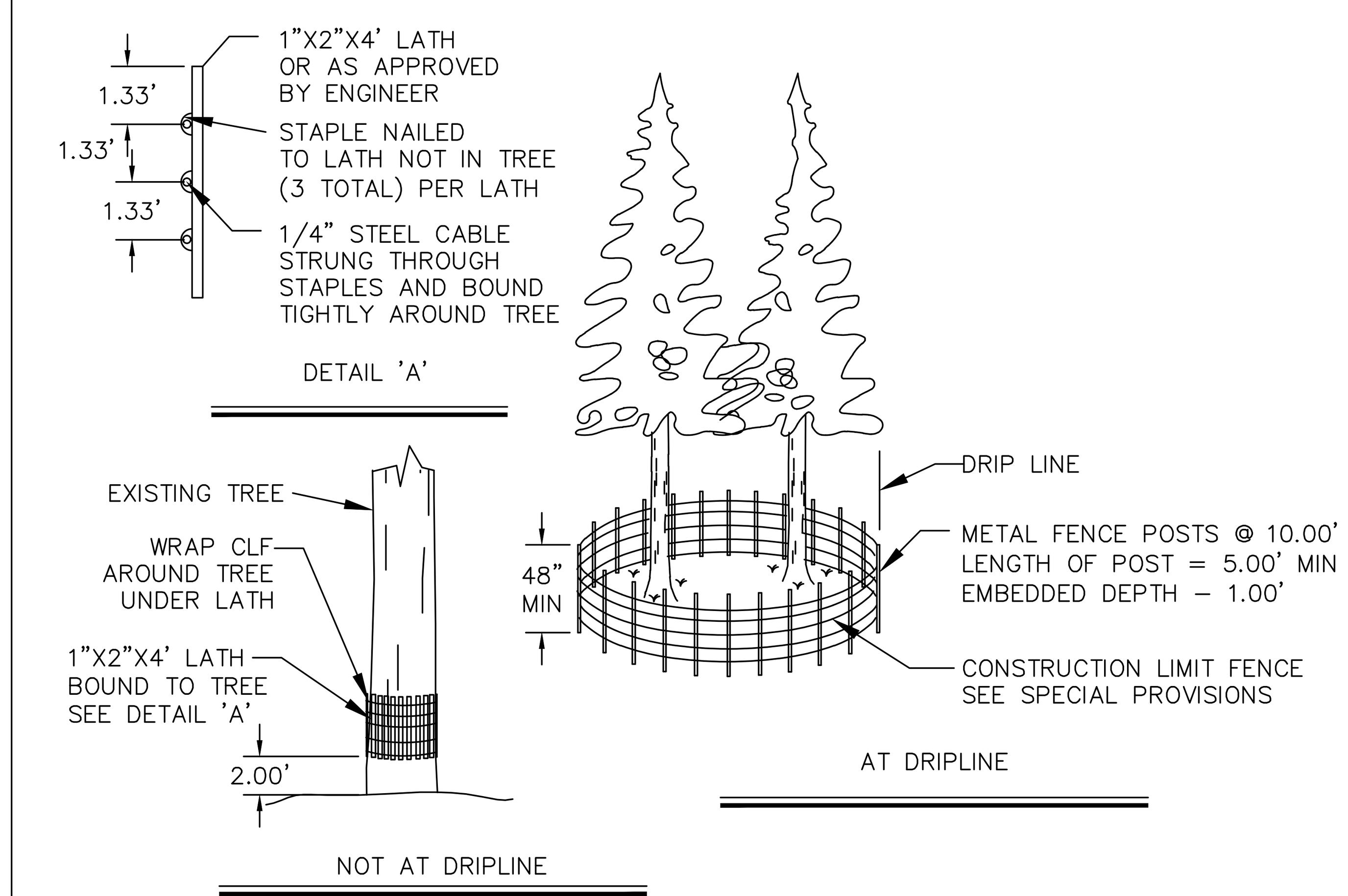
CONCRETE CURB AND GUTTER (1 / D-1)
SCALE: NTS





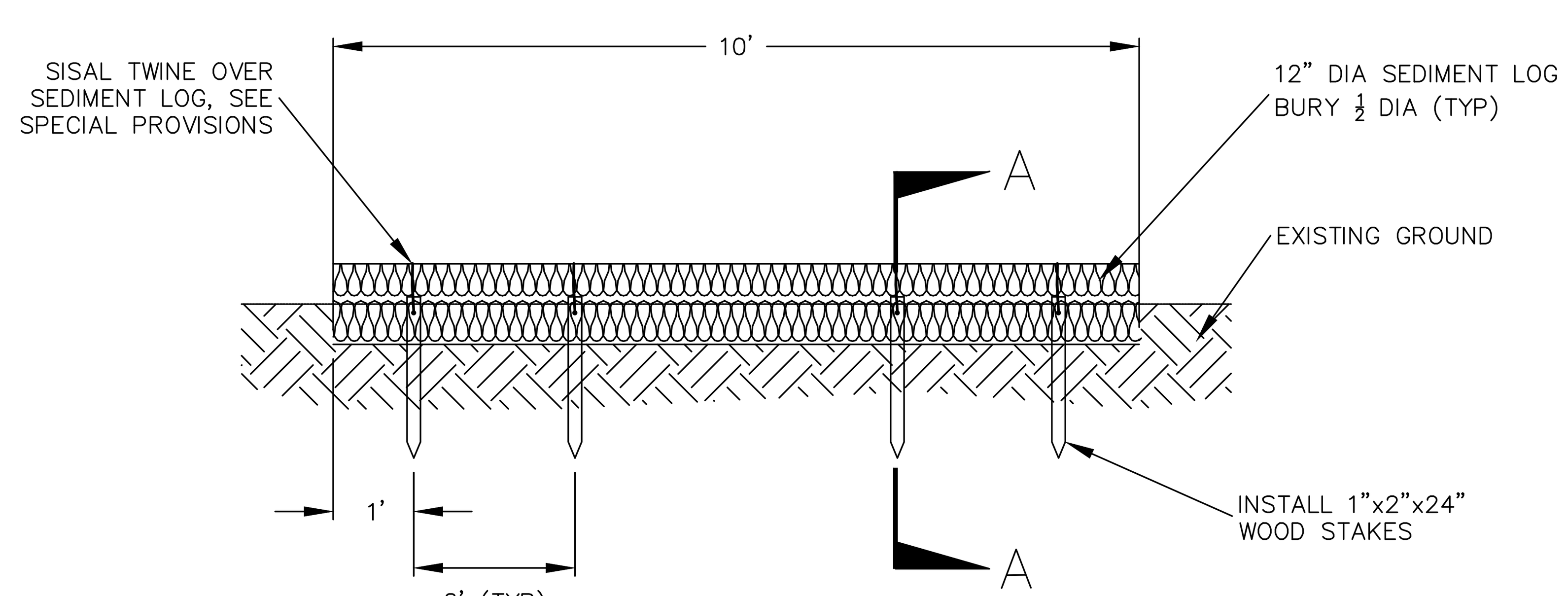
SECTION A–A

DRAINAGE INLET PROTECTION (2 / D-1)

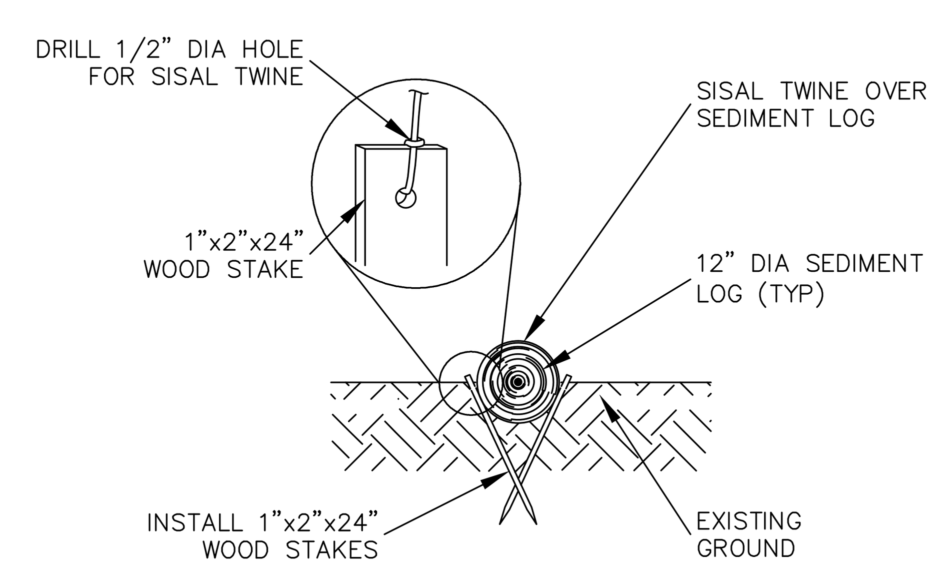


NOTE:
1. CLF AND TREE PROTECTION FENCE SHALL BE A MINIMUM OF 48" HIGH. FOR TREES WITH DRIPLINES THAT OVERHANG THE CONSTRUCTION AREAS, THE LOCATION OF THE TREE PROTECTION FENCE SHALL BE DETERMINED IN THE FIELD BY THE ENGINEER AND/OR THE TRPA AT THE PREGRADE MEETING.
2. THE DETAIL SHOWN IS FOR TREE PROTECTION. MATERIAL AND SPACING SHOWN ALSO APPLIES TO CLF.
3. QUANTITY OF FILTER FENCE AND CONSTRUCTION LIMIT FENCE DOES NOT INCLUDE MINIMUM LIMITS FOR TREE PROTECTION. TREE PROTECTION FENCING TO BE PER DETAIL THIS SHEET AND/OR AS DETERMINED IN THE FIELD.

CONSTRUCTION LIMIT AND TREE PROTECTION FENCING (3 / D-1)
NOT TO SCALE

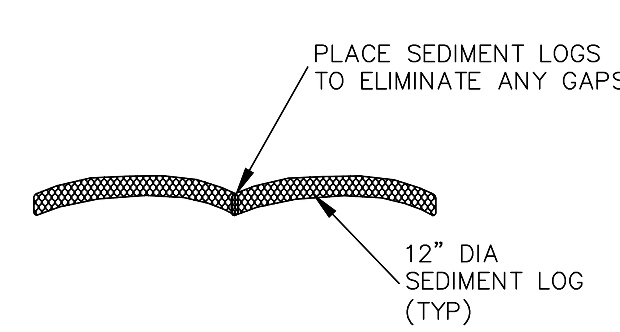


PROFILE



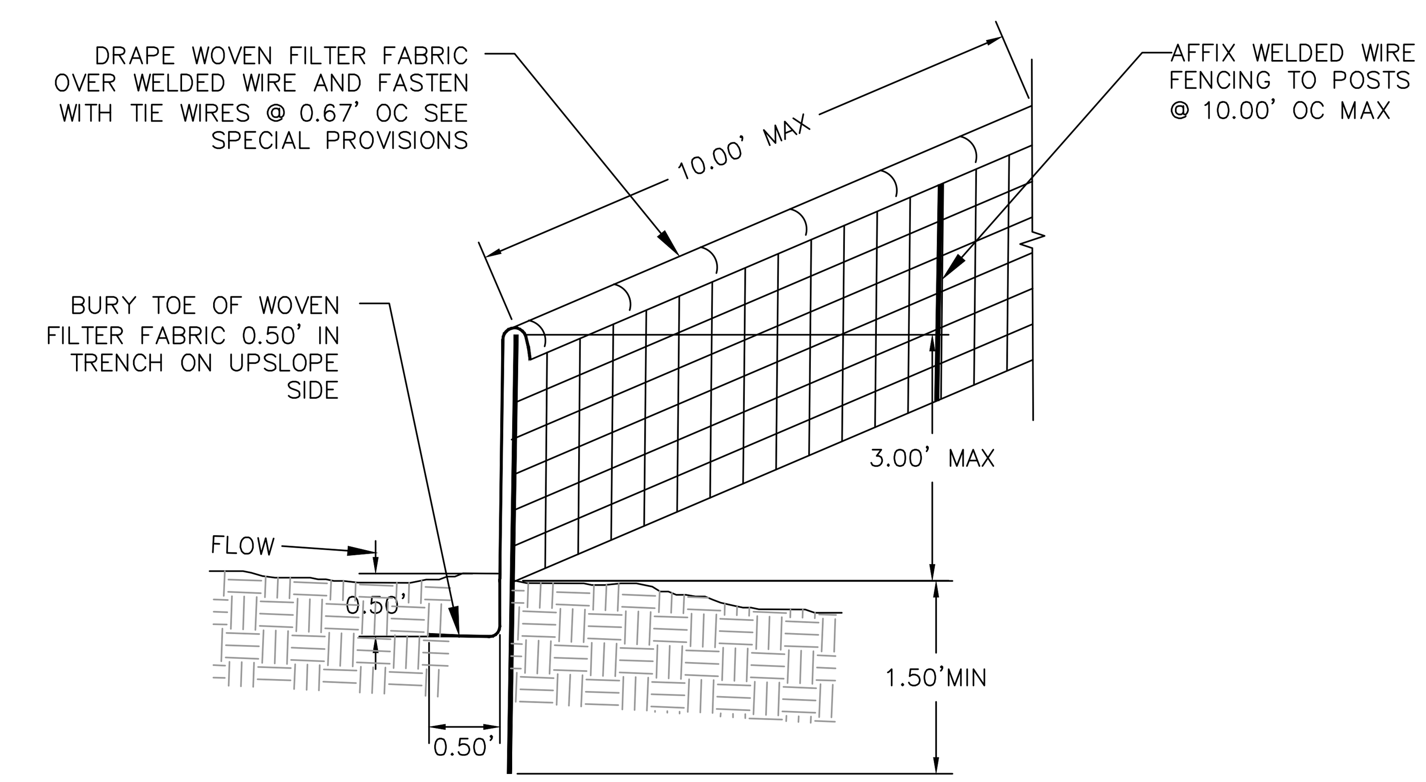
SECTION A–A

NOTES:
1. PLACEMENT OF SEDIMENT LOGS IS SUBJECT TO EXISTING CONDITIONS. FINAL LOCATIONS TO BE DETERMINED BY THE ENGINEER IN THE FIELD.
2. SEE SPECIAL PROVISIONS FOR SPECIFICATIONS REGARDING SEDIMENT LOG MATERIAL REQUIREMENTS.
3. WEIGHTED SEDIMENT LOGS MAY BE NECESSARY ON PAVED AREAS.



50% DESIGN PLANS
NOT FOR CONSTRUCTION

SEDIMENT ROLL (COIR LOG) (4 / D-1)
NOT TO SCALE



NOTES:
1. CONTRACTOR MAY USE PRE MANUFACTURED SEDIMENT CONTROL FENCE AS APPROVED BY TRPA. SEE SPECIAL PROVISIONS.
2. PLACE FENCING SUCH THAT STORM RUNOFF CANNOT PASS AROUND OR UNDER FENCE

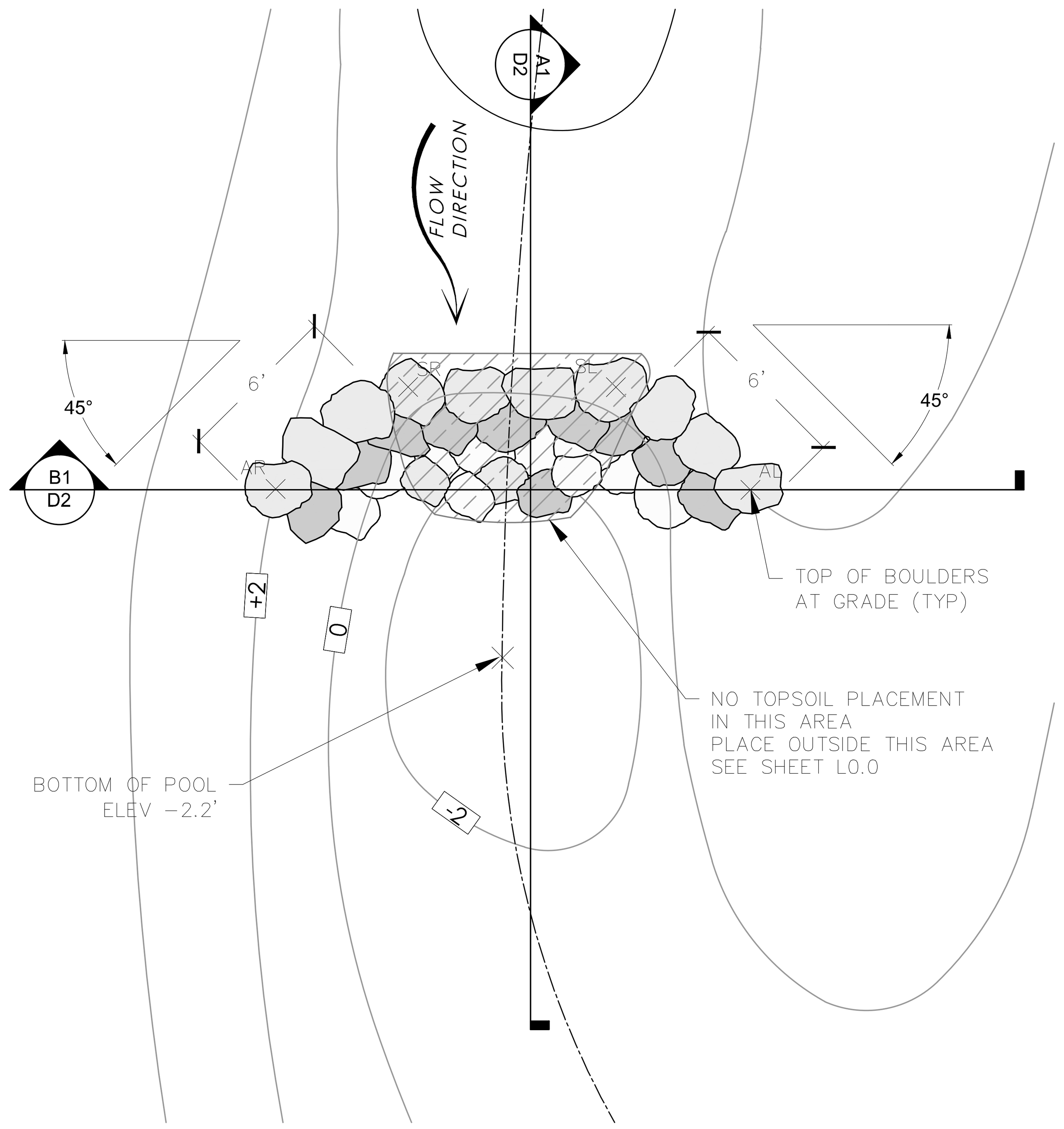
FILTER FENCE (5 / D-1)
NOT TO SCALE

Nevada Tahoe Conservation District

DETAILS
BURKE CREEK HWY 50 CROSSING AND REALIGNMENT PROJECT
PHASE 1

DESIGNED/DRAWN	MK/MK
CHECKED	MG
DATE	6/24/2015
SCALE	AS SHOWN
PROJECT	BCC

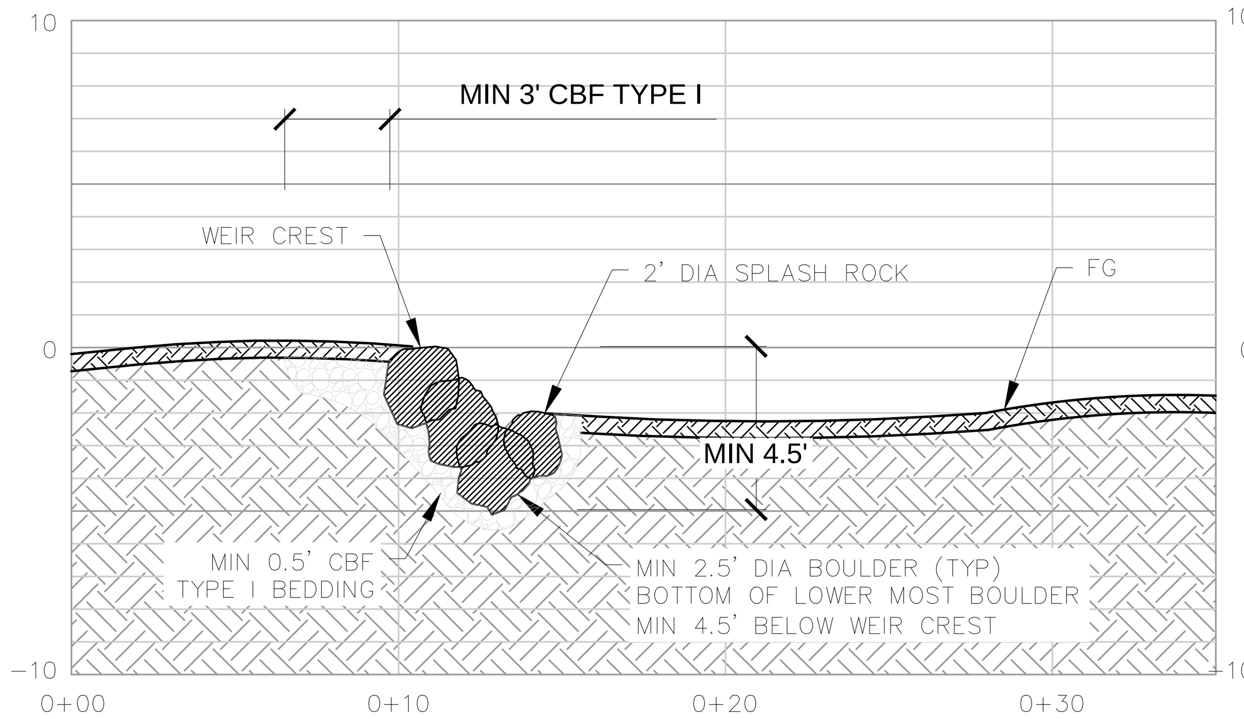
SHEET
D-1



BOULDER STEP POOL

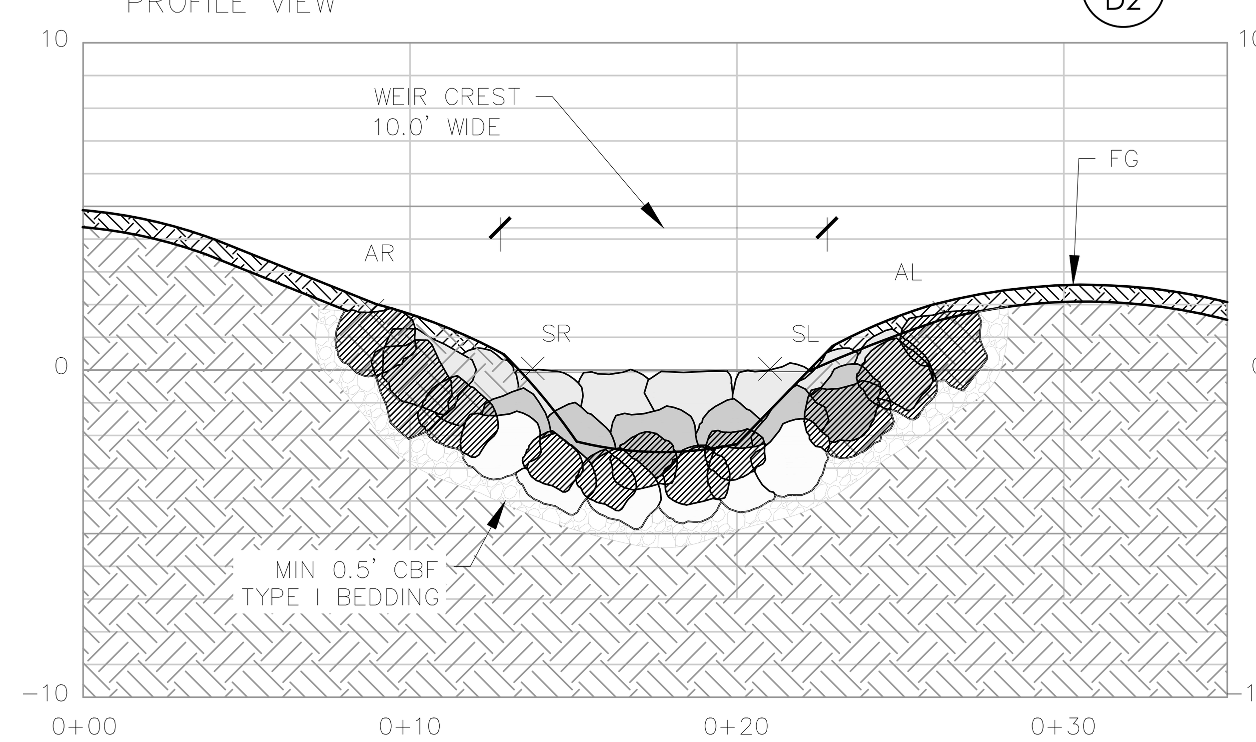
SCALE: 1" = 5'

1
D-2



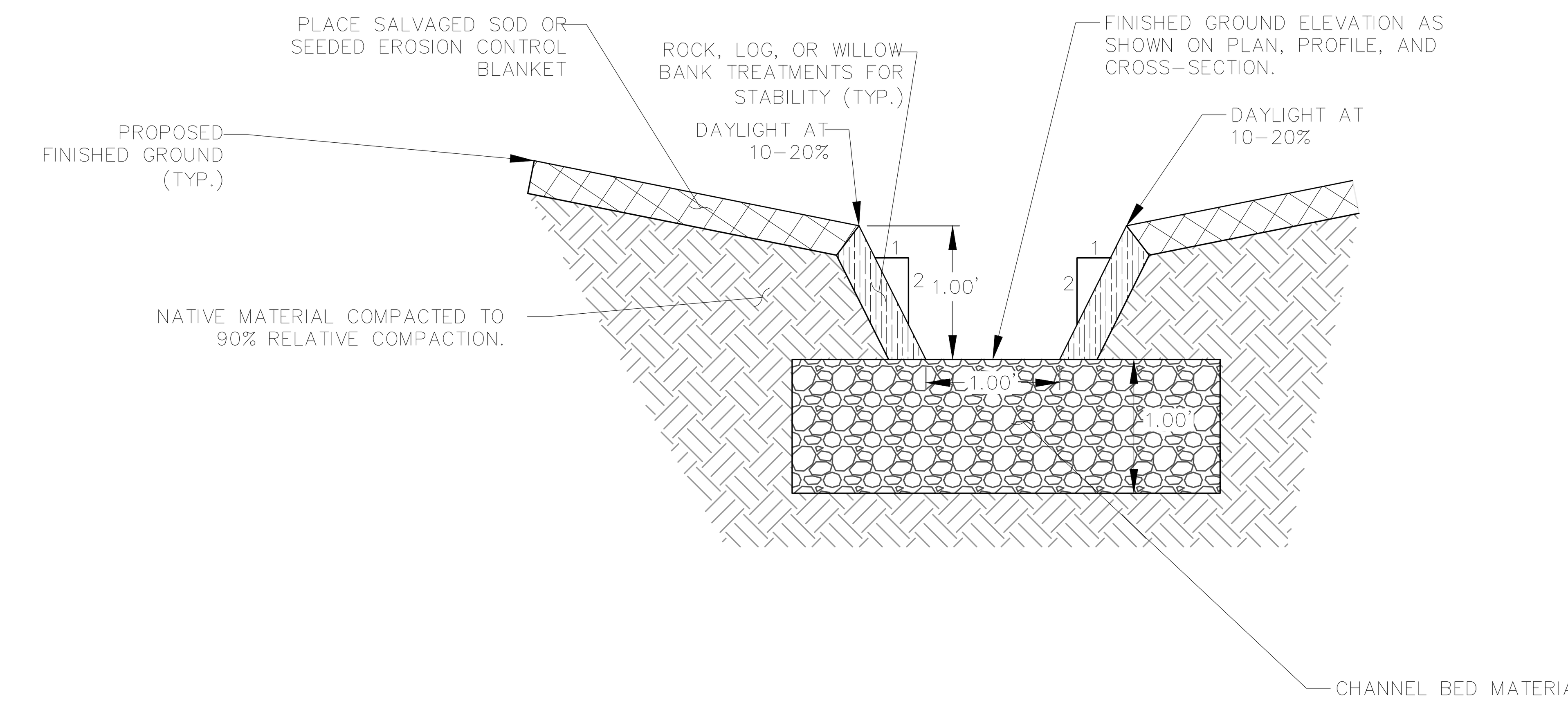
BOULDER STEP POOL
PROFILE VIEW

A1
D2



BOULDER STEP POOL
SECTION VIEW

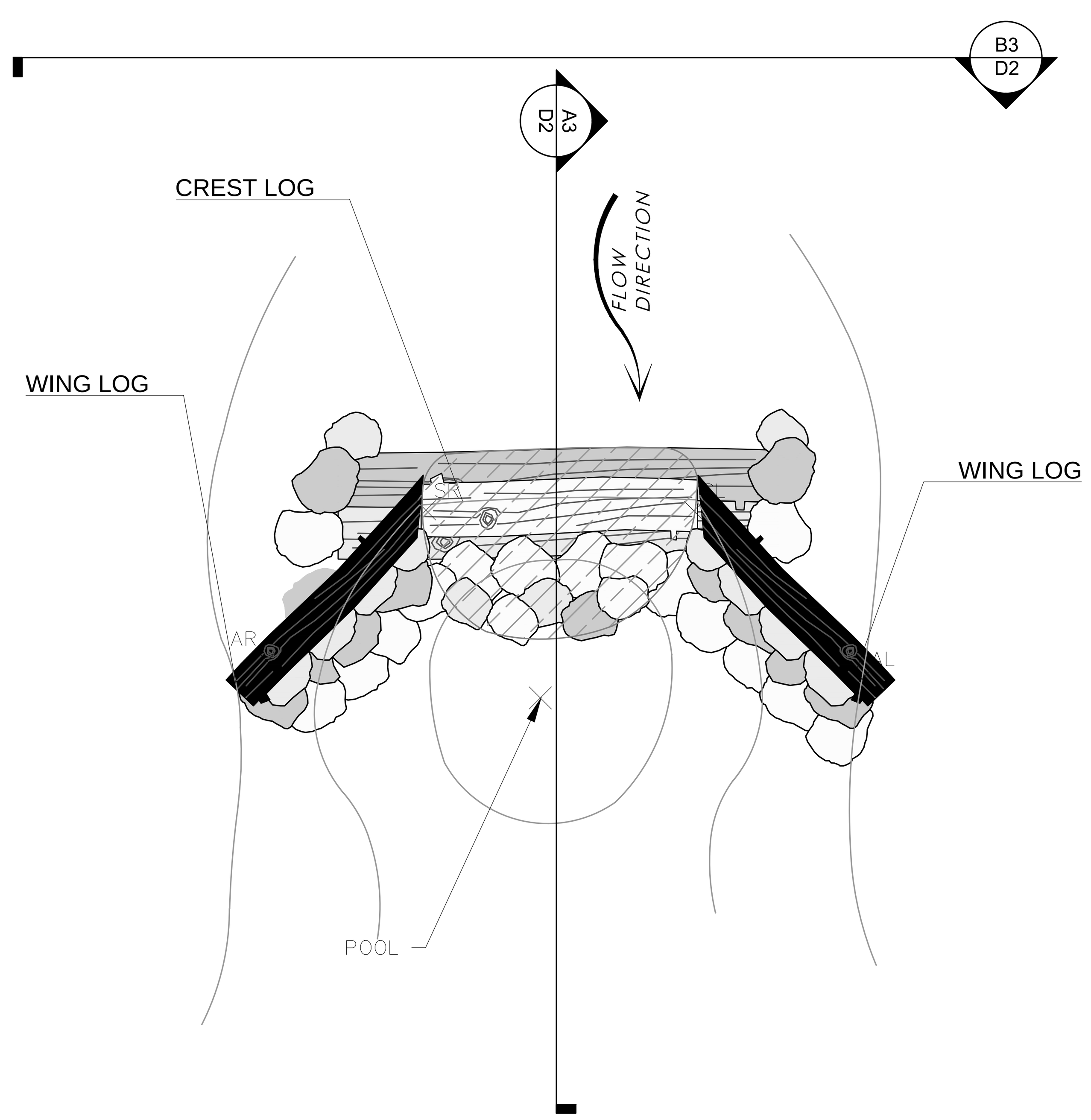
B1
D2



CHANNEL CROSS-SECTION

SCALE: 1" = 1'

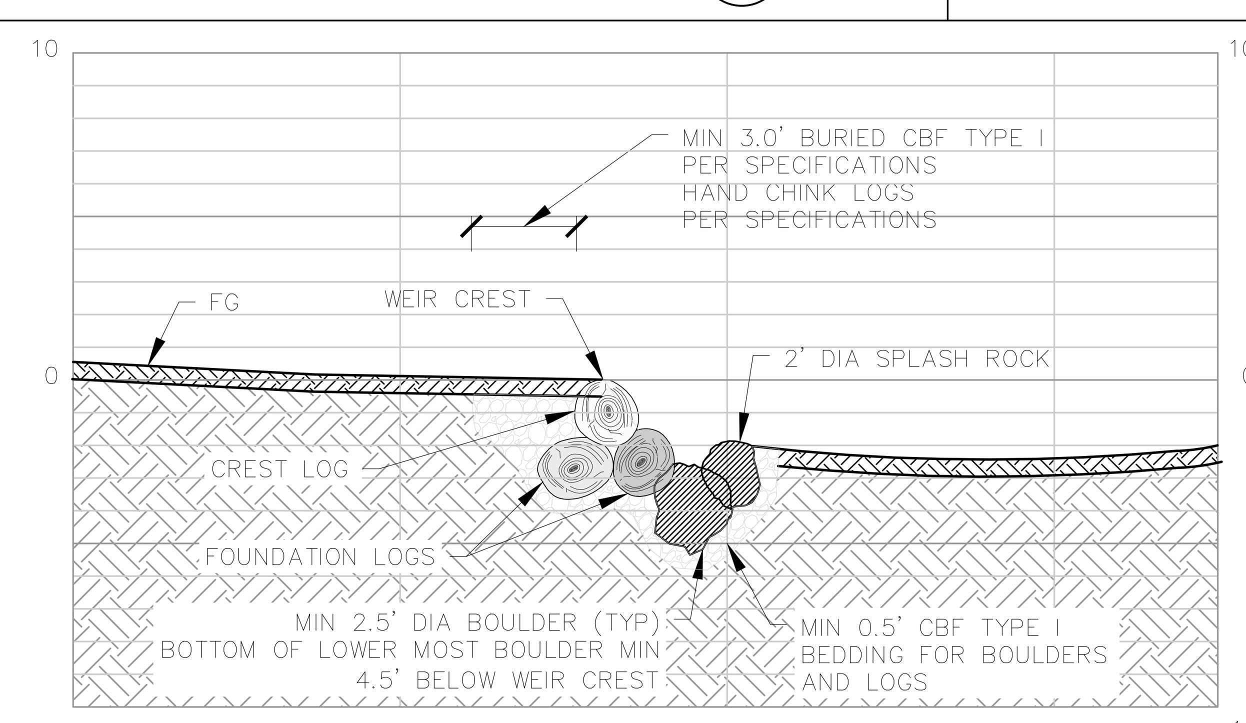
1
D-2



LOG STEP POOL -TYPE 1

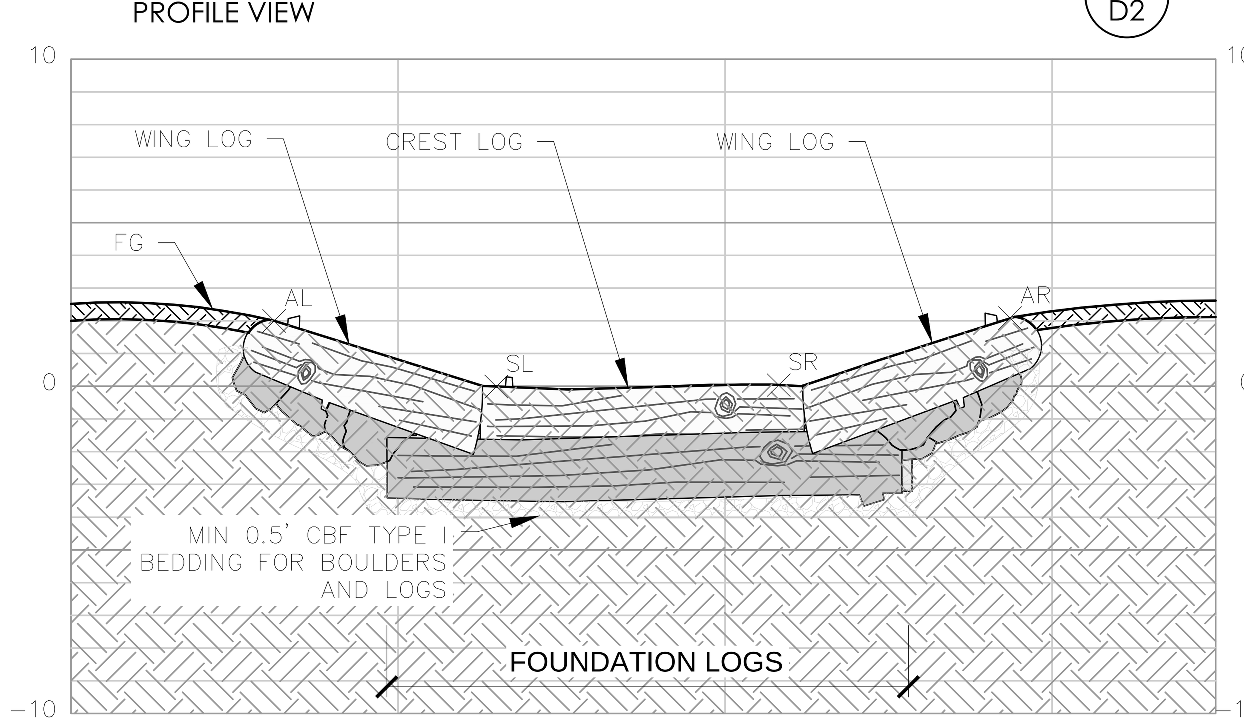
SCALE: 1" = 5'

3
D-2



LOG STEP POOL
PROFILE VIEW

A3
D2



LOG STEP POOL
ELEVATION VIEW

B3
D2

CHANNEL TIE-IN WITH FLOW SPLIT

NOT TO SCALE

4
D-2

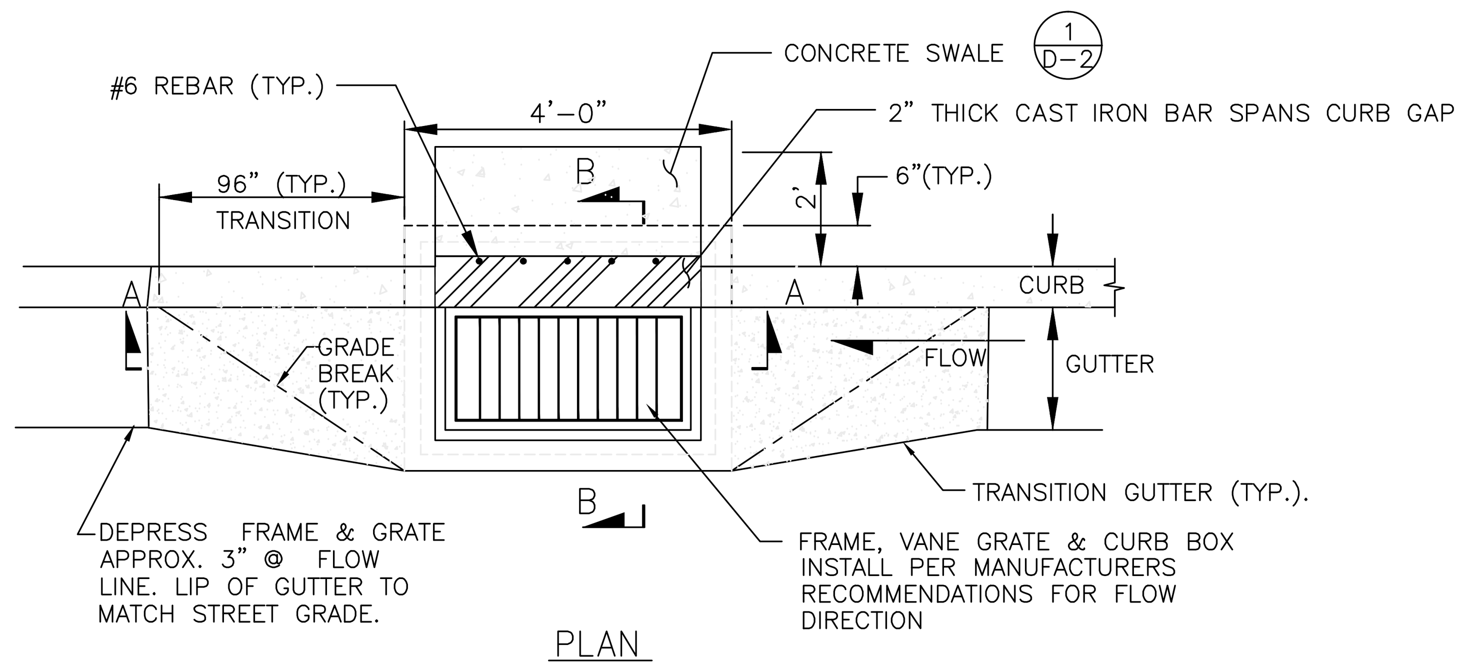
50% DESIGN PLANS
NOT FOR CONSTRUCTION

Nevada Tahoe Conservation District

DETAILS
BURKE CREEK HWY 50 CROSSING AND
REALIGNMENT PROJECT
PHASE 1

DESIGNED/DRAWN	DS/MK
CHECKED	MK
DATE	6/24/2015
SCALE	AS SHOWN
PROJECT	BCC

SHEET
D-2

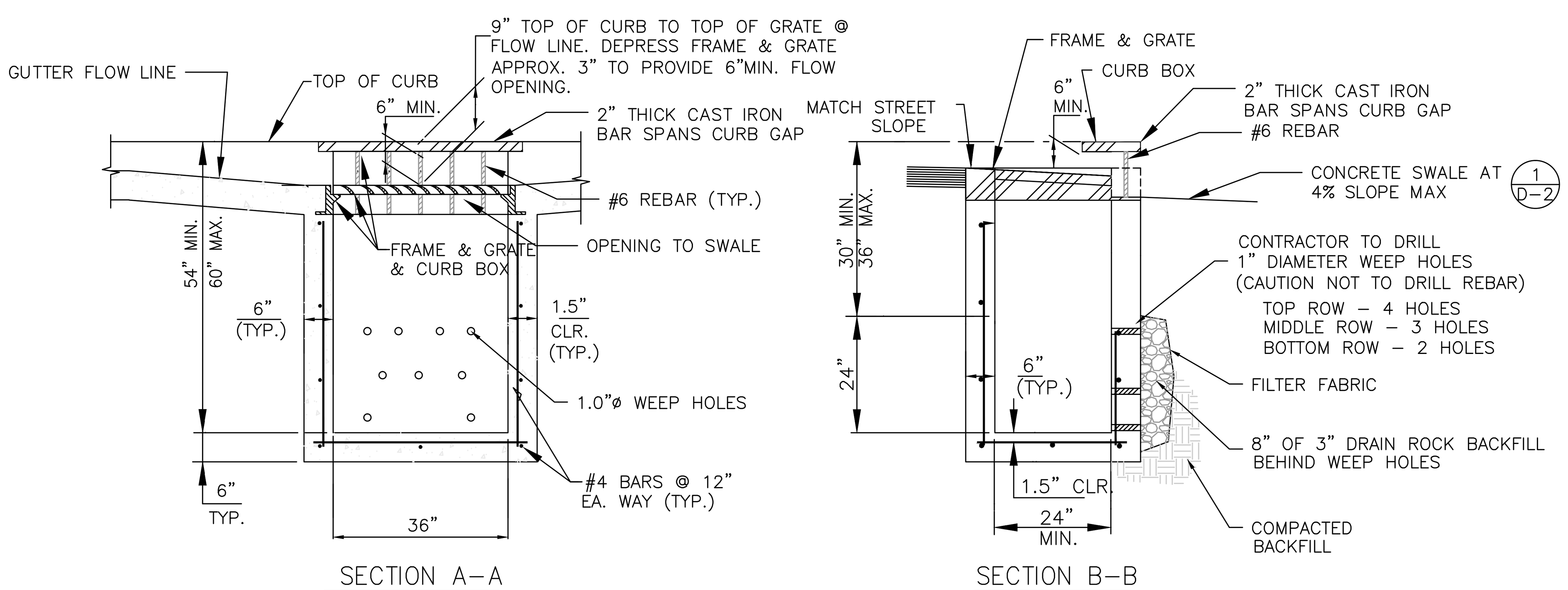


NOTES:
CONCRETE FOR CAST IN PLACE CATCH BASIN AND 4'x2' CONCRETE PAD SHALL BE 6.25 SACK 4000psi WITH 4.5–7.5% ENTRAINED AIR.

REINFORCING STEEL SHALL BE FIBERMESH.

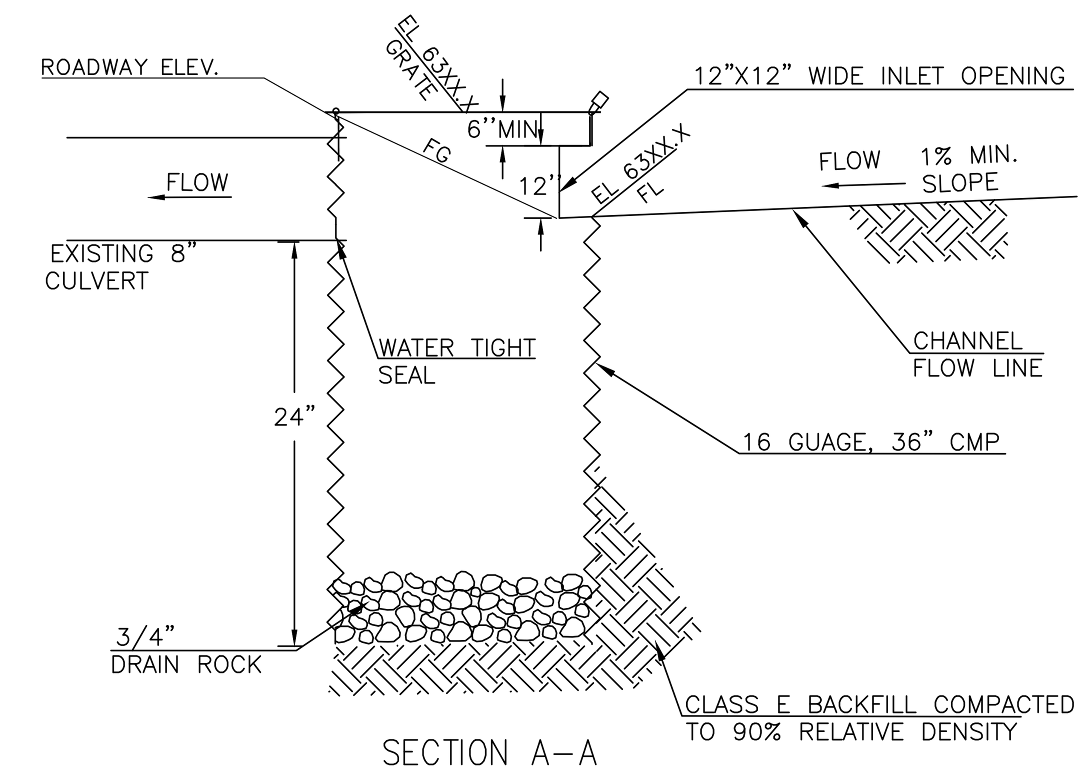
CONCRETE STRUCTURE MAY BE A PRE–CAST CONCRETE UNIT UPON APPROVAL OF THE COUNTY ENGINEER.

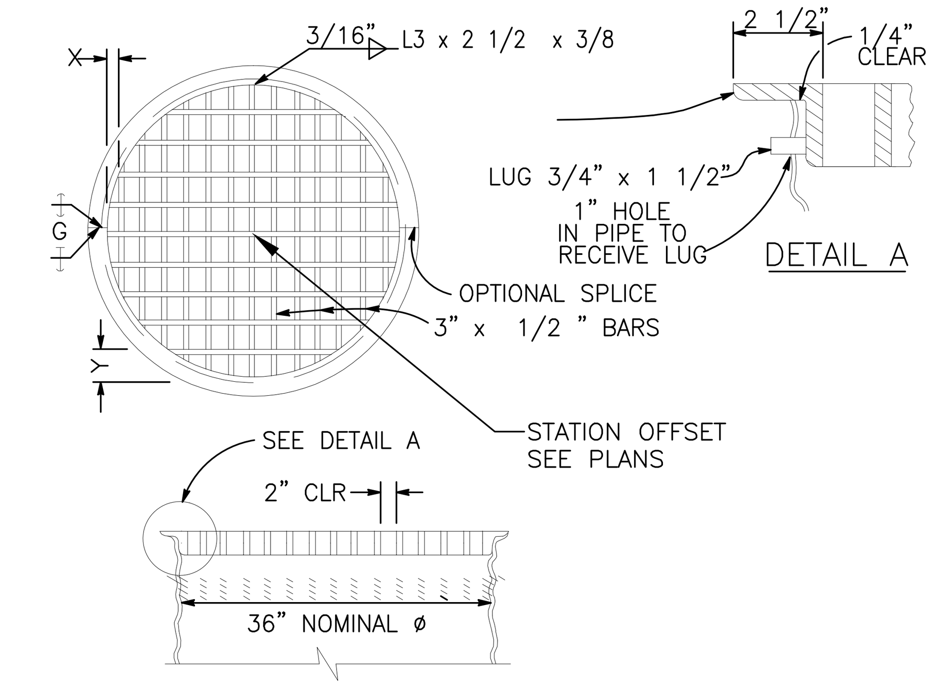
FRAME AND GRATE SHALL BE NEENAH R–3067–V (VANE GRATE) OR APPROVED EQUAL.



COMBINATION DROP INLET (1 / D-3)

SCALE: 1" = 2'





GRATE BAR SPACING TABLE

NO. OF BARS	CLEAR BAR SPACING	X (in)	Y (in) 4" SPACING	Y (in) 6" SPACING	Z (in)
13	2"	2 1/8"	–	–	–

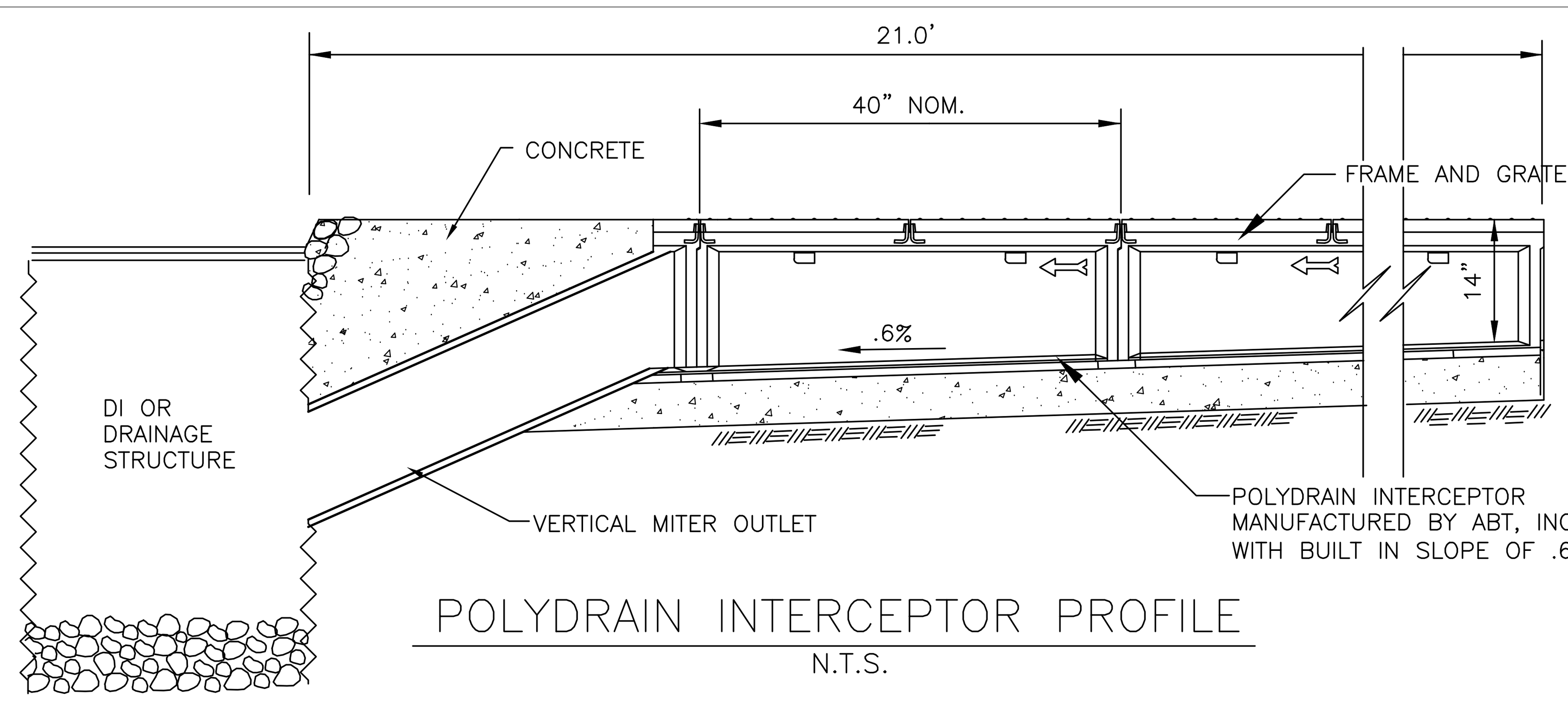
NOTES:
1. ALL CONNECTIONS SHALL BE WELDED WITH 1/4" BEAD MIN BOTH SIDES OF BARS
2. ENTIRE GRATE TO BE HOT–DIP GLAVANIZED AFTER ASSEMBLY PRIOR TO INSTALLATION.

SEDIMENT TRAP GRATE

NO SCALE

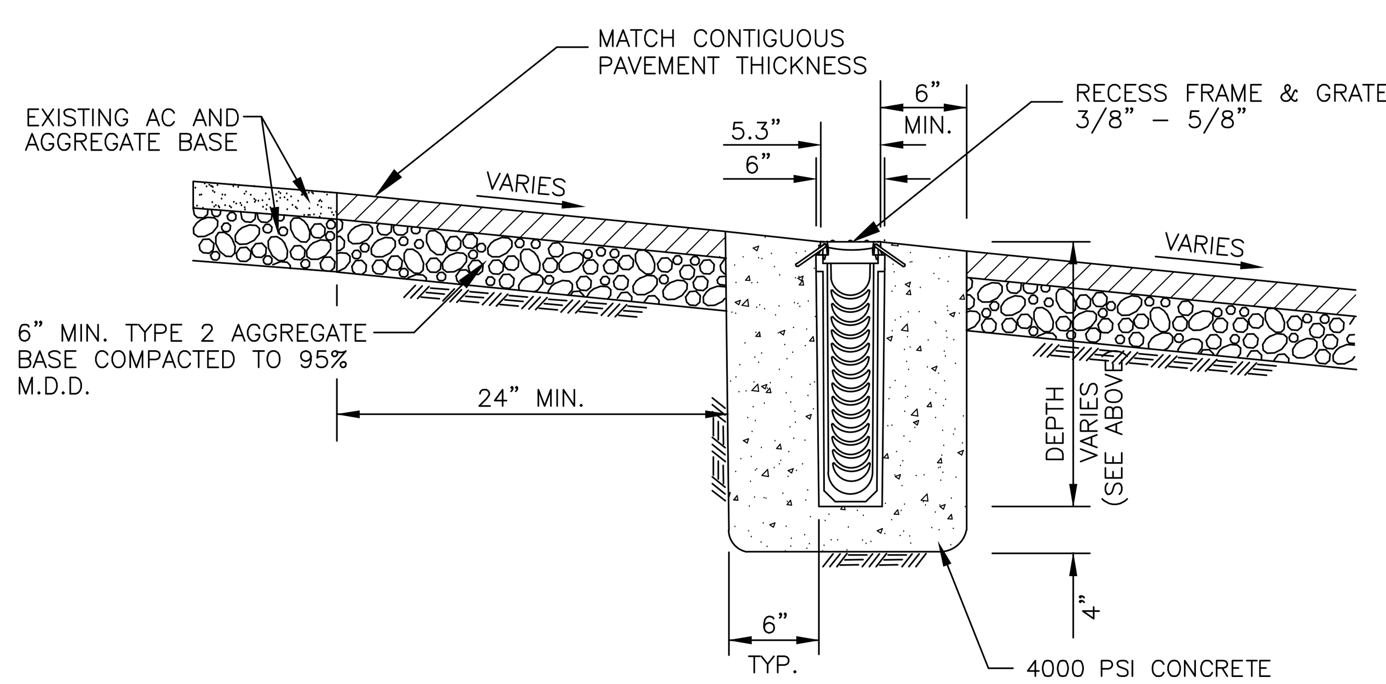
DOUBLE SEDIMENT CAN (2 / D-3)

SCALE: NTS



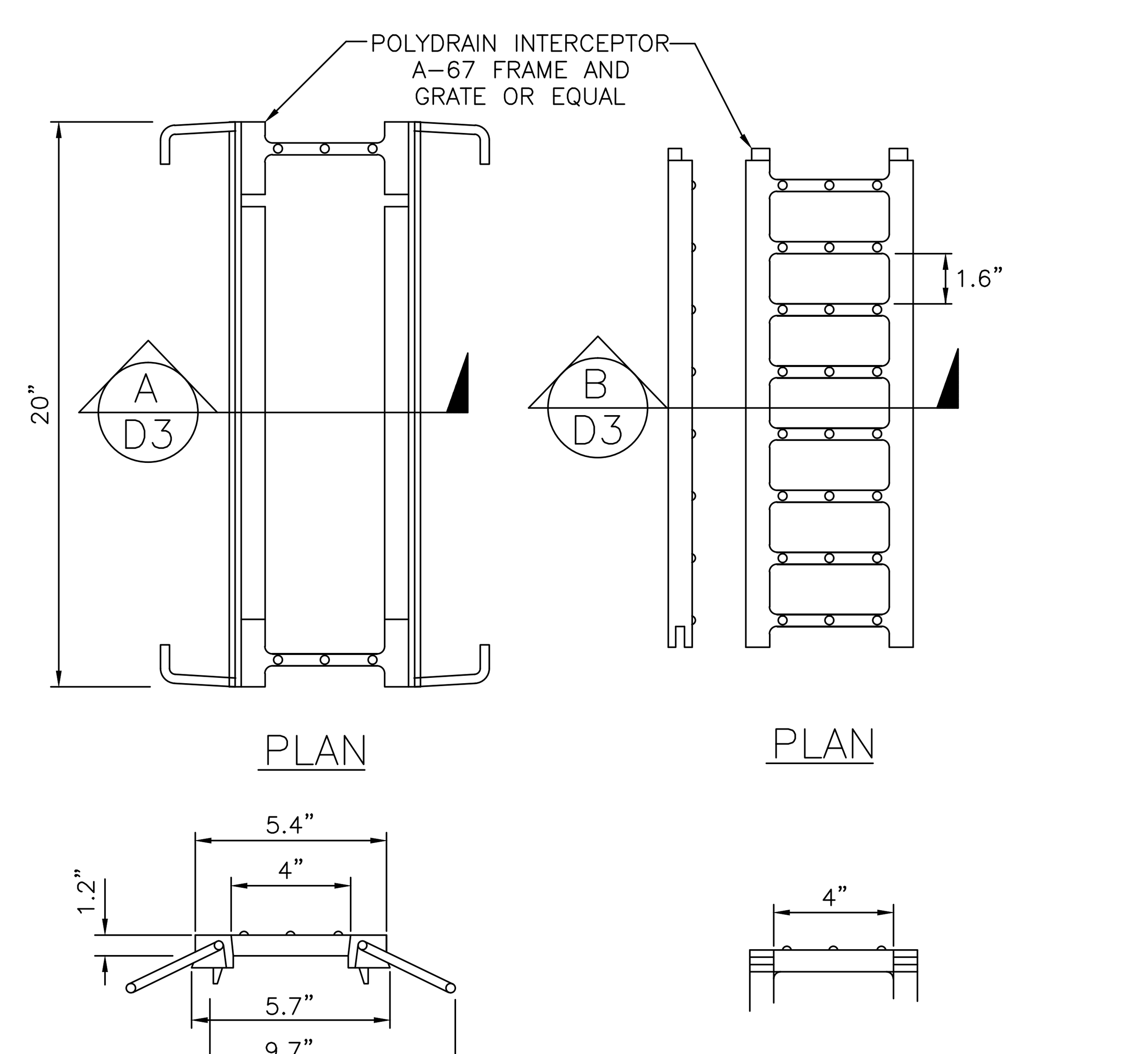
POLYDRAIN INTERCEPTOR PROFILE

N.T.S.



POLYDRAIN INTERCEPTOR SECTION

N.T.S.



FRAME SECTION (A / D3)

N.T.S.

GRATE SECTION (B / D3)

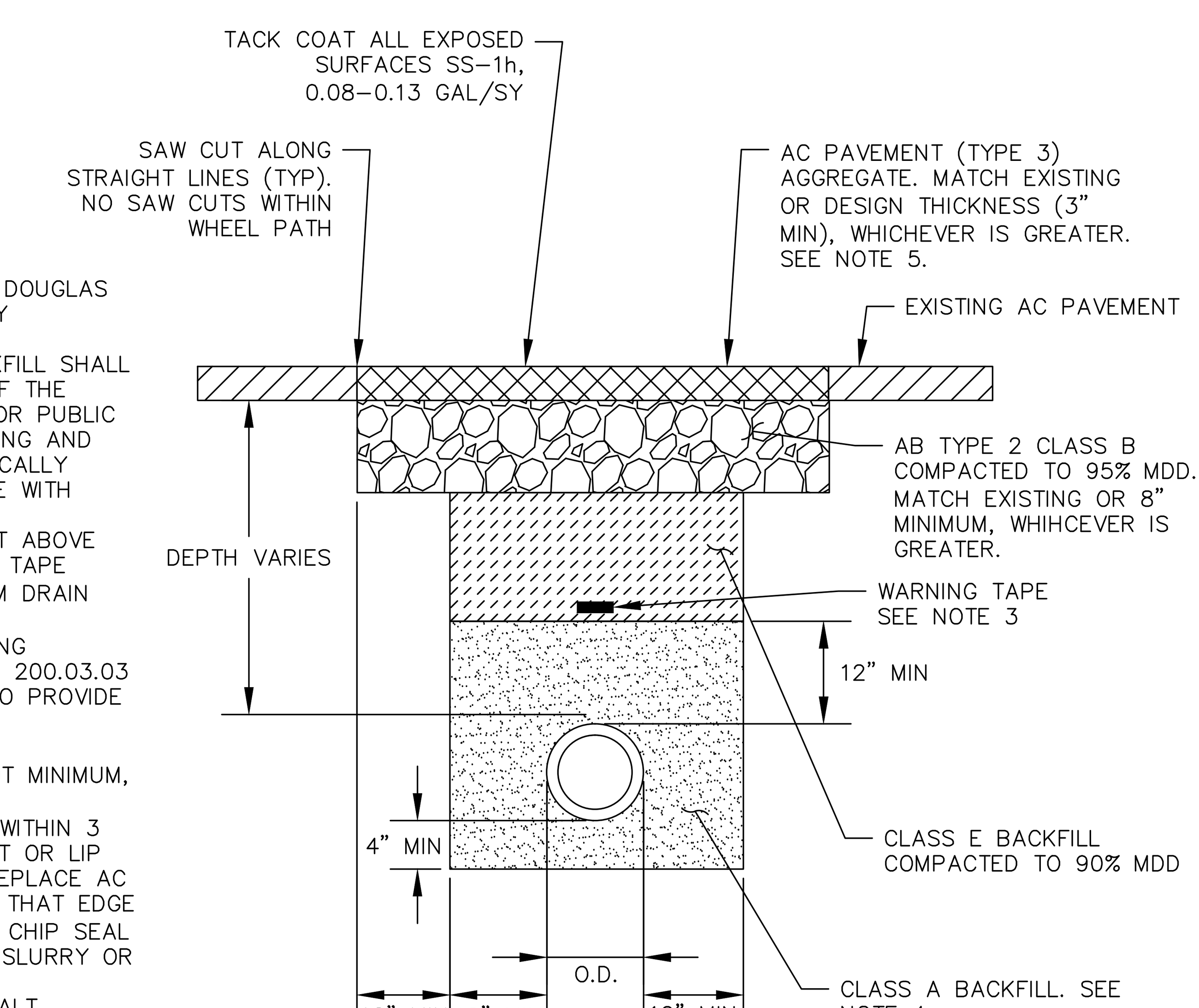
N.T.S.

NOTES:
1. GRATE SHALL BE HS–25 LOAD RATED AND BICYCLE SAFE.
2. ALL GRATES SHALL BE REMOVABLE. USE TWO–PIECE GRATES THROUGHOUT.

TRENCH DRAIN (3 / D-3)

SCALE: NTS

NOTES:
1. ALL REQUIREMENTS FOR THE DOUGLAS COUNTY STORM DRAIN UTILITY ORDINANCE MUST BE MET.
2. CLASS A AND CLASS E BACKFILL SHALL CONFORM TO SECTION 200 OF THE STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION. BEDDING AND BACKFILL SHALL BE MECHANICALLY COMPACTED IN CONFORMANCE WITH SECTION 305.10.
3. PLACE WARNING TAPE 1 FOOT ABOVE STORM DRAIN PIPE. WARNING TAPE SHALL READ "CAUTION STORM DRAIN MAIN".
4. CLASS A BACKFILL AS BEDDING MATERIAL PER ORANGE BOOK 200.03.03 COMPACT OR CONSOLIDATE TO PROVIDE PROPER SUPPORT OF PIPE
5. PATCH WIDTH:
   A) PATCHES WILL BE 4 FOOT MINIMUM, ANY DIRECTION.
   B)IF EDGE OF PATCHING IS WITHIN 3 FEET OF EDGE OF PAVEMENT OR LIP OF GUTTER, REMOVE AND REPLACE AC PAVEMENT FROM PATCH TO THAT EDGE
   C) PLACE SLURRY SEAL OR CHIP SEAL ON STREETS WITH EXISTING SLURRY OR CHIP SEAL
6. SURFACE TOLERANCES, ASPHALT CONCRETE CONSTRUCTION MATERIALS, AND CONSTRUCTION TESTING SHALL CONFORM TO THE STANDARD SPECIFICATIONS (ORANGE BOOK).
7. ASPHALT CEMENT SHALL BE PG 64–28 NV UNLESS OTHERWISE APPROVED BY DOUGLAS COUNTY ENGINEERING. WHEN PG 64–28 NV ASPHALT CEMENT IS NOT USED, NEW ASPHALT CONCRETE SURFACE SHALL BE FOG SEALED.



STORM DRAIN PIPE (4 / D-3)

SCALE: NTS

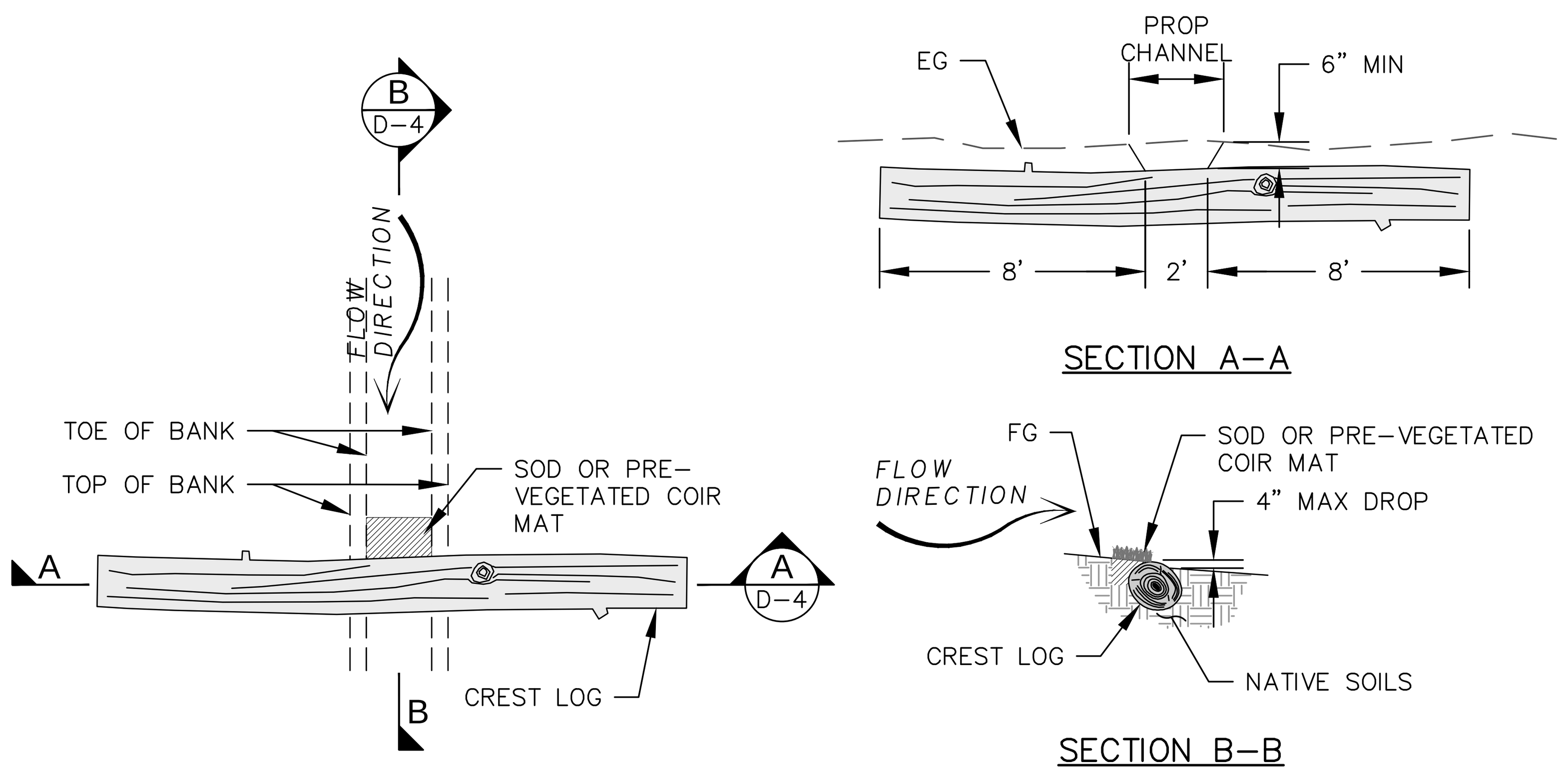
Nevada Tahoe Conservation District

DETAILS
BURKE CREEK HWY 50 CROSSING AND REALIGNMENT PROJECT
PHASE 1

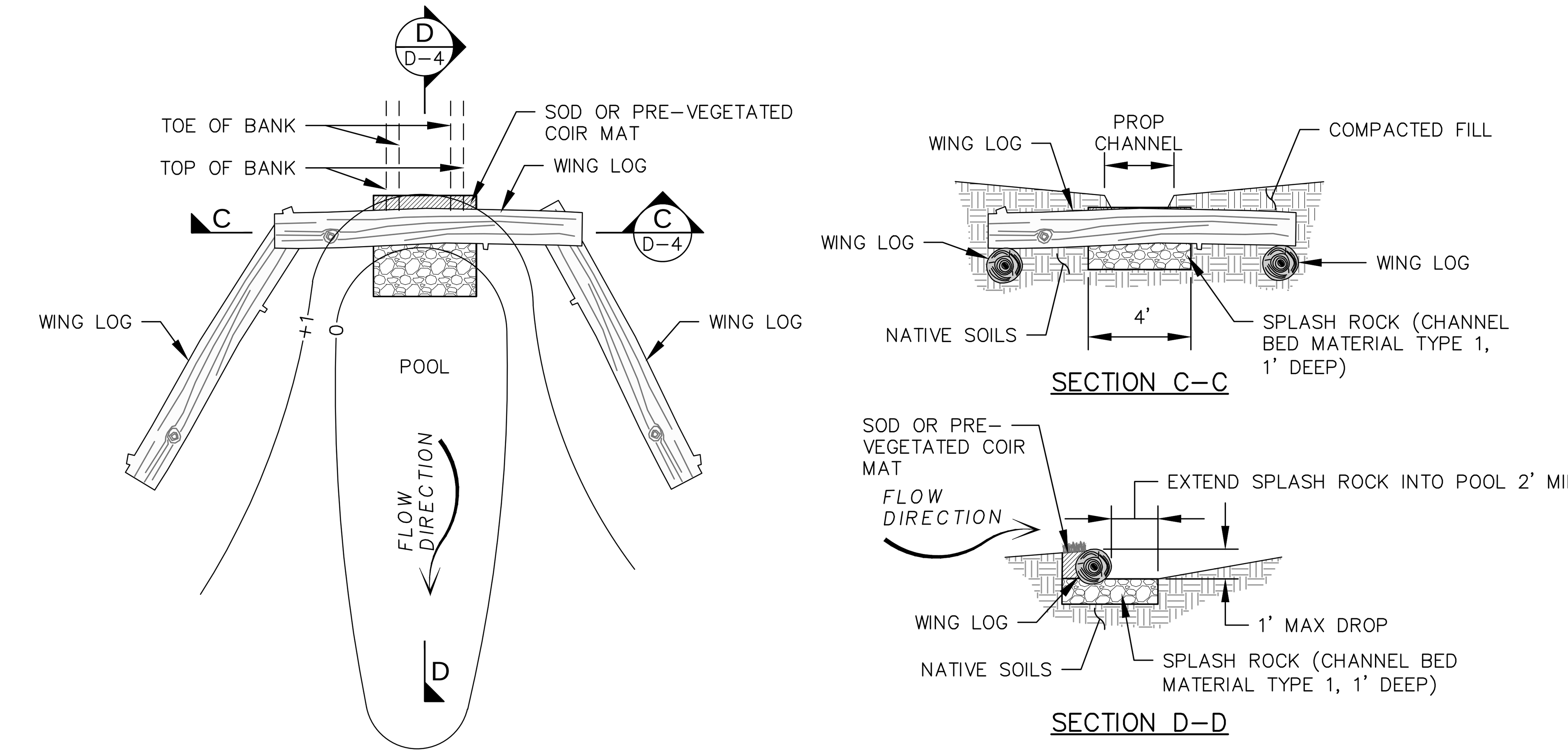
DESIGNED/DRAWN	MK/MK
CHECKED	MG
DATE	6/24/2015
SCALE	AS SHOWN
PROJECT	BCC

SHEET
D-3

NOTES:
1. CREST LOGS ARE 15–24" DIAMETER AND 18' LONG.
2. WING LOGS ARE 12–18" DIAMETER AND 12' LONG.
3. CHANNEL BED MATERIAL TYPE 1 IS FINER THAN CHANNEL BED MATERIAL TYPE 2; TYPE 1 SHALL HAVE A D90 OF 0.5' AND TYPE 2 SHALL HAVE A D90 OF 1.0'.
4. COMPLETE MATERIALS SPECIFICATIONS WILL BE PROVIDED IN FUTURE SUBMITTALS.



GRADE CONTROL LOG (1 / D-4)
SCALE: 1" = 5'



LOG STEP POOL (2 / D-4)
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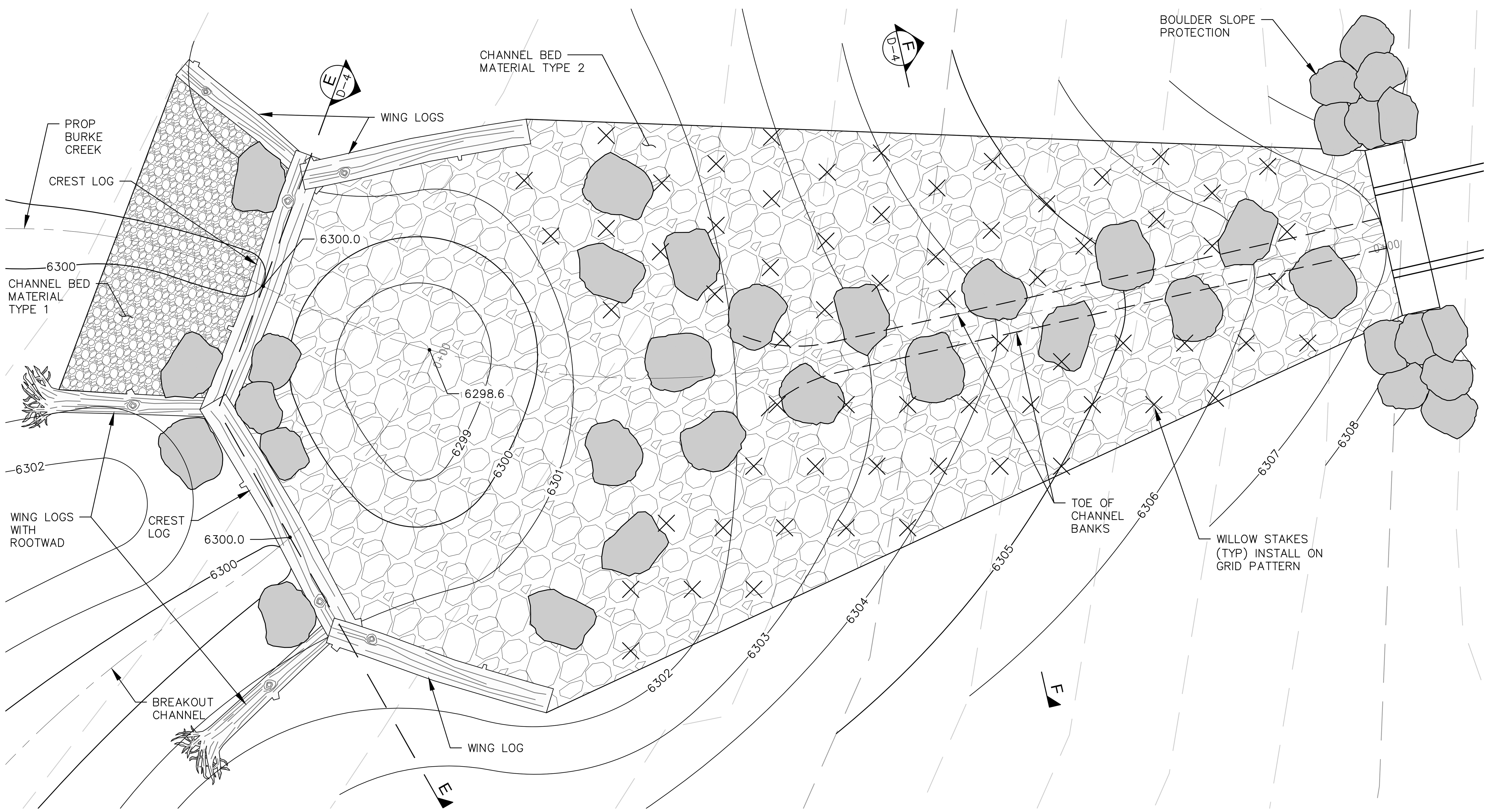
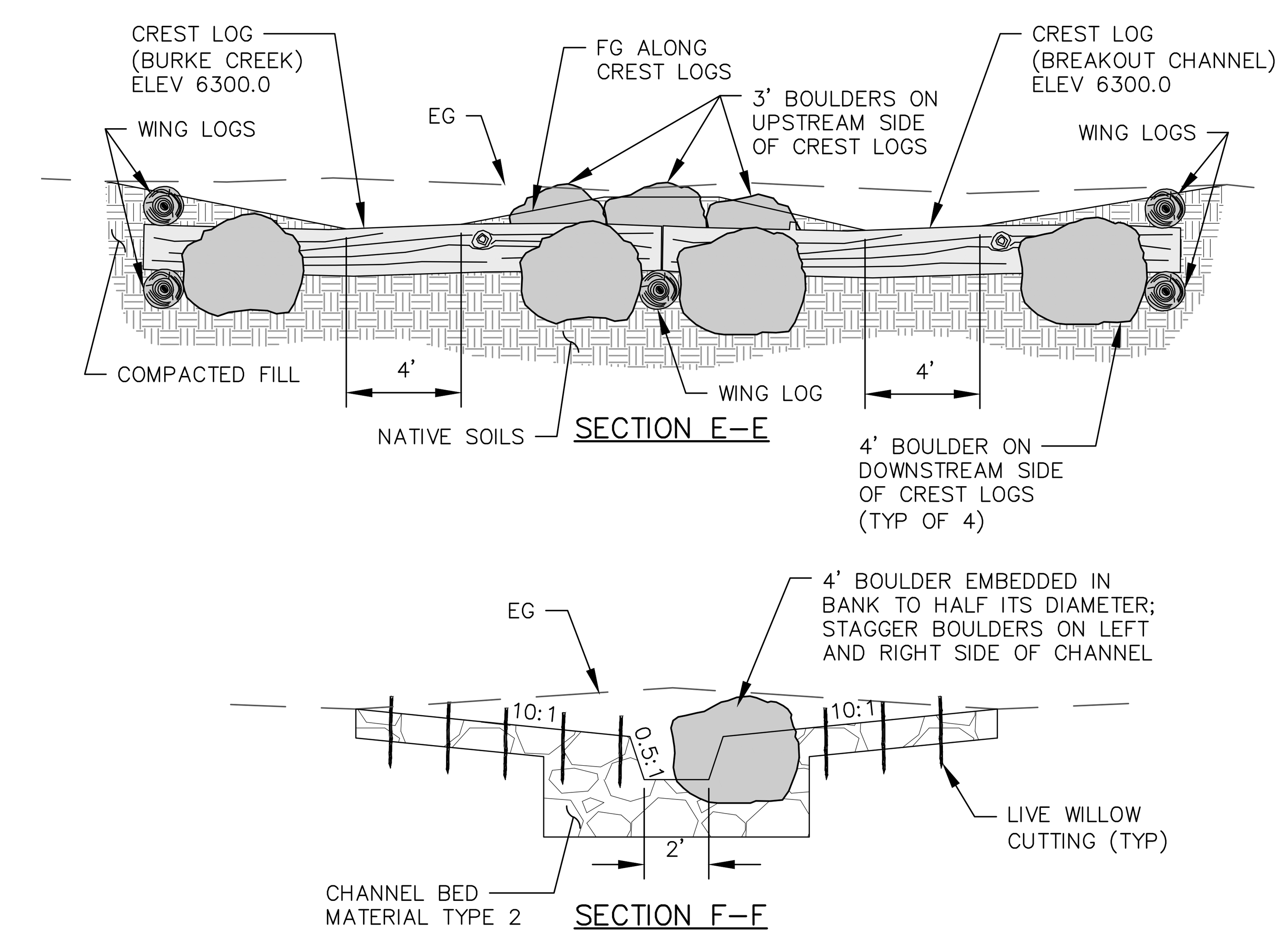
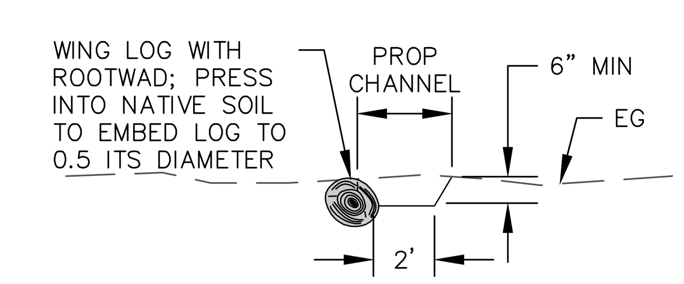




CULVERT OUTLET PROTECTION/FLOW DISSIPATER (3 / D-4)
SCALE: 1" = 5'



BANK LOG (4 / D-4)
SCALE: 1" = 5'

Nevada Tahoe Conservation District

DETAILS
BURKE CREEK HWY 50 CROSSING AND REALIGNMENT PROJECT
PHASE 2

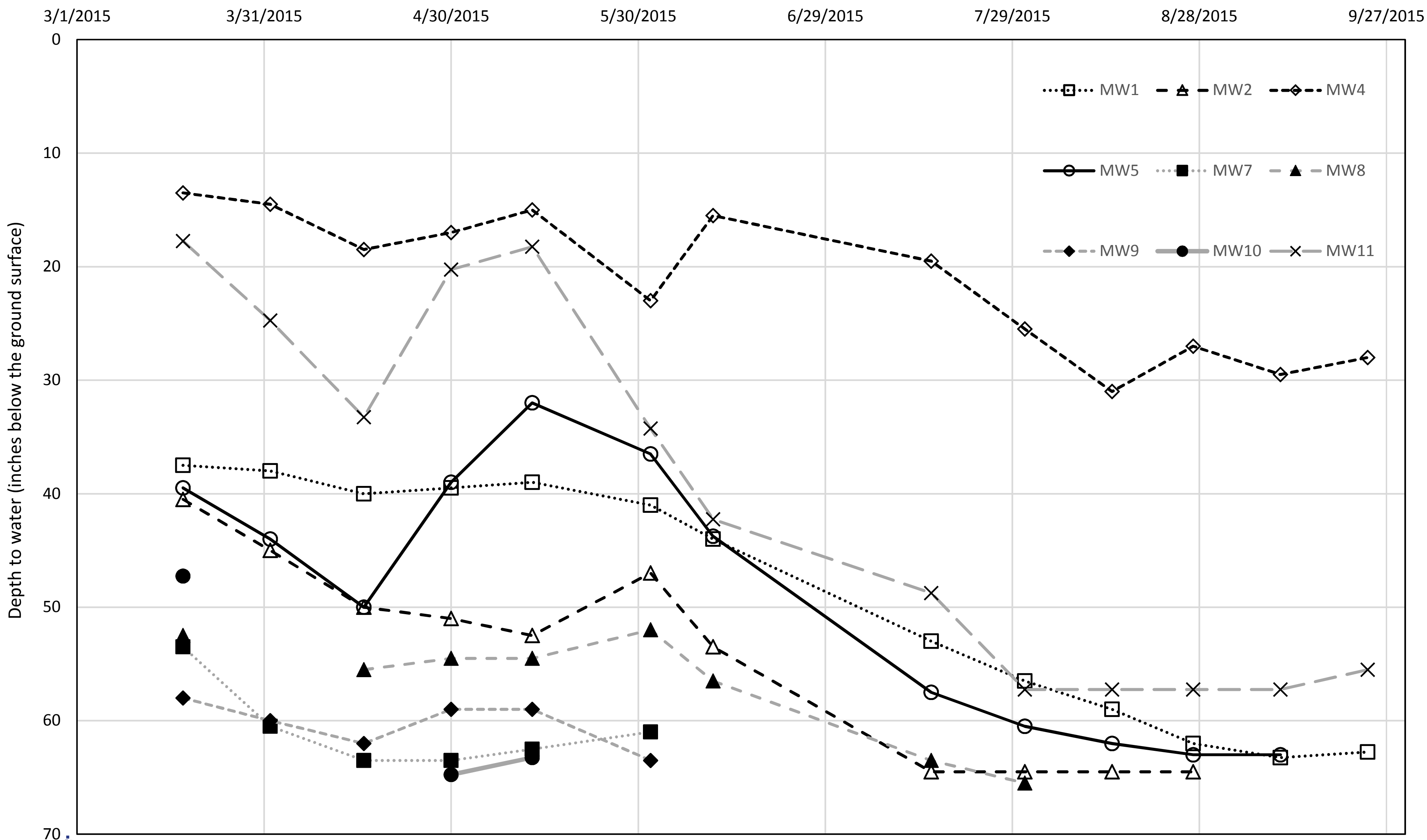
DESIGNED/DRAWN	DS/PK
CHECKED	MK/MG
DATE	6/24/2015
SCALE	AS SHOWN
PROJECT	BCC
SHEET	D-4

APPENDIX B:
SUMMARY OF GROUNDWATER DATA,
MARCH TO OCTOBER 2015

Appendix B. Summary of groundwater data, March to October 2015
Burke Creek Restoration, Douglas County, Nevada

Site	Total Depth	Stickup	Effective Depth	Top of pipe elevation	Depth to groundwater below ground													
					3/18/2015	4/1/2015	4/16/2015	4/30/2015	5/13/2015	6/1/2015	6/11/2015	7/16/2015	7/31/2015	8/14/2015	8/27/2015	9/10/2015	9/24/2015	10/19/2015
	(in)	*(in)*	*(in)*	*(ft)*	*(in)*	*(in)*	*(in)*	*(in)*	*(in)*	*(in)*	*(in)*	*(in)*	*(in)*	*(in)*	*(in)*	*(in)*	*(in)*	*(in)*
MW1	76	3	73	6305.11	34.5	35	37	36.5	36	38	41	50	53.5	56	59	60.25	59.75	52.75
MW2	67.25	2	65.25	6304.08	38.5	43	48	49	50.5	45	51.5	62.5	62.5	62.5	62.5	>65.25	>65.25	>65.25
MW3	70	4	66	6300.55	>66	>66	>66	>66	>66	>66	>66	>66	>66	>66	>66	>66	>66	>66
MW4	52	4	48	6301.00	9.5	10.5	14.5	13	11	19	11.5	15.5	21.5	27	23	25.5	24	9.5
MW5	68	4	64	6297.71	35.5	40	46	35	28	32.5	39.75	53.5	56.5	58	59	59	>64	>64
MW6	69.5	3	66.5	6297.84	>66.5	>66.5	>66.5	>66.5	>66.5	>66.5	>66.5	>66.5	>66.5	>66.5	>66.5	>66.5	>66.5	>66.5
MW7	69.25	3.5	65.75	6293.92	50	57	60	60	59	57.5	>65.75	>65.75	>65.75	>65.75	>65.75	>65.75	>65.75	>65.75
MW8	72.5	4.5	68	6285.36	48	>68	51	50	50	47.5	52	59	61	>68	>68	>68	>68	56.5
MW9	76.25	4	72.25	6287.95	54	56	58	55	55	59.5	>72.25	>72.25	>72.25	>72.25	>72.25	>72.25	>72.25	>72.25
MW10	72.25	5.25	67	6290.17	42	>67	>67	59.5	58	>67	>67	>67	>67	>67	>67	>67	>67	>67
MW11	60	1.25	58.75	6292.62	16.5	23.5	32	19	17	33	41	47.5	56	56	56	56	54.25	54.25

1. Total depth is the total depth of well, from the top of the pipe to the bottom of well.
2. Stickup is the distance the top of pipe sticks up from the adjacent ground.
3. Effective depth is the difference between total depth and stickup; it is the depth of well as measured from the adjacent ground.
4. Groundwater data were collected by NTCD staff. Top of pipe elevations were collected by Wood Rodgers survey crew.



Balance Hydrologics, Inc.

Appendix B. Groundwater levels downstream of US 50, March to October 2015
Burke Creek Restoration, Douglas County, Nevada

Groundwater wells MW3 and MW6 not shown because groundwater levels were below the bottom of the well for all visits. Data were collected by NTCD staff.

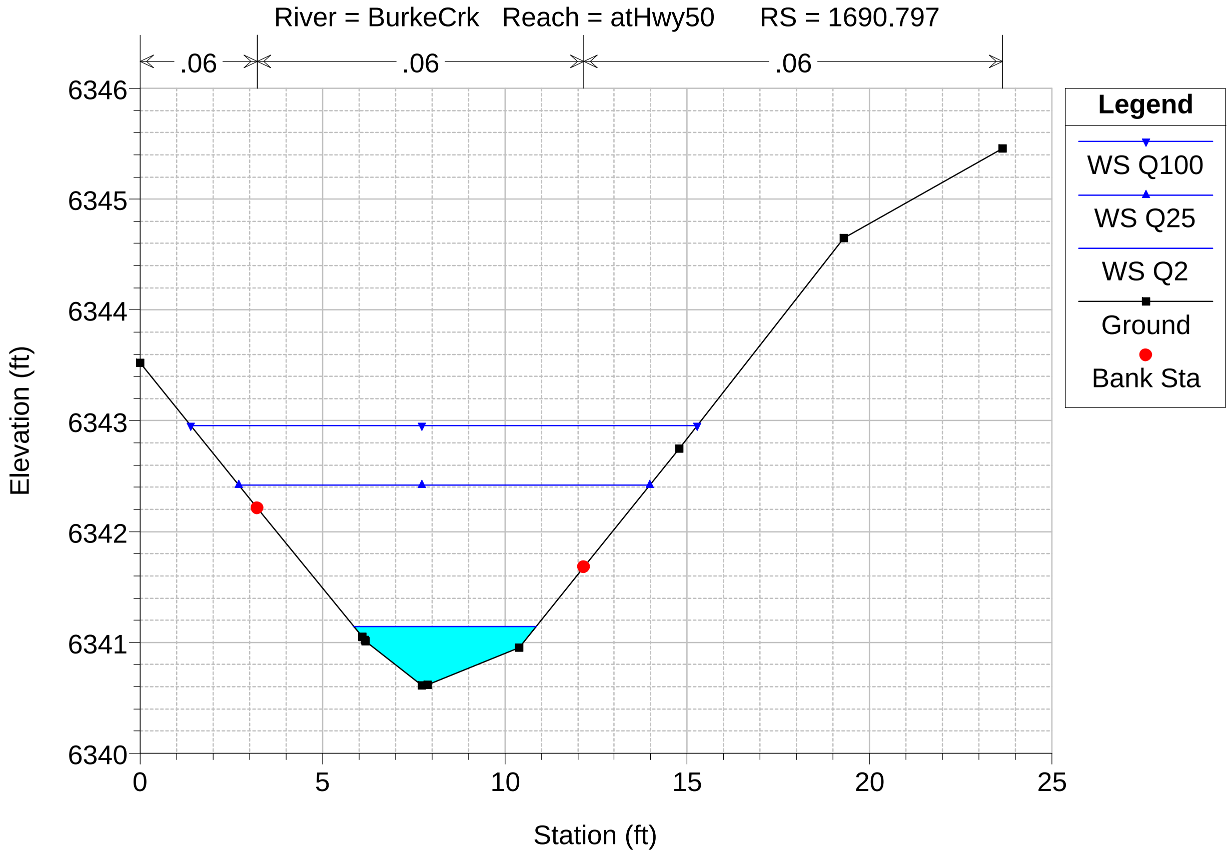
APPENDIX C:
EXISTING HEC-RAS MODEL OUTPUT

HEC-RAS Plan: Burke Ex SS River: BurkeCrk Reach: atHwy50

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
atHwy50	1690.797	Q2	5.00	6340.61	6341.15	6341.15	6341.30	0.079901	3.18	1.57	5.01	1.00
atHwy50	1690.797	Q25	71.00	6340.61	6342.42	6342.42	6343.00	0.048639	6.15	11.96	11.28	0.97
atHwy50	1690.797	Q100	121.00	6340.61	6342.96	6342.96	6343.68	0.039368	7.01	18.70	13.89	0.92
atHwy50	1690.482		Lat Struct									
atHwy50	1656.372	Q2	5.00	6337.53	6338.01	6338.01	6338.16	0.082792	3.15	1.59	5.23	1.01
atHwy50	1656.372	Q25	71.00	6337.53	6339.26	6339.26	6339.80	0.052358	5.99	12.25	11.89	0.99
atHwy50	1656.372	Q100	121.00	6337.53	6339.75	6339.75	6340.45	0.042630	6.88	18.77	14.53	0.95
atHwy50	1626.174	Q2	5.00	6334.97	6335.65	6335.56	6335.77	0.039872	2.78	1.82	4.39	0.73
atHwy50	1626.174	Q25	57.09	6334.97	6336.72	6336.72	6337.26	0.058469	6.09	9.87	9.86	1.03
atHwy50	1626.174	Q100	88.94	6334.97	6337.11	6337.11	6337.79	0.050191	6.91	13.95	11.24	1.00
atHwy50	1597.988	Q2	5.00	6333.46	6334.02	6334.02	6334.17	0.086123	3.08	1.62	5.72	1.02
atHwy50	1597.988	Q25	54.77	6333.46	6335.05	6335.05	6335.56	0.052106	5.76	9.85	10.27	0.97
atHwy50	1597.988	Q100	80.19	6333.46	6335.38	6335.38	6335.96	0.047905	6.28	13.41	11.71	0.96
atHwy50	1563.039	Q2	5.00	6330.52	6331.16		6331.25	0.030953	2.36	2.12	4.98	0.64
atHwy50	1563.039	Q25	54.77	6330.52	6332.31	6332.22	6332.77	0.045979	5.47	10.13	9.75	0.89
atHwy50	1563.039	Q100	80.19	6330.52	6332.58	6332.58	6333.20	0.049549	6.37	13.01	11.23	0.95
atHwy50	1531.132	Q2	5.00	6329.15	6329.60	6329.60	6329.75	0.078324	3.12	1.64	5.58	0.99
atHwy50	1531.132	Q25	54.77	6329.15	6330.66	6330.66	6331.19	0.053435	6.02	9.67	9.49	0.99
atHwy50	1531.132	Q100	80.04	6329.15	6331.00	6331.00	6331.61	0.050136	6.56	13.02	10.59	0.99
atHwy50	1495.74	Q2	5.00	6327.23	6327.77	6327.67	6327.86	0.035422	2.42	2.06	5.30	0.68
atHwy50	1495.74	Q25	54.77	6327.23	6328.89	6328.77	6329.33	0.035087	5.39	10.77	10.49	0.83
atHwy50	1495.74	Q100	80.04	6327.23	6329.16	6329.13	6329.75	0.037999	6.34	13.81	12.23	0.89
atHwy50	1469.533	Q2	5.00	6325.88	6326.60	6326.54	6326.72	0.053799	2.75	1.82	5.20	0.81
atHwy50	1469.533	Q25	53.75	6325.88	6327.72	6327.72	6328.21	0.053555	5.76	9.89	9.93	0.97
atHwy50	1469.533	Q100	76.78	6325.88	6327.99	6327.99	6328.60	0.051688	6.50	12.67	11.28	0.98
atHwy50	1436.528	Q2	5.00	6324.02	6324.62	6324.59	6324.73	0.068192	2.67	1.87	6.78	0.89
atHwy50	1436.528	Q25	52.41	6324.02	6325.51	6325.51	6325.92	0.048327	5.36	10.61	12.81	0.92
atHwy50	1436.528	Q100	72.21	6324.02	6325.71	6325.71	6326.20	0.048732	5.89	13.25	13.24	0.95
atHwy50	1407.668	Q2	5.00	6322.07	6322.46	6322.46	6322.61	0.079177	3.07	1.63	5.45	0.99
atHwy50	1407.668	Q25	52.41	6322.07	6323.44	6323.44	6323.91	0.047838	5.64	9.91	11.43	0.95
atHwy50	1407.668	Q100	72.00	6322.07	6323.69	6323.69	6324.23	0.042129	6.08	12.99	12.93	0.92
atHwy50	1375.358	Q2	5.00	6319.02	6319.72	6319.70	6319.90	0.067932	3.34	1.50	3.70	0.93
atHwy50	1375.358	Q25	52.41	6319.02	6321.07	6320.97	6321.58	0.045406	5.71	9.24	7.81	0.89
atHwy50	1375.358	Q100	72.00	6319.02	6321.34	6321.27	6321.98	0.044344	6.42	11.49	8.63	0.91
atHwy50	1341.575	Q2	5.00	6318.04	6318.84		6318.89	0.015713	1.94	2.58	4.89	0.47
atHwy50	1341.575	Q25	52.41	6318.04	6320.17		6320.47	0.022378	4.39	12.25	9.56	0.65
atHwy50	1341.575	Q100	72.00	6318.04	6320.47		6320.83	0.023638	4.91	15.19	10.57	0.68
atHwy50	1320.007	Q2	5.00	6317.50	6318.55		6318.59	0.012167	1.66	3.01	5.96	0.41
atHwy50	1320.007	Q25	52.41	6317.50	6319.90		6320.10	0.011725	3.72	15.98	14.07	0.50
atHwy50	1320.007	Q100	72.00	6317.50	6320.23		6320.45	0.010938	4.03	21.04	16.39	0.49
atHwy50	1319.047		Lat Struct									
atHwy50	1301.462	Q2	5.00	6317.26	6317.92	6317.92	6318.11	0.080219	3.52	1.42	3.75	1.01
atHwy50	1301.462	Q25	52.41	6317.26	6319.13	6319.13	6319.68	0.047093	5.98	9.17	9.23	0.94
atHwy50	1301.462	Q100	71.98	6317.26	6319.40	6319.40	6320.05	0.044707	6.62	11.67	9.65	0.94
atHwy50	1284.566	Q2	5.00	6315.77	6316.27	6316.27	6316.44	0.085103	3.35	1.49	4.48	1.02
atHwy50	1284.566	Q25	52.41	6315.77	6317.50	6317.47	6318.03	0.056416	5.86	8.95	7.88	0.97
atHwy50	1284.566	Q100	71.92	6315.77	6317.76	6317.75	6318.41	0.057250	6.49	11.09	8.79	1.00
atHwy50	1274.042	Q2	5.00	6314.65	6315.23	6315.23	6315.44	0.080858	3.65	1.37	3.32	1.00
atHwy50	1274.042	Q25	52.41	6314.65	6317.60		6317.75	0.007374	3.12	17.56	10.50	0.39
atHwy50	1274.042	Q100	71.34	6314.65	6317.88		6318.09	0.008643	3.68	20.74	12.63	0.43
atHwy50	1263.036	Q2	5.00	6312.77	6313.77	6313.77	6314.10	0.124505	4.61	1.08	1.68	1.01
atHwy50	1263.036	Q25	52.41	6312.77	6317.59	6315.89	6317.65	0.005625	1.98	26.41	18.95	0.30
atHwy50	1263.036	Q100	71.33	6312.77	6317.90	6316.27	6317.97	0.005576	2.22	32.19	18.95	0.30
atHwy50	1015.005		Culvert									
atHwy50	955.91	Q2	5.00	6306.18	6306.60	6306.60	6306.73	0.077769	2.97	1.73	6.27	0.98
atHwy50	955.91	Q25	52.01	6306.18	6307.58	6307.58	6308.09	0.051885	6.06	9.48	10.58	0.99

HEC-RAS Plan: Burke Ex SS River: BurkeCrk Reach: atHwy50 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
atHwy50	955.91	Q100	67.72	6306.18	6307.82	6307.82	6308.36	0.043933	6.34	12.34	12.69	0.94
atHwy50	843.0182	Q2	5.00	6302.61	6303.42	6303.31	6303.45	0.015100	1.35	4.27	20.10	0.43
atHwy50	843.0182	Q25	52.01	6302.61	6304.06	6303.81	6304.14	0.013853	2.75	25.68	48.32	0.50
atHwy50	843.0182	Q100	67.72	6302.61	6304.18	6303.91	6304.27	0.014814	3.07	31.68	59.75	0.53
atHwy50	723.1375	Q2	5.00	6300.20	6300.57		6300.63	0.044314	1.68	2.60	12.21	0.69
atHwy50	723.1375	Q25	52.01	6300.20	6301.00	6300.97	6301.16	0.062860	3.41	16.51	46.62	0.94
atHwy50	723.1375	Q100	67.72	6300.20	6301.10	6301.03	6301.26	0.055421	3.70	21.52	55.33	0.91
atHwy50	582.1964	Q2	5.00	6295.03	6295.75		6295.82	0.026930	2.16	2.47	11.35	0.60
atHwy50	582.1964	Q25	52.01	6295.03	6296.45	6296.26	6296.57	0.019966	3.33	20.05	33.65	0.60
atHwy50	582.1964	Q100	67.72	6295.03	6296.55	6296.37	6296.70	0.021277	3.67	23.32	34.14	0.63
atHwy50	497.4508	Q2	5.00	6292.25	6293.14		6293.24	0.034720	2.50	2.00	4.81	0.67
atHwy50	497.4508	Q25	52.01	6292.25	6294.19	6294.19	6294.42	0.034315	4.22	15.62	36.36	0.78
atHwy50	497.4508	Q100	67.72	6292.25	6294.30	6294.30	6294.54	0.032066	4.41	19.81	37.68	0.77
atHwy50	396.845	Q2	5.00	6290.95	6290.52		6290.58	0.020902		2.58	6.24	0.00
atHwy50	396.845	Q25	52.01	6290.95	6291.39	6291.26	6291.50	0.023253	2.03	20.93	44.56	0.57
atHwy50	396.845	Q100	67.72	6290.95	6291.48	6291.34	6291.61	0.024176	2.38	25.22	47.90	0.60
atHwy50	250.7608	Q2	5.00	6287.47	6287.56		6287.63	0.019660	0.44	2.47	6.58	0.36
atHwy50	250.7608	Q25	52.01	6287.47	6288.28		6288.35	0.020138	2.51	25.14	58.24	0.57
atHwy50	250.7608	Q100	67.72	6287.47	6288.38		6288.46	0.019359	2.73	31.66	67.09	0.57
atHwy50	181.0474	Q2	5.00	6285.02	6285.51	6285.47	6285.57	0.049503	2.06	2.43	10.78	0.76
atHwy50	181.0474	Q25	52.01	6285.02	6286.23	6286.15	6286.49	0.036038	4.28	13.22	19.90	0.81
atHwy50	181.0474	Q100	67.72	6285.02	6286.37	6286.29	6286.67	0.034416	4.63	16.18	21.07	0.81
atHwy50	126.0456	Q2	5.00	6283.35	6284.04	6283.80	6284.08	0.017012	1.60	3.13	8.80	0.47
atHwy50	126.0456	Q25	52.01	6283.35	6284.80	6284.62	6284.98	0.021275	3.62	16.41	22.53	0.63
atHwy50	126.0456	Q100	67.72	6283.35	6284.93		6285.14	0.022802	4.05	19.28	23.70	0.67
atHwy50	38.1314	Q2	5.00	6281.74	6282.63	6282.42	6282.67	0.014981	1.47	3.57	12.22	0.43
atHwy50	38.1314	Q25	52.01	6281.74	6283.30	6283.13	6283.39	0.015026	2.91	24.39	48.65	0.52
atHwy50	38.1314	Q100	67.72	6281.74	6283.41	6283.22	6283.51	0.014985	3.11	29.93	53.11	0.52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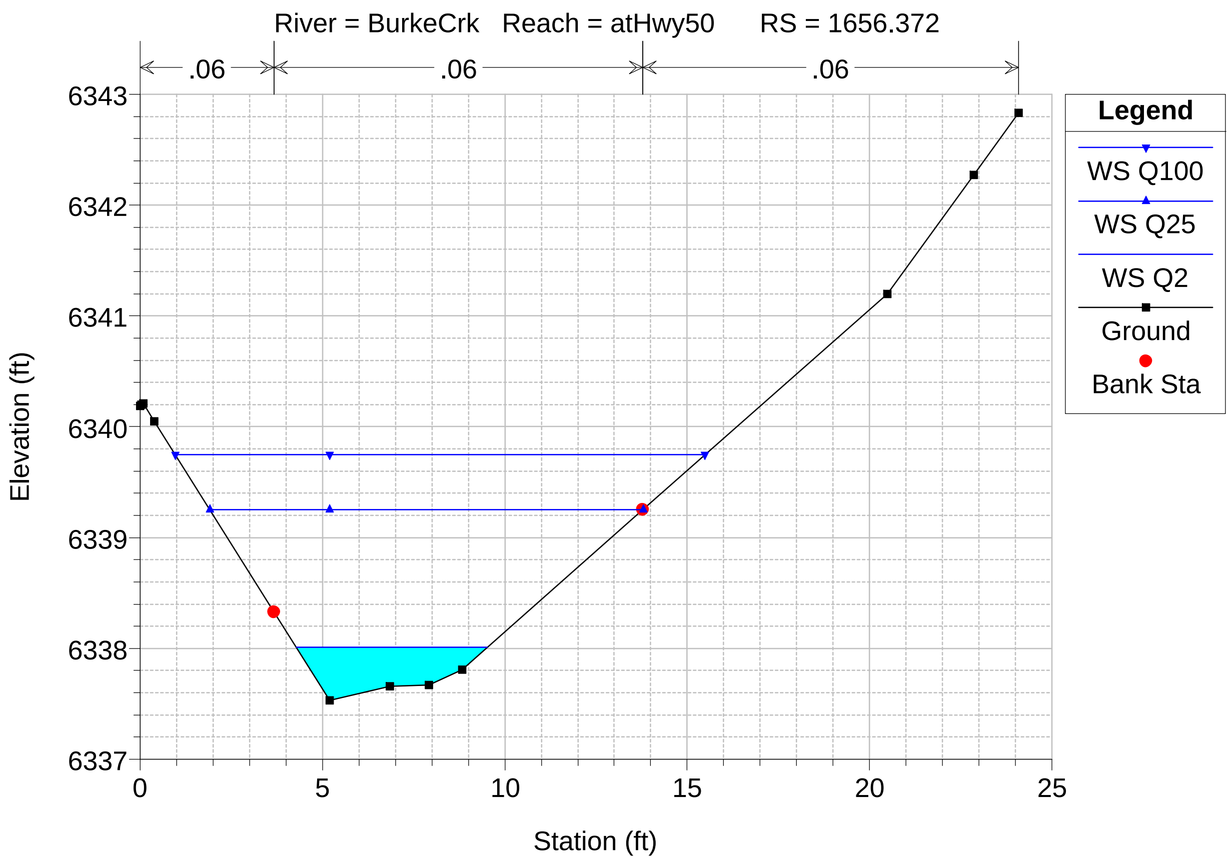
.06
.06
.06
6346
6345
6344
6343
6342
6341
6340
Elevation (ft)
0
5
10
15
20
25
Station (ft)
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta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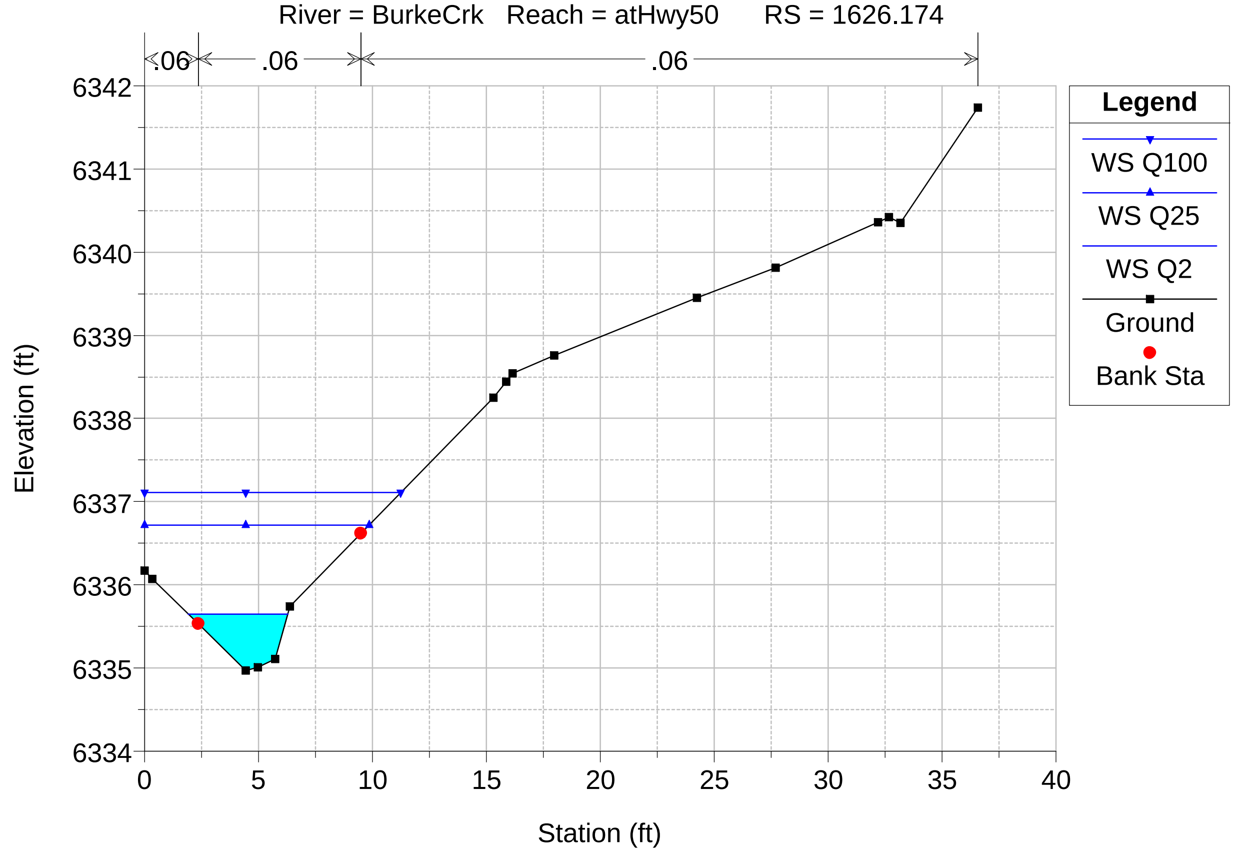
.06
.06
.06
6343
6342
6341
6340
6339
6338
6337
Elevation (ft)
0
5
10
15
20
25
Station (ft)
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta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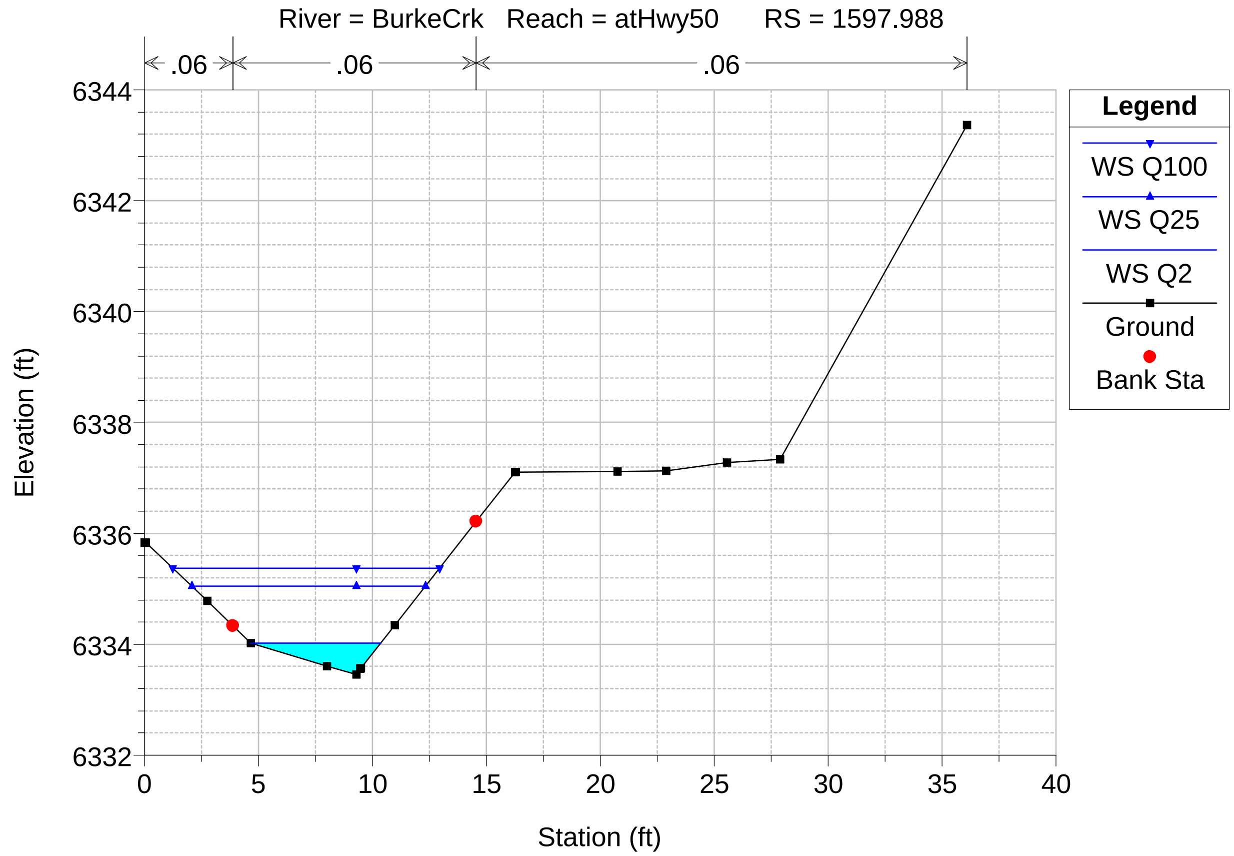
.06
.06
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta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.06
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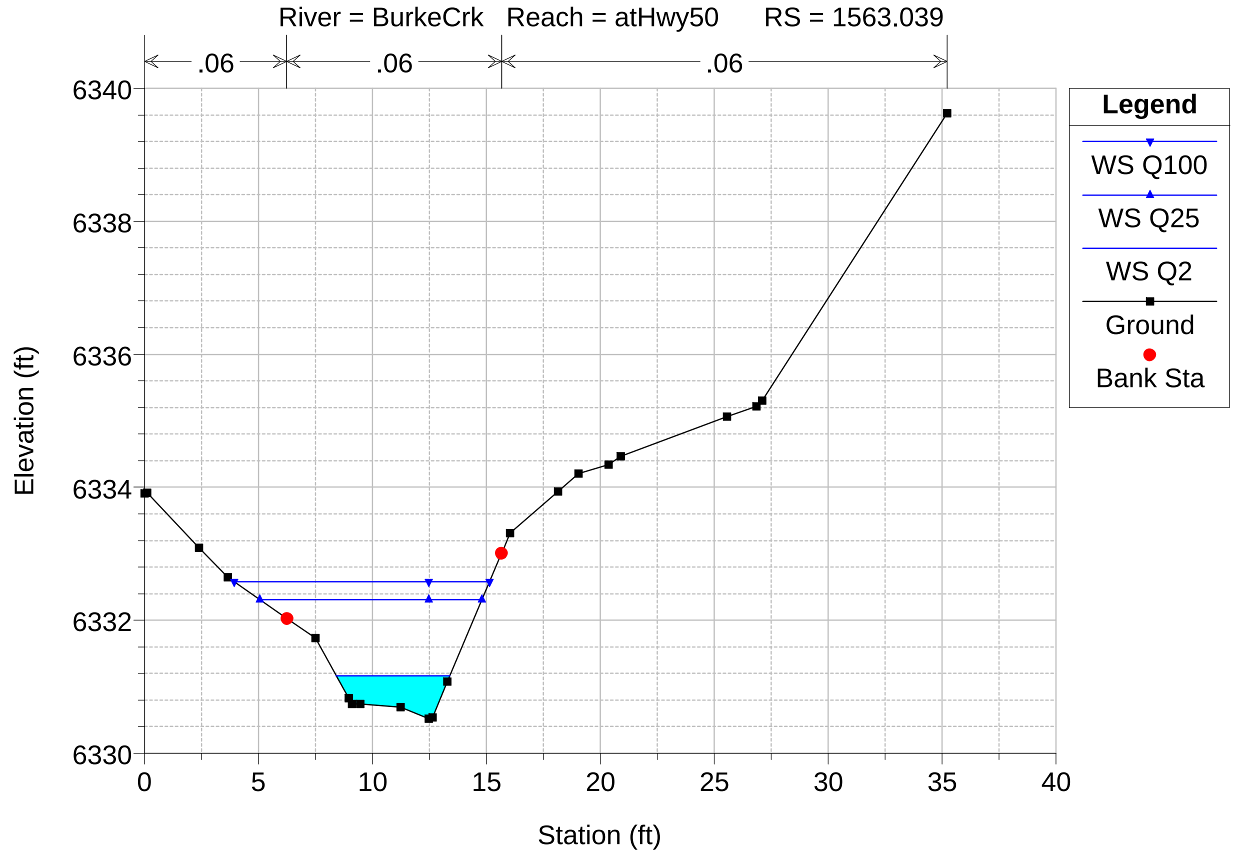
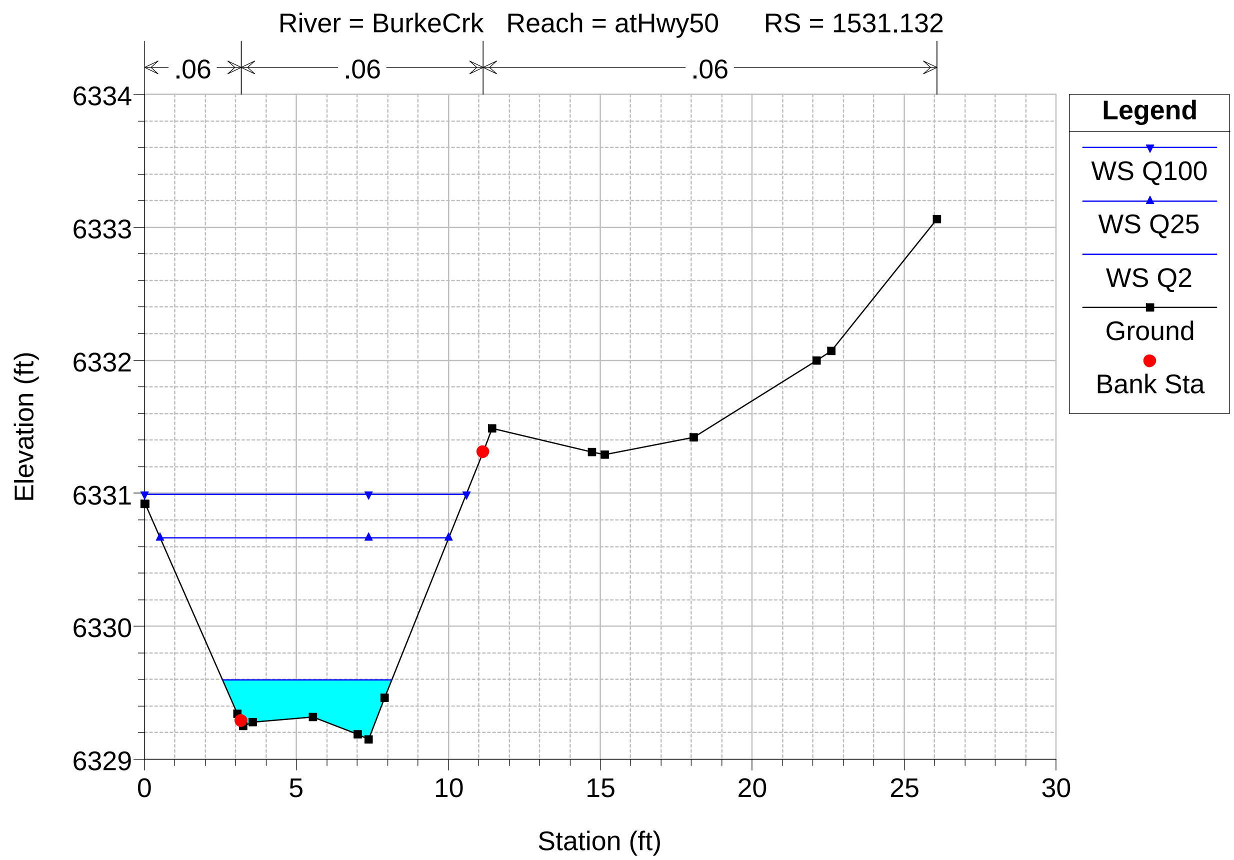
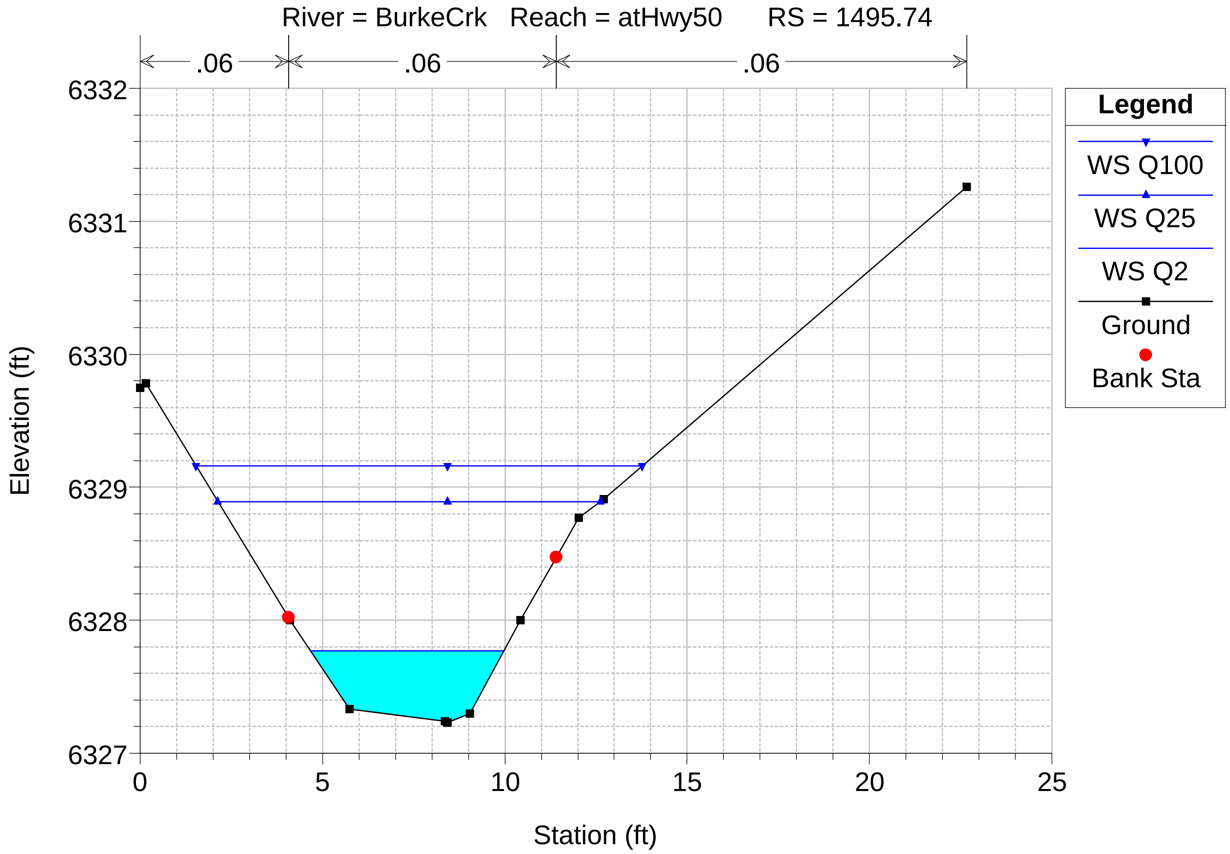
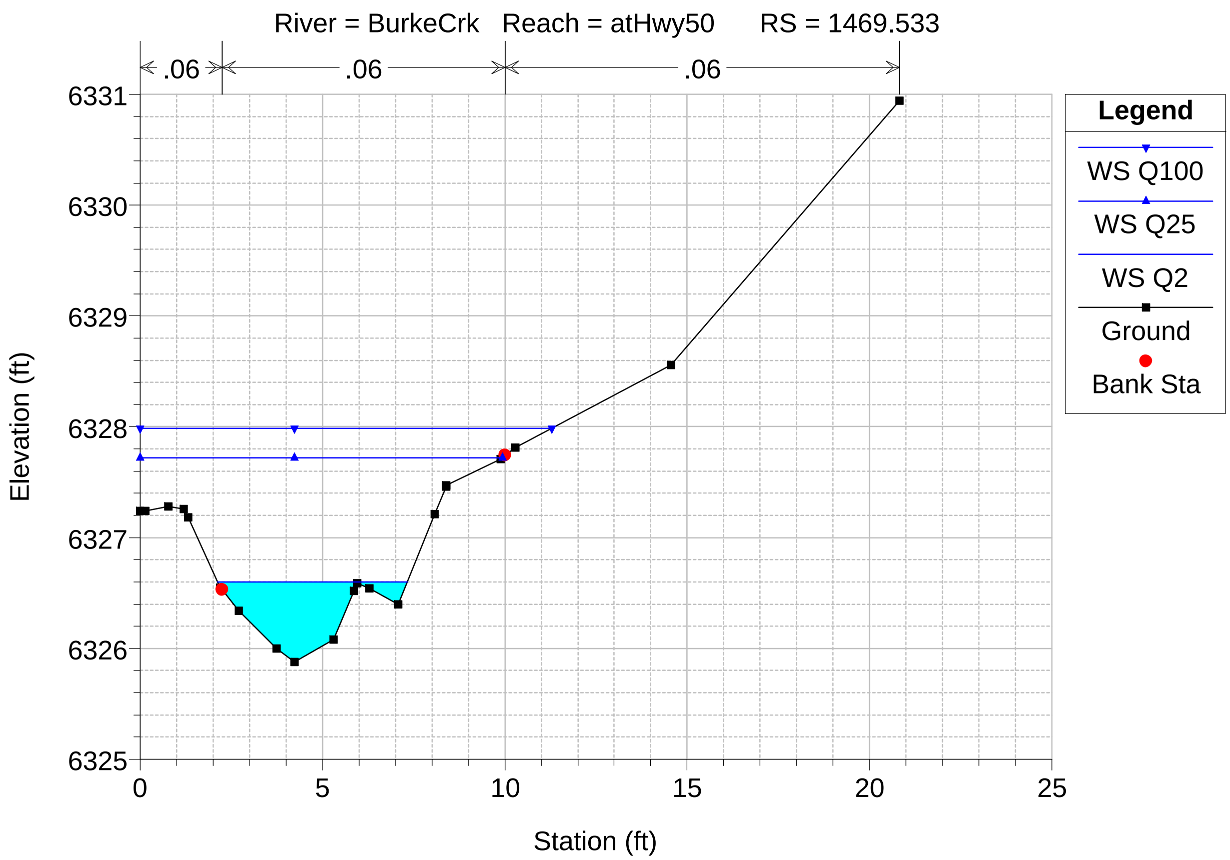
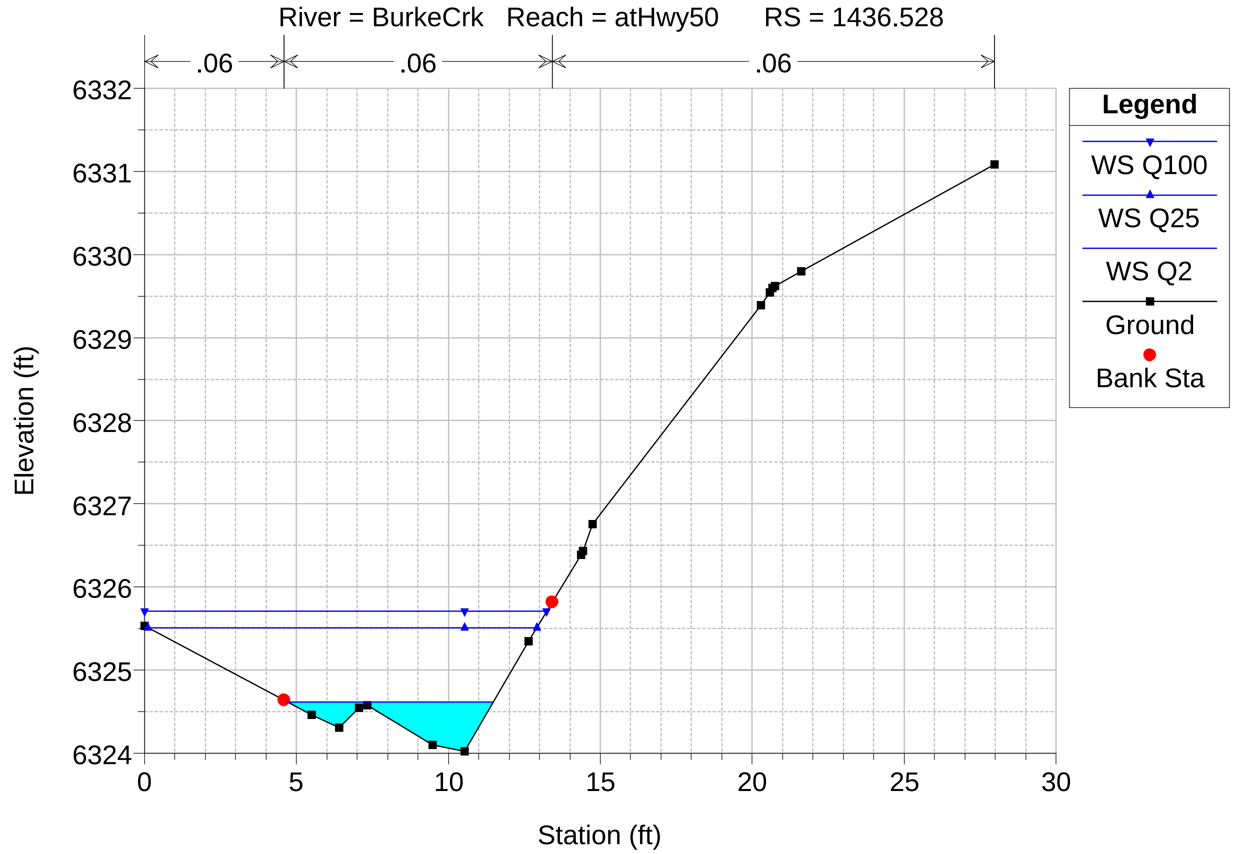
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta

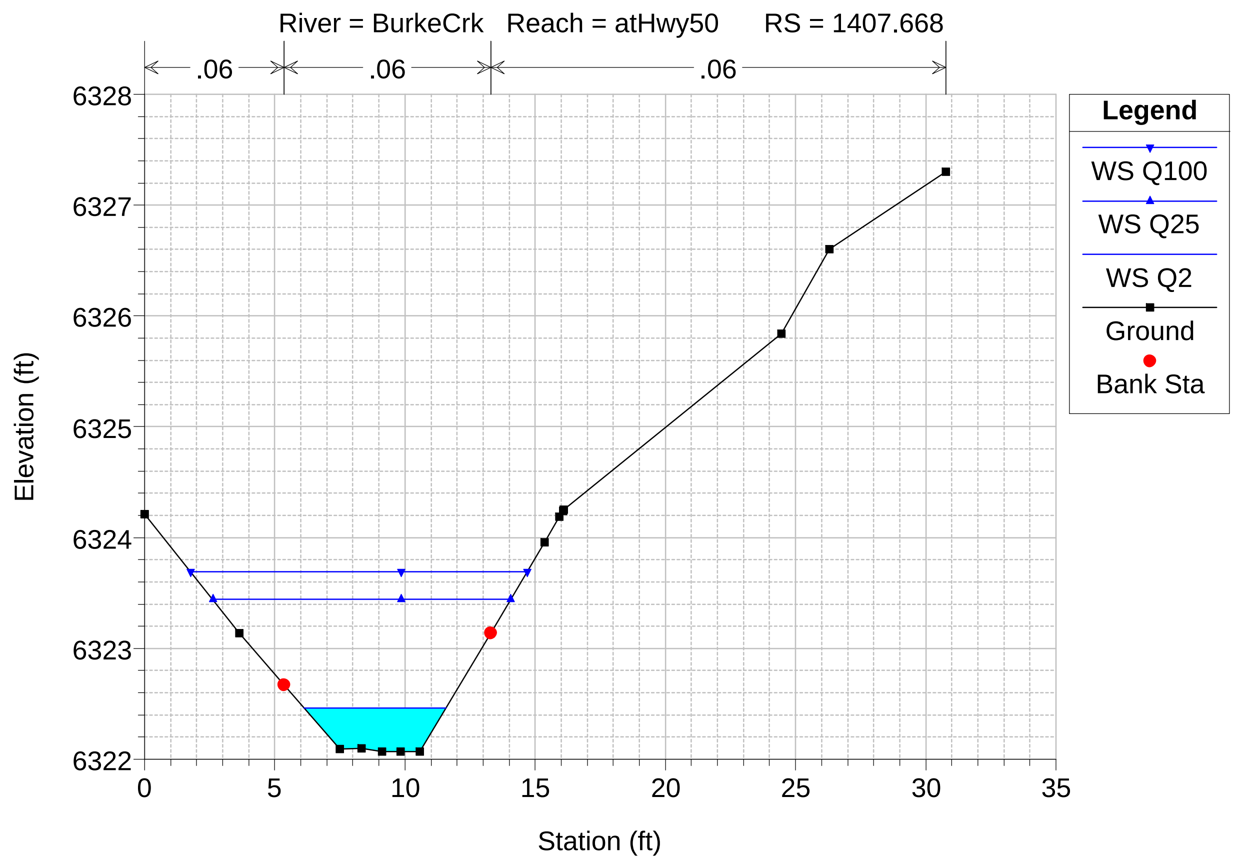

River = BurkeCrk Reach = atHwy50 RS = 1563.039
.06
.06
.06
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta

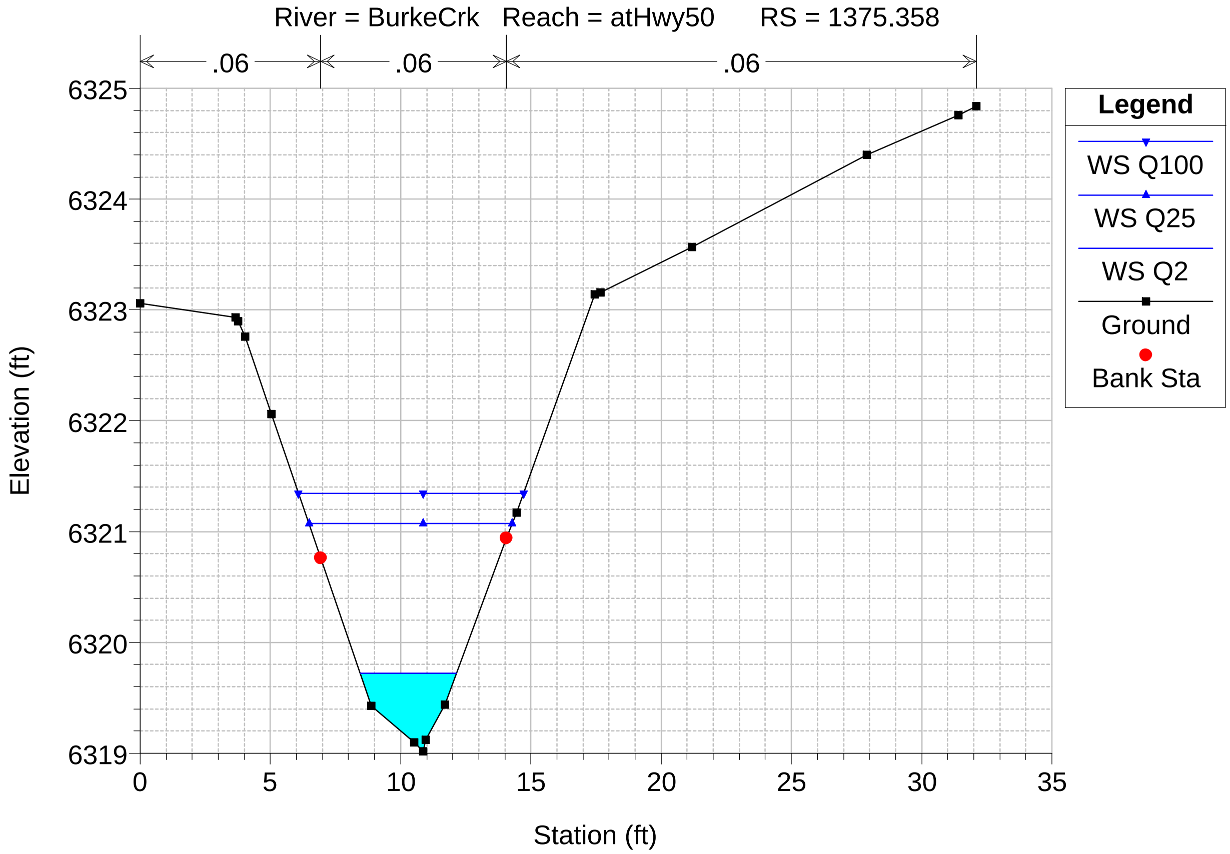

River = BurkeCrk Reach = atHwy50 RS = 1531.132
.06
.06
.06
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta

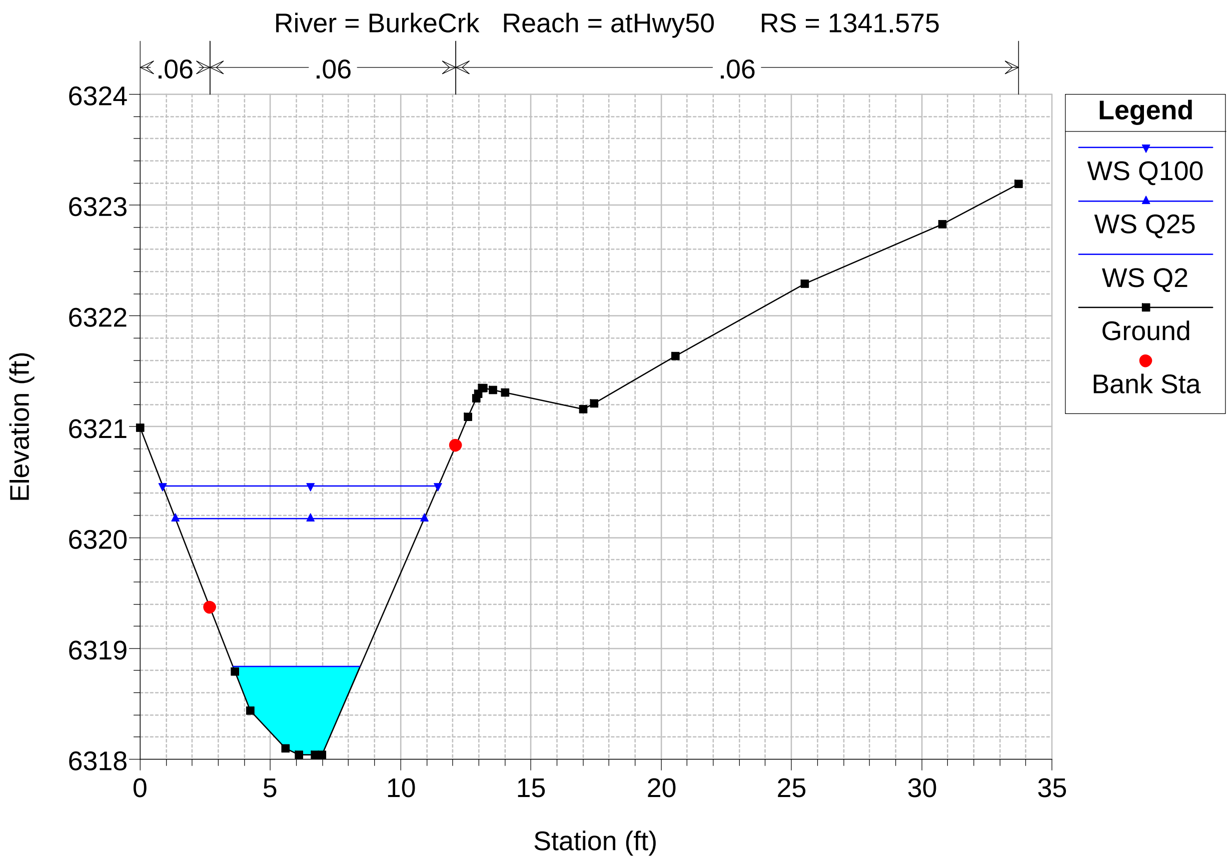

River = BurkeCrk Reach = atHwy50 RS = 1495.74
.06
.06
.06
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta
Elevation (ft)
6332
6331
6330
6329
6328
6327
0
5
10
15
20
25
Station (ft)

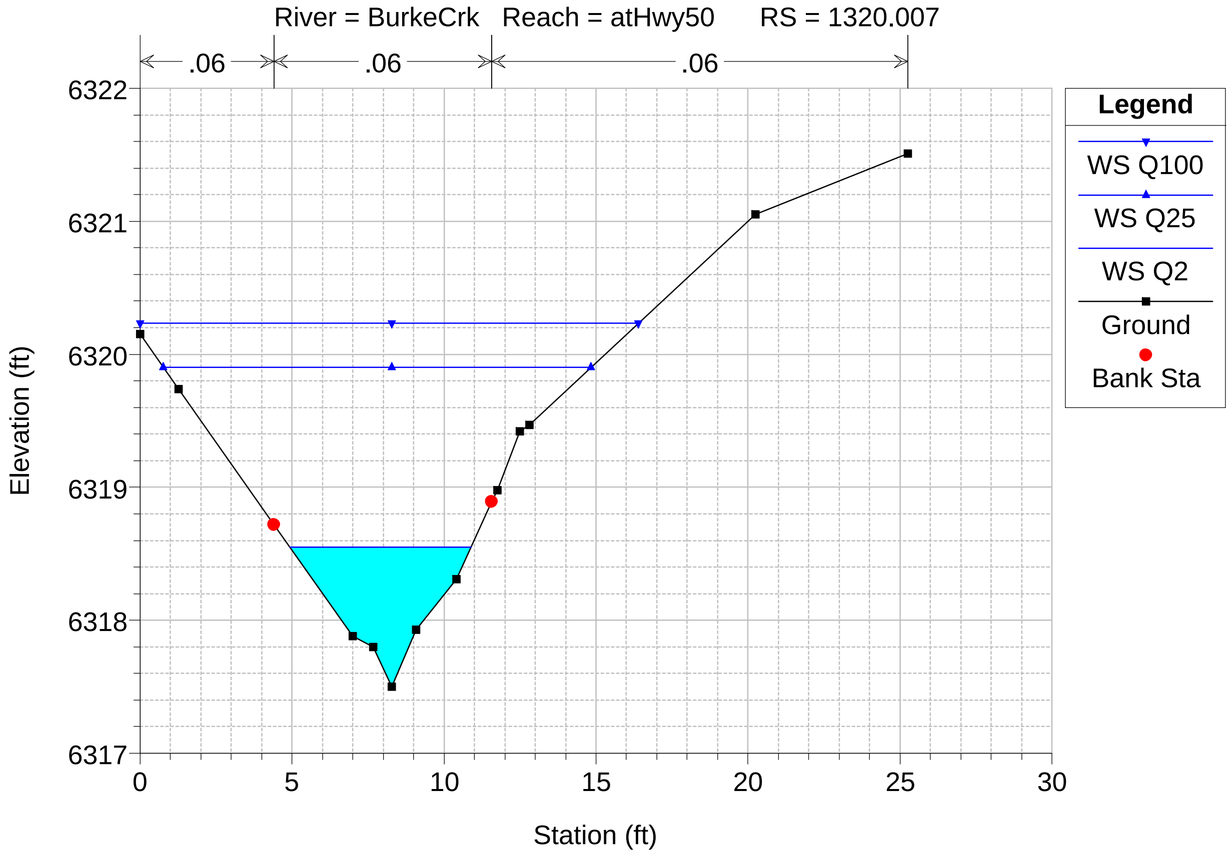

River = BurkeCrk Reach = atHwy50 RS = 1469.533
.06
.06
.06
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta
Elevation (ft)
6331
6330
6329
6328
6327
6326
6325
0
5
10
15
20
25
Station (ft)

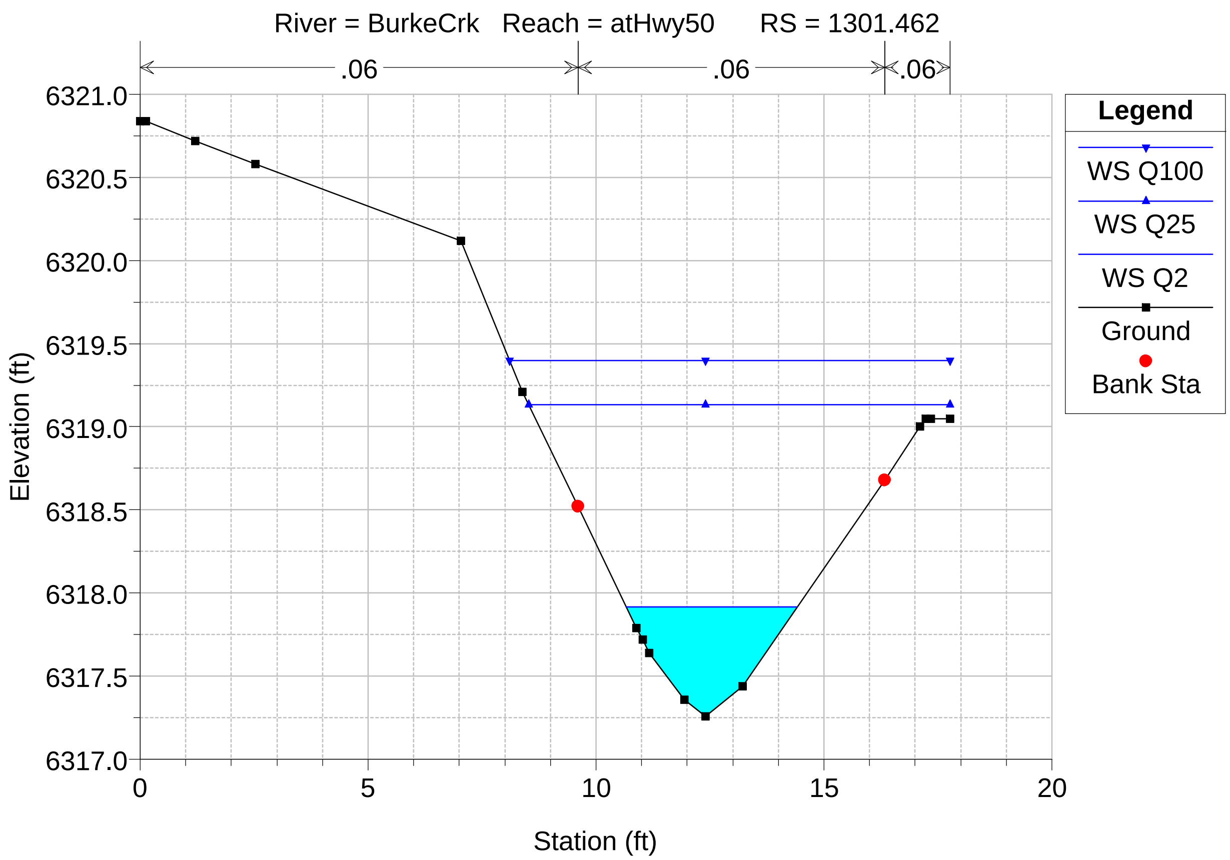

River = BurkeCrk Reach = atHwy50 RS = 1436.528
.06
.06
.06
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta

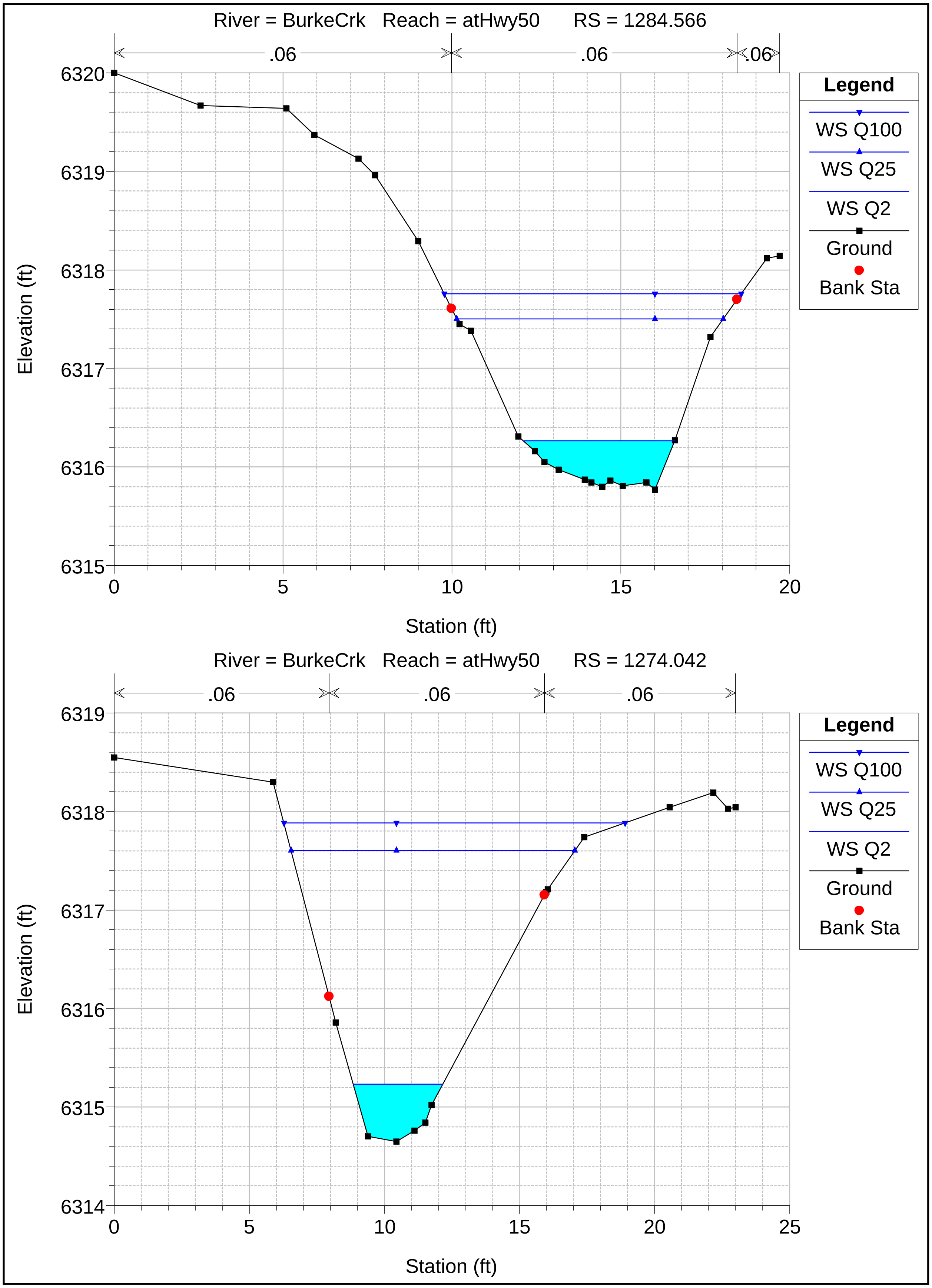

River = BurkeCrk Reach = atHwy50 RS = 1407.668
.06
.06
.06
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta

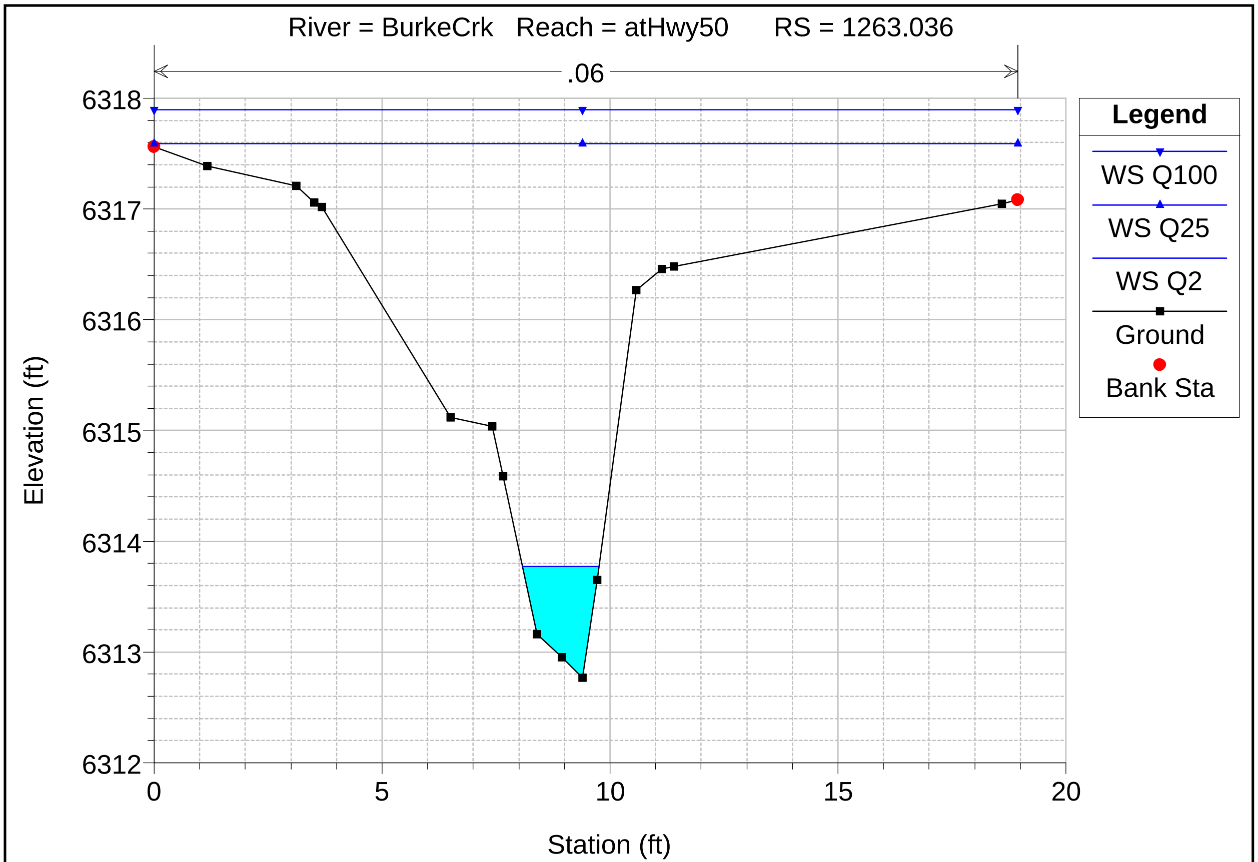

River = BurkeCrk Reach = atHwy50 RS = 1375.358
.06
.06
.06
Elevation (ft)
6325
6324
6323
6322
6321
6320
6319
0
5
10
15
20
25
30
35
Station (ft)
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta

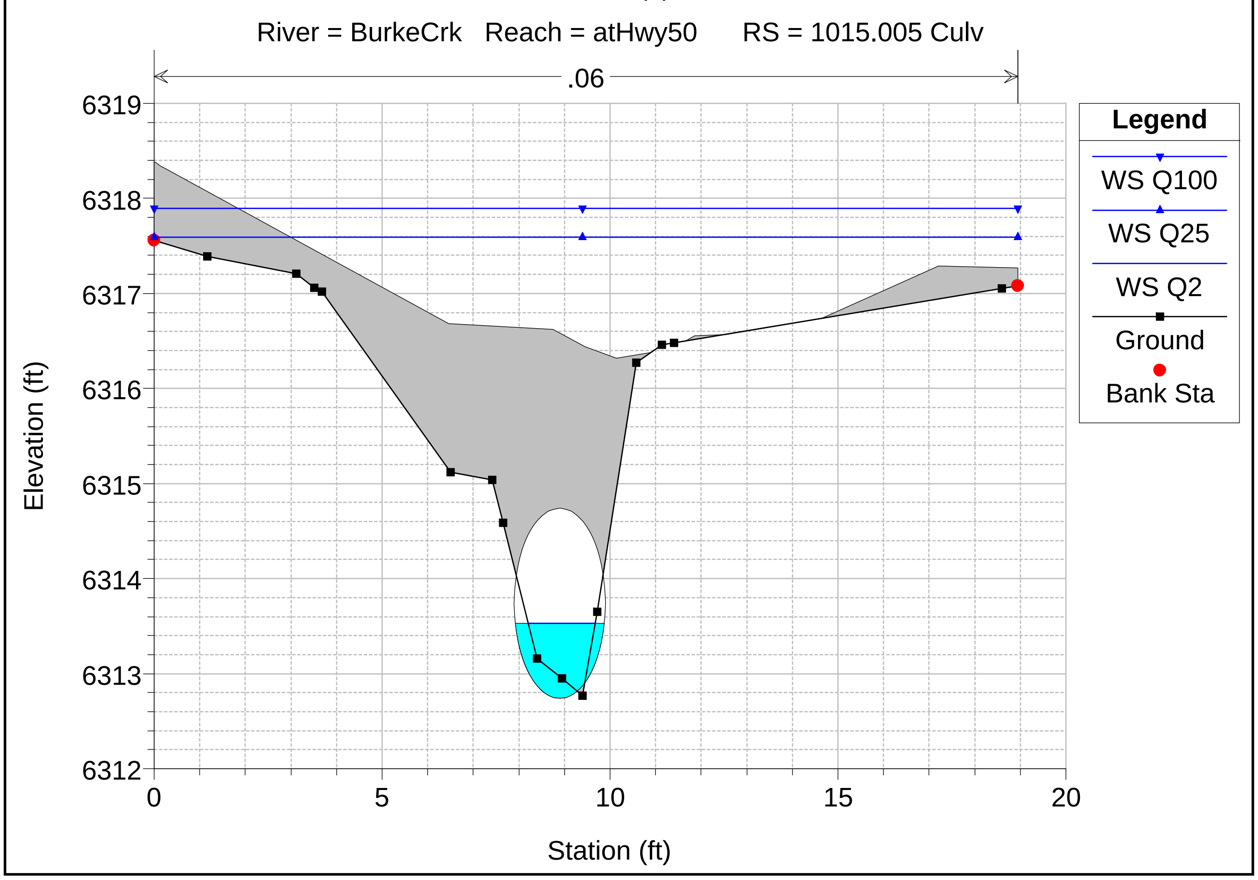

River = BurkeCrk Reach = atHwy50 RS = 1341.575
.06
.06
.06
Elevation (ft)
6324
6323
6322
6321
6320
6319
6318
0
5
10
15
20
25
30
35
Station (ft)
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta

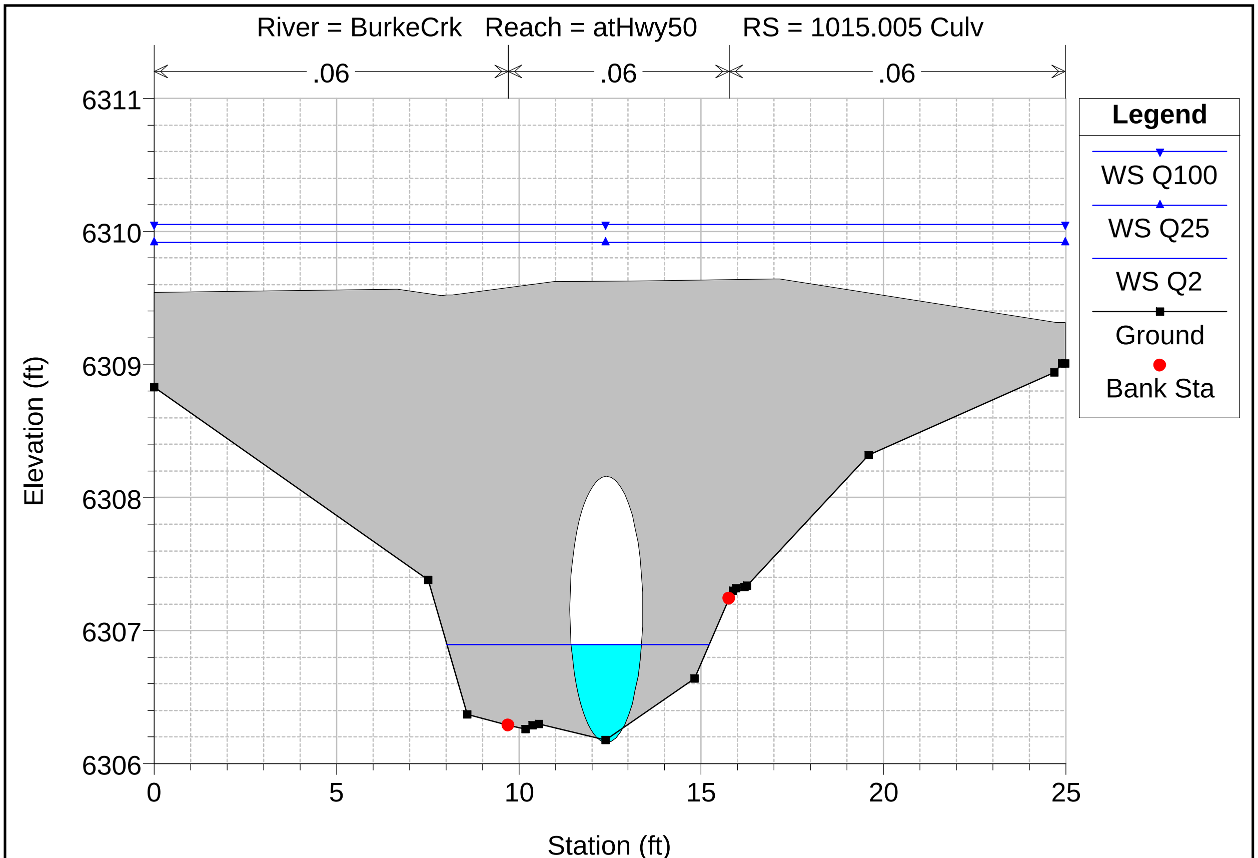

River = BurkeCrk Reach = atHwy50 RS = 1320.007
.06
.06
.06
Elevation (ft)
6322
6321
6320
6319
6318
6317
0
5
10
15
20
25
30
Station (ft)
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta


River = BurkeCrk Reach = atHwy50 RS = 1301.462
.06
.06
.06
Elevation (ft)
6321.0
6320.5
6320.0
6319.5
6319.0
6318.5
6318.0
6317.5
6317.0
0
5
10
15
20
Station (ft)
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta

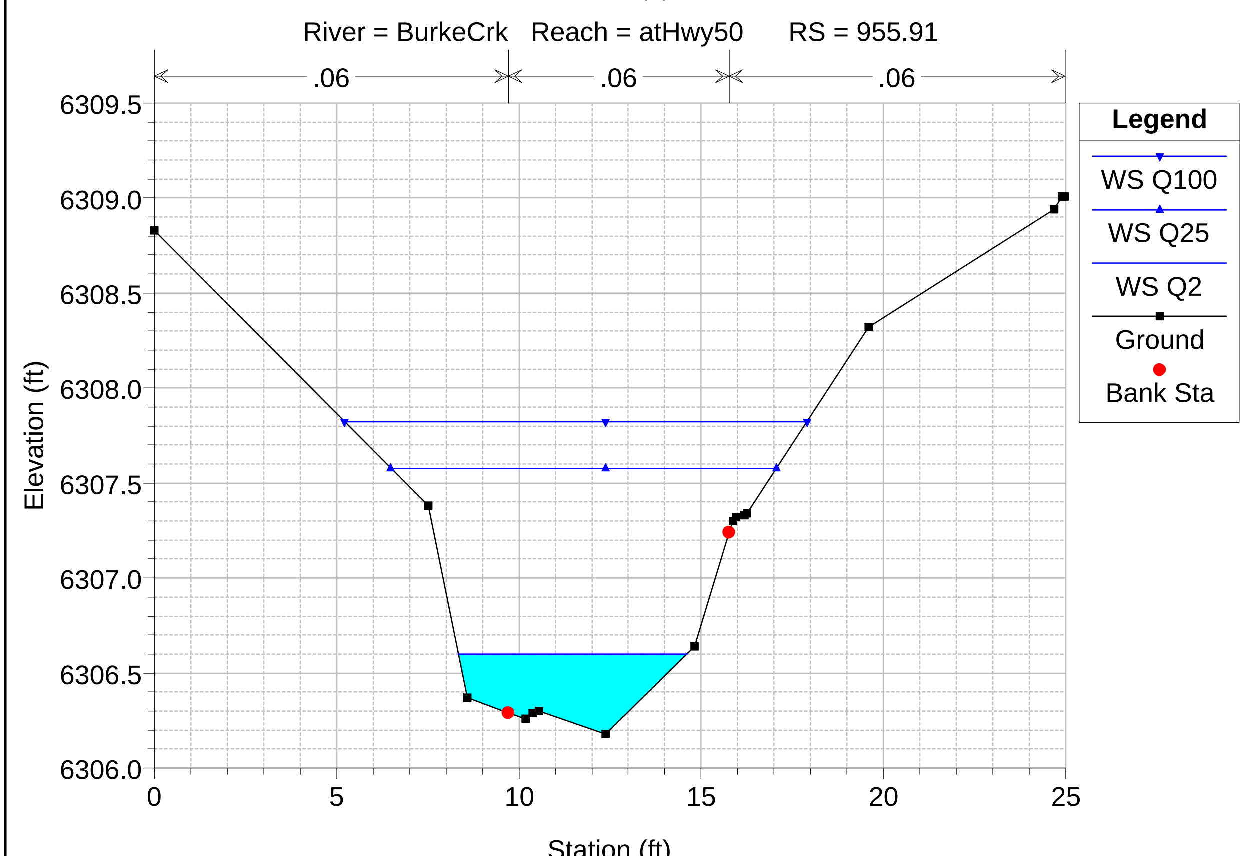

River = BurkeCrk Reach = atHwy50 RS = 1284.566
.06
.06
.06
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta
Elevation (ft)
6320
6319
6318
6317
6316
6315
0
5
10
15
20
Station (ft)
River = BurkeCrk Reach = atHwy50 RS = 1274.042
.06
.06
.06
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta
Elevation (ft)
6319
6318
6317
6316
6315
6314
0
5
10
15
20
25
Station (ft)


River = BurkeCrk   Reach = atHwy50   RS = 1263.036
.06
Elevation (ft)
Station (ft)
6318
6317
6316
6315
6314
6313
6312
0
5
10
15
20
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta

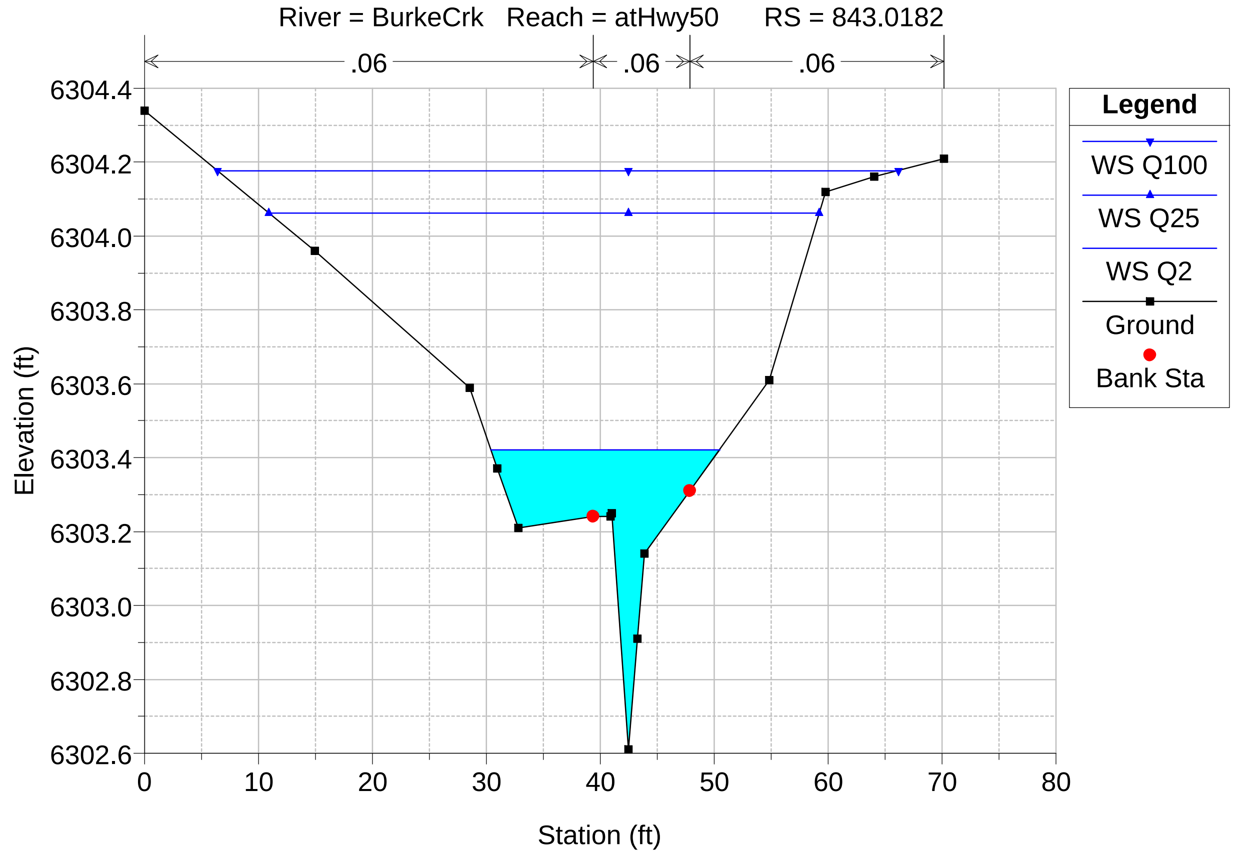

River = BurkeCrk   Reach = atHwy50   RS = 1015.005 Culv
.06
Elevation (ft)
Station (ft)
6319
6318
6317
6316
6315
6314
6313
6312
0
5
10
15
20
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta

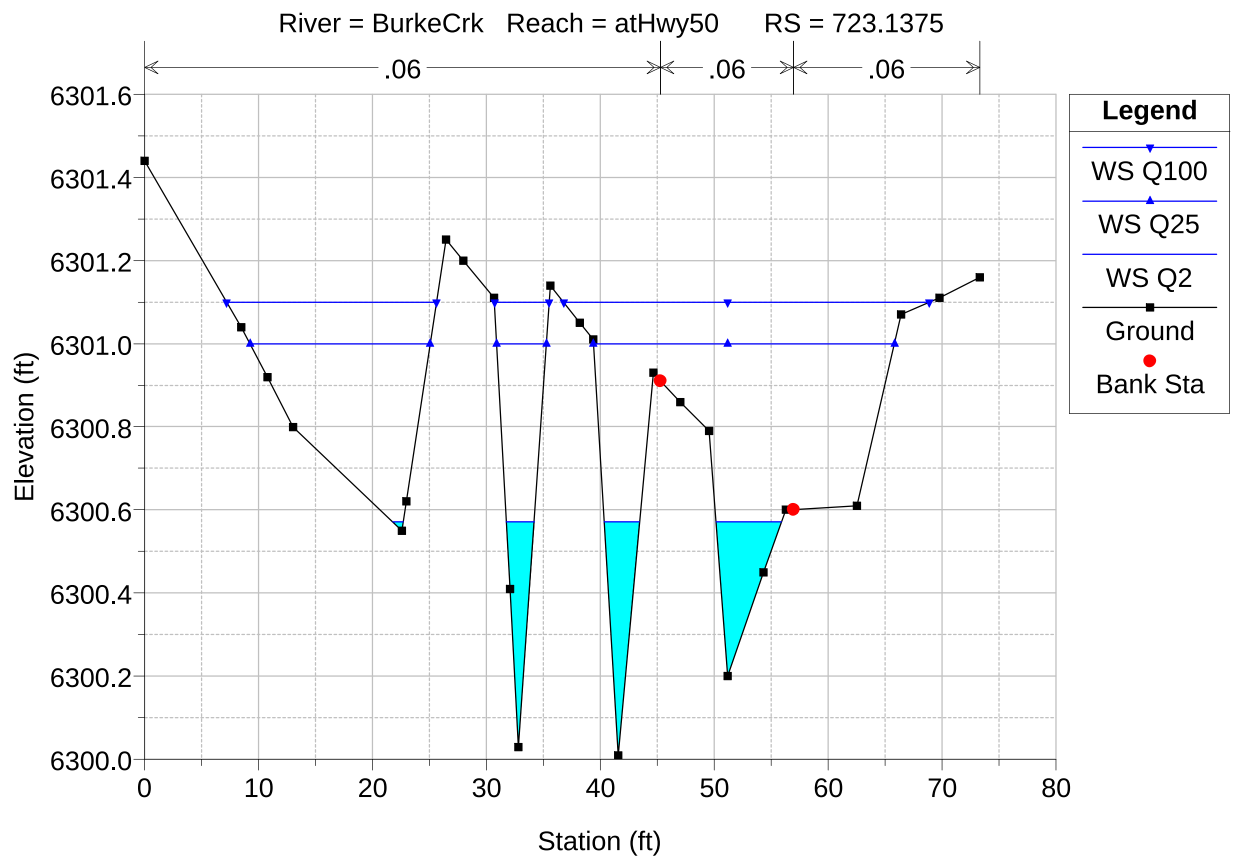


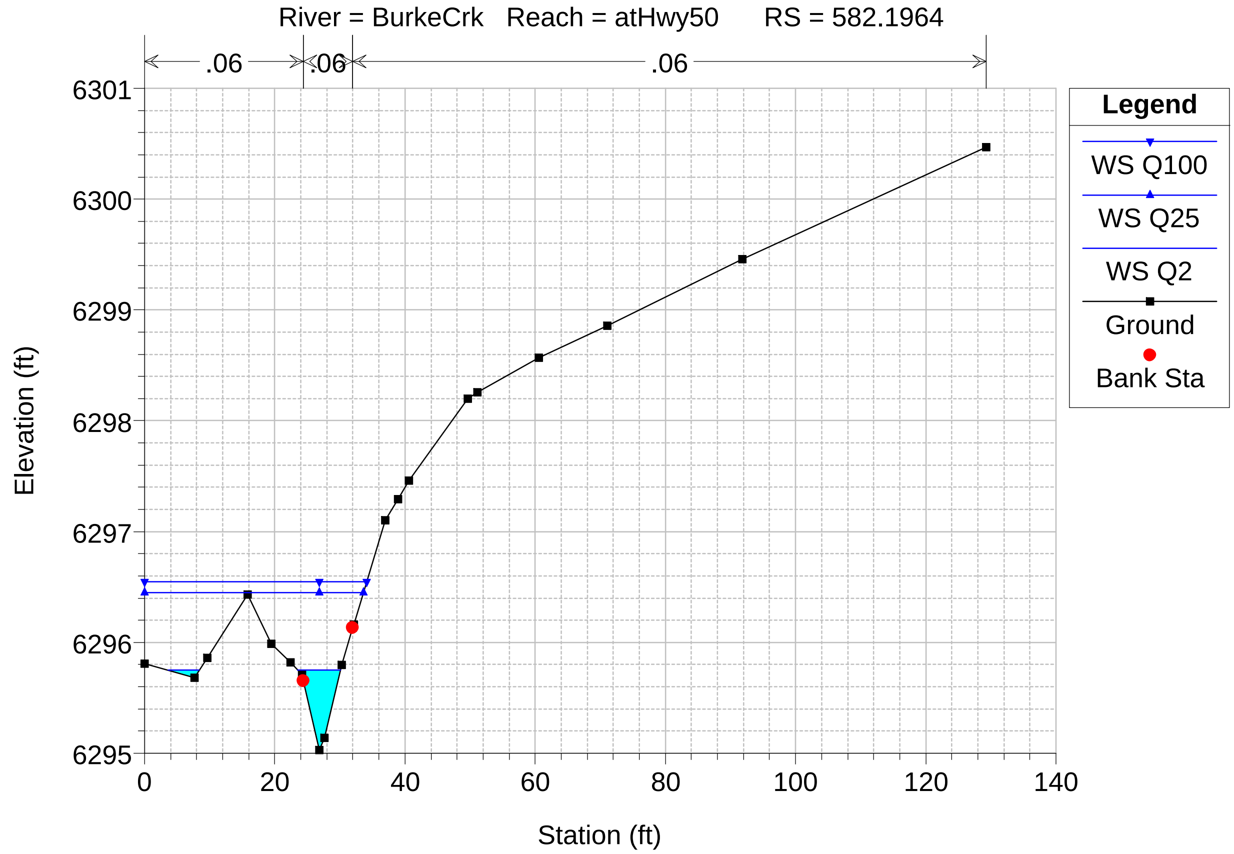
River = BurkeCrk Reach = atHwy50 RS = 1015.005 Culv
.06
.06
.06
6311
6310
6309
6308
6307
6306
Elevation (ft)
0
5
10
15
20
25
Station (ft)
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta

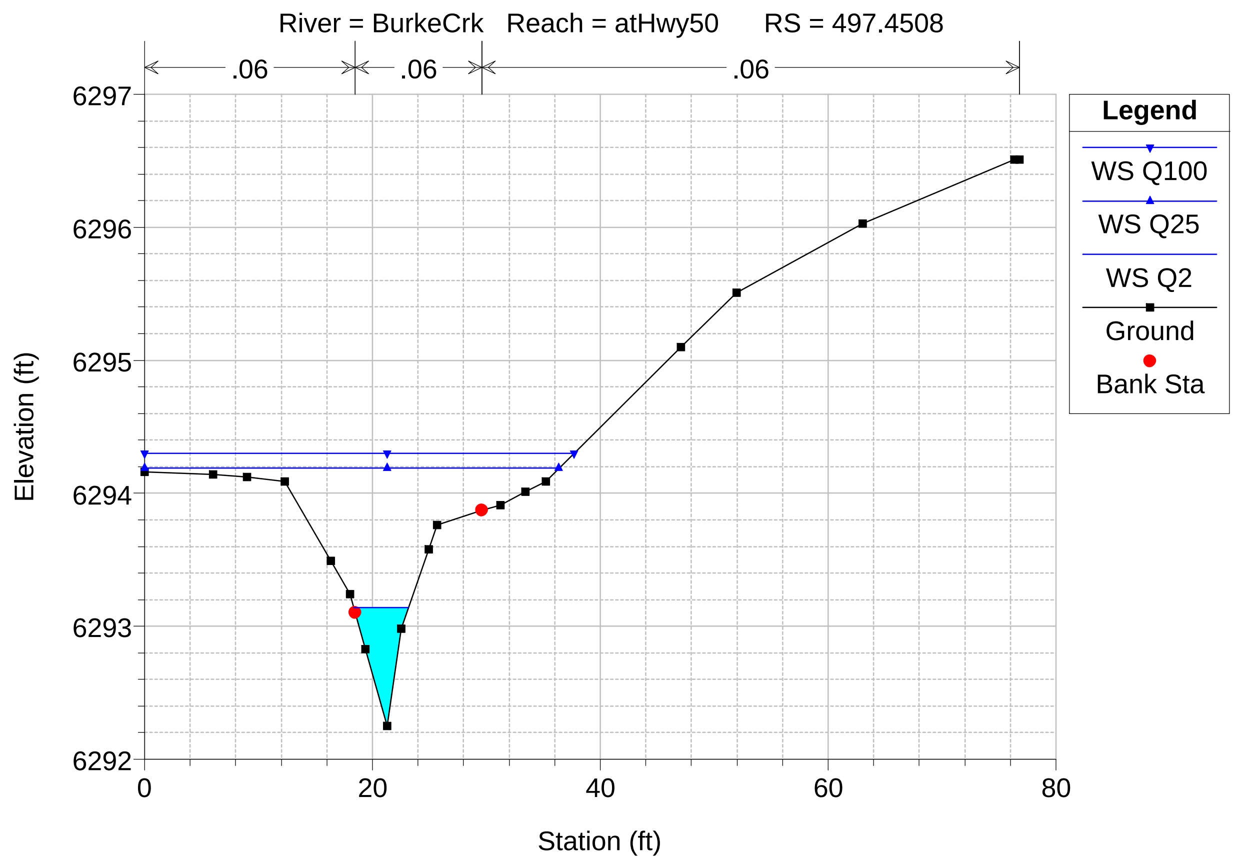


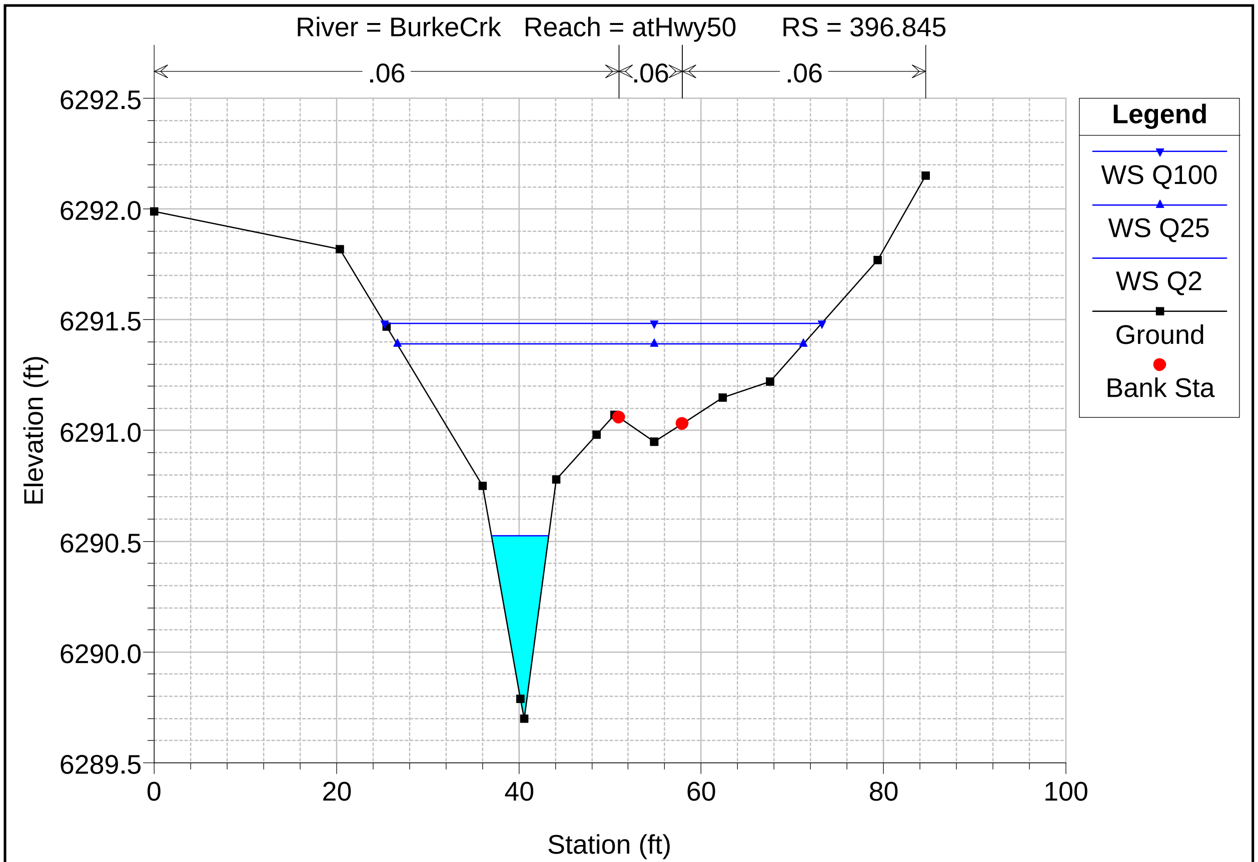
River = BurkeCrk Reach = atHwy50 RS = 955.91
.06
.06
.06
6309.5
6309.0
6308.5
6308.0
6307.5
6307.0
6306.5
6306.0
Elevation (ft)
0
5
10
15
20
25
Station (ft)
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta

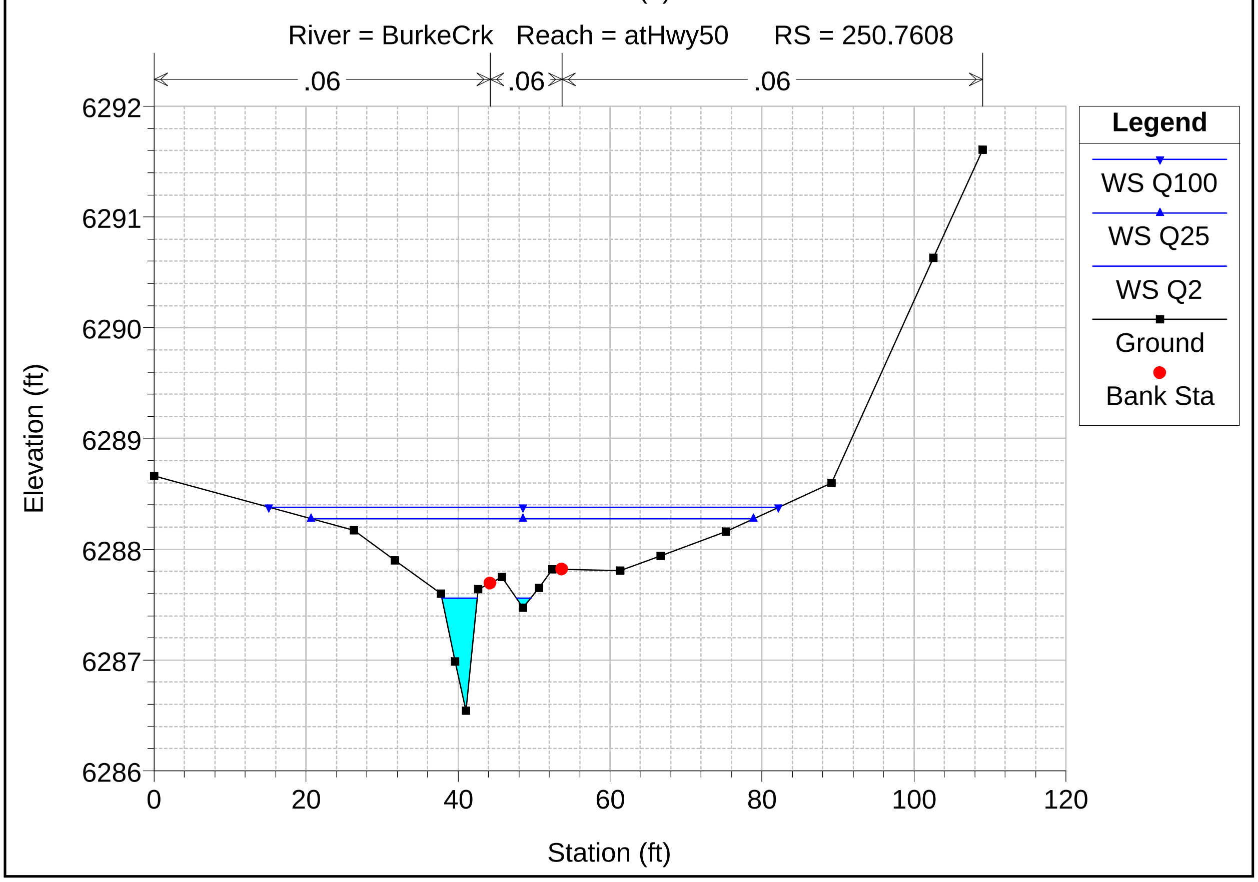

River = BurkeCrk Reach = atHwy50 RS = 843.0182
.06
.06
.06
Elevation (ft)
6304.4
6304.2
6304.0
6303.8
6303.6
6303.4
6303.2
6303.0
6302.8
6302.6
0
10
20
30
40
50
60
70
80
Station (ft)
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta

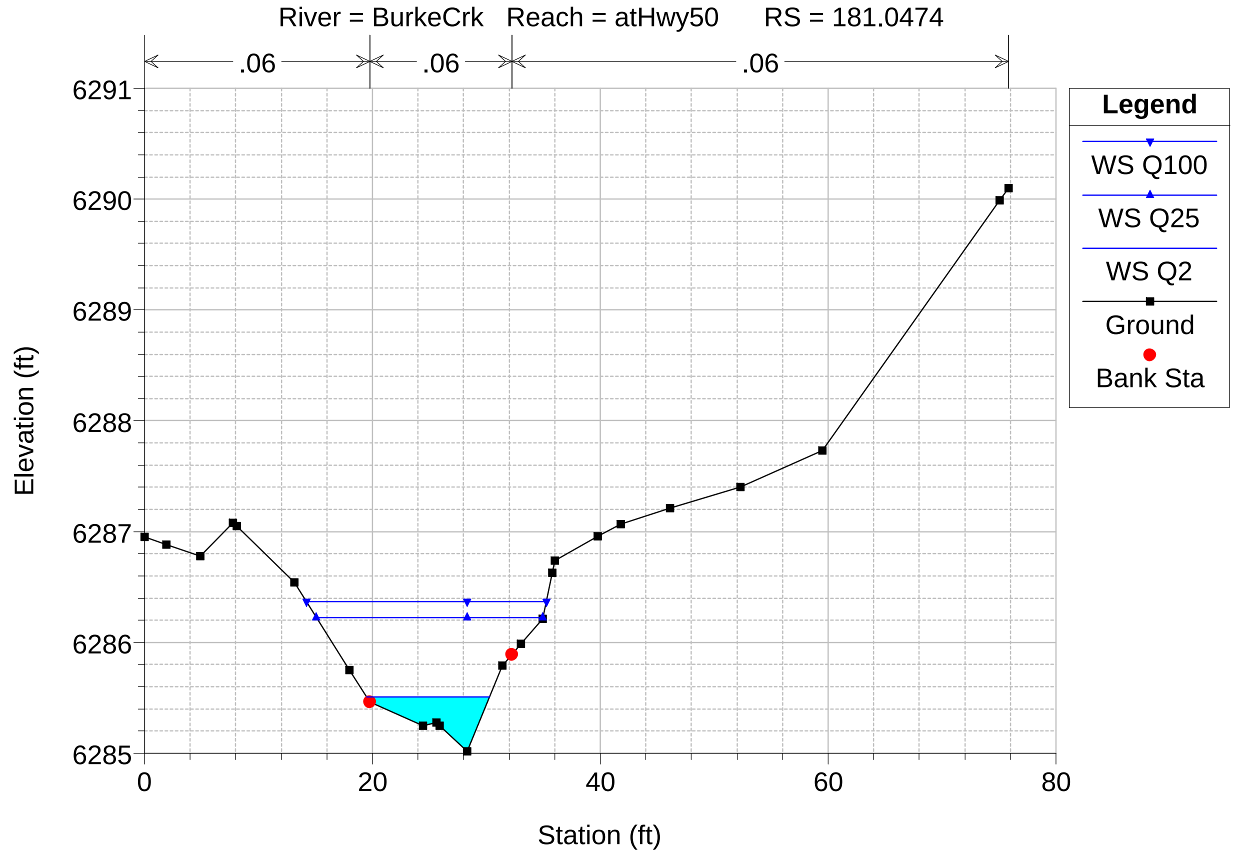

River = BurkeCrk Reach = atHwy50 RS = 723.1375
.06
.06
.06
Elevation (ft)
6301.6
6301.4
6301.2
6301.0
6300.8
6300.6
6300.4
6300.2
6300.0
0
10
20
30
40
50
60
70
80
Station (ft)
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta


River = BurkeCrk Reach = atHwy50 RS = 582.1964
.06
.06
.06
6301
6300
6299
6298
6297
6296
6295
0
20
40
60
80
100
120
140
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta

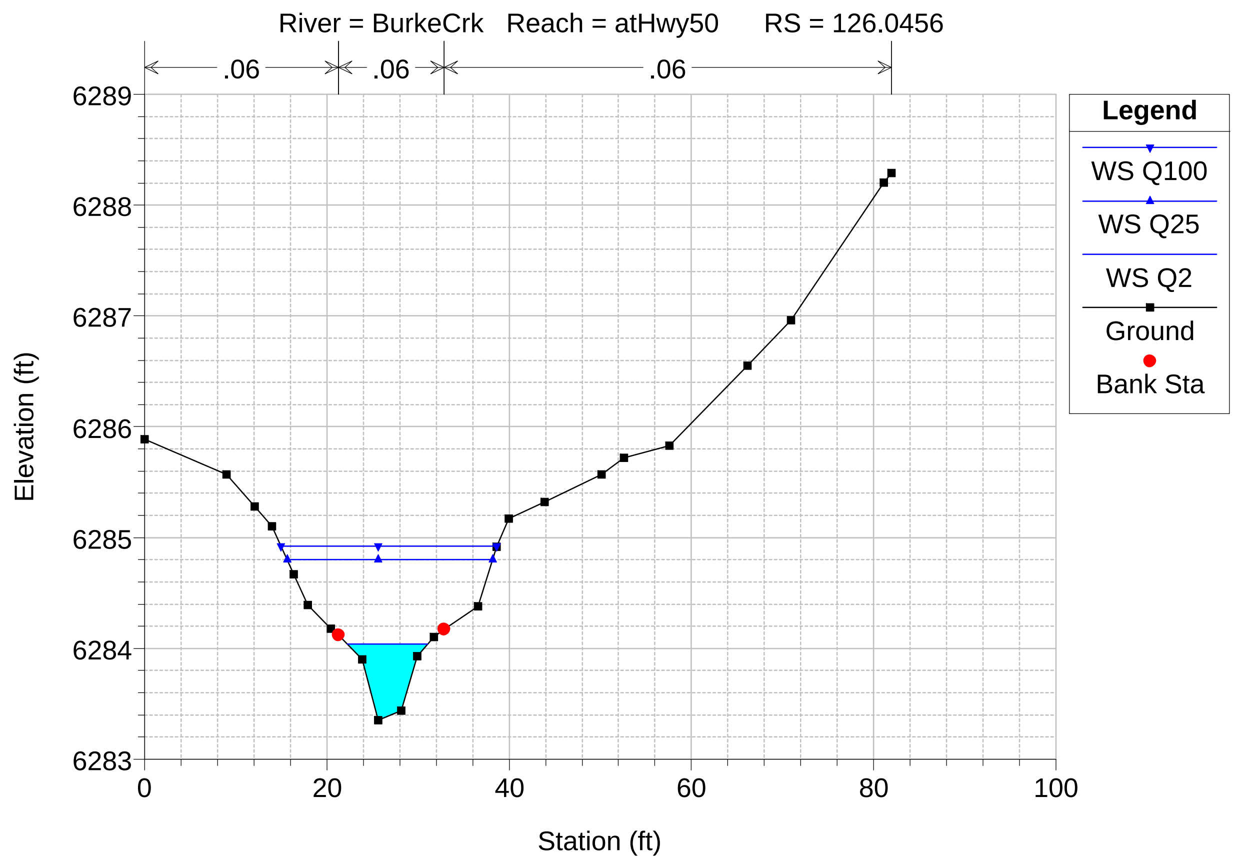

River = BurkeCrk Reach = atHwy50 RS = 497.4508
.06
.06
.06
6297
6296
6295
6294
6293
6292
0
20
40
60
80
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta


River = BurkeCrk Reach = atHwy50 RS = 396.845
.06
.06
.06
Elevation (ft)
Station (ft)
6292.5
6292.0
6291.5
6291.0
6290.5
6290.0
6289.5
0
20
40
60
80
100
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta

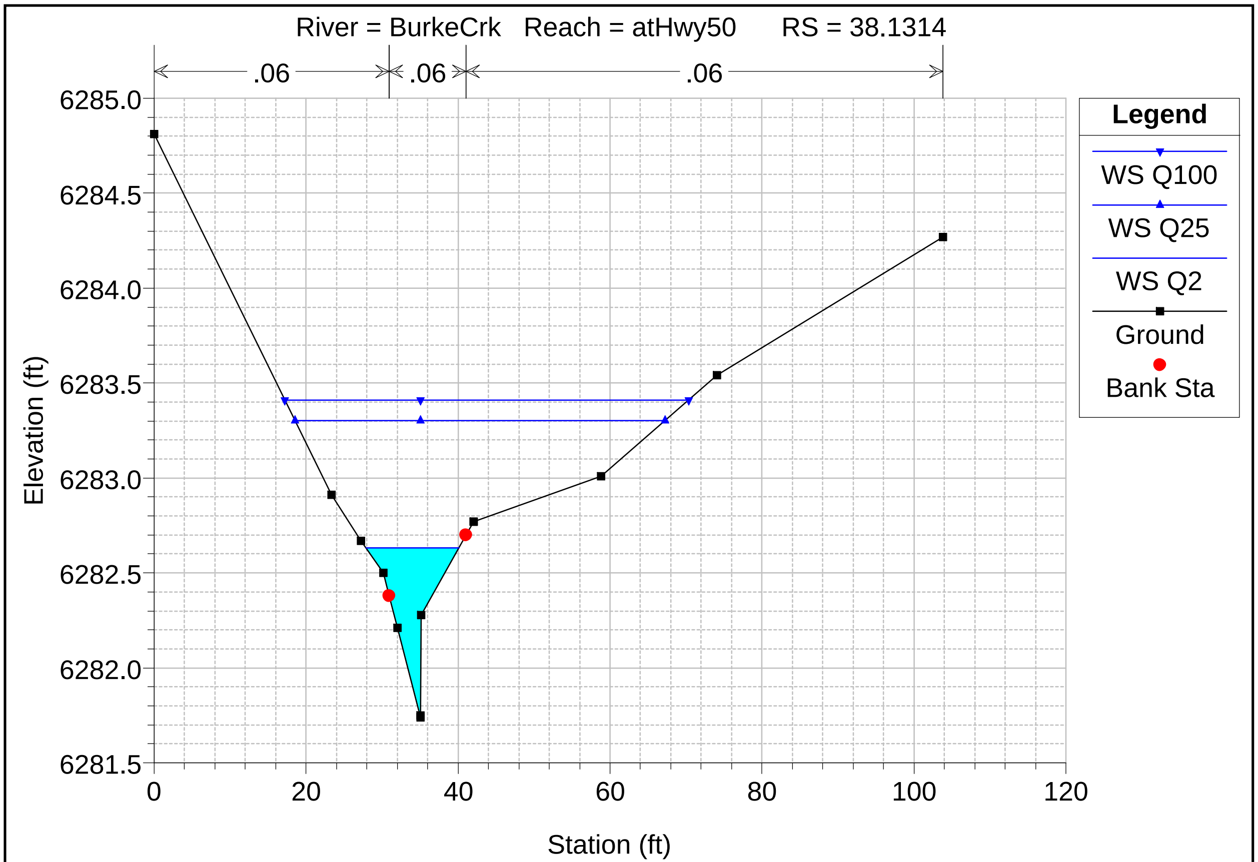

River = BurkeCrk Reach = atHwy50 RS = 250.7608
.06
.06
.06
Elevation (ft)
Station (ft)
6292
6291
6290
6289
6288
6287
6286
0
20
40
60
80
100
120
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta



River = BurkeCrk   Reach = atHwy50   RS = 181.0474
.06
.06
.06
Elevation (ft)
6291
6290
6289
6288
6287
6286
6285
0
20
40
60
80
Station (ft)
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta



River = BurkeCrk   Reach = atHwy50   RS = 126.0456
.06
.06
.06
Elevation (ft)
6289
6288
6287
6286
6285
6284
6283
0
20
40
60
80
100
Station (ft)
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta



River = BurkeCrk Reach = atHwy50 RS = 38.1314
.06
.06
.06
Legend
WS Q100
WS Q25
WS Q2
Ground
Bank Sta
6285.0
6284.5
6284.0
6283.5
6283.0
6282.5
6282.0
6281.5
Elevation (ft)
0
20
40
60
80
100
120
Station (ft)

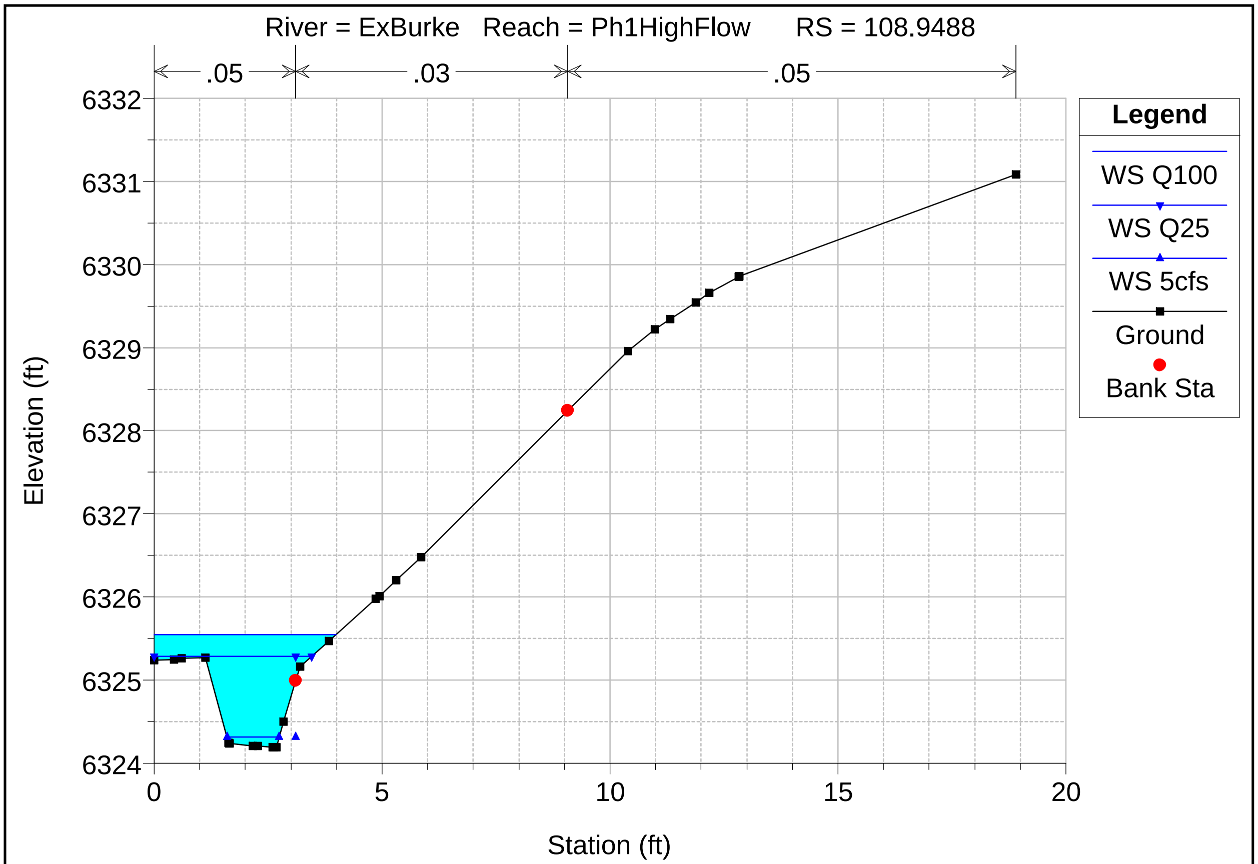
APPENDIX D:
PROPOSED HEC-RAS MODEL OUTPUT

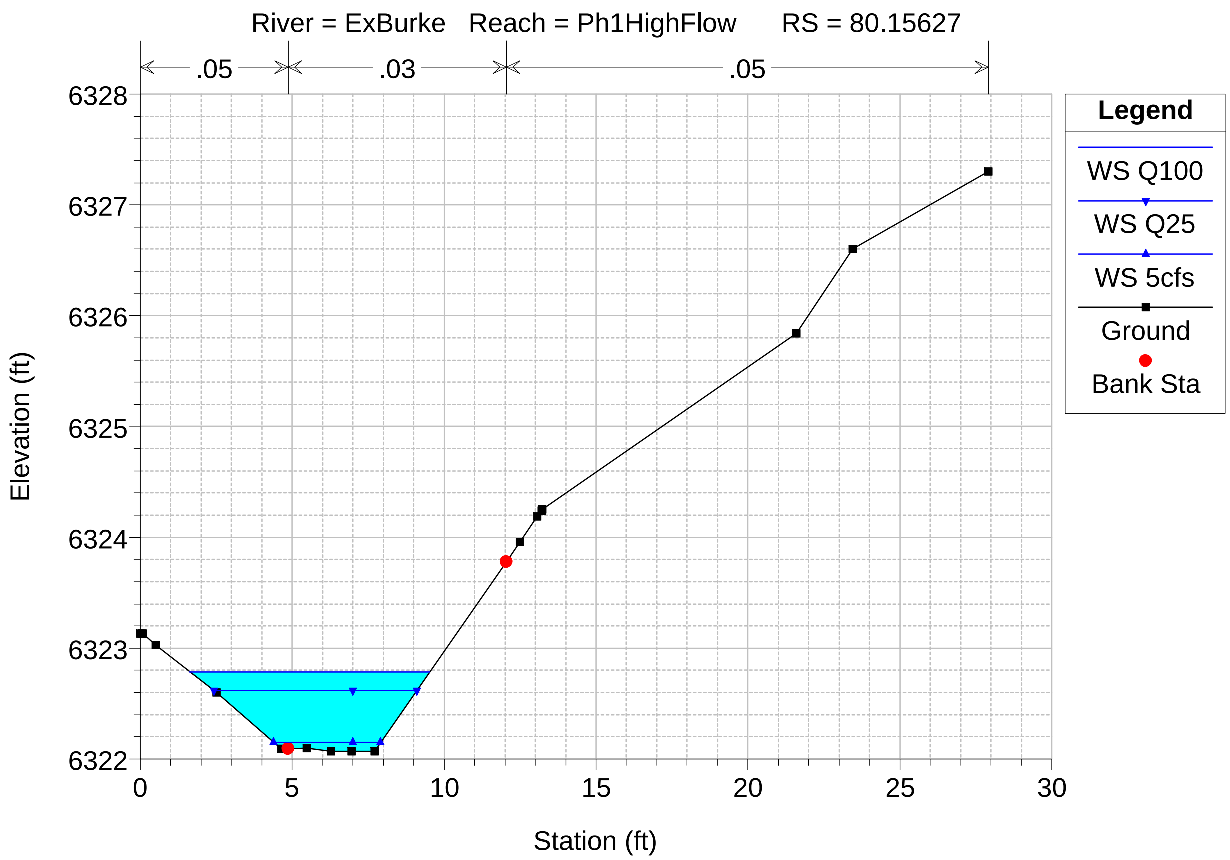
HEC-RAS Plan: BurkePh1_SS_v2 Locations: User Defined

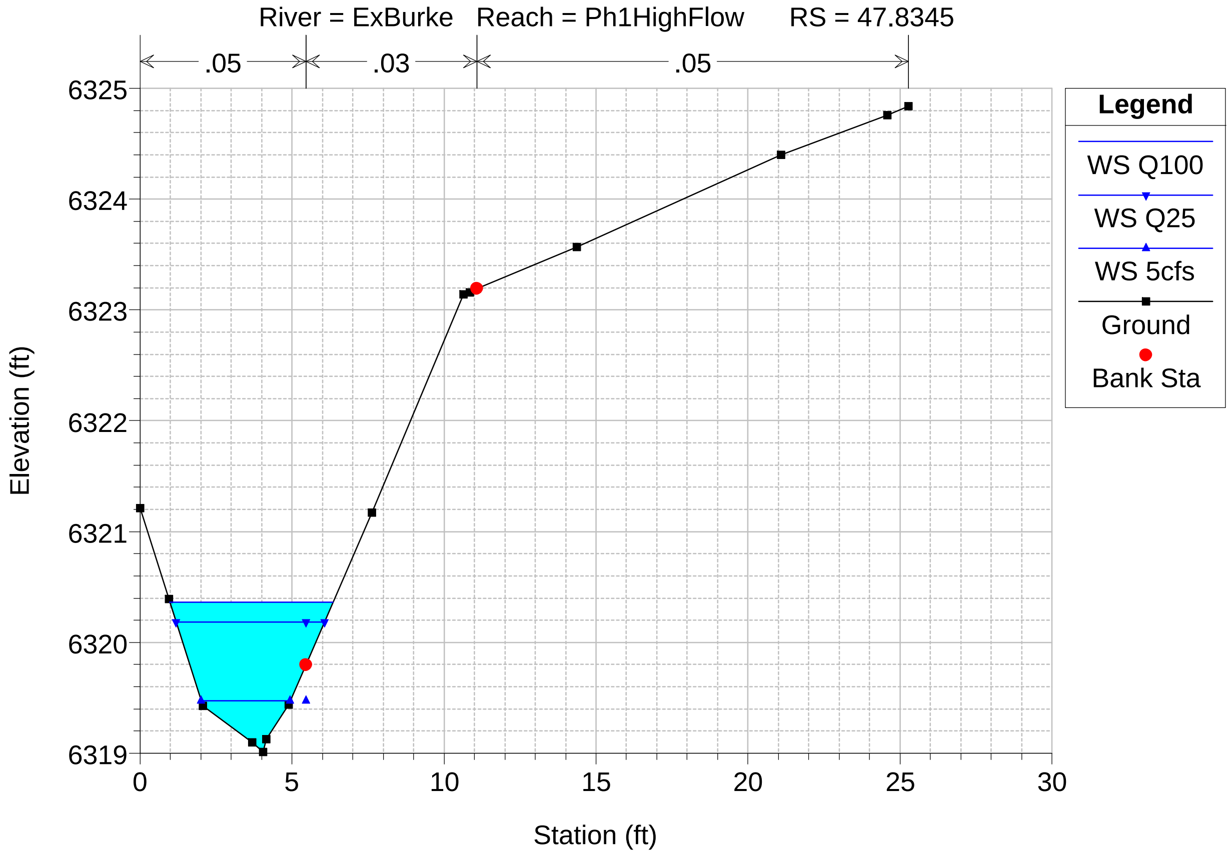
River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
ExBurke	Ph1HighFlow	108.9488	Q100	0.10	6324.99	6325.56		6325.56	0.000003	0.03	2.78	4.02	0.01
ExBurke	Ph1HighFlow	108.9488	5cfs	0.10	6324.99	6324.32		6324.33	0.019622		0.12	1.15	0.00
ExBurke	Ph1HighFlow	108.9488	Q25	0.10	6324.99	6325.34		6325.34	0.000010	0.03	1.93	3.56	0.02
ExBurke	Ph1HighFlow	80.15627	Q100	14.34	6322.07	6322.80	6322.80	6323.06	0.016971	4.39	3.93	7.97	1.02
ExBurke	Ph1HighFlow	80.15627	5cfs	0.31	6322.07	6322.15	6322.15	6322.18	0.030403	1.43	0.23	3.53	0.97
ExBurke	Ph1HighFlow	80.15627	Q25	9.57	6322.07	6322.66	6322.66	6322.87	0.017494	3.94	2.87	6.95	1.00
ExBurke	Ph1HighFlow	47.8345	Q100	14.34	6319.80	6320.37		6320.54	0.016123	2.44	4.42	5.41	0.80
ExBurke	Ph1HighFlow	47.8345	5cfs	0.31	6319.80	6319.50		6319.50	0.001302		0.75	3.00	0.00
ExBurke	Ph1HighFlow	47.8345	Q25	9.57	6319.80	6320.22		6320.33	0.012842	1.76	3.61	4.97	0.68
ExBurke	Ph1HighFlow	17.06541	Q100	14.34	6317.23	6318.68	6318.68	6318.98	0.021359	4.40	3.26	5.53	1.01
ExBurke	Ph1HighFlow	17.06541	5cfs	0.31	6317.23	6317.38	6317.38	6317.45	0.038765	2.19	0.14	1.17	1.11
ExBurke	Ph1HighFlow	17.06541	Q25	9.57	6317.23	6318.47	6318.47	6318.75	0.023380	4.26	2.25	4.07	1.01
ExBurke	Ph1HighFlow	12.88618	Q100	14.34	6316.66	6318.07	6318.07	6318.35	0.021917	4.22	3.40	6.45	1.02
ExBurke	Ph1HighFlow	12.88618	5cfs	0.31	6316.66	6316.81	6316.81	6316.88	0.031604	2.06	0.15	1.15	1.01
ExBurke	Ph1HighFlow	12.88618	Q25	9.57	6316.66	6317.91	6317.91	6318.15	0.022613	3.91	2.45	5.14	1.00
BurkeCrk	Ph1	1120.758	Q100	78.32	6325.88	6328.08	6328.08	6328.69	0.046988	6.47	13.02	11.80	0.95
BurkeCrk	Ph1	1120.758	5cfs	5.00	6325.88	6326.57	6326.54	6326.71	0.068056	3.01	1.66	4.95	0.91
BurkeCrk	Ph1	1120.758	Q25	54.56	6325.88	6327.74	6327.74	6328.27	0.057147	5.97	9.49	9.15	1.00
BurkeCrk	Ph1	1104.017	Q100	62.23	6325.16	6327.53	6327.53	6328.13	0.049714	6.23	9.98	8.31	1.00
BurkeCrk	Ph1	1104.017	5cfs	4.79	6325.16	6325.95	6325.95	6326.25	0.075852	4.41	1.09	1.78	0.99
BurkeCrk	Ph1	1104.017	Q25	44.94	6325.16	6327.25	6327.25	6327.77	0.052754	5.76	7.80	7.76	1.01
BurkeCrk	Ph1	1093.753	Q100	62.23	6324.15	6326.22	6326.22	6326.68	0.045995	5.49	11.34	12.24	1.00
BurkeCrk	Ph1	1093.753	5cfs	4.79	6324.15	6324.92	6324.92	6325.23	0.078212	4.46	1.07	1.78	1.01
BurkeCrk	Ph1	1093.753	Q25	44.94	6324.15	6326.02	6326.02	6326.41	0.048910	5.01	8.98	11.77	1.01
BurkeCrk	Ph1	1086.995	Q100	62.23	6322.95	6325.28	6325.28	6325.67	0.045116	5.01	12.43	16.01	1.00
BurkeCrk	Ph1	1086.995	5cfs	4.79	6322.95	6323.85		6324.07	0.050757	3.79	1.27	1.86	0.81
BurkeCrk	Ph1	1086.995	Q25	44.94	6322.95	6324.98	6324.98	6325.41	0.047786	5.22	8.60	10.40	1.01
BurkeCrk	Ph1	1074.112	Q100	62.23	6322.36	6323.92	6323.92	6324.22	0.049339	4.39	14.17	24.33	1.01
BurkeCrk	Ph1	1074.112	5cfs	4.79	6322.36	6323.25	6323.25	6323.36	0.069441	2.66	1.80	8.01	0.99
BurkeCrk	Ph1	1074.112	Q25	44.94	6322.36	6323.81	6323.81	6324.05	0.051434	3.94	11.41	23.91	1.00
BurkeCrk	Ph1	1066.267	Q100	62.23	6320.92	6322.86	6322.86	6323.15	0.048302	4.30	14.46	25.65	1.01
BurkeCrk	Ph1	1066.267	5cfs	4.79	6320.92	6321.69	6321.69	6322.00	0.077773	4.45	1.08	1.80	1.01
BurkeCrk	Ph1	1066.267	Q25	44.94	6320.92	6322.71	6322.71	6322.98	0.051091	4.12	10.91	21.34	1.02
BurkeCrk	Ph1	1047.896	Q100	62.23	6317.89	6319.71	6319.71	6320.02	0.048489	4.47	13.93	23.33	1.02
BurkeCrk	Ph1	1047.896	5cfs	4.79	6317.89	6318.90		6319.06	0.036216	3.15	1.52	2.42	0.70
BurkeCrk	Ph1	1047.896	Q25	44.94	6317.89	6319.58	6319.58	6319.84	0.050742	4.11	10.95	21.46	1.01
BurkeCrk	Ph1	1042.392	Q100	62.23	6317.62	6319.42		6319.58	0.034989	3.24	19.20	41.69	0.84
BurkeCrk	Ph1	1042.392	5cfs	4.79	6317.62	6318.79		6318.82	0.027449	1.56	3.07	16.01	0.63
BurkeCrk	Ph1	1042.392	Q25	44.94	6317.62	6319.33		6319.46	0.034185	2.88	15.62	39.82	0.81
BurkeCrk	Ph1	1026.729	Q100	62.23	6317.14	6318.84	6318.83	6319.02	0.053966	3.42	18.20	50.87	1.01
BurkeCrk	Ph1	1026.729	5cfs	4.79	6317.14	6318.26		6318.35	0.038907	2.37	2.02	6.60	0.76
BurkeCrk	Ph1	1026.729	Q25	44.94	6317.14	6318.79	6318.76	6318.91	0.043727	2.82	15.92	50.67	0.89
BurkeCrk	Ph1	1020.738	Q100	62.23	6316.90	6318.64		6318.75	0.024170	2.65	23.45	52.46	0.70
BurkeCrk	Ph1	1020.738	5cfs	4.79	6316.90	6318.09		6318.13	0.028505	1.57	3.04	16.07	0.64
BurkeCrk	Ph1	1020.738	Q25	44.94	6316.90	6318.56		6318.64	0.024210	2.34	19.20	51.90	0.68
BurkeCrk	Ph1	1000.867	Q100	62.23	6316.36	6318.12		6318.26	0.037162	3.01	20.66	52.92	0.85
BurkeCrk	Ph1	1000.867	5cfs	4.79	6316.36	6317.19	6317.13	6317.45	0.061670	4.08	1.18	1.84	0.90
BurkeCrk	Ph1	1000.867	Q25	44.94	6316.36	6318.04		6318.15	0.039218	2.73	16.48	51.01	0.85
BurkeCrk	Ph1	995.3325	Q100	62.23	6316.03	6317.87	6317.87	6318.06	0.055875	3.51	17.72	48.81	1.03
BurkeCrk	Ph1	995.3325	5cfs	4.79	6316.03	6316.93		6317.15	0.048710	3.73	1.28	1.88	0.80
BurkeCrk	Ph1	995.3325	Q25	44.94	6316.03	6317.79	6317.78	6317.95	0.053368	3.24	13.85	41.34	0.99
BurkeCrk	Ph1	989.9223	Q100	62.23	6315.80	6317.57	6317.57	6317.75	0.055653	3.44	18.08	51.19	1.02
BurkeCrk	Ph1	989.9223	5cfs	4.79	6315.80	6316.62	6316.58	6316.89	0.065271	4.16	1.15	1.82	0.92
BurkeCrk	Ph1	989.9223	Q25	44.94	6315.80	6317.49	6317.49	6317.64	0.061936	3.16	14.20	49.45	1.04
BurkeCrk	Ph1	984.6146	Q100	62.23	6315.48	6317.13		6317.28	0.042063	3.10	20.06	53.96	0.90
BurkeCrk	Ph1	984.6146	5cfs	4.79	6315.48	6316.45		6316.62	0.035079	3.30	1.45	2.00	0.68
BurkeCrk	Ph1	984.6146	Q25	44.94	6315.48	6317.06		6317.18	0.039139	2.68	16.76	53.18	0.84
BurkeCrk	Ph1	974.7529	Q100	62.23	6315.16	6316.72	6316.69	6316.88	0.044476	3.24	19.22	50.47	0.92
BurkeCrk	Ph1	974.7529	5cfs	4.79	6315.16	6316.06		6316.27	0.047417	3.70	1.30	1.90	0.79
BurkeCrk	Ph1	974.7529	Q25	44.94	6315.16	6316.64	6316.60	6316.77	0.042369	2.94	15.29	44.66	0.89
BurkeCrk	Ph1	963.7718	Q100	78.32	6314.64	6316.23	6316.23	6316.45	0.048069	3.76	20.82	44.99	0.97

HEC-RAS Plan: BurkePh1_SS_v2 Locations: User Defined (Continued)

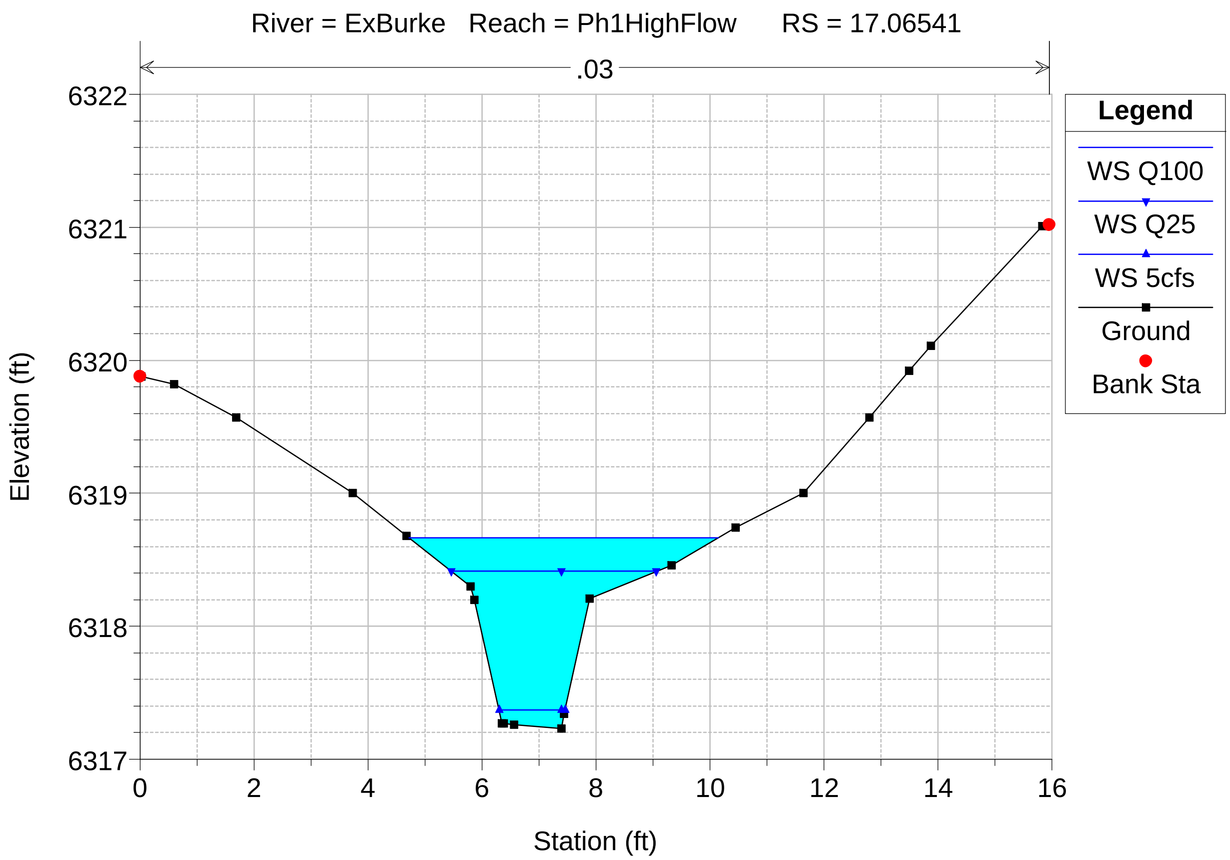
River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
BurkeCrk	Ph1	963.7718	5cfs	5.00	6314.64	6315.61	6315.61	6315.71	0.070260	2.56	1.95	11.14	0.99
BurkeCrk	Ph1	963.7718	Q25	54.56	6314.64	6316.09	6316.09	6316.29	0.054428	3.61	15.13	37.90	1.01
BurkeCrk	Ph1	953.0905	Q100	78.32	6313.75	6315.77		6315.93	0.028243	3.24	24.14	44.81	0.78
BurkeCrk	Ph1	953.0905	5cfs	5.00	6313.75	6314.85		6314.93	0.026226	2.29	2.18	5.40	0.63
BurkeCrk	Ph1	953.0905	Q25	54.56	6313.75	6315.63		6315.77	0.027967	2.97	18.40	38.62	0.76
BurkeCrk	Ph1	934.3893	Q100	78.32	6313.25	6315.13	6315.13	6315.39	0.050466	4.08	19.19	38.81	1.02
BurkeCrk	Ph1	934.3893	5cfs	5.00	6313.25	6314.05	6314.05	6314.36	0.075829	4.46	1.12	1.80	1.00
BurkeCrk	Ph1	934.3893	Q25	54.56	6313.25	6315.01	6315.01	6315.22	0.054220	3.74	14.61	35.50	1.03
BurkeCrk	Ph1	927.8279	Q100	78.32	6312.67	6314.69		6314.84	0.018435	3.08	25.42	36.76	0.65
BurkeCrk	Ph1	927.8279	5cfs	5.00	6312.67	6313.48	6313.47	6313.79	0.075305	4.45	1.13	1.79	0.99
BurkeCrk	Ph1	927.8279	Q25	54.56	6312.67	6314.35	6314.35	6314.58	0.050037	3.90	14.01	29.94	1.00
BurkeCrk	Ph1	910.6393	Q100	78.32	6311.53	6314.70	6313.42	6314.73	0.001124	1.24	63.03	43.65	0.18
BurkeCrk	Ph1	910.6393	5cfs	5.00	6311.53	6312.33	6312.33	6312.64	0.076639	4.48	1.12	1.80	1.00
BurkeCrk	Ph1	910.6393	Q25	54.56	6311.53	6314.00	6313.26	6314.03	0.002753	1.56	35.01	33.60	0.27


River = ExBurke Reach = Ph1HighFlow RS = 108.9488
.05
.03
.05
6332
6331
6330
6329
6328
6327
6326
6325
6324
0
5
10
15
20
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta

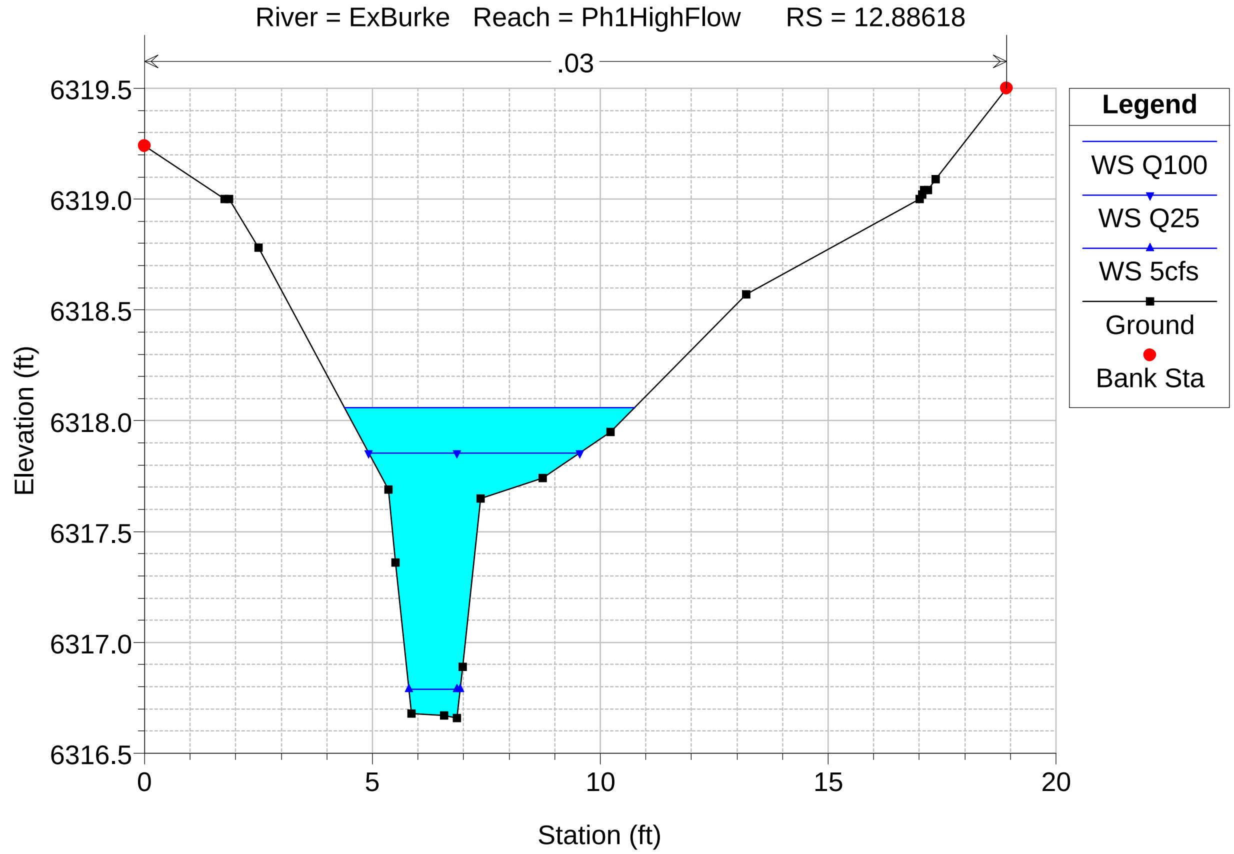

River = ExBurke Reach = Ph1HighFlow RS = 80.15627
.05
.03
.05
6328
6327
6326
6325
6324
6323
6322
0
5
10
15
20
25
30
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta

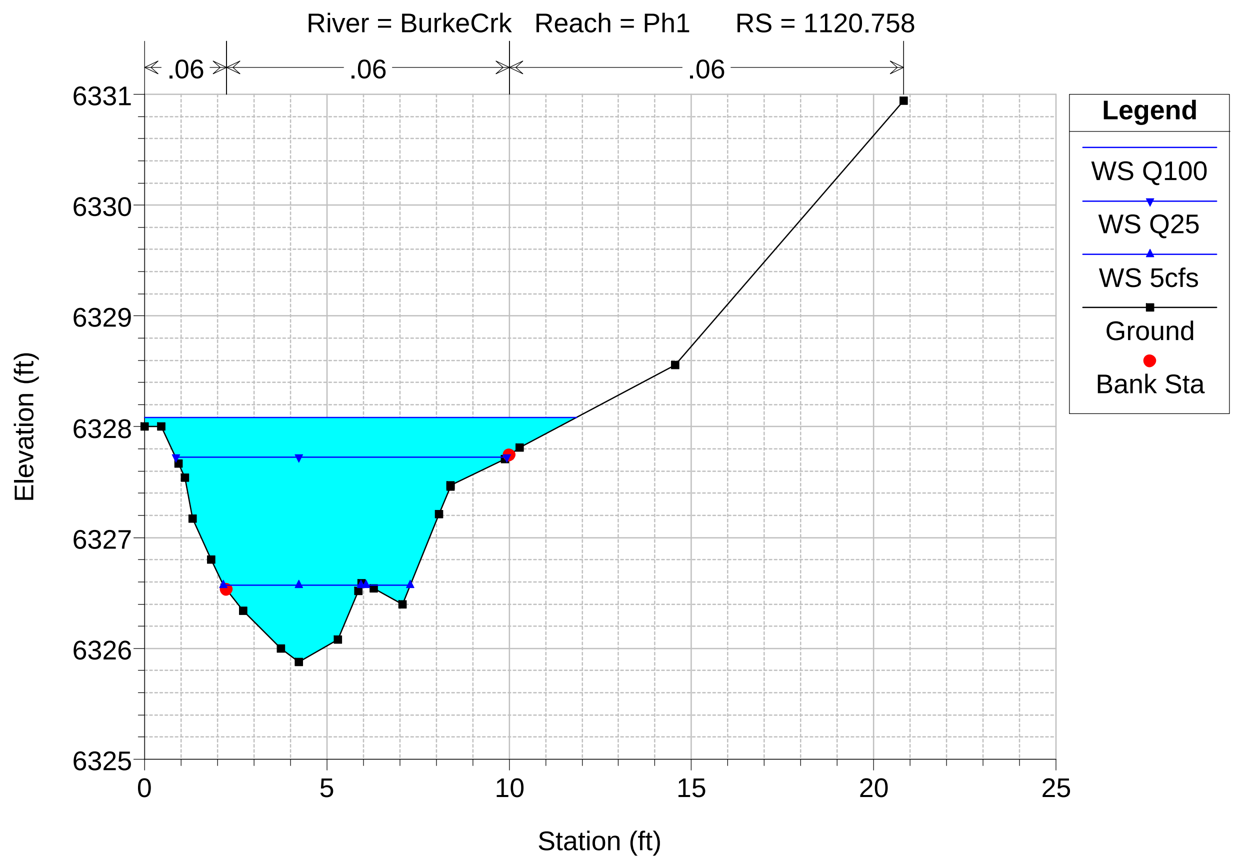


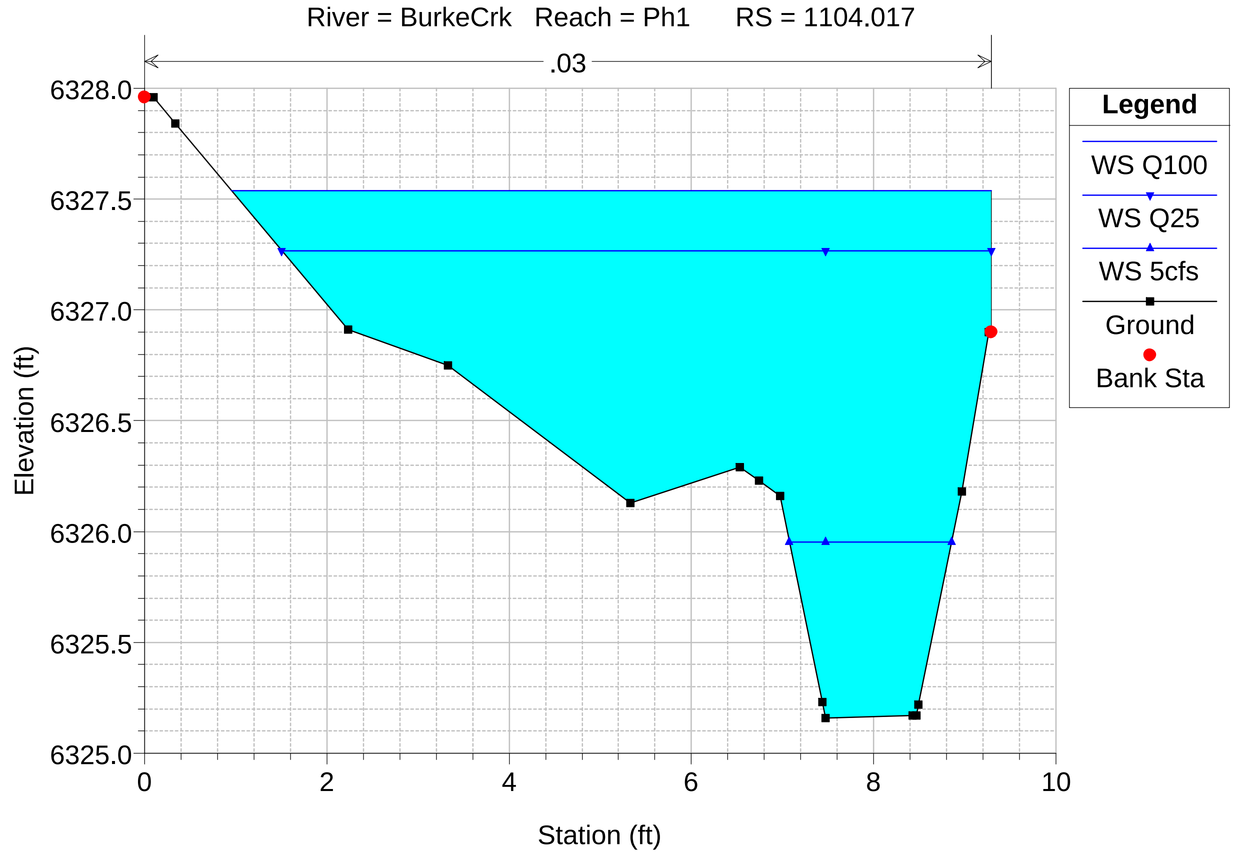
River = ExBurke Reach = Ph1HighFlow RS = 47.8345
.05
.03
.05
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)
6325
6324
6323
6322
6321
6320
6319
0
5
10
15
20
25
30



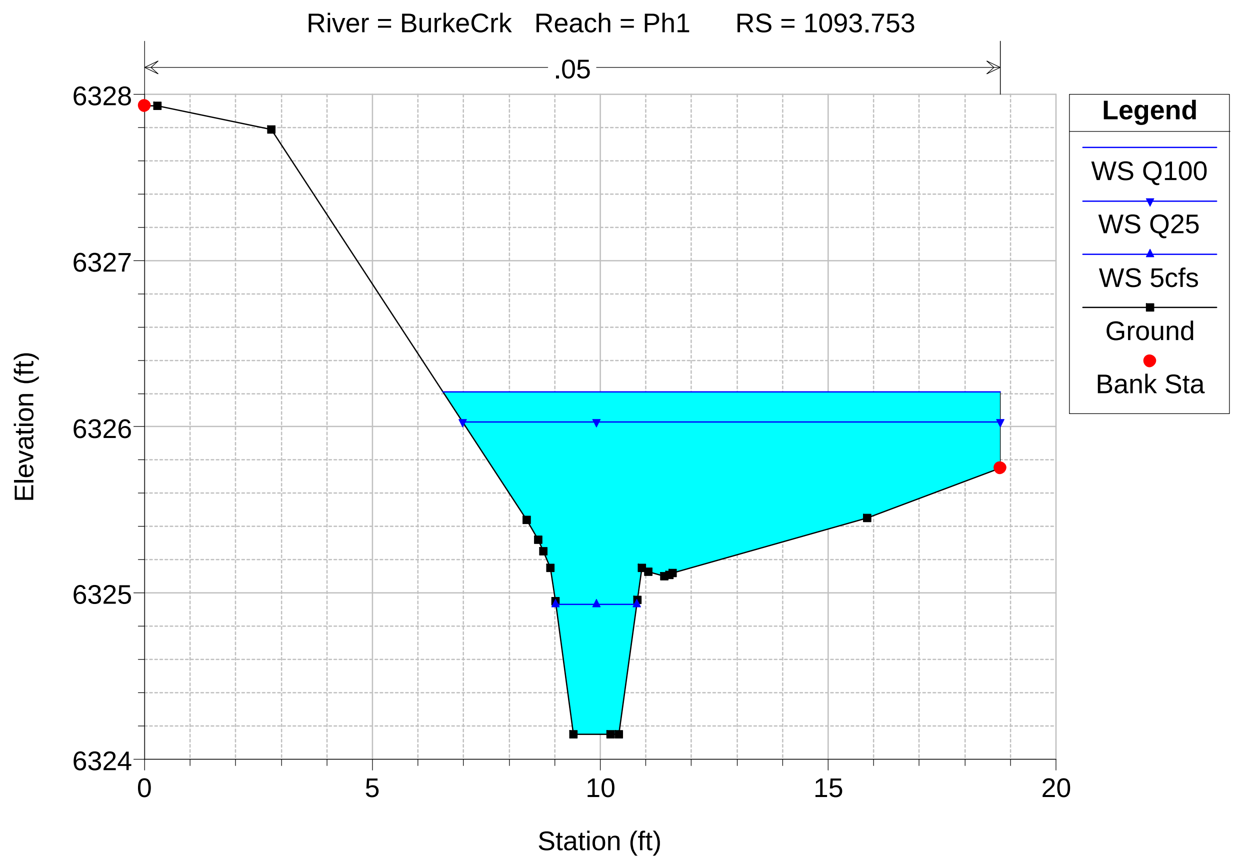
River = ExBurke Reach = Ph1HighFlow RS = 17.06541
.03
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)
6322
6321
6320
6319
6318
6317
0
2
4
6
8
10
12
14
16


River = ExBurke Reach = Ph1HighFlow RS = 12.88618
.03
Elevation (ft)
6319.5
6319.0
6318.5
6318.0
6317.5
6317.0
6316.5
0
5
10
15
20
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta

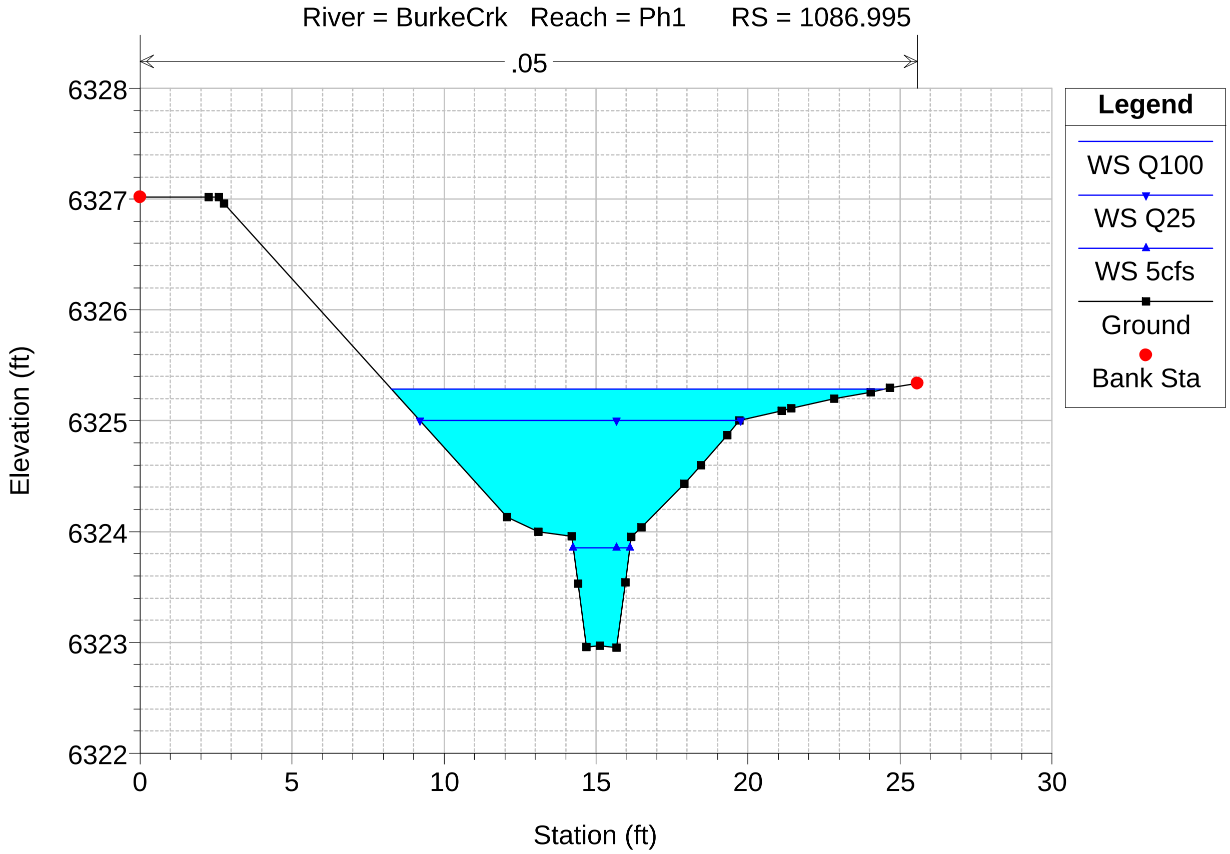

River = BurkeCrk Reach = Ph1 RS = 1120.758
.06
.06
.06
Elevation (ft)
6331
6330
6329
6328
6327
6326
6325
0
5
10
15
20
25
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta

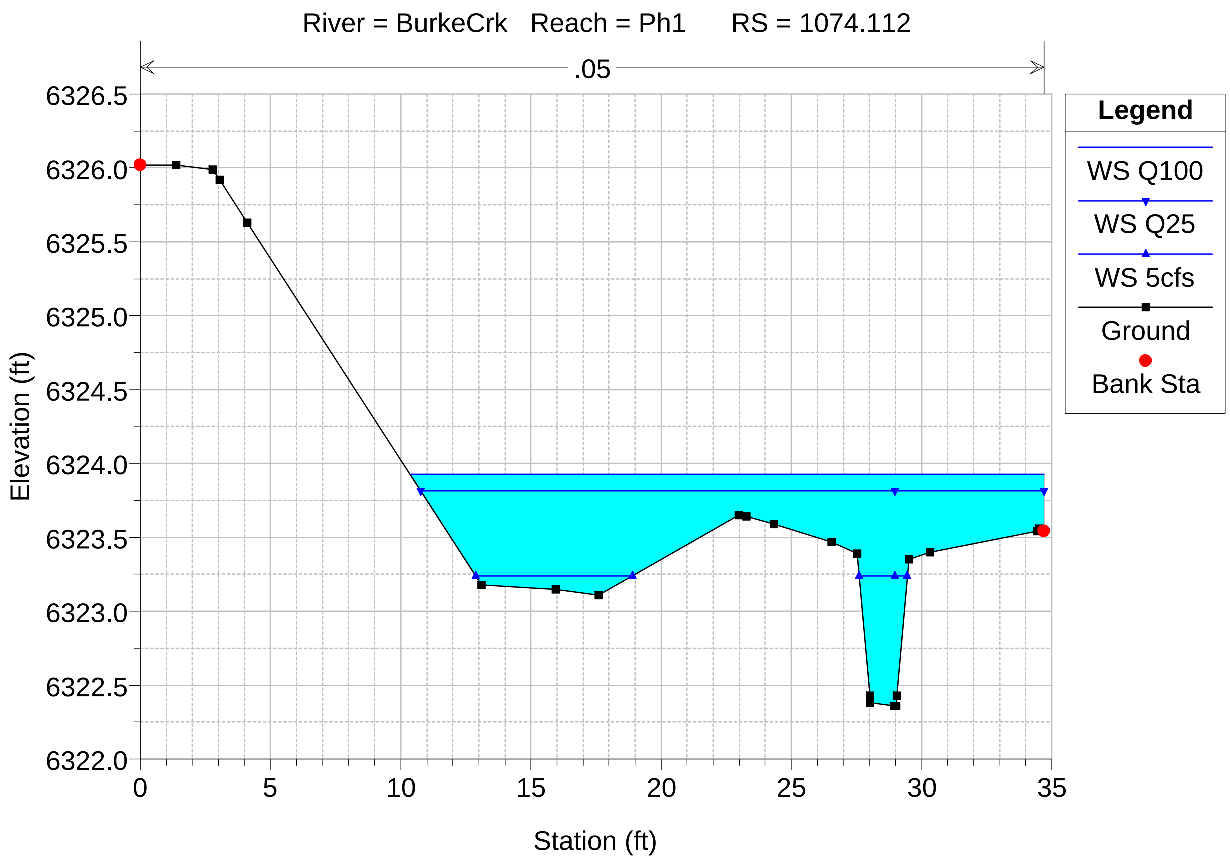


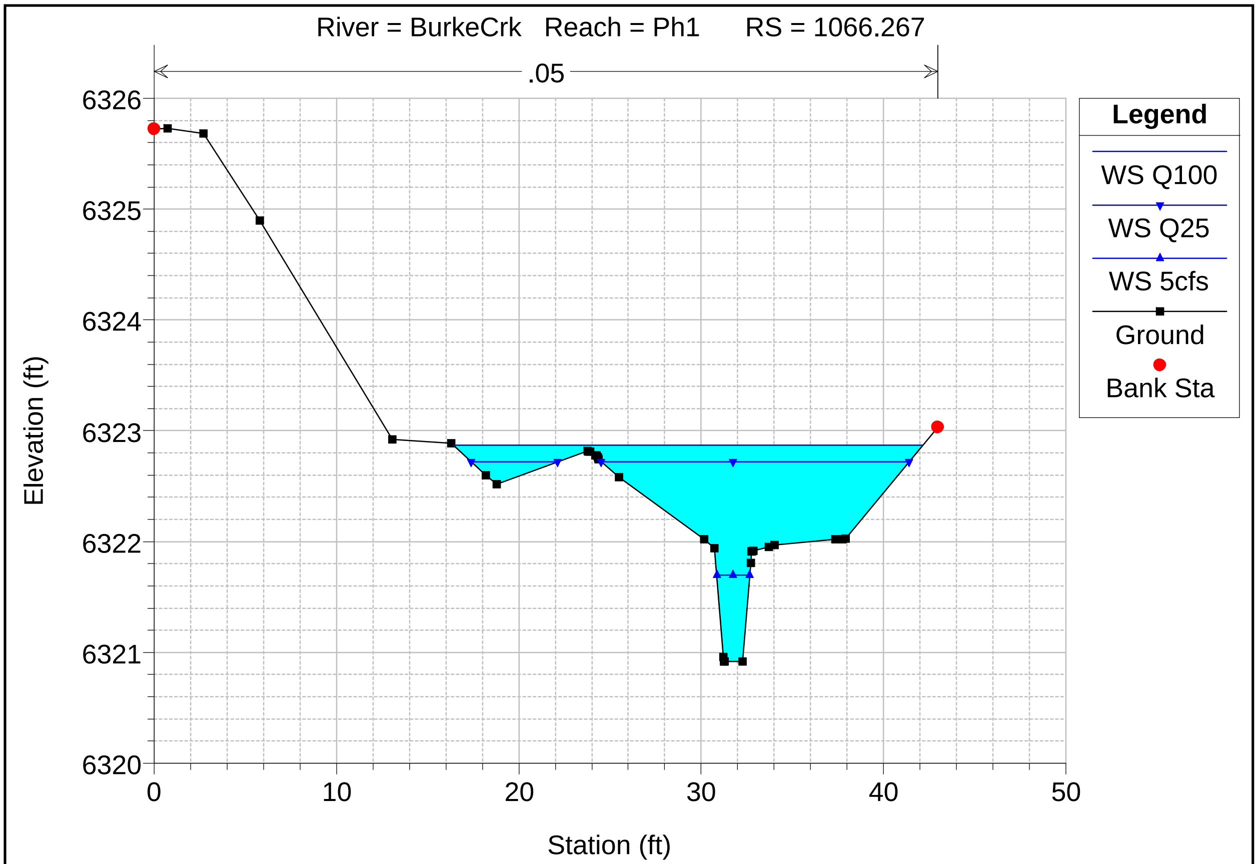
River = BurkeCrk Reach = Ph1 RS = 1104.017
.03
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta



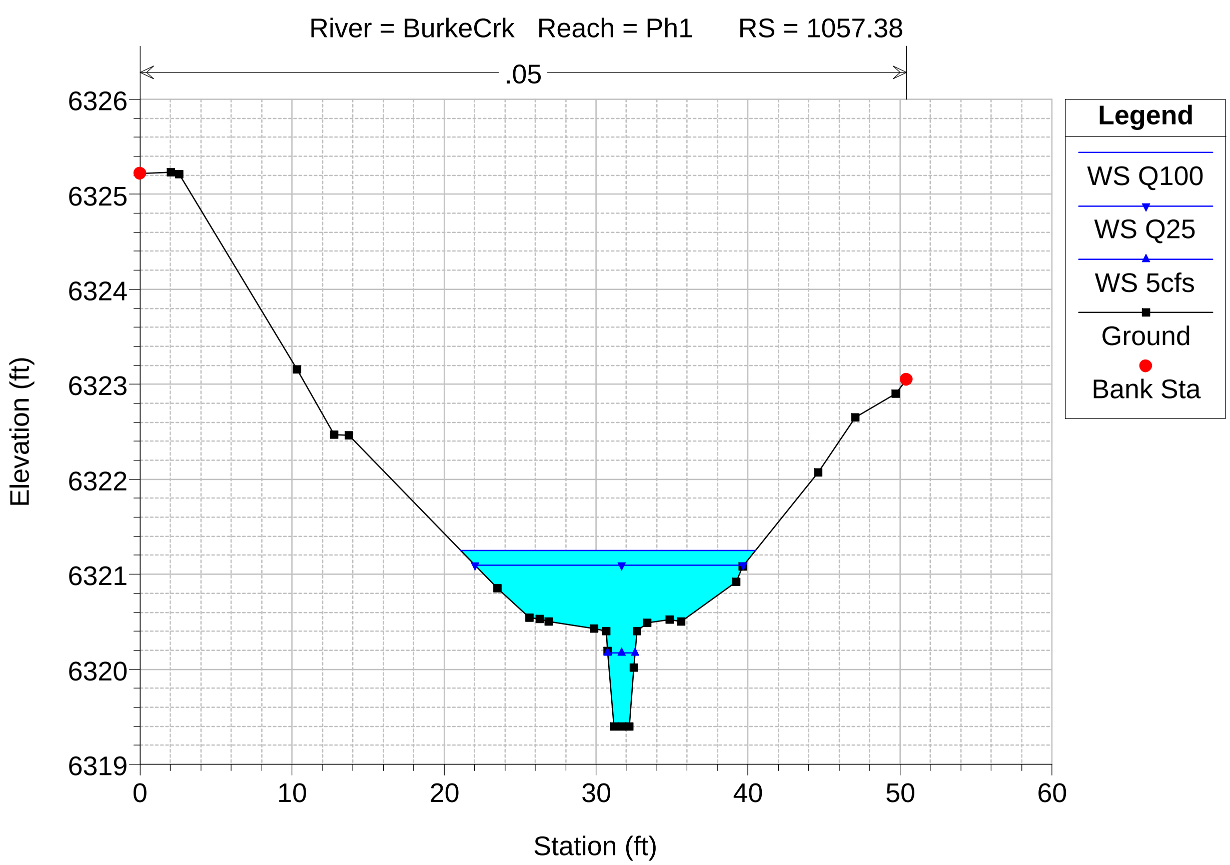
River = BurkeCrk Reach = Ph1 RS = 1093.753
.05
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta


River = BurkeCrk   Reach = Ph1   RS = 1086.995
.05
Elevation (ft)
6328
6327
6326
6325
6324
6323
6322
0
5
10
15
20
25
30
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta

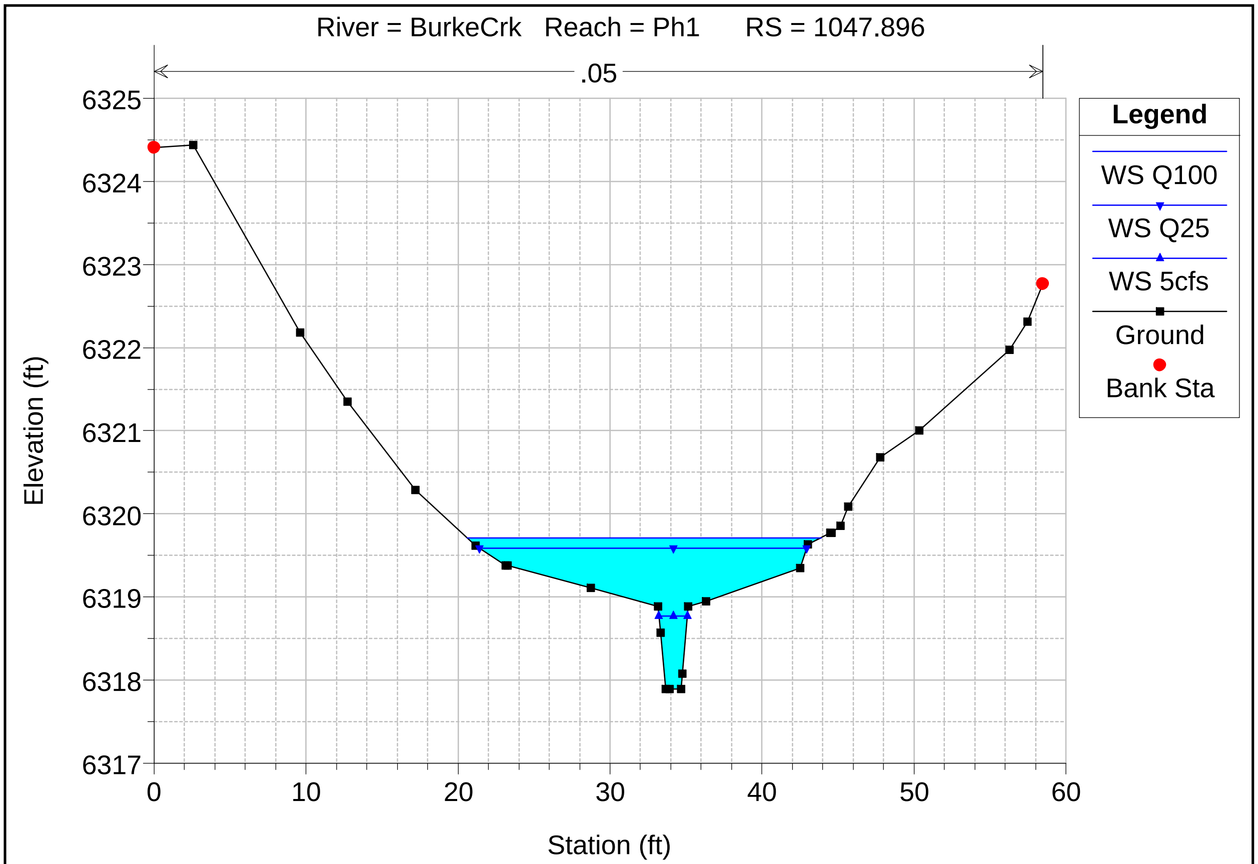

River = BurkeCrk   Reach = Ph1   RS = 1074.112
.05
Elevation (ft)
6326.5
6326.0
6325.5
6325.0
6324.5
6324.0
6323.5
6323.0
6322.5
6322.0
0
5
10
15
20
25
30
35
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta



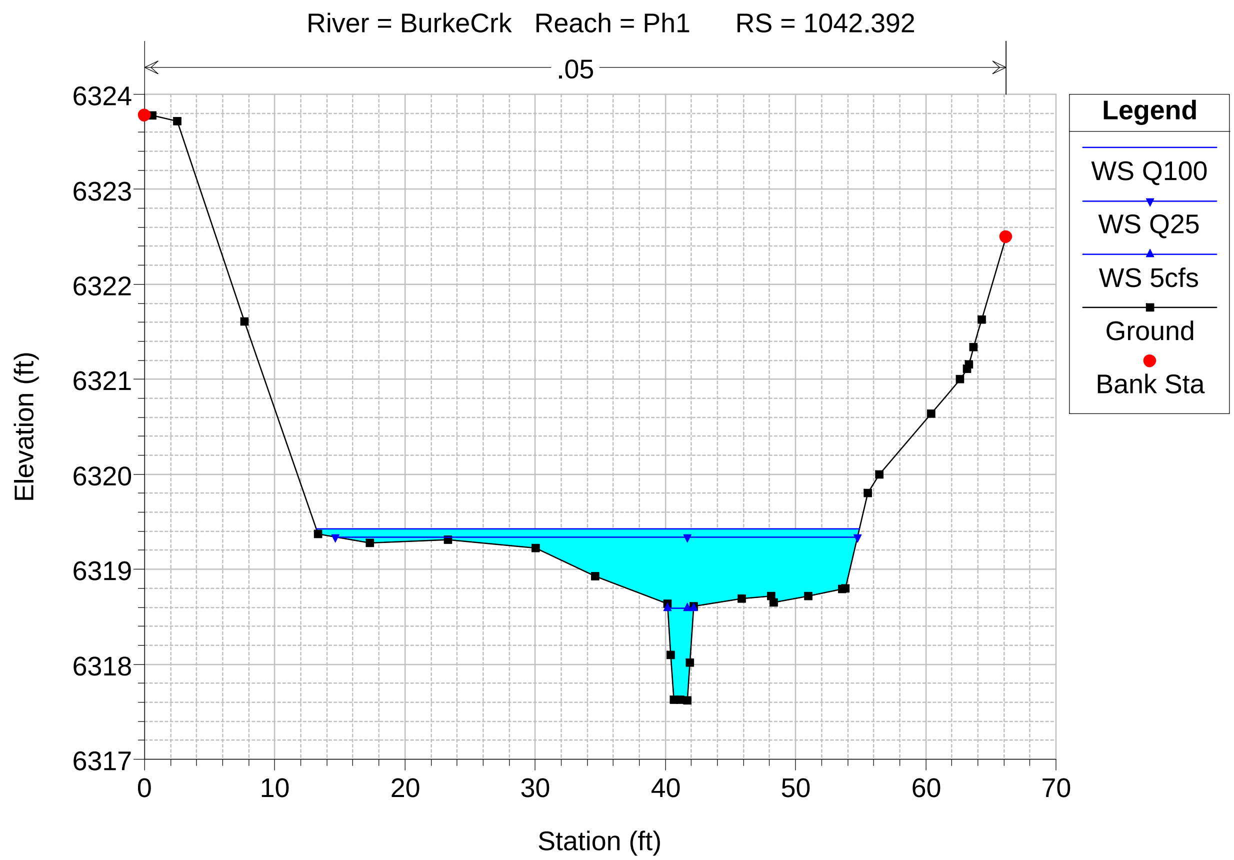
River = BurkeCrk Reach = Ph1 RS = 1066.267
.05
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta



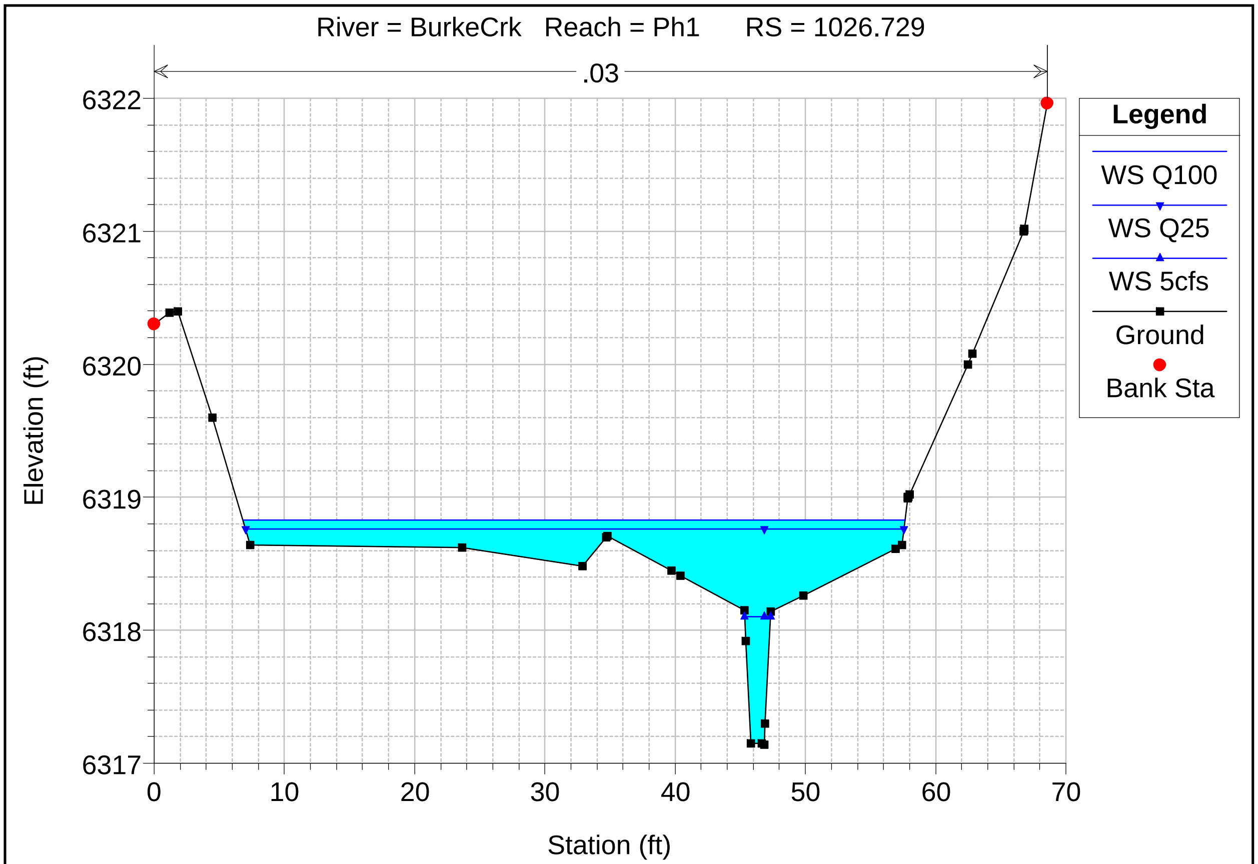
River = BurkeCrk Reach = Ph1 RS = 1057.38
.05
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta

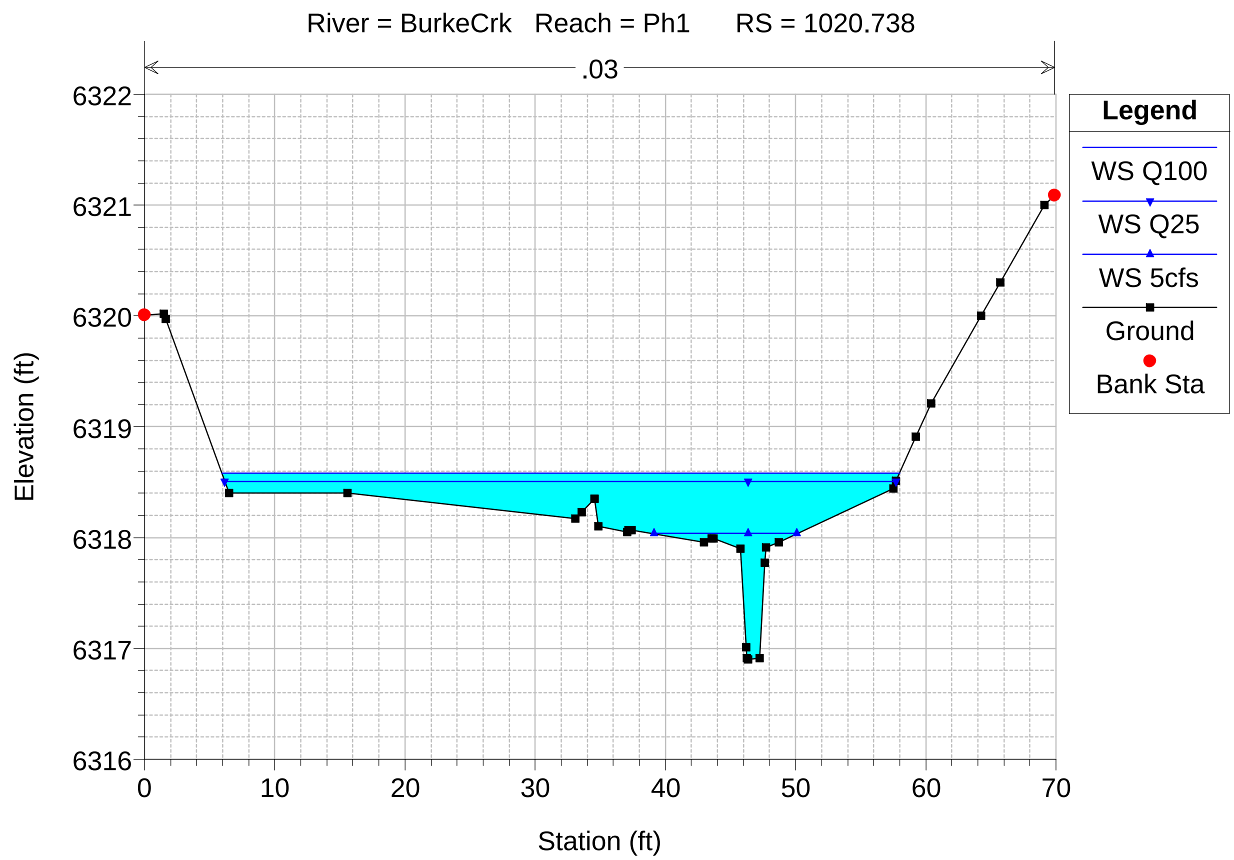


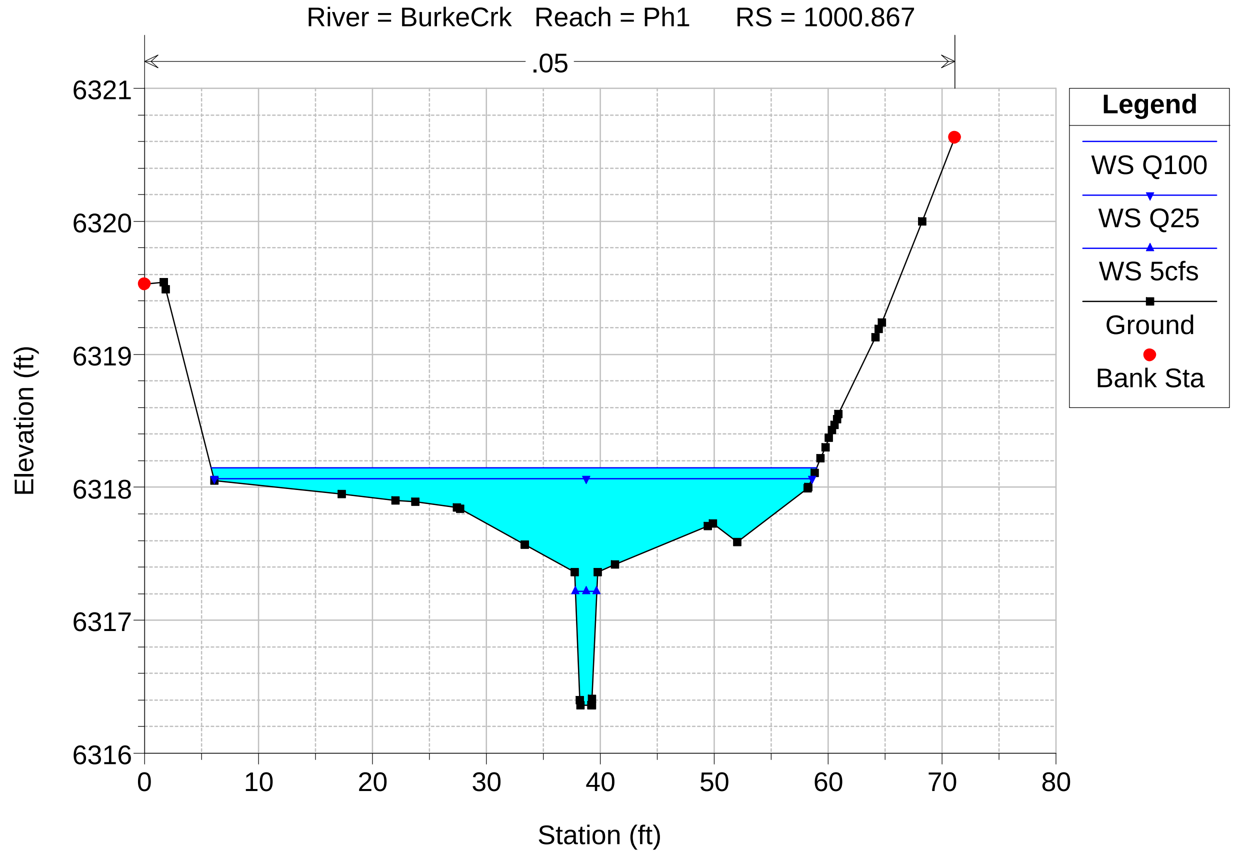
River = BurkeCrk Reach = Ph1 RS = 1047.896
.05
Elevation (ft)
6325
6324
6323
6322
6321
6320
6319
6318
6317
0
10
20
30
40
50
60
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta

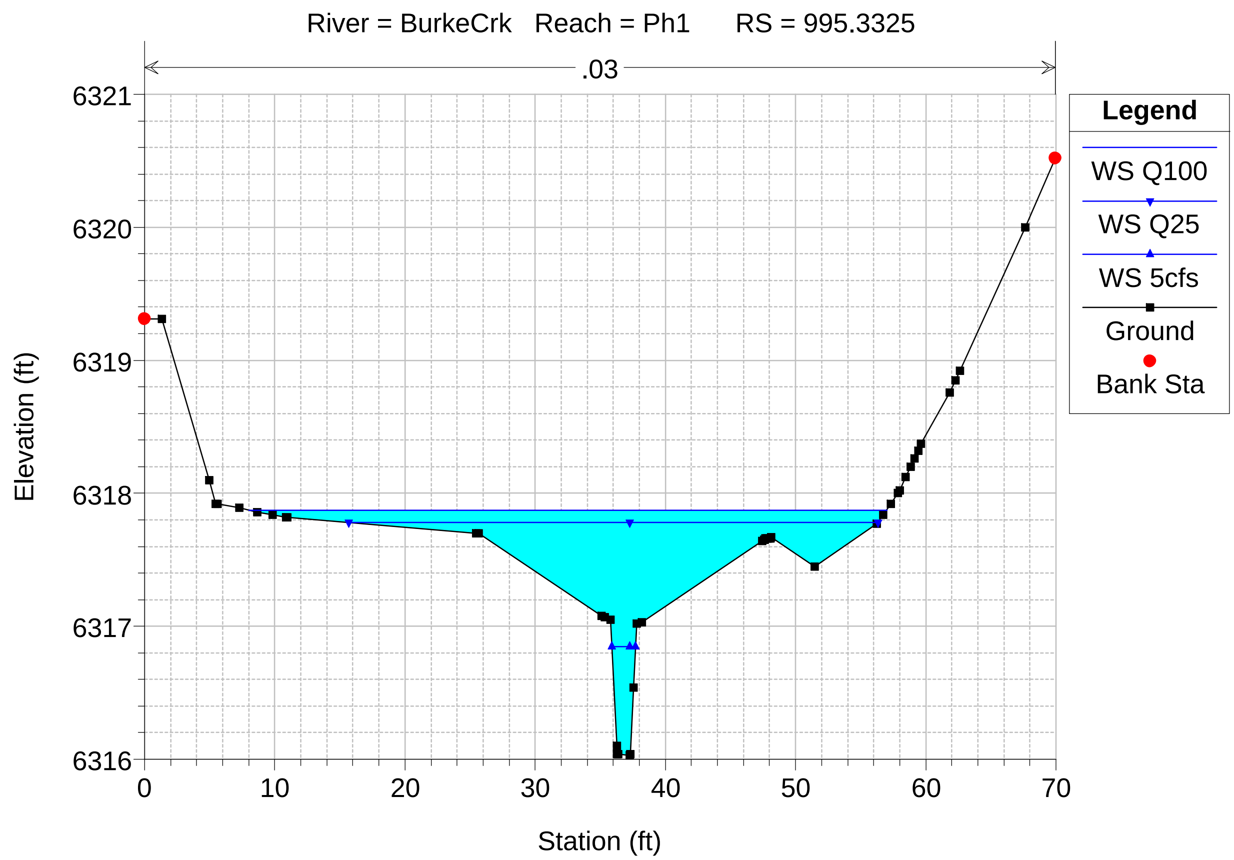


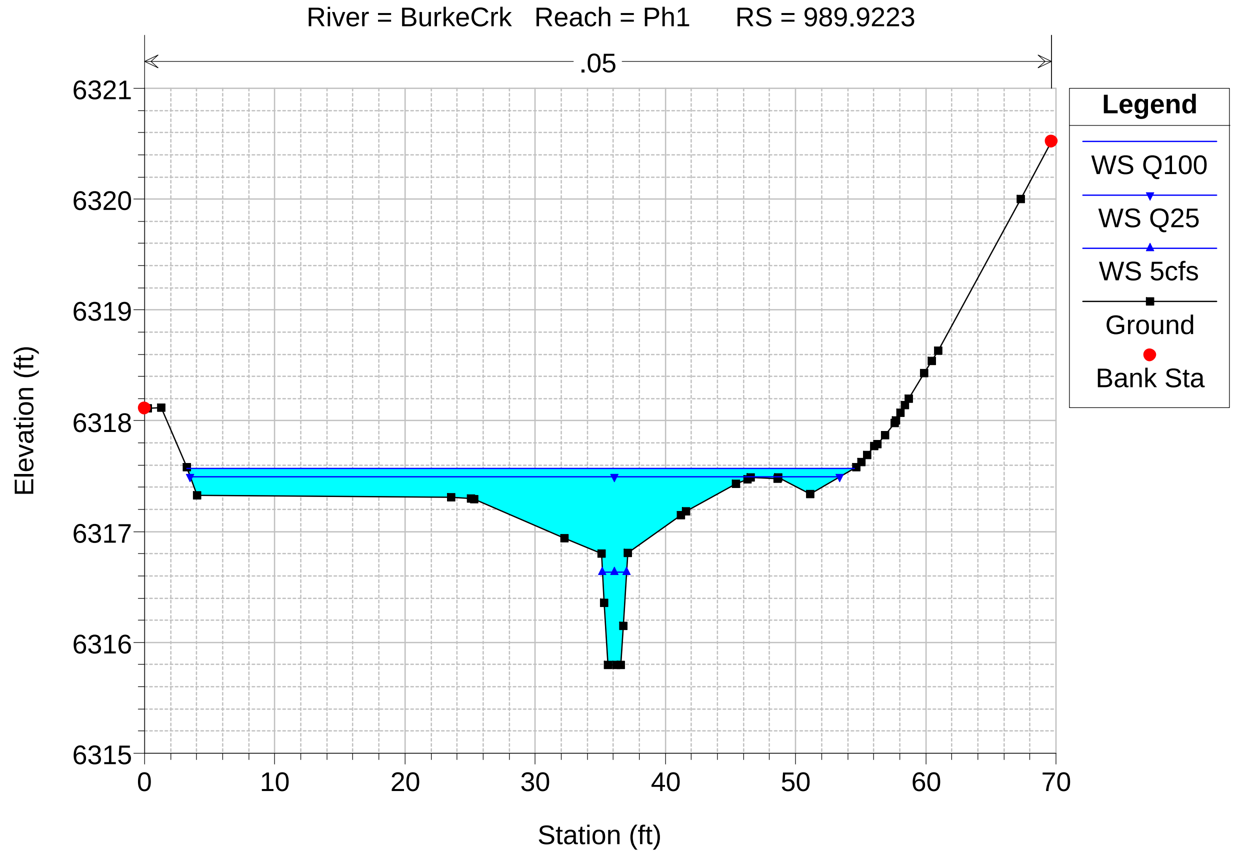
River = BurkeCrk Reach = Ph1 RS = 1042.392
.05
Elevation (ft)
6324
6323
6322
6321
6320
6319
6318
6317
0
10
20
30
40
50
60
70
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta

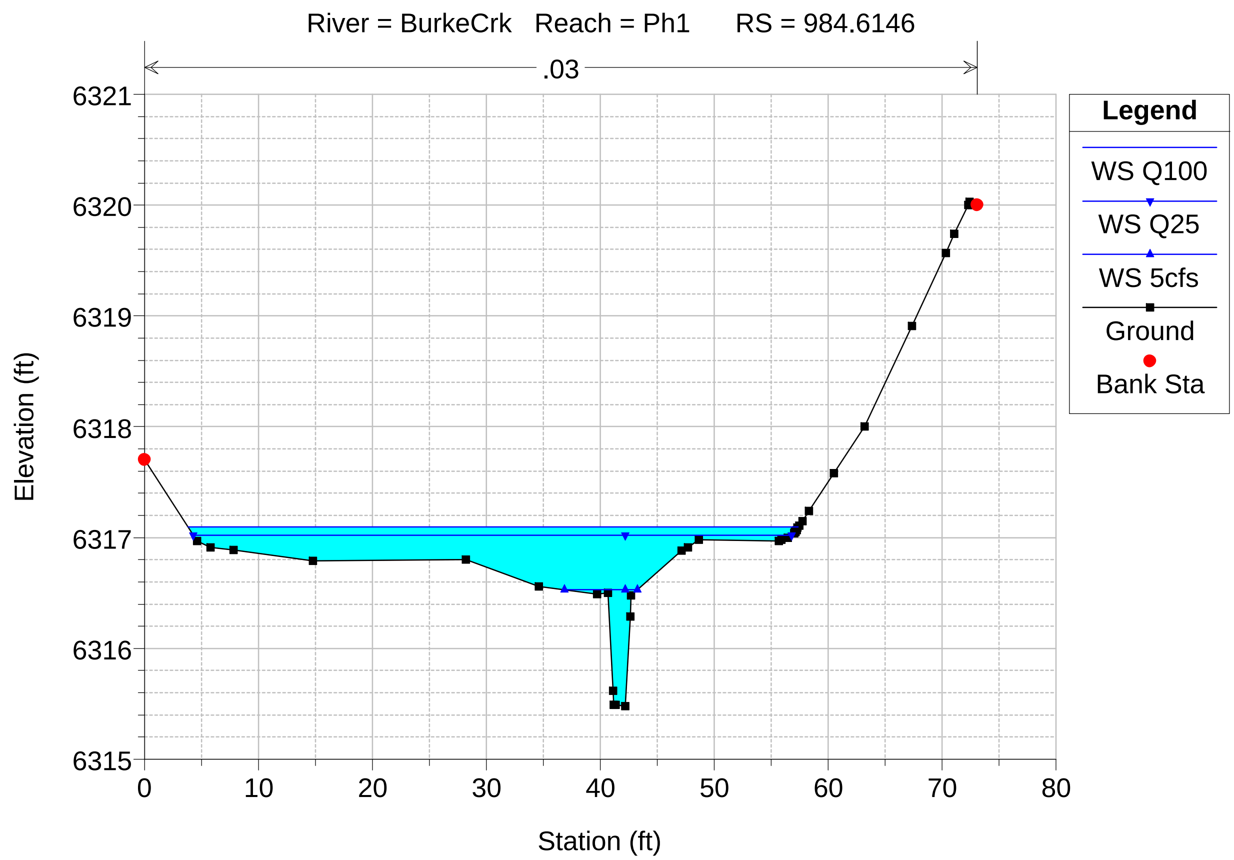

River = BurkeCrk Reach = Ph1 RS = 1026.729
.03
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta

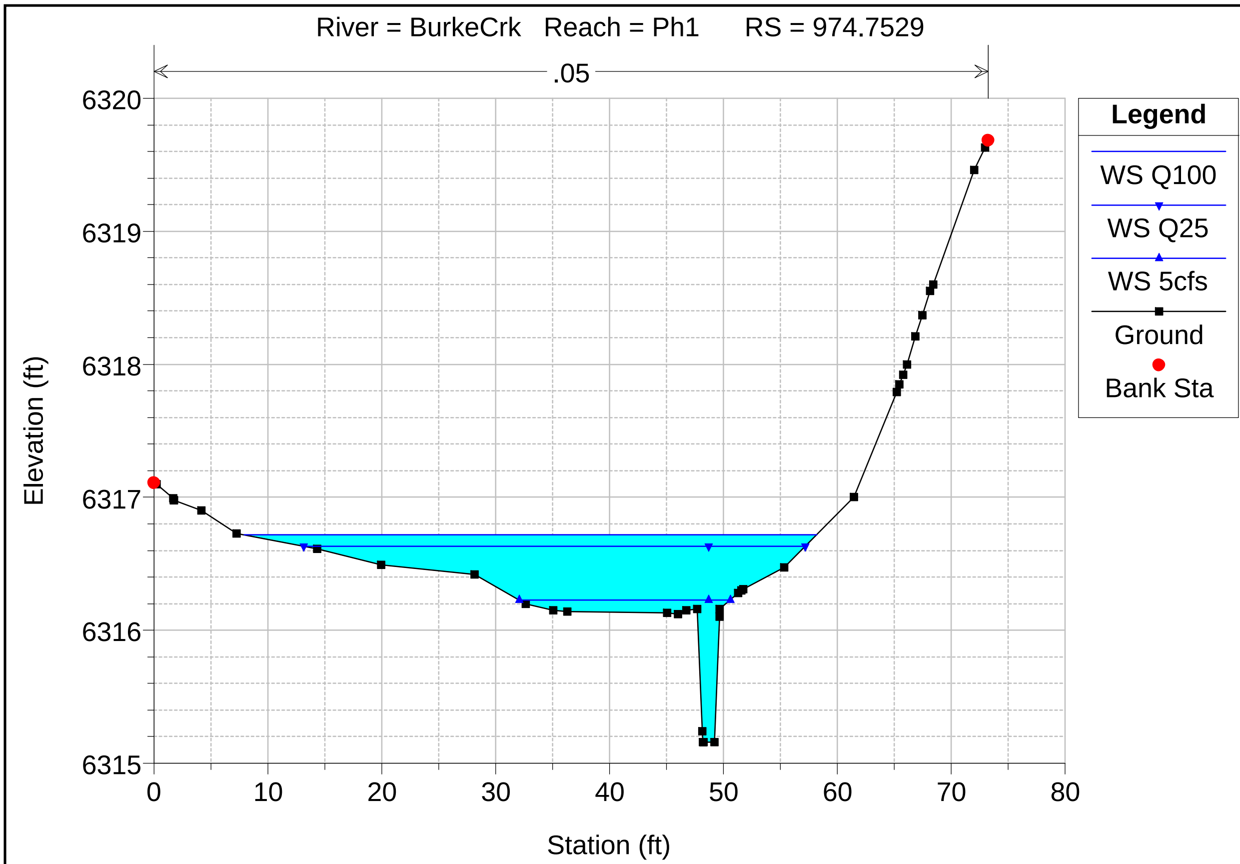

River = BurkeCrk Reach = Ph1 RS = 1020.738
.03
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta

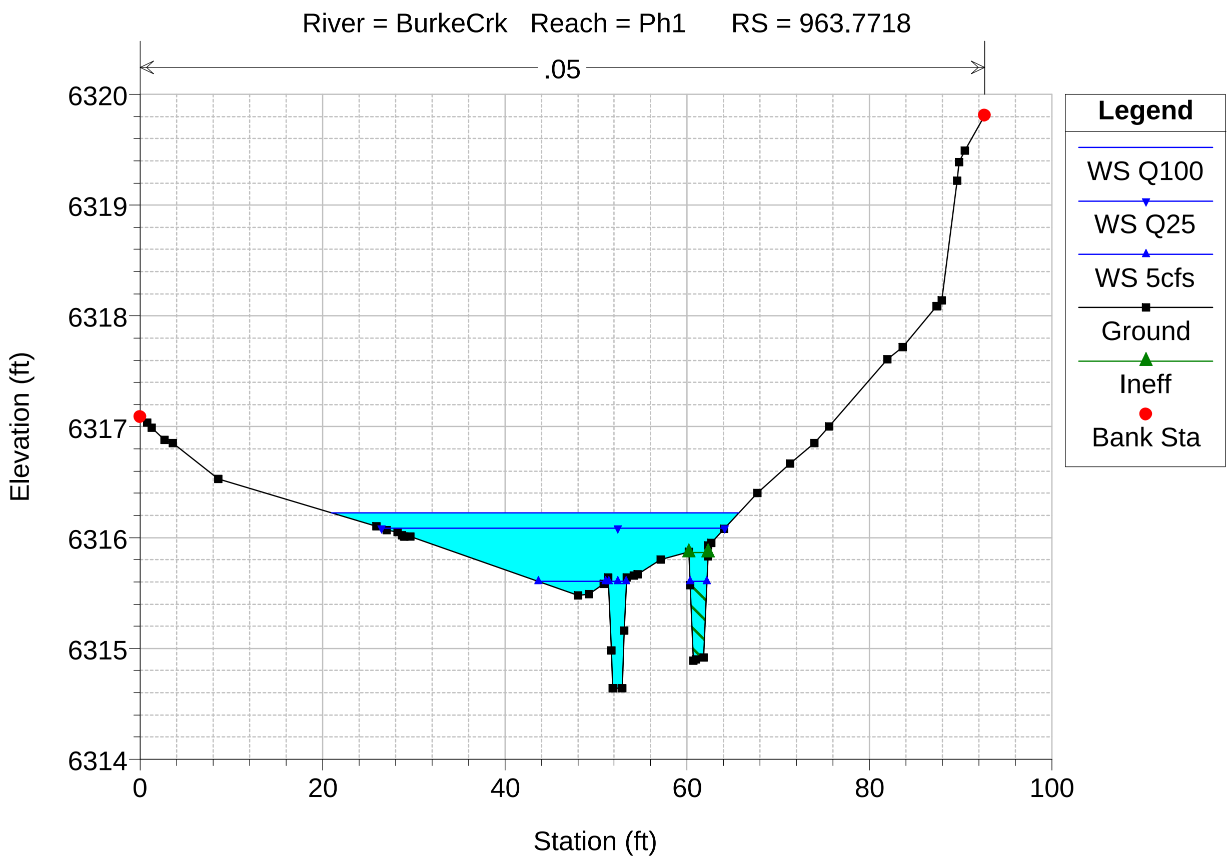

River = BurkeCrk Reach = Ph1 RS = 1000.867
.05
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)
6321
6320
6319
6318
6317
6316
0
10
20
30
40
50
60
70
80

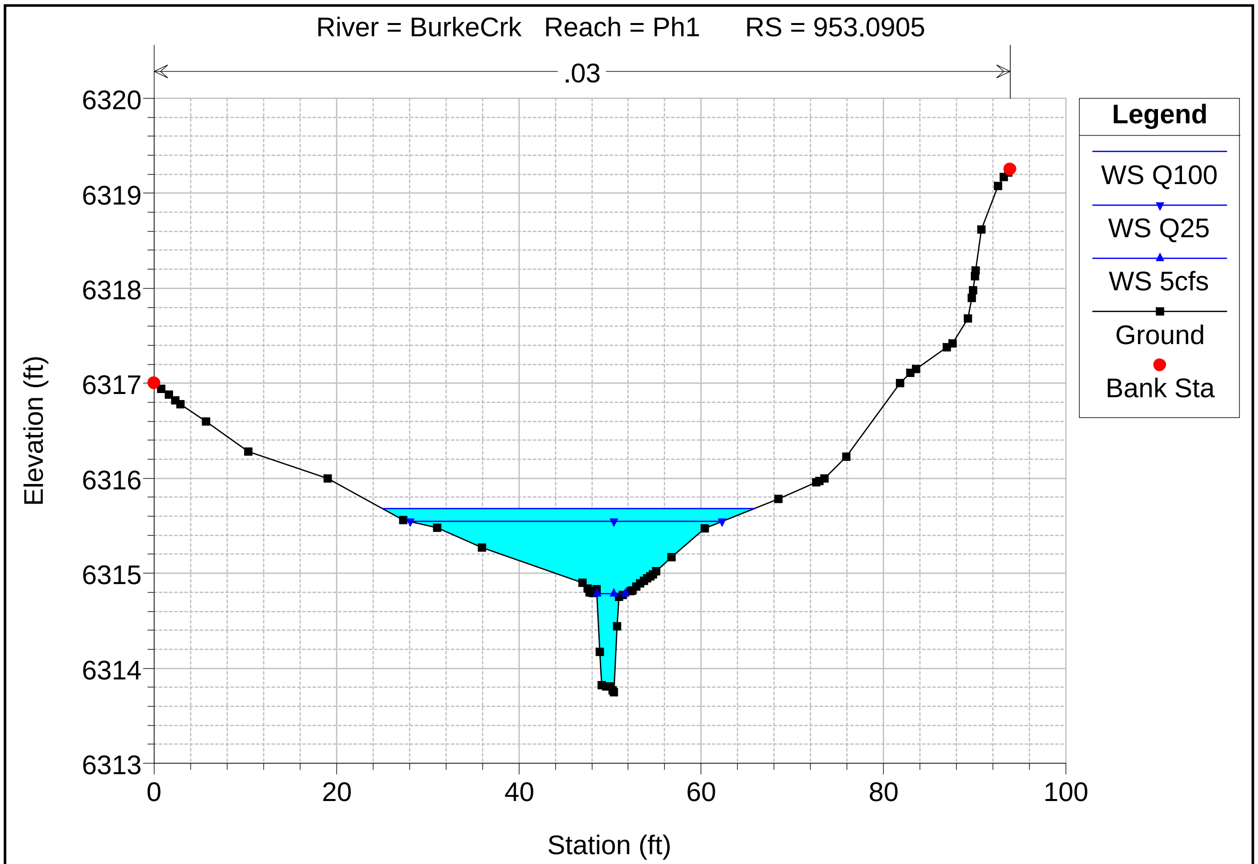

River = BurkeCrk Reach = Ph1 RS = 995.3325
.03
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta
Elevation (ft)
Station (ft)
6321
6320
6319
6318
6317
6316
0
10
20
30
40
50
60
70

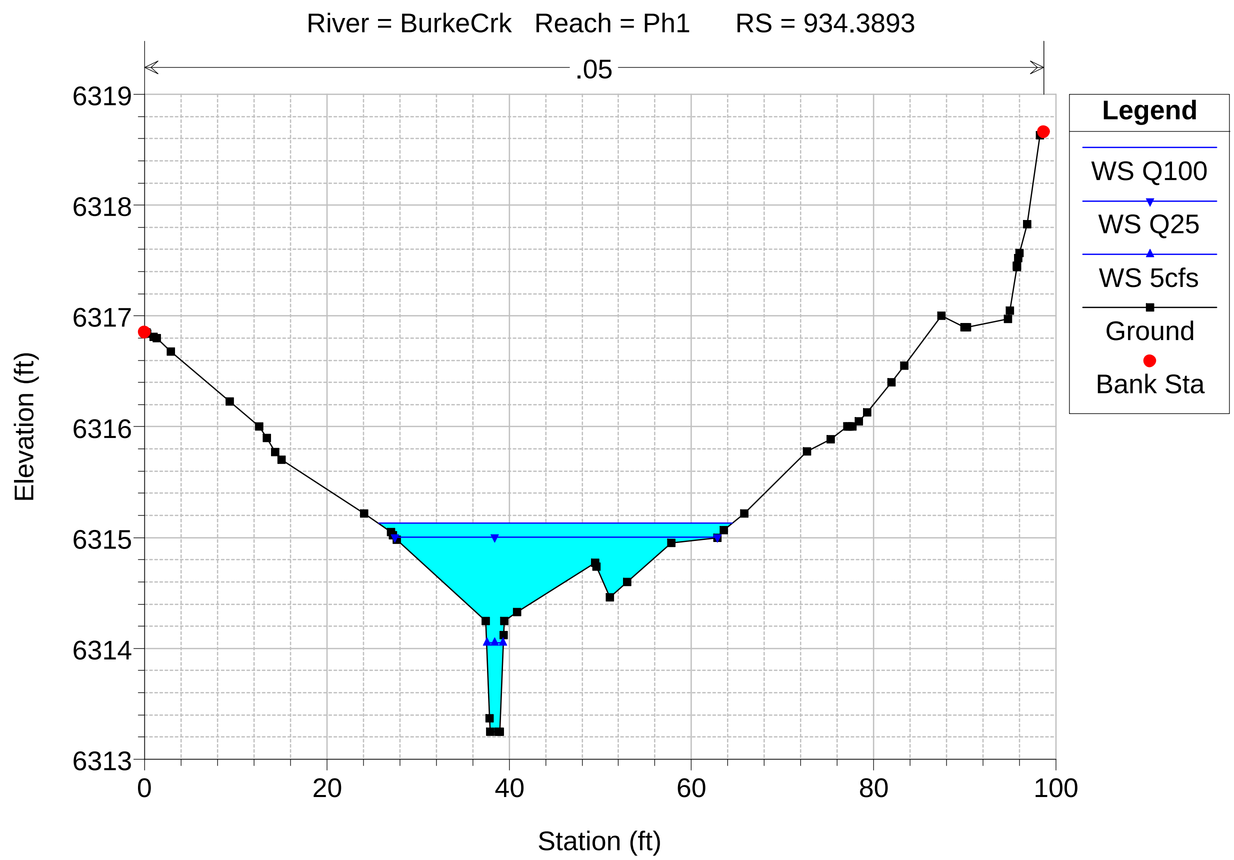

River = BurkeCrk Reach = Ph1 RS = 989.9223
.05
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta

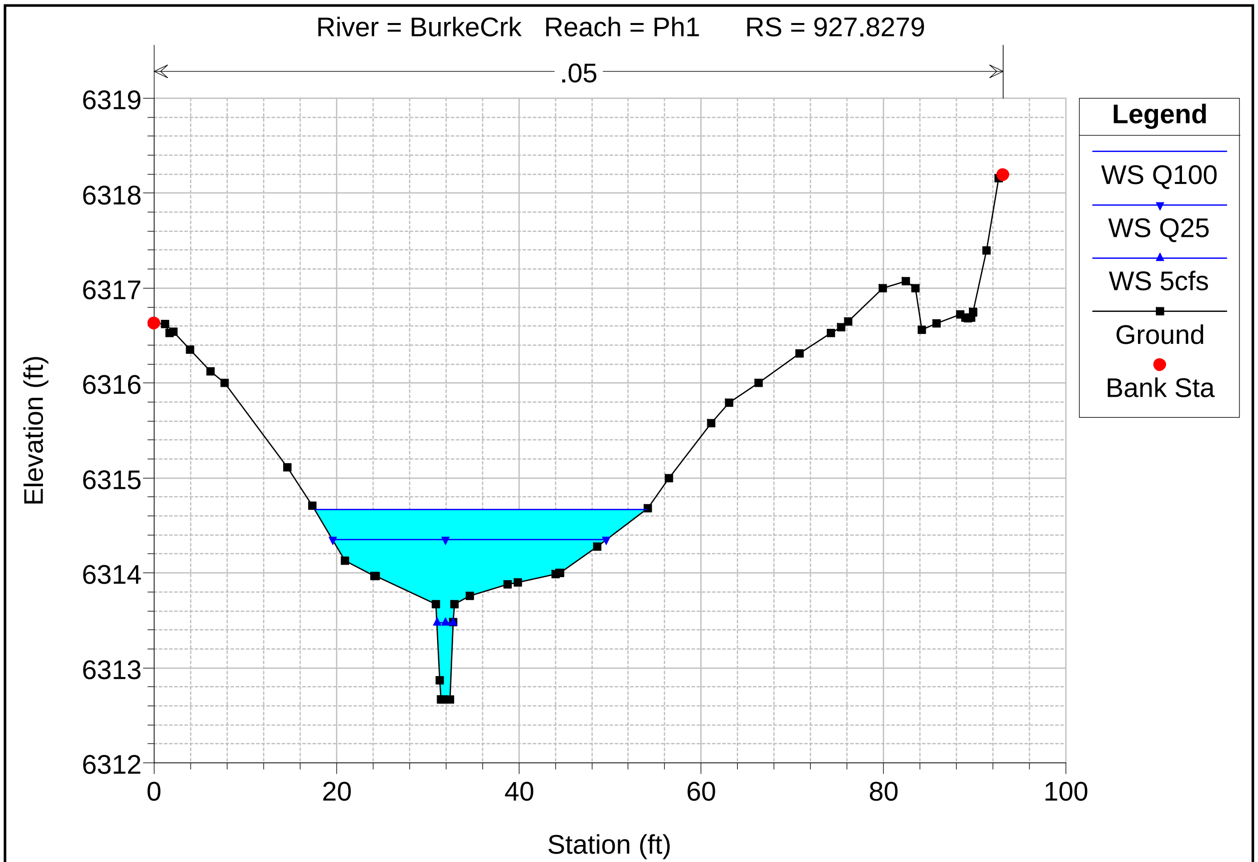

River = BurkeCrk Reach = Ph1 RS = 984.6146
.03
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta

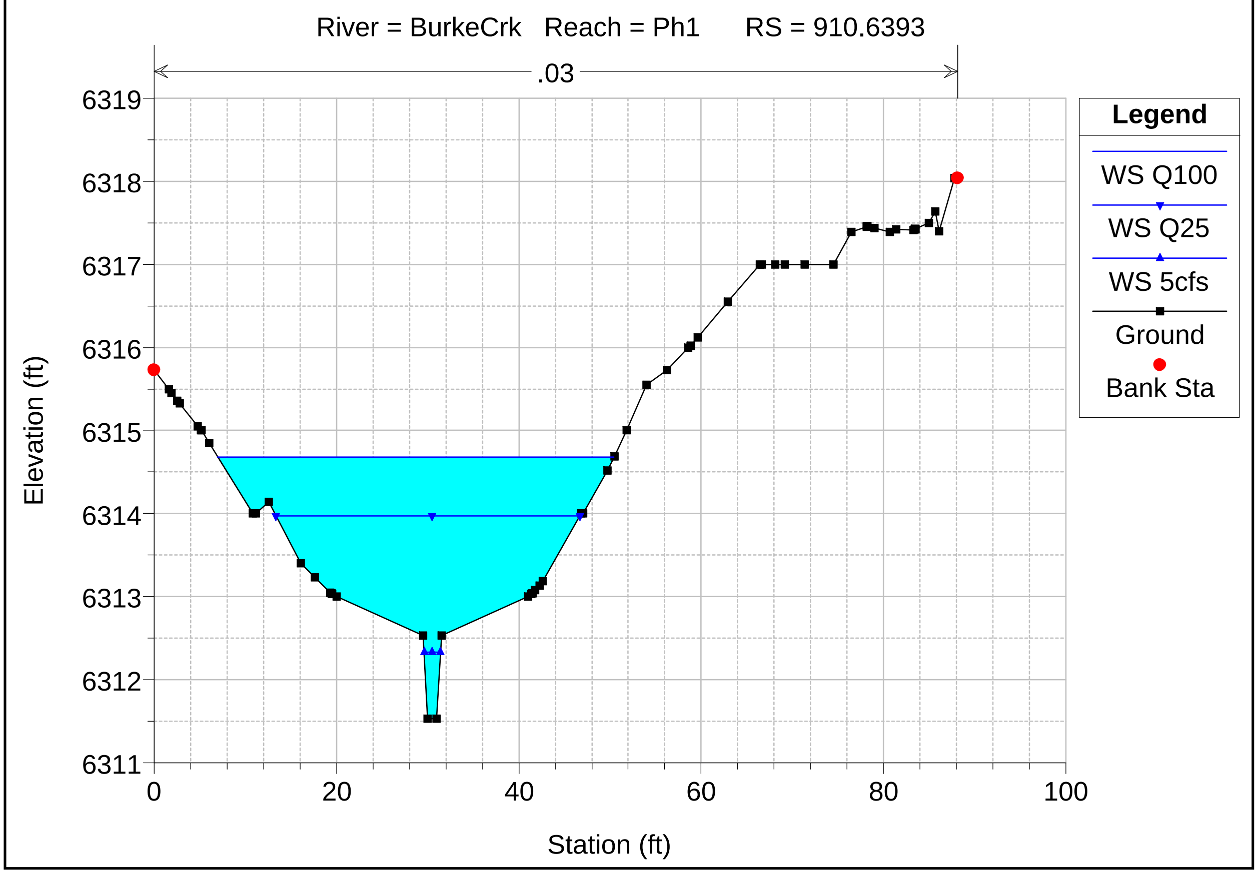

River = BurkeCrk   Reach = Ph1   RS = 974.7529
.05
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta
Elevation (ft)
6320
6319
6318
6317
6316
6315
0
10
20
30
40
50
60
70
80
Station (ft)

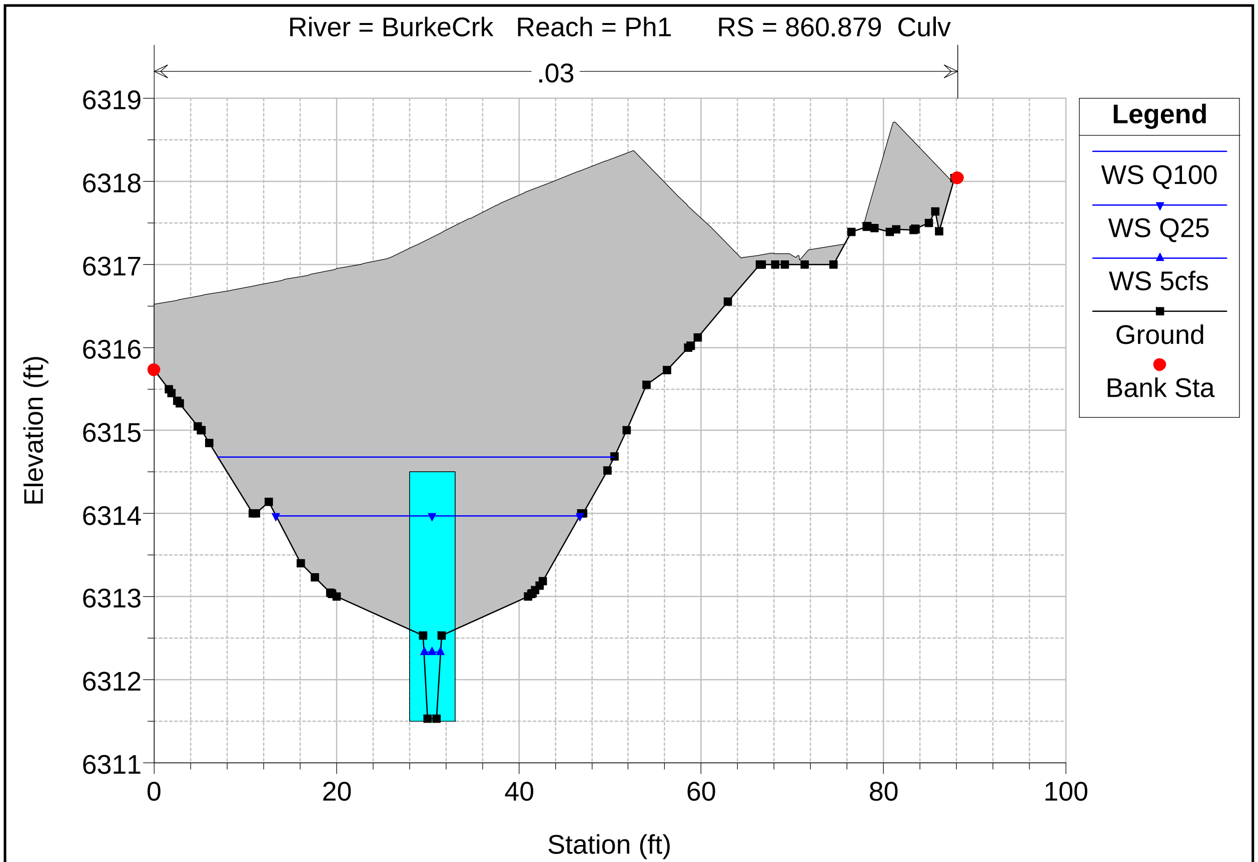

River = BurkeCrk   Reach = Ph1   RS = 963.7718
.05
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Ineff
Bank Sta
Elevation (ft)
6320
6319
6318
6317
6316
6315
6314
0
20
40
60
80
100
Station (ft)

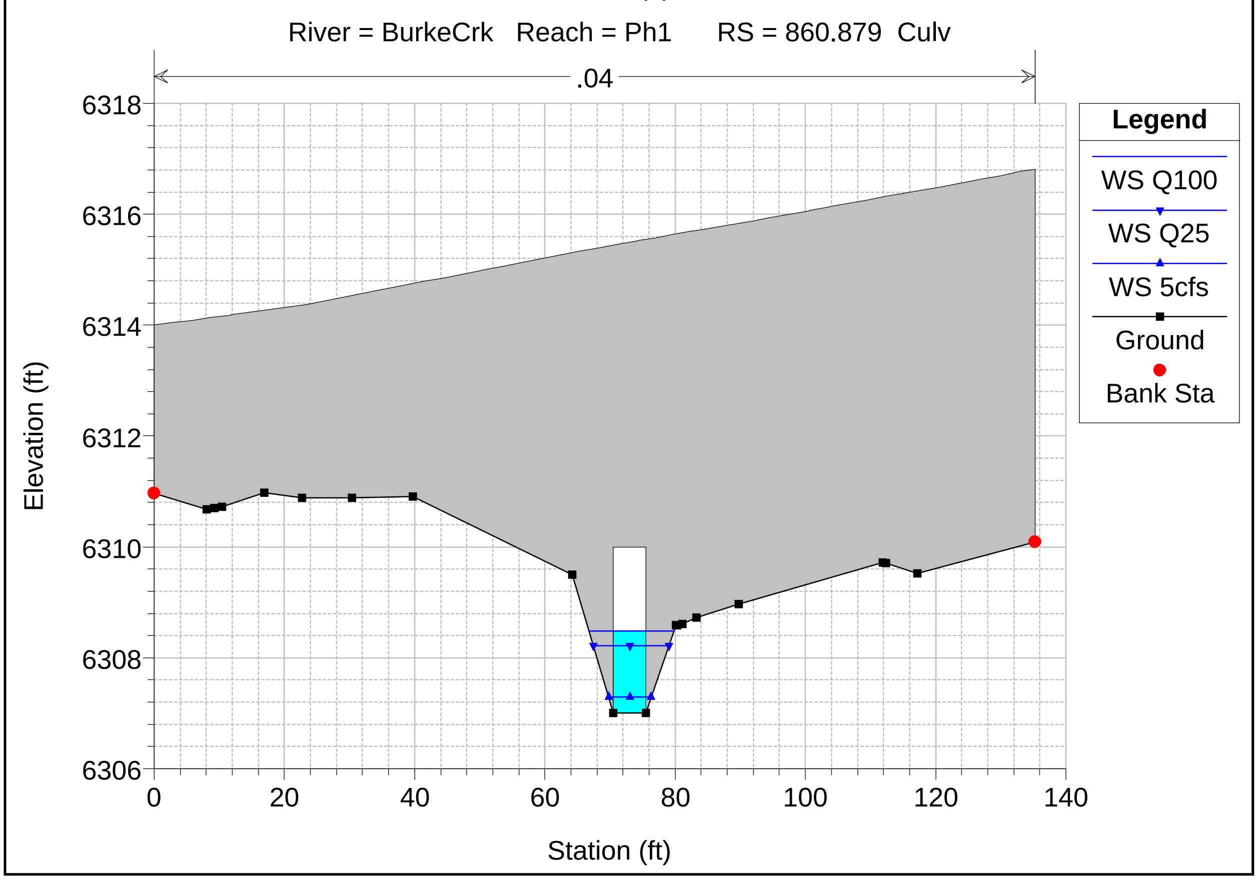

River = BurkeCrk Reach = Ph1 RS = 953.0905
.03
Elevation (ft)
6320
6319
6318
6317
6316
6315
6314
6313
0
20
40
60
80
100
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta


River = BurkeCrk Reach = Ph1 RS = 934.3893
.05
Elevation (ft)
6319
6318
6317
6316
6315
6314
6313
0
20
40
60
80
100
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta


River = BurkeCrk Reach = Ph1 RS = 927.8279
.05
Elevation (ft)
6319
6318
6317
6316
6315
6314
6313
6312
0
20
40
60
80
100
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta


River = BurkeCrk Reach = Ph1 RS = 910.6393
.03
Elevation (ft)
6319
6318
6317
6316
6315
6314
6313
6312
6311
0
20
40
60
80
100
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta


River = BurkeCrk Reach = Ph1 RS = 860.879 Culv
.03
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta


River = BurkeCrk Reach = Ph1 RS = 860.879 Culv
.04
Elevation (ft)
Station (ft)
Legend
WS Q100
WS Q25
WS 5cfs
Ground
Bank Sta

APPENDIX G: PLRM RESULTS MEMO

PLRM v2 Results w/OCRAM accounted for					
SubCatchment	% Connectivity	Baseline FSP	SWT FSP **(potential lbs/yr FSP reduction)**	SWT BMP Load Reduction	Notes
OF_Exdepress (5009a)	0	0	0	0	
Folsom Spring (5009c)	5	189	157	32	FSP reduction from Rd Shlrs installed in 2005
Overland Flow (5009f)	1	0	0	0	
OF_TrnchDrn (5009b)	1	154	150	4	FSP reduction from Rd Shlrs installed in 2005
OF_NewSWT	5	1274	1334	-60	FSP increase due to increasing the 5008a Road Directly Connected
E (Vanbuskirk)	0	0	777		
5008a	0	0	556		
KCCtr	5	273	273	0	
FSP Totals		**1890**	**1914**	**-24**	
Credit Totals		**9**	**10**	**0**	
			PLRMv2 credits for BRC->	**0**	

1 credit = 200 lb/yr FSP

	FSP (lb/yr)	Credits
NDOT lbs/yr FSP & Credits Potential->	864	4.3
DC lbs/yr FSP & Credits Potential->	1050	5.3

The Land swap reduced DC's pollutant level by 50 lbs/yr of FSP or 1/4 credit (200 lb/yr FSP is 1 credit), but the catchment increased in Directly Connected Impervious Surface so the FSP increased

Note: all drainage areas, except Vanbuskirk's (E), are smaller than the recommended PLRM size range

1. Folsom Spring (5009c)- NTCD can not disconnect this catchment due to utilities
2. OF_TrnchDrn (5009b)- NTCD has no plans to provide any stormwater treatment
3. OF_NewSWT (E- Vanbuskirk & 5008a)- 1334 lb/yr of which 556.4 are NDOT & 777.4 are DC, need to determine how to treat or disconnect
4. KCCtr - 273 lb/yr FSP for DC if they treat and/or disconnect this parcel