Basis of Design Report for the

Restoration of Hotelling Gulch

Cecilville, Siskiyou County, California

October 2018

Prepared for:

Salmon River Restoration Council

Klamath National Forest (Agreement No. 15-CS-11050500-025)

U. S. Fish and Wildlife Service (Agreement No. F17AC00686)

Prepared by:

Michael Love & Associates

Hydrologic Solutions

PO Box 4477 • Arcata, CA 95518 • (707) 822-2411

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Prepared by:

Rachel Shea, P.E.
Engineering Geomorphologist
License No. C72614
Michael Love & Associates, Inc.
shea@h2odesigns.com • (707) 822-2411 x3

Michael Love P.E.
Principal Engineer
License No. C71681
Michael Love & Associates, Inc.
mlove@h2odesigns.com • (707) 822-2411 x1

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1 PURPOSE OF REPORT

The purpose of this Basis of Design Report (BODR) is to present the analyses and decisions supporting the design for reoccupying and restoring the Hotelling Gulch stream channel along its historical (western) alignment. It also provides design details for a bridge crossing on Cecilville Road where the channel will be realigned. Design plans for the project are included in Appendix A.

2 BACKGROUND

The Hotelling Gulch project area is located on the Klamath National Forest lands. The stream crosses under Cecilville Road (County Road 1CO2), which is maintained by Siskiyou County Department of Public Works. Cecilville Road is also designated as a Forest Highway (FR93).

Hotelling Gulch is a tributary to the South Fork (SF) Salmon River, located in the Klamath National Forest, Siskiyou County, California, as shown in Figure 1. The river supports numerous aquatic species, including coho salmon (*Oncorhynchus kisutch*), steelhead trout (*Oncorhynchus mykiss*).

The project area is located in the lower Hotelling Gulch watershed that experienced extensive hydraulic mining that ended before the mid-1900's. The existing channel alignment crosses under Cecilville Road via twin 36-inch corrugated metal pipe (CMP) culverts. The crossing is located at an abrupt break-in-slope in the overall channel profile causing sedimentation and channel aggradation that requires relatively frequent maintenance by the County. The County also dredges the channel occasionally to maintain flow conveyance. The sediment deposition has reduced channel and crossing capacity, causing flows to overtop the left channel bank and flow down the road/ditch and into an existing channel to the west, which is lower in elevation. Larger flows overtop the roadway and have caused substantial damage to the roadway in the recent past.

The existing twin 36" CMP culvert crossing of Cecilville Road at Hotelling Gulch was listed by Ross Taylor & Associates (RTA) as priority number four in the Siskiyou County Culvert Inventory and Fish Passage Evaluation (Ross Taylor & Associates, 2002). The undersized nature of the culverts creates a fish passage barrier for salmonids of all age classes due to excessive water velocities at high fish passage flows and insufficient water depths at low fish passage flows. The crossing blocks fish passage to approximately 1.4 miles of stream habitat, which contains perennial pools that hold cool water in the summer and has adjacent dense riparian canopy.

The RTA report recommended that the current road crossing be replaced with a bridge or large culvert that creates unimpeded fish passage and allows natural geomorphic processes to occur. The RTA report also indicates that the current stream alignment and the location of its confluence with the South Fork Salmon River may not be in its original location, but possibly moved towards the east, as suggested by existing topography and other field indicators.

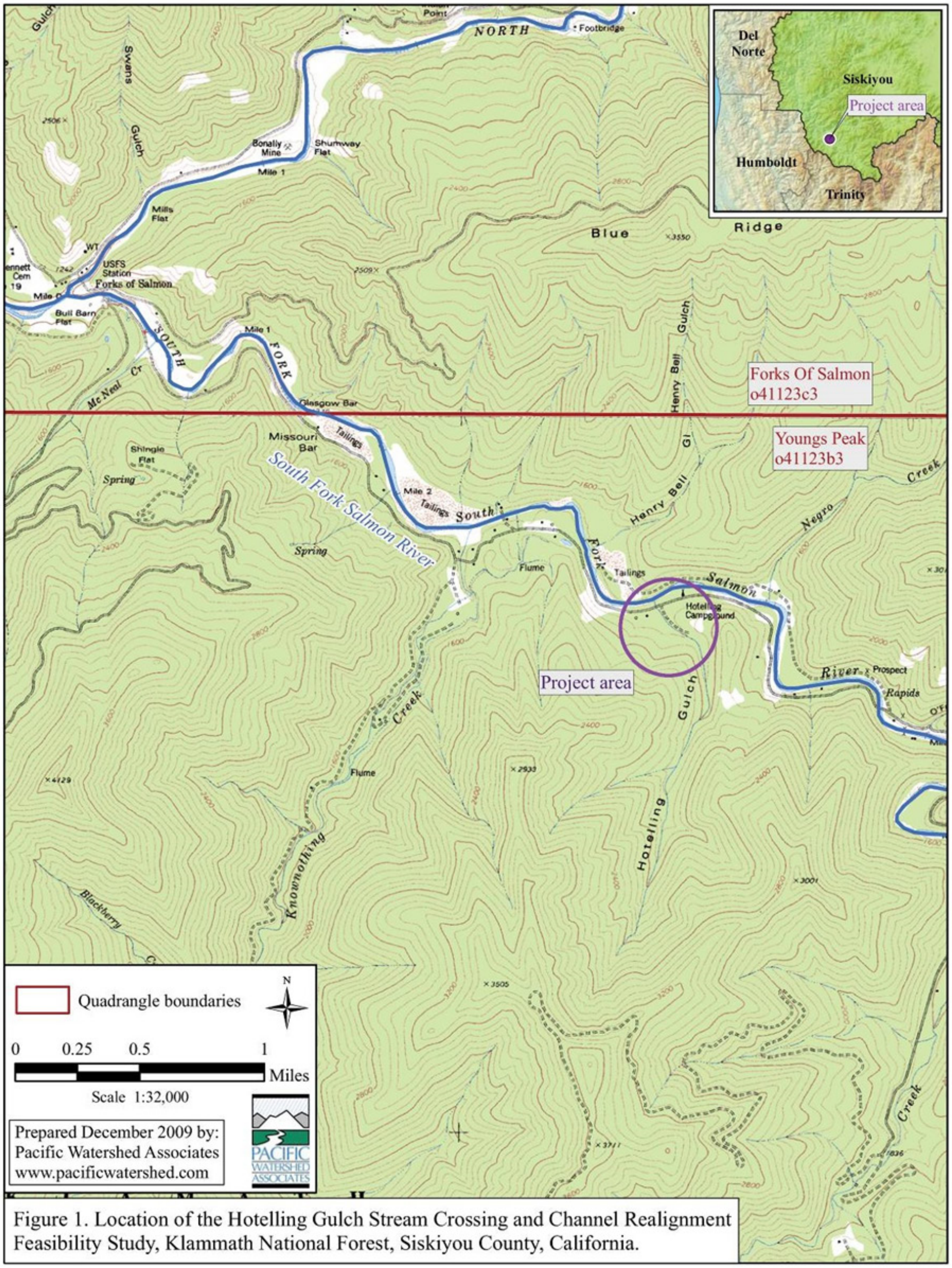


Figure 1. Location of the Hotelling Gulch Stream Crossing and Channel Realignment Feasibility Study, Klammath National Forest, Siskiyou County, California.

Figure 1. Plan view map of Hotelling Gulch at Cecilville Road in Siskiyou County, California (*From PWA, 2010).*

Subsequent to the RTA (2002) report, numerous studies were prepared for the Hoteling Gulch crossing of Cecilville Road by Pacific Watershed Associates (PWA) and Michael Love & Associates, Inc. (MLA) to identify the geologic, hydrologic, geomorphic, and fish passage conditions to support the selection of a replacement crossing location. These studies include the following:

- Hotelling Gulch Stream Crossing and Channel Realignment Feasibility Study (PWA, 2010).
- Technical Memorandum: Preliminary Hydraulic Analysis of Existing and Proposed Conditions along the Present Hotelling Gulch Channel Alignment (MLA, 2009) (Appendix to PWA, 2010).
- Technical Memorandum: Fish Access to Hotelling Gulch from the South Fork Salmon River (MLA, 2012).
- Preliminary Exploration of Alluvial Deposits in the West Channel of Hotelling Gulch, Memorandum by PWA, October 15, 2012.
- Basis of Preliminary Design Memorandum for the Restoration of Hoteling Gulch with a Road-Stream Crossing Replacement on Cecilville Road, Siskiyou County, California, (MLA, 2016).

These studies provided much of the information summarized in the Project Support Information section of this BODR. The results of the studies identified that the historical channel alignment of Hotelling Gulch was to the west of the existing alignment and drained into the river in a different location. Based on air photo interpretation, Hotelling Gulch avulsed to its current location between 1964 and 1971.

Fish access into the existing Hotelling Gulch channel is limited due to a narrow bedrock notch and shelf at the confluence with the river and the presence of a swift riffle in the river at the existing confluence location (MLA, 2012). The 2012 Fish Access TM identified that the Hotelling Gulch historical western alignment drained into a pool in the river that would have provided much improved fish access compared to existing conditions; particularly if deposited alluvium in the western channel near the confluence was physically removed or flushed by reestablishing flows. The PWA (2012) geologic investigation identified that the alluvial material creating the elevated mouth of the historical channel could be excavated to improve fish access.

Based on the findings of these studies, it was agreed by Siskiyou County and the USFS that Hotelling Gulch should be realigned into its historical western alignment and a new, properly-sized road-stream crossing be constructed at the realigned location.

The Salmon River Restoration Council (SRRC) has requested that Michael Love & Associates, Inc. (MLA) prepare conceptual through final designs for the project. Quincy Engineering, Inc. provided structural and roadway design services. PWA provided the geotechnical investigations for the project.

3 PROJECT DESCRIPTION

This BODR describes the basis for design-condition for the channel planform, profile and cross-sectional geometry to realign approximately 640 feet of Hotelling Gulch from its present alignment to its historical western alignment to reduce flooding, improve sediment transport, facilitate fish access into Hotelling Gulch from the river, and provide seasonal and potentially perennial fish habitat. Figure 2 shows a photograph of the historical stream valley into which Hotelling Gulch will be realigned.

The realigned channel will have similar channel slopes and cross-sectional hydraulic geometry as a reference reach located approximately 200 feet upstream of the project area. The realigned channel will have an overall slope of 6.8% with an undulating profile comprised riffles, cascades, steps and pools made of existing streambed material, with salvaged large cobbles, boulders, and large wood used to help force the streambed features, mimicking features documented in the reference reach. The channel cross section will have an active channel (bottom) width ranging from 8 to 11 feet, bankfull width ranging from 11 to 13 feet, and a floodplain width up to 20 feet. The existing channel reach that will be abandoned as part of the project will be "plugged" using excess material excavated for the channel realignment. The plugging is intended to prevent re-occupation of the existing channel alignment by the stream.

Two off-channel alcoves will be constructed to provide high-flow velocity refugia for fish and other aquatic species. The alcoves will be located on the east bank of the channel, upstream and downstream of the bridge crossing. Each alcove will be about 40-feet long with a 4-foot bottom width. Large wood will be placed in the alcoves for habitat.

The channel realignment will necessitate replacing the existing 36-inch CMP road-stream crossing to accommodate the realigned channel. The replacement road-stream crossing will be a cast-in-place concrete slab bridge with a spread footing system on shallow bedrock. The new bridge will have a minimum span of 23 feet width, and will provide freeboard for the 100-year flow event. To accommodate the 100-year flow, and to pass the expected high sediment load and large wood, the roadway will be raised about 3.5 feet to accommodate a higher elevation soffit on the new crossing.

Total excavation for the project will be approximately 3,000 cubic yards. A portion of this material will be used as backfill to plug the exiting channel and to raise the roadway profile. Excess excavated materials will be spoiled on site in stockpile area to north of Cecilville Road. Boulders and cobbles used to construct the channel will be salvaged from the project excavation.

For construction, it will be necessary to clear about 20 trees with diameters greater than 1-foot, including mostly pines, some alders and small madrones. Several of the existing large trees on site are dead. The cleared trees will be salvaged and incorporated into the channel as large wood habitat features.

The channel banks will be planted with live stakes. It will be necessary to import trees and shrubs for riparian planting due to their scarcity within the project area.

Figure 2. Historical stream valley of Hotelling Gulch into which the channel will be realigned.

4 DESIGN APPROACH

The design for the Hotelling Gulch channel realignment and new road-stream crossing was based on reference reach based channel restoration and stream-simulation design methodologies (CDFG, 2009; USFS, 2008). Reference reach based channel design is conducted using a combination of hydrologic, hydraulic, and geomorphic analyses of an adjacent, properly functioning, geomorphically stable channel reach. The reference reach information is then used to design the channel in the project area with similar characteristics so it has similar geomorphic stability and performance as the reference reach.

In stream simulation design of road-stream crossings, the reference reach based design method is applied such that the restored channel through the crossing has similar geomorphic form and function as the reference reach; thus providing no more of a barrier to movement of aquatic organisms than the adjacent natural channel. A stream-simulation crossing is also designed to fully-span the bankfull width of the channel and to convey the 100-year flow without submerging the soffit of the crossing.

5 PROJECT SUPPORT INFORMATION

5.1 Topographic Survey

LiDAR-based topography obtained from SRRC was used for the base-mapping and preparation of the designs. A topographic survey of the project area was conducted by PWA in 2009. The horizontal control for the LiDAR survey is NAD83 California State Plane, Zone

1, in feet and vertical control is NAVD88 in feet. GMA Hydrology established survey control in the project area corresponding to the LiDAR datums.

To supplement the LiDAR surveys and previous survey work completed by PWA, MLA surveyed trees larger than 6-inches in diameter along the western alignment of Hotelling Gulch in May 2016. MLA also surveyed previously established benchmarks to shift the assumed datums used in previous survey efforts to the LiDAR datums so that information from previously surveyed areas could be used during design development.

5.2 Peak Flows

Hoteling Gulch has a drainage area of 1.2 square miles, and is not gaged, necessitating prediction of flows using indirect methods. Peak flows and associated return periods were estimated using three different methods. The first used USGS annual peak flow data for the South Fork Salmon River near Forks of Salmon (Station No. 11522300, drainage area 252 square miles). South Fork Salmon River gage was located downstream of the confluence with Methodist Creek, approximately two river miles upstream of the Hotelling Gulch confluence. It had a 25-year record, from 1953 and 1977. This peak flow record was scaled by drainage area and then evaluated using statistical methods presented in Bulletin 17B (USGS, 1982).

The second method used Regional Regression Equations developed by the USGS (USGS, 2012), which ae based on drainage area and mean annual precipitation (MAP). The computations were prepared using the USGS StreamStats Version 3.0, which indicated a MAP of 46.3 inches.

The third method of peak estimation was performed using the Siskiyou County drainage Manual (Siskiyou County Department of Public Works, 1974), which is based on regional frequency analyses of USGS stream gages. For the methods in the Siskiyou County Drainage manual, flows were computed using graphs from the Zone 1B Hydrologic Region and Flows, a drainage area of 1.2 square miles, and a mean annual rainfall depth of 50 inches for the watershed (PRISM, 2010).

Peak flows in Hotelling Gulch are presented in Table 1. Flows estimated using the Siskiyou County Drainage Manual and the nearby USGS stream gage were nearly identical for smaller flow events, but diverge at the 10-year flows above. Flows computed using the USGS regional regression equations were substantially higher than the other two methods, likely due to the larger geographic area from which the equations were derived.

For this study, peak flows estimated using the USGS (1982) method were used for flow events having less than a 5-year return period, and the flows predicted using the Siskiyou County Drainage Manual were used for flows with a 10-year and greater return period.

Hydrologic computations are shown in Appendix B.

Because the crossing replacement was designed using the Stream Simulation Methodology (CDFG, 2009), fish passage flows were not computed.

Table 1. Summary of peak flows in Hotelling Gulch using three methods of flow estimation. Bolded values in the table were those used in this study.

Method	Return Period of Peak Flow (Year)						
	1.2	2	2.33	5	10	50	100
Siskiyou County Drainage Manual (1974)	-	-	38 cfs	66 cfs	**104 cfs**	**230 cfs**	**281 cfs**
USGS Regression Equations (2012)	-	93	-	184	251	339	479
Scaled Peak Flows using USGS (1982)	**13 cfs**	**34 cfs**	**40 cfs**	**67 cfs**	89 cfs	138 cfs	157 cfs

5.3 Geologic and Geotechnical Investigations

5.3.1 Regional Geology and Geomorphology

PWA performed a geologic investigation including a review of the regional geology, subsurface investigations at the project area, review of historical aerial photography, and field-level reconnaissance to map local geologic and geomorphic features of the lower Hotelling Gulch project area. The results of this investigation are included as a Technical Memorandum in Appendix C (PWA, 2016). This work supplemented previous investigations of the project area (PWA 2010, 2012). The 2016 PWA Technical Memorandum also provided recommendations regarding stable side slopes, suitability of materials for re-use, water management, sediment control, and site stabilization, as summarized below.

PWA (2016) indicates that Hotelling Gulch is located in an alluvial valley bounded by bedrock types that are particularly susceptible to erosion and mass wasting events during periods of heavy rainfall. The geomorphic feature map prepared by PWA indicates a debris landslide visible in a 1944 aerial photograph that is located on a hillslope directly adjacent to Hotelling Gulch approximately 800 feet upstream of the project area.

Aerial photographic and field evidence indicates that hillslopes adjacent to both sides of Hotelling Gulch were extensively hydraulically mined and evidence of mining deposits and mining activities are visible throughout the project area. Based on aerial photo evidence, PWA estimates that mining ceased prior to 1944. The hydraulic mining activities and hydraulic connection of the mining deposits to Hotelling Gulch has disturbed the natural hillslope processes and channel geomorphology within the lower reaches of Hotelling Gulch.

The lower Hotelling Gulch stream valley is dominated by channel and alluvial fan processes where the stream valley transitions from the steeper and confined reaches of the upper watershed to a lower gradient reach near the SF Salmon River. Test-pitting conducted in 2008 by PWA indicates that the alluvial fan on which both the existing and historical Hotelling Gulch channels are located was extensively reworked by historic mining activities.

The test-pitting indicated that depth to bedrock varies, from over 18 feet below ground surface upstream, to surface exposures along the river where both existing and historical

Hoteling Gulch channels confluence with the river. Boulder content and size typically increased with the depth of the test-pits. Groundwater appears to flow towards the western channel alignment. During the dry season, the current alignment of Hotelling Gulch dries out, but the abandoned western channel downstream of Cecilville road maintains perennial pools from groundwater inputs.

An aerial photographic analysis indicates that in 1964 (pre-flood), Hotelling Gulch was located to the west of its current alignment, and occupied the stream valley visible in the topography on the western side of the alluvial fan, including a reach of channel downstream of Cecilville Road. Between the time the 1964 (pre-flood) and 1971 aerial photos were taken, the channel avulsed into its present location. There was insufficient data to determine the date or cause of the channel avulsion, but it is reasonable to suspect that it occurred during the 1964 flood of record.

PWA recommended that the channel and crossing be designed to accommodate episodic large influxes of sediment and large woody debris, and that channel maintenance may be necessary after a large flow event. Material excavated for the realigned channel are expected to be suitable for backfill of the existing channel to create a "plug" that will block the existing channel and redirect flow into the realigned channel. Some excavated materials may also be suitable for structure backfill to raise the roadway, but would likely need to be screened. Maximum side-slopes for excavated areas should not exceed 2H:1V in alluvial materials.

5.3.2 Geotechnical Investigations

On October 4, 2016, PWA conducted 3 exploratory borings at the proposed crossing location. Geotechnical findings and recommendations are provided in Appendix E. In general, site soils consist of a relatively hard and competent sedimentary rock overlain by alluvial sands, silts, and gravels. At the bridge crossing location, the depth to competent bearing bedrock ranges from 11 to 12 feet below existing grade. Groundwater was encountered in boring holes approximately 7 to 8 feet below grade.

6 STREAM MORPHOLOGY CHARACTERIZATION

To understand the geomorphic processes of the current Hotelling Gulch channel and to establish design parameters for the channel realignment, MLA conducted a geomorphic assessment of Hotelling Gulch that extended approximately 500 feet upstream of the channel avulsion location.

The geomorphic assessment included a survey using a tape and laser level to map the thalweg bankfull, floodprone and storm rack line elevations where visible. Measurements of active channel, bankfull and floodprone widths, and individual boulders forming bed forcing features were also conducted along with pebble counts. Field-level geomorphic sketches of surveyed channel reach and sketches detailing the arrangement of individual boulder and cobble step and riffle features were made. Pebble count and thalweg data collected by PWA in 2008 were also used as part of the geomorphic assessment. A summary of the geomorphic data collected is presented in Appendix D.

6.1 Overview of Chanel Geomorphology

A geomorphic sketch-map of the project area and upstream channel is presented in Figure 3. Included on the map are features noted by PWA (2010, 2016), including mined areas, mining deposits, and exposed bedrock. A channel profile of the project area is shown in Figure 4.

As evident in Figure 3, lower Hotelling Gulch is surrounded by hillslopes that have been hydraulically mined. The channel banks of the existing channel consist of non-cohesive, loose rounded alluvial materials ranging from sands to boulders that were likely delivered directly or indirectly by the mining processes on the adjacent hillslopes. The presence of pipes and other mining debris was evident in the channel bed and overbanks in several locations. A steep and narrow dirt access ramp from the USFS road to the stream is present near station 6+50, and a small knickpoint is present in the area where there is evidence of a manmade low-water access area.

Upstream of the avulsion location and station 6+50 the stream is surrounded by a riparian forest of moderate age consisting of alder, pines, fir, madrone, and dense native underbrush. Tree roots provide bank stability in stream reaches with lower overbank benches. Higher streambanks typically were un-reinforced by tree roots and appeared to provide a source of material to the stream channel via slow to moderate bank erosion. There is little large wood in the channel, with only occasional small pieces incorporated into steps.

Moving downstream, the channel becomes more incised and entrenched approaching the point of avulsion. The channel banks in the entrenched reach are relatively unstable and support young alders and dense brush.

6.2 Upstream of Channel Avulsion

Hotelling Gulch upstream of the channel avulsion is an approximate 10-foot wide channel with a profile slope between 6 and 7%, as shown in Figure 4. The step near station 8+05 appears to be a knickpoint, creating an approximate 2.5-foot offset between the upstream and downstream channel profile. A lobe of mining deposits along the west side of the channel confines the stream valley near this location, visible in Figure 3. This confinement appears to have played a role in delivering the large boulders that form the stable step that has arrested the knickpoint.

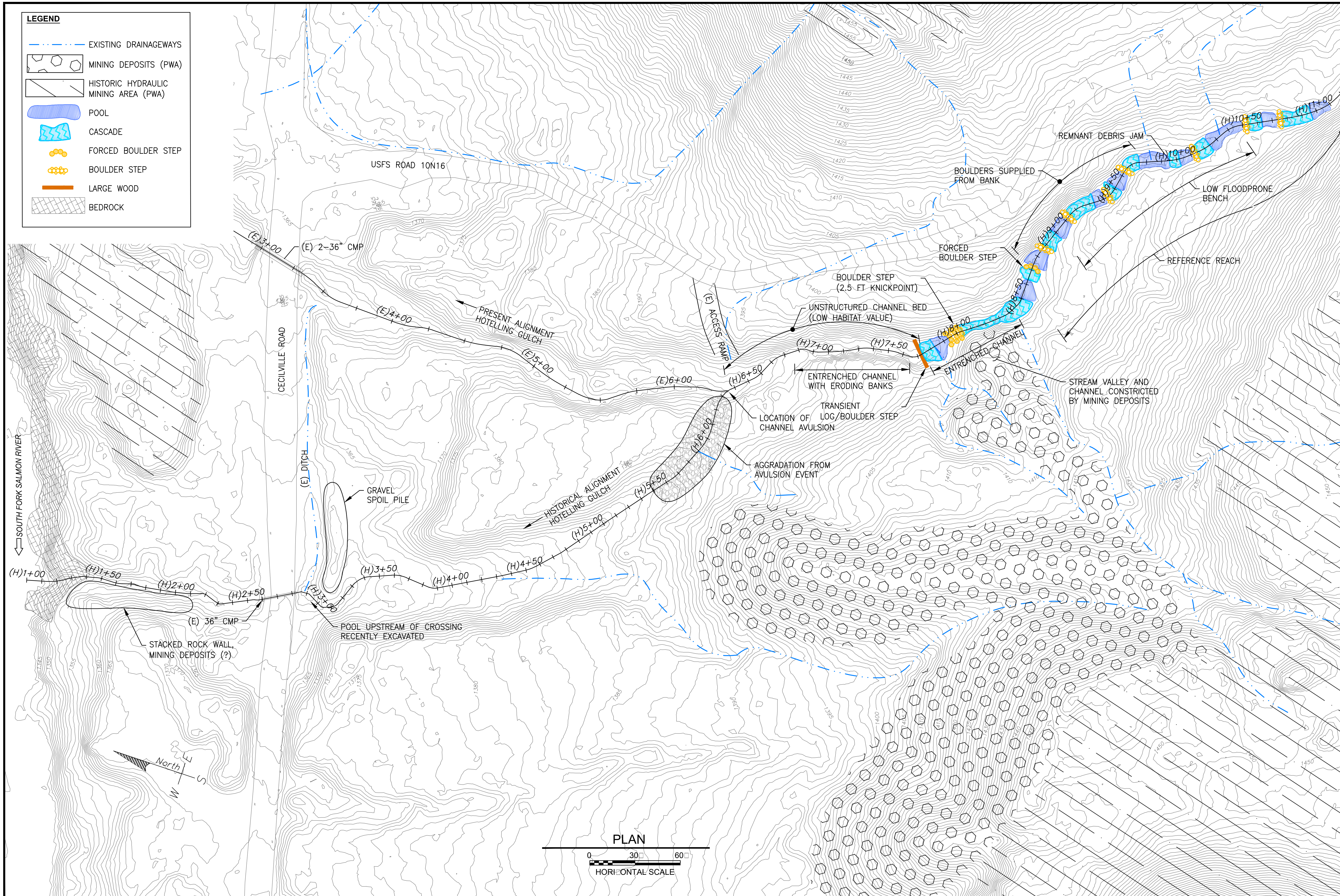
Between the knickpoint and the downstream point of channel avulsion, the channel is entrenched, the banks are nearly vertical, partially bare and eroding and undercutting, and there is little organization of the channel bed. The channel morphology appears to be "younger" than upstream of the knickpoint, providing relatively poor fish habitat.

Upstream of the knickpoint is the project reference reach. This channel reach consists of two distinct subunits: (1) a series of mobile-bedded cascades and small pools and (2) more stable forced boulder step and pools, as shown in Figure 3, Figure 5, and Figure 6. The cascades and pools consist of semi-organized, rhythmic rock bands or steps comprised of large cobbles and small boulders that partially to fully span the channel. These steps are interspersed with pools and appear to be relatively mobile. Drop residual over these steps is up 1.25 feet. The rock step features in the cascades have been identified by Church and Jones (1982), as described in Montgomery and Buffington (1997), as being formed by larger bed material in "congested zones," increasing localized flow resistance and causing further accumulation of large particles, with the structure breaking apart relatively frequently, even on an annual basis. These features have also been called "Stone Cells" by Church, et al. (2000), and form in plane-bed cobble channels. The rhythmic nature of these rock bands and pools is described by several authors, including Chin (1999) and Chartrand and Whiting (2000) as being formed similarly to anti-dunes.

The more stable and larger steps found between the cascade reaches appear to be forced by the presence of two or more large colluvial boulders delivered from the channel banks in tandem with trees, bends in the channel, and confinement by the streambanks. Combined, they induce a stable jam of larger mobile bed material. These forced steps produce a drop of approximately 2 feet and create localized discontinuities in the channel profile. Despite the frequent presence of large colluvial boulders in some reaches of the channel, forced boulder steps were relatively uncommon within the surveyed stream reach, and only two were identified, located near stations 8+95 and Station 8+05.

As shown in Figure 4, the channel reaches upstream of the knickpoint, including the cascade-pool reaches and the forced boulder step and pool near station 8+95, have an overall slope of 6.75%. The slope of the cascade-pool reach upstream of station 8+95 has a slope of 6.23%. Between the knickpoint and Cecilville Road, the channel has an overall slope of 6.3%.

MLA conducted one pebble count approximately 200 feet upstream of the point of avulsion (Appendix D). This reach was located in a cascade system. The size of material comprising the channel bed consisted of sands through boulders, with an intermediate particle size (D_{50}) of approximately 80 mm and maximum particle sizes comprised of boulders up to 450 mm (1.5 feet in diameter). Based on visual observations, the size of channel materials increased in the upstream direction, and boulders over 3 feet in diameter were not uncommon.



Michael Love & Associates, Inc.
PO Box 4477 Arcata, CA 95518 (707) 822-2411

Salmon River Restoration Council
PO BOX 1089 • 25631 Sawyers Bar RD, Sawyers Bar CA 96027
530-462-4665 Fax 530-462-4664

VERIFY SCALE
THIS BAR IS ONE INCH LONG AT FULL SCALE

Salmon River Restoration Council and Klamath National Forest
HOTELLING GULCH FISH ACCESS AND CHANNEL RESTORATION PROJECT

GEOMORPHIC MAP

DATE: JUNE. 2016
SUBMITTAL: 30% DESIGN
DESIGN: RS / ML
DRAWN: AL/NN

FIGURE
3

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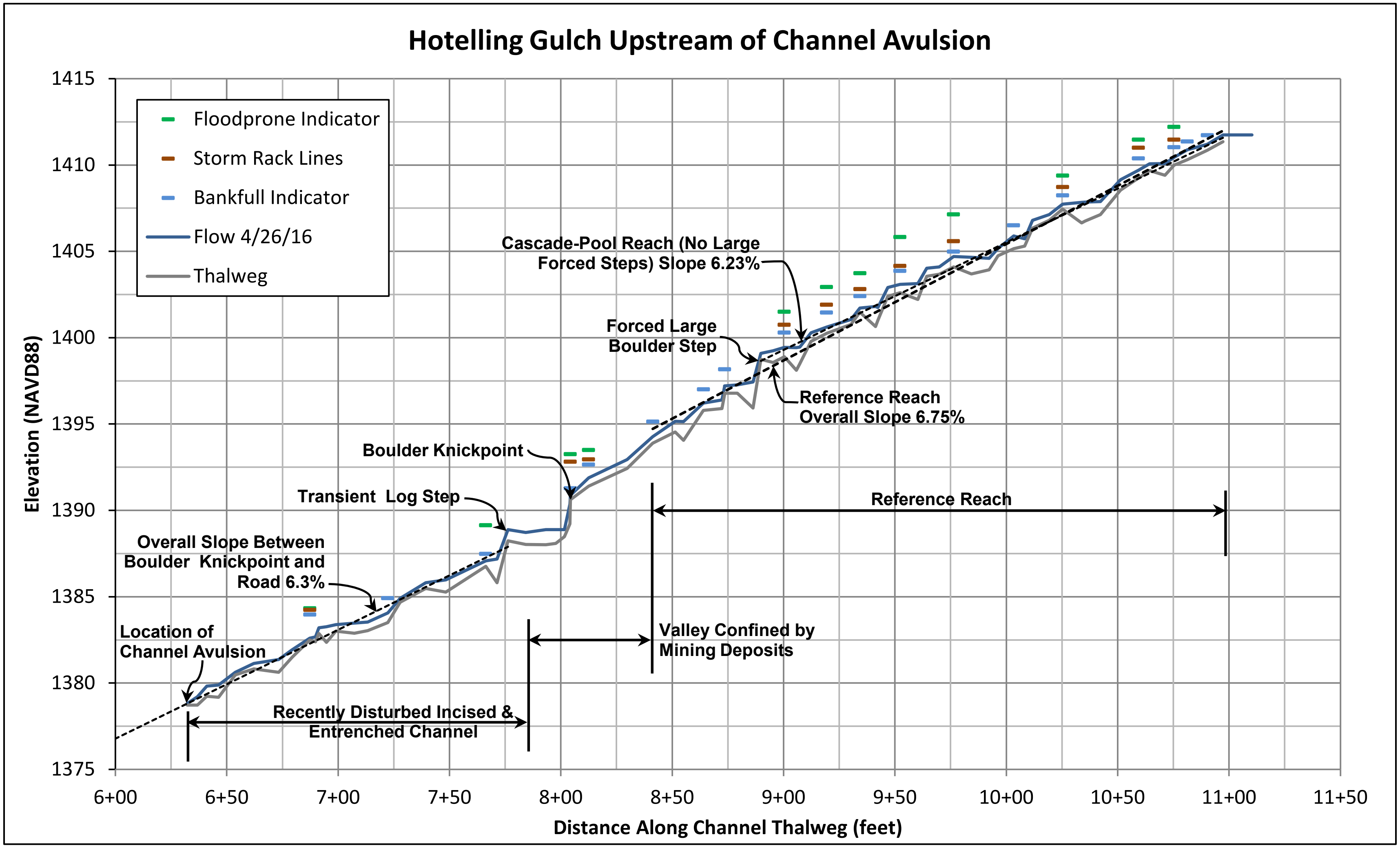


Figure 4. Channel profile of Hotelling Gulch upstream of channel avulsion.

Figure 5. Typical cascade-pool channel reach in Hotelling Gulch.

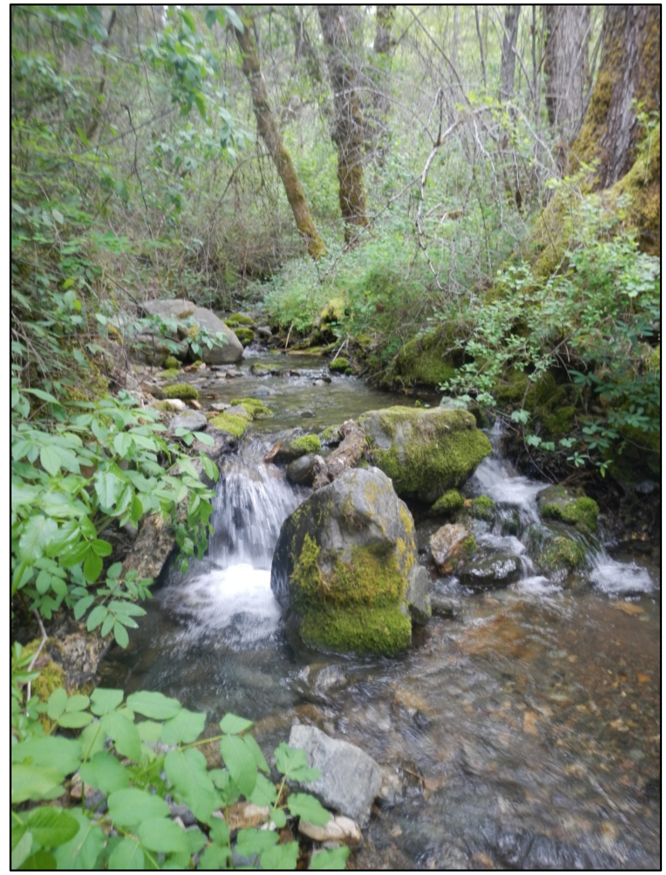


Figure 6. Forced boulder step with some wood creating an approximate 2-foot drop in the channel profile in Hotelling Gulch.

6.3 Existing Channel Downstream of Channel Avulsion

A profile of the present (eastern) alignment of Hotelling Gulch, including approximately 500 feet of channel upstream of the avulsion location, is presented in Figure 9. The current Hotelling Gulch downstream of the avulsion location is entrenched with little organization of the channel bed, and has fewer and smaller boulders than upstream of the knickpoint, as shown in Figure 7. There is little in the way of riparian cover in this reach and vegetation and downed wood plays little to no role in the geomorphology of the reach.

The slope of the channel between the boulder knickpoint and Cecilville Road is 6.3% (Figure 9), similar to the cascade-pool reach upstream of the knickpoint (Figure 4). The channel profile downstream of Cecilville Road changes dramatically, creating a low-sloped channel as it flows over an alluvial and bedrock-controlled river terrace before dropping steeply into the river through a notch in the bedrock. The bedrock notch appears to be manmade, possibly associated with mining activities, such as sluicing.

Cecilville Road is located where the channel slope decreases abruptly. The abrupt decrease in slope and undersized nature of the culverts cause sediment aggradation at the crossing inlet, causing overbank flooding and roadway overtopping and roadway damage if not cleared of sediment regularly.

PWA performed two pebble counts in the existing channel of Hotelling Gulch upstream of Cecilville Road (PWA, 2010). The size of material comprising the channel bed consisted of sands through boulders, with an intermediate particle size (D_{50}) of approximately 20 mm and maximum particle sizes comprised of boulders up to 355 mm (1.2 feet in diameter, as shown in Appendix D.

The historical alignment of Hotelling Gulch is located further to the west of the channel current alignment. There is little evidence of the historic channel thalweg upstream of Cecilville Road except the broader stream valley through which it flowed, as shown in Figure 8. Downstream of Cecilville Road, a perennial groundwater-fed channel persists in the presumed location of the historical alignment.

According to the PWA reports (PWA, 2010, 2016) sometime between when the 1964 (pre-flood) and 1971 aerial photographs were taken, Hotelling Gulch avulsed from its historical alignment on the western side of the stream valley to its current alignment on the eastern side. A large mound of aggraded sediment is present in historical channel alignment just downstream of the avulsion location, visible in Figure 3 and Figure 10. It is presumed this aggradation lead to the avulsion, but it is unknown what caused it. Potential causes include sudden delivery of landslide material to the channel, a debris flow, and/or wood jams.

Figure 7. Photograph of the existing alignment of Hotelling Gulch (looking upstream).

Figure 8. Remnants of stream valley along the historical alignment of Hotelling Gulch, looking downstream to Cecilville Road.

In Figure 10, the 6.75% overall channel slope upstream of the boulder knickpoint is shown projected downstream to the confluence with the river. Where the projected profile intersects the river is coincident with the surveyed elevation of the bedrock spanning the channel bottom near the river confluence. Also shown on Figure 10 are elevations from PWA's test-pits where the size and frequency of larger boulders increased in the test pits. These boulders appear to be similar in size to the upstream channel reach. The coincidence of the projected stream profile from upstream to the surveyed bedrock/alluvium contact point at the confluence, with the presence of larger boulders, suggests that the projected profile line is close to the historical thalweg of the stream channel prior to the avulsion.

Similar to the existing alignment of Hotelling Gulch, the channel slope decreases abruptly at Cecilville Road. Near the river confluence, the channel cascades downward through a notch in the bedrock. It is unknown whether the notch was manmade. Investigations both MLA and PWA have identified that the channel bottom is alluvial, and the bottom of the notch beneath the alluvium is much lower than the existing channel thalweg, as shown on Figure 10. MLA surmises that Hotelling Gulch aggraded with sediment during one or several events when high sediment loads were being delivered by Hotelling Gulch concurrently with elevated flow in the river. The narrowness of the notch likely aggravated the situation.

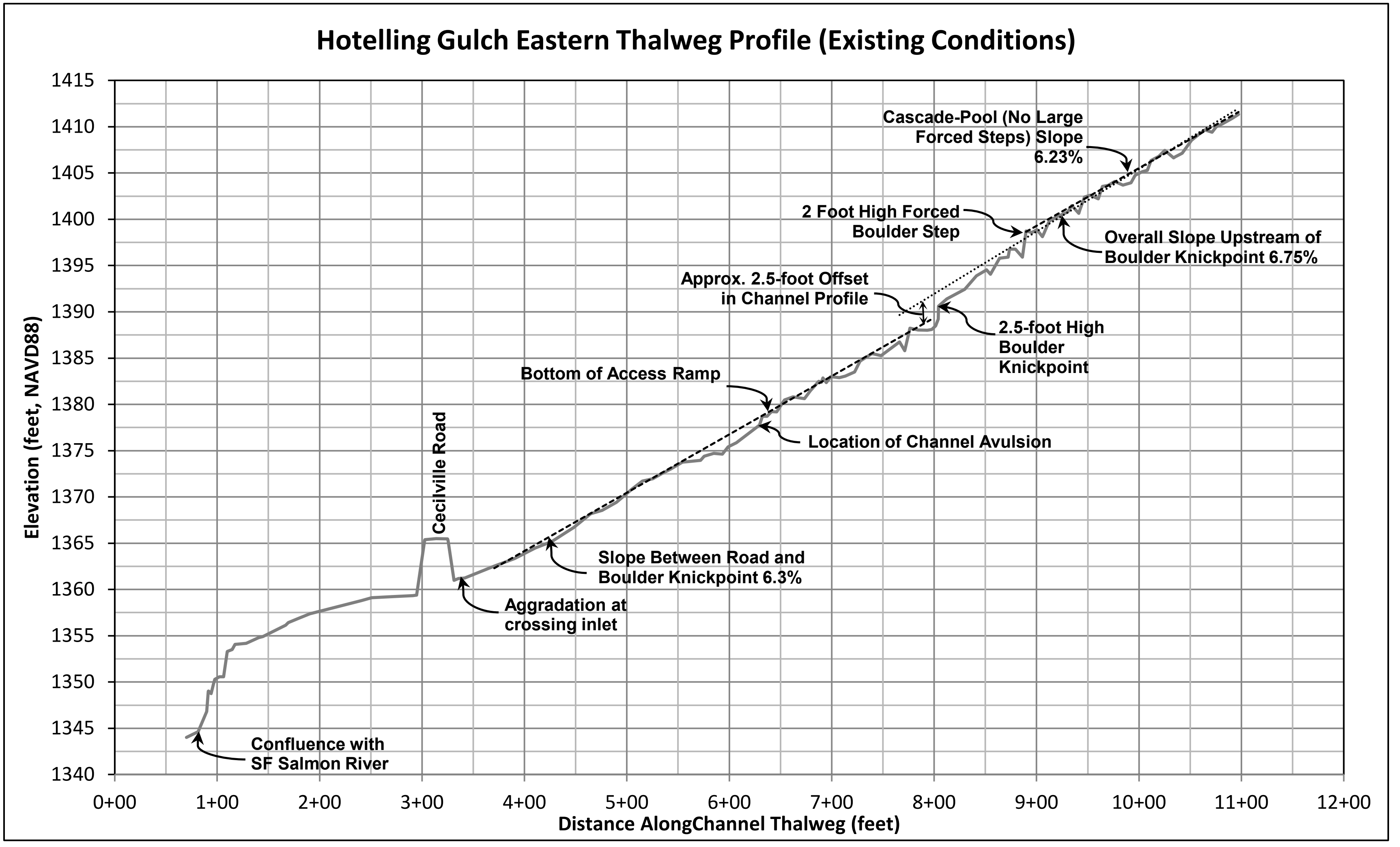


Figure 9. Thalweg profile of Hotelling Gulch along its current alignment, from the river to approximately 500 feet upstream of the avulsion location.

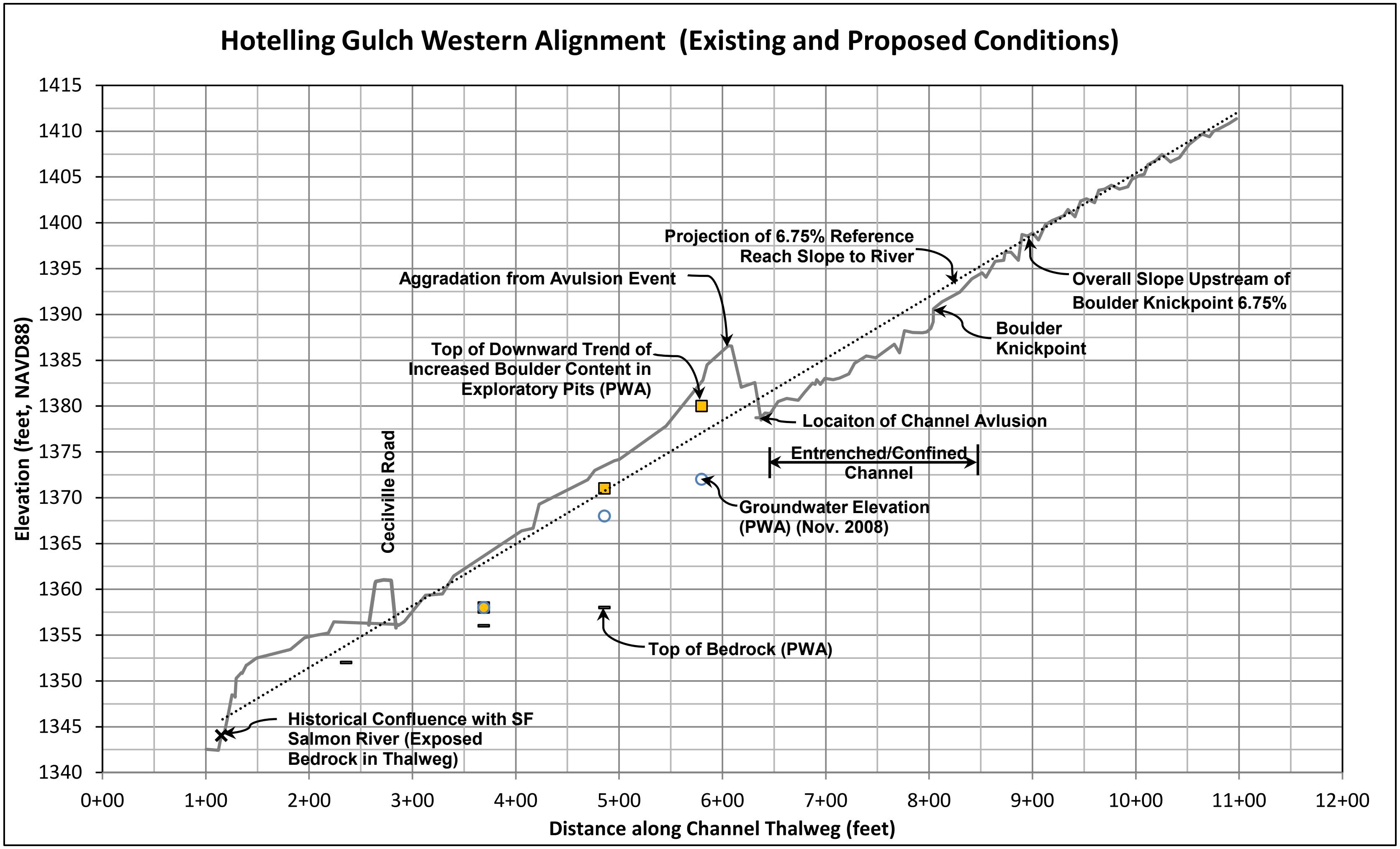


Figure 10. Thalweg profile along the historical (western) alignment of Hotelling Gulch, from the river to approximately 500 feet of the avulsion location.

6.4 Reference Reach Characteristics

The geomorphic evaluation characterized existing channel bed upstream of the knickpoint, located near station 8+00, appears to be more stable and less confined and entrenched than downstream of the knickpoint. This reach of channel has a low floodprone bench on one side along much its length, and has well developed cascade- pool and step-pool profile diversity. Therefore, an approximately 260-foot long reach of Hotelling Gulch upstream of the knickpoint was selected as the reference reach for design of the restored channel along the historic (western) alignment.

To establish design parameters for the channel realignment, a detailed evaluation of the channel cross section hydraulic geometry and profile characteristics was conducted for the reference reach. This information was used to develop typical ranges for the channel cross section and profile dimensions, which were then used to develop the channel realignment. The boulder structures forming stable bed features were photographed and sketched for use in developing construction details.

The channel cross section hydraulic geometry assessment included evaluation of active channel widths, and bankfull and floodprone widths and depths. The results of these analyses are summarized in Table 2. Figure 11 presents the relationships between active channel width and bankfull and floodprone widths. Generally, as active channel width increased, bankfull and floodprone widths tended to stay relatively constant. Detailed results are presented in Appendix D, including a cross section surveyed in the reference reach with normal-depth hydraulics computed using WinXSPro (USFS, 2005).

Figure 12 presents a detailed profile of the reference reach. The reference reach, including both the cascade-pool reaches and the forced boulder step-pool near station 8+95 has an overall slope of 6.75%. The localized slope of the cascade-pool reach, which has forced boulder step at station 8+95 as its base-level control, has a slope of 6.23%. The overall slopes of the surveyed bankfull, floodprone and storm rack lines along the cascade-pool reach have similar slopes as the thalweg slope in this reach, supporting the estimation of the localized slope.

For the profile analysis, each geomorphic feature surveyed along the channel profile was characterized as a cascade, pool, or step-pool. The length, slope, drop across the feature and residual pool depths were computed for each feature as appropriate. Pools were not present at all of the steps within the cascades. Where pools where not present, the feature was identified as a “Step (No Pool).” These values are shown in Table 3.

Figure 13 presents the relationships between cascade length and slope, cascade length and pool depth, and step height and pool depth in the Hotelling Gulch reference reach. As is evident in Figure 13, there are no strong relationships between cascade length and slope, cascade length and pool length or step height and pool depth. The 2-foot outlier for step height is the forced boulder step near station 8+75. Detailed results are presented in Appendix D.

Within the limits of the reference reach, there was only one forced large boulder step, suggesting that the larger steps would naturally be random and dependent on less mobile colluvially supplied boulders.

Table 2. Summary of reference reach channel hydraulic geometry.

Range	Active Channel Width (feet)	Bankfull Width (feet)	Floodprone Width (feet)	Bankfull Depth (feet)	Floodprone Depth (feet)
Minimum Value	7.6 feet	8.3 feet	12.0 feet	0.8 feet	1.9 feet
Maximum Value	12.8 feet	14.5 feet	18.4 feet	1.5 feet	3.2 feet
No. in Sample	14	14	14	14	8

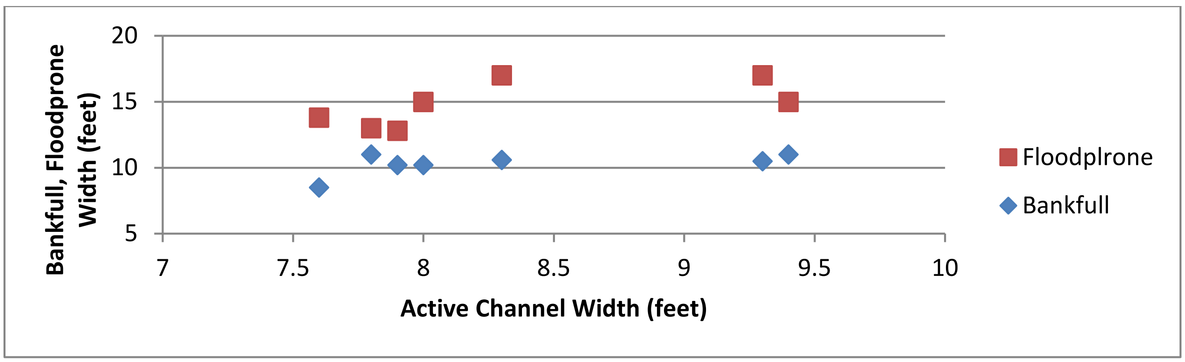


Figure 11. Relationships between active channel, bankfull and floodprone widths in the reference reach.

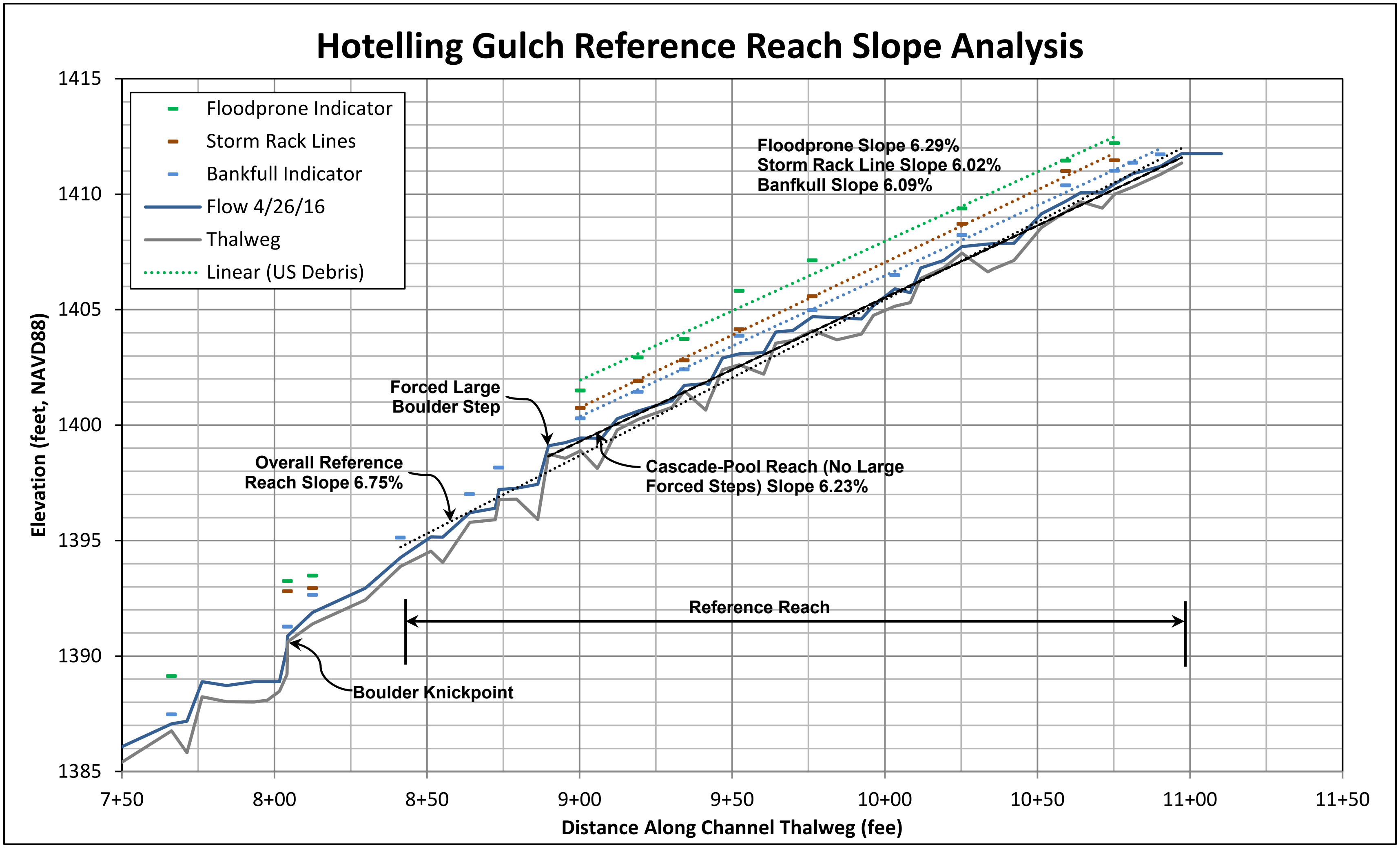
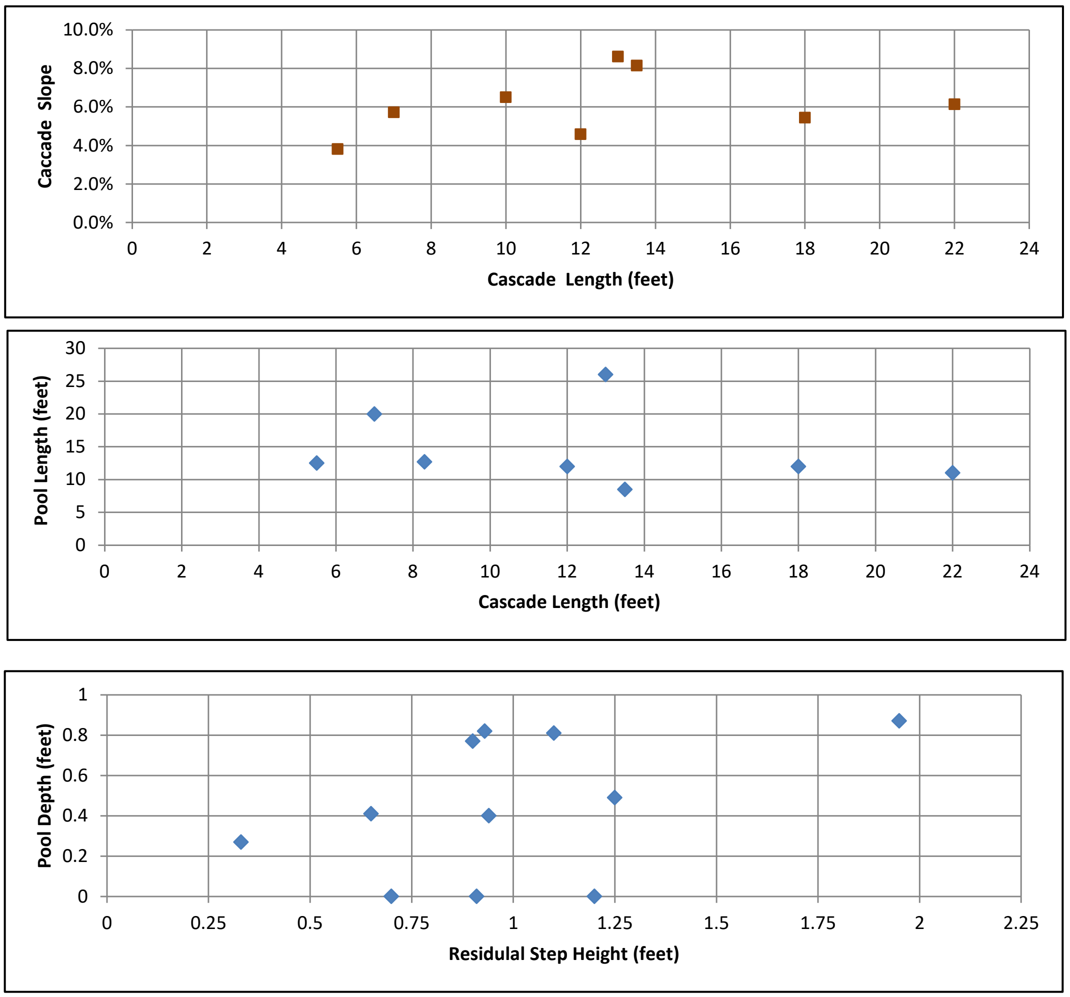


Figure 12. Profile of reference reach approximately 200 feet upstream of the proposed channel realignment in Hotelling Gulch.

Table 3. Summary of reference reach channel profile characteristics. Overall reference reach slope is 6.75% and the slopes of the cascade-pool reach is 6.23%.

Data Range	Cascade Slope	Cascade Length (feet)	Pool Length (feet)	Ste Drop (feet)	Pool Residual Depth (feet)
Minimum	3.82%	5.5	4.0	0.3	0.0
Maximum	8.62%	22.0	26.0	1.9	0.9
No. in Sample	8	9	11	11	11



a.

b.

c.

Figure 13. Relationships between (a) cascade length and slope, (b) cascade length and pool depth, and (c) step height and pool depth in the Hotelling Gulch reference reach.

7 DESIGN DEVELOPMENT

7.1 Design Objectives

The design intent for the project was to re-establish Hotelling Gulch stream channel in its historical alignment and create a geomorphically stable channel similar to the reference reach. Because the channel will be similar to the reference reach, it will provide no more of a barrier to movement of aquatic organisms than the reference reach. Other design objectives included:

- Maintaining stability of the channel reach upstream of the project area
- Minimizing tree removal, as feasible
- Using on-site materials for channel restoration and for plugging of the existing channel to minimize the potential for a future avulsion
- Minimizing the amount of excess excavated material requiring off-haul or permanent on-site spoiling
- Maintain the channel crossing in the same location as the existing culvert crossing along the western channel alignment
- Maintaining the alignment of stream channel downstream of Cecilville Road

Additional design objectives for the replacement road-stream crossing are presented in the sections of this report addressing the road-stream crossing design.

7.2 Channel Design

Design plans for the realigned channel are shown in Appendix A.

7.2.1 Planform

The design centerline of the channel will follow the existing channel alignment starting approximately 50 feet upstream of the location of the channel avulsion. Moving downstream, the alignment curves to the west through the aggraded near the avulsion and follows roughly the center of the historical stream valley. Efforts were made to create a channel alignment that has a similar planform sinuosity as the reference reach. However, the design channel sinuosity was limited the overall width of the historical stream valley and desire to preserve upslope trees. The realigned channel will cross Cecilville Road slightly to the east of the existing culvert crossing, and then continue along the existing channel to meet the river. To minimize tree disturbance in the existing riparian area downstream of Cecilville Road, the stream channel in this area was shifted slightly to the east so that the west streambank and trees on that bank will be preserved.

Near the confluence with the River, the alignment of Hotelling Gulch will bend to the west to exit through the existing notch in the bedrock. Some excavation into bedrock may be necessary to achieve the desired cross section and preserve trees on the western streambank.

7.2.2 Cross Sectional Shape

The cross-sectional shapes of the realigned stream channel were based on ranges of channel dimensions measured in the reference reach, except near the confluence with the river, where bedrock is present in the channel banks. The ranges of active channel, bankfull, and floodprone widths and depths upstream of the bedrock confluence section are presented in

Table 4. The reference reach showed some variability in the bankfull and floodprone depths. This variability was not specified explicitly in the design cross sections, but is expected to be realized during construction resulting from the varying sizes and shapes of the boulders used to construct the stream channel.

Table 4. Ranges in active channel, bankfull and floodprone widths and depths in the realigned channel of Hotelling Gulch. Values are based on the reference reach.

	Active Channel	Bankfull	Floodprone
Width	8-11 feet	11-13 feet	19-21 feet
Depth	0-0.5 feet	1-1.5 feet	2.5 feet

Typical Channel Section (Upstream of Bedrock Confluence Area)

A typical cross section of the realigned channel is shown in Figure 14. As indicated in the figure, the reference reach floodplain bench present between the bankfull and floodprone elevations typically occurred on one or the other side of the channel. The location, width, and slope of the floodplain varies with location. Final locations and dimensions are expected to be field-fit during construction to fit the landscape and constraints such as trees and large boulders.

The channel bank side slopes above the floodprone elevation will vary to meet existing grade. Downstream of Cecilville Road, the western side slopes of the new channel will vary, with a maximum slope of 2H:1V to protect the existing trees on the west bank. The eastern slopes of the channel downstream of Cecilville Road will be graded with side slopes of approximately 2H:1V to maintain a stable slope angle in the unconsolidated material forming the streambanks. It is likely that bedrock will be encountered along both banks of the channel downstream of the road, and grading will be adjusted in the field to accommodate the bedrock.

Upstream of Cecilville Road, the channel banks above the floodprone elevations will have a variable side slope, with a maximum of 2H:1V to maintain slope stability in the unconsolidated alluvium that will form the channel banks.

Channel Cross Section in Bedrock Confluence Area

Within the bedrock-bounded area at the confluence of Hotelling Gulch with the river, the channel cross section was simplified to include an 11-foot active channel width, gentle to and steep side slopes, as show in Figure 15. An 11-foot bottom width is recommended to maintain flow and sediment transport continuity through the confluence area and into the River. This is expected to reduce the amount of sedimentation that may occur at the confluence. The actual width of the channel bottom and side slopes is expected to vary in the field with the location and degree that the bedrock can be economically excavated.

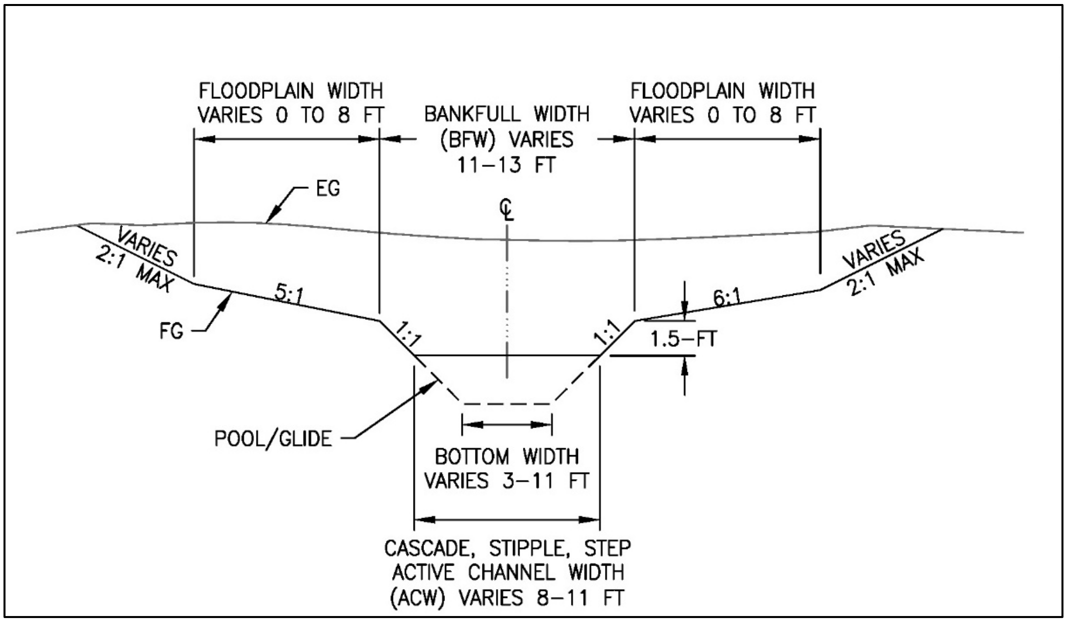


Figure 14. Typical design cross section for the realigned channel upstream of the bedrock confluence reach on Hotelling Gulch.

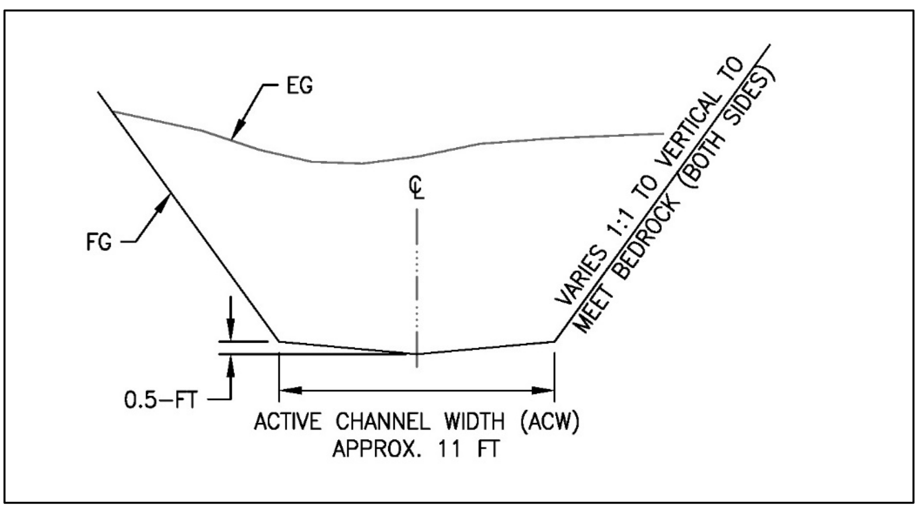


Figure 15. Typical design cross section for the realigned within the bedrock confluence area.

Plugging the Abandoned Eastern Channel Reach

Spoils from excavation of the realigned channel will be placed within the existing eastern channel alignment to create a "plug" to minimize the potential for channel avulsion back into the eastern channel. The top of the plug will be placed equal to the adjacent hillslopes and approximately 5 feet above the constructed channel bed. Even in the event of extreme channel aggradation, as defined by the High VAP Profile (See Road-Stream Crossing Section), the 100-year water surface elevation is predicted to be 3 feet below the top of the plug. To protect against scour and erosion, the face of the plug will be armored with salvaged boulders and cobbles, and planted with live willow cuttings.

The placed plug material will be graded to accommodate any drainageways that currently flow into the existing channel from the adjacent hillslopes. It will be necessary to remove the existing vegetation and other organic material in the channel where the material will be placed for the plug.

The channel plug will terminate approximately 50 feet upstream of the existing eastern culvert crossing on Cecilville Road. This crossing, consisting of 2-36-inch CMP culverts, will remain to convey localized drainage.

7.2.3 Channel Design Profile

Overall Profile Slope

As discussed in the Reference Reach Characteristics section of this TM, when the overall 6.75% slope of the reference reach is projected downstream to the confluence with the river, it nearly coincides with the surveyed interface between exposed bedrock and deposited alluvium. Therefore, it was used as a guide for the overall design slope of the realigned channel.

Figure 16 presents the proposed design profile for the realigned reach of the Hotelling Gulch Channel. For reference, it also includes the existing thalweg profile of Hotelling Gulch upstream of the realigned area, including the reference reach. An overall design slope of 6.8% was used for the realigned channel. This slope is only slightly steeper than the reference reach slope, and is expected to remain stable.

The limits of the realigned channel will extend a total of 540 feet, beginning approximately 50 feet upstream the location of the historical point of avulsion, and continue downstream through a bridged Cecilville Road road-stream crossing to confluence with the River. The downstream limits of the design channel will end at the surveyed elevation of the exposed bedrock at the confluence with the river.

Profile Variability

The profile of the reference reach is controlled by the cobble and boulder cascades and the more stable forced step made of larger boulders. To maintain the profile stability within the realigned channel, it will be constructed using repeating series of cascades and pools interspersed with larger boulder-forced step pools. The dimensions and slopes of the features along the design profile fall within the range of values measured in the reference reach and are summarized in Table 5. The repeating series of cascades and pools will form a cycle with an overall slope of 6.23%, the same slope as the cascade-pool reach in the reference reach. The cycles of cascade- pools series will be interspersed with forced boulder steps, creating localized 2-foot drops in the channel profile, resulting in an overall design channel slope of 6.8%.

Figure 16 shows the profile variability created by the cascades, step and pools in relation to the overall slope of the channel. It is expected that there will be three series of cascade-pool cycles, interspersed with two boulder-forced steps and pools. Profile variability is not shown near the confluence of Hotelling Gulch with the River because this portion of the channel bottom is expected to be bedrock. The channel profile in this area is intended to conform to the existing bedrock, with the potential of some limited bedrock removal of the channel widths are overly constricted.

Design of Profile Control Features

The plan, and profile and arrangements and sizes of the boulders forming cascades, steps and pools are based on boulder arrangements observed during the reference reach characterization.

Essential to the structural stability of the forced boulder steps in the reference reach were the presence of two to three 2.5 to 3.5-foot diameter boulders or tree roots that confined the stream channel. These boulders have been defined as "keystone boulders" that initiate stable rock jams across a portion or the entire stream channel (Zimmerman and Church, 2001; Moses and Lower, 2003). Channel-wide jams containing keystone boulder typically form step-pools similar to those in the reference reach of Hotelling Gulch.

The cascade units of the reference reach typically consisted of one to two smaller keystone boulders, typically 1.5 to 2.5 feet in diameter with smaller 10-18-inch diameter rocks forming rock bands between the keystone boulders. The rocks forming the rock bands were loosely consolidated and appeared to be frequently mobilized.

Table 5. Ranges in longitudinal dimensions of each feature in the proposed channel, based on the reference reach characterizations. Series of cascades and pools will create localized slopes of 6.23%. Occasional forced bolder steps and pools will create an overall design slope of 6.8%.

Feature	Length	Slope	Residual Step Height	Residual Pool Depth
Cascades	6-15 feet	5.0-6.5%	0.8-1.1 feet	-
Pools	14-16 feet	-	-	~0.5 feet
Forced Boulder Steps	-	-	~2.0 feet	-
Forced Pools	~11 feet	-	-	~1.0

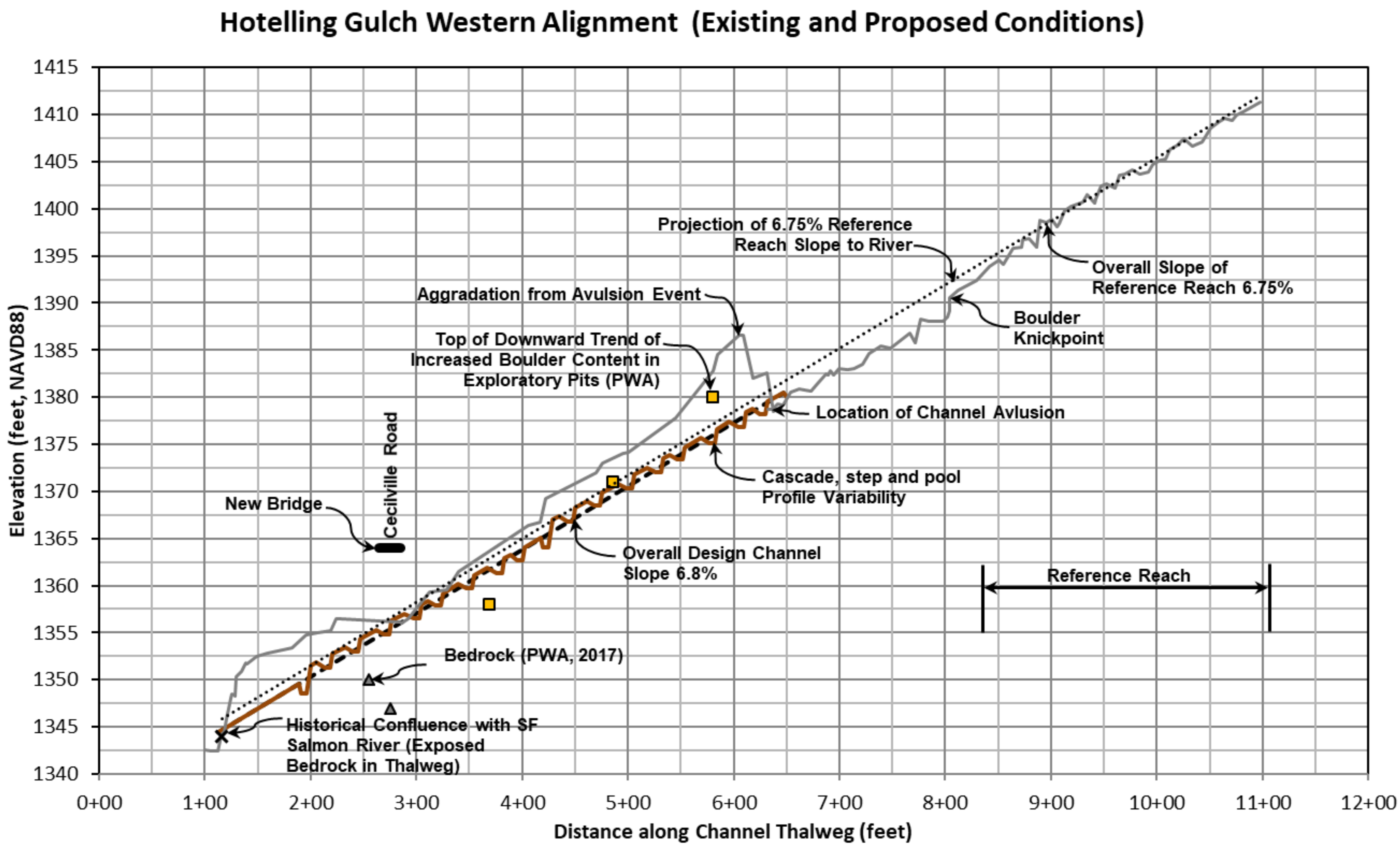


Figure 16. Design thalweg profile for the realigned reach of Hotelling Gulch.

Figure 17 depicts a typical plan layout for a portion of the Hotelling Gulch channel showing the planform and profile of the cascades, steps and pools to be constructed in the restored channel. They mimic the observed features in the reference reach.

It is expected that the boulder profile control features can be constructed of the larger boulders identified in the PWA test-pits near the elevation of the realigned channel thalweg. No importation of boulders is expected to be necessary for the project. Salvaged large wood and woody material from the project area will also be incorporated into the structure and pools, as available, in lieu of keystone rocks or to create channel complexity within the pools.

7.3 Alcove

Two off-channel alcoves are proposed on the east side of the channel upstream and downstream of the road. The alcove will be located in a lower overbank area and will provide an off-channel velocity refugia for fish during higher flows. The alcove bottom elevation will be the same elevation as the adjacent channel thalweg. Wood structures made of salvaged trees will be incorporated into the alcove as cover structures.

7.4 Revegetation

The realigned channel is expected to maintain flows for substantially longer than the existing channel, and is expected to support a riparian area similar to what is present along the channel downstream of Cecilville Road. Streambank stabilization can be accomplished using willow clumps and staking with live willows salvaged from the existing channel alignment both upstream and downstream of Cecilville Road. Some riparian plants can be salvaged from the project area, but plants will need to be imported to more rapidly establish a riparian area. Irrigation may be required to sustain planted riparian vegetation that is not rooted to the summer groundwater elevation.

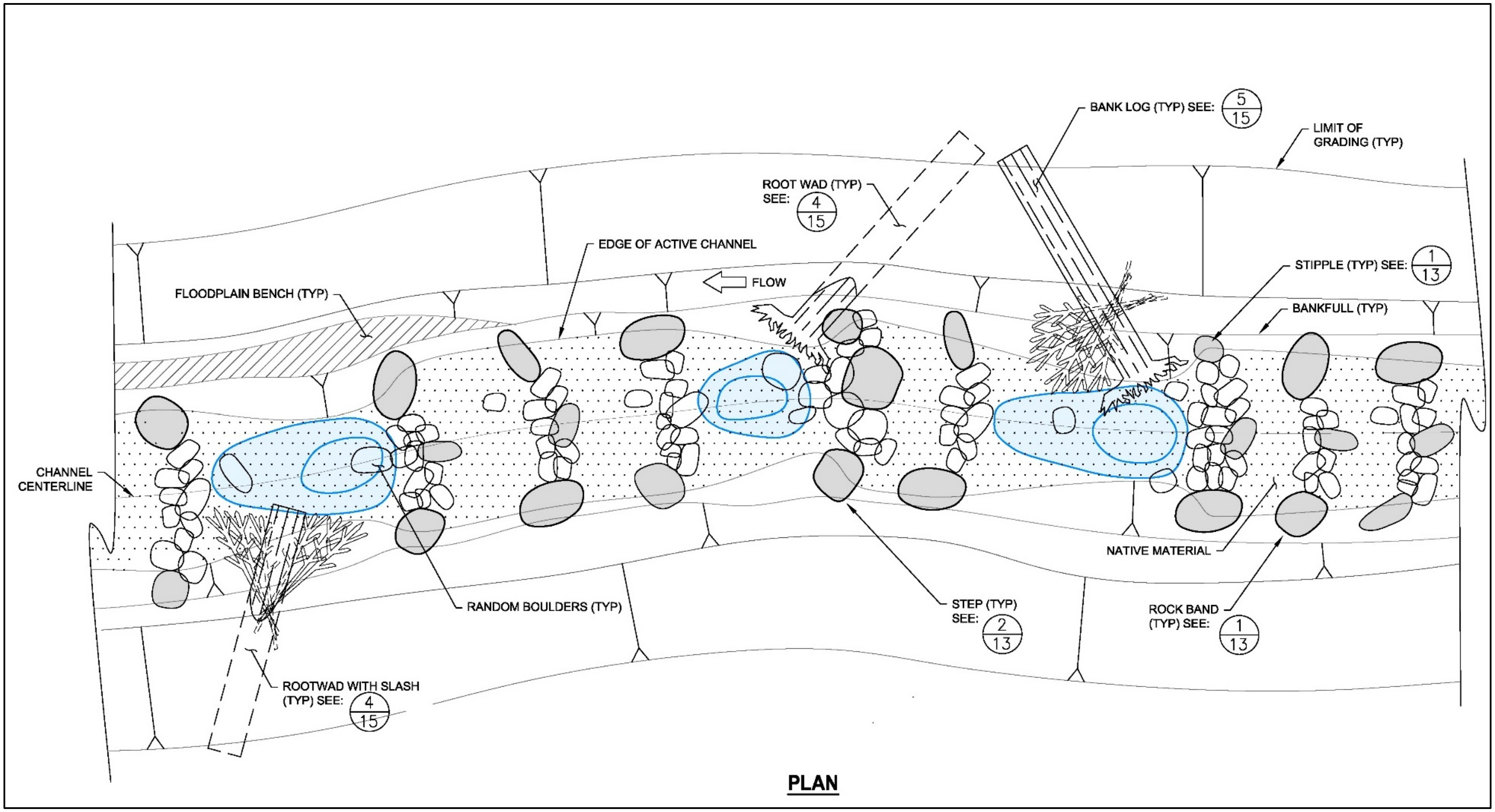


Figure 17. Planform overview for the bed features to be constructed in specified locations within the realigned channel.

8 ROAD-STREAM CROSSING REPLACEMENT DESIGN

This section provides design recommendations for the road-stream crossing based on geomorphic (stream simulation) and hydraulic design objectives. The new road-stream crossing will replace the existing single 36-inch CMP, which is vastly undersized for conveying the 100-year flow and would fail to meet fish passage criteria for minimum depth and maximum water velocity. The structural and roadway engineering design report prepared by Quincy Engineering (2018) for the project is shown in Attachment F.

8.1 Design Considerations

The project area of Hotelling Gulch is located on the Klamath National Forest. Cecilville Road is designated as a Forest Highway (FR93) maintained by Siskiyou County Department of Public Works as County Road 1CO2. A Forest Highway is a category of road within U.S. National Forests that connects the national forests to the existing state highway systems, and provides improved access to recreational and logging areas. Though maintained by Siskiyou County, the designs for the roadway and crossing are required to meet Federal Highway Administration (FHWA) design standards and undergo FHWA reviews. Cecilville Road is relatively straight at the location of the new road-stream crossing. The crossing will be located in a sag in the road profile. There are no utilities along the roadway.

The design of the new Hotelling Gulch road-stream crossing was based on stream simulation design methodologies (CDFG, 2009; USFS, 2008), which used the reference reach information for the project. A stream-simulation crossing is designed to fully-span the bankfull width of the design channel and to convey the 100-year flows to maintain stable geomorphic processes through the crossing and reduce the risk of plugging with debris.

The CDFW stream simulation design process recommends that a crossing maintain freeboard between the 100-year water surface and the soffit of the crossing. This will minimize the chance of pressure flow occurring, which can cause scour under a crossing. Maintaining freeboard also minimizes the potential of debris jamming at the upstream face of a crossing. At Hotelling Gulch, a substantial amount of freeboard should be provided due to large size of boulders in transport in the stream channel, likelihood of large wood delivered to the crossing, and the potential of landslide and debris flow inputs from the watershed (PWA, 2016).

8.2 Potential Profile Adjustments

To design an adequately sized crossing in a channel that regularly experiences sediment aggradation and conveys large debris and sediment, it was necessary to evaluate the potential long-term vertical adjustment profiles (VAP) of the channel. VAP analyses identify the potential range of channel bed elevation over the design life of a crossing and are used to set the soffit elevation of the crossing and to support foundation design. The High VAP shows the highest expected channel profile elevation, and includes consideration for potential large wood blockages or sediment aggradation. The Low VAP shows the best estimate of lowest expected channel profile elevation, including localized pool scour, but excluding bridge scour.

8.2.1 High VAP

The High VAP is based on field observations, interpretation of the site geomorphology, hydraulic model results, and professional judgment. The high VAP was predicted assuming that no channel maintenance, in the form of dredging, will occur.

Both the existing and historical mouths of Hotelling Gulch are substantially aggraded. The cause of the aggradation is unknown, and could be a result of a large sediment delivery event in Hotelling Gulch coincident with elevated flows in the river. Another cause may be narrowness of the bedrock notches controlling the channel cross section at the confluence. The realigned channel design will include increasing the opening of the bedrock notch at the confluence, which is expected to improve sediment transport through the confluence. However, sediment deposition and aggradation may still occur. This could result in a channel profile similar to the existing valley profile of the realigned channel of Hotelling Gulch, as shown in Figure 18, which includes several feet of aggradation extending upstream from the river and through the crossing opening, upstream to the knickpoint.

8.2.2 Low VAP

The low VAP profile is not constructed; it is used to establish various design elevations, including the bottom elevation of the crossing foundation, scour depth, and revetment rock used to stabilize the channel banks. The extents of potential long-term scour associated with channel degradation was assessed by predicting the Low Vertical Adjustment Potential (VAP) for the channel profile. The predicted Low VAP is based on field observations, interpretation of the site geomorphology and reference reach, and professional judgment. The realigned channel construction will include using native material to construct large boulder cascades that will form localized steps in the profile up to 2 feet high, and scour pools up to 1-foot deep, as shown in Figure 18. Once built, the constructed bed features are expected to shift and lock into a stable position. After initial adjustment, they are expected to be as stable/mobile as in the reference reach. The flow return period that this may occur is unknown, but is expected to be a relatively infrequent flow event.

The predicted Low VAP for the Hotelling Gulch channel was set to extend from the top of an exposed bedrock shelf at the confluence of Hotelling Gulch with the South Fork Salmon River, and extend upstream through the bottoms of the constructed pools in the constructed channel, as shown in Figure 18. When extended upstream of the constructed channel at the same slope, the predicted Low VAP coincides with naturally formed pool bottoms in the upstream reach. Based on the predicted Low VAP profile, up to 2.1 feet of degradation could occur below the constructed channel bottom at the new Cecilville Road crossing. Near the new road-stream crossing, the channel profile predicted by the Low VAP may come within about 1-2 feet of the bedrock elevation identified by PWA (2016, 2017).

8.3 Hydraulic Capacity Evaluation

A HEC-RAS hydraulic model (ACOE, 2010a) was prepared for proposed conditions at Hotelling Gulch to evaluate flow hydraulics for the 50 the 100-year flow events. The hydraulic capacity of the replacement crossing at Hotelling Gulch was modeled for two scenarios:

1. As-Designed: No aggradation of the design profile
2. High VAP Profile: Assuming sediment has aggraded in the channel to the High VAP elevation predicted in Section 8.2.

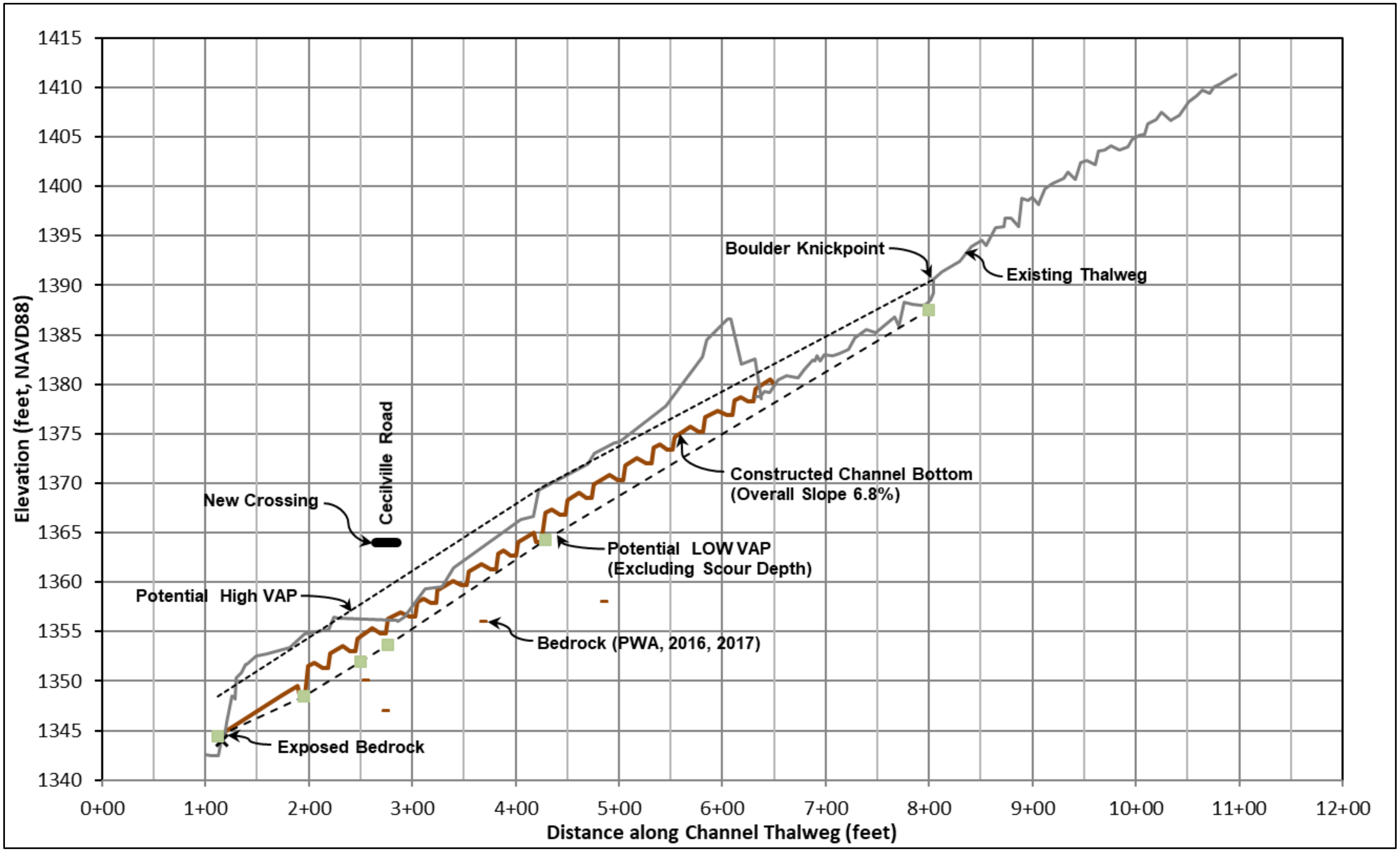


Figure 18. Channel thalweg profile of Hotelling Gulch showing the existing and design channel, the extents of the predicted high and low vertical adjustment profiles (VAP) along the project area.

8.3.1 Hydraulic Model Setup

The HEC-RAS model extended from the river confluence to 537 feet upstream. The model was based on existing-condition channel cross sections obtained from the LIDAR. Where channel grading is proposed, the model geometry consisted of a composite of the existing ground and design cross sections based on the overall slope of the stream channel.

Cross sections were spaced at a maximum of 50 feet apart, and were spaced more closely when needing to better define details of the channel geometry and road-stream crossing. Cross section numbering was based on alignment stationing for the existing channel, with station 1+00 located at the confluence of Hotelling Gulch and the South Fork of the Salmon River. A Manning's roughness value (n) of 0.07 used for the channel was derived from a roughness value computed using Limerinos (1970) in WinXSPro (USFS, 2005) (Appendix D). Overbank roughness values of 0.1 were used to simulate the brushy riparian area that is expected to become established adjacent to the realigned channel.

The design cross section under the crossing will have the same active channel, bankfull, and floodprone dimensions as the other portion of the realigned channel, shown in Figure 14. A crossing opening of 23 feet was selected to span the floodprone width and allow larger woody material to pass. The larger opening will minimize backwatering at the crossing at flows up to 100-year design flow event to maximize sediment transport efficiency and allow large trees to pass under the bridge. The design channel profile under the new road-stream crossing will be as shown in Figure 16.

The replacement crossing was modeled as a 23-foot span, double-lane (22-feet wide) bridge with vertical abutments, a 1.5-foot thick deck, and a natural channel bottom. The internal cross sections of the crossing were modified to reflect the proposed channel elevation and cross sections within the structure. The impacts of sediment aggradation for Scenario 2 on the water surface profiles was evaluated using the "Fixed Sediment Elevations" module and the elevation of the High VAP.

Contraction and expansion coefficients for each cross section were set at 0.3 and 0.5 to reflect head losses associated with the tumbling flow over the boulder channel bottom (ACOE, 2010b). Ineffective flow areas bounding the width of the crossing opening were set at the crossing face sections. Levees and ineffective were incorporated into the model where appropriate to properly simulate in-channel and overbank flows.

The HEC-RAS model was run using the mixed flow method and downstream normal-depth boundary conditions with a slope of 0.063 ft/ft for the 100-year return periods event. The upstream boundary condition was set at critical depth. No modeling scenarios were conducted using a flood stage in the river as a boundary condition.

8.3.1 Model Results and Recommended Crossing Span and Soffit Elevation

The results of the design-condition hydraulic modeling at Hotelling Gulch for the 100-year flow event for Scenarios 1 and 2 are shown in Figure 19 and Table 6. Additional modeling results are shown in Appendix F.

To minimize the potential for debris jamming during a large flow event, a crossing with a clear-span of 23.0 feet and a minimum soffit elevation of 1362.0 feet is recommended.

Table 6. HEC-RAS Model Predicted 50 and 100-year water surface elevations (WSE) at the Hotelling Gulch bridge. The soffit of the bridge will be set at elevation 1362.2.

Scenario	50-Year WSE (Freeboard)	100-Year WSE (Freeboard)
1-As-Designed	1368.6 feet (3.6 feet)	1368.9 feet (3.3 feet)
2-High VAP	1360.3 feet (1.9 feet)	1360.5 feet (1.7 feet)

8.4 Bridge Scour Analysis

The proposed road-stream crossing will have a natural channel bottom. To facilitate design of the crossing foundation system, a series of scour analyses were prepared. The potential for scour to occur under the new road-stream crossing was assessed using Federal Highway Administration's HEC-18 procedures (FHWA, 2012). The scour analyses included contraction scour, local abutment scour, and long-term scour (incision).

The scour analysis was performed using the HEC-RAS modeling results (MLA, 2016) for design conditions using the 100-year flow. Detailed information on the scour analysis is presented in Appendix G.

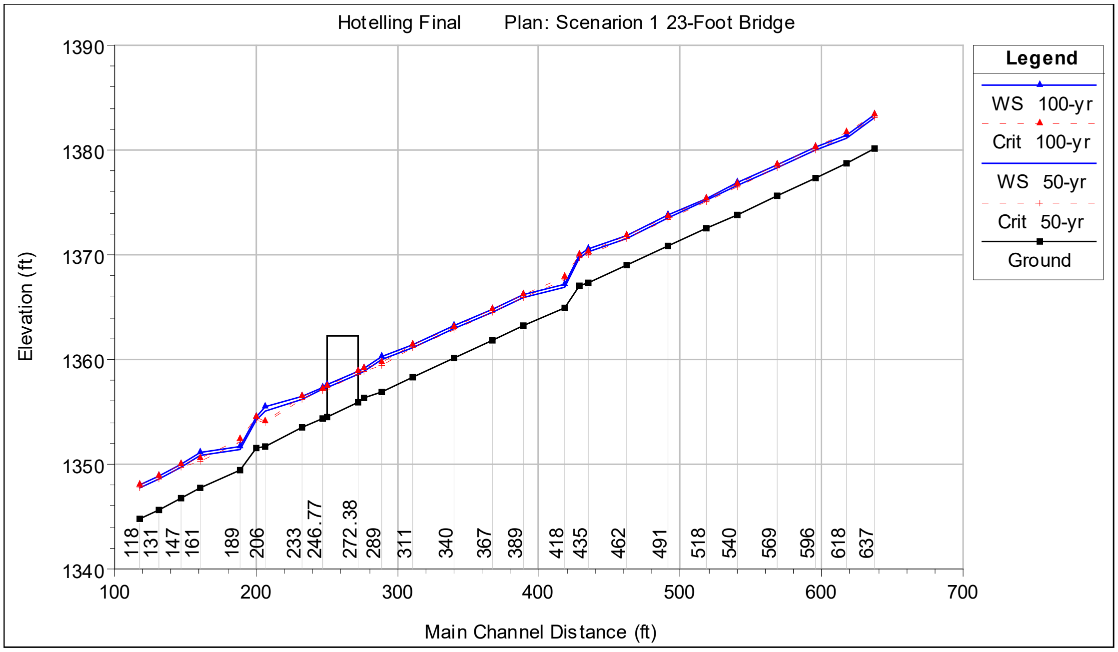
8.4.1 Long-Term Scour (Channel Stability)

Long term scour consists of potential channel aggradation, degradation and lateral migration that could occur during the lifespan of the structure. The geomorphic analysis presented in Section 8.2 provides an analysis of long-term channel stability, including avulsion potential, debris loading, and the vertical adjustment potential (VAP) of the channel (CDFG, 2009). Based on the predicted Low VAP profile, up to 2.1 feet of long-term degradation could occur below the constructed channel bottom at the proposed Cecilville Road crossing.

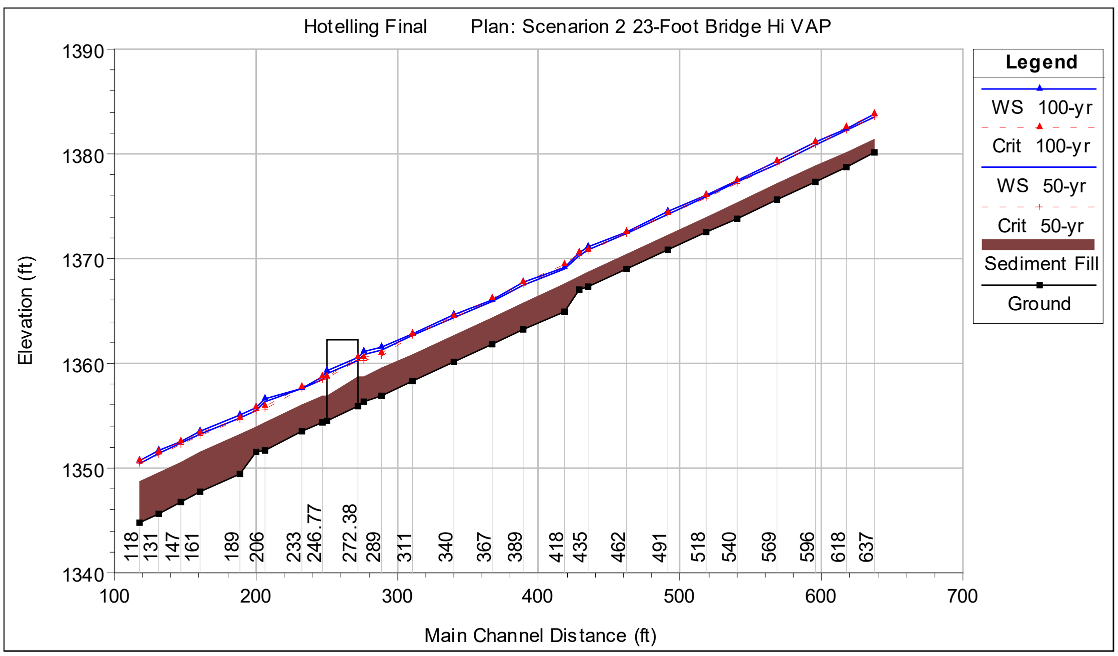
8.4.2 Contraction Scour Computation

Live-bed contraction scour at the new crossing was computed using the Modified Laursen equations and the top width of the channel (FHWA, 2012). This equation computes the average channel depth during scour in the crossing based on the changes in average flow depth, top width, and flow conveyance between channel cross sections upstream and in the contracted reach within the crossing. The hydraulic variables used for the "uncontracted" cross section were average values derived from HEC-RAS results at cross sections 340 to 596. The modeling results from the upstream internal cross section of the road-stream crossing was used for the "contracted" section. A k_1 value of 0.59 was used, assuming that bed material is transported mostly as bedload.

The computations indicated that contraction scour is not expected to occur at the new road-stream crossing. This is understandable, as the 100-year flow is not contracting as it goes into the bridge crossing.



(a)



(b)

Figure 19. HEC-RAS profiles of downstream portion of Hotelling Gulch for (a) Scenario 1 (Design Conditions) and Scenario 2 (High VAP) for the 50 and 100-year flow event. The grey rectangle reflects the location and elevation of the road-stream crossing. The brown fill reflects sediment aggradation within the channel at the High VAP profile. The Red line reflects critical depth.

8.4.3 Abutment Scour Computation (Local Scour)

Local abutment scour was computed using the Froelich equation (FHWA, 2012). This equation computes the average channel depth during scour in the cross section under a crossing based on floodplain flow depth, length the abutments projection into the flow, and Froude number. A K_1 value of 1 was used to simulate a vertical wall abutment, and a K_2 value was derived assuming the face of the abutments will be 90-degrees to flow. The hydraulic variables used for the "approach" cross section were average values derived from HEC-RAS results at cross sections 340 to 596. The modeling results from the approach sections and the internal cross section of the road-stream crossing was used to determine the average length that the abutments will project into the flow.

The computations indicated that abutment scour is not expected at the new road-stream crossing because the abutments do not project into the flow area and flows do not touch the abutments.

8.4.4 Total Potential Scour Depth

Table 7 summarizes the scour depths predicted for various types of scour. HEC-18 recommends that the total potential scour depth be the sum of contraction, abutment and long-term scour. Therefore, the bridge foundations were designed considering a scour depth up to 2.1 feet below the constructed channel bed.

Table 7. Summary of predicted scour depths at the proposed Hotelling Gulch road-stream crossing. The total potential scour depth is measured from the crest of a cascade or riffle.

Type of Scour	Scour Depth
Predicted Contraction Scour Depth	0.0 feet
Predicted Abutment Scour	0.0 feet
Long-Term Scour	2.1 feet
Total Potential Scour Depth	**2.1 feet**

8.5 Future Channel and Road-Stream Crossing Stability

The realigned channel is expected to experience high sediment and debris loading during large flow events. With debris jamming and/or excess sediment delivery, there remains the potential that the channel could avulse back into the eastern alignment. Prior to the avulsion, it is likely there was a channel feature along the eastern alignment created by historical mining in that area, making it more likely that an avulsion could take place.

To reduce the risk of another avulsion, the entire eastern channel reach, extending from the upstream end of the project area to upstream of Cecilville Road, will be plugged to an elevation equal to the adjacent hillslope on both sides. The top of the plug will be approximately 4 feet higher than the predicted 100-year flood elevation at the High VAP profile, and 5 feet above the 100-year water flood elevation under design conditions. To protect against scour and erosion along the face of the plug, it will be armored with salvaged boulders and cobbles, and planted with live willow cuttings.

In general, the channel and road-stream crossing should be monitored to minimize the amount of sediment aggregation occurs following large storm events, and action should be taken if conditions appear to increase the potential for channel avulsion or substantial reduction in the opening of the road-stream crossing.

Once built, the constructed bed features are expected to shift and lock into a stable position. After initial adjustment, they are expected to be as stable/mobile as in the reference reach. As such, these constructed and natural bed features would become mobile, break apart, and reform during similar flow events.

9 CONSTRUCTION CONSIDERATIONS

9.1 Excavation, Earthwork, and Spoils

Based on the final design, it is expected that approximately 2,900 cy of material will be excavated as part of the steam channel realignment and bridge construction.

Approximately 1,500 cy of this material will be used to construct the plug in the existing channel alignment. About 300 cy of excavated material will also be used for raising the road, with screening and soil conditioning.

The excess excavated material could be placed in a flat area to the north of Cecilville Road to the east of the stream channel. This area could accommodate roughly 1,100 cy of material. If placement of material in this location is not desirable, it will need to be off-hauled to a permitted site.

The project may require some bedrock excavation near the confluence of Hotelling Gulch and the river. The geotechnical report for the project indicated that the bedrock can be excavated with regular heavy equipment. Excavation into bedrock is not expected upstream of the confluence area.

9.2 Construction Access and Traffic Control

Construction access will be relatively simple at the project site. Both the existing channel and upstream limits of the realigned channel can be accessed from the existing access ramp off of USFS Road 10N16. Access to the downstream portion of the channel can be form a relatively clear flat are area east of the channel. Construction access areas will be limited to preserve as much riparian vegetation as feasible. A large and flat staging and stockpile area is available to the north of Cecilville Road on the east side of the stream channel.

Cecilville Road experiences moderate traffic loading. It is unlikely that the road can be closed for construction of the replacement road-stream crossing. A temporary roadway will need to be constructed to maintain traffic on Cecilville Road during construction. CalFire regulations require a minimum roadway width of 10-feet for a single-lane road with minimum inside turning radii of 50 feet (California Department of Forestry and Fire, 2008). A proposed location of a Temporary Traffic Bypass Road that meets CalFire requirements is shown in on the design plans and is located on the upstream side of Cecilville Road. Traffic control will include signage for a one-lane road with yield to oncoming traffic signage.

9.3 Utilities

A request was made to 811 to USA the project area. The USA ticket number is W826900440. USA indicated that there are no utilities in the area.

9.4 Erosion Control and Water Management

Construction of the project is expected to occur during the dry season. However, the stream channel may be flowing and groundwater will be present. A clear water diversion may be necessary during construction. Due to the slope of the project area, a gravity-fed clearwater diversion appears to be feasible. Dewatering of the work and treatment of the sediment-laden water from the dewatering process can be expected. Water from the dewatering operations can be pumped to a flat area away from the work area, de-silted with a sediment bag as needed, and then allowed to infiltrate back into the ground. It can also be used for dust control and for wetting materials to obtain desired compaction.

It is recommended that the project be sequenced so that the tie-in to the river is done later in the construction. This will allow river water levels to drop and eliminate the need for a clearwater exclusion at the river confluence. This timing will also need to be balanced with the arrival of late-fall spawning fish.

Erosion and sediment control measures will be necessary to stabilize the roadway fill slopes and around stockpile area. Standard erosion prevention measures should be practiced throughout the site in the event of rain. Preparation of a Stormwater Pollution Prevention Plan (SWPPP) may be necessary for the project, depending on the funding source and permitting. Construction water may need to be drafted from an approved drafting location.

9.5 Construction Quantities and Costs

Project quantities and construction costs are shown in Appendix H. The cost estimate was prepared with a 15% contingency for the stream channel realignment portion of the project to account for the field-fit nature of the channel construction and for unforeseen conditions during construction. The bridge and roadway construction portions of the project have a 10% contingency. Table 8 lists some of the major items and quantities necessary for the construction, but is not all-inclusive.

The cost estimate includes line items with quantities, unit costs, and total costs for each activity that is anticipated during construction. Excavation costs for the bridge include costs for shoring due to the limited size of the work area. Costs were based on quantities measured from the construction drawings and from material and installation costs derived from bid tabulations of similar and recently completed projects.

The cost estimate assumes that all large wood and streambed material can be salvaged from the project area. Excavation unit costs assume that the material excavated from the project area can be reused or stockpiled on site, and no borrow will be necessary for the project.

The cost estimate covers implementation costs, but excludes permitting and preparation of environmental documents, preparation of a SWPPP, and construction management.

The opinion of probable construction cost for construction of the channel, bridge, and roadway is approximately $1,431,000 (Appendix H). This cost includes an escalation of 3% over 2 years to when the project is expected to be implemented.

Table 8. Summary of major project quantities.

Item	Quantity
Stream Excavation	2,640 CY
Structural/Road Excavation	400 CY
Bedrock Excavation	62 CY + unknown amount at confluence
Tree Removal/In-Stream Wood Placement	20 (approx.)
Structural Concrete for Bridge	146 CY
Bar Reinforcing Steel	15,000 lbs
Guardrail (excluding bridge rail and end sections)	126 LF
RSP (size varies) (no Fabric)	170 Tons
Class 2 Aggregate Base	248 CY
Hot Mix Asphalt (Type A)	205 Tons
Riparian Trees and Shrubs (1 Gallon)	200
Live Willow Stakes	700
Fiber Rolls for Sediment Control	373 LF
Silt Fence for Sediment Control	468 LF
High Visibility Fence	608 LF

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Appendix A – Design Plans

SALMON RIVER RESTORATION COUNCIL

PLANS FOR CONSTRUCTION OF

HOTELLING GULCH
AQUATIC RESTORATION PROJECT

OCTOBER, 2018

90% Design

Prepared For:

- **SALMON RIVER RESTORATION COUNCIL**
- **USDA FOREST SERVICE, KLAMATH NATIONAL FOREST**
- **US FISH & WILDLIFE SERVICE**

VICINITY MAP
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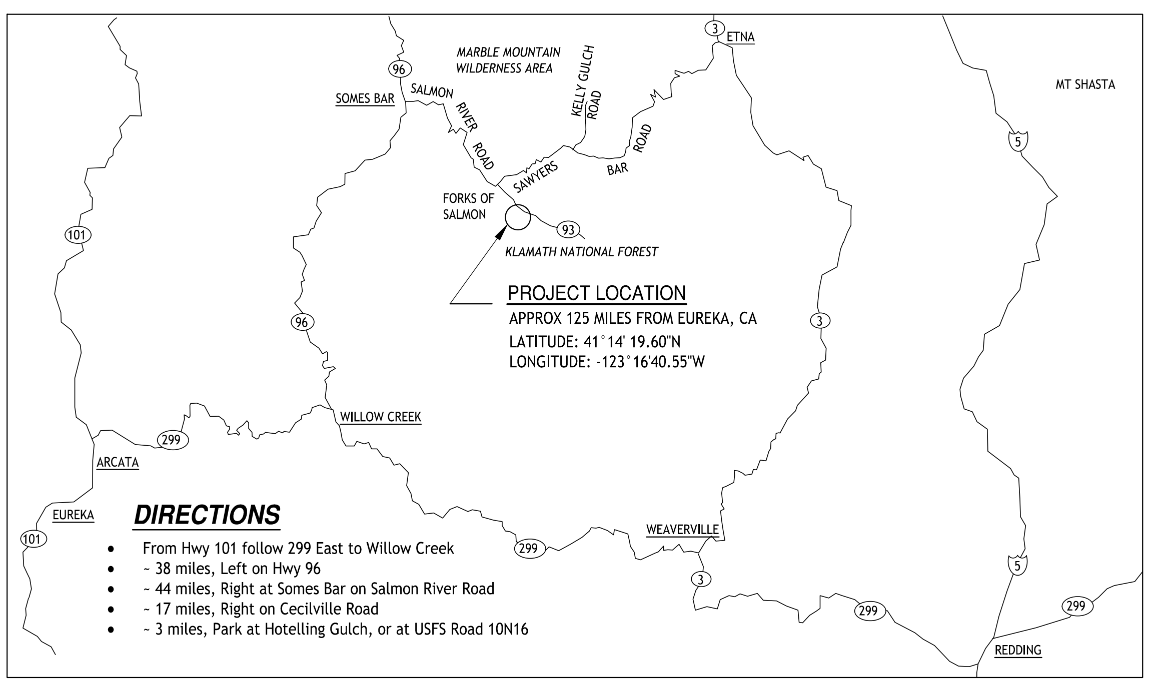

LOCATION MAP
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Michael Love & Associates, Inc.
PO Box 4477 • Arcata, CA 95518 • (707) 822-2411

QUINCY ENGINEERING
11017 COBBLEROCK DRIVE, SUITE 100
RANCHO CORDOVA, CA 95670
P: 916.368.9181

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SHEET INDEX

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3	NOTES
4	WATER MANAGEMENT
5	EXISTING CONDITIONS
6	CONSTRUCTION ACCESS AND DEMOLITION
7	TEMPORARY TRAFFIC BYPASS ROAD GEOMETRY
8	PLAN & PROFILE - DOWNSTREAM
9	PLAN & PROFILE - UPSTREAM
10	PLAN & SECTION - EXISTING CHANNEL ALIGNMENT
11	TYPICAL CHANNEL SECTIONS
12	BOULDER CASCADE, STEP AND POOL TYPICALS
13	BOULDER STRUCTURE TYPICALS
14	BOULDER STRUCTRE TABLE
15	LARGE WOOD STRUCTURE TYPICALS
16	TYPICAL CROSS SECTIONS
17	PLAN & PROFILE
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20	CONSTRUCTION AREA SIGNS & TRAFFIC HANDLING
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27	TYPICAL SECTION
28	OREGON 2-TUBE SIDE MOUNT RAIL
29	OREGON 2-TUBE SIDE MOUNT TRANSITION (MOD)

Michael Love & Associates, Inc.
PO Box 4477 • Arcata, CA 95518 • (707) 822-2411
Salmon River Restoration Council
PO BOX 1089 • 25631 Sawyers Bar RD, Sawyers Bar CA 96027
530-462-4665 Fax 530-462-4664

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Salmon River Restoration Council and Klamath National Forest
HOTELLING GULCH
AQUATIC RESTORATION PROJECT

TITLE

DATE: OCT 2018
SUBMITTAL: 90% DESIGN
DESIGN: RS / ML
DRAWN: AL
SHEET: 1 of 29

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LEGEND AND SYMBOLS

EXISTING

——x——	FENCE LINE
——95——	CONTOUR AND ELEVATION
+99.0	SPOT ELEVATION
	CHANNEL THALWEG OR DRAINAGE
1+00	ALIGNMENT STATIONING (FEET)
	CONTROL POINT/TEMPORARY BENCH MARK
	FLOW DIRECTION
	EXPOSED BEDROCK
	TREE

NEW

	SURVEY CONTROL POINT
16	CONTOUR AND ELEVATION
1+00	STATIONING ALONG NEW ALIGNMENT (FEET)
	LIMIT OF DISTURBANCE

ABBREVIATIONS

ALD	ALDER	NFSR	NORTH FORK SALMON RIVER
APPROX, ~	APPROXIMATELY	NTS	NOT TO SCALE
CA	CALIFORNIA	OZ	OUNCE
CL	CENTERLINE	O.C.	ON CENTER
CMP	CORRUGATED METAL PIPE	RD	ROAD
CP	SURVEY CONTROL POINT	R.C	RELATIVE COMPACTION
CFS	CUBIC FEET PER SECOND	STA	STATION
DIA	DIAMETER	SY	SQUARE YARDS
EG	EXISTING GROUND	TBM	TEMPORARY BENCHMARK
EL	ELEVATION	TYP	TYPICAL
(E)	EXISTING	W/	WITH
EP	AVERAGE DAILY EXCEEDANCE PROBABILITY	WSE	WATER SURFACE ELEVATION
FG	FINISHED GROUND	YR	YEAR
FT	FEET	(1.5:1)	(HORIZONTAL:VERTICAL) SLOPE
LOD	LIMIT OF DISTURBANCE	%	PERCENT
MAX/MIN	MAXIMUM/MINIMUM	'	FOOT OR FEET
(N)	NEW		

$\frac{1}{4}$ SECTION DETAIL OR TYPICAL NAME

SHEET NUMBER ON WHICH SECTION, DETAIL OR TYPICAL APPEARS

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Michael Love & Associates, Inc.
PO Box 4477 • Arcata, CA 95518 • (707) 822-2411

Salmon River Restoration Council
PO BOX 1089 • 25631 Sawyers Bar RD, Sawyers Bar CA 96027
530-462-4665 Fax 530-462-4664

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SHEET
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General Notes

1. Salmon River Restoration Council (SRRC) is the "contract owner" (CO). The term "contract owner representative (COR)" is defined as authorized qualified professional(s) designated by the CO. All improvements shall be accomplished under the approval, inspection and to the satisfaction of the COR.
2. In the event cultural resources (i.e., historical, archaeological, and paleontological resources, or human remains) are discovered during grading or other construction activities, work shall be halted within a 100 foot radius of the find. A qualified archeologist retained by the COR shall be consulted for an on-site evaluation. Additional mitigation may be required, at owners expense per the archeologist's recommendations. If human burials or human remains are encountered, the contractor shall immediately notify the county coroner.
3. If hazardous materials or what appear to be hazardous materials are encountered, stop work in the affected area immediately and contact 911 or the appropriate agency for further instruction.
4. All work shall comply with State of California Department of Transportation Standard Plans & Specifications (Caltrans 2015) and the Contract Documents unless noted otherwise.
5. A set of signed working drawings shall be kept on site at all times on which Contractor shall record variations in the work, including all existing utilities. These "Red Line" drawings shall be submitted to the COR upon completion of work.
6. Contractor agrees to assume sole and complete responsibility for the work area during the course of construction, including safety of all persons and property. This requirement shall apply continuously and shall not be limited to normal working hours. The Contractor shall defend, indemnify and hold the CO, COR and its representatives harmless from any liability, real and or alleged, in conjunction with the performance of this project.
7. Placed materials not conforming to specifications shall be removed and replaced as directed by the COR at no additional cost to the CO.
8. The contractor, before submitting a bid for this project, shall visit the construction site and thoroughly familiarize themselves with all existing conditions above and below ground. Before submitting a bid, Bidders shall be satisfied as to the accuracy and completeness of these Specifications and Construction Documents regarding the nature and extent of all work described.
9. The contractor shall immediately notify the COR upon discovering significant discrepancies, errors or omissions in the plans. Prior to proceeding, the COR shall have the plans revised to clarify identified discrepancies, errors or omissions.
10. Traffic control shall conform to Caltrans California Manual on uniform traffic control device (CA MUTCD, 2014). Cecilville Road shall remain open during construction.
11. Contractor shall be responsible for providing their own water and power for operations, irrigation and dust control. Water shall not be pumped from the live creek for these uses.
12. Noted dimensions take precedence over scale.

Clearing and Grubbing Notes

1. Clearing and Grubbing shall be in accordance with the erosion and sediment control notes in the Contract Documents.
2. The limit of disturbance does not denote the limit of clearing and grubbing. The extent of clearing shall be minimized to the extent possible within the Limit of Disturbance to allow maneuverability of equipment.
3. Trees designated for removal shall be salvaged and cut to the lengths specified for use in log structures. Root wads shall remain intact with stem min 18 feet in length.
4. Limbs and slash shall be retained in as large lengths as possible (preferably 10 ft) for incorporation into log structures.
5. Existing tree roots within limits of excavation shall be preserved as possible.
6. Remaining organic material from clearing and grubbing shall be chipped and used for site stabilization.
7. Trees not designated for removal shall remain and be protected.
8. Salvage existing downed trees within work area for use in Log Structures.

Erosion & Sediment Control Notes

General Notes

1. At minimum the contractor shall employ the following Best Management Practices (BMPs) as applicable, as described in the current California Stormwater BMP Handbook for Construction (CASQA Handbook) (www.CASQA.org):

EC-1	Scheduling
EC-2	Preservation of Existing Vegetation
EC-8	Wood Mulching
SE-1	Silt Fence
SE-5	Fiber Rolls
WE-1	Wind Erosion Control
NS-1	Water Conservation Practices
NS-2	Dewatering Operation
NS-5	Clearwater Diversion
NS-8	Vehicle and Equipment Cleaning
NS-9	Vehicle and Equipment Fueling
NS-10	Vehicle and Equipment Maintenance
SS-9	Earth Dikes and Drainage Swales
SS-10	Velocity Dissipation Devices
WM-1	Materials Delivery and Storage
WM-2	Material Use
WM-3	Stockpile Management
WM-4	Spill Prevention and Control
WM-5	Solid Waste Management
WM-8	Concrete Waste Management
WM-9	Sanitary/Septic Waste Management

2. Contractor must ensure that the construction site is stabilized prior to the onset of any rain event to prevent sediment delivery to waterways.
3. It is the responsibility of the contractor to minimize erosion and prevent the transport of sediment to the adjacent stream and sensitive areas. Contractor will be responsible for all fines and cleanup of any violations.
4. Sufficient erosion control supplies shall be available on-site at all times to address areas susceptible to erosion during rain events.
5. Minimize disturbance of existing vegetation to that necessary to complete work.
6. All heavy equipment shall be steam cleaned prior to entry to the project site to inhibit the spread of exotic seed. All heavy equipment shall be leak free upon entry to the project site and any leaks shall be repaired immediately.
7. Activities such as vehicle washing are to be carried out at an off-site facility whenever practical.
8. The Contractor, as necessary, shall implement other BMPs specified in the CASQA Handbook dictated by site conditions and as directed by the COR. This plan may not cover all the situations that arise during construction due to unanticipated field conditions. Variations may be made to the plan in the field subject to the approval of or at the direction of the COR.
9. The Contractor shall make adequate preparations, including training and equipment, to contain spills of oil and other hazardous materials. Spill kits shall be present at each work site to inhibit the spread of fluid leaks onto the ground or surrounding areas.
10. Contractor shall keep project areas that generate dust well watered during the term of the contract.
11. The contractor shall provide covered waste receptacle for common solid waste at convenient locations on the job site and provide regular collection of wastes.
12. Both active and non-active soil and material stockpiles shall be properly protected to minimize sediment and pollutant transport from the construction site (WM-3).
13. The Contractor shall provide sanitary facilities of sufficient number and size to accommodate construction crews and ensure adequate anchorage of such facilities to prevent tipping by weather or vandalism.
14. Prior to final acceptance, all disturbed areas shall be permanently stabilized with wood chips, weed free straw and temporary sediment control measures shall be installed as specified.

Channel Excavation and Fill Notes

1. The Geotechnical Report prepared by PWA is available upon request.
2. Excavation shall include excavation and handling of saturated soils. Contractor shall be prepared to dewater and /or transport saturated soil in a manner that prevents excess discharge or spillage of soils or water within the construction access area or on adjacent properties or roadways. Should any discharge occur, the Contractor shall be responsible for immediate and complete clean up. Multiple handling of material may be necessary.
3. Unsuitable material shall become the property of the contractor and shall be removed from the site by the contractor for disposal in an approved location. Unsuitable material includes concrete, grouted riprap, pipes and all other manmade materials within the Limit of Disturbance (LOD).
4. All cross sections are looking up-station (upstream).
5. Unless otherwise specified, tolerance for finished grading in the stream channel shall be $\pm$ 0.2 feet vertical $\pm$ 0.5 feet horizontal.
6. Suitable excavated material shall be stockpiled in the designated soils stockpile area.
7. Spoils shall be placed to maintain positive drainage with a finished surface of ± 3 inches and no clumps greater than ± 3 inches in diameter.
8. Grading may be adjusted at direction of COR to avoid trees and other features.
9. Detrimental amounts of organic material shall not be permitted in fills.
10. Backfill shall be placed in 1-foot lifts, unless otherwise specified, and thoroughly compacted to the satisfaction of the COR.
11. Bedrock excavation may be necessary near the river conflucence.

Utility Notes

1. All utilities shown were located from above ground visual structures. No utility research was conducted for the site. Notify Underground Service Alert (DigAlert) at least two days prior to any grading or excavation within the site by calling 811 or 1-800-227-2600.
2. Contractor is responsible for any damage to utilities, features and structures located in the project area and construction access routes. Contractor shall avoid disruption of any utilities unless previously arranged with COR.
3. Construction may take place in the vicinity of overhead utility lines. It is the Contractor's responsibility to be aware of and observe the minimum clearances for workers and equipment operating near high voltage, and comply with the Safety Orders of the California Division of Industrial Safety as well as other applicable safety regulations.
4. All utilities shall be protected during construction to prevent interruption of service.

Sequence of Construction

Work phasing shall occur as follows, unless otherwise approved by COR:

1. Mobilization
2. Installation of fish exclusion devices and removal of fish from work area.
3. Installation of temporary cofferdams, clear water diversions, de-watering, and sediment control within work area as needed.
4. Clearing and grubbing of work area.
5. Installation of Temporary Access Road
6. In-stream and bridge construction.
7. Removal of water management devices.
8. Removal of fish exclusion devices.
9. Stabilization of the work area.
10. Demobilization.

Construction Sequencing and Access Notes:

1. Cecilville Road shall remain open and passable during construction.
2. Telephone, fiber optic and other utility lines if present shall be protected during construction to prevent interruption of service.

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Michael Love & Associates, Inc.
PO Box 4477 • Arcata, CA 95518 • (707) 822-2411

Salmon River Restoration Council
PO BOX 1089 • 25631 Sawyers Bar RD, Sawyers Bar CA 96027
530-462-4665 Fax 530-462-4664

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NOTES

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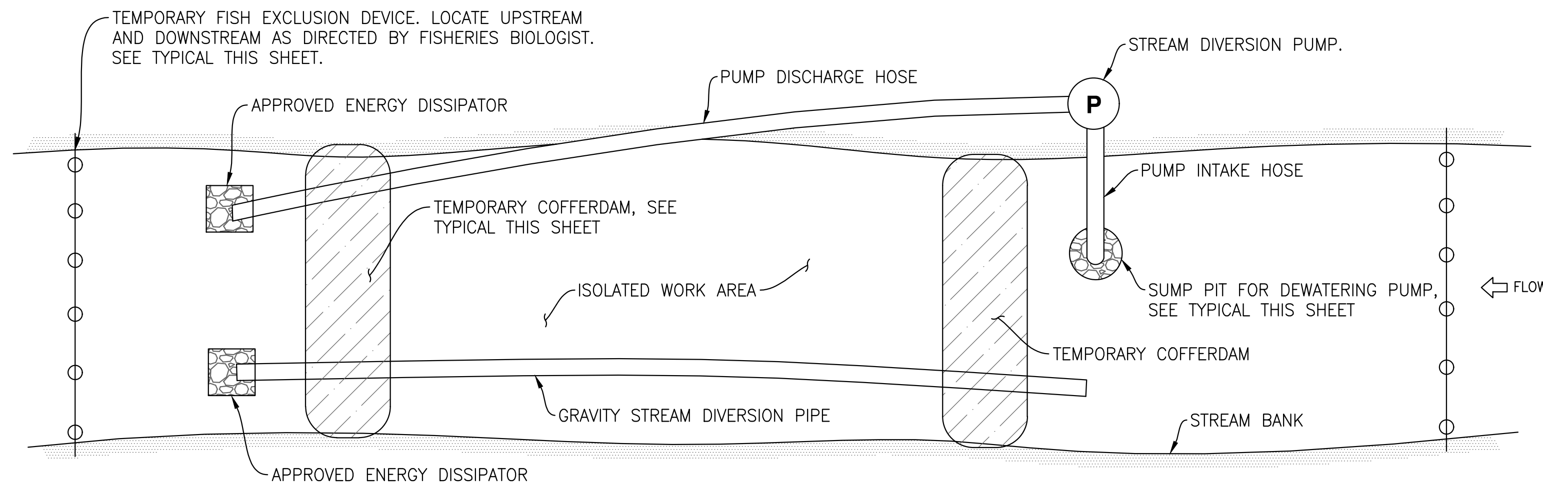
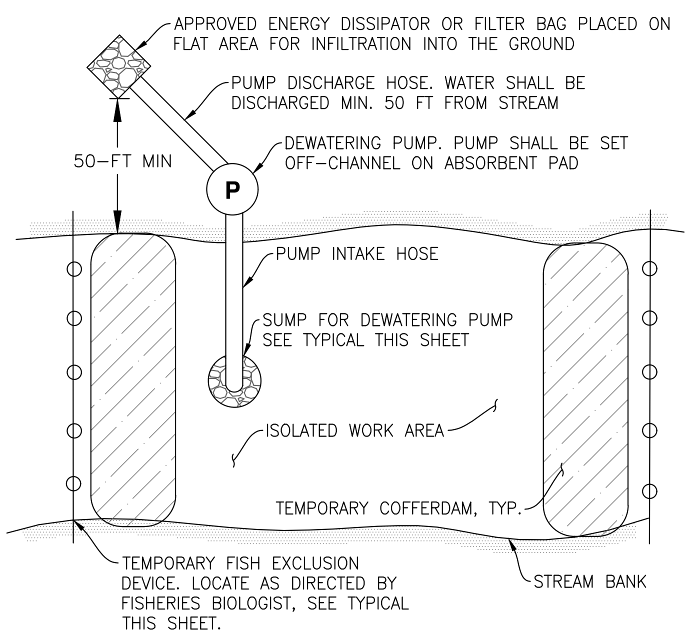
SUBMITTAL	90% DESIGN
DESIGN	RS / ML
DRAWN	AL
SHEET	3 of 29



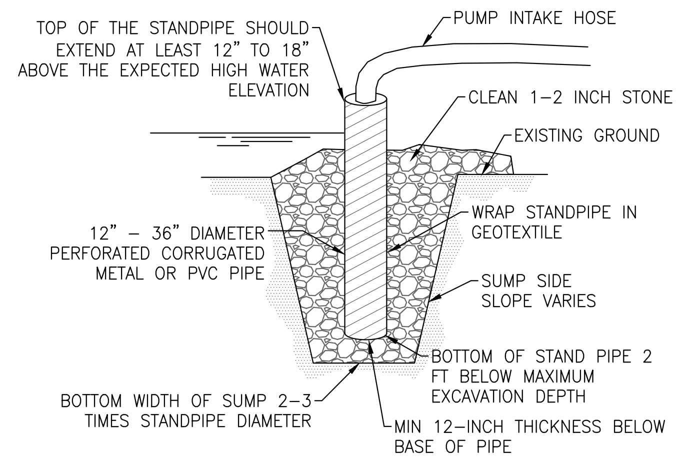
TEMPORARY CLEAR WATER DIVERSION

TYPICAL PLAN (NTS)



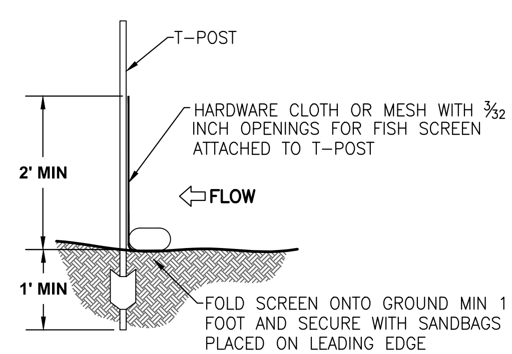
TEMPORARY NUISANCE AND POND DEWATERING MEASURES

TYPICAL PLAN (NTS)



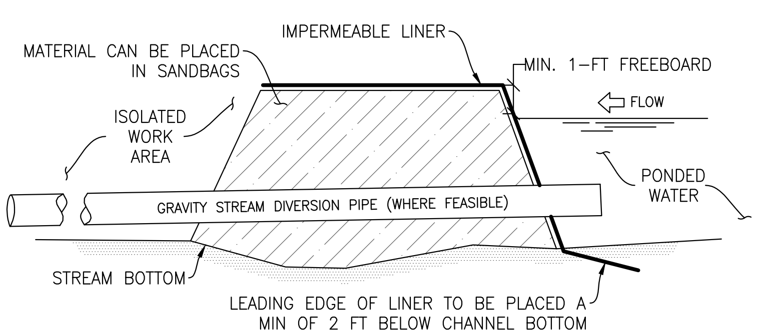
SUMP PIT

TYPICAL SECTION (NTS)



TEMPORARY FISH EXCLUSION DEVICE

TYPICAL PROFILE (NTS)



TEMPORARY COFFERDAM

TYPICAL PROFILE (NTS)

1 TYP **WATER MANAGEMENT**

TYPICAL

WATER MANAGEMENT

GENERAL

1. THE WATER MANAGEMENT FEATURES (E.G. COFFERDAMS) SHOWN IN THE CONTRACT DRAWINGS ARE APPROXIMATE. THE CONTRACTOR SHALL DESIGN A WATER MANAGEMENT APPROACH THAT MEETS ALL PERMIT AND OTHER CONSTRAINTS.
2. THE OBJECTIVE OF WATER MANAGEMENT IS TO ISOLATE THE CHANNEL WORK SO THAT WORK IS COMPLETED IN DRY CONDITIONS. TO ACCOMPLISH THIS, THE CONTRACTOR MUST EMPLOY A CLEAR WATER DIVERSION SYSTEM AND A DEWATERING SYSTEM. THE CLEAR WATER DIVERSION SYSTEM BYPASSES CREEK WATER AROUND THE WORK AREA. THE DEWATERING SYSTEM REMOVES "NUISANCE" WATER (E.G. SEEPAGE) FROM WITHIN THE ISOLATED WORK AREA AND IS TREATED TO REMOVE SEDIMENT.
3. NO CONSTRUCTION ACTIVITIES ARE PERMITTED UNTIL A WATER MANAGEMENT PLAN HAS BEEN ACCEPTED.
4. FISH REMOVAL WILL BE CONDUCTED BY A BIOLOGIST PROVIDED BY THE CO. CONTRACTOR SHALL COORDINATE WITH BIOLOGIST DURING PLANNING AND IMPLEMENTATION OF DEWATERING ACTIVITIES.

SUBMITTALS

WATER MANAGEMENT PLAN MUST INCLUDE THE FOLLOWING:

1. SUMMARY OF THE CONTRACTOR'S WATER MANAGEMENT APPROACH.
2. DESCRIBE THE APPROACH TO COORDINATE WITH THE CO BIOLOGIST THE REMOVAL OF FISH AND OTHER SPECIES FROM THE ISOLATED WORK AREA.
3. DESCRIBE IN DETAIL, INCLUDING GRAPHICAL FIGURES, THE CLEAR WATER DIVERSION SYSTEM. THIS INCLUDES, BUT IS NOT LIMITED TO, LOCATION OF INFRASTRUCTURE, TYPE OF INFRASTRUCTURE, DESIGN FLOW, PIPE SIZE, PIPE MATERIAL, PIPE LENGTH, PIPE ROUTING, ETC., AND PUMP DETAILS, IF UTILIZED.
4. DESCRIBE IN DETAIL, INCLUDING GRAPHICAL FIGURES, THE DEWATERING SYSTEM. THIS INCLUDES, BUT IS NOT LIMITED TO, THE LOCATION OF INFRASTRUCTURE, TYPES OF EQUIPMENT, SIZE OF EQUIPMENT, DISCHARGE LOCATIONS, ETC.
5. DESCRIBE IN DETAIL THE PROCEDURES TO BE EXECUTED SHOULD THE CHANNEL FLOW INCREASE (I.E. BECAUSE OF RAIN EVENT).

PRODUCTS

COFFERDAM

1. MAY BE CONSTRUCTED USING NATIVE OR IMPORTED MATERIAL PLACED IN BAGS (E.G. SAND BAGS, SUPERSACKS). NO COFFERDAM MATERIAL MAY BE RELEASED TO THE CHANNEL AT THE COMPLETION OF THE CONSTRUCTION WITHOUT APPROVAL. MATERIAL AND APPROACH TO BE DESCRIBED IN THE WATER MANAGEMENT PLAN.
2. THE IMPERMEABLE LINER MATERIAL TO BE USED SHALL BE IDENTIFIED IN THE WATER MANAGEMENT PLAN.
3. COFFERDAMS SHALL NOT BE OVERTOPPED.

CLEAR WATER DIVERSION SYSTEM

1. GRAVITY SYSTEM IS PREFERRED. SYSTEM SHALL BE CAPABLE OF CONVEYING ALL OF THE STREAM FLOW, 24-HOURS PER DAY UNTIL AREA IS STABILIZED.
2. THE PIPE MATERIAL SHALL BE SELECTED FOR FLEXIBILITY AND DURABILITY TO ALLOW FOR THE OCCASIONAL RELOCATION DURING CONSTRUCTION.
3. THE CONTRACTOR SHALL USE RESTRAINED PIPE JOINTS OR USE FITTINGS AND COUPLINGS THAT PREVENT SEPARATION OF PIPES.
4. THE CONTRACTOR HAS THE OPTION TO USE PUMPING INSTEAD OF GRAVITY FOR THE CLEAR WATER DIVERSION, BUT GRAVITY IS PREFERRED. IF GRAVITY IS NOT UTILIZED, PRESENT REASONS WITHIN THE WATER MANAGEMENT PLAN.
5. THE PUMP AND PUMPING APPARATUS USED FOR THE CLEAR WATER DIVERSION SHALL BE OF SUFFICIENT CAPACITY TO PUMP ALL THE STREAM FLOW.
6. THE CONTRACTOR SHALL PROVIDE BACKUP POWER AND PUMPING EQUIPMENT TO ASSURE THAT THE CLEAR WATER DIVERSION REMAINS FUNCTIONAL THROUGHOUT THE TIME PERIOD THAT THE CHANNEL IS ISOLATED.

DEWATERING SYSTEM

1. THE CONTRACTOR SHALL FURNISH ALL MATERIALS, TOOLS, EQUIPMENT, FACILITIES AND SERVICES AS REQUIRED FOR PROVIDING THE NECESSARY DEWATERING WORK AND FACILITIES, AND PROVIDE BACKUP EQUIPMENT AS NECESSARY FOR REPLACEMENT AND FOR UNANTICIPATED EMERGENCIES.
2. NUISANCE WATER IS WATER WITHIN THE ISOLATED WORK AREA.
3. REMOVED NUISANCE WATER SHALL NOT BE RETURNED DIRECTLY TO SURFACE WATERS AND SHALL BE TREATED IN ACCORDANCE WITH PERMITS.
4. REMOVAL OF NUISANCE WATER MAY BE NECESSARY 24-HOURS PER DAY TO MAINTAIN SUITABLE CONDITIONS IN THE WORK AREA.
5. GAS PUMPS SHALL BE SET IN APPROVED CONTAINMENT DEVICES.

EXECUTION

1. NO WORK MAY BEGIN UNTIL THE CONTRACTOR'S WATER MANAGEMENT PLAN HAS BEEN APPROVED.
2. PRIOR TO ANY INSTALLATION OF WATER MANAGEMENT FACILITIES, THE FISH REMOVAL WORK MUST BE COMPLETED.
3. INSTALL WATER MANAGEMENT SYSTEMS PER THE APPROVED WATER MANAGEMENT PLAN.
4. REFER TO CONTRACT DRAWING DETAILS FOR ADDITIONAL INFORMATION.
5. ONCE THE IN-CHANNEL WORK IS COMPLETED AND ACCEPTED, REMOVE WATER MANAGEMENT SYSTEMS PER THE APPROVED WATER MANAGEMENT PLAN AND AS DIRECTED.

.

FISH AND OTHER SPECIES MANAGEMENT

GENERAL

1. THE PROJECT AREA WILL LIKELY INCLUDE FISH AND OTHER SPECIES THAT NEED TO BE REMOVED PRIOR TO ANY IN-CHANNEL WORK, INCLUDING THE INSTALLATION OF WATER MANAGEMENT SYSTEMS. THE CONTRACTOR SHALL WORK WITH THE CONTRACT OWNER'S BIOLOGIST TO COORDINATE THE REMOVAL OF FISH AND OTHER SPECIES.
2. NO WORK MAY BE COMPLETED UNTIL THE WATER MANAGEMENT PLAN HAS BEEN APPROVED.

PRODUCTS

1. REFER TO CONTRACT DRAWING DETAILS FOR PRODUCT INFORMATION.

EXECUTION

1. THE CONTRACTOR MUST COORDINATE WITH THE CONTRACT OWNER AND THEIR BIOLOGIST. IT IS THE CONTRACTOR'S RESPONSIBILITY TO NOTIFY THE CONTRACT OWNER AT LEAST ONE WEEK PRIOR TO NEEDING THE BIOLOGIST'S SERVICES.

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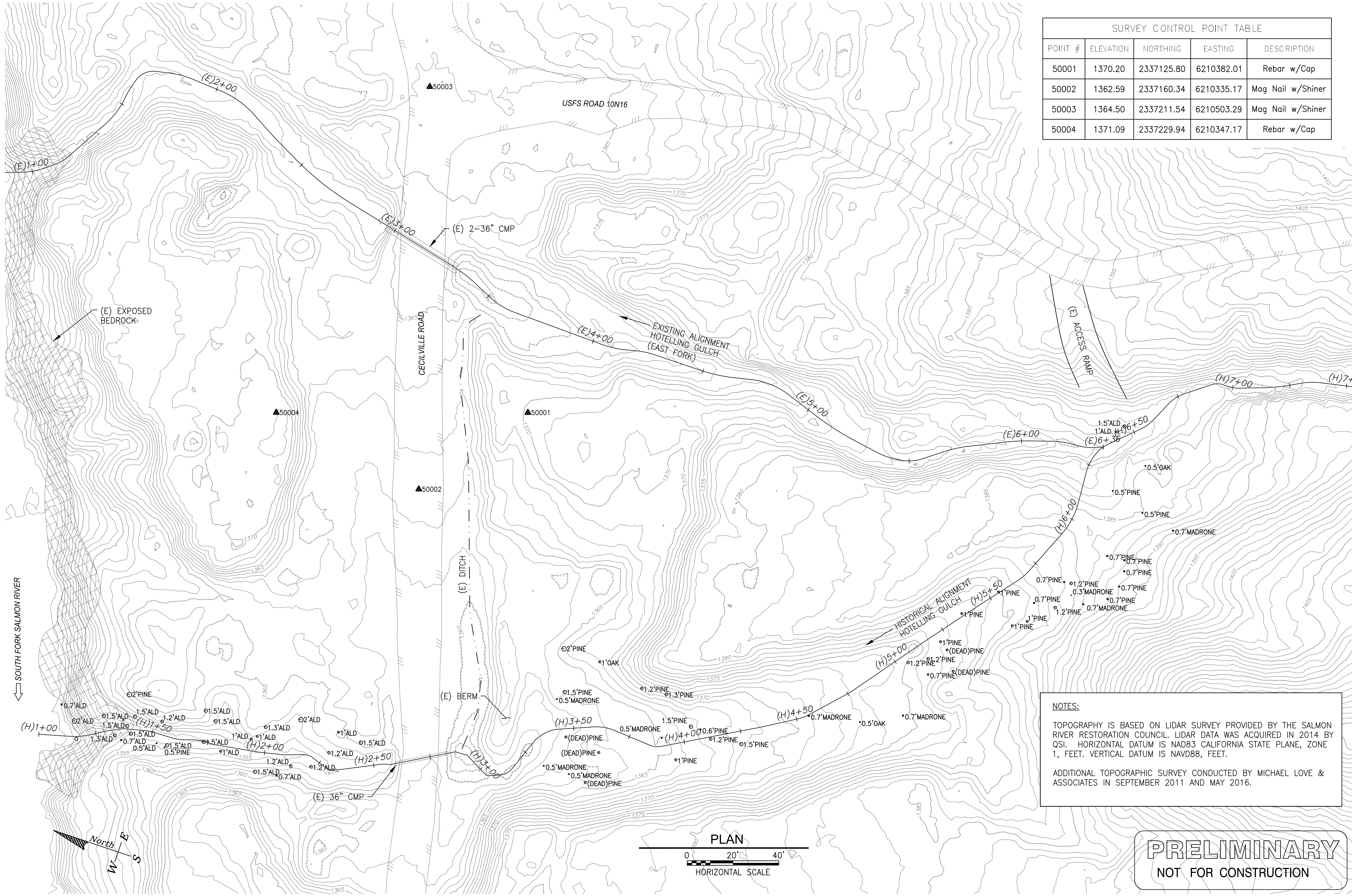
HOTELLING GULCH
AQUATIC RESTORATION PROJECT

WATER MANAGEMENT

DATE	OCT 2018
SUBMITTAL	90% DESIGN
DESIGN	RS / ML
DRAWN	AL
SHEET	4 of 29



SURVEY CONTROL POINT TABLE				
POINT #	ELEVATION	NORTHING	EASTING	DESCRIPTION
50001	1370.20	2337125.80	6210382.01	Rebar w/Cap
50002	1362.59	2337160.34	6210335.17	Mag Nail w/Shiner
50003	1364.50	2337211.54	6210503.29	Mag Nail w/Shiner
50004	1371.09	2337229.94	6210347.17	Rebar w/Cap

NOTES:

TOPOGRAPHY IS BASED ON LIDAR SURVEY PROVIDED BY THE SALMON RIVER RESTORATION COUNCIL. LIDAR DATA WAS ACQUIRED IN 2014 BY QSI. HORIZONTAL DATUM IS NAD83 CALIFORNIA STATE PLANE, ZONE 1, FEET. VERTICAL DATUM IS NAVD88, FEET.

ADDITIONAL TOPOGRAPHIC SURVEY CONDUCTED BY MICHAEL LOVE & ASSOCIATES IN SEPTEMBER 2011 AND MAY 2016.

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HOTELLING GULCH
AQUATIC RESTORATION PROJECT

EXISTING CONDITIONS

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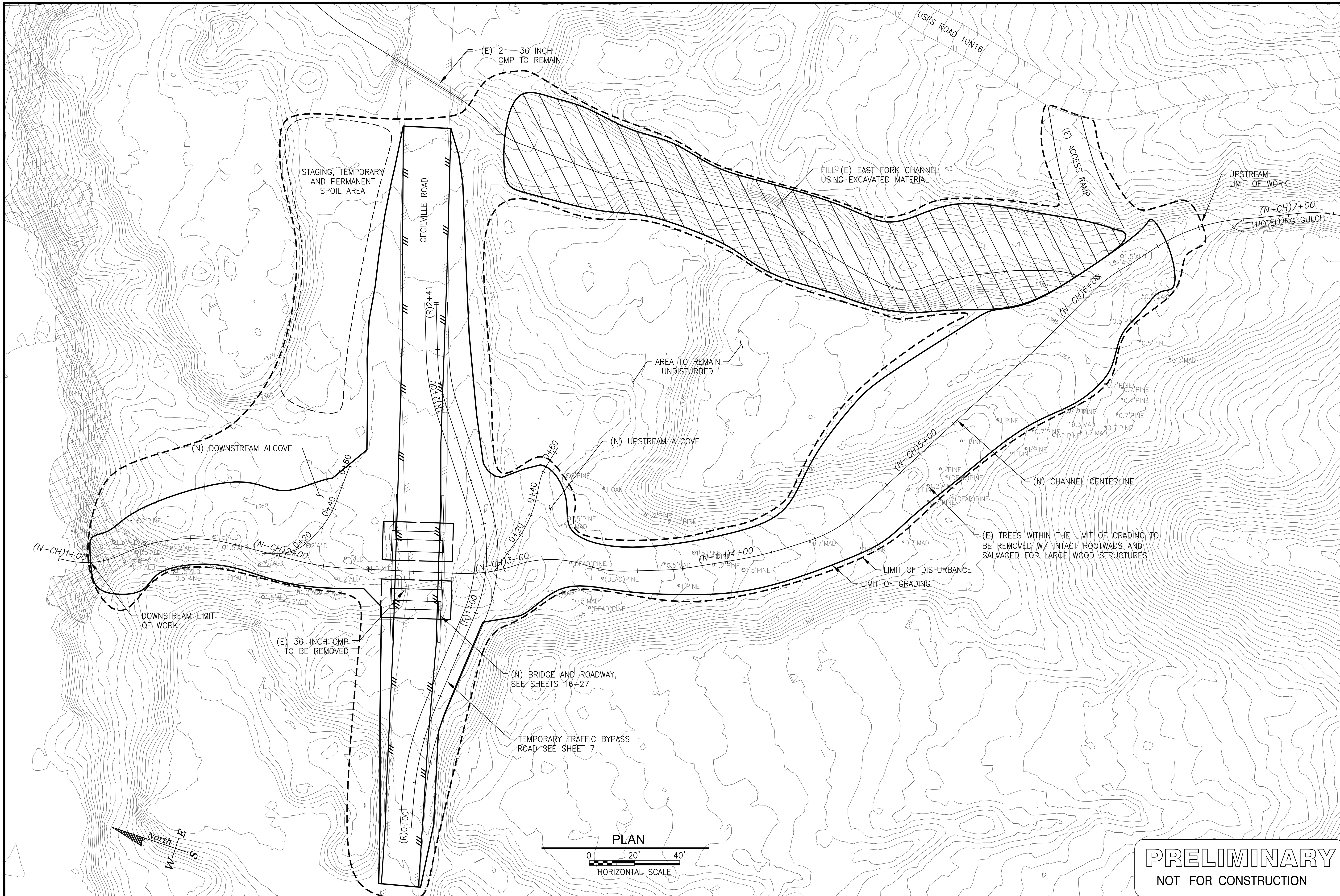

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AQUATIC RESTORATION PROJECT

CONSTRUCTION ACCESS AND DEMOLITION

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DESIGN
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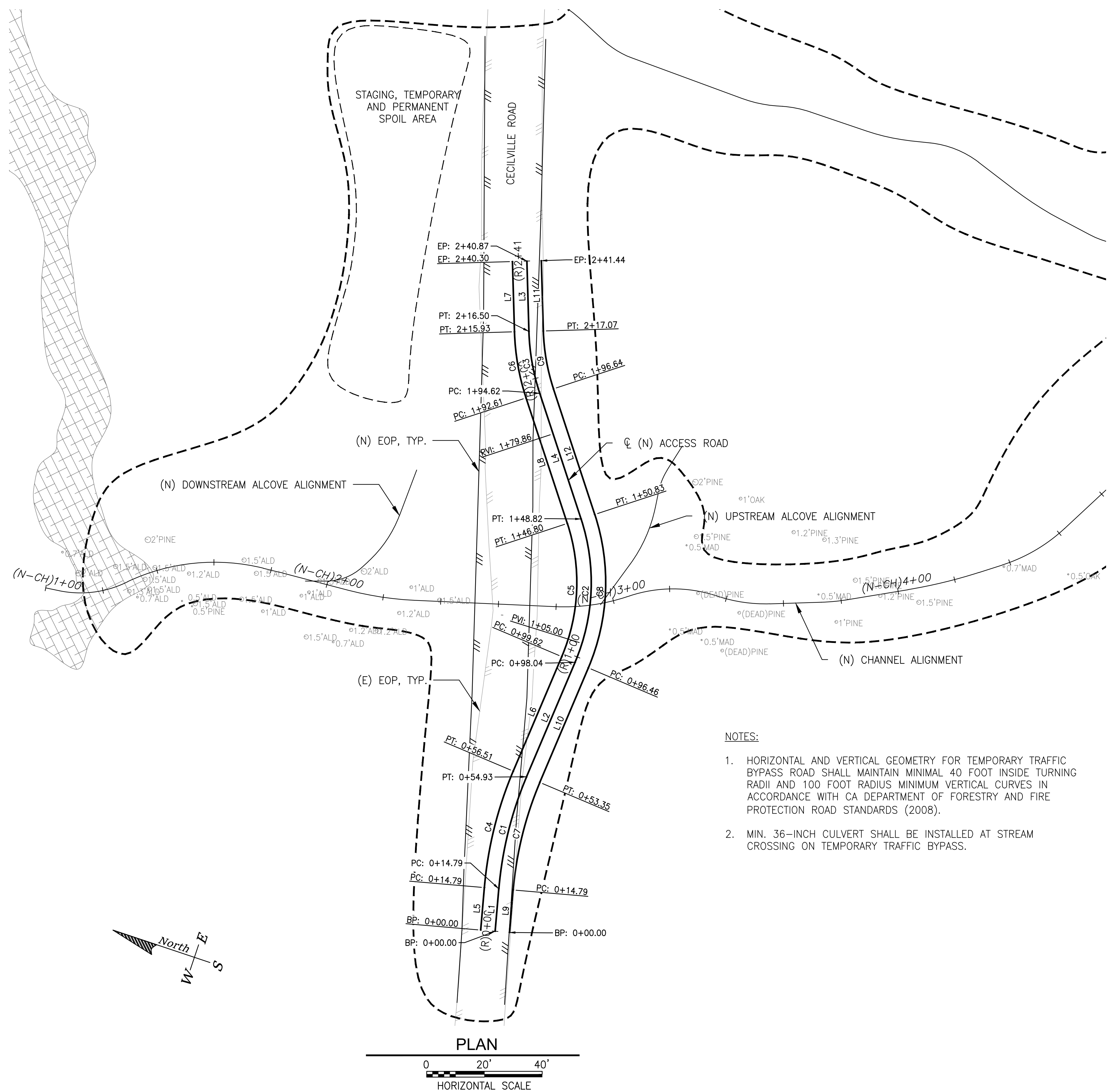

NOTES:

1. HORIZONTAL AND VERTICAL GEOMETRY FOR TEMPORARY TRAFFIC BYPASS ROAD SHALL MAINTAIN MINIMAL 40 FOOT INSIDE TURNING RADII AND 100 FOOT RADIUS MINIMUM VERTICAL CURVES IN ACCORDANCE WITH CA DEPARTMENT OF FORESTRY AND FIRE PROTECTION ROAD STANDARDS (2008).

2. MIN. 36-INCH CULVERT SHALL BE INSTALLED AT STREAM CROSSING ON TEMPORARY TRAFFIC BYPASS.

ROAD–BYPASS

Number	Length	Radius	Line/Chord Direction	Start Point (E,N)	End Point (E,N)
L1	14.788		N76° 22' 41.09"E	(6210119.6265,2337094.5437)	(6210133.9987,2337098.0266)
C1	40.144	127.193	N85° 25' 11.09"E		
L2	43.108		S85° 32' 18.91"E	(6210173.8485,2337101.2190)	(6210216.8262,2337097.8657)
C2	50.777	70.689	N73° 52' 59.06"E		
L4	45.807		N53° 18' 17.03"E	(6210264.5656,2337111.6602)	(6210301.2951,2337139.0328)
C3	21.878	75.798	N61° 34' 24.65"E		
L3	24.370		N69° 50' 32.27"E	(6210320.4686,2337149.4113)	(6210343.3461,2337157.8095)

ROAD–BYPASS–Left

Number	Length	Radius	Line/Chord Direction	Start Point (E,N)	End Point (E,N)
L5	14.788		N76° 22' 41.09"E	(6210118.4489,2337099.4031)	(6210132.8212,2337102.8859)
C4	41.722	132.193	N85° 25' 11.09"E		
L6	43.108		S85° 32' 18.91"E	(6210174.2374,2337106.2038)	(6210217.2152,2337102.8505)
C5	47.185	65.689	N73° 52' 59.06"E		
L8	45.807		N53° 18' 17.03"E	(6210261.5778,2337115.6693)	(6210298.3073,2337143.0419)
C6	23.321	80.798	N61° 34' 24.65"E		
L7	24.370		N69° 50' 32.27"E	(6210318.7455,2337154.1051)	(6210341.6231,2337162.5032)

ROAD–BYPASS–Right

Number	Length	Radius	Line/Chord Direction	Start Point (E,N)	End Point (E,N)
L9	14.788		N76° 22' 41.09"E	(6210120.8041,2337089.6844)	(6210135.1763,2337093.1672)
C7	38.566	122.193	N85° 25' 11.09"E		
L10	43.108		S85° 32' 18.91"E	(6210173.4596,2337096.2341)	(6210216.4373,2337092.8808)
C8	54.369	75.689	N73° 52' 59.06"E		
L12	45.807		N53° 18' 17.03"E	(6210267.5534,2337107.6511)	(6210304.2829,2337135.0237)
C9	20.435	70.798	N61° 34' 24.65"E		
L11	24.370		N69° 50' 32.27"E	(6210322.1916,2337144.7176)	(6210345.0691,2337153.1157)

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HOTELLING GULCH
AQUATIC RESTORATION PROJECT

TEMPORARY TRAFFIC BYPASS
ROAD GEOMETRY

DATE
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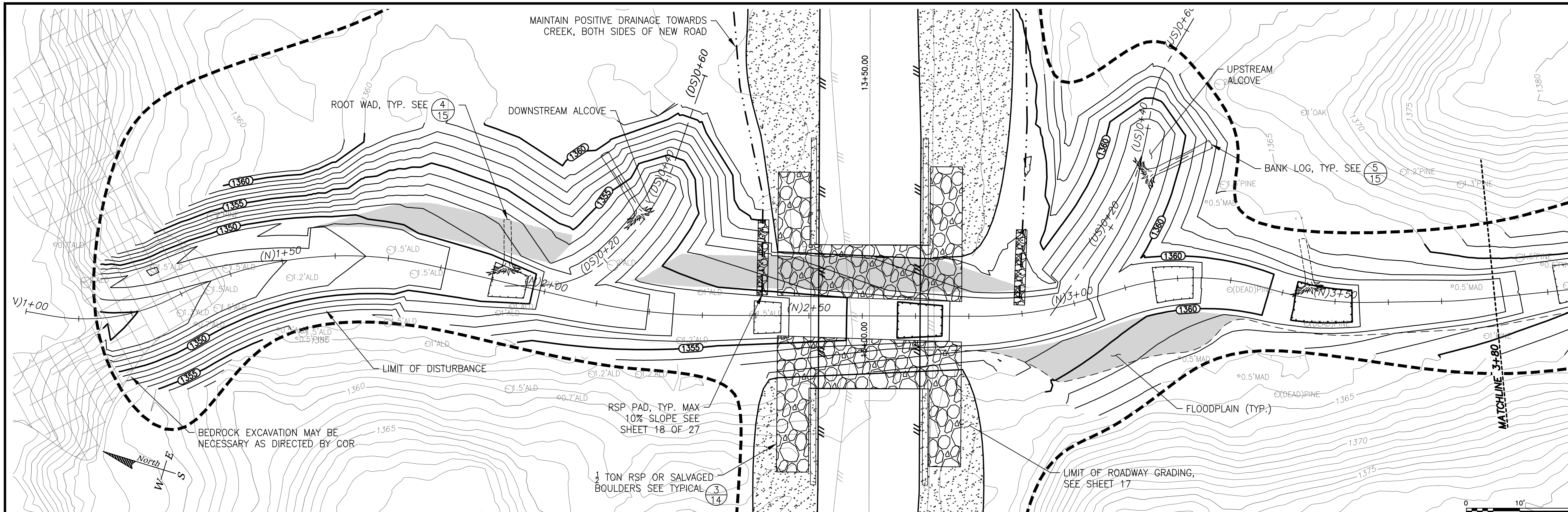
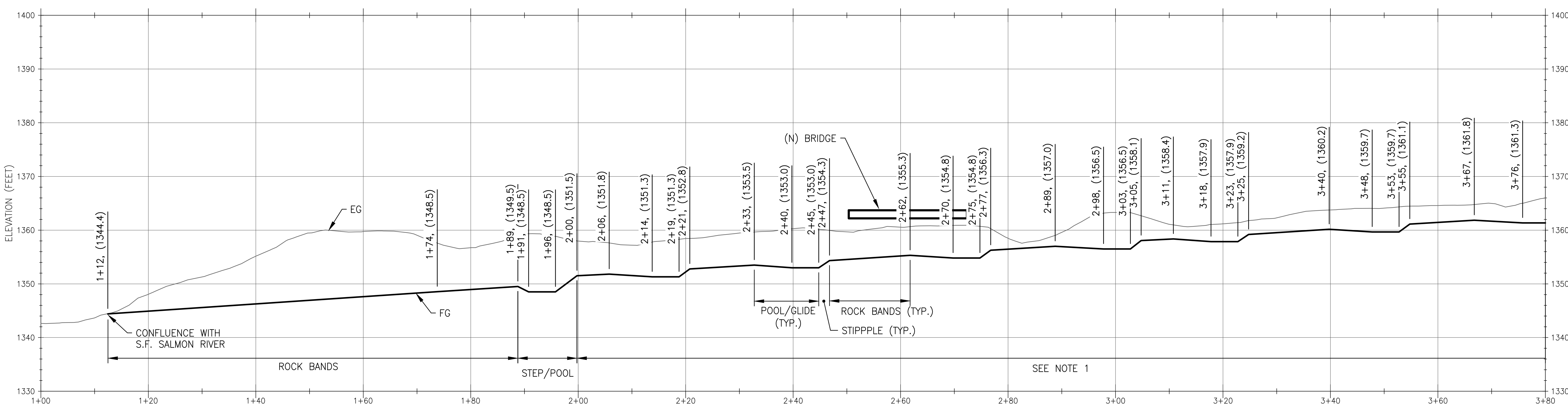


PLAN

(N) HOTELLING GULCH ALIGNMENT



NOTES:
1. FOR BOULDER AND LARGE WOOD STRUCTURES SEE TYPICAL: 1/13 2/13 4/15 5/15

HORIZONTAL AND VERTICAL SCALE

PROFILE

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PLAN & PROFILE - DOWNSTREAM

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SHEET: 8 of 29

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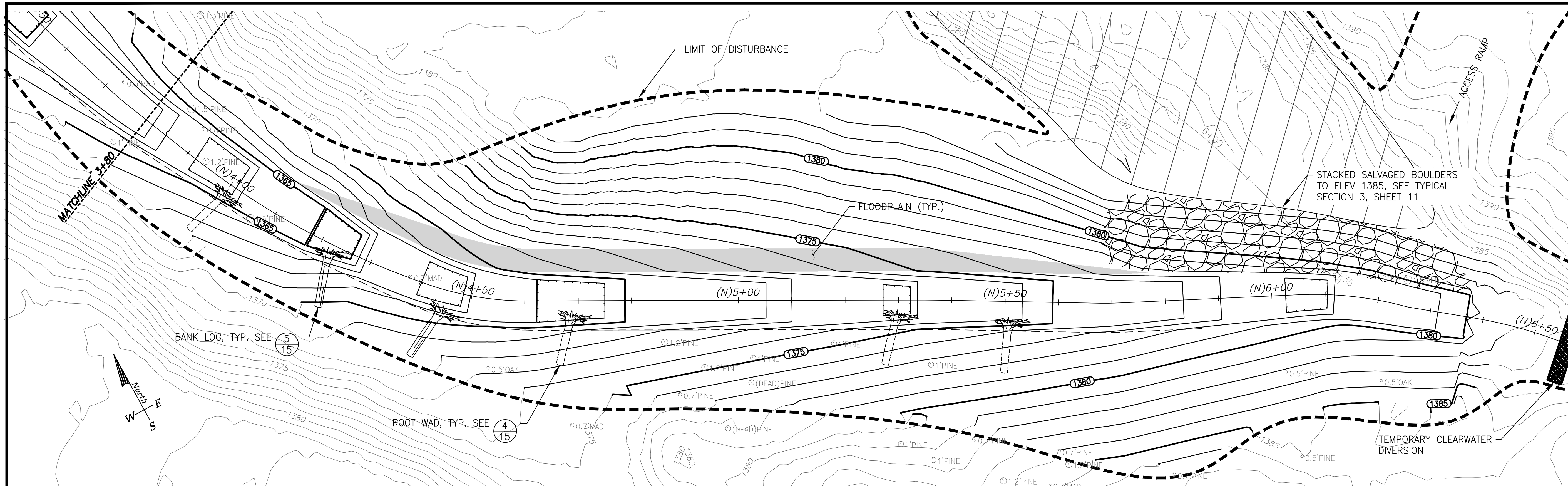
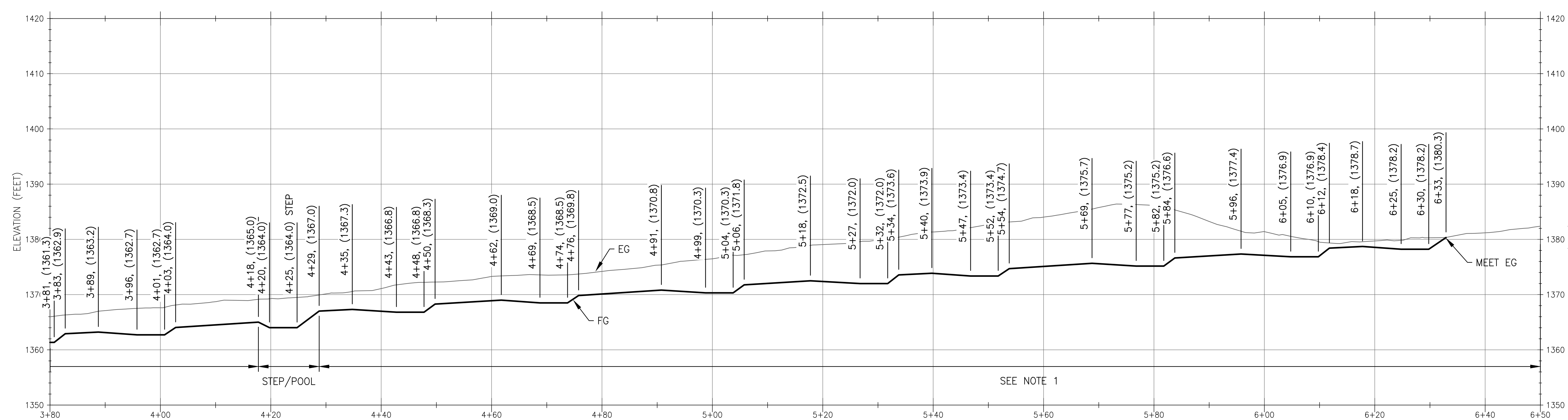


PLAN

(N) HOTELLING GULCH ALIGNMENT

0 10' 20'
HORIZONTAL SCALE



NOTES:
1. FOR BOULDER AND LARGE WOOD STRUCTURES SEE TYPICAL: 1/13 2/13 4/15 5/15

PROFILE

(N) HOTELLING GULCH ALIGNMENT

0 10' 20'
HORIZONTAL AND VERTICAL SCALE

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HOTELLING GULCH
AQUATIC RESTORATION PROJECT

PLAN & PROFILE - UPSTREAM

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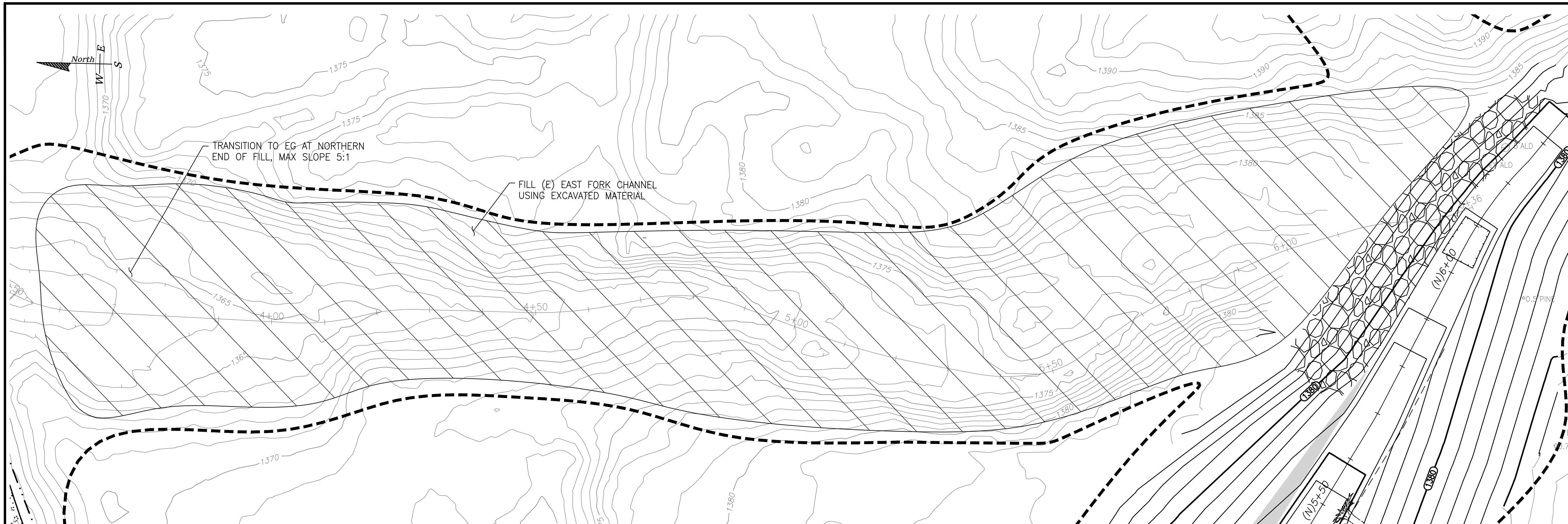
SHEET	9 of 29



NOTE: EXISTING TREES NOT SHOWN

0 10' 20'
HORIZONTAL SCALE

PLAN

EAST FORK HOTELLING GULCH ALIGNMENT

TYPICAL CROSS SECTION 5

FILL IN EAST FORK (TO BE ABANDONED) (NTS)

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HOTELLING GULCH
AQUATIC RESTORATION PROJECT

PLAN & SECTION - EXISTING CHANNEL ALIGNMENT

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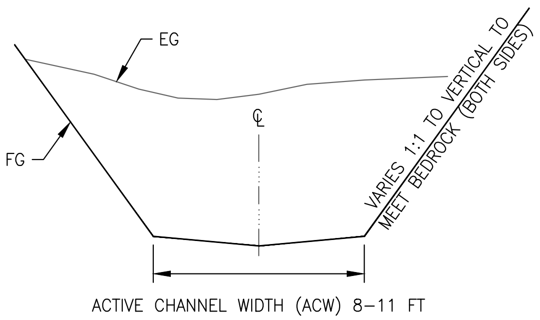
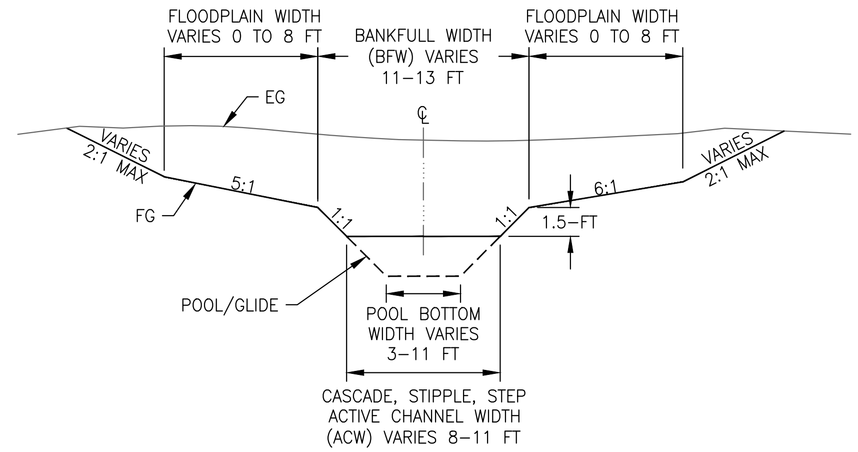


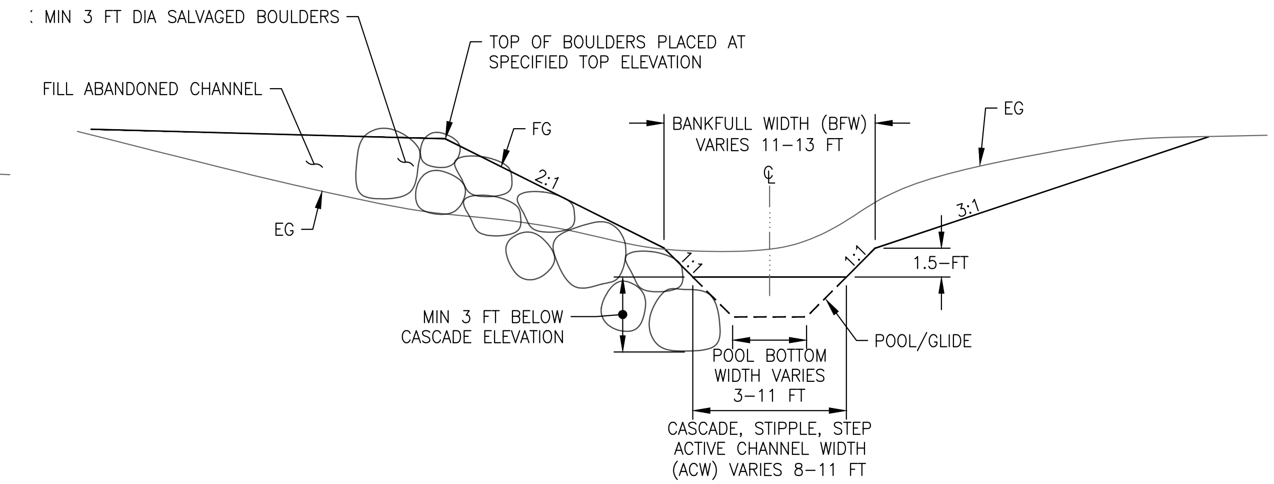
TYPICAL CROSS SECTION 1

STATIONS 1+10 TO 1+70 (NTS)



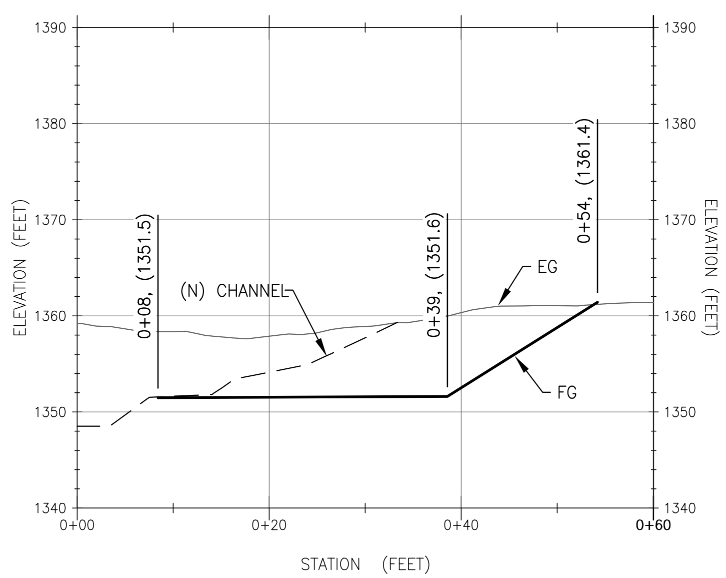
TYPICAL CROSS SECTION 2

STATIONS 1+80 TO 5+60 (NTS)



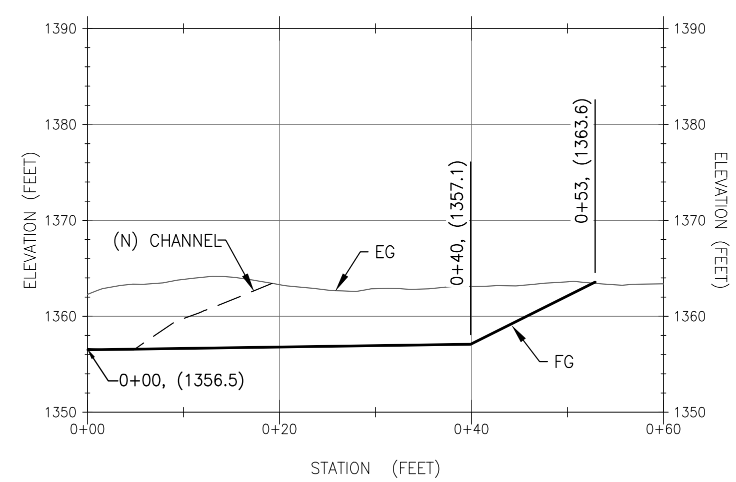
TYPICAL CROSS SECTION 3

STATIONS 5+70 TO 6+40 (NTS)



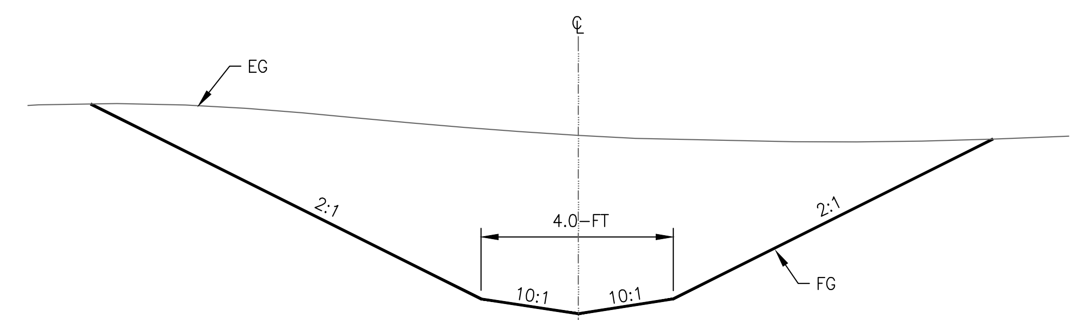
PROFILE

DS ALCOVE ALIGNMENT



PROFILE

US ALCOVE ALIGNMENT



TYPICAL CROSS SECTION 4

US AND DS ALCOVE (NTS)

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HOTELLING GULCH
AQUATIC RESTORATION PROJECT
TYPICAL CHANNEL SECTIONS

DATE	OCT 2018
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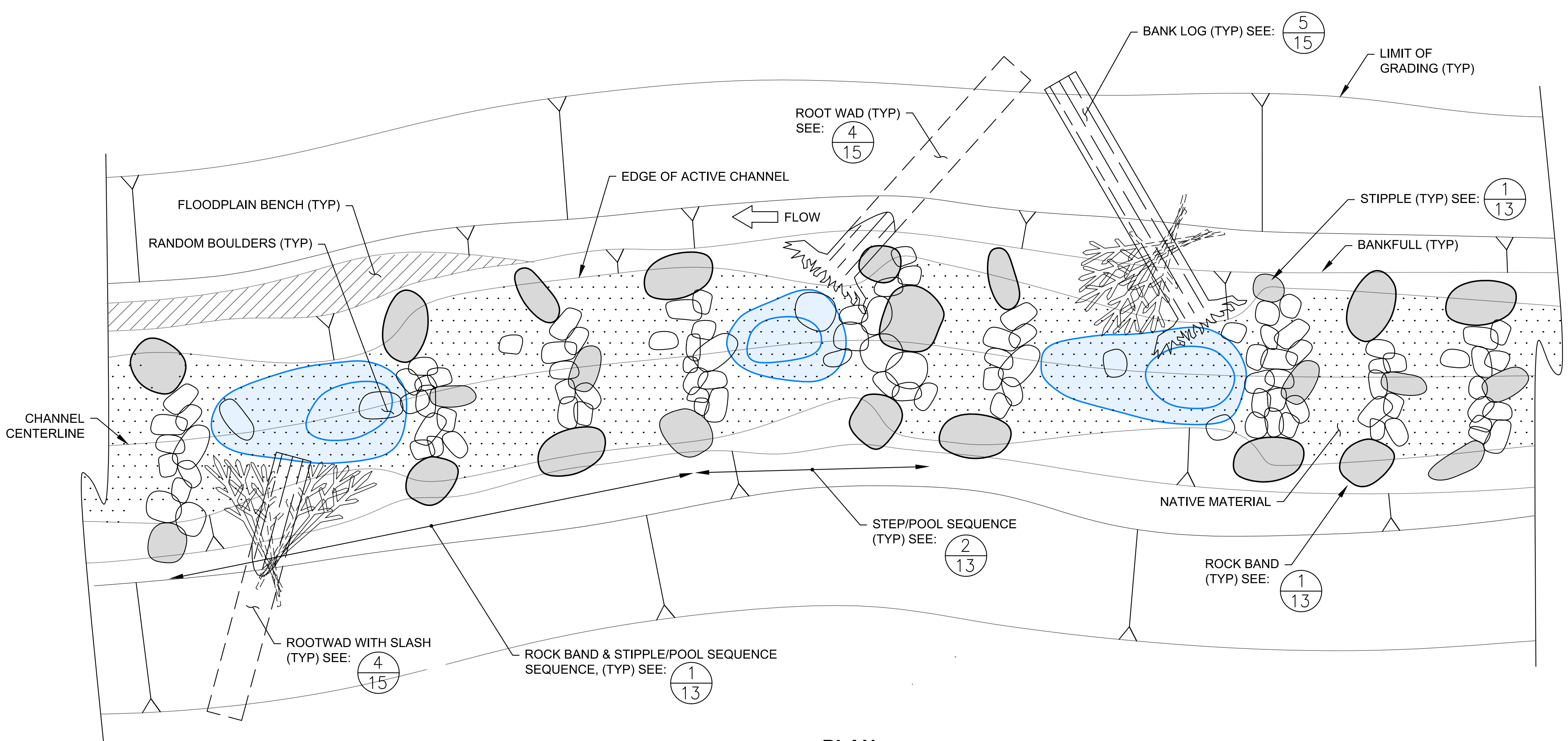
SHEET	11 of 29



NOTES:

1. THIS VIEW INTENDED TO SHOW SCHEMATICALLY PLACEMENT OF LARGE WOOD AND BOULDER STRUCTURES. SEE TYPICAL: 1/13, 2/13, 4/15, 5/15

PLAN

BOULDER AND LARGE WOOD PLACEMENT

SCHEMATIC LAYOUT **NTS**

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BOULDER CASCADE, STEP AND POOL TYPICALS

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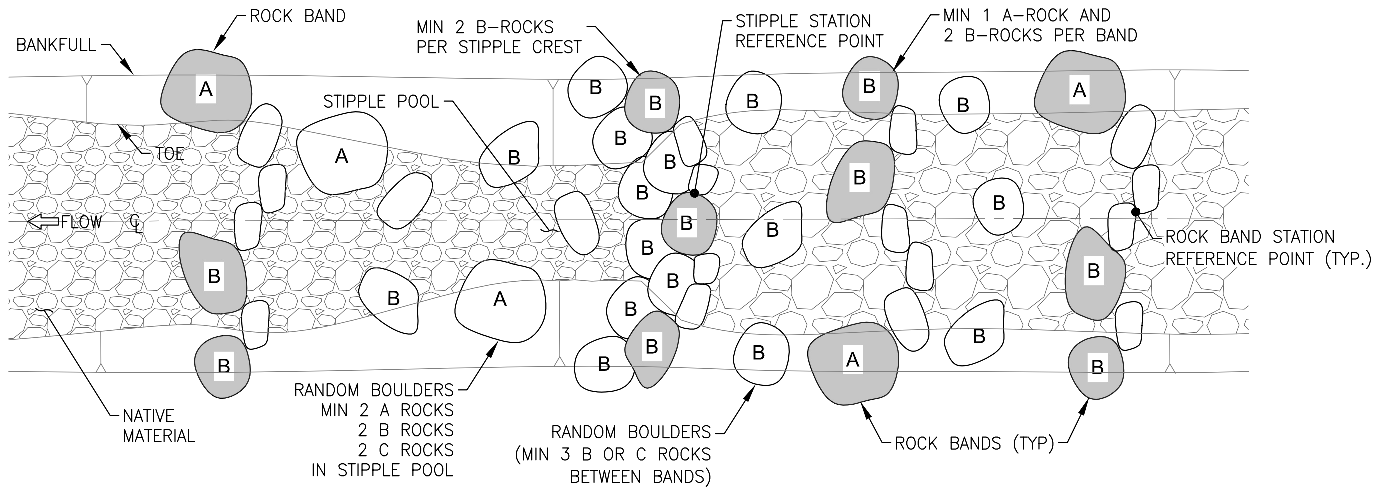
SHEET	12 of 29



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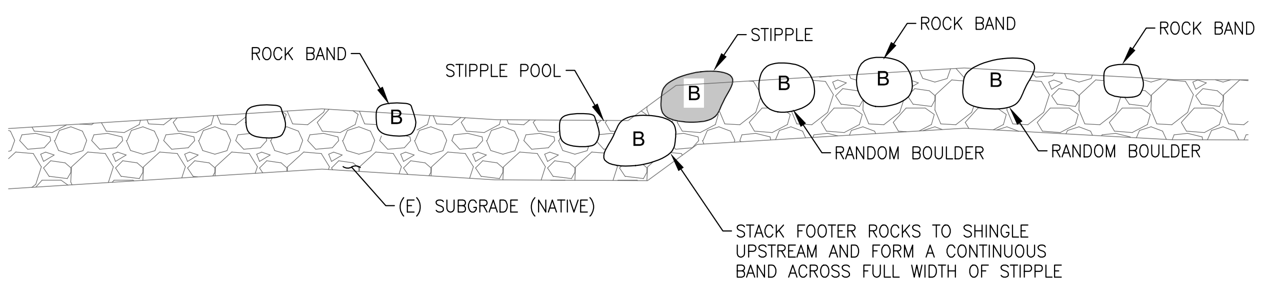

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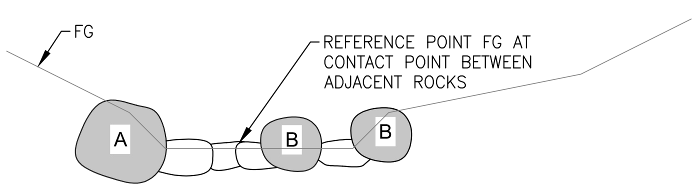
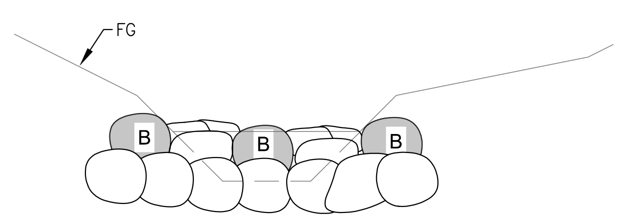
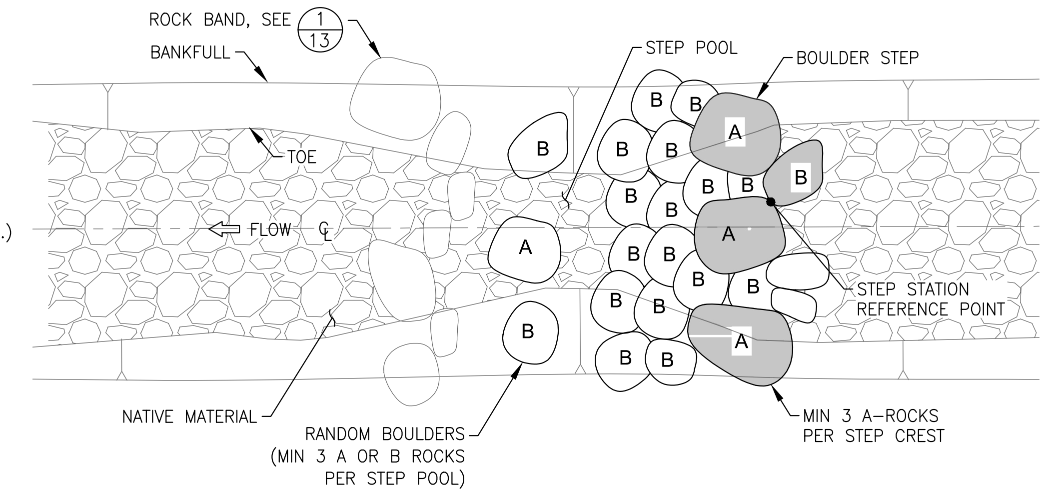


ROCK BAND CROSS SECTION



STIPPLE CROSS SECTION

1 **ROCK BAND AND STIPPLE / POOL**
TYPICAL **NTS**

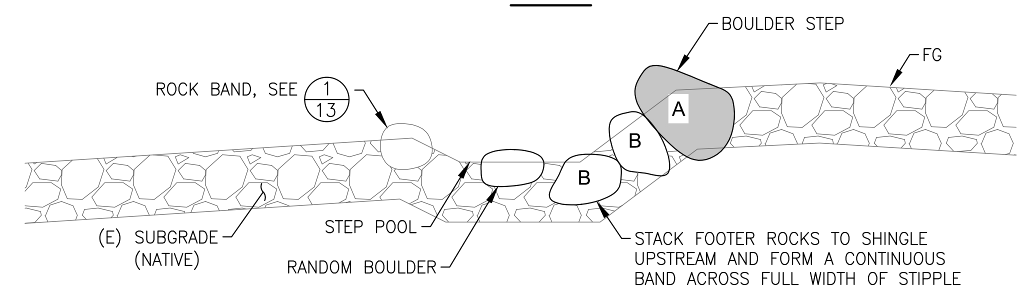


PLAN

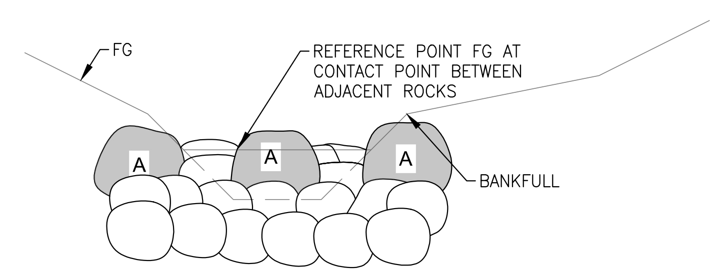
NOTES FOR BOULDER STRUCTURES:
1. "C" ROCKS SHOWN BUT NOT LABELED
2. SALVAGED ROOT WADS WITH STEMS TO BE SUBSTITUTED FOR "A" ROCKS AT DIRECTION OF COR
3. ADD ROOT WAD OR BANK LOG TO POOLS WHERE SPECIFIED AND AS DIRECTED BY COR
4. SEE TABLE SHEET 14 FOR LOCATIONS AND ELEVATIONS OF BOULDER STRUCTURES

BOULDER SIZE TABLE
(INTERMEDIATE DIAMETER)

A – 30 TO 40 INCHES
B – 18 TO 30 INCHES
C – 10 TO 18 INCHES



PROFILE



CROSS SECTION

2 **STEP / POOL**
TYPICAL **NTS**

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HOTELLING GULCH
AQUATIC RESTORATION PROJECT
BOULDER STRUCTURE TYPICALS

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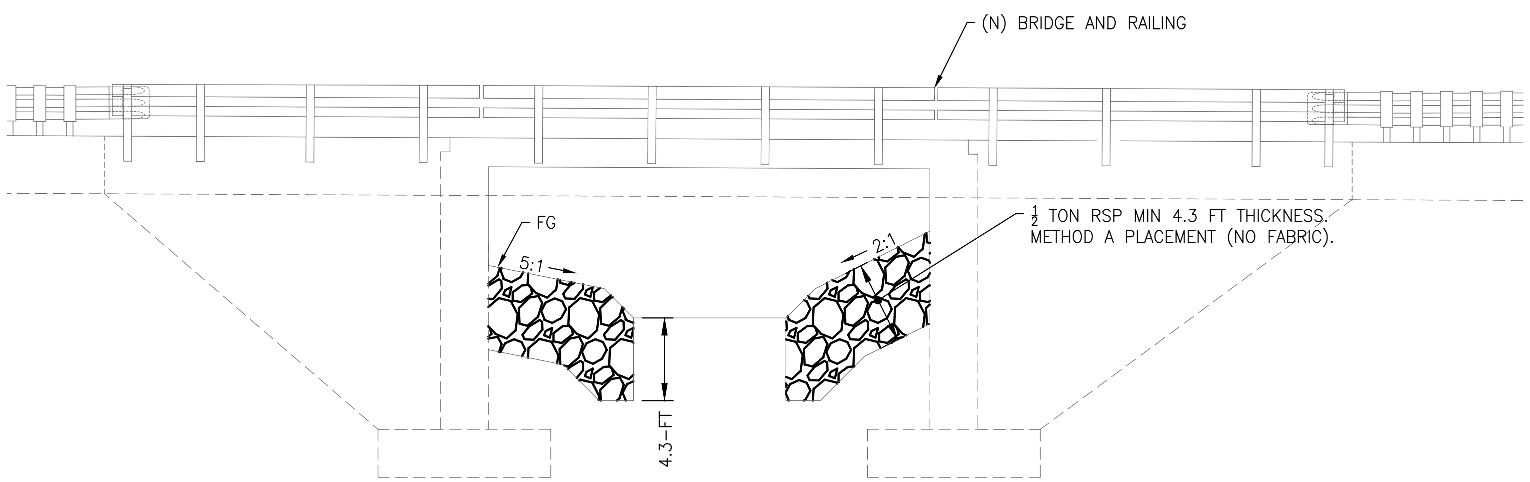
SUBMITTAL 90% DESIGN
DESIGN RS / ML
DRAWN AL
SHEET 13 of 29



3 RSP AT BRIDGE

TYPICAL NTS

LOCATIONS AND ELEVATIONS OF BOULDER STRUCTRES

STATION	ELEVATION	STRUCTRE TYPE
6+47	1380.5	ROCK BAND
6+39	1380.0	ROCK BAND
6+32	1379.6	STIPPLE
6+18	1378.7	ROCK BAND
6+12	1378.4	STIPPLE
5+96	1377.4	ROCK BAND
5+90	1377.0	ROCK BAND
5+84	1376.6	STIPPLE
5+69	1375.7	ROCK BAND
5+61	1375.2	ROCK BAND
5+54	1374.7	STIPPLE
5+40	1373.9	ROCK BAND
5+34	1373.6	STIPPLE
5+18	1372.5	ROCK BAND
5+12	1372.1	ROCK BAND
5+06	1371.8	STIPPLE
4+91	1370.8	ROCK BAND
4+83	1370.3	ROCK BAND
4+76	1369.8	STIPPLE
4+62	1369.0	ROCK BAND
4+56	1368.6	ROCK BAND
4+50	1368.3	STIPPLE
4+35	1367.3	ROCK BAND
4+29	1367.0	STEP
4+18	1365.0	ROCK BAND
4+10	1364.5	ROCK BAND
4+03	1364.0	STIPPLE
3+89	1363.2	ROCK BAND
3+83	1362.9	STIPPLE
3+67	1361.8	ROCK BAND
3+61	1361.5	ROCK BAND
3+55	1361.1	STIPPLE
3+40	1360.2	ROCK BAND
3+32	1359.7	ROCK BAND
3+25	1359.2	STIPPLE
3+11	1358.4	ROCK BAND
3+05	1358.1	STIPPLE
2+89	1357.0	ROCK BAND
2+83	1356.6	ROCK BAND
2+77	1356.3	STIPPLE
2+62	1355.3	ROCK BAND
2+54	1354.8	ROCK BAND
2+47	1354.3	STIPPLE
2+33	1353.5	ROCK BAND
2+27	1353.1	ROCK BAND
2+21	1352.8	STIPPLE
2+06	1351.8	ROCK BAND
2+00	1351.5	STEP
1+89	1349.5	ROCK BAND
1+78	1348.8	ROCK BAND
1+67	1348.1	ROCK BAND
1+56	1347.3	ROCK BAND
1+45	1346.6	ROCK BAND
1+34	1345.9	ROCK BAND
1+23	1345.1	ROCK BAND
1+12	1344.4	ROCK BAND

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VERIFY SCALE
THIS BAR IS ONE INCH LONG AT FULL SCALE

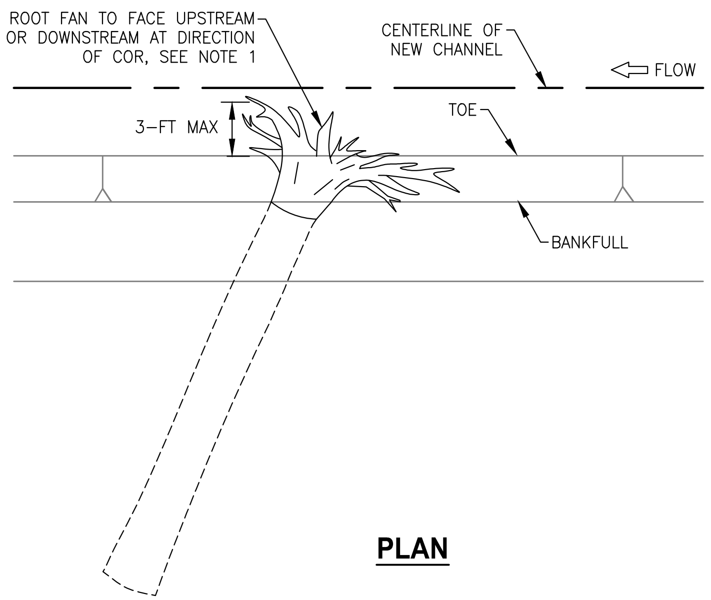
Salmon River Restoration Council and Klamath National Forest
HOTELLING GULCH
AQUATIC RESTORATION PROJECT
BOULDER STRUCTRE TABLE

DATE: OCT 2018
SUBMITTAL: 90% DESIGN
DESIGN: RS / ML
DRAWN: AL
SHEET: 14 of 29

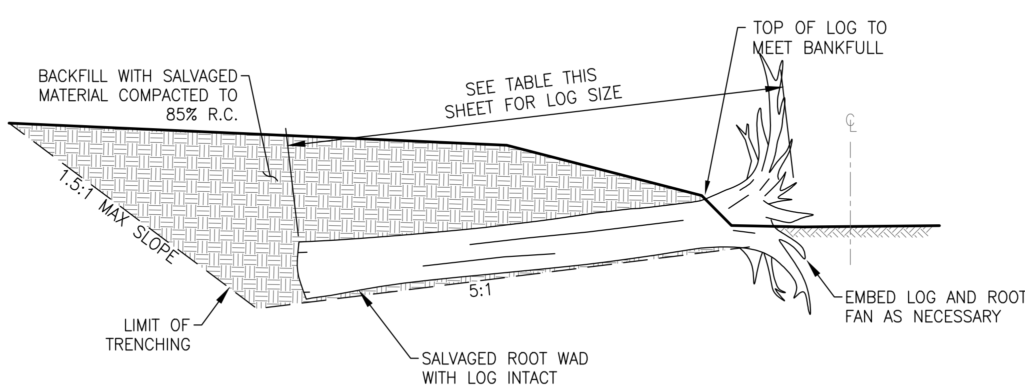
NOTE:
1. IF ROOTWAD NOT AVAILABLE INCORPORATE SLASH PINNED UNDER LOG IN STREAM CHANNEL AS DIRECTED BY COR.

LOG SIZES FOR ROOTWADS	
LOG DIAMETER	MIN LOG LENGTH
<2 FT	15 FT
2–3 FT	18 FT

1. LOG LENGTH INCLUDES ROOTWAD
2. LOG DIAMETER SHALL BE MEASURED AT LOG MIDPOINT
3. LOGS EXCEEDING THE MAXIMUM DIAMETER WILL NEED ADDITIONAL BURIAL AS DIRECTED BY THE COR

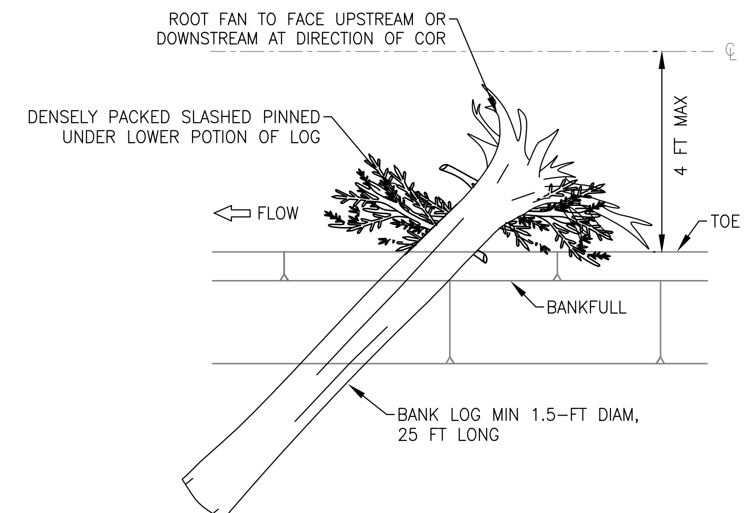


PLAN



ELEVATION

4 ROOTWAD PLACEMENT DETAIL
TYPICAL **NTS**



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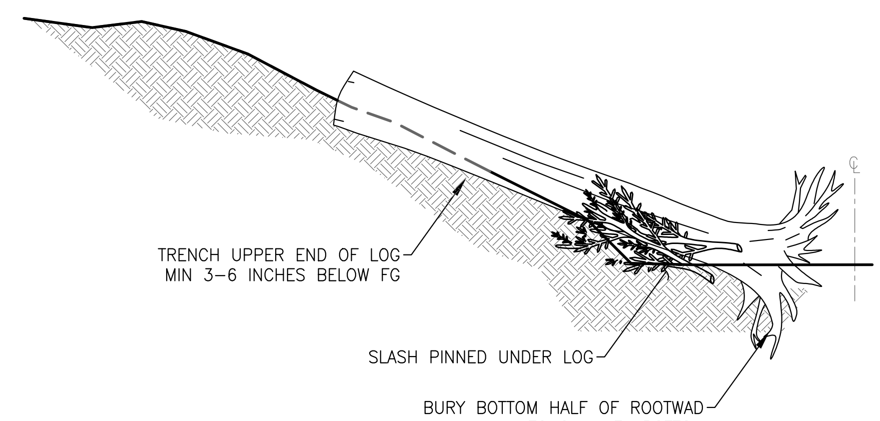

ELEVATION

5 BANK LOG DETAIL
TYPICAL **NTS**

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HOTELLING GULCH
AQUATIC RESTORATION PROJECT
LARGE WOOD STRUCTURE TYPICALS

DATE
OCT 2018
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DESIGN
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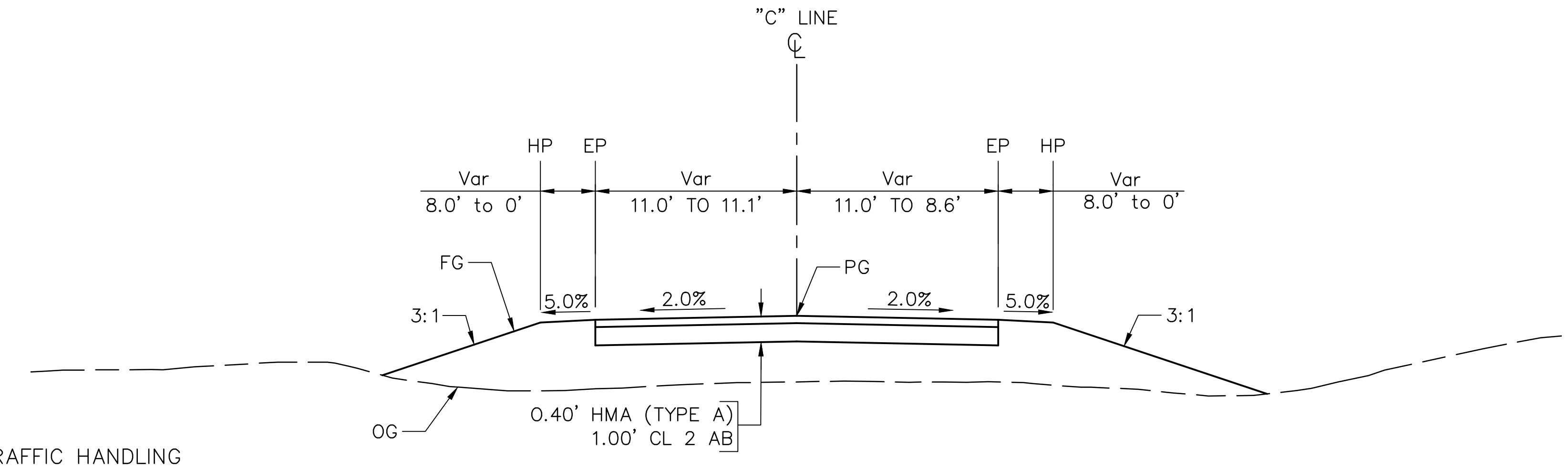
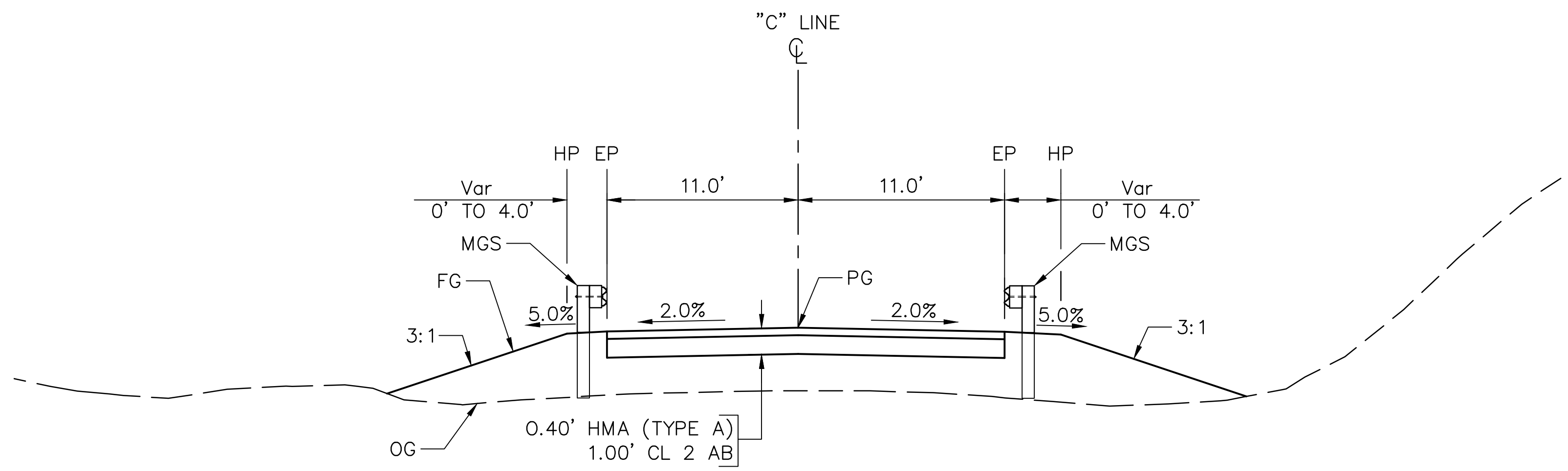
90% DRAFT PLANS
NOT FOR CONSTRUCTION

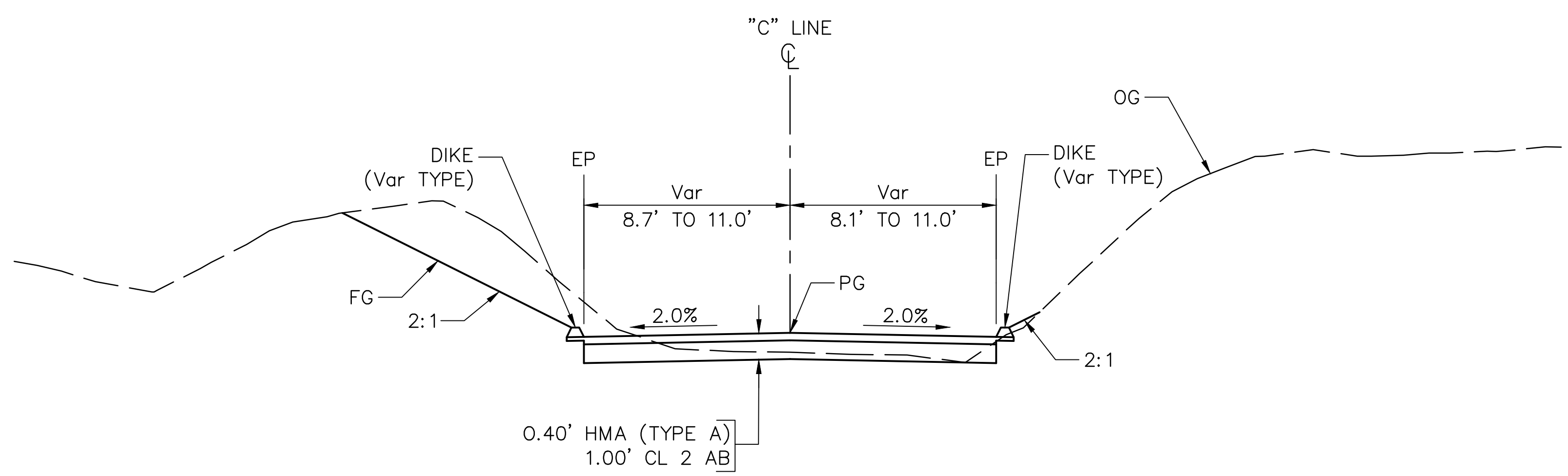
INDEX OF ROAD PLANS



CECILVILLE ROAD
STA "C" 13+17.75 EB TO STA "C" 15+00.00



CECILVILLE ROAD
STA "C" 12+40.00 TO STA "C" 12+90.75 BB



CECILVILLE ROAD
STA "C" 11+65.00 TO STA "C" 12+40.00

DESIGN DATA: CECILVILLE ROAD

V = 35 MPH
R = 30
TI = 7

NOTES:

1. DIMENSIONS OF THE PAVEMENT STRUCTURES (STRUCTURAL SECTIONS) ARE SUBJECT TO TOLERANCES SPECIFIED IN THE STANDARD SPECIFICATIONS.
2. FOR METAL BEAM GUARD RAILING AND DIKE LIMITS, SEE PLAN AND PROFILE SHEET.

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11017 COBBLEROCK DRIVE, SUITE 100
RANCHO CORDOVA, CA 95670
P: 916.368.9181

Salmon River Restoration Council
PO BOX 1089 • 25631 Sawyers Bar RD, Sawyers Bar CA 96027
530-462-4665 Fax 530-462-4664

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HOTELLING GULCH FISH ACCESS
AND CHANNEL RESTORATION PROJECT

TYPICAL CROSS SECTIONS

DATE
OCTOBER 2018
SUBMITTAL
90% DESIGN
DESIGN
AM / □□
DRAWN
AM
SHEET
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NOTES:

1. FOR COMPLETE R/W DATA, SEE R/W RECORD MAPS AT THE CO OFFICE.
2. FOR Chnl WORK, SEE Chnl PLANS.

ABBREVIATIONS:

USFS UNITED STATES FOREST SERVICE

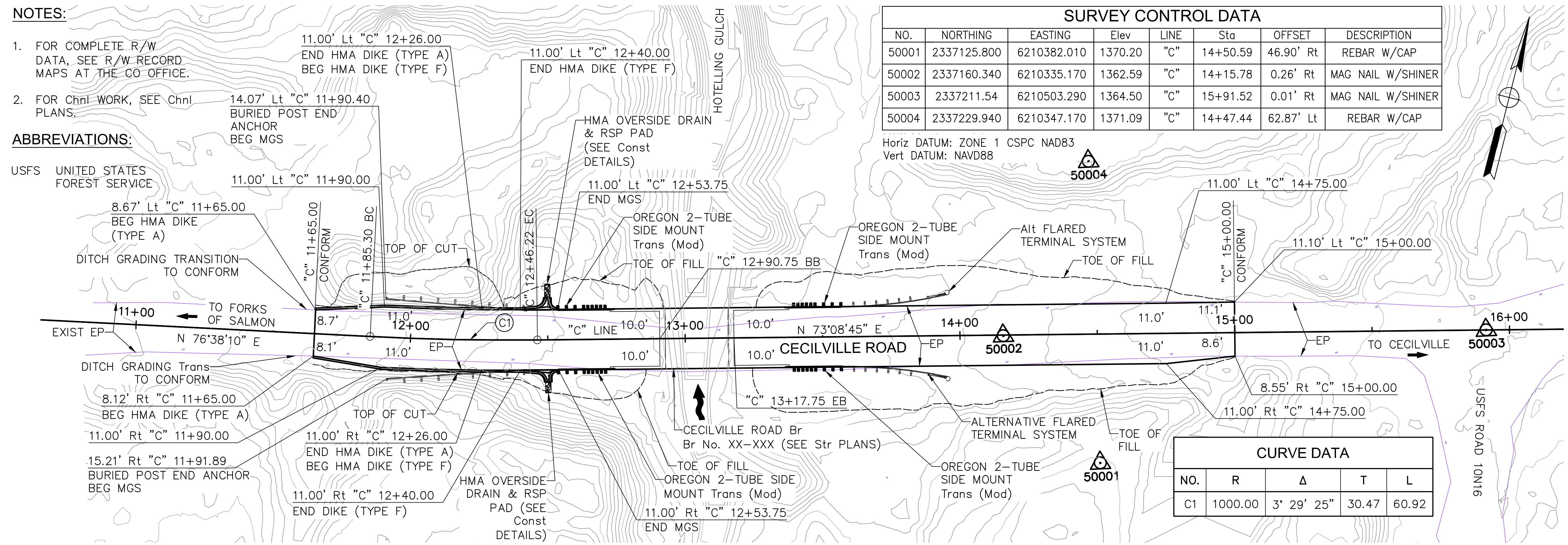
SURVEY CONTROL DATA

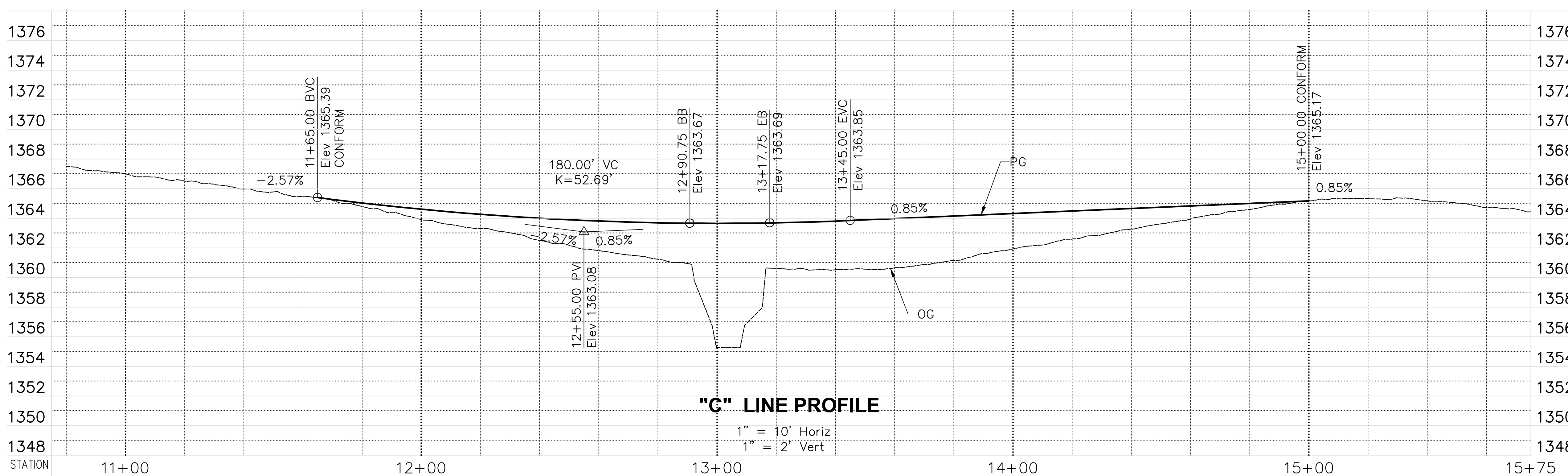
NO.	NORTHING	EASTING	Elev	LINE	Sta	OFFSET	DESCRIPTION
50001	2337125.800	6210382.010	1370.20	"C"	14+50.59	46.90' Rt	REBAR W/CAP
50002	2337160.340	6210335.170	1362.59	"C"	14+15.78	0.26' Rt	MAG NAIL W/SHINER
50003	2337211.54	6210503.290	1364.50	"C"	15+91.52	0.01' Rt	MAG NAIL W/SHINER
50004	2337229.940	6210347.170	1371.09	"C"	14+47.44	62.87' Lt	REBAR W/CAP

Horiz DATUM: ZONE 1 CSPC NAD83
Vert DATUM: NAVD88

CURVE DATA

NO.	R	Δ	T	L
C1	1000.00	3° 29' 25"	30.47	60.92





"C" LINE PROFILE

1" = 10' Horiz
1" = 2' Vert

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HOTELLING GULCH FISH ACCESS AND CHANNEL RESTORATION PROJECT

PLAN & PROFILE

DATE
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90% DESIGN
DESIGN
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AM
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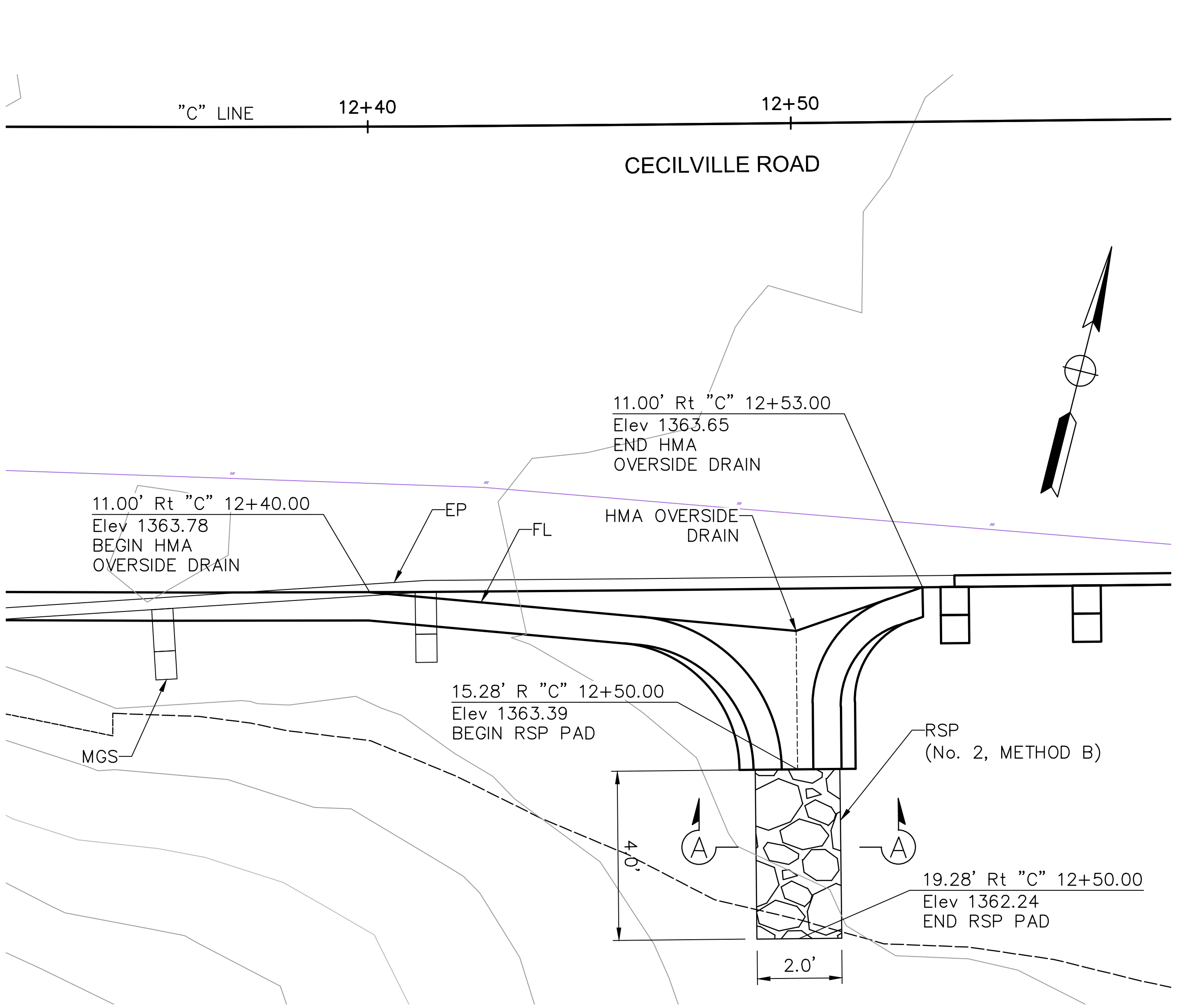
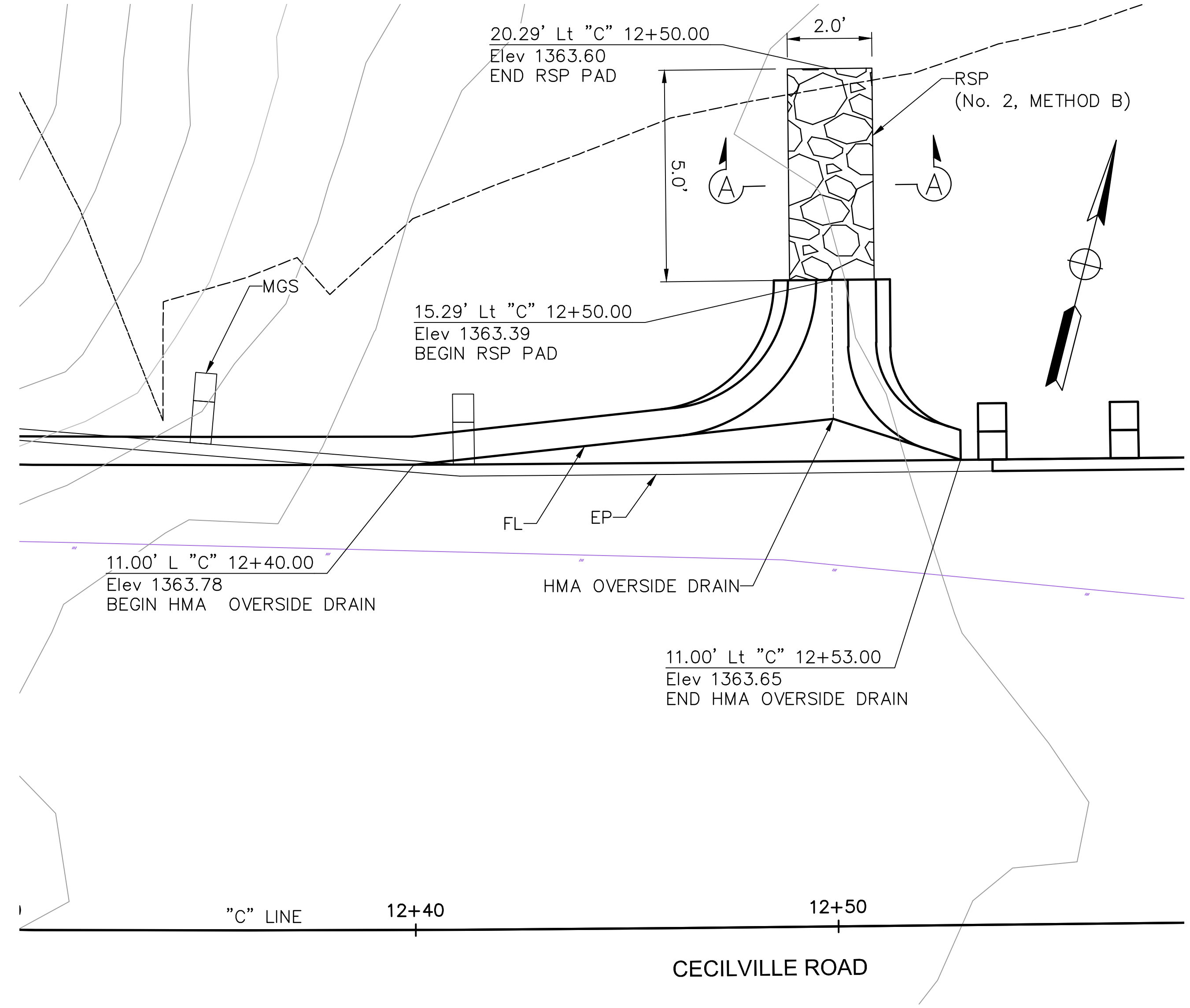


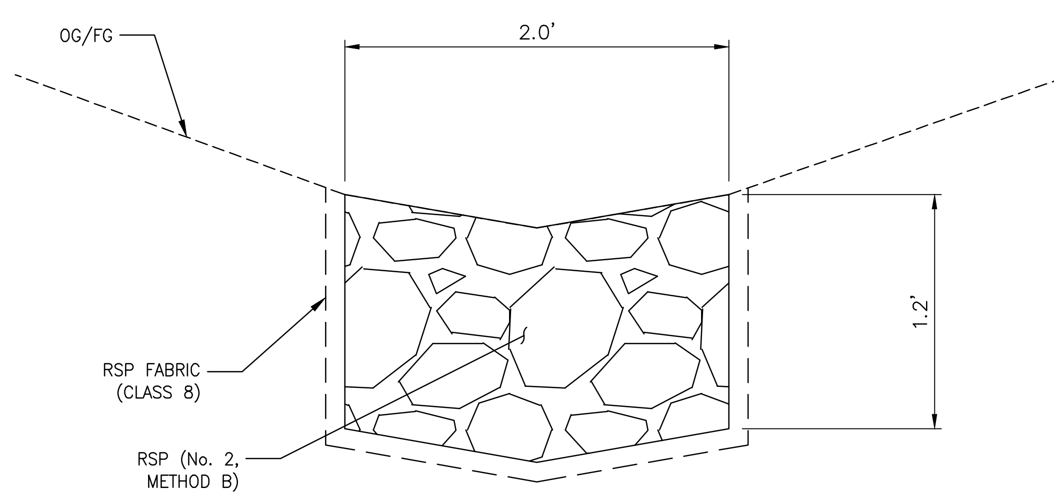
RSP PLAN

1" = 2'



RSP PLAN

1" = 2'



SECTION A-A

NO SCALE

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HOTELLING GULCH FISH ACCESS AND CHANNEL RESTORATION PROJECT

CONSTRUCTION DETAILS

DATE OCTOBER 2018

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DESIGN AM /

DRAWN AM

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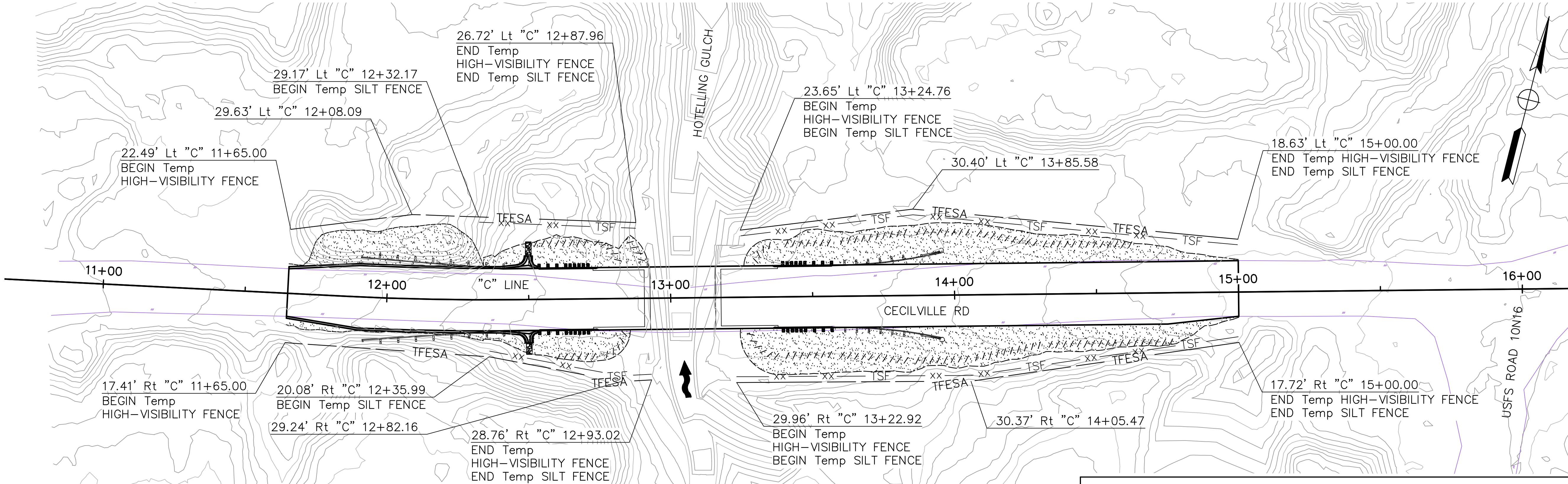
NOTES:

1. THIS PLAN ACCURATE FOR EROSION CONTROL ONLY.
2. LOCATION AND PLACEMENT OF FIBER ROLLS TO BE DETERMINED BY THE ENGINEER.



LEGEND:

- EROSION CONTROL (TYPE 1)
- — — — — TFESA — TEMPORARY HIGH–VISIBILITY FENCE
- —xx—xx— TSF — TEMPORARY SILT FENCE
- FIBER ROLL

EROSION CONTROL (TYPE 1)

SEQUENCE	ITEM	MATERIAL DESCRIPTION	MATERIAL TYPE	APPLICATION RATE	REMARKS
STEP 1	HYDROSEED	SEED	MIX	110 LB/ACRE	
		FIBER	WOOD	500 LB/ACRE	
STEP 2	STRAW	STRAW	WHEAT &/OR BARLEY	2 TON/ACRE	
STEP 3	HYDROMULCH	FIBER	WOOD	750 LB/ACRE	
		TACKIFIER	PSYLLIUM	120 LB/ACRE	
STEP 4	ROLLED EROSION CONTROL PRODUCT (NETTING)	NETTING	TYPE B		
STEP 5	FIBER ROLLS	FIBER ROLL	8" TO 10" DIA		TYPE 2 INSTALLATION

SEED MIX

BOTANICAL NAME (COMMON NAME)	PERCENT GERMINATION (MINIMUM)	POUNDS PURE LIVE SEED PER ACRE (SLOPE MEASUREMENT)
ACHILLEA MILLEFOLIUM (WHITE YARROW)	40.0	1.0
BROMUS CARINATUS (CALIFORNIA BROME)	45.0	35.0
DESCHAMPSIA CESPITOSA ssp. CESPITOSA (TUFTED HAIRGRASS)	40.0	3.0
ELYMUS GLAUCUS 'BERKELEY' (BLUE WILD RYE, BERKELEY)	55.0	20.0
ELYMUS X TRITICUM (REGREEN)	10.0	60.0
FESTUCA IDAHOENSIS (IDAHO FESCUE)	40.0	12.0
FESTUCA CALIFORNICA (CALIFORNIA FESCUE)	40.0	8.0
LOTUS PURSHIANUS 'SHASTA' (PURSHING'S LOTUS, SHASTA)	40.0	10.0
VULPIA MICROSTACHYS (SIX WEEKS FESCUE)	55.0	3.0
	TOTAL	152.0

OTHER NATIVE SPECIES APPROPRIATE TO THE ECOSITE MAY BE SUBSTITUTED FOR THE ABOVE SPECIES; WITH APPROVAL OF THE ENGINEER

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Salmon River Restoration Council and Klamath National Forest
HOTELLING GULCH FISH ACCESS AND CHANNEL RESTORATION PROJECT

EROSION CONTROL PLAN

DATE OCTOBER 2018
SUBMITTAL 90% DESIGN
DESIGN AM /
DRAWN AM
SHEET 19 of 29

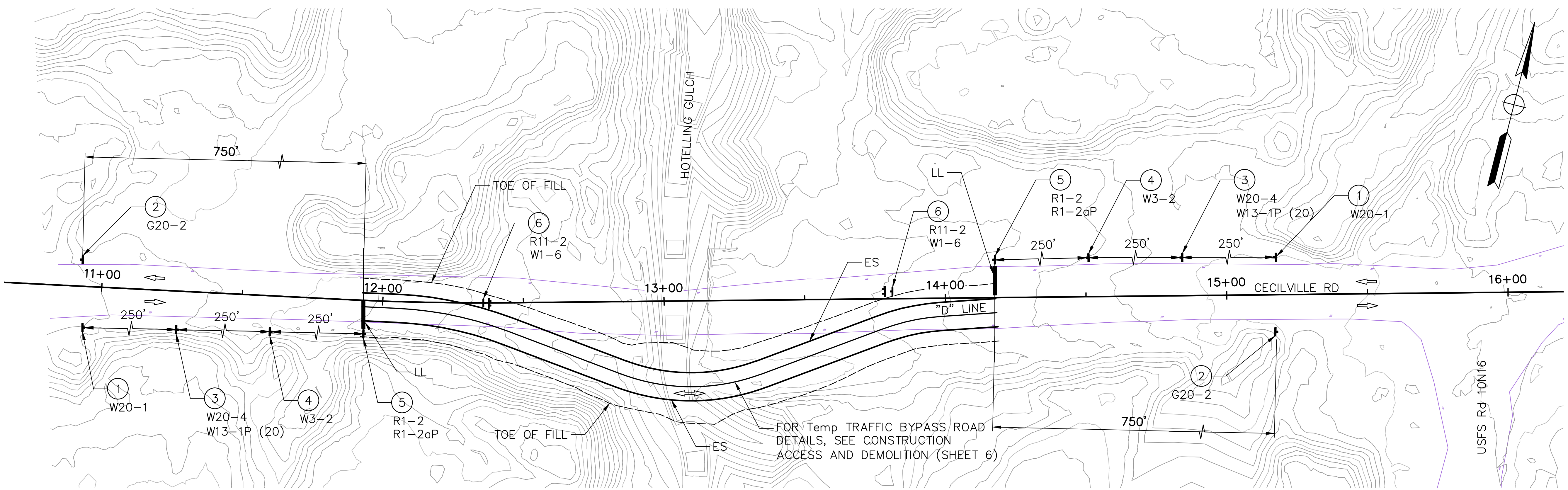
\\qeserver5\client$\MLA\Hotelling\CAD\Roadway\Hotellingrgh001.dwg

NOTE:

1. THIS PLAN ACCURATE FOR CONSTRUCTION AREA SIGN WORK AND TRAFFIC HANDLING ONLY.

LEGEND:

- ROADSIDE SIGN – ONE POST
- OR DIRECTION OF TRAFFIC
- LL LIMIT LINE
- (X) SIGN NUMBER
- TYPE 3 BARRICADE



CONSTRUCTION AREA SIGNS

SIGN No.	SIGN CODE FEDERAL	SIGN CODE CALIFORNIA	SIGN MESSAGE	PANEL SIZE	No. OF POSTS AND SIZE	No. OF SIGNS
1	W20–1		"ROAD WORK AHEAD"	36 x 36	1 – 4 x 4	2
2	G20–2		"END ROAD WORK"	36 x 18	1 – 4 x 4	2
3	W20–4		"ONE LANE ROAD AHEAD"	36 x 36	1 – 4 x 4	2
	W13–1P		"20 MPH"	24 x 24		2
4	W3–2		"YIELD AHEAD"	36 x 36	1 – 4 x 4	2
5	R1–2		"YIELD"	36 x 36 x 36	1 – 4 x 4	2
	R1–2aP		"TO ONCOMING TRAFFIC"	36 x 30		2
6	R11–2		"ROAD CLOSED"	48 x 30	1 – 4 x 4	2
	W1–6		"ONE–DIRECTION LARGE ARROW"	36 x 18		2

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CONSTRUCTION AREA SIGNS & TRAFFIC HANDLING

DATE OCTOBER 2018
SUBMITTAL 90% DESIGN
DESIGN AM / □
DRAWN AM
SHEET 20 of 29

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EROSION CONTROL QUANTITIES

FROM			TO			HYDROSEED	HYDROMULCH	TEMPORARY FIBER ROLL	TEMPORARY SILT FENCE	TEMPORARY HIGH-VISIBILITY FENCE	ROCK SLOPE PROTECTION (No. 2, METHOD B)	ROCK SLOPE PROTECTION FABRIC (CLASS 8)	COMMENTS
LINE	FROM	OFFSET	LINE	TO	OFFSET	SQFT	SQFT	LF	LF	LF	CY	SQYD	
"C"	11+65.00	22.49' Lt	"C"	12+87.96	26.72' Lt					122			
"C"	12+32.17	29.17' Lt	"C"	12+87.96	26.72' Lt				56				
"C"	13+24.76	23.65' Lt	"C"	15+00.00	18.63' Lt				176	177			
"C"	11+65.00	17.41' Rt	"C"	12+93.00	28.76' Rt					131			
"C"	12+35.99	20.08' Rt	"C"	12+93.00	28.76' Rt				58				
"C"	13+22.92	29.96' Rt	"C"	15+00.00	17.72' Rt				178	178			
"C"	12+51.27	19.62' Lt	"C"	12+82.04	11.00' Lt			36					
"C"	12+84.69	20.63' Lt	"C"	12+90.22	10.92' Lt			12					
"C"	13+29.69	11.00' Lt	"C"	14+63.29	17.05' Lt			139					
"C"	12+59.34	20.34' Rt	"C"	12+83.65	11.00' Rt			30					
"C"	13+27.82	11.00' Rt	"C"	14+77.86	17.28' Rt			156					
"C"	11+65.00	8.70' Lt	"C"	12+87.96	11.00' Lt	1340	1340						
"C"	13+24.76	11.00' Lt	"C"	15+00.00	11.00' Lt	1765	1765						
"C"	11+65.00	8.10' Rt	"C"	12+93.00	11.00' Rt	515	515						
"C"	13+22.92	11.00' Lt	"C"	15+00.00	11.00' Rt	2091	2091						
"C"	12+50.00	20.29' Lt	"C"	12+50.00	15.29' Lt						0.6	3	
"C"	12+50.01	15.28' Rt	"C"	12+50.01	19.28' Rt						0.4	3	
					TOTAL	5711	5711	373	468	608	1	6	

GUARD RAILING QUANTITIES

LINE	STATION	OFFSET	ALTERNATIVE FLARED TERMINAL SYSTEM	OREGON 2-TUBE SIDE MOUNT TRANSITION (MOD)	MIDWEST GUARDRAIL SYSTEM	COMMENTS
			EA	EA	LF	
"C"	11+90.40	Lt	0	1	63	NW QUADRANT
"C"	14+00.00	Lt	1	1	0	NE QUADRANT
"C"	11+91.89	Rt	0	1	63	SW QUADRANT
"C"	14+00.00	Rt	1	1	0	SE QUADRANT
		TOTAL	2	4	126	

ROADWAY QUANTITIES

FROM			TO			HOT MIX ASPHALT (TYPE A)	CLASS 2 AGGREGATE BASE	PLACE HOT MIX ASPHALT DIKE (TYPE A)	PLACE HOT MIX ASPHALT DIKE (TYPE F)	PLACE HOT MIX ASPHALT (MISCELLANEOUS AREA)	ROADWAY EXCAVATION	EMBANKMENT (N)	IMPORTED BORROW	TYPE III BARRICADE	COMMENTS
LINE	FROM	OFFSET	LINE	TO	OFFSET	TON	CY	LF	LF	SQYD	CY	CY	CY	EA	
"C"	11+65.00	0.00'	"C"	12+90.75	0.00'	83	100				127	100		1	
"C"	13+17.75	0.00'	"C"	15+00.00	0.00'	122	148				39	376		1	
"C"	11+65.00	8.67' Lt	"C"	12+26.00	11.00' Lt			61							
"C"	12+26.00	11.00' Lt	"C"	12+40.00	11.00' Lt				14						
"C"	11+65.00	8.12' Rt	"C"	12+26.00	11.00' Rt			62							
"C"	12+26.00	11.00' Rt	"C"	12+40.00	11.00' Rt				14						
"C"	12+40.00	11.00' Lt	"C"	12+53.00	11.00' Lt					3					
"C"	12+40.01	11.00' Rt	"C"	12+53.01	11.00' Rt					3					
					TOTAL	205.0	248	123	28	6	166	476	310	2	

(N) = NOT A BID ITEM, FOR INFORMATION ONLY

TRAFFIC STRIPING QUANTITIES

FROM			TO			TEMPORARY PAVEMENT MARKING (PAINT)	REMOVE PAINTED PAVEMENT MARKING	COMMENTS
LINE	FROM	OFFSET	LINE	TO	OFFSET	SQFT	SQFT	
"C"	11+65.00	0.00' Lt	"L"	15+00.00	0.00' Lt	20	20	
					TOTAL	20	20	

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RANCHO CORDOVA, CA 95670
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PO BOX 1089 • 25631 Sawyers Bar RD, Sawyers Bar CA 96027
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SUMMARY OF QUANTITIES

DATE: OCTOBER 2018
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DRAWN: AM

90% DRAFT PLANS
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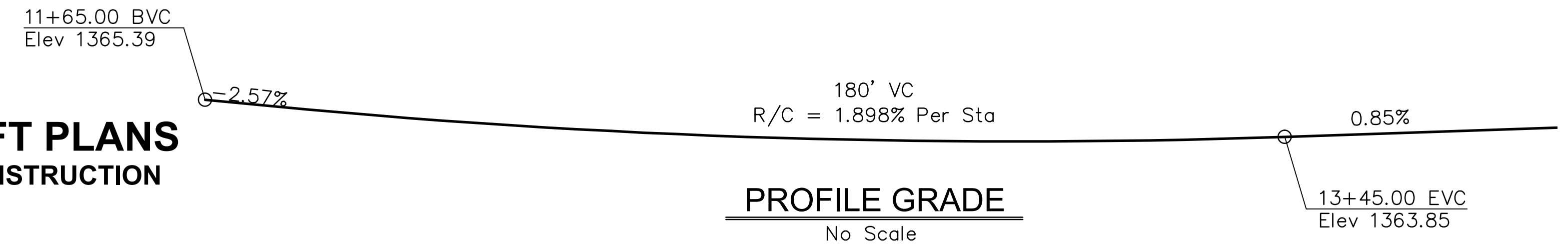
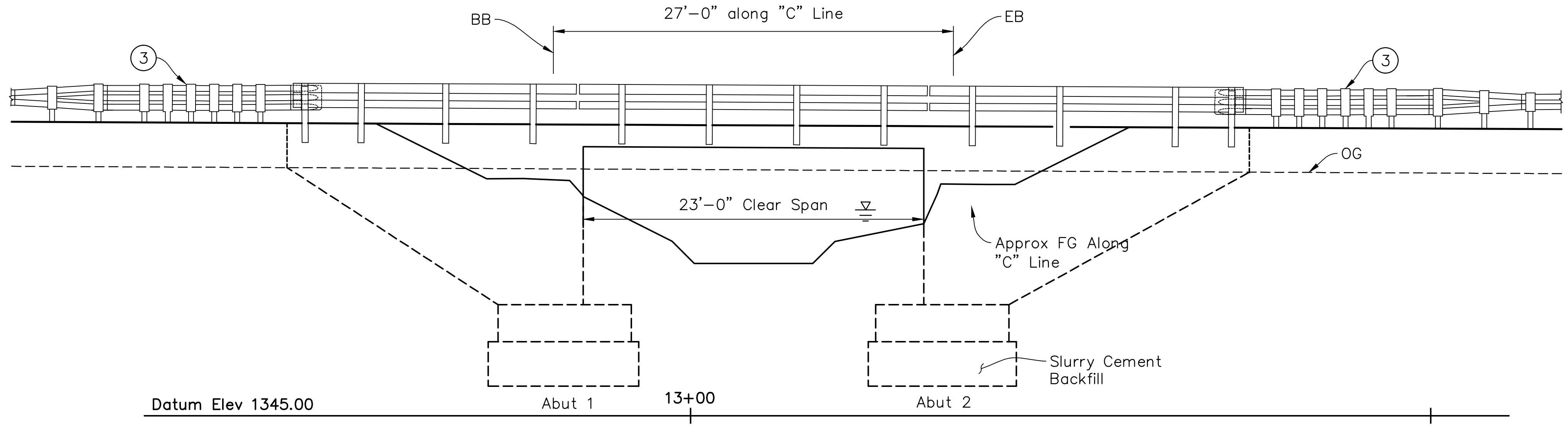
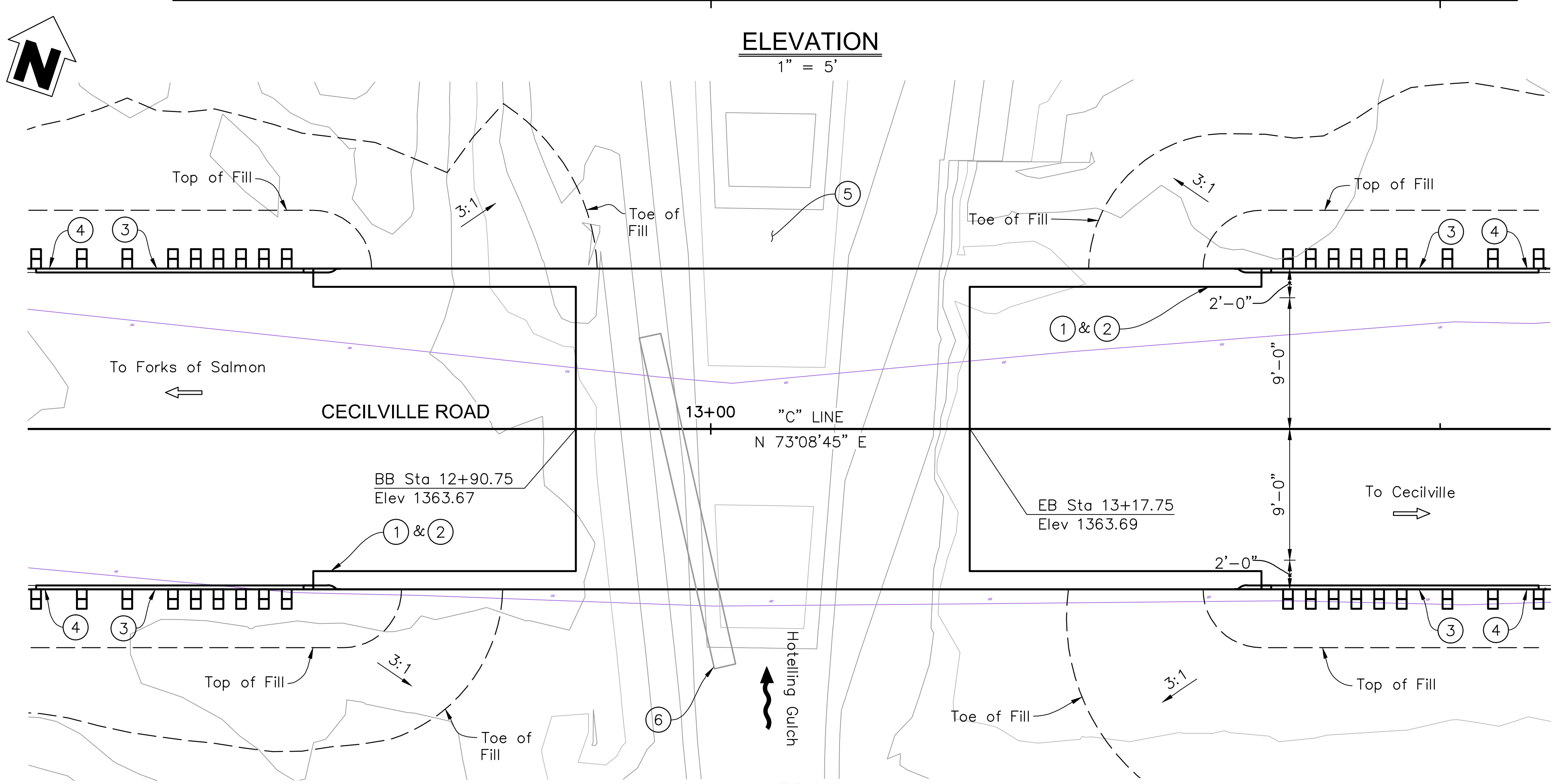


PROFILE GRADE
No Scale

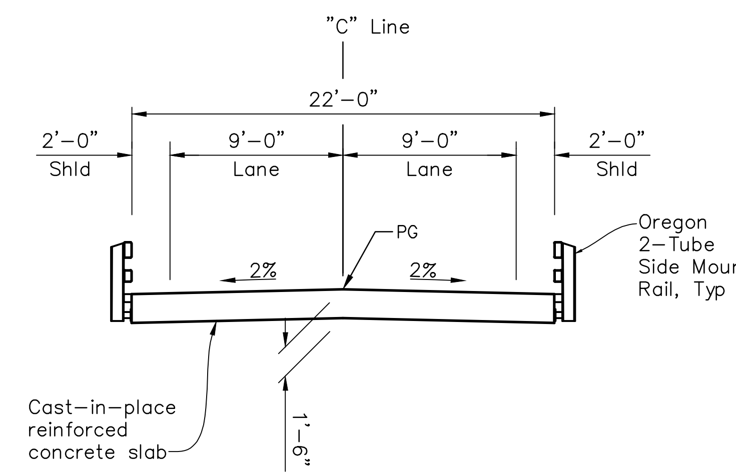


ELEVATION
1" = 5'



PLAN
1" = 5'

INDEX TO PLANS



TYPICAL SECTION
1" = 5'

Legend:

1. Paint "Cecilville Road Bridge"
2. Paint "Bridge No. XXX-XXXX"
3. See "Oregon 2-Tube Side Mount Transition (Mod)" Sheet
4. MGS, see Road Plans
5. Channel Restoration Work, see "Restoration Plans"
6. Remove Existing Culvert

- Direction of Flow
- Direction of Travel
- Indicates Highwater Elevation

Notes:

1. For General Notes, Standard Plans List, and Quantities, see "Deck Contours" sheet.
2. For Spread Footing Data Table, Scour Data Table, Hydrologic Summary, and Survey Control Data, see "Foundation Plan" sheet.

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11017 COBBLEROCK DRIVE, SUITE 100
RANCHO CORDOVA, CA 95670
P: 916.368.9181

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PO BOX 1089 • 25631 Sawyers Bar RD, Sawyers Bar CA 96027
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GENERAL PLAN

DATE	OCTOBER 2018
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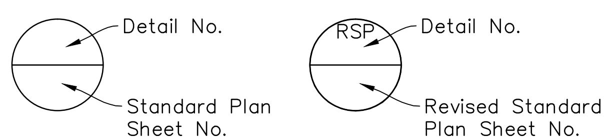
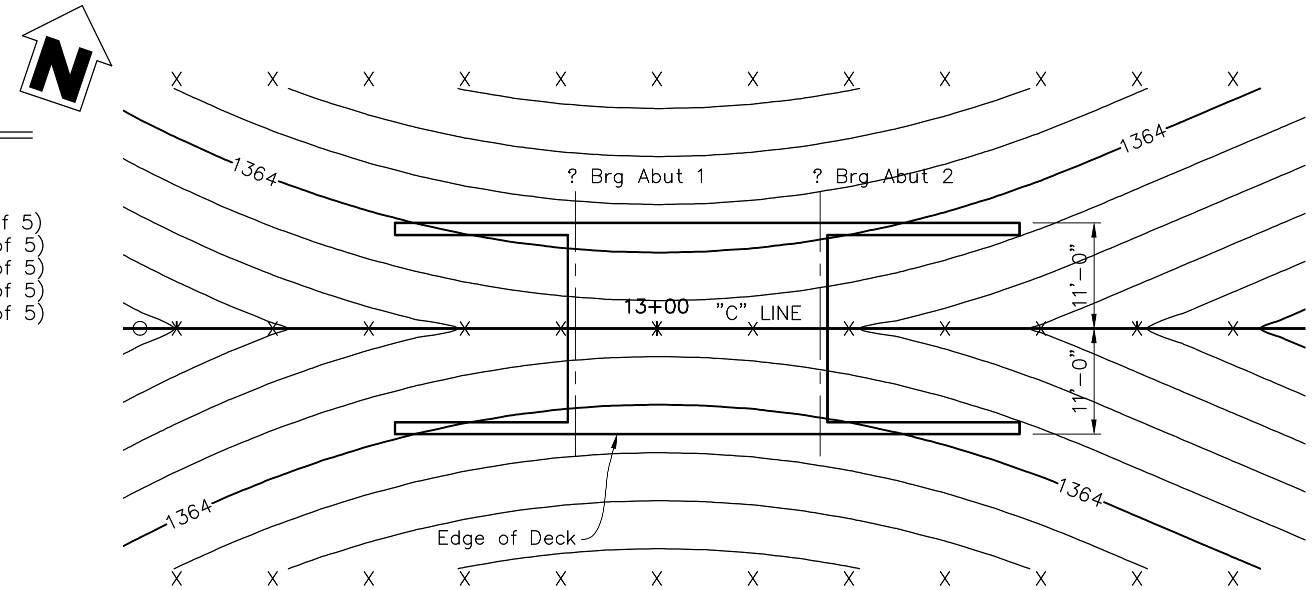
DRAWN	AM / SB
SHEET	22 of 29

CALTRANS STANDARD PLANS DATED MAY 2015

	A3A	Abbreviations (sheet 1 of 3)
	A3B	Abbreviations (sheet 2 of 3)
	A3C	Abbreviations (sheet 2 of 3)
	A10A	Legend – Lines and Symbols (sheet 1 of 5)
RSP	A10B	Legend – Lines and Symbols (sheet 2 of 5)
	A10C	Legend – Lines and Symbols (sheet 3 of 5)
	A10D	Legend – Lines and Symbols (sheet 4 of 5)
	A10E	Legend – Lines and Symbols (sheet 5 of 5)
	A10F	Legend – Soil (Sheet 1 of 2)
	A10G	Legend – Soil (Sheet 2 of 2)
	A62C	Limits of Payment for Excavation and Backfill– Bridge
	B0–1	Bridge Details
RSP	B0–3	Bridge Details
	B0–13	Bridge Details





Notes:

X = 10' intervals along station line

Contours Intervals = 0.10'

Contours do not include camber

PLAN

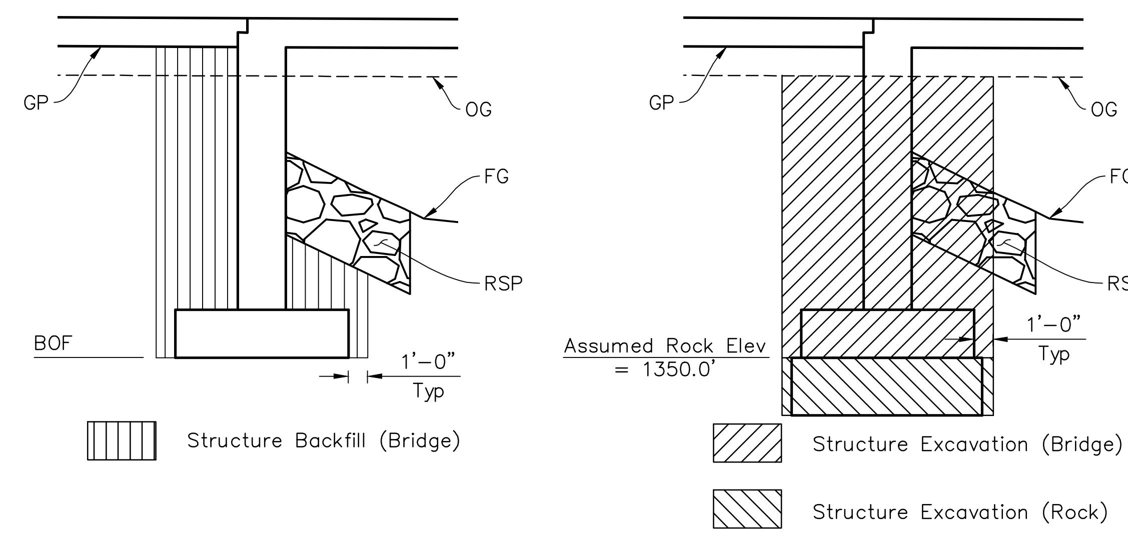
1" = 10'

GENERAL NOTES
LOAD AND RESISTANCE FACTOR DESIGN

DESIGN:	AASHTO LRFD Bridge Design Specifications, 6th edition with Caltrans Amendments.
SEISMIC DESIGN:	Caltrans Seismic Design Criteria (SDC), version 1.7, dated April 2013.
DEAD LOADING:	Includes 35 psf for future wearing surface.
LIVE LOADING:	HL93 and permit design load.
SEISMIC LOADING:	Soil profile V_S =600 to 1200 ft/s Depth of Alluvium = 10–13 ft.
REINFORCED CONCRETE:	f_y = 60,000 psi f'_c = 3,600 psi n = 8

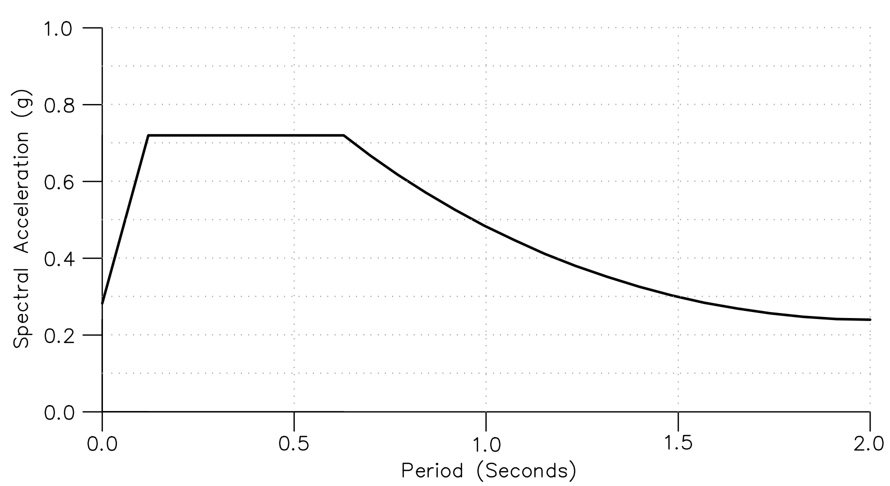
QUANTITIES

Structure Excavation (Bridge)	234	CY
Structure Excavation (Rock)	62	CY
Structure Backfill (Bridge)	137	CY
Structure Backfill (Slurry Cement)	46	CY
Structural Concrete, Bridge Footing	38	CY
Structural Concrete, Bridge	72	CY
Structural Concrete, Bridge (Polymer Fiber)	36	CY
Bar Reinforcing Steel (Bridge)	11092	LB
Bar Reinforcing Steel (Epoxy Coated)	3657	LB
Bridge Removal	LUMP	SUM
Oregon 2–Tube Side Mount Rail	130	LF



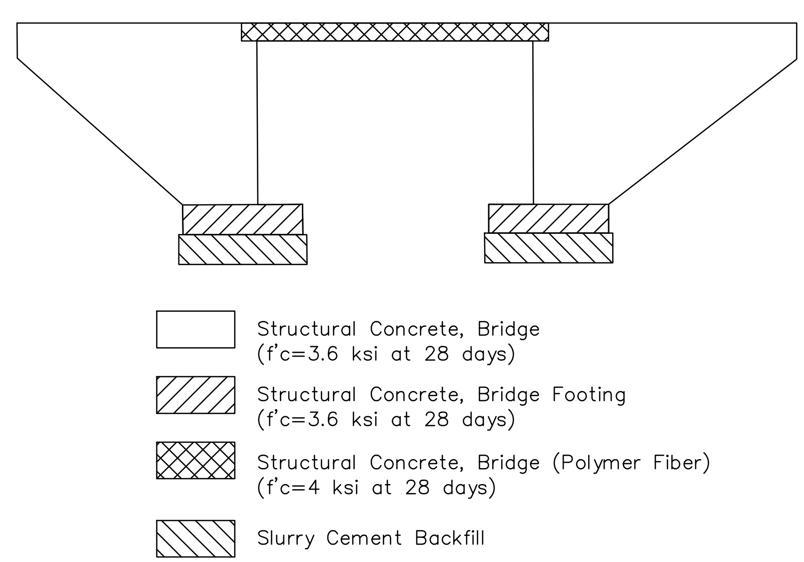
LIMITS OF PAYMENT FOR EXCAVATION AND BACKFILL

No Scale



ACCELERATION RESPONSE SPECTRA CURVE

No Scale



CONCRETE STRENGTH AND TYPE LIMITS

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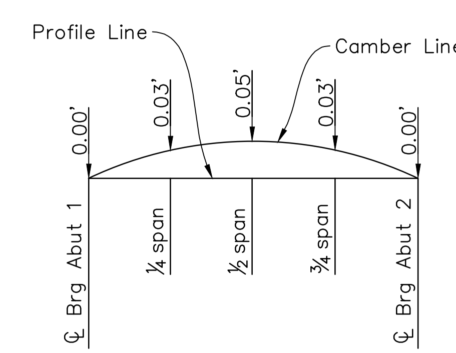

Note: Does not include allowance for falsework settlement

CAMBER DIAGRAM

No Scale

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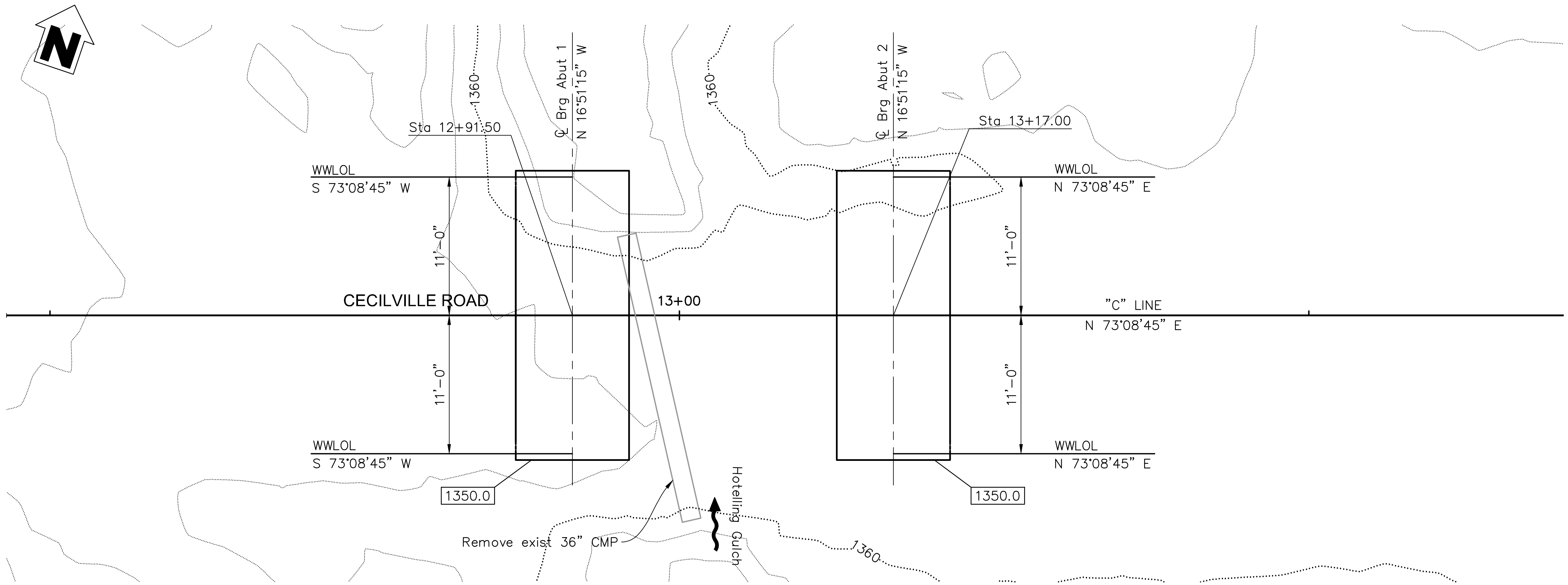
DECK CONTOURS

DATE	OCTOBER 2018
SUBMITTAL	90% DESIGN
DESIGN	MK / SB
DRAWN	AM / SB
SHEET	23 of 29



PLAN

1" = 5'

Legend:

X.X Indicates bottom of footing elevation

LOAD AND RESISTANCE FACTOR DESIGN SPREAD FOOTING DATA TABLE

LOCATION	NET PERMISSABLE CONTACT STRESS (SERVICE) (SETTLEMENT) ksf	FACTORED GROSS NOMINAL BEARING RESISTANCE (RESISTANCE FACTOR=0.45) (STRENGTH) ksf	FACTORED GROSS NOMINAL BEARING RESISTANCE (RESISTANCE FACTOR=1.00) (EXTREME EVENT) ksf
Abut 1	20.0	3.6	8.0
Abut 2	20.0	3.6	8.0

SCOUR DATA TABLE

SUPPORT No.	LONG-TERM (DEGRADATION AND CONTRACTION) DEPTH (ft)	SHORT-TERM (LOCAL) SCOUR DEPTH (ft)
Abut 1	2.1	0.0
Abut 2	2.1	0.0

SURVEY CONTROL DATA

NO.	NORTHING	EASTING	ELEVATION	LINE	STATION	OFFSET	DESCRIPTION
50001	2337125.800	6210382.010	1370.20	"C"	14+50.59	46.90' Rt	REBAR W/CAP
50002	2337160.340	6210335.170	1362.59	"C"	14+15.78	0.26' Rt	MAG NAIL W/SHINER
50003	2337211.54	6210503.290	1364.50	"C"	15+91.52	0.01' Rt	MAG NAIL W/SHINER
50004	2337229.940	6210347.170	1371.09	"C"	14+47.44	62.87' Rt	REBAR W/ CAP

Horizontal Datum: Zone 1 CSPC NAD83
Vertical Datum: NAVD88

HYDROLOGIC SUMMARY

Drainage area: 1.2 Square Miles

	Design Flood	Base Flood
Frequency (years)	50	100
Discharge (cubic feet per second)	230	281
Water Surface Elev at Bridge (ft)	1358.6	1358.9

Flood plain data based upon information available when the plans were prepared and are shown to meet Federal requirements. The accuracy of said information is not warranted by the County and interested or affected parties should make their own investigations.

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PO BOX 1089 • 25631 Sawyers Bar RD, Sawyers Bar CA 96027
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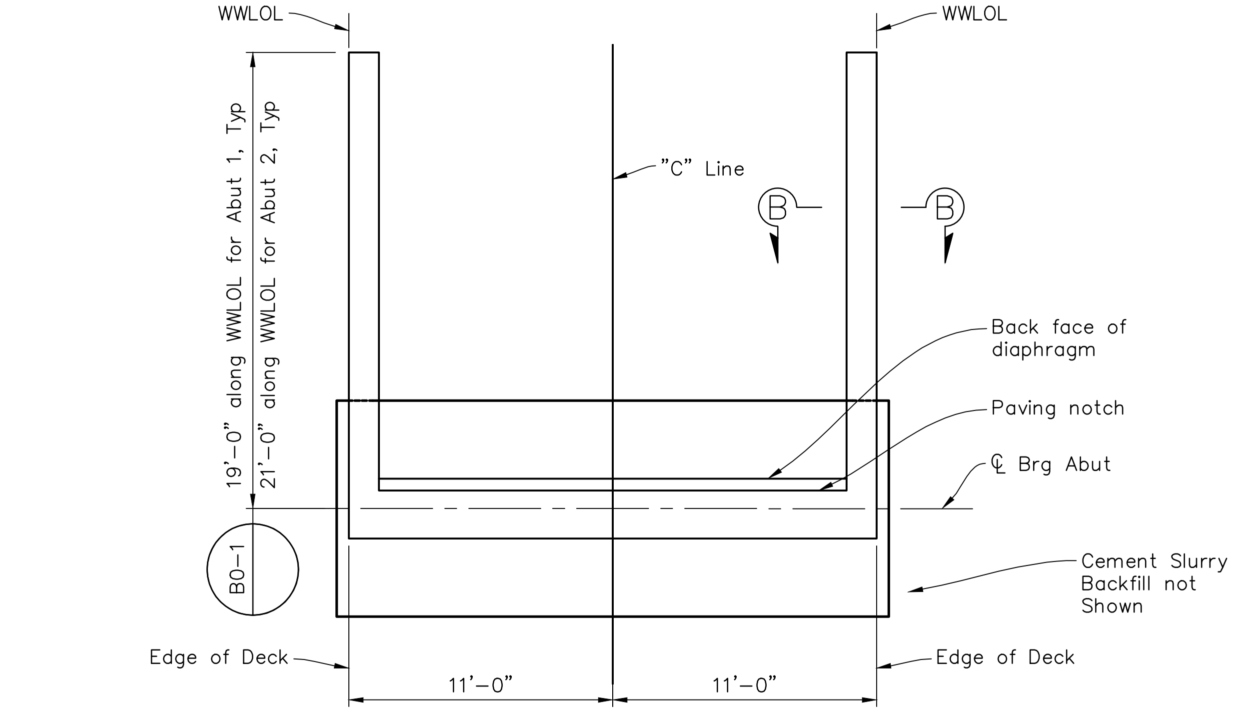
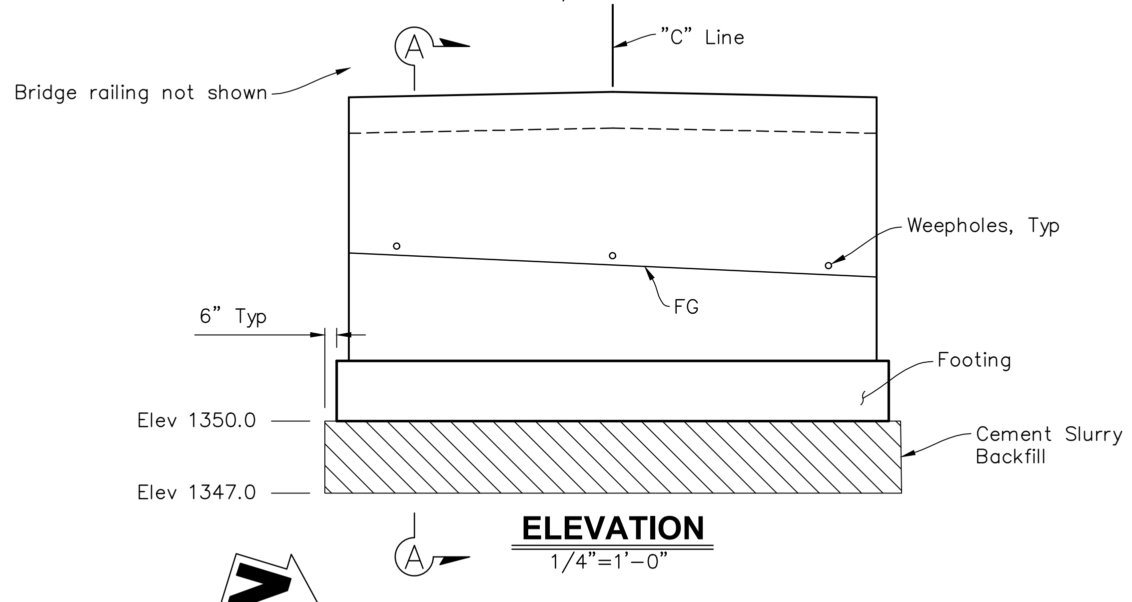
FOUNDATION PLAN

DATE OCTOBER 2018
SUBMITTAL 90% DESIGN
DESIGN MK / SB
DRAWN AM / SB
SHEET 24 of 29



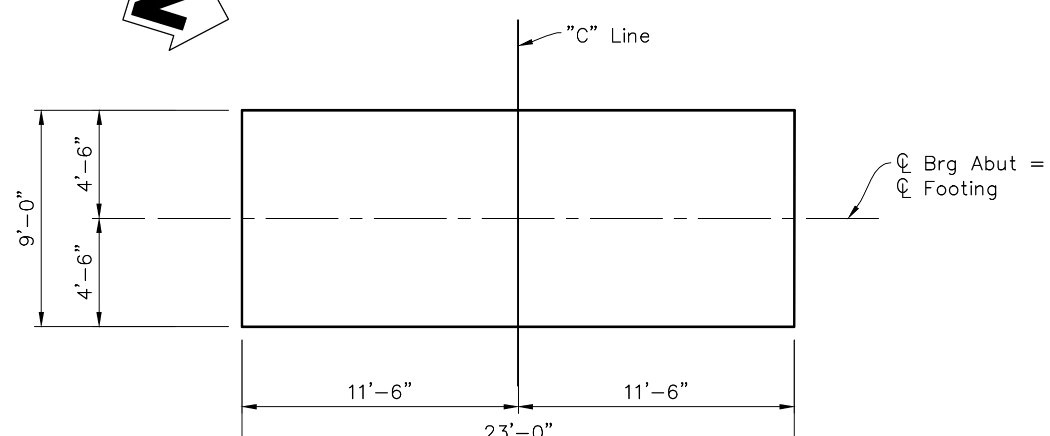
PLAN

1/4"=1'–0"



ELEVATION

1/4"=1'–0"



FOOTING PLAN

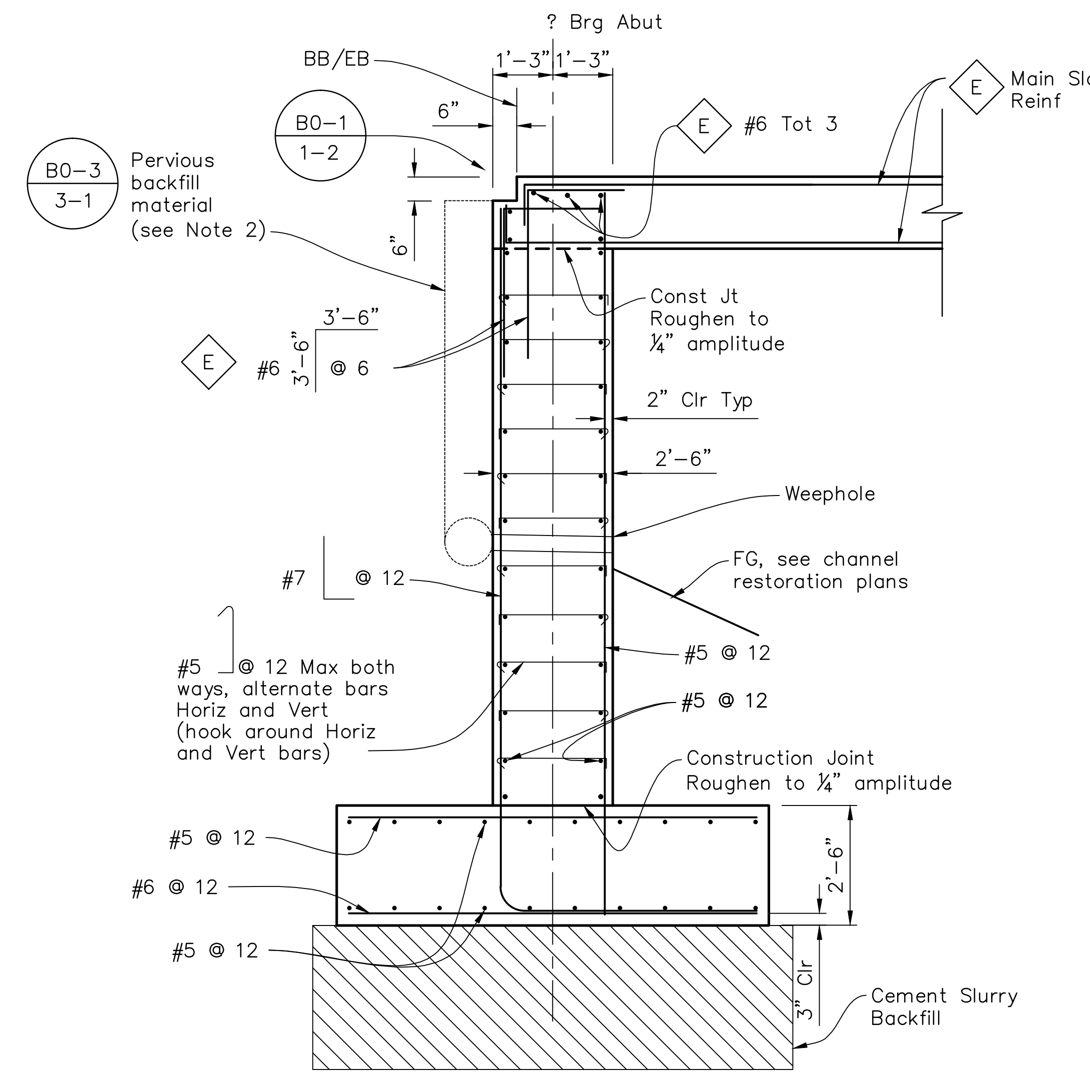
1/4"=1'–0"

Notes:

1. Abutment 1 shown, Abutment 2 similar.
2. For sections and details not shown, see "Abutment Details" sheet.
3. Structure backfill behind the abutments, diaphragms, and wingwalls shall not be placed prior to 10 days after the superstructure is completed. No more than half of the abutment shall be backfilled vertically prior to backfilling half of the opposite abutment.

Legend:

E Denotes epoxy coated bar reinforcement



SECTION A-A

1/2"=1'–0"

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ABUTMENT LAYOUT

DATE	OCTOBER 2018
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DESIGN	MK / SB
DRAWN	AM / SB
SHEET	25 of 29

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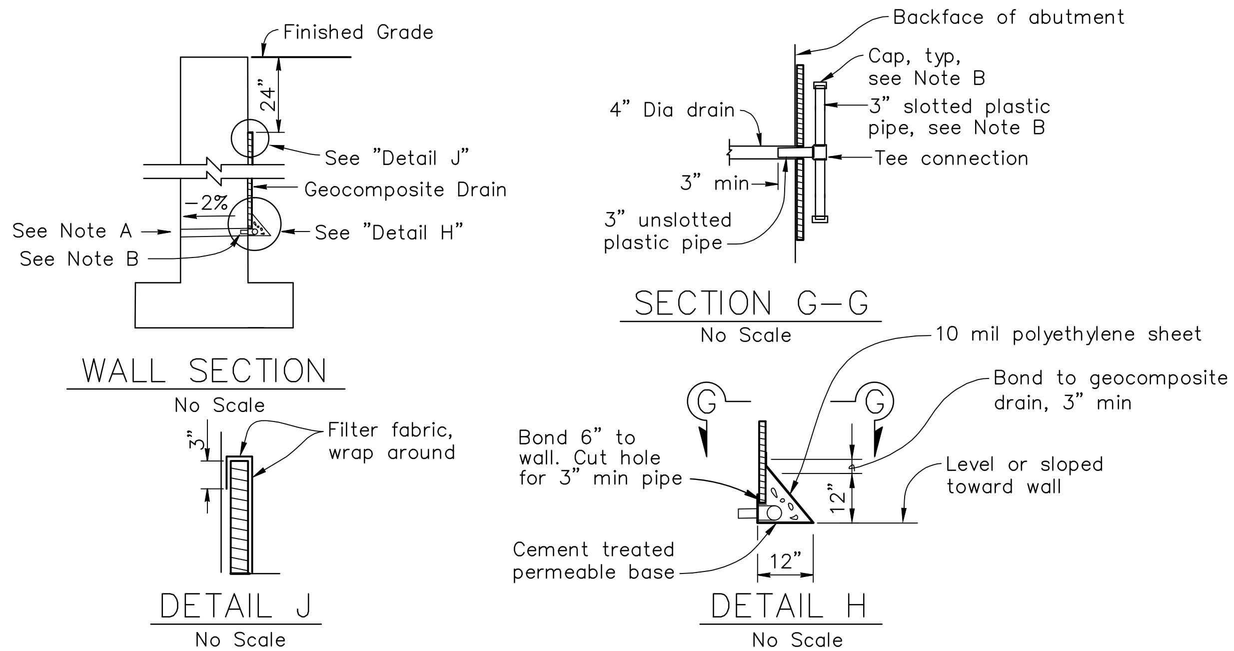


WEEP HOLE AND GEOCOMPOSITE DRAIN

Alternative to Bridge Detail

B0-3
3-1

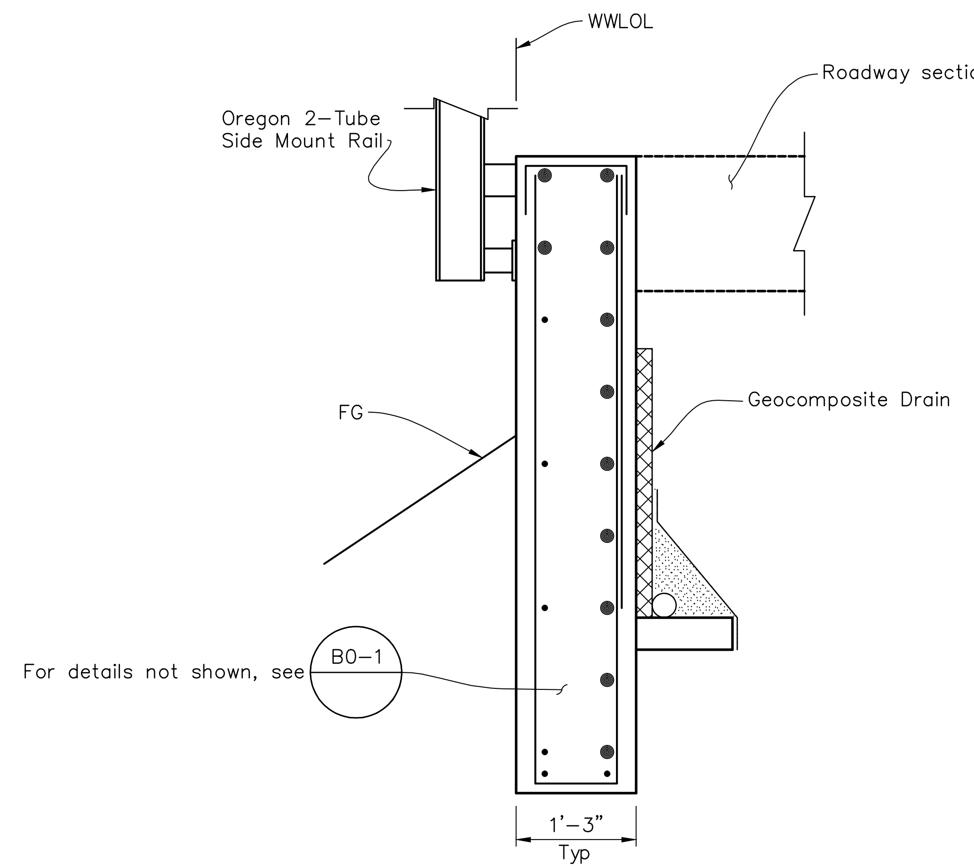
Notes:

A. 4" Dia drains at intermediate sag points and at 9'-0" max center to center. Exposed wall drains shall be located 3"± above finished grade.

B. Geocomposite drain, cement treated permeable base, and 3" Dia slotted plastic pipe continuous behind abutment. Cap ends of pipe. Provide "Tee" connection at each 4" Dia drain.

C. Connect the low end of plastic pipe to the main outlet pipe as applicable.

D. Limits of geocomposite drain inside face of wingwall to inside face of wingwall, typ.



SECTION B-B

1" = 1'-0"

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ABUTMENT DETAILS

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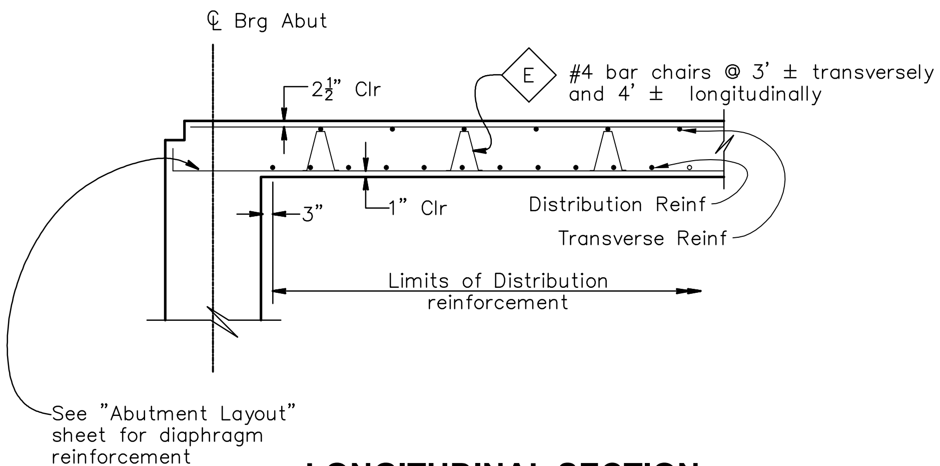
DRAWN	AM / SB
SHEET	26 of 29



LONGITUDINAL SECTION

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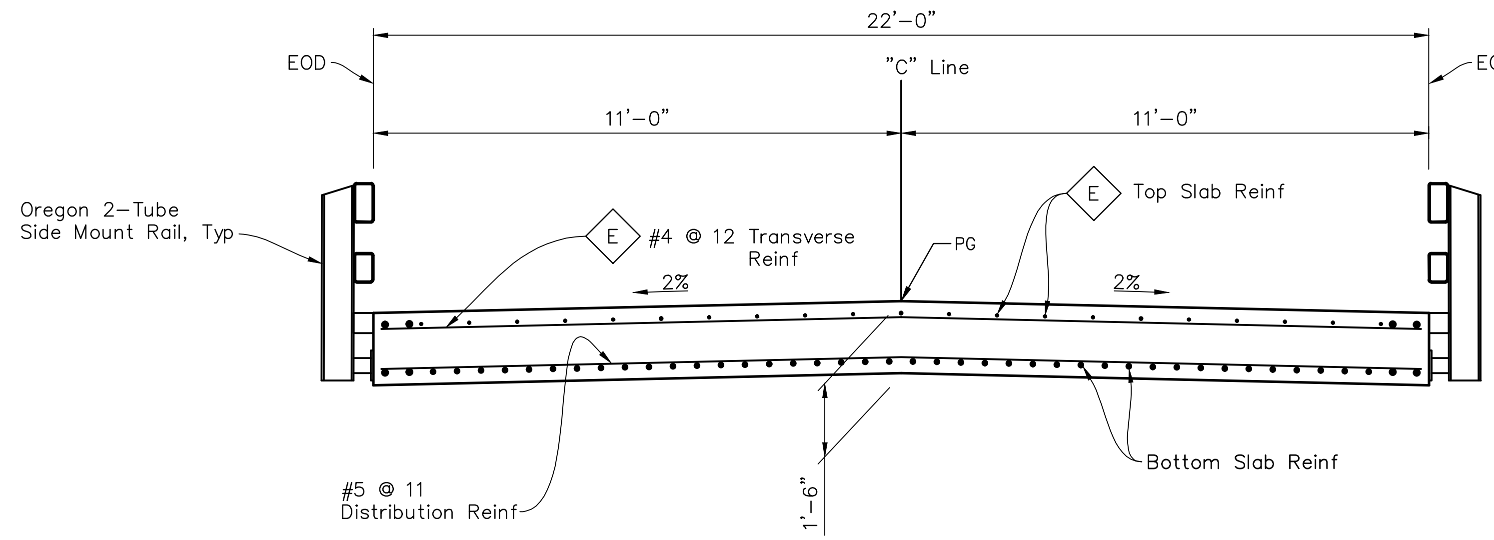


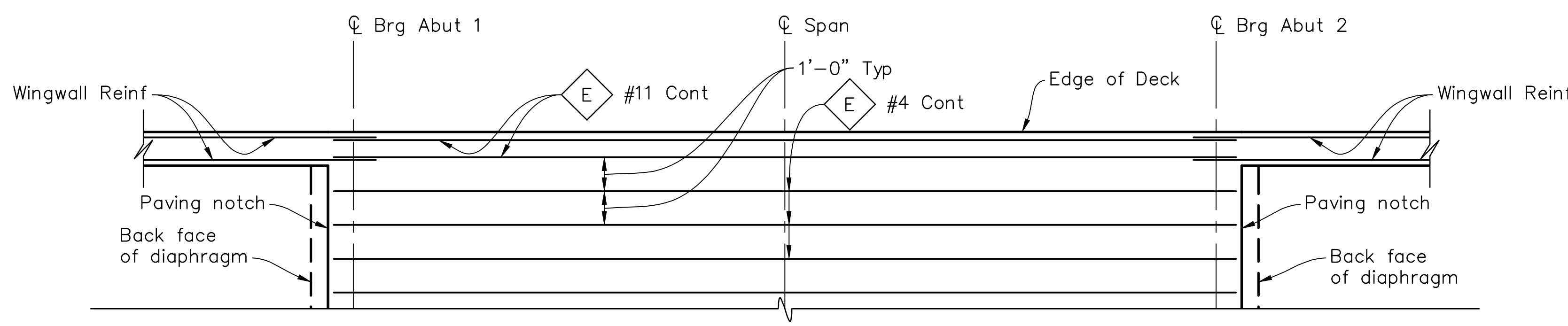
TYPICAL SECTION

1/2" = 1'-0"

* Place transverse reinforcement parallel to Brg Abut and space along "C" line

Notes:

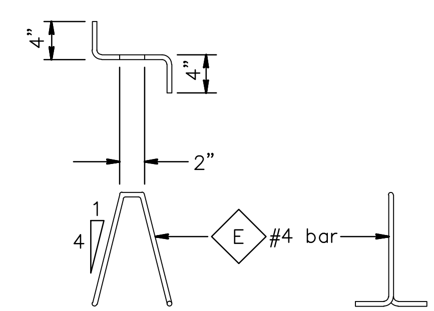
1. No splices allowed in main top slab or bottom slab reinforcement.



TOP SLAB REINFORCEMENT

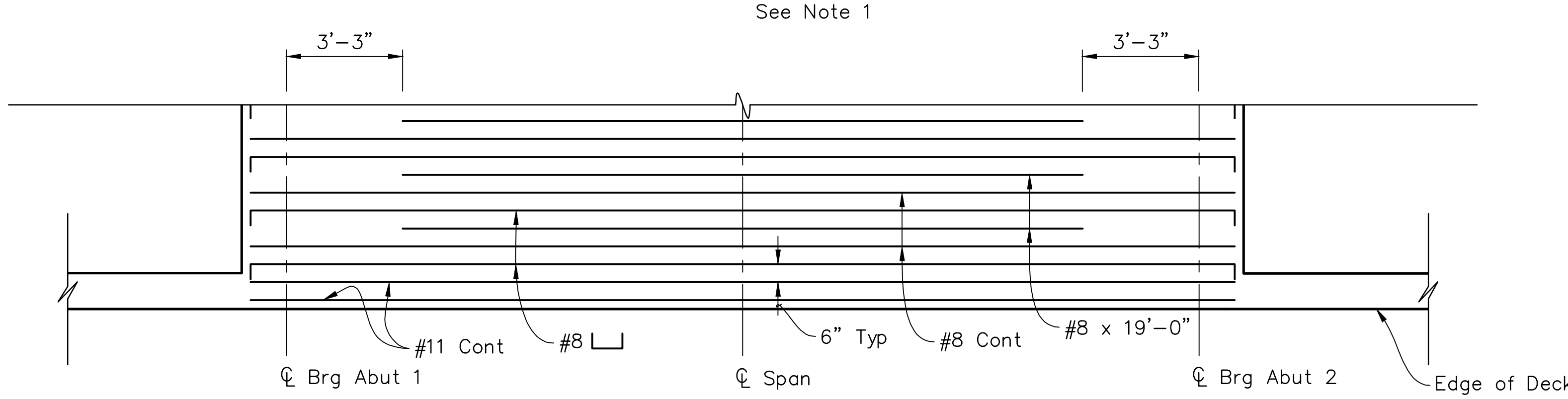
3/8" = 1'-0"

See Note 1



BAR CHAIR DETAIL

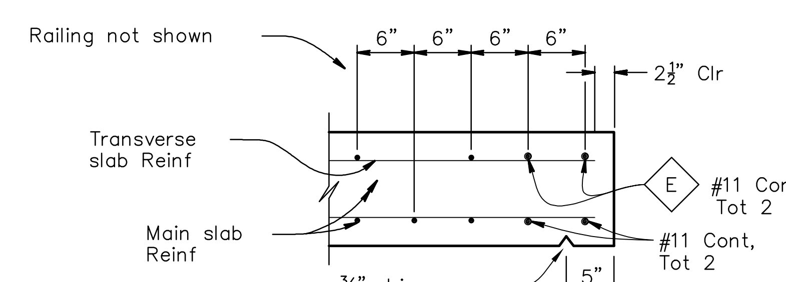
No Scale



BOTTOM SLAB REINFORCEMENT

3/8" = 1'-0"

See Note 1



EDGE OF SLAB DETAIL

No Scale

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HOTELLING GULCH FISH ACCESS AND CHANNEL RESTORATION PROJECT

TYPICAL SECTION

DATE	OCTOBER 2018
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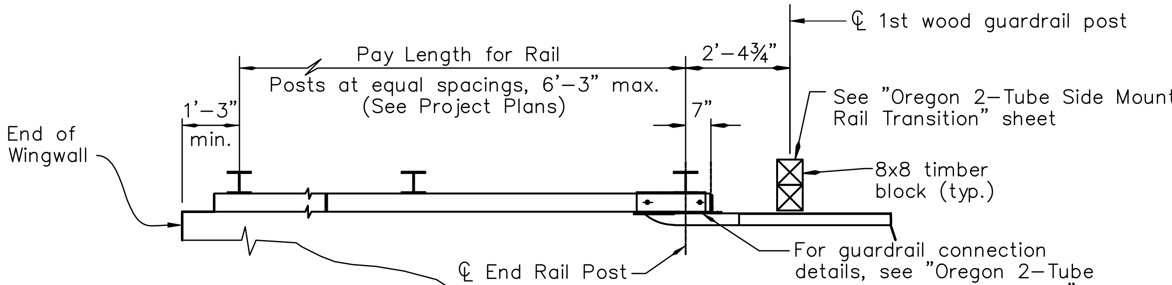
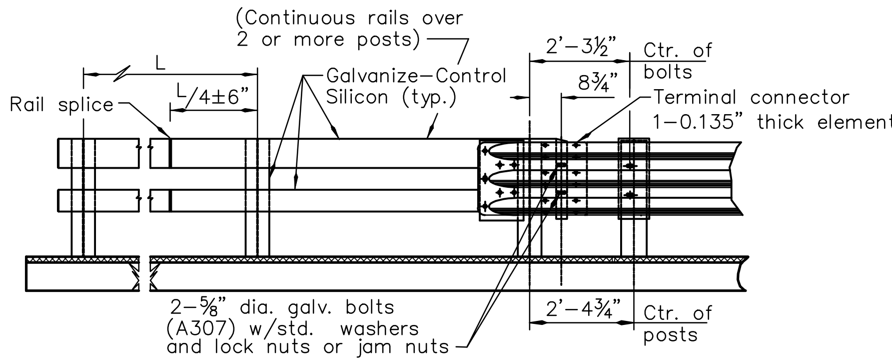
SHEET	27 of 29

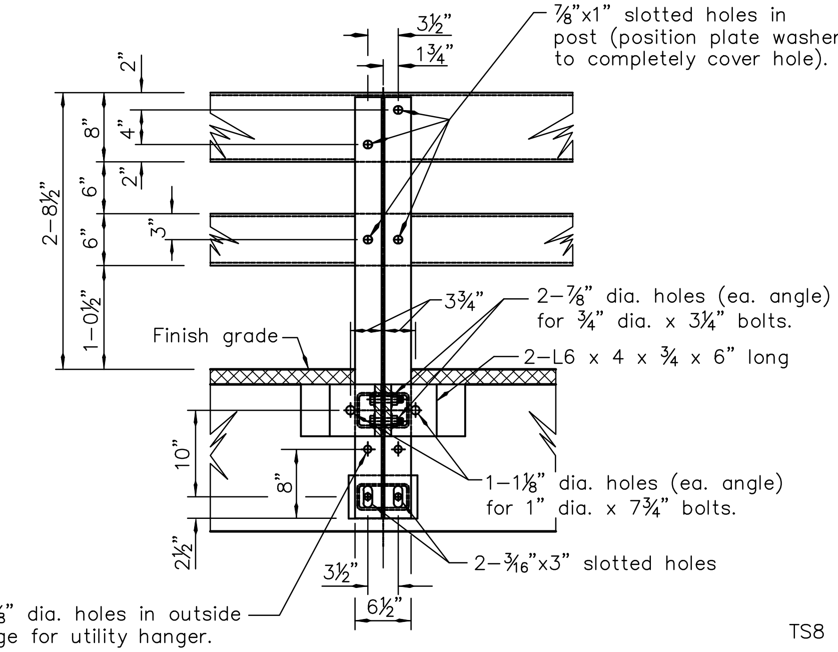


NOTE:
Guardrail Connection may be omitted on exit end of one way structures when omitted on detail plans.

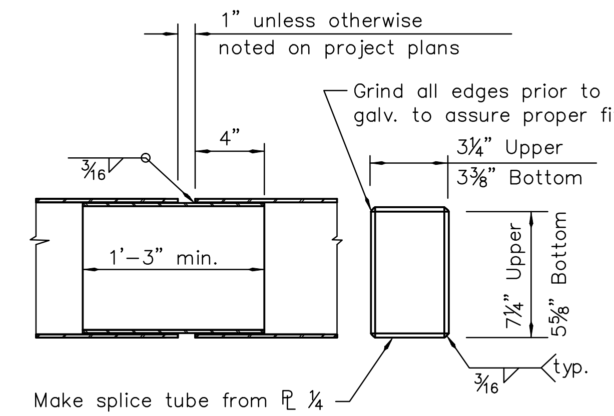
PLAN



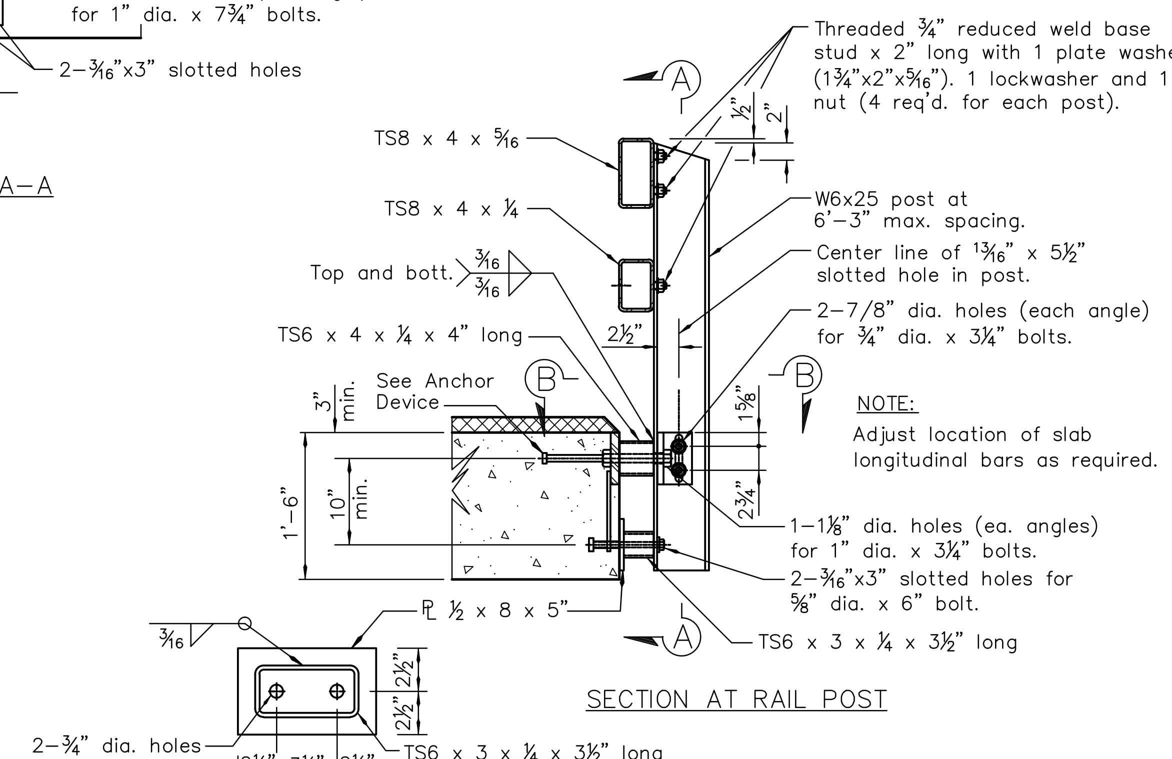
ELEVATION



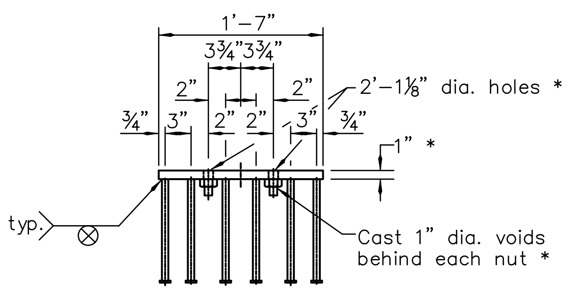
SECTION A-A



RAIL SPLICE DETAILS

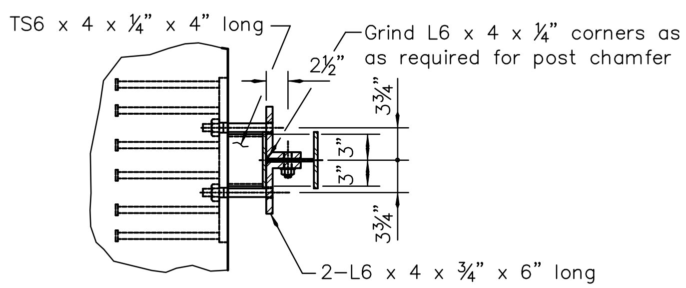


SECTION AT RAIL POST

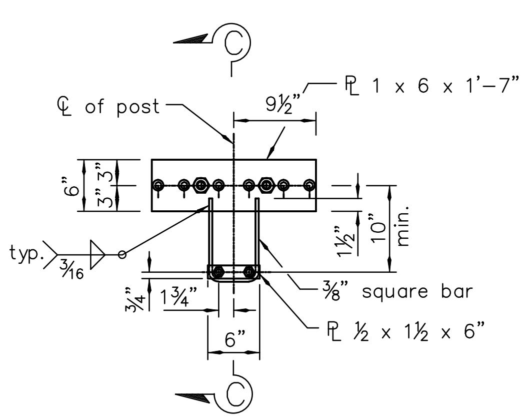


PLAN

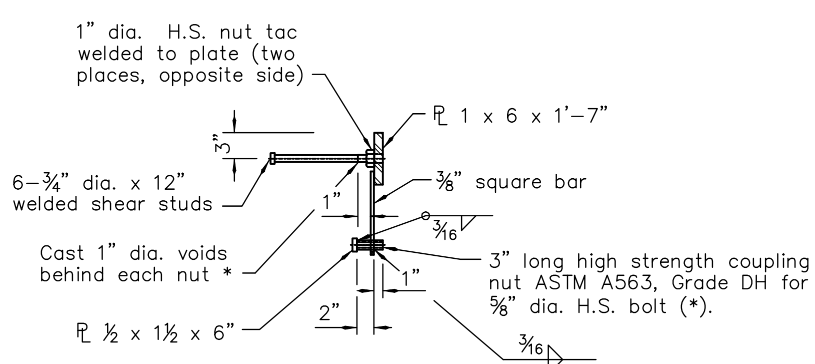
NOTE:
* Plug or block off holes and threaded area during casting of slabs.



SECTION B-B



ANCHOR DEVICE



SECTION C-C

GENERAL NOTES:

1. Provide steel tubing conforming to ASTM Specification A500, Grade B, A501 or A618.
2. Provide structural steel shapes and plates conforming to AASHTO Specification M183 or (ASTM A36) unless otherwise noted.
3. Provide bolts conforming to AASHTO Specification M164, (ASTM A325) unless otherwise noted.
4. Construct rail normal to slab in both the longitudinal and the transverse direction. When wearing surface thickness varies due to beam camber and/or superelevation, vary rail post lengths to provide uniform rail height. Field verify post lengths before fabrication.
5. Hot-dip galvanize structural steel including fasteners after fabrication. Provide Galvanize-Control Silicon posts and horizontal rail steel tubing according to ODOT Specification 02530.70. Tap nuts 0.021+0.01- 0.00 oversize after galvanizing in accordance with ASTM A563.
6. Tighten upper post bolts 240° turn past snug tight condition and lower post bolts 120° turn past snug tight condition.
7. Estimated rail mass (for slab design) is 72 lb. per linear foot.

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OREGON 2-TUBE SIDE MOUNT RAIL

DATE	OCTOBER 2018
SUBMITTAL	90% DESIGN
DESIGN	MK / SB
DRAWN	AM / SB
SHEET	28 of 29

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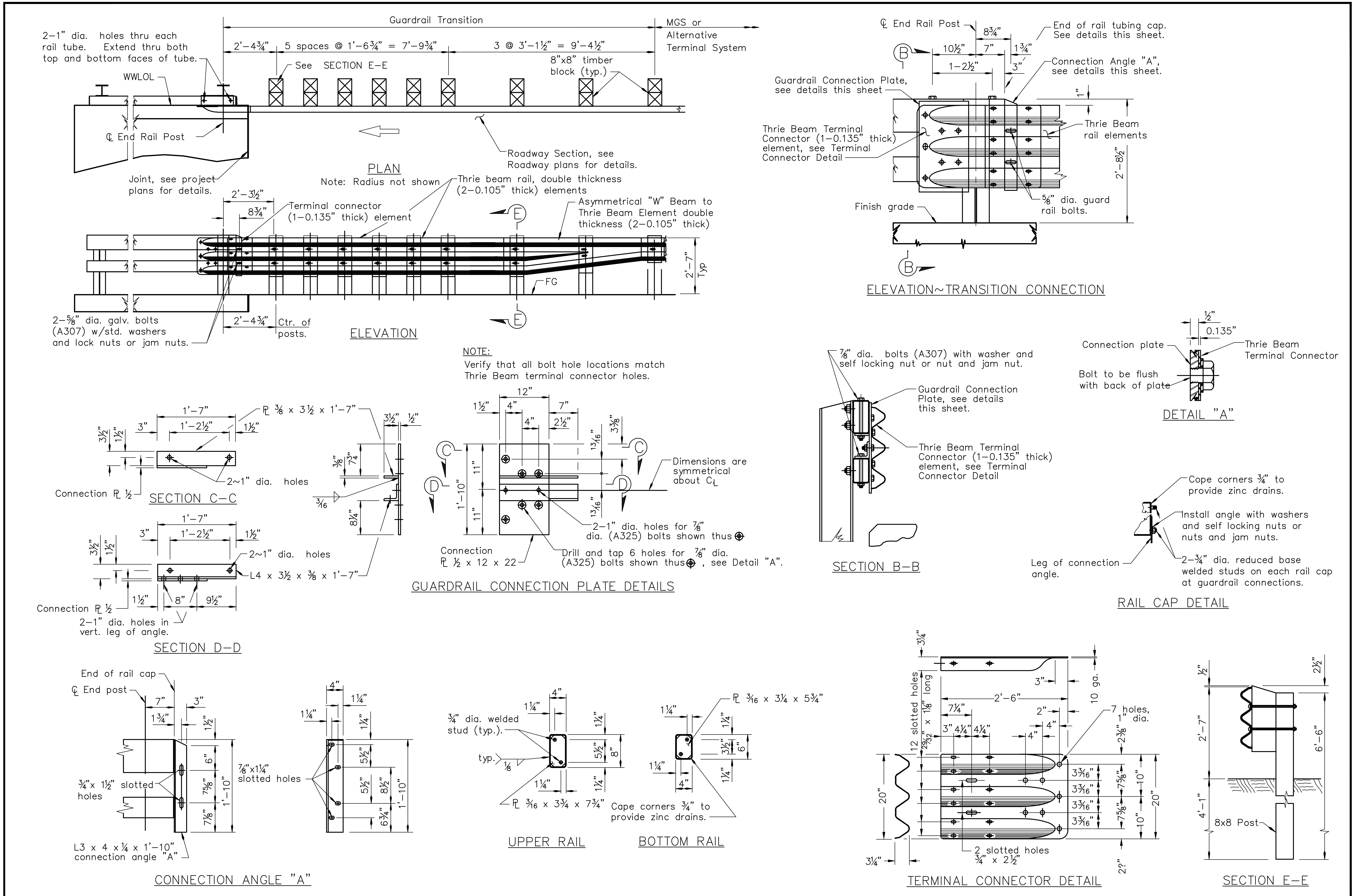

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OREGON 2-TUBE SIDE MOUNT TRANSITION (MOD)

DATE: OCTOBER 2018
SUBMITTAL: 90% DESIGN
DESIGN: MK / SB
DRAWN: AM / SB
SHEET: 29 of 29

Appendix B – Hydrology

Summary of flows at SF Salmon River and Hotelling Gulch computed using various methods.							
	LP3 Results from USGS Gage (USGS, 1982)			**Siskyou County Drainage Manual (1974)**		**USGS (2012)**	
Return Period (years)	Discharge/Mi^2 (cfs/mi^2)	**SF Salmon @ Hotelling cfs**	**Hotelling Gulch cfs**	**SF Salmon @ Hotelling cfs**	**Hotelling Gulch cfs**	**Hotelling Gulch cfs**	**SF Samon cfs**
1.20	10.86	2,827	**13**				
1.50	19.21	4,999	**23**				
1.80	25.25	6,571	**30**				
2.00	28.66	7,457	**34**			93.1	13800
2.33	33.34	8,676	**40**				
2.40	34.28	8,922	**41**				
2.60	36.83	9,584	**44**				
2.80	39.16	10,190	**47**				
3.00	41.30	10,747	**50**				
3.50	45.93	11,953	**55**				
4.00	49.75	12,945	**60**				
5.00	55.62	14,475	67	10,123	**66**	184	24100
10.00	74.54	19,398	89	13,691	**104**	251	31300
25.00	98.06	25,517	118	21,776	**169**	339	40600
50.00	114.77	29,865	138	27,406	**230**	407	47500
100.00	130.56	33,976	157	32,297	**281**	479	54400
SF Salmon at Hotelling Gulch Drainage Area 260.23 sq mi.							
Hotelling Gulch Drainage Area 1.2 sq mi.							

Flood Frequency based on Annual Maximum Series

USGS 11522300 SF SALMON R NR FORKS OF SALMON CA

Drainage area
(square miles) **252**

Date of Peak	Discharge (cfs)	RANK	Recurrence Interval (years)	Discharge (cfs)	Discharge (cms)	Log Discharge (cfs)
12/22/1964	31400	1	26.00	31400	889.15	4.50
12/22/1955	24200	2	13.00	24200	685.27	4.38
1/16/1974	18400	3	8.67	18400	521.03	4.26
3/2/1972	13100	4	6.50	13100	370.95	4.12
1/22/1970	12700	5	5.20	12700	359.63	4.10
1/17/1971	12500	6	4.33	12500	353.96	4.10
12/2/1962	10600	7	3.71	10600	300.16	4.03
2/23/1968	9290	8	3.25	9290	263.06	3.97
1/20/1964	8110	9	2.89	8110	229.65	3.91
1/29/1958	7970	10	2.60	7970	225.69	3.90
3/18/1975	7750	11	2.36	7750	219.46	3.89
1/12/1959	7690	12	2.17	7690	217.76	3.89
1/4/1966	7590	13	2.00	7590	214.93	3.88
1/29/1967	7360	14	1.86	7360	208.41	3.87
2/8/1960	7330	15	1.73	7330	207.56	3.87
2/11/1961	5630	16	1.63	5630	159.42	3.75
11/24/1953	5400	17	1.53	5400	152.91	3.73
1/20/1969	4840	18	1.44	4840	137.05	3.68
11/15/1975	4420	19	1.37	4420	125.16	3.65
1/13/1973	3470	20	1.30	3470	98.26	3.54
12/19/1961	3230	21	1.24	3230	91.46	3.51
12/31/1954	2800	22	1.18	2800	79.29	3.45
12/14/1977	2630	23	1.13	2630	74.47	3.42
2/26/1957	2600	24	1.08	2600	73.62	3.41
5/26/1977	360	25	1.04	360	10.19	2.56

Generalized Skew=	**-0.3**	A=	-0.16218
Station Skewness (log Q)=	-1.19	B=	0.62989
Station Mean (log Q)=	3.81	station skew) =	0.38651
Station Std Dev (log Q)=	0.39		
Weighted Skewness (G_W)=	**-0.69**		

Log Pearson Type III Distribution

Return Period (years)	Exceedence Probability	Log-Pearson K	Predicicted Discharge (cfs)	Discharge/ Mi^2 (cfs/mi^2)
1.2	0.833	-0.97152	2,738	10.86
1.5	0.667	-0.33333	4,841	19.21
1.8	0.556	-0.02717	6,364	25.25
2.0	0.500	0.11440	7,221	28.66
2.33	0.429	0.28392	8,402	33.34
2.4	0.417	0.31523	8,640	34.28
2.6	0.385	0.39538	9,281	36.83
2.8	0.357	0.46408	9,868	39.16
3	0.333	0.52362	10,407	41.30
3.5	0.286	0.64270	11,575	45.93
4	0.250	0.73201	12,536	49.75
5.0	0.200	0.85704	14,017	55.62
10	0.100	1.18489	18,785	74.54
25	0.040	1.49187	24,710	98.06
50	0.020	1.66806	28,921	114.77
100	0.010	1.81245	32,901	130.56

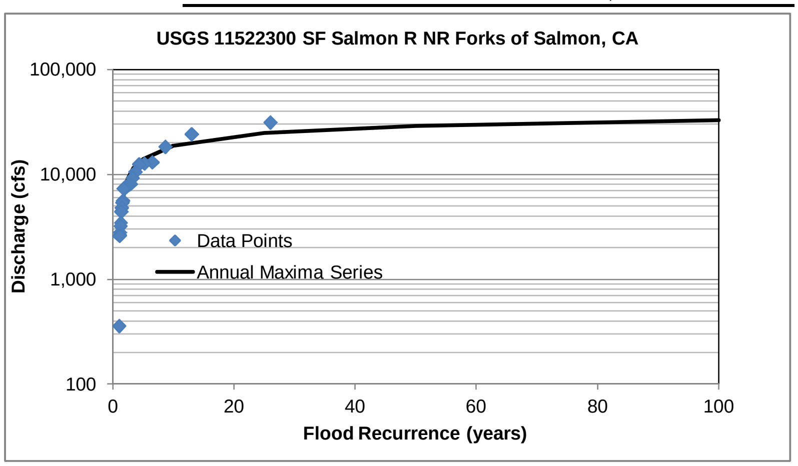
Sample Size, n =	25		
Skewness =	1.82	1.82	-1.193
Mean=	8855	251	3.814
Std Dev=	7070	200	0.388

Outliers

Kn= 2.134

Q-low = 969 cfs

Q-high = 43,846 cfs



Hotelling Gulch

StreamStats Version 3.0

Flow Statistics Ungaged Site Report

Date: Wed May 11, 2016 3:23:42 PM GMT-7
Study Area: California
NAD 1983 Latitude: 41.2388 (41 14 20)
NAD 1983 Longitude: -123.2775 (-123 16 40)
Drainage Area: 1.2 mi2

Peak-Flow Basin Characteristics

100% 2012 5113 Region 1 North Coast (1.2 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	1.2	0.04	3200
Mean Annual Precipitation (inches)	46.3	20	125

Peak-Flow Statistics

Statistic	Value	Unit	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
					Min	Max
PK2	93.1	ft3/s	59		37.9	229
PK5	184	ft3/s	47		87.4	388
PK10	251	ft3/s	44		124	509
PK25	339	ft3/s	43		172	667
PK50	407	ft3/s	43		206	804
PK100	479	ft3/s	44		237	969
PK200	547	ft3/s	44		270	1110
PK500	638	ft3/s	46		307	1330

#http://pubs.usgs.gov/sir/2012/5113/#
Gotvald_ A.J._ Barth_ N.A._ Veilleux_ A.G._ and Parrett_ Charles_ 2012_ Methods for determining magnitude and frequency of floods in California_ based on data through water year 2006: U.S. Geological Survey Scientific Investigations Report 2012-5113_ 38 p._ 1 pl.

Appendix C – Geologic Report

Date: June 23, 2016

To: Lyra Cressey and Karuna Greenberg
Salmon River Restoration Council
PO Box 1089, Sawyers Bar, CA 96027

Cc: Michael Love, PE
Michael Love & Associates, Inc.
427 F Street, Suite 223, Eureka CA 95501

From: William Randy Lew, Professional Geologist (#7872)
Pacific Watershed Associates Inc.
P.O. Box 4433, Arcata CA, 95518-4433
Randyl@pacificwatershed.com / 707-839-5130

Subject: Focused Engineering Geologic Investigation Technical Memorandum for the Hotelling Gulch Fish Access and Channel Restoration Design Project

Introduction and Background

The *Hotelling Gulch Fish Access and Channel Restoration Design Project* (HGFCDP) is located within the South Fork Salmon River watershed, approximately 2.7 aerial miles southeast of the town of Forks of Salmon, in northern California (Map 1). Hotelling Gulch watershed covers an area of approximately 1.2 mi^2, and drains into the South Fork from the left bank approximately 3.3 river miles upstream from the South Fork/North Fork Salmon River confluence. The HGFCDP area is located within the USGS Youngs Peak 7.5-minute quadrangle in Township 10N Range 8E Section 28, Siskiyou County, California (Map 1). The Cal Watershed HUC 8 is 18010210.

An inventory and fish passage evaluation of road crossings in Siskiyou County identified the county road crossing of Hotelling Gulch as a high priority site because it effectively prevents all species and life stages of fish from moving upstream to access a large area of high quality habitat (Ross Taylor and Associates (RTA), 2002). Following the RTA fish passage evaluation at Hotelling Gulch, Salmon River Restoration Council (SRRC), a non-profit organization committed to restoring ecological function and aquatic habitat in the Salmon River, and educating and empowering local riverine communities, initiated the development of a feasibility study to remediate the fish barrier at the Hotelling Gulch Road Crossing. Subsequently, SRRC worked with Pacific Watershed Associates (PWA) to develop a feasibility analysis of fish passage alternatives at the Hotelling Gulch site. With Funding from the Bureau of Reclamation, PWA completed the *Hotelling Gulch Stream Crossing and Channel Realignment Feasibility Study* (PWA, 2010).

In 2016, SRRC obtained funding to complete 100% engineering designs for the channel restoration component of the HGFCDP. SRRC contracted Mike Love and Associates (MLA) to develop the engineering plans. In addition, due to the complex geomorphic nature of the project area, SRRC contracted PWA to conduct a focused engineering geologic investigation to support engineering design. This focused engineering geologic technical memorandum is the result of the investigation.

Focused Scope of Work

The scope of this part of the larger HGFCDP was limited to the characterization of subsurface stratigraphy and alluvial fan geomorphology as they relate to channel reconfiguration design. In addition, the scope included the evaluation of potential constraints imposed by constructing a new channel alignment and creating a “plug” in the newly abandoned portion of the channel, and providing recommendations that limit or mitigate identified geologic constraints. Specifically, the project tasks included:

(1) Pre-field work meetings with the project engineer, SRRC and the US Forest Service staff to discuss site conditions and proposed engineering alternatives.

(2) A review of existing reports and studies conducted within the project area.

(3) A historical aerial imagery review focusing on channel avulsion and alluvial fan evolution.

(4) A field-level reconnaissance to map local geologic and geomorphic conditions/features and evaluate exposures of subsurface stratigraphy.

(5) Description and analysis of data evaluated at previous exploration pit locations (PWA, 2010), geomorphic features and at surficial stratigraphic exposures.

(6) Preparing a technical memorandum summary report and recommendations pertaining to the proposed restoration design project.

Geologic and Geomorphic Setting

The regional geology of the Salmon River watershed is composed of diverse rock groups including several distinct metamorphic belts, intrusive granitic batholiths, alluvial terrace deposits, colluvial deposits, and recent alluvial deposits. The Salmon River watershed is part of the greater regional physiographic Klamath Mountain province. Both poorly consolidated and sheared to well lithified and well indurated metamorphic rocks, as well as deeply weathered granitic rocks that are particularly susceptible to erosion and mass wasting during periods of sustained or heavy rainfall are exposed throughout the watershed.

Published geologic mapping of the area (Ernst, 1998; Wagner and Saucedo, 1987) shows that the project area is underlain by Quaternary alluvium (Qal), while the adjacent hillslopes are composed of argillites, meta-sedimentary and meta-volcanic rocks from the Western Paleozoic and Triassic Belt Hayfork terrane (Map 2). A characterization of subsurface materials within the project area identified alluvial deposits and bedrock exposures consistent with these published California Division of Mines and Geology (DMG) maps. A detailed description of subsurface materials, stratigraphic relationships, depths to inferred bedrock and the water table are included in Figures 1 and 2.

The geomorphic setting of the HGFCDP area is dominated by channel and alluvial fan processes where the Hotelling Gulch stream valley transitions from the steeper and confined upper and middle watershed into its lower gradient reach within ~1,000 of the confluence with the South Fork Salmon River. Similar to many geomorphically comparable areas in the Salmon River watershed, much of the upper and middle Hotelling Gulch watershed is located in steep, mountainous terrain with hillslope gradients frequently exceeding 70% along inner gorges, headwalls and upper ridge slopes. In contrast, the area of the lower Hotelling Gulch watershed where the current stream crossing culvert is located, as well as extending approximately 450 feet upslope from the Cecilville Roadh, is a topographic low gradient strath terrace, where deposition or aggradation of upslope-derived alluvium and colluvium has resulted in a broad alluvial fan/river terrace complex (Map 3). Subsurface and surface investigations indicate that the alluvial/colluvial deposits in this area are of varying thicknesses (~1 to +/- 30ft; Figures 1 and 2), and are underlain by the Western Paleozoic/Triassic belt meta-sedimentary rocks (meta-sandstones, etc.; Wagner et al. 1987). Field and aerial photo evidence suggests most of the alluvial/colluvial cap has been reworked by historical mining activities (see Discussion section). Within the steeper middle watershed above the project area, the Western Paleozoic/Triassic belt meta-sedimentary rocks and lenses of colluvium are exposed at the surface and in road cuts (Photo 1). Both aerial photo and field evidence suggest that hydraulic mining of hillslope materials above the project area has significantly disturbed natural hillslope and channel morphology, as well as alluvial stratigraphy, within the lower Hotelling Gulch watershed (Photos 2 and 3).

Methods

Our geologic investigation consisted of three parts: (1) an re-evaluation of results from previously excavated exploratory trenches/pits at 4 locations adjacent to the new proposed channel alignment. This was conducted to log and characterize the subsurface stratigraphic conditions that will be encountered within the proposed project area; (2) a field-based reconnaissance to evaluate surficial exposures of stratigraphic and geomorphic conditions relevant to channel reconfiguration design; and (3) analyzing and reporting on the results. The exploratory trenches/pits were excavated in 2008 using a hydraulic excavator that track-walked along the dry alluvial fan to reach the trench locations. Once the excavation trenches were completed to the desired depth, detailed logs of the subsurface stratigraphy were compiled, then were backfilled with alluvial materials removed during the excavation. Field classification method ASTM D 2488-00 (Visual-Manual Procedure) was used to describe and identify the soils and alluvial materials observed in the excavation pits. Soil descriptions were classified according to the Unified Soil Classification System (Figure 1).

Discussion

Aerial Photographic Geomorphic Interpretation

PWA staff reevaluated sequential historical aerial photographs and a set of digital imagery to document the history of channel and hillslope geomorphic changes within the HGFCDP area. Five sets of aerial photographs and one set of National Agricultural Imagery Program (NAIP) digital imagery were used in the analysis.

Based on the stereoscopic analysis, the location of the Hotelling Gulch channel on the unconfined alluvial fan surface has avulsed over time. In the 1944, 1955 and 1964 photo sets, the main Hotelling Gulch channel is located to the west of its current location (Map 3). This is indicated by a riparian vegetation corridor that veers west from its current configuration upstream of the Cecilville Road crossing. The channel configuration visible in the photo sets from 1971 and later closely approximates the current stream location. However, the geomorphic channel expression along the alluvial fan of Hotelling Gulch is difficult to discern in the photos due to minimal relief and poor resolution of the available photo sets. Therefore, some uncertainty lies in the interpretation of the exact channel location. Some lateral channel migration from any known position has likely occurred historically due to the geomorphic nature of this alluvial fan setting and due to the past extensive mining disturbance of the alluvial deposits.

The first available photo set (1944) indicates a significant area (~2.5 acres) of ground disturbance approximately 800 feet south, upslope from the current Hotelling Gulch road crossing (Map 3; Photo 2). Similarly, a large (~5 acres), terraced surface with high cut-slopes appears approximately 1,000 feet east of the HGFCDP area (Map 3; Photo 3). Aerial photo and field-based geomorphic evidence show direct hydrologic connection of hydraulically mined deposits into Hotelling Gulch from these areas (Map 3). Large placer deposit piles appear just below the mined areas and extend across the alluvial fan surface in the project area (Photo 4). Based on the extent of revegetation visible on the 1944 photos, major hydraulic placer mining activity appears to have ceased prior to the 1944 photo year.

Within the near project vicinity at least one large (~2 acres) landslide was identified in the 1944 photo set (Map 3). This appears to be an inner gorge debris landslide that delivered sediment directly into Hotelling Gulch approximately 750 ft above the apex of the alluvial fan complex. Based on the photos it is unknown whether or not mining activities initiated or contributed to this slide. Nonetheless, field evidence suggests the toe of this feature buried Hotelling Gulch stream valley up to ~15 ft deep for approximately 100+ ft of channel length, and subsequent winter flows incised through the deposits and redefined the original channel gradient. It is unknown how far downstream landslide debris was deposited in the Hotelling Gulch channel, as little field evidence is present today. However, the slide most certainly delivered significant quantities of sediment through the project reach and this illustrates the some potential for future events of a similar nature.

Characterization of subsurface stratigraphy

For the purposes of this focused study, the stratigraphy was evaluated at 4 discreet excavated observation pits adjacent to the proposed design channel alignment (Map 3). The subsurface stratigraphy in all of the trenches was fairly consistent. In general, subsurface units consisted primarily of un-laminated (massive), unsorted heterogeneous deposits, with rounded to sub-rounded particles ranging in size from sand to boulder up to 2+ feet in diameter (Photos 5, 6 and 7). The observation pits exhibited weak stratigraphic horizons and no obvious or apparent sedimentary structures, such as cross-bedding, but rather a heterogeneous mix of particles throughout each pit (Figure 1; Photos 5 & 6). There were no definitive paleo-current pattern indicators such as clast imbrication or other sedimentary structures indicative of fluvial environments.

In 3 of the 4 test pits, depth to bedrock was clearly identified and ranged from approximately 4 feet below ground surface elevation in Test Pit 1 to over 18 feet in Test Pit 7 (Photo 7). In Test Pit 8, the excavator reached 18 feet below the ground surface elevation and either the bedrock was deeper than the excavator's workable reach, or the high rate of groundwater inflow obscured visibility and it was not possible to determine if bedrock had been reached. The slope of the bedrock contact observed between test pits 1 and 7 averages less than 1% (Figure 2). In all test pits, the seasonal water table surface was identified and ranged from approximately 4 feet below ground surface elevation in Test Pit 1 to over 12 feet in Test Pit 8. Prior to backfilling the test pits, the bedrock/alluvium contact, the water table surface elevation, and the test pit aerial extent were surveyed (Map 3; Figure 1, Photo 7). All of the observed deposits overlying bedrock were unconsolidated and are considered to be anthropogenic re-worked, cohesion-less alluvial/colluvial deposits (Figure 1; Photos 5 & 6).

Interpretation of subsurface stratigraphy

Geomorphic and geologic observations indicate the stratigraphy within the project area is interpreted to be a result of alluvial/colluvial deposits being extensively reworked through historic mining activities, road construction, and associated human settlement. Aerial photographic and field-based geomorphic evidence clearly indicate upslope hydraulic mining scars and associated alluvial (placer) deposits that were "washed" down into the project area (Map 3; Photo 4). There is no age control on the deposition (natural and anthropogenic) of these sediments so the actual timing of deposition is equivocal. However, giving the mining history and the geomorphic nature of the HGFCDP area alluvial fan complex, it is likely the re-worked deposits observed in the exploratory trenches are of historic (< 170 years) origin.

The intrinsic permeability of the substrate encountered during the subsurface investigation is relatively high given the coarse nature of materials encountered throughout the exploratory pits. The sands, gravels, cobbles and boulders encountered during the subsurface exploration are typical of high-energy channel, bar, floodplain and alluvial fan deposits found along the South Fork Salmon River (SFSR). Depending upon channel excavation depths, these high permeability units are likely to pose the most significant challenge to managing groundwater during construction, especially towards the downstream portion of the channel construction area, where groundwater depths were observed to be shallow (Figures 1 and 2).

Potential Project Constraints and Recommendations

1) **Hotelling Gulch Channel Avulsion within the Alluvial Fan**: As already described, historical aerial photo research conducted during this study suggests that the Hotelling Gulch channel thalweg has undergone periodic lateral migration within the project reach. Potential historic causes include both anthropogenic (e.g., hydraulic mining) and natural (e.g., debris flows and torrents) sediment pulses. The entire project area including the proposed channel locations lie within a broad alluvial fan complex that has likely been subject to multiple episodes of lateral channel migration and large influxes of sediment through time (Map 3). Any attempt to design, construct and maintain an engineered channel over 300 feet in length in this geomorphic setting is potentially subject to unforeseen complications. There is some likelihood that influxes of sediment could shift the channel laterally and divert flows outside of the reconstructed alignment. Engineered channel, bridge, and roadway damage could result. Similarly, large influxes of upstream sediment could reduce capacity under the bridge and reduce the effective conveyance of stream flow and large woody debris.

   It should be considered that some level of maintenance will be required to sustain flow conveyance within the new channel configuration for the design life of the project. However, this also applies to the current, poorly designed and undersized stream crossing if the status quo is maintained. It is our opinion that the need for maintenance will be significantly reduced by re-establishing the streamflow into the pre-1971 approximate channel alignment in all but very large debris flow events. In lesser events, the loci of maintenance activities will likely shift to the head of the newly constructed channel and away from the county road itself.

Recommendations:

- Engineering design considerations should account for the possibility of episodic pulses of upstream sediment (from debris flows or flood-based fluvial pulses) which may accelerate significant lateral channel shifts or migration within the design life of the project.

- Develop a monitoring and maintenance plan in preparation for sediment aggradation that could threaten failure of project goals (e.g., fish passage) or infrastructure (e.g., road crossing(s).

2) **Soil and Groundwater Constraints during Construction:** The proposed restoration project intends to excavate and relocate the Hotelling Gulch channel alignment through the re-worked alluvial fan deposits along the approximate pre-1971 channel alignment, across the County road with a new bridge and back into the SFSR. During channel excavation and construction, saturated soils and groundwater piping are likely to be encountered. Excavation of saturated materials is likely to cause significant turbidity; therefore, preventing sediment discharge to SFSR will require special care. In the upper portions of the channel excavation column, cohesion-less alluvium consisting of relatively dry sands, gravels, cobbles and boulders will be encountered (Figures 1 and 2). However, in the lower portions of the excavation column, a saturated mix of alluvial sands, gravels, cobbles and boulders will be encountered (Figures 1 and 2). These materials may be subject to slumping and calving during construction, particularly as groundwater sapping occurs during initial drawdown.

Recommendations:

- During channel excavation and construction, hydraulic pumps, sumps and/or coffer dams may need to be utilized for water and sediment control.
- An erosion and sediment control plan should be developed by a qualified professional prior to the beginning of construction. Among other things, the plan should specifically address the disposal or treatment of turbid water and liquefied silt and sandy sediment.
- The project engineer, in consultation with the project geologist when deemed necessary, should evaluate exposed excavated materials in determining final as-built slope grades. In general, final slope grades in the excavated channel banks should be no steeper than 2:1 (H:V), and perhaps less depending upon design and modeling considerations. Exceptions to final slope grades greater than 2:1 (H:V) should be justified by engineering design constraints.

3) **Placement of Spoils/Channel Plug:** The excavation and removal of soils for the construction of the channel will generate excess spoil material that will need to be disposed of or reused in the construction of designed landforms. Excess spoil material should be suitable for use to plug/fill the current Hotelling Gulch (decommissioned) channel or for even distribution along the adjacent alluvial terrace surfaces, away from any watercourses or wetland areas that are not part of designed landforms. The distribution may require some soil conditioning to allow for sufficient drying prior to the final regrading of the materials. Based on our subsurface investigation, it is likely that minor amounts of organic debris will be excavated during the channel excavations.

If not available on-site, additional fill materials (coarse rock for armor) will need to be brought in for the upstream channel plug face.

Recommendations:

- Most of the heterogeneous alluvial material that will be excavated to construct the proposed western Hotelling Gulch channel should be suitable for backfilling and decommissioning the current channel. The current channel can be backfilled for approximately 300 feet from the proposed head of the new western channel to within 30 to 40 feet of the Cecilville Road (Figure 2).
- During construction of the abandoned channel plug fill, living organic material (plants/trees) should be cleared, grubbed and removed from the plug area prior to the placement of fill.
- Channel plug fill should be placed in lifts no greater than 1 foot and mechanically compacted according to a minimum 90% relative compaction standard, or greater if specified by the design engineer.
- The finish grade of the channel plug fill should, at a minimum, match the existing elevation of the alluvial terraces to the right and left of the channel.
- Organic debris should not be buried or distributed within the fill material being used to plug/fill the current (decommissioned) channel; or within material being spread throughout the project area; or where spoils may be stockpiled. However, organic debris can be used as a final surface treatment on top of finish grade slopes or for in-channel habitat benefits; when and where agency permits allow.
- The project engineer should consider the placement of a near vertical, impervious geotextile blanket/barrier/membrane within the upstream-most 10 feet of the channel plug to minimize downstream seepage through the abandoned channel constructed plug fill.
- Armor the upstream plug fill face with coarse rip-rap designed to resist hydraulic forces from the 100-yr recurrence interval discharge, keyed in at least 3 feet below design channel grade. Consider the use of a bioengineered structure composed of both rock and willow branches (e.g., vegetated bankline rock, bent pole willow mattress) to accomplish this task.

- The final graded spoil material should be mulched, seeded and planted as necessary to prevent surface erosion and any potential for fine sediment delivery.
- If the existing structure at the current Hotelling Gulch road crossing is determined to be unsuitable by the design engineer, a new, minimum 30” diameter culvert should be installed to accommodate seepage during the winter months.

4) **Suitability of Excavated/Dredge Materials for Structural Fills:** If structural fills or embankments are incorporated into the final project design (e.g., stream crossing or bridge-related construction fills), special care should be taken in the use of excavated/dredge materials. Some of the excavated materials generated on-site may be suitable for structural fills. However, some portion of the excavated materials will be unsuitable for structural fill construction because of their composition, grain size, grain shape and/or moisture content. Excavated materials that are composed of, or incorporate, organic debris or other deleterious materials are unsuitable for construction. Additionally, materials that are saturated may require soil conditioning if they are to be used for construction. Some alluvial materials may not be suitable for achieving required design compaction specifications.

Recommendations:

- Use only excavated/dredge materials that are free from organic debris or other deleterious materials, and of proper soil moisture, to construct structural fills.
- Prior to construction, develop relative compaction and optimum moisture content standards based on site specific soils and project design criteria.
- Import additional engineered fill material as necessary to construct structural fills.
- Condition (spread and air dry) saturated soils to specified moisture content standard prior to use in structural fills.

5) **Additional General Recommendations:**

- Grazing livestock should be excluded from any proposed channel(s) excavation areas as they can and will browse stabilizing riparian vegetation, destabilize channel banks, produce turbidity, increase erosion rates, and accelerate infilling of the channel(s).
- Prior to construction, develop a revegetation plan that incorporates native aquatic and terrestrial plants suitable to the project area and implement the plan following construction. Planting with willows and/or other fast growing, deep-rooted native plants should be incorporated into the revegetation plan. However, given the seasonally dry nature of the soils within the project area, irrigation may need to be incorporated into the plan.

References

Ernst, W.G., 1998, DMG Map Sheet 47, Geology of the Sawyers Bar area, Klamath Mountains, Northern California, scale 1:48,000.

Wagner, D.L. and Saucedo, G.J., 1987, DMG Map NO. 4A, Geologic Map of the Weed Quadrangle, California, scale 1:250,000.

Pacific Watershed Associates (PWA), 2010, Hotelling Gulch Stream Crossing and Channel Realignment Feasibility Study, Prepared for Salmon River Restoration Council, Sawyers Bar, California.

Ross Taylor and Associates, 2002, Final report: Siskiyou County culvert inventory and fish passage evaluation. Report for the California Department of Fish and Game.

Ross Taylor and Associates, 2006, Field notes for Hotelling Gulch stream habitat assessment. Prepared for the Salmon River Restoration Council.

Aerial Photography Reviewed

1944, Salmon River Restoration Council digital catalog, origin unknown, flight 000, frames 38-35 through 38-36, approximate scale 1: 24,000.

1955, Salmon River Restoration Council digital catalog, origin unknown, flight DDC, frames 16P-120 through 16P-121, approximate scale 1: 24,000.

1964, Salmon River Restoration Council digital catalog, origin unknown, flight ENU, frames 12-220 through 12-221, approximate scale 1: 16,000.

1971, Salmon River Restoration Council digital catalog, origin unknown, flight EXW, frames 5-164 through 5-165, approximate scale 1: 18,000.

1980, Salmon River Restoration Council digital catalog, U.S.D.A., flight 625050, frames 180-108 through 180-109, approximate scale 1: 12,000.

2005, NAIP county mosaics [Internet]: Sacramento, CA, California Spatial Information Library [cited December 2008]. Available from: http://gis.ca.gov/

Certification and Limitations

This report, entitled *Focused Engineering Geologic Investigation Technical Memorandum for the Hotelling Gulch Fish Access and Channel Restoration Design Project* was prepared by or under the direction of a licensed professional geologist at Pacific Watershed Associates Inc. (PWA), and all information herein is based on data and information collected by PWA staff. The subsurface investigation analysis for the project, as well as engineering design recommendations, were similarly conducted by, or under the responsible charge of, a California licensed professional geologist at PWA.

The interpretations and recommendations presented in this report are based on a study of inherently limited scope. Observations are qualitative, or semi-quantitative, and confined to surface expressions of limited extent and shallow borings of subsurface materials. Interpretations of problematic geologic and geomorphic constraints and erosion processes are based on the information available at the time of the study, and on the nature and distribution of existing features.

The recommendations contained in this report are professional opinions derived in accordance with current standards of professional practice, and are valid as of the submittal date. No other warranty, expressed or implied, is made. PWA is not responsible for changes in the conditions of the property with the passage of time, whether due to natural processes or to the works of man, or changing conditions on adjacent areas. Furthermore, to be consistent with existing conditions, information contained in this report should be re-evaluated after a period of no more than three years. It is the responsibility of the project engineer and project proponent to ensure that all recommendations in this report are reviewed and implemented according to the conditions existing at the time of construction. Also, PWA, including the licensed professionals, are not responsible for recommendations implemented outside of their professional oversight. Finally, PWA is not responsible for changes in applicable or appropriate standards beyond our control, such as those arising from changes in legislation or the broadening of knowledge, which may invalidate any of our findings.

Certified by:

Randy Lew

William R. Lew, California PG #7872
Associate Geologist
Pacific Watershed Associates Inc.

Attachments:

Map 1. *Location map for the Focused Engineering Geologic Investigation of the Hotelling Gulch Fish Access and Channel Restoration Design Project, Siskiyou County, California*

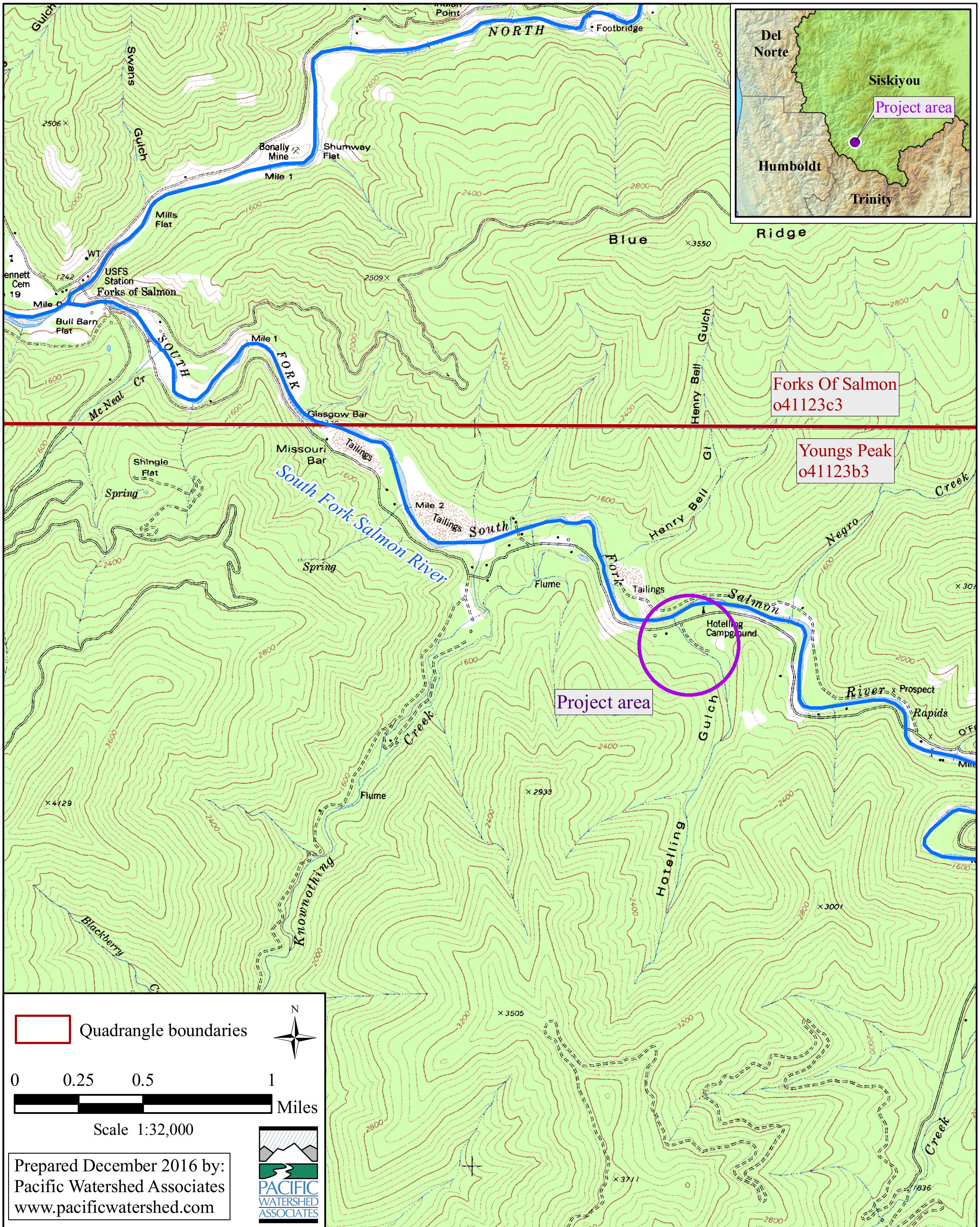
Map 2. *Geologic Map of the Hotelling Gulch Fish Access and Channel Restoration Design Project, Siskiyou County, California*

Map 3. *Geomorphic features and exploration test pit locations for the Focused Engineering Geologic Investigation of the Hotelling Gulch Fish Access and Channel Restoration Design Project, Siskiyou County, California*

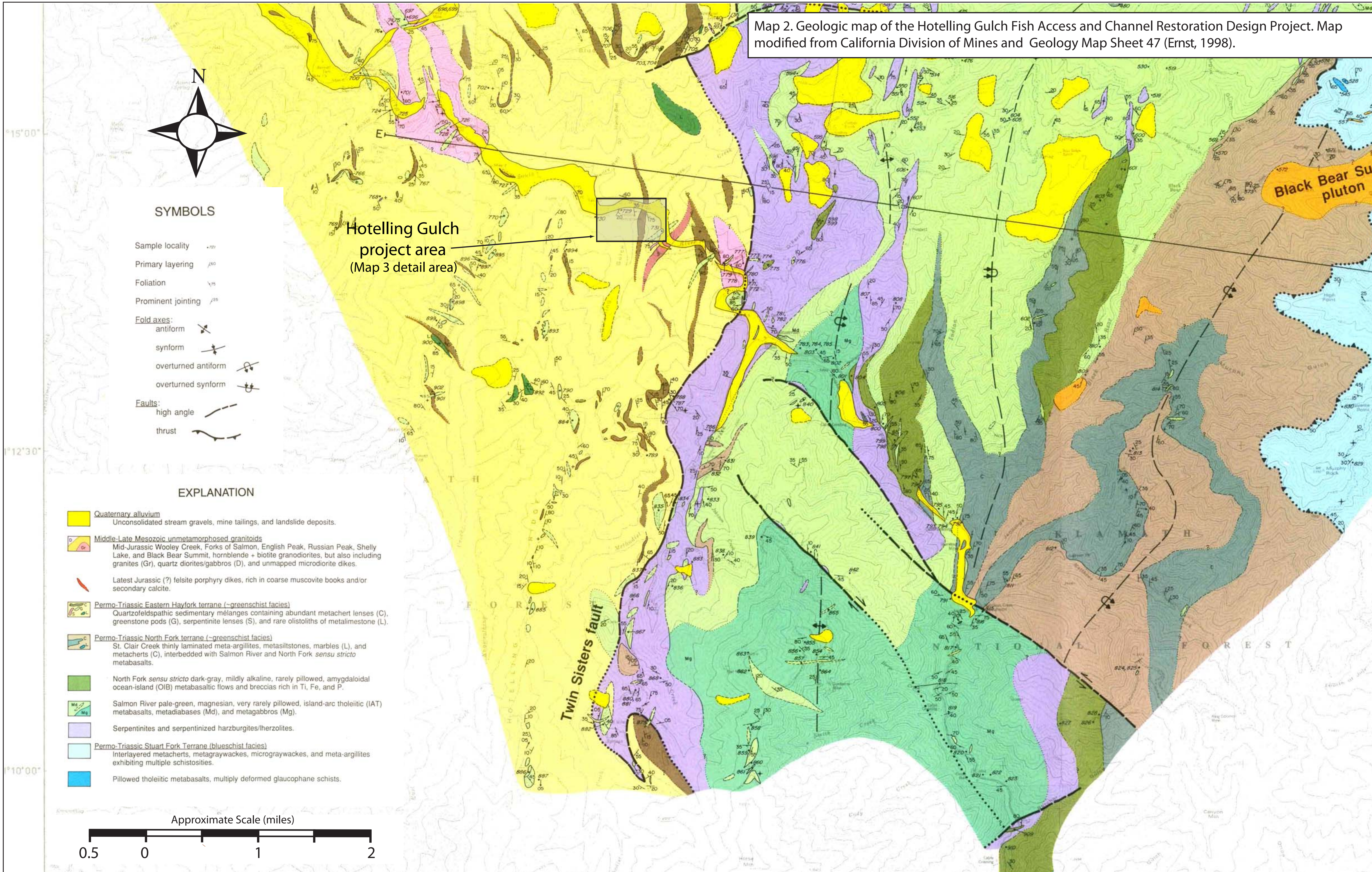
Figure 1. *Exploration test pit logs for the Focused Engineering Geologic Investigation of the Hotelling Gulch Fish Access and Channel Restoration Design Project, Siskiyou County, California*

Figure 2. *Inferred bedrock depth and seasonal water table surface along the proposed channel alignment, Focused Engineering Geologic Investigation of the Hotelling Gulch Fish Access and Channel Restoration Design Project, Siskiyou County, California*

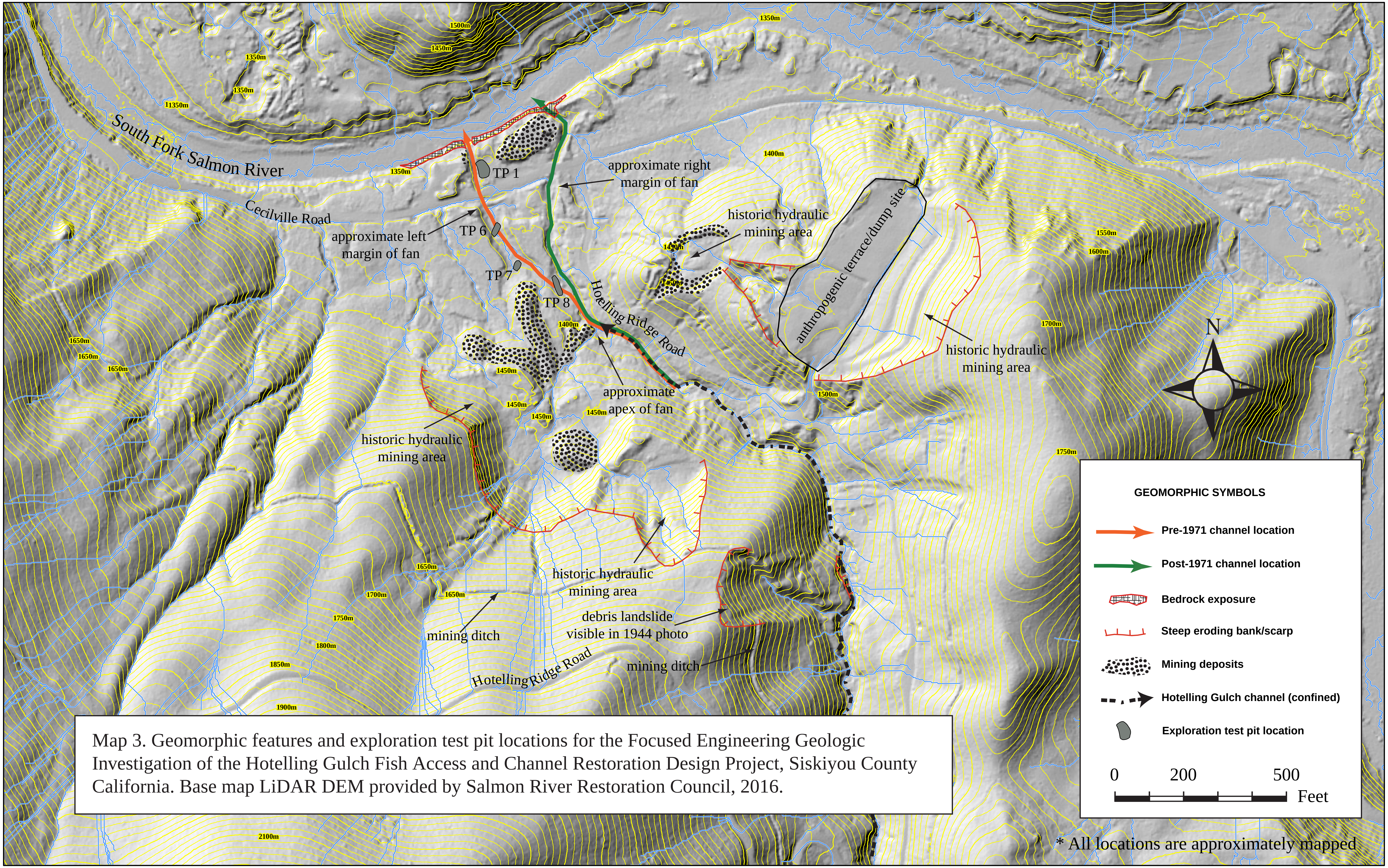
Photo Appendix *for the Focused Engineering Geologic Investigation of the Hotelling Gulch Fish Access and Channel Restoration Design Project, Siskiyou County, California*



Map 1. Location map for the Focused Engineering Geologic Investigation of the Hotelling Gulch Fish Access and Channel Restoration Design Project, Siskiyou County, California.



Map 2. Geologic map of the Hotelling Gulch Fish Access and Channel Restoration Design Project. Map modified from California Division of Mines and Geology Map Sheet 47 (Ernst, 1998).



Map 3. Geomorphic features and exploration test pit locations for the Focused Engineering Geologic Investigation of the Hotelling Gulch Fish Access and Channel Restoration Design Project, Siskiyou County California. Base map LiDAR DEM provided by Salmon River Restoration Council, 2016.

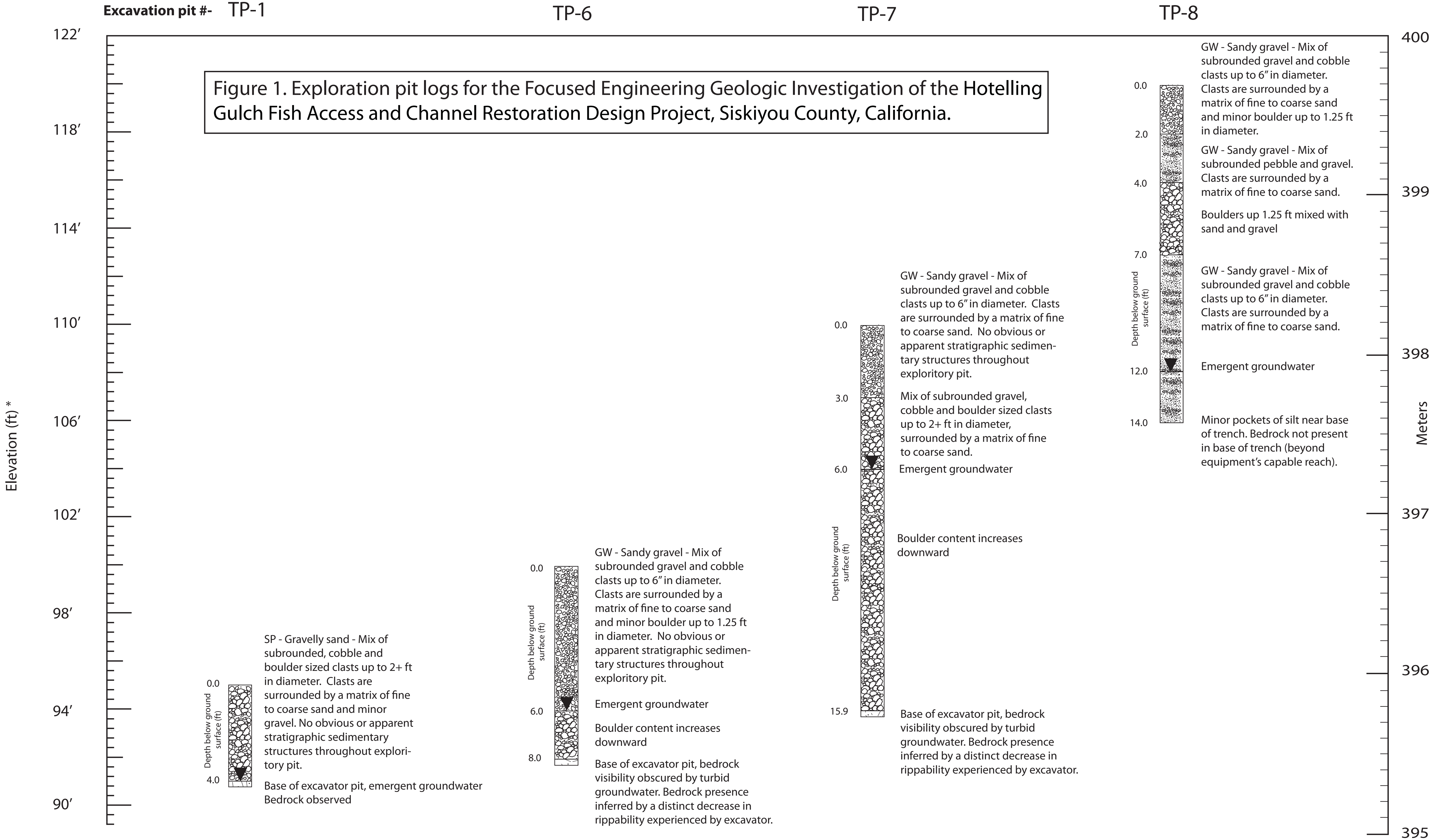
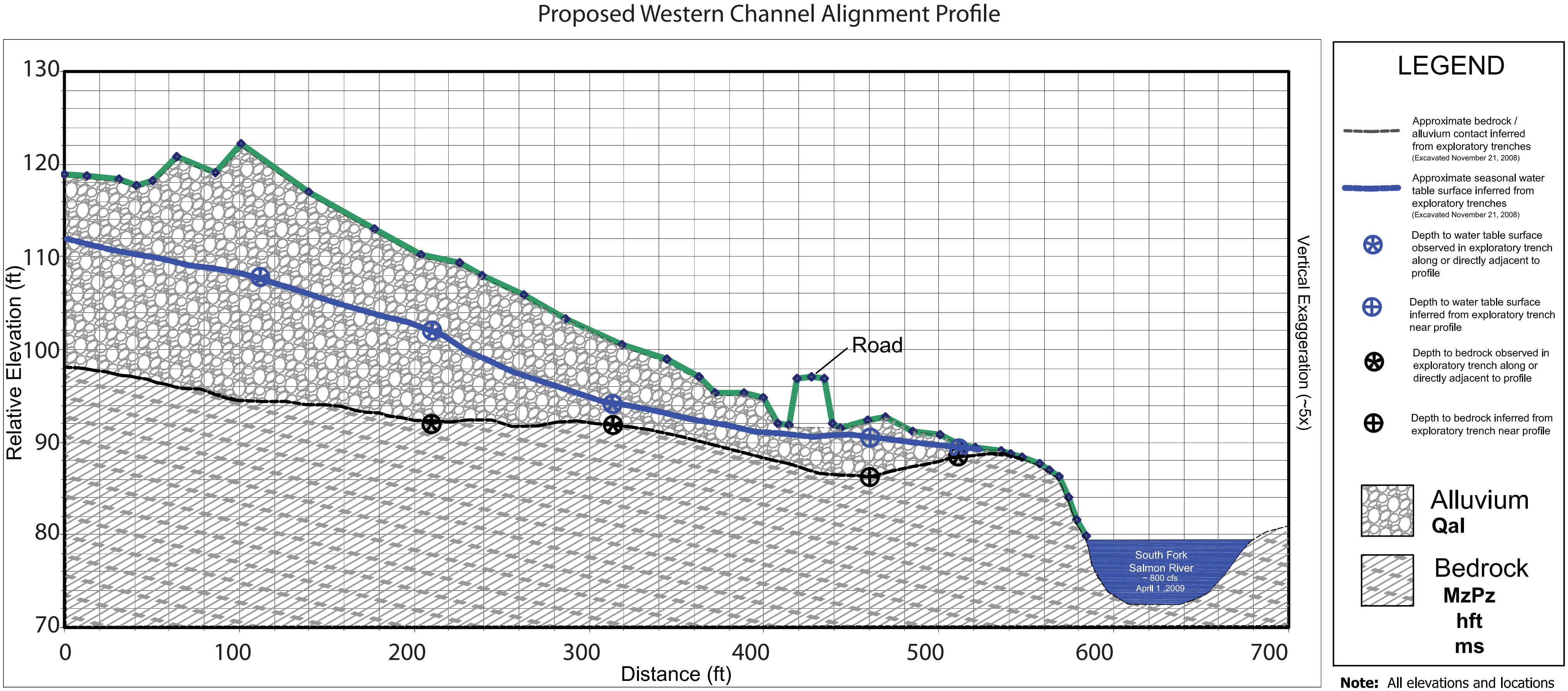


Figure 1. Exploration pit logs for the Focused Engineering Geologic Investigation of the Hotelling Gulch Fish Access and Channel Restoration Design Project, Siskiyou County, California.

*Relative elevation in feet based on survey conducted by Pacific Watershed Associates, 2010.

Note: Soil cores described using field classification method ASTM D 2488-00 (Visual-Manual Proceedure)

Figure 2. Inferred Bedrock Depth and Seasonal Water Table Surface along the Proposed Channel Alignment, Focused Engineering Geologic Investigation of the Hotelling Gulch Fish Access and Channel Restoration Design Project, Siskiyou County, California. Figure modified from the Hotelling Gulch Stream Crossing and Channel Realignment Feasibility Study, PWA 2010.



Note: All elevations and locations are relative and approximate. This survey is not tied to any geodetic datum.

Photo Appendix

Focused Engineering Geologic Investigation Technical Memorandum
for

Hotelling Gulch Fish Access and Channel Restoration Design Project
Siskiyou County, California.

Photo 1. Bedrock outcrop of the Hayfork terrane within the project vicinity.

Photo 2. Hydraulically mined hillslope above (south) the HGFCDP area.

Photo 3. Terraced surface with high cut-slopes. Aerial photo evidence suggests this area was hydraulically mined prior to 1944 and placer deposits were conveyed directly into Hotelling Gulch above the HGFCDP area.

Photo 4. Placer deposit piles appear just below hillslope hydraulic mining area scar and within the HGFCDP area.

Photo 5. Excavation Test Pit # 6 showing typical stratigraphy; poorly sorted, heterogeneous alluvial deposits that have been reworked by hydraulic mining activities.

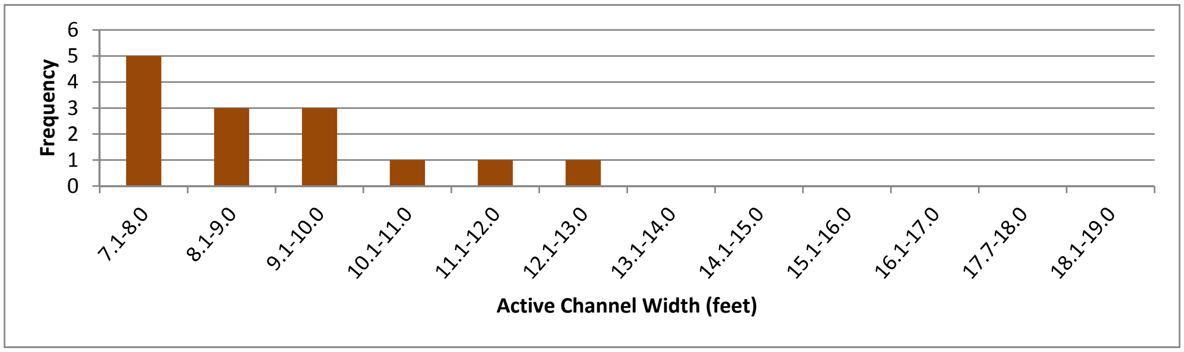
Photo 6. Excavation Test Pit # 7 showing similar stratigraphy.

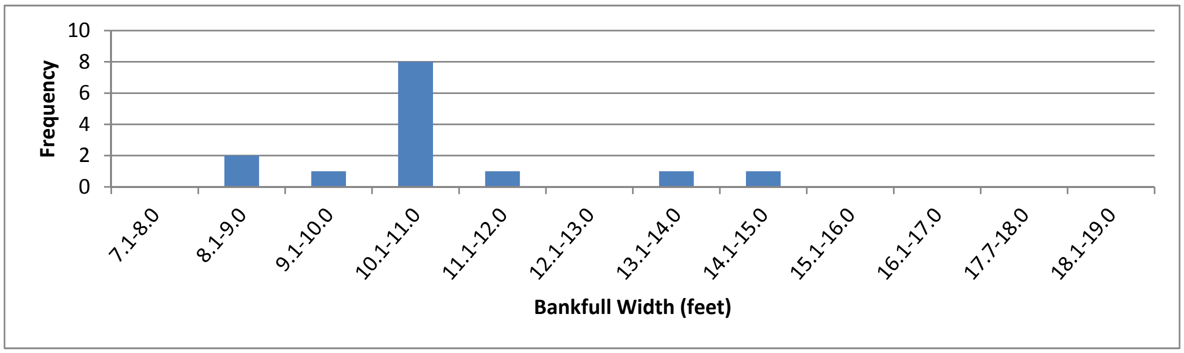
Photo 7. Surveying depth to bedrock and the water table surface in Excavation Pit # 6.

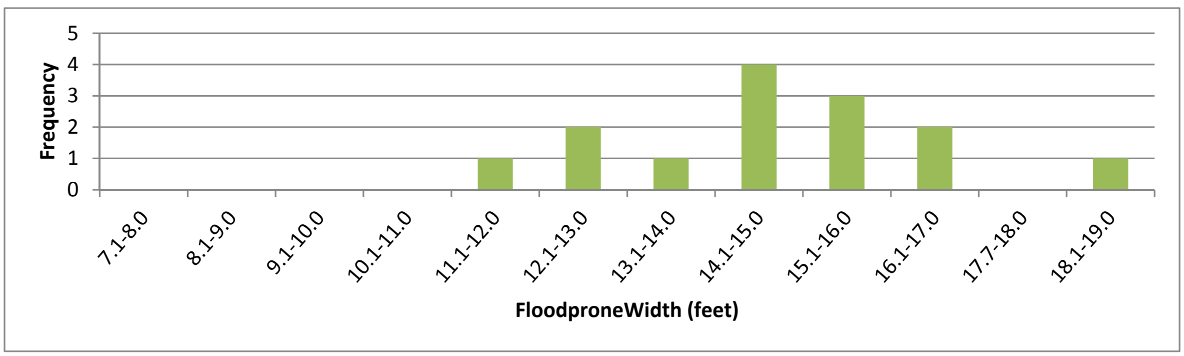
Photo 8. Typical exposure of alluvial stratigraphy encountered along the current Hotelling Gulch stream alignment near the proposed plug location (left bank facing downstream).

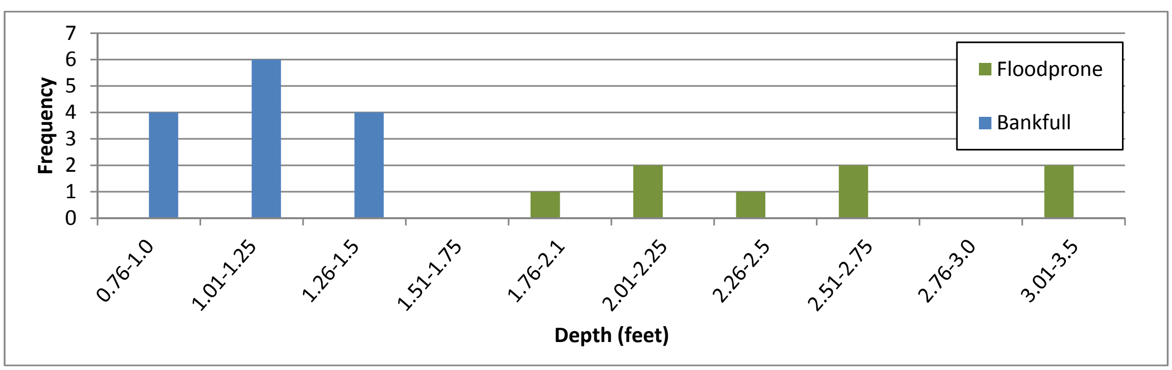
Appendix D – Geomorphology

Summary of Hotelling Gulch Reference Reach Hydraulic Geometry

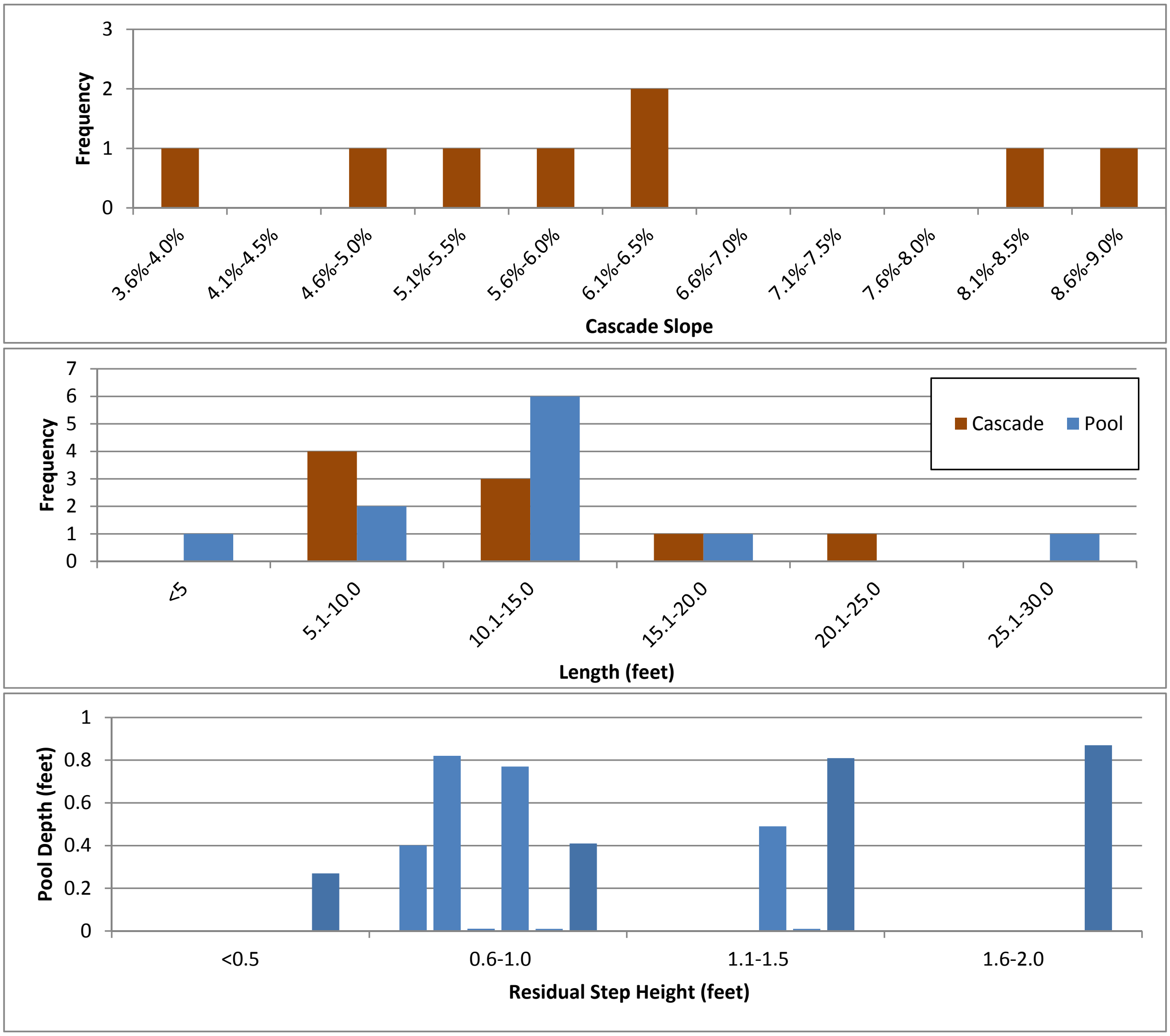






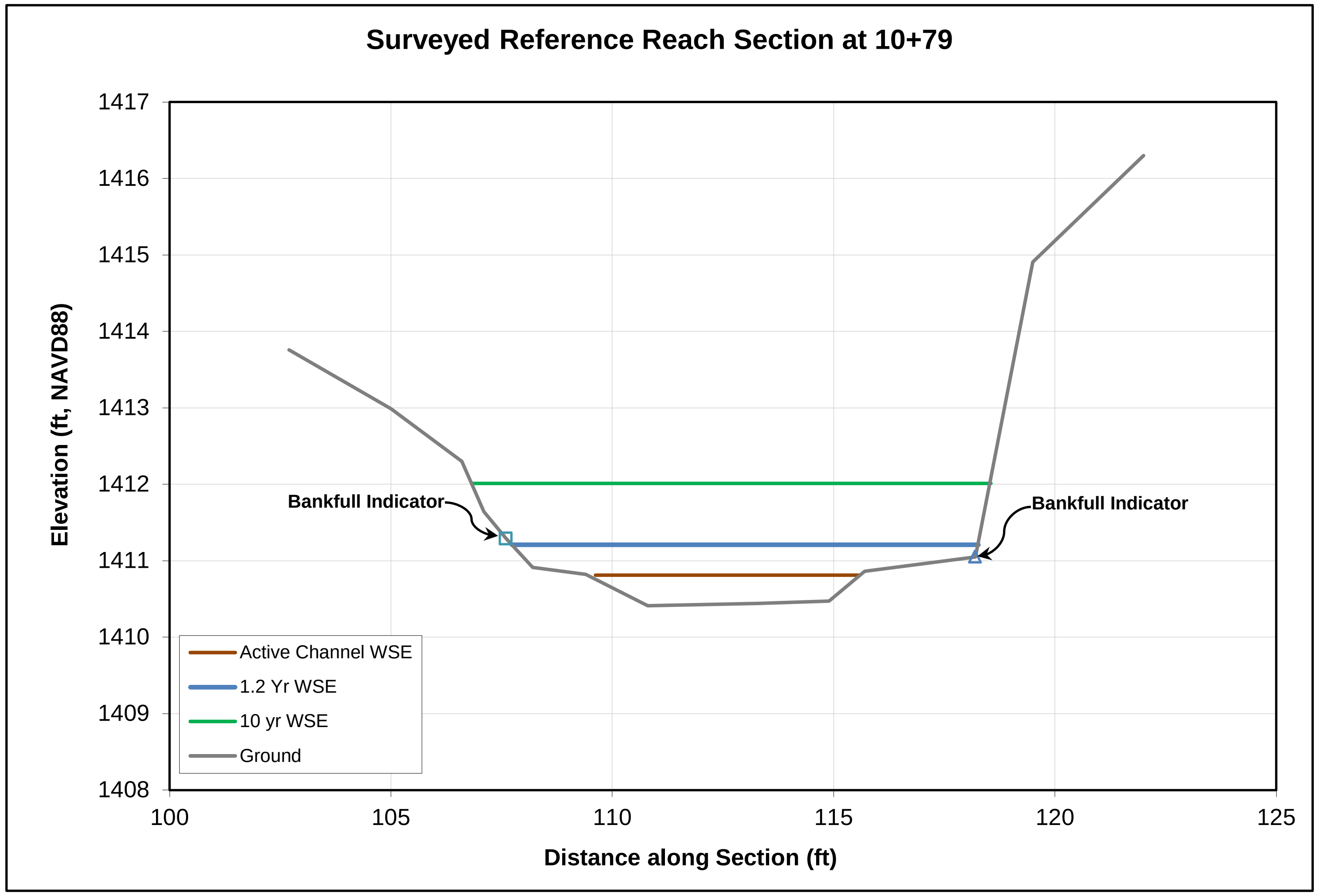


Summary of Hotelling Gulch Reference Reach Profile Characteristics



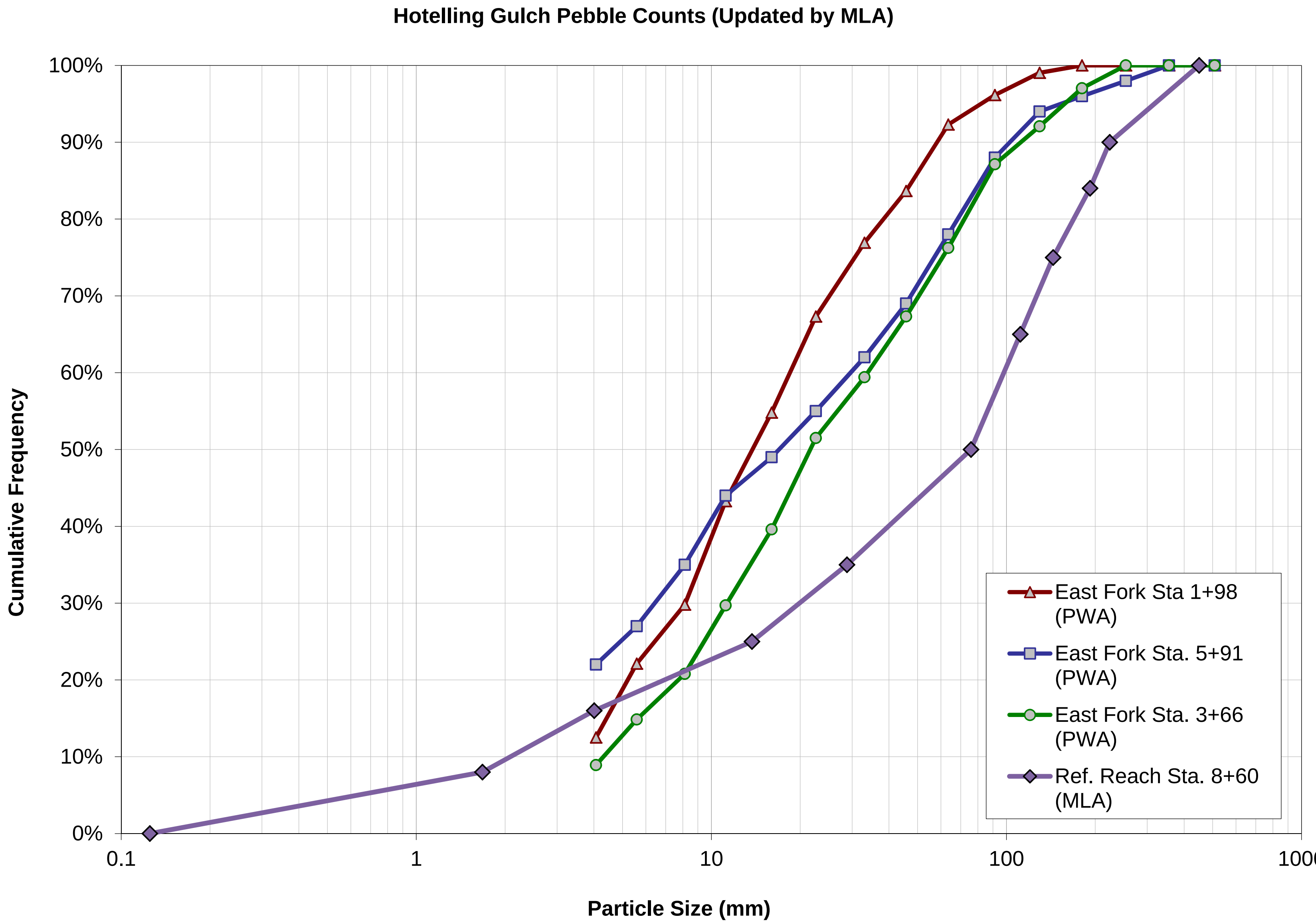
Hotelling Gulch
Surveyed Reference Reach Section at 10+79

Station (ft)	Elevation (ft)	Notes
102.7	1413.76	top terrace, valley slope beyond gentle
105	1412.99	top floodprone
106.6	1412.3	top bank
107.1	1411.64	debris line
107.6	**1411.29**	**BF**
108.2	1410.91	toe
109.4	1410.82	LEW
110.8	**1410.41**	**TW, cobble**
113.3	1410.44	cobble
114.9	1410.47	toe
115.7	1410.86	REW
118.2	**1411.05**	**BF?**
119.5	1414.91	mid slope
122	1416.3	TB flat OB, 15' ft too valley wall



Hydraulics Using Limerinos (1970) from WinXS Pro (USFS, 2005) (Red values out of range of applicability)

Design Flows	Water Surface Elevation (ft)	Flow (cfs)	Max. Depth (ft)	Top Width (ft)	Area (SF)	Shear Stress (psf)	Avg Depth (ft)	Velocity (fps)	Manning's n	W/d	R/D84
Active Channel WSE	1411.0	4	0.6	9.6	3.5	1.4	0.4	0.7	0.287	26.8	0.360
1.2 Yr WSE	1411.2	13	0.8	10.5	5.6	2.0	0.5	1.7	0.144	19.9	0.510
1.5 Yr WSE	1411.4	23	1.0	10.9	7.7	2.6	0.7	2.7	0.107	15.3	0.670
2 yr WSE	1411.5	34	1.1	11.1	8.8	3.0	0.8	3.2	0.097	13.8	0.750
10 yr WSE	1412.1	104	1.7	11.8	15.7	4.7	1.3	5.8	0.073	8.9	1.190
100 yr WSE	1413.2	281	2.8	14.6	30.0	6.9	2.1	8.8	0.062	7.1	1.760
Method Range of Applicability									*0.02-0.107*		*0.9-69*


Hotelling Gulch Pebble Counts (Updated by MLA)
Cumulative Frequency
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
0.1
1
10
100
1000
Particle Size (mm)
East Fork Sta 1+98 (PWA)
East Fork Sta. 5+91 (PWA)
East Fork Sta. 3+66 (PWA)
Ref. Reach Sta. 8+60 (MLA)

Appendix E – Structural and Roadway Engineering Report with Geotechnical Report

October 17, 2018

PREPARED FOR:

Mr. Michael Love
Michael Love & Associates, Inc.
PO Box 4477
Arcata, CA 95518

Re: FINAL Hotelling Gulch Bridge Type Considerations and Recommendations

Executive Summary

The Salmon River Restoration Council, in cooperation with Siskiyou County and the US Forest Service, proposes to realign and restore a portion of Hotelling Gulch Creek at the S. Fork of the Salmon River near Cecilville, CA. The purpose of this project is to improve fish passage and access to upstream habitat. As part of the stream restoration, an existing pipe culvert will be replaced by a larger bridge structure to remove a fish passage barrier at the intersection of the restored Hotelling Gulch and Cecilville Road. Replacement of the pipe culvert and restoration of the creek will also reduce dredging maintenance performed by the County and overtopping flows that cause damage to the existing County roadway.

The most economical bridge type that meets the project need and purpose is a cast-in-place reinforced concrete slab bridge based on road alignment geometry, bridge length, and site terrain. The most cost-effective foundation system for the bridge is a spread footing system based on the presence of shallow, high quality bedrock and channel scour considerations.

The construction duration required to build this bridge is approximately 12-16 weeks. The estimated construction cost for this bridge, including associated roadway improvements is $920,000 including a 10% for Mobilization and 10% for Contingency.

Hydrology and Hydraulics

Hydrologic and hydraulic analysis for the restored channel design has been performed by Michael Love & Associates. Based on this analysis, the minimum soffit elevation of the proposed bridge must be no lower than elevation 1362.0'. This bridge profile will convey the 100-year storm event with 3.1' of freeboard under design conditions and 0.5' of freeboard if the channel aggrades to the highest estimated vertical adjustment potential. Local abutment scour and Contraction scour are not anticipated based on analysis of water surface elevations and velocities within the channel at the proposed road crossing. The total scour is will the result of the combined effects of long-term degradation, contraction scour and local abutment scour. The total combined scour is expected be 2.1' below the channel invert elevation at the abutments, from long-term degradation only. A detailed hydraulic technical memorandum covering channel design, hydraulics, and scour was prepared for the project, *Basis of Design for the Restoration of Hotelling Gulch with a Road-Stream Crossing Replacement on Cecilville, Siskiyou County, California* by Michael Love and Associates in 2018.

Road Design Criteria and Standards

Road design criteria for Cecilville Road will follow the American Association of State Highway and Transportation Officials (AASHTO) guidelines for rural collectors in rolling terrain. Current and future Average Daily Traffic (ADT) is assumed to be less than 100. Roadway width will include 9’ lanes and 2’ paved shoulders, making for a total paved roadway width of 22’ through the project and across the proposed bridge. Typical unpaved shoulder widths will be 3’ from the edge of pavement to the hinge point of the side slopes and taper to match the existing roadway cross-section. The proposed design speed for Cecilville Road is 35 mph.

The proposed roadway structural section along Cecilville Road will consist of 0.4’ depth of hot mix asphalt on top of 1.0’ depth of aggregate base. Side slopes will be 2:1 (horizontal : vertical) consistent with recommendations made by geotechnical evaluation by Pacific Watershed Associates. Roadway embankment will utilize graded materials from channel excavation to the maximum extent possible to eliminate the need for import fill.

The terrain in the vicinity of the new bridge is flat. Raising the profile of the roadway at the new channel will result in a new road fill prism. On the western end of the alignment, the existing roadway runs through an existing cut approximately 10' deep with slopes as steep as 1:1. It is desirable to minimizing the extent of cut to these existing slopes features as much as possible to reduce the total project footprint and required earthwork volumes.

Proposed Roadway Design

The proposed horizontal alignment for this segment of Cecilville Road closely follows the original roadway alignment with improvements made to eliminate narrow locations in the roadway pavement. Vertically, the roadway profile will be raised approximately 3 feet in the vicinity of the proposed bridge in order to provide adequate freeboard for flows in the restored channel. The raised profile will conform to the existing roadway grade within the minimum attainable touchdown distance without negatively affect vertical sight distance.

To minimize disturbance of the existing slopes on the eastern side of the alignment, an AC dike will be utilized to reduce the unpaved shoulder width beyond the hinge point. The AC dike will provide a physical separation between the existing cut slope and new AC pavement as well as collect and control roadway runoff drainage. This design practically eliminates cut on the south side of the road. Cut will still be required on the north side of the road due to the increase in roadway widths between the existing road and proposed standard. Alternatives that would allow for eliminating this cut that were considered, by ultimately rejected, included:

1. Add a short retaining wall in lieu of cutting back the existing slope
2. Reduce the width of this stretch of roadway to less than the remainder of the new roadway

The County, who will own and maintain the roadway and bridge facility, prefers to maintain roadway widths for preserve standards. The retaining wall was rejected because it did not significantly reduce earthwork impacts and represented a poor return for the investment cost.

Bridge Design Criteria and Standards

The proposed bridge will be designed in accordance with AASHTO Load and Resistance Factor Design 6th Edition with Caltrans Amendments including P15 permit loading. Seismic design will perform in accordance with Caltrans Seismic Design Criteria version 1.7 dated April 2013.

Bridge Type Selection

Bridge Geometry: As the facility owner, Siskiyou County does not want a structure that will be included in the National Bridge Inventory. Therefore, the bridge clear span along centerline of the road must be kept below 20' between support faces. Hydraulic clearance will be provided by raising the roadway to allow the soffit of the bridge to clear elevation 1362.0 per the Hydraulic Technical Memo. Abutment scour will be addressed by ensuring the abutment footings are below the calculated scour elevations or founded on scour resistant rock.

Slab Bridge Superstructure Type: Solid slab bridges are relatively simple superstructures that are easy to construct and work well for short spans, where they are typically the most cost effective type. Based on a span length of less than twenty feet, the preferred bridge type is a simply supported slab bridge. A slab bridge will require the thinnest cross section and least amount of profile adjustment of the existing roadway grade. It is also the most cost effective type for this span length.

Typical Reinforced Concrete Slab Bridge during Construction

Bridge Structural Materials

Cast-in-Place Concrete: Cast-in-place concrete is a durable building material that is resistant to many environmental factors that could adversely impact other materials. The quality and durability of concrete structures is dependent on handling techniques during placement which is also sensitive to timing considerations. A disadvantage to cast-in-place concrete is that it is a heavy material that requires adequate support until it has gained enough strength to support itself. On-site construction of cast-in-place structures requires erection of formwork and falsework which can lead to a longer duration construction schedule and more temporary impacts to the channel below.

Precast Concrete: As an alternative to cast-in-place methodology, concrete slabs elements could be precast away from the site, transported to the site, and set in position on constructed foundation supports. Precast concrete is faster to erect because it requires no forms or falsework and the construction of foundation elements and superstructure elements can overlap. Elimination of falsework also reduces the project footprint and temporary impacts to channels and waterways below the bridge. Precast concrete bridges are more costly due to transportation and erection costs and added complexity in the design and construction phases.

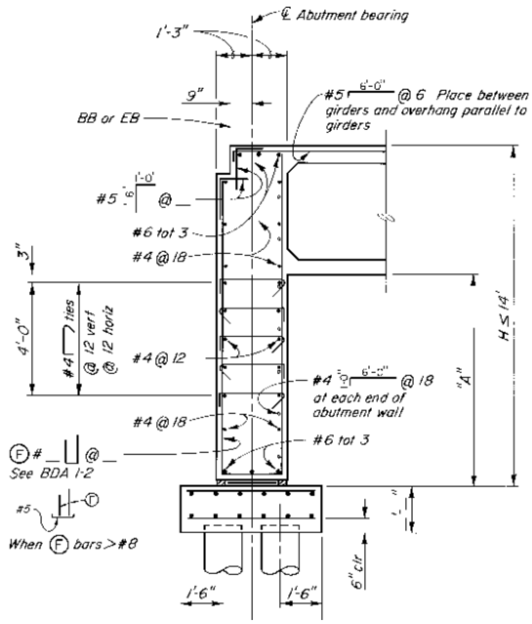
Due the short length of the bridge, the relatively small volumes of concrete required, simplicity of forms and falsework, and minimal specialized equipment required, the preferred bridge type is a cast-in-place slab bridge. Precast components do not warrant the additional cost for speed of erection and do not reduce environmental impacts. Special transportation and concrete mixing techniques will be required based on site location such as dry batching concrete or site mixing short loads. The additional costs of these concrete handling techniques is not enough to overcome the inherent materials premium of precast concrete or structural steel.

Bridge Substructure & Foundations

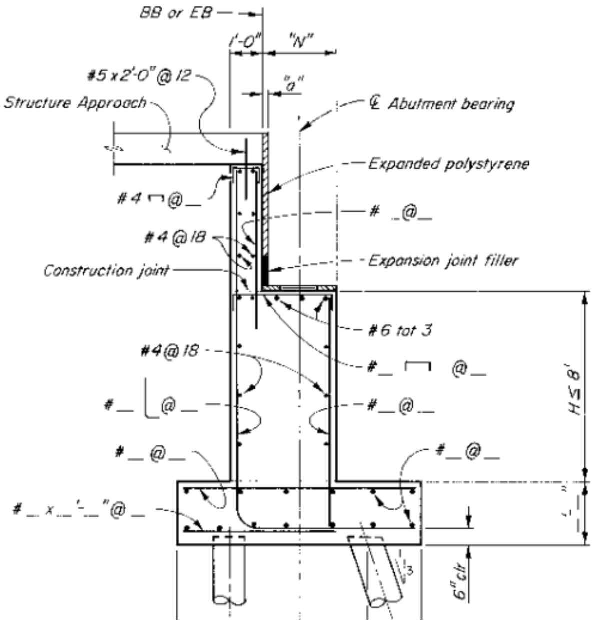
Geotechnical Considerations: Site geotechnical exploration has been performed and summarized along with foundation geotechnical recommendations in a Bridge Foundation Report by Pacific Watershed Associates. Site soils consist of a relatively hard and competent sedimentary rock overlain by alluvial sands, silts, and gravels. At the bridge crossing location, the depth to competent bearing bedrock ranges from 11' - 12' below existing grade. Groundwater was encountered in boring holes approximately 7' - 8' below grade. Based on these soils, the two foundation types are most feasible: spread footings bearing on rock and short cast-in-place bearing type piles embedded into rock. A shallow spread footing founded in the alluvial overburden materials would require very large footings to achieve bearing and be more susceptible to local scour in future flood events. The Bridge Foundation Report is included as an attachment.

Substructure & Foundations Types

Abutments are foundation elements at the ends of bridges that transfer loads from the superstructure to the earth while also retaining roadway embankments and providing transitions from the bridge to the roadway.



Typical Diaphragm style Abutment



Typical Seat style Abutment

Diaphragm Type Abutments: Diaphragm type abutments are a foundation system where the superstructure is integral (strongly connected) with the abutment. These abutments are simple and less expensive than seat type abutments. Diaphragm abutments can utilize the bridge superstructure to balance lateral earth loads on both sides of the bridge and reduce the required footing size compared to seat type abutments. Diaphragm abutments are limited to short spans where thermal movement and concrete shrinkage are anticipated to be small. These abutments are ideal for the short span of the proposed structure.

Seat Type Abutments: Seat abutments allow for longer spans by providing greater movement for expansion and contraction caused by thermal effects and concrete shrinkage. Seat abutments are slightly more costly than diaphragm abutments due to larger footings and the requirement of an additional bearing system at the seat level and a seal system at the superstructure-substructure joint.

A diaphragm system is the most efficient abutment for this span length and foundation depth.

Spread Footings: Spread footings are the simplest bridge foundation type and are most cost effective in competent materials with good bearing capacity. When site soils offer lower bearing capacity or depth to bearing materials is deep, spread footings become less cost effective due to greater earthwork excavation, the need for temporary shoring, and the greater potential to encounter groundwater which may require special dewatering techniques.

Cast-In-Drilled-Hole (CIDH) Piles: Cast-in-drilled-hole piles are also feasible at this site. CIDH piles consist of reinforcement and concrete place in drilled holes that then support a pile cap. Often drilling slurry and temporary casings are used to displace groundwater and prevent the hole from caving during drilling. CIDH piles are more complex than spread footings, but can be more cost effective depending on required pile lengths because they can reduce the depth of excavation and amount of shoring required for foundation construction.

CIDH piles will be challenging to construct at this site. The upper alluvial materials will require a temporary or permanent casing to prevent caving. This casing would be advanced through the upper alluvial materials and embedded into rock to serve as a form. While limiting the extent of foundation excavation and shoring, these piles will be relatively expensive due to their short length and the large number required at each abutment. CIDH pile construction also requires specialized equipment which will not be required for construction of any other portion of the project. Last, CIDH piles constructed in wet conditions require special testing after installation to verify integrity. The outcome of this testing can often require remediation and repair to portions of the pile. Therefore, this foundation type carries more constructability and schedule risk than a spread footing founded on rock at a slightly lower elevation.

Based on these considerations, the preferred foundation is a spread footing founded on bedrock. Due to the depth of rock, a cement slurry backfill will be used to facilitate construction by limiting the depth of open excavation and providing a working platform for forming and pouring the footing. Shoring will be required and control of ground water will require measures such as pumping and gravel leveling pads, but these measures will not increase costs to the point where cased slurry displacement CIDH piles will become cost competitive.

<u>Bridge Type Selection Recommendations</u>

The bridge type that best meets the needs and purpose of the project is a cast-in-place reinforced concrete slab bridge founded on reinforced concrete diaphragm abutments on spread footings.

A slab bridge is cost-effective for this bridge length and will minimize the amount of profile grade adjustment required to accommodate the bridge depth over the top of restored channel's water surface. Even at this fairly remote site, use of cast-in-place concrete is a proven technique as demonstrated by the other nearby cast-in-place bridge structures. Some special mix design modification will be likely be required including retarding admixtures and mix cooling. However, due to the relatively small volumes of concrete required, the additional cost premium for these techniques is still expected to result in a lower total cost compared to other systems such as precast concrete or structural steel.

Diaphragm abutments will support the slab and also serve to retain the roadway embankment that encroaches beyond the channel slopes. A shallow footing founded in alluvium overburden would be too vulnerable to future scour potential. A CIDH foundation would require specialized equipment and techniques (casings & slurry displacement) to achieve installation. CIDH piles would not achieve significant savings in earthwork costs compared to a spread footing founded on rock, particularly for the level of risk associated with constructing CIDH piles at this site. Spread footings founded on bedrock are the best foundation system for this bridge at this site.

The construction schedule required to construct this bridge is approximately 12-16 weeks in duration. The estimated construction cost for this bridge, including associated roadway improvements is $920,000 including 10% for Mobilization and 10% for Contingency. The unit cost estimate reflects recent increases in bidding prices due the large amount of heavy civil construction project leads available for bid and statewide global demand for road and bridge contractors due to available funding for road and bridge construction projects. Additional factors that influence road and bridge cost for this project include a remote site location, wet excavation conditions, and dewatering and shoring requirements.

Sincerely,
Quincy Engineering, Inc.

Jason P. Jurrens | Maxwell Katt

Jason Jurrens, P.E.	Maxwell Katt, P.E.
Project Manager	Bridge Project Engineer

Attachments:

- 90% Roadway and Bridge Plans (Sections, Layout, Profile, & Bridge General Plan)
- 90% Roadway and Bridge Engineers Estimate
- *Cecilville Road, Siskiyou County, California Geotechnical Exploration-Final Bridge Foundation Report* by Pacific Watershed Associates dated August 2, 2017

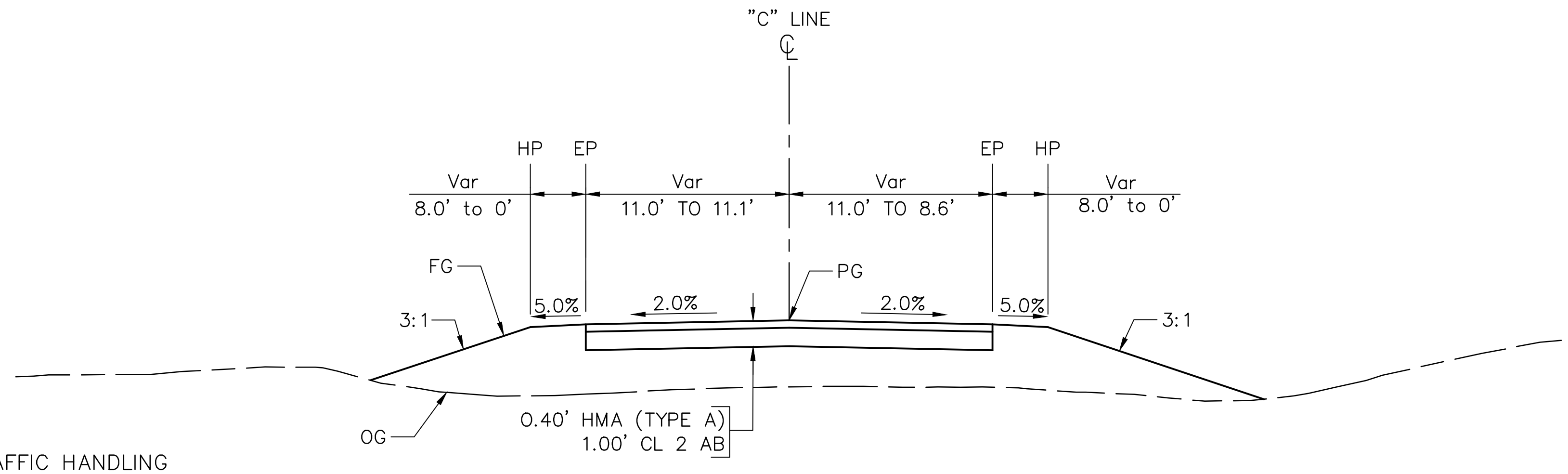
TYPE SELECTION REPORT

Attachment A

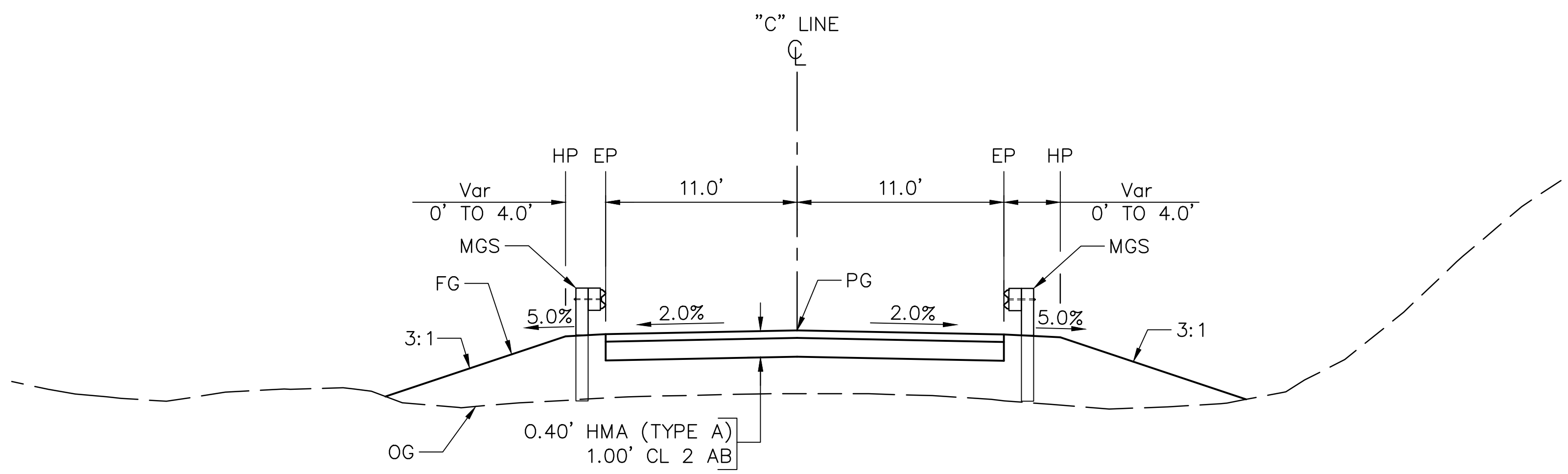
90% Roadway Cross Section, Plan, and Profile and Bridge General Plan

90% DRAFT PLANS
NOT FOR CONSTRUCTION

INDEX OF ROAD PLANS



CECILVILLE ROAD
STA "C" 13+17.75 EB TO STA "C" 15+00.00



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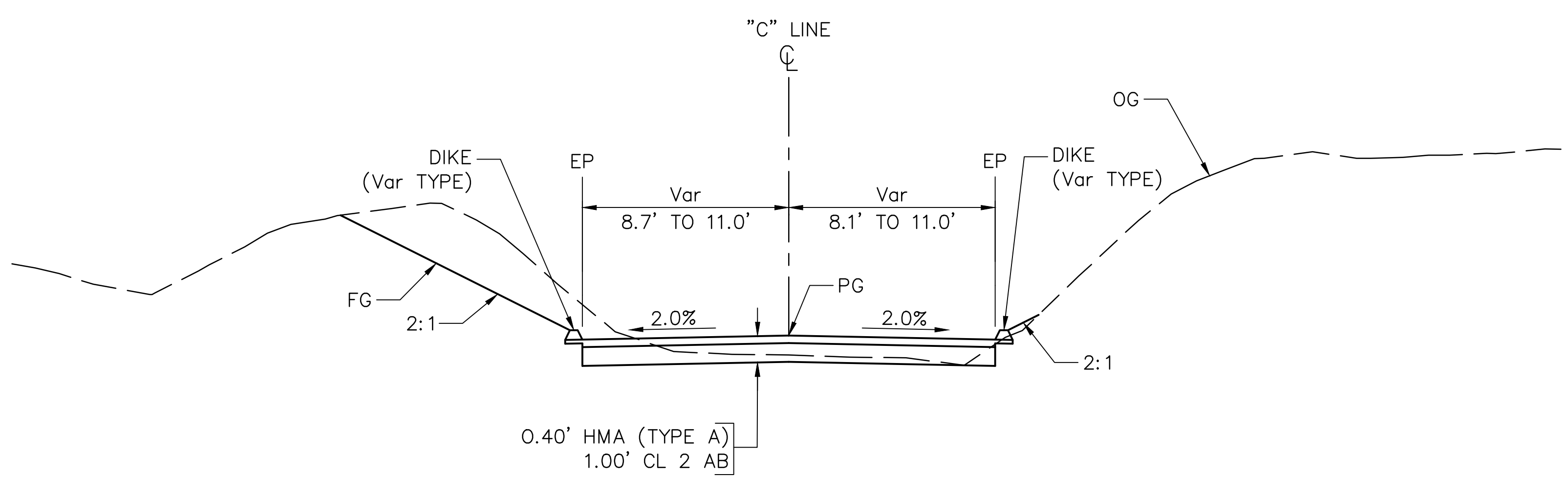


CECILVILLE ROAD
STA "C" 11+65.00 TO STA "C" 12+40.00

DESIGN DATA: CECILVILLE ROAD

V = 35 MPH
R = 30
TI = 7

NOTES:

1. DIMENSIONS OF THE PAVEMENT STRUCTURES (STRUCTURAL SECTIONS) ARE SUBJECT TO TOLERANCES SPECIFIED IN THE STANDARD SPECIFICATIONS.
2. FOR METAL BEAM GUARD RAILING AND DIKE LIMITS, SEE PLAN AND PROFILE SHEET.

PRELIMINARY
NOT FOR CONSTRUCTION

QUINCY ENGINEERING
11017 COBBLEROCK DRIVE, SUITE 100
RANCHO CORDOVA, CA 95670
P: 916.368.9181

Salmon River Restoration Council
PO BOX 1089 • 25631 Sawyers Bar RD, Sawyers Bar CA 96027
530-462-4665 Fax 530-462-4664

DRAFT

VERIFY SCALE
THIS BAR IS ONE INCH LONG AT FULL SCALE

Salmon River Restoration Council and Klamath National Forest
HOTELLING GULCH FISH ACCESS AND CHANNEL RESTORATION PROJECT

TYPICAL CROSS SECTIONS

DATE OCTOBER 2018
SUBMITTAL 90% DESIGN
DESIGN AM / □
DRAWN AM
SHEET 16 of 29

\\qeserver5\client$\MLA\Hotelling\CAD\Roadway\Hotellingrca001.dwg

NOTES:

1. FOR COMPLETE R/W DATA, SEE R/W RECORD MAPS AT THE CO OFFICE.
2. FOR Chnl WORK, SEE Chnl PLANS.

ABBREVIATIONS:

USFS UNITED STATES FOREST SERVICE

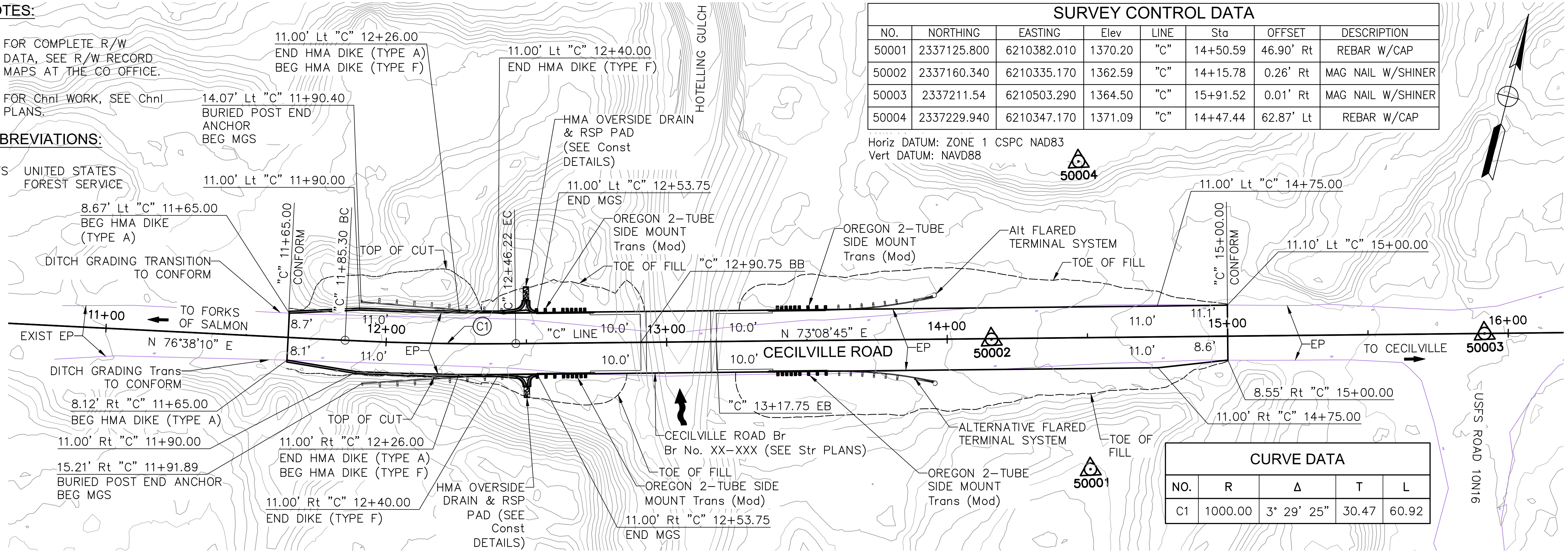
SURVEY CONTROL DATA

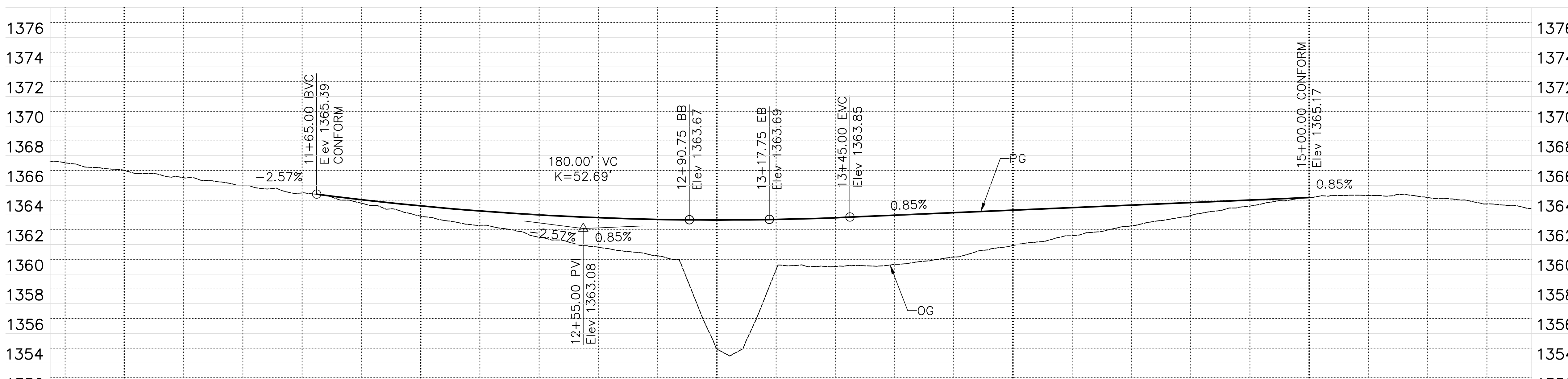
NO.	NORTHING	EASTING	Elev	LINE	Sta	OFFSET	DESCRIPTION
50001	2337125.800	6210382.010	1370.20	"C"	14+50.59	46.90' Rt	REBAR W/CAP
50002	2337160.340	6210335.170	1362.59	"C"	14+15.78	0.26' Rt	MAG NAIL W/SHINER
50003	2337211.54	6210503.290	1364.50	"C"	15+91.52	0.01' Rt	MAG NAIL W/SHINER
50004	2337229.940	6210347.170	1371.09	"C"	14+47.44	62.87' Lt	REBAR W/CAP

Horiz DATUM: ZONE 1 CSPC NAD83
Vert DATUM: NAVD88

CURVE DATA

NO.	R	Δ	T	L
C1	1000.00	3° 29' 25"	30.47	60.92





"C" LINE PROFILE

1" = 10' Horiz
1" = 2' Vert

PRELIMINARY
NOT FOR CONSTRUCTION

QUINCY ENGINEERING
11017 COBBLEROCK DRIVE, SUITE 100
RANCHO CORDOVA, CA 95670
P: 916.368.9181

Salmon River Restoration Council
PO BOX 1089 • 25631 Sawyers Bar RD, Sawyers Bar CA 96027
530-462-4665 Fax 530-462-4664

DRAFT

VERIFY SCALE
THIS BAR IS ONE INCH LONG AT FULL SCALE

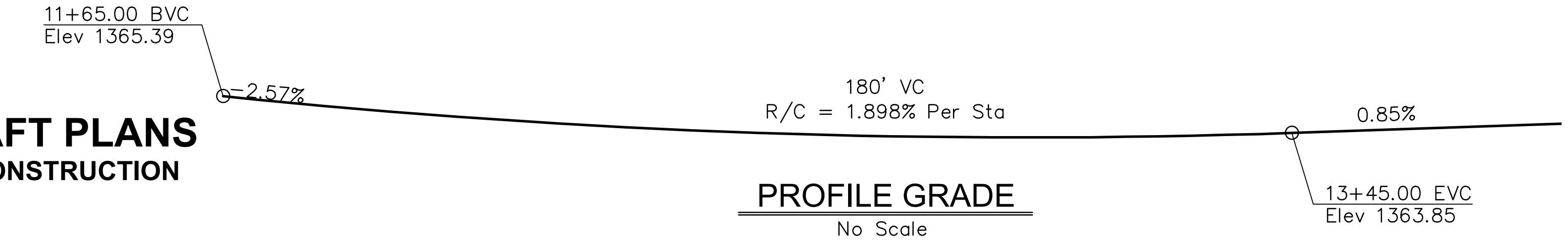
Salmon River Restoration Council and Klamath National Forest
HOTELLING GULCH FISH ACCESS AND CHANNEL RESTORATION PROJECT

PLAN & PROFILE

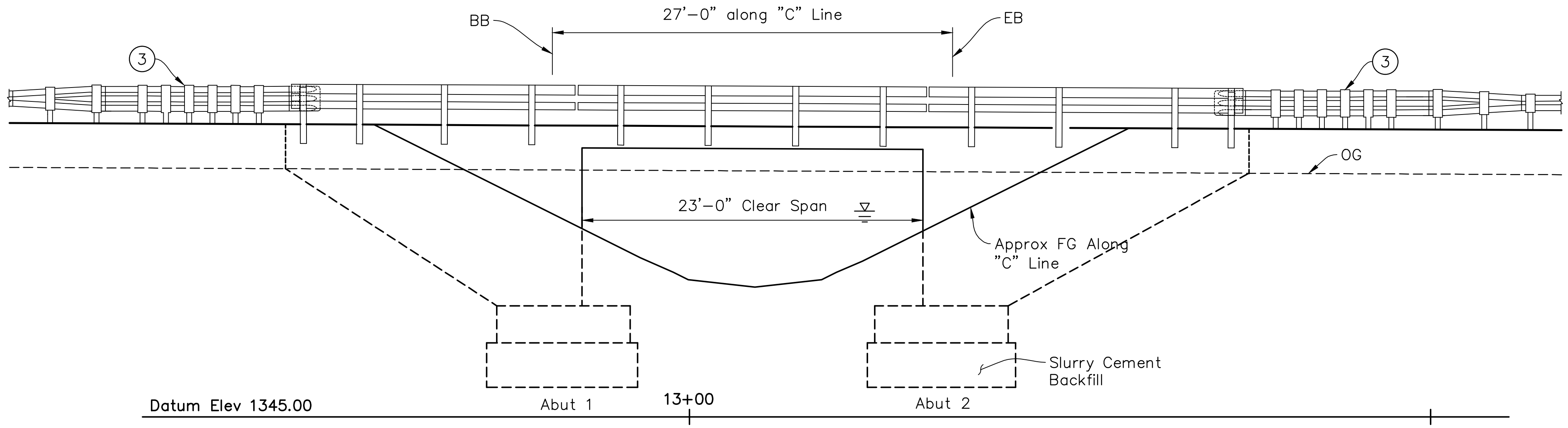
DATE
OCTOBER 2018
SUBMITTAL
90% DESIGN
DESIGN
AM / ☐
DRAWN
AM
SHEET
17 of 29

\\qeserver5\client$\MLA\Hotelling\CAD\Roadway\Hotellingrea001.dwg

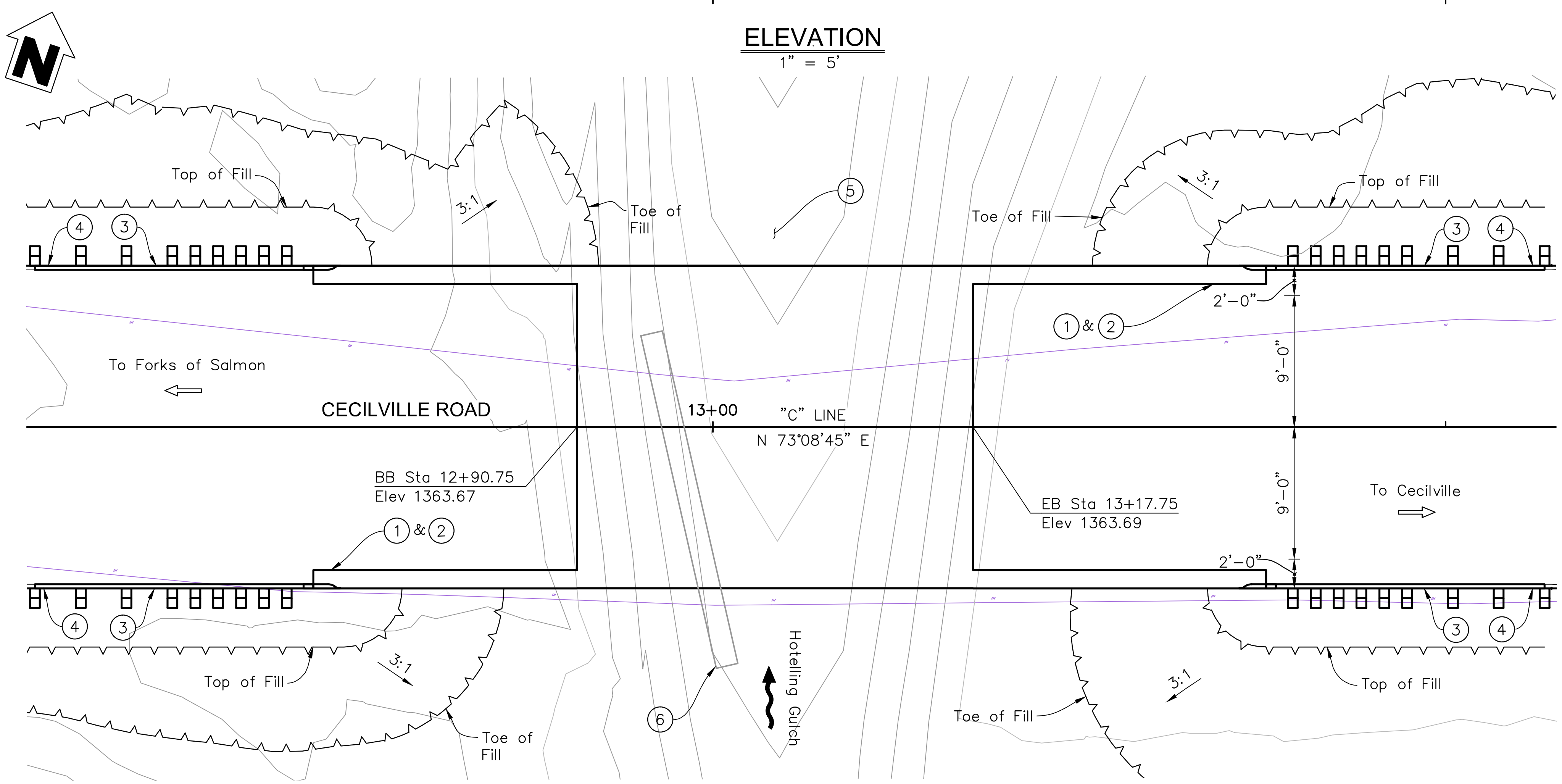
90% DRAFT PLANS
NOT FOR CONSTRUCTION



PROFILE GRADE
No Scale

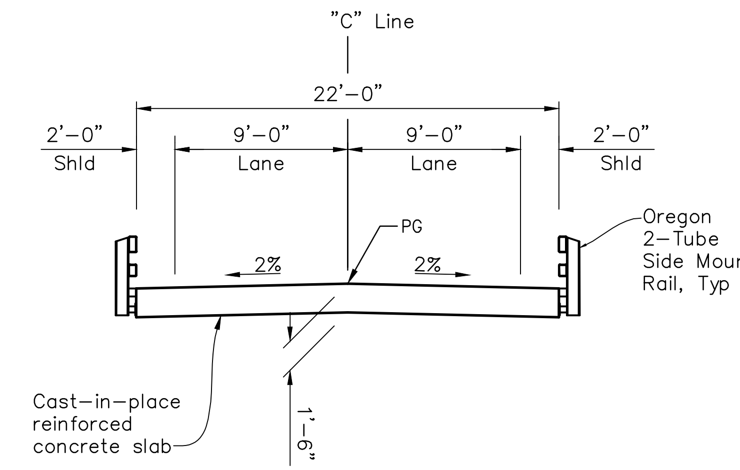


ELEVATION
1" = 5'



PLAN
1" = 5'

INDEX TO PLANS



TYPICAL SECTION
1" = 5'

Legend:

1. Paint "Cecilville Road Bridge"
2. Paint "Bridge No. XXX-XXXX"
3. See "Oregon 2-Tube Side Mount Transition (Mod)" Sheet
4. MGS, see Road Plans
5. Channel Restoration Work, see "Restoration Plans"
6. Remove Existing Culvert

Direction of Flow
Direction of Travel
Indicates Highwater Elevation

Notes:

1. For General Notes, Standard Plans List, and Quantities, see "Deck Contours" sheet.
2. For Spread Footing Data Table, Scour Data Table, Hydrologic Summary, and Survey Control Data, see "Foundation Plan" sheet.

QUINCY ENGINEERING
11017 COBBLEROCK DRIVE, SUITE 100
RANCHO CORDOVA, CA 95670
P: 916.368.9181

Salmon River Restoration Council
PO BOX 1089 • 25631 Sawyers Bar RD, Sawyers Bar CA 96027
530-462-4665 Fax 530-462-4664

DRAFT

VERIFY SCALE
THIS BAR IS ONE INCH LONG AT FULL SCALE

Salmon River Restoration Council and Klamath National Forest
HOTELLING GULCH FISH ACCESS AND CHANNEL RESTORATION PROJECT

GENERAL PLAN

DATE	OCTOBER 2018
SUBMITTAL	90% DESIGN
DESIGN	MK / SB
DRAWN	AM / SB
SHEET	22 of 29

\\qeserver5\client$\MLA\Hotelling\CAD\Bridge\L12-406a-a-gp01.dwg

TYPE SELECTION REPORT

Attachment B

90% Roadway and Bridge

Engineer's Estimate

Hotelling Gulch Stream Realignment & Restoration Project

90% ROAD & BRIDGE GENERAL PLAN ESTIMATE

Bridge	*Cecilville Road at Hotelling Gulch*		Br.No.	*TBD*					
Type	*CIP RC Slab on Diaph Abut Spread Ftgs*		District	*2*	Co.	*Sis*	Rte.	*CR*	P.M.
Length	*27*	Width *22*	Area	*594*	sq.ft.				

Design Section	*Quincy Engineering*	Quantities by:	AM / SB	Date	*10/15/18*	Estimate No.	*1*
Project Includes:	*1* structures	Quant. Checked by:	MK	Date	*10/17/18*	Price by:	*MLK*
	N/A	CU / EA	*N/A*			Cost Index	*2018*

	Contract Items	Unit	Quantity	Price	Amount
1	Structure Excavation (Bridge)	CY	234	$450.00	$105,120
2	Structure Excavation (Rock)	CY	62	$650.00	$40,300
3	Structure Backfill (Bridge)	CY	137	$200.00	$27,400
4	Structure Backfill (Slurry Cement)	CY	46	$450.00	$20,700
5	Structural Concrete, Bridge Footing	CY	38	$1,200.00	$45,960
6	Structural Concrete, Bridge	CY	72	$1,600.00	$115,200
7	Structural Concrete, Bridge (Polymer Fiber)	CY	36	$2,000.00	$72,000
8	Bar Reinforcing Steel (Bridge)	LB	11,092	$1.80	$19,966
9	Bar Reinforcing Steel (Epoxy Coated) (Bridge)	LB	3,657	$2.50	$9,143
10	Oregon 2-Tube Side Mount Rail	LF	130	$350.00	$45,500
11	Temporary Silt Fence	LF	468	$5.00	$2,340
12	Temporary High-Visiblity Fence	LF	608	$6.00	$3,648
13	Clearing and Grubbing	LS	1	$10,000.00	$10,000
14	Construction Staking	LS	1	$20,000.00	$20,000
15	Roadway Excavation	CY	166	$100.00	$16,600
16	Imported Borrow	CY	311	$130.00	$40,430
17	Hydromulch	SQFT	5,968	$0.50	$2,984
18	Fiber Rolls	LF	373	$5.00	$1,865
19	Hydroseed	SQFT	5,968	$0.50	$2,984
20	Class 2 Aggregate Base	CY	248	$160.00	$39,680
21	Hot Mix Asphalt (Type A)	TON	205	$250.00	$51,150
22	Place Hot Mix Asphalt Dike (Type A)	LF	123	$40.00	$4,920
23	Place Hot Mix Asphalt Dike (Type F)	LF	28	$40.00	$1,120
24	Place Hot Mix Asphalt (Miscellaneous Area)	SQYD	6	$500.00	$2,800
25	Temporary Pavement Marking (Paint)	SQFT	20	$10.00	$200
26	Remove Painted Pavement Marking	SQFT	20	$5.00	$100
27	Rock Slope Protection (No. 2, Method B)	CY	1	$2,000.00	$2,000
28	Rock Slope Protection Fabric (Class 8)	SQYD	6	$50.00	$275
29	Midwest Guardrail System	LF	126	$90.00	$11,340
30	Construction Area Signs	LS	1	$10,000.00	$10,000
31	Prepare Water Pollution Control Program	LS	1	$5,000.00	$5,000
32	Alternative Flared Terminal System	EA	2	$4,000.00	$8,000
33	Oregon 2-Tube Side Mount Transition (Mod)	EA	4	$4,000.00	$16,000

SUBTOTAL	$754,724
MOBILIZATION (___ 10 %)	$75,472.41
SUBTOTAL	$830,197
CONTINGENCIES (_____ %) 10 %)	$83,019.65
BRIDGE REMOVAL (Conting. incl.)	
WORK BY RAILROAD OR UTILITY FORCES	
GRAND TOTAL	$913,216
FOR BUDGET PURPOSES - SAY	**$920,000**

Comments:

TYPE SELECTION REPORT

Attachment C

Technical Memo - *Siskiyou County, California Geotechnical Exploration-Preliminary Bridge Foundation Report* by Pacific Watershed Associates

Report of Geotechnical Exploration- Bridge Foundation Report
Hotelling Gulch Fish Access and Channel Restoration Design Project
Cecilville Road, Siskiyou County, California

Updated August 2, 2017

Prepared by:
Thomas H. Leroy, Engineering Geologist # 7751
Ryan Seng, Staff Engineer
Brad Job, Senior Civil Engineer, P.E # C55699
Pacific Watershed Associates, Inc.
P.O. Box 4433, Arcata, CA 95518
toml@pacificwatershed.com / 707-839-5130

Location and Description

The project includes the replacement of a culvert with a bridge on Hotelling Creek on Cecilville Road in Siskiyou County, California. The project location is approximately 3.3 miles southeast of Forks of the Salmon. The bridge replacement is part of a more extensive project intended to allow for fish passage upstream of the road. Other elements of the project include rerouting the channel above the road to a location suitable for fish passage.

This geotechnical report addresses geotechnical recommendations for the proposed Hotelling Creek Bridge. The geotechnical considerations for the rerouting and construction of the channel upstream of the bridge site have been addressed in a separate report titled *Focused Engineering Geologic Investigation Technical Memorandum for the Hotelling Gulch Fish Access and Channel Restoration Design Project* (PWA, 2016).

The proposed structure location is illustrated in Map 1, a set of 30% design plans for the project including: the proposed channel alignment, grading plan, long profile, typical cross sections, and boulder step-pools typical drawings are included in Appendix A. Documentation of the subsurface exploration is illustrated in Appendix B.

Site Topography and Geologic Conditions

Hotelling Gulch watershed covers an area of approximately 1.2 mi^2, and drains into the South Fork Salmon River from the left bank approximately 3.3 river miles upstream from the South Fork/North Fork Salmon River confluence. The project area is located within the USGS Youngs Peak 7.5-minute quadrangle in Township 10N Range 8E Section 28, Siskiyou County, California (Map 1). The Cal Watershed HUC 8 is 18010210.

The regional geology of the Salmon River watershed is composed of diverse rock groups including several distinct metamorphic belts, intrusive granitic batholiths, alluvial terrace deposits, colluvial deposits, and recent alluvial deposits. The Salmon River watershed is part of the greater regional physiographic Klamath Mountain province which includes both poorly consolidated and sheared to well lithified and well indurated metamorphic rocks, as well as deeply weathered granitic rocks that are particularly susceptible to erosion and mass wasting during periods of sustained or heavy rainfall. Both primary rock units are exposed throughout the watershed.

Published geologic mapping of the area (Ernst, 1998; Wagner and Saucedo, 1987) shows that the project area is underlain by Quaternary alluvium (Qal), while the adjacent hillslopes are composed of argillites, meta-sedimentary and meta-volcanic rocks from the Western Paleozoic and Triassic Belt Hayfork terrane. A characterization of subsurface materials within the project area identified alluvial deposits and bedrock exposures consistent with these published California Division of Mines and Geology (DMG) maps. A detailed description of subsurface materials, stratigraphic relationships, depths to inferred bedrock and the water table are included in the *Focused Engineering Geologic*

Investigation Technical Memorandum for the Hotelling Gulch Fish Access and Channel Restoration Design Project (PWA, 2016).

The geomorphic setting of the *Hotelling Gulch Fish Access and Channel Restoration Design Project* (HGFCDP) area is dominated by channel and alluvial fan processes where the Hotelling Gulch stream valley transitions from the steeper and confined upper and middle watershed into its lower gradient reach within ~1,000 of the confluence with the South Fork Salmon River. Similar to many geomorphically comparable areas in the Salmon River watershed, much of the upper and middle Hotelling Gulch watershed is located in steep, mountainous terrain with hillslope gradients frequently exceeding 70% along inner gorges, headwalls and upper ridge slopes. In contrast, the area of the lower Hotelling Gulch watershed, where the proposed bridge will be located, is a topographically low-gradient strath terrace, where deposition or aggradation of upslope-derived alluvium and colluvium has resulted in a broad alluvial fan/river terrace complex (Map 3). Subsurface and surface investigations indicate that the alluvial/colluvial deposits in this area are of varying thicknesses ~1 to +/- 30ft; (PWA, 2016), and are underlain by the Western Paleozoic/Triassic belt meta-sedimentary rocks (meta-sandstones, etc.; Wagner et al. 1987). Field and aerial photo evidence suggests most of the alluvial/colluvial cap has been reworked by historical mining activities (see PWA, 2016). Within the steeper middle watershed above the project area, the Western Paleozoic/Triassic belt meta-sedimentary rocks and lenses of colluvium are exposed at the surface and in road cuts. Both aerial photo and field evidence suggest that hydraulic mining of hillslope materials above the project area has significantly disturbed natural hillslope and channel morphology, as well as alluvial stratigraphy, within the lower Hotelling Gulch watershed (PWA, 2016).

Field Exploration

A total of 3 borings were advanced for the proposed Hotelling Gulch Bridge. Test hole #1 was located near the right upstream bridge abutment location and advanced to a depth of approximately 6’. Test holes #2 and #3 were advanced on the left side of the channel near the location of the proposed left abutment on the downstream and upstream sides respectively (Appendix B). Test hole #2 was advanced to a depth of 21’ test hole #3 was advanced to a depth of 11’. The subsurface investigation was directed by the PWA engineering department. Drilling was conducted on October 4, 2016, utilizing Taber drilling from Sacramento California. A CME 55HD Crawler drill rig equipped with an auto hammer for Standard Penetration Testing (SPT) was used. A 4” inside diameter (ID) hollow stem auger was used in the upper soils with SPTs taken at 5 foot intervals and a diamond core wire line system was used to core the bedrock. Due to the remote location, limited water supply, and abundant proximal representative outcrops of bedrock, rock coring was only conducted in Test hole #2. Test hole #1 met refusal at 6’ at what we interpret as a large boulder within the sedimentary deposits. Test hole #3 met refusal at approximately 11’ at what we interpret as the native (Hayfork Terrane) in-place bedrock. Logs of the subsurface conditions, SPT and RQD results can be found in appendix B.

At the proposed location for the bridge at Hotelling Gulch, the test holes were positioned along both sides, near the proposed location of the abutments. The geologic conditions encountered from the surface down were as follows:

At *Test Hole #1*, near the approximate location of the proposed upstream margin of the right bent, the material encountered was approximately 6' alluvium predominantly characterized as a gravel-sand-silt (GM). The auger met refusal at 6' BGS in the alluvium. Because of the high percentage of >6" rocks in the stratigraphy, there was minimal retrieval of material out of the test hole as the auger tended to "Rod" its way through the coarse alluvium. The auger met complete refusal on what we interpret as a large boulder within the alluvium. In general the material we encountered is a mix of alluvium and fill, which are generally indistinguishable from each other because the project location was subjected to hydraulic mining of alluvial deposits which were then re-sorted locally by Hotelling Creek. Groundwater was not encountered in Test Hole #1. A single SPT was conducted in Test Hole #1 starting at 4' BGS. The first 6" required 17 blows, the next 50 blows drove the sampler 5.5" which we logged as refusal. We retrieved 40% of the sample.

At *Test Hole #2*, near the approximate proposed location of the downstream portion of the left bent, the material encountered was approximately 13' of alluvium directly overlying argillite bedrock of the Hayfork terrane. The alluvium consisted of a silty sand with gravel (SM). As with the other test holes, there was little retrieval of material out of the auger hole. Groundwater was encountered at 8.5' BGS. The elevation of the groundwater did not change as the hole was advanced. Two STP's were conducted in Test Hole #2. The first SPT was between 5' and 6.5' with blow counts logged as 11-12-18 and 10% recovery of the sample. The second SPT was between 10' and 11.5' with blow counts logged as 17-13-08 and 40% recovery in the sampler. At the base of the alluvium we cored the bedrock between 13'-21' BGS. The bedrock consisted of bluish grey bedrock with minimal weathering. It was relatively hard with no apparent jointing in upper section. Fractures appear to be from coring process in upper section. Calcite filled fractures increase in frequency with depth, the fracture filling typically included less than 2mm of calcite. Some fractures were filled with 1-2mm of serpentinite.

At *Test Hole #3*, near the approximate proposed location of the upstream portion of the left bent, the material encountered was approximately 11' of alluvium directly overlying argillite bedrock of the Hayfork terrane. The alluvium consisted of reddish brown clayey sand with gravels (SC). Gravel content increases with depth and ranges in size from 0.5"-3"+. Based on random intermittent auger advancement rates and drill rig shaking, there are likely large (>6") clasts within the alluvium. The alluvial unit is sitting directly on bedrock of the Hayfork Terrane. Groundwater was encountered at 7.5' BGS. The elevation of the groundwater did not change as the hole was advanced. Two STP's were conducted in Test Hole #3. The first SPT was between 5' and 6.5' with blow counts logged as 06-04-05 and 50% recovery of the sample. The second SPT was between 10' and 11' with blow counts logged as 07 and 50 for 5.5" with 40% recovery in the sampler. We encountered bedrock at 11' BGS during a STP. Rock chips in the sampler indicate we encountered similar material to the bedrock observed in Test Hole#2.

The cores and chips retrieved from the test pits are consistent with exposed proximal bedrock outcrops which are highly lithified meta-sedimentary fractured argillites of the Hayfork terrane (Figure 1).

The bedrock elevation difference between the upstream and downstream left bent location (Test Holes #2&3) is approximately 2' as the ground surface elevation of the two test holes is approximately the same. This observation along with other observations of outcrops and proximal backhoe pits indicate the bedrock contact has the potential to vary at least 2'-3' in the immediate area of the proposed bridge location.

OSHA Soil Classification for Shoring Design

Shoring may be a necessary component of abutment construction and it is mandatory to assure that the excavated areas are properly shored to provide safety and constructability. The exposures in local soil pits as well as the borings that were advanced near the proposed abutments suggest that the soil is mostly granular and cohesionless. The observed exposures vary greatly in their relative particle size distribution but in general the sites are more than 15% silts with some clay. These observations indicate the site exhibits Occupational Safety and Health Administration (OSHA) Type B soils for the purposes of shoring design. Much of the site has groundwater present at elevations between 7-9 ft bgs. This will significantly impact the performance of trench shores if deployed at those depths.

Soil Corrosivity

PWA did not perform tests to evaluate corrosion potential at the proposed bridge site, nor are we able to identify any locally pertinent historical corrosivity data. However, generally, the neither the local or regional geologic conditions are likely to create aggressively corrosive soil conditions. The regional bedrock including the Western Paleozoic and Triassic Belt Hayfork Terrane and the observed argillites are not likely to contribute significant amounts of corrosion inducing chloride ions. Furthermore, the observed soils are composed primarily of cohesionless material, which reduces potential corrosivity.

The ambient conditions at the proposed bridge location are generally hot and dry in the summer and cold and wet in the winter. There is no potential for exposure to salt air at the site. The site is exposed to some freeze thaw conditions during the winter months but most of the winter the ambient ground conditions are above freezing. We are unaware of deicers being employed in the vicinity of the project site. However, to assure a margin of safety, it would be safer to assume that the area may be subject to deicing.

Thus, the proposed bridge at Hotelling creek is likely in a relatively low-corrosion geologic setting, but there may be local variables that have a limited potential to exacerbate the corrosion process. However, for preliminary design purposes the site soils and geology should be considered non-corrosive. In general, we recommend the use of Type II Portland cement.

Abutment Options for the Proposed Bridge

Based on geotechnical and site characteristics, consideration of the site specific technical challenges, and discussions with Michael Love Associates and Quincy Engineering there are three options for bridge abutments which may be practically employed at the proposed Hotelling Creek bridge site. Each of these options has its benefits and limitations as discussed below.

Option #1- Cast in place abutment in open excavation completed to bedrock.

Benefits:

- Most capable of handling vertical and horizontal channel adjustments, requires locally available construction equipment, work can be accomplished by local contractors.

Limitations/technical challenges:
This type of abutment will require significant amounts of concrete, enhanced shoring, and full time water management to employ at the site. As a result, this approach has some cost uncertainty.

- Enhanced shoring- The unconsolidated gravely nature of the material likely to be encountered during excavation will require more than typically spaced trench shores. There is a high chance that the excavated material will collapse if the excavation side slopes are not laid back to at least a 1:1 slope. These concerns are exacerbated by the likelihood of encountering a saturated alluvium at this site.
- High water table - the borings were drilled in October when the water table is at its lowest levels. The borings in Test pits 2 and 3 indicated the water table is between 3.5 and 4.5 feet above the bedrock contact with the alluvium. Because the alluvium has a high intrinsic permeability, it is likely that any deep trench excavated to bedrock will be continually flooded by groundwater intrusion. This will exacerbate the likelihood of sidewall collapse of the trench walls during construction.

Option 1 – Allowable design bearing strength = 8,000 pounds per square foot. Projected depth of excavation = 11-13 feet bgs. Lateral resistance to sliding of alluvium overlying bedrock = 150 pounds per square foot per foot of foundation depth (below native ground surface). Coefficient of sliding friction at base of abutment = 0.35.

Option #2- Spread footing on alluvium

Benefits

- This will be the least expensive and excavation intensive abutment approach. It is likely that little or no construction dewatering would be required with a shallow raft-type abutment.
- This approach requires only locally available construction equipment and the work can be accomplished by local contractors. As such the cost uncertainties for this approach are limited.
- Regardless of the low friction-angle of the alluvial stream banks underlying the abutments, anticipated high groundwater elevations, and moderate but non-negligible seismic risks at sites like this one, this abutment approach has been successfully employed in similar locations.

Limitations
- There is more potential for settlement.
- If stream hydraulics are not well controlled and lateral and/or vertical migration of the thalweg occurs, there could be lateral displacement of the abutments.
- The potential for encountering large boulders may complicate excavation and require engineered fill of the resulting voids.
- This design is subject to the largest amount of total and differential settlement.
- Bridge deck designs that are less susceptible to settlement would be the most appropriate for this design approach.

Option 2 – Allowable design bearing strength = 2,000 pounds per square foot. Foundation excavation should extend no less than 3 feet bgs. Lateral bearing strength of alluvium overlying bedrock = 150 pounds per square foot per foot of foundation depth (below the native ground surface). Coefficient of sliding friction at base of abutment = 0.25.

Option #3- Cast-in-place concrete piles

Benefits:
- This construction method will have the least potential for post-construction settlement, will be tolerant/resistant to lateral and vertical migration of the thalweg.
- The cost for this approach should roughly equal to cost for the abutments excavated to bedrock but higher than shallow abutments.
- There is limited cost uncertainty for this approach.
- Conductor or temporary casings are recommended to prevent caving/sloughing of open boreholes.
- Actual construction time would be the least with this approach, resulting in the least disruption to local traffic.
- This approach would result in the least excavated material to be spoiled or off-hauled.

- Depending on groundwater chemistry and conditions, tremie placement of concrete may limit the need to pump groundwater.

Limitations:

- This approach will require specialized construction equipment and contractors. This could result in scheduling challenges.
- Mobilization costs for the specialized equipment will tend to increase project costs.
- Requirement for significant volume of water for drilling and disposal of drill cuttings could complicate logistics and construction permitting.
- Limited on-site availability of water for drilling may require California Department of Fish and Wildlife permit for construction water intake.

Option 3 – Allowable design bearing strength = 10,000 pounds per square foot of pile tip. Projected minimum pile tip depth = 13-15 feet bgs. Lateral resistance of alluvium overlying bedrock = 150 pounds per square foot per foot of depth below ground surface. Lateral resistance of bedrock = 400 pounds per square foot per foot of depth below soil/bedrock interface. Coefficient of sliding friction at tip of pile = 0.35.

Seismic Design Parameters

There are no faults mapped by the U.S. Geological Survey (USGS) in the general vicinity and no evidence of surface faulting was observed at the time of the site investigation. The site is not located within a mapped Alquist-Priolo Fault Zone. However, this portion of the state has not as been well-mapped.

The California Building Code requires that structures be designed to withstand credible earthquake loads as determined by geographic and geologic considerations. The geographic location of the site used to determine the seismic design parameters was: Latitude = 41.23889°, Longitude = 123.27776°. Per USGS's Seismic Hazard Curves and Uniform Hazard Response Spectra application and in accordance with the 2013 California Building Code, the mapped spectral acceleration values for seismic design are as follows:

Parameter (period)	Value (g)
S_s (0.2 sec.)	0.979
S_1 (1.0 sec.)	0.444
SM_s (0.2 sec.)	1.085
SM_1 (1.0 sec.)	0.690
SD_s (0.2 sec.)	0.723
SD_1 (1.0 sec.)	0.460

Other Soil/Geologic Factors

The alluvial soils have a relatively low friction angle (ϕ), which we estimate to be about 30°. We recommend limiting fill slopes comprised of native materials to 3:1

(horizontal:vertical) or less. Excavated slopes should be limited to 2:1 (horizontal:vertical) or less.

The site soils are relatively well-drained. Most settlement is anticipated to occur relatively rapidly as a result of immediate settlement with minor primary consolidation and very little secondary consolidation. Waiting periods for embankment fills of native materials should be in the order of a few days.

Soil resistance values (R-value) were not assessed. Given the composition and conditions of the existing chip-seal pavement, we recommend a total depth of asphaltic cement (AC) pavement of 4 inches (2.5 inched AC base course and 1.5 inches AC wear course) overlying 6 inches of compacted aggregate base and a geotextile grade-separation fabric layer overlying the compacted native subgrade.

Certification and Limitations

This report, entitled *Report of Geotechnical Exploration- Bridge Foundation Report Hotelling Gulch Fish Access and Channel Restoration Design Project Cecilville Road, Siskiyou County, California* was prepared by or under the direction of a licensed professional geologist and engineer at Pacific Watershed Associates Inc. (PWA), and all information herein is based on data and information collected by PWA staff. The subsurface investigation analysis for the project, as well as engineering design recommendations, were similarly conducted by, or under the responsible charge of, a California licensed professional geologist and engineer at PWA.

The interpretations and recommendations presented in this report are based on a study of inherently limited scope. Observations are qualitative, or semi-quantitative, and confined to surface expressions of limited extent and shallow borings of subsurface materials. Interpretations of problematic geologic and geomorphic constraints and erosion processes are based on the information available at the time of the study, and on the nature and distribution of existing features.

The recommendations contained in this report are professional opinions derived in accordance with current standards of professional practice, and are valid as of the submittal date. No other warranty, expressed or implied, is made. PWA is not responsible for changes in the conditions of the property with the passage of time, whether due to natural processes or to the works of man, or changing conditions on adjacent areas. Furthermore, to be consistent with existing conditions, information contained in this report should be re-evaluated after a period of no more than three years. It is the responsibility of the project engineer and project proponent to ensure that all recommendations in this report are reviewed and implemented according to the conditions existing at the time of construction. Also, PWA, including the licensed professionals, are not responsible for recommendations implemented outside of their professional oversight. Finally, PWA is not responsible for changes in applicable or appropriate standards beyond our control, such as those arising from changes in legislation or the broadening of knowledge, which may invalidate any of our findings.

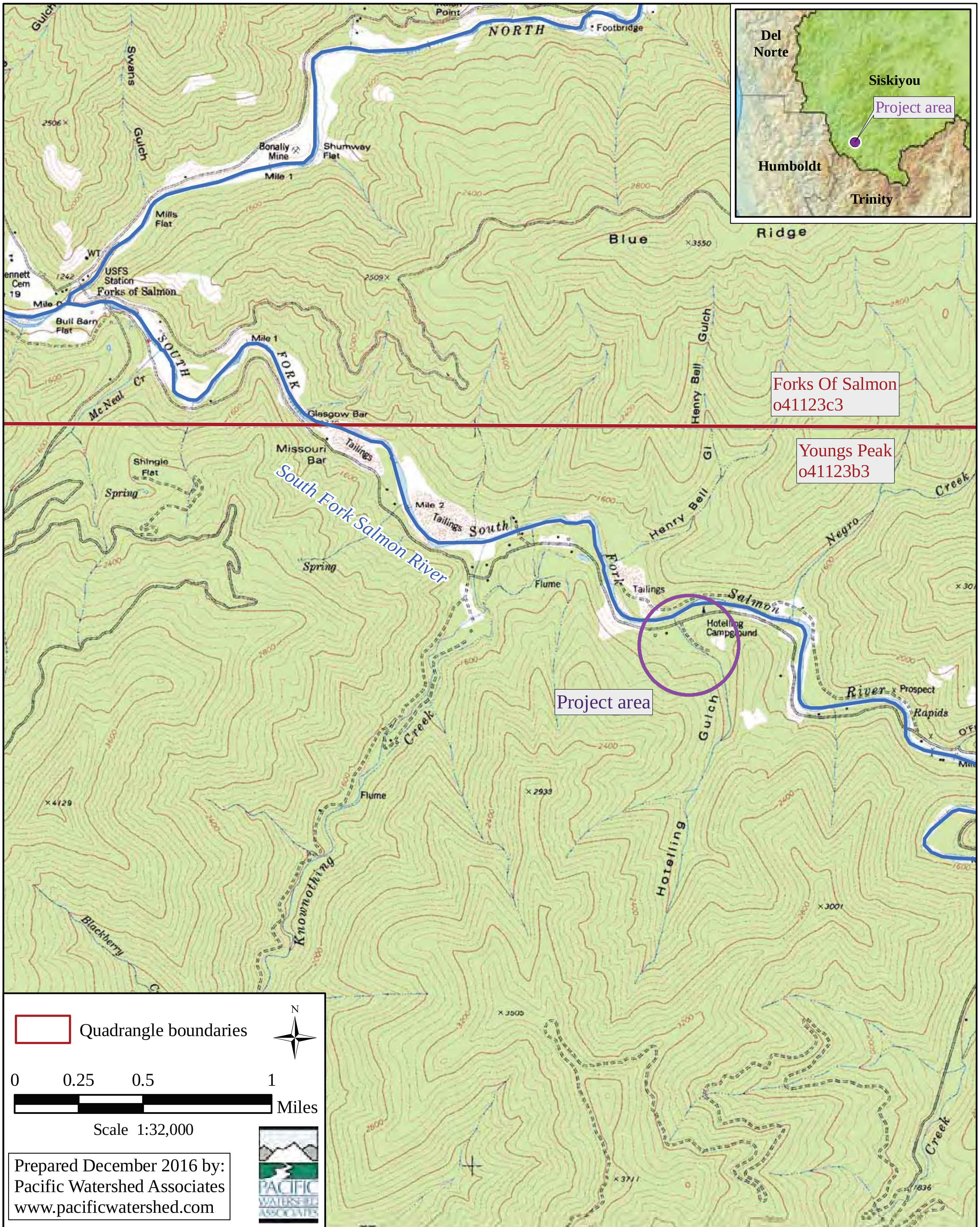
Certified by:

Thomas H. Leroy, CEG #2593
Associate Geologist
Pacific Watershed Associates Inc.

Leonard Brad Job PE#C55699
Senior Civil Engineer
Pacific Watershed Associates Inc.

ENGINEERING GEOLOGIST
THOMAS H. LEROY
THL
No. 2593
Exp. 11-2017
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
L. B. JOB
LBJ
C 055699
Exp. 12/18
CIVIL
STATE OF CALIFORNIA



Map 1. Location map for the report of geotechnical exploration- bridge foundation report Hottelling Gulch fish access and channel restoration design project.

Figure 1. photographs showing typical bedrock characteristics. The top photo shows how the bedrock sample was observed in a typical core retrieval. The lower photo shows how the bedrock is exposed at the natural ground surface locally. The lower photo location is along the left bank of the South Fork Salmon River near its confluence with Hottelling Creek.

Appendix A.

Hotelling Gulch Fish Access and Channel Restoration Design

30% Design

Michael Love and Associates

SALMON RIVER RESTORATION COUNCIL

PLANS FOR CONSTRUCTION OF

HOTELLING GULCH FISH ACCESS AND CHANNEL RESTORATION DESIGN

JUNE, 2016

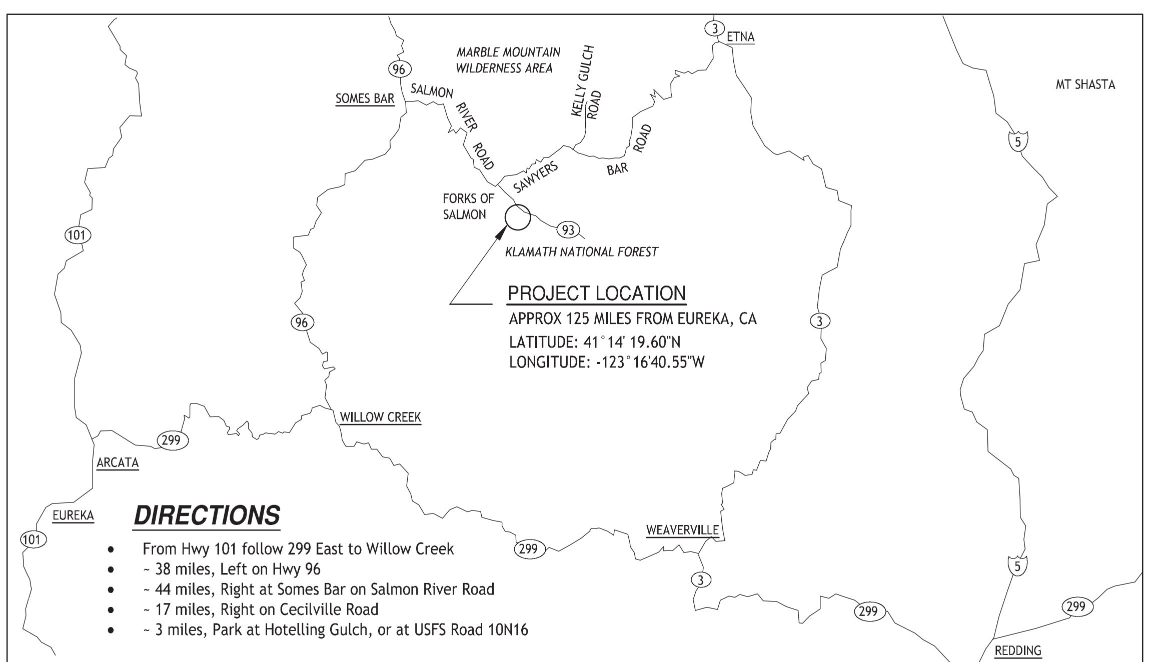
30% Design

Prepared For:

- **SALMON RIVER RESTORATION COUNCIL**
- **USDA FOREST SERVICE, KLAMATH NATIONAL FOREST (AGREEMENT No 15-CS-11050500-025)**

VICINITY MAP

NOT TO SCALE



LOCATION MAP

NOT TO SCALE

SHEET INDEX

Sheet Number	Sheet Title
1	TITLE
2	LEGEND ABBREVIATIONS
3	EXISTING CONDITIONS
4	CONCEPTUAL PLAN VIEW
5	DESIGN PROFILE AND TYPICAL SECTIONS
6	BOULDER CASCADE, STEP AND POOL TYPICALS

PRELIMINARY

NOT FOR CONSTRUCTION

Michael Love & Associates, Inc.
PO Box 4477 • Arcata, CA 95518 • (707) 822-2411
Salmon River Restoration Council
PO BOX 1089 • 25631 Sawyers Bar RD, Sawyers Bar CA 96027
530-462-4665 Fax 530-462-4664

DRAFT

VERIFY SCALE
THIS BAR IS ONE INCH LONG AT FULL SCALE

Salmon River Restoration Council and Klamath National Forest
HOTELLING GULCH FISH ACCESS AND CHANNEL RESTORATION PROJECT

TITLE

DATE: JUNE. 2016
SUBMITTAL: 30% DESIGN
DESIGN: RS / ML
DRAWN: AL / NN
SHEET: 1 of 6

Q:\Hotelling Gulch\05_CAD\2_Sheets\1_TITLE.dwg

LEGEND AND SYMBOLS

EXISTING

FENCE LINE

95 EXISTING CONTOUR AND ELEVATION

+99.0 SPOT ELEVATION

CHANNEL THALWEG OR DRAINAGE

1+00 ALIGNMENT STATIONING (FEET)

CONTROL POINT/TEMPORARY BENCH MARK

FLOW DIRECTION

BEDROCK

NEW

SURVEY CONTROL POINT

16 SPOT ELEVATION

1+00 STATIONING ALONG NEW ALIGNMENT (FEET)

SLOPE LINE

ABBREVIATIONS

APPROX, ~	APPROXIMATELY	NFSR	NORTH FORK SALMON RIVER
CA	CALIFORNIA	NTS	NOT TO SCALE
CL	CENTERLINE	OZ	OUNCE
CP	SURVEY CONTROL POINT	O.C.	ON CENTER
CFS	CUBIC FEET PER SECOND	RD	ROAD
DIA	DIAMETER	R.C	RELATIVE COMPACTION
EG	EXISTING GROUND	STA	STATION
EL	ELEVATION	SY	SQUARE YARDS
(E)	EXISTING	TBM	TEMPORARY BENCHMARK
EP	AVERAGE DAILY EXCEEDANCE PROBABILITY	TYP	TYPICAL
FG	FINISHED GROUND	W/	WITH
'	FOOT OR FEET	WSE	WATER SURFACE ELEVATION
LOD	LIMIT OF DISTURBANCE	YR	YEAR
MAX/MIN	MAXIMUM/MINIMUM	(1.5:1)	(HORIZONTAL:VERTICAL) SLOPE
(N)	NEW	%	PERCENT

1
4

SECTION DETAIL OR TYPICAL NAME

SHEET NUMBER ON WHICH SECTION, DETAIL OR TYPICAL APPEARS

PRELIMINARY

NOT FOR CONSTRUCTION

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DRAFT

VERIFY SCALE

THIS BAR IS ONE INCH LONG AT FULL SCALE

Salmon River Restoration Council and Klamath National Forest
HOTELLING GULCH FISH ACCESS
AND CHANNEL RESTORATION PROJECT

LEGEND ABBREVIATIONS

DATE
JUNE. 2016
SUBMITTAL
30% DESIGN
DESIGN
RS / ML
DRAWN
AL / NN
SHEET
2 of 6

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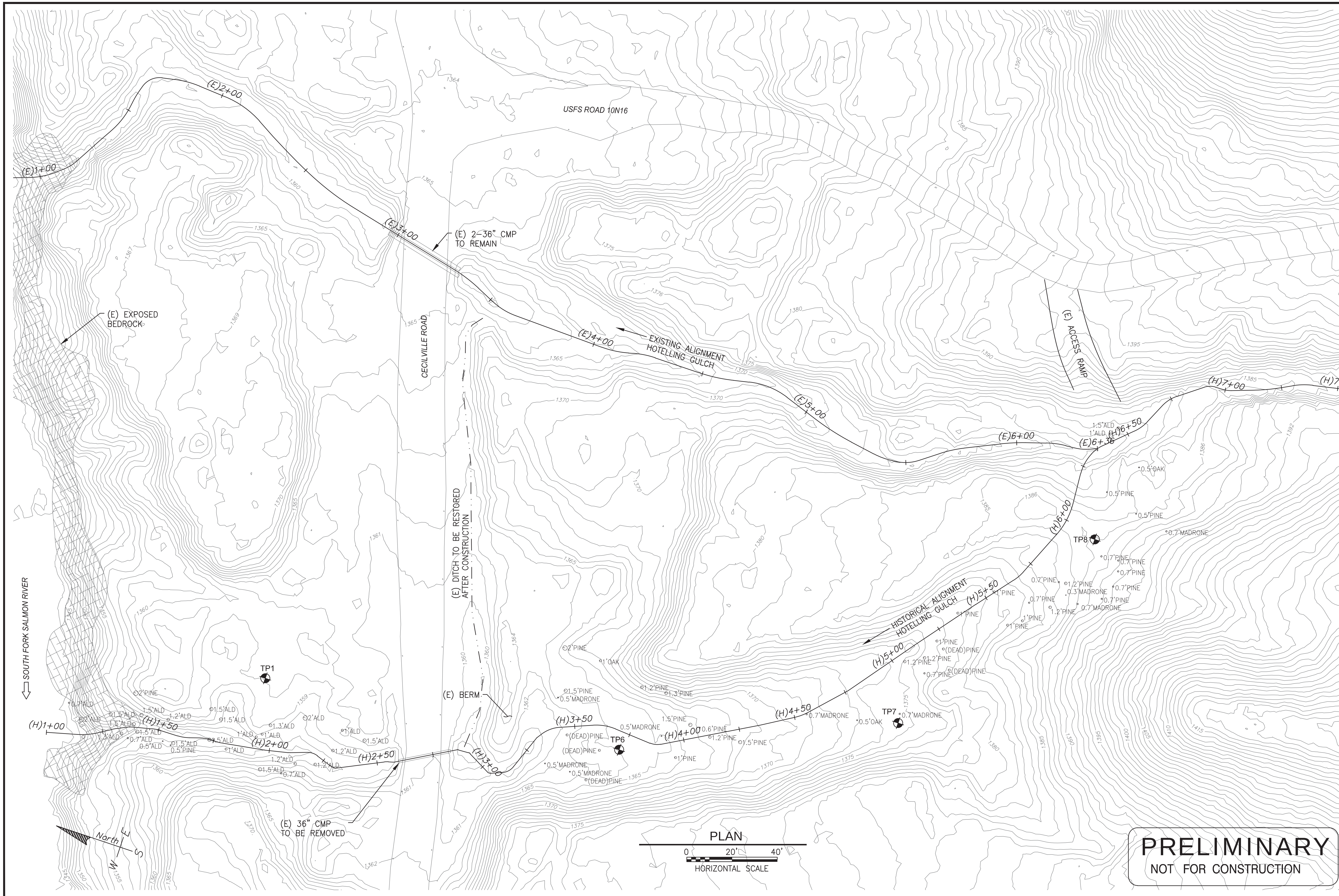

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EXISTING CONDITIONS

PRELIMINARY
NOT FOR CONSTRUCTION

DATE	JUNE. 2016
SUBMITTAL	30% DESIGN
DESIGN	RS / ML
DRAWN	AL / NN
SHEET	3 of 6

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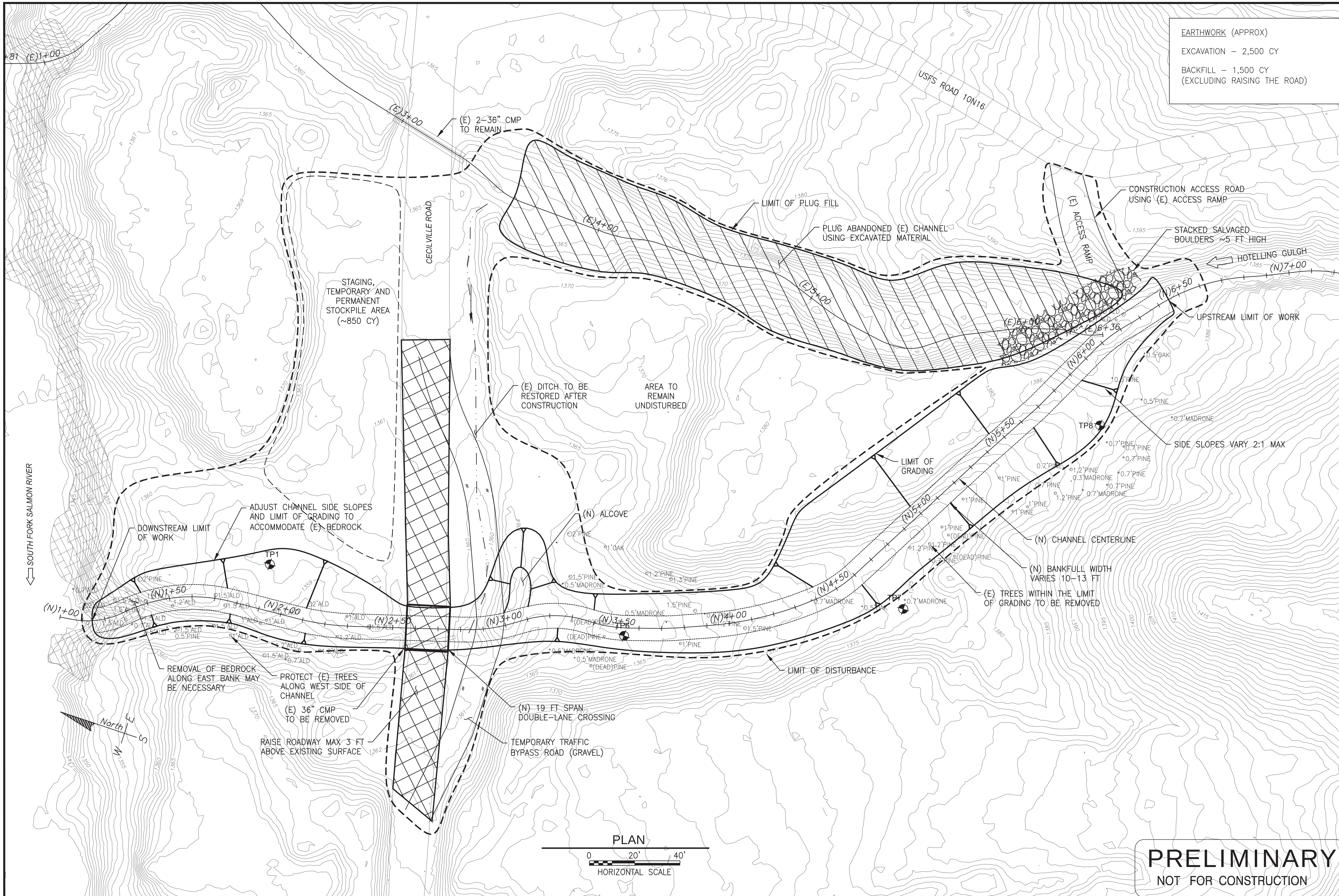

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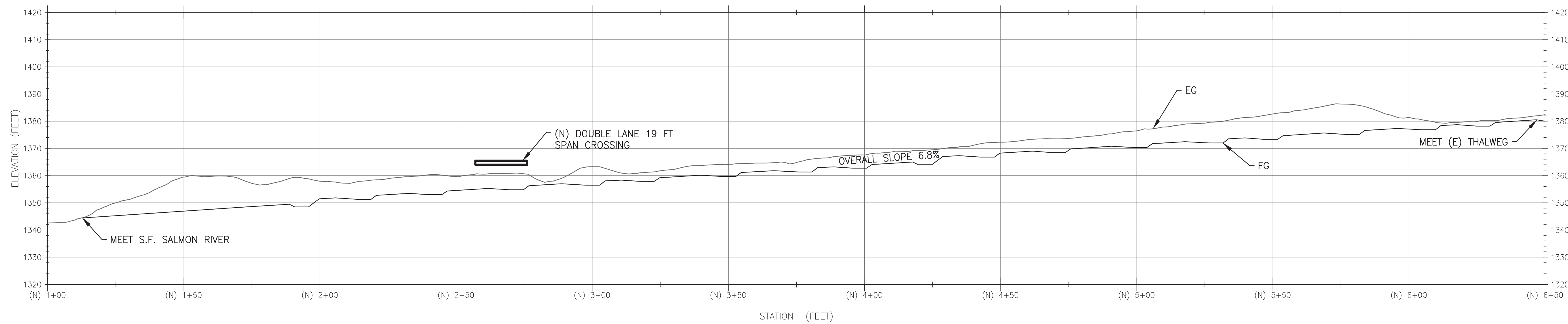
HOTELLING GULCH FISH ACCESS AND CHANNEL RESTORATION PROJECT

CONCEPTUAL PLAN VIEW

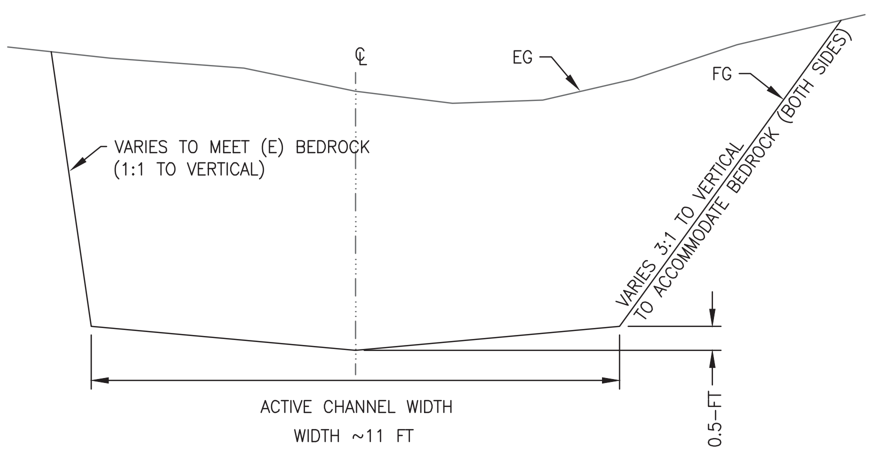
DATE: JUNE. 2016
SUBMITTAL: 30% DESIGN
DESIGN: RS / ML
DRAWN: AL / NN
SHEET: 4 of 6

Q:\hotelling Gulch\05_CAD\2_Sheets\3_CONCEPTUAL.dwg



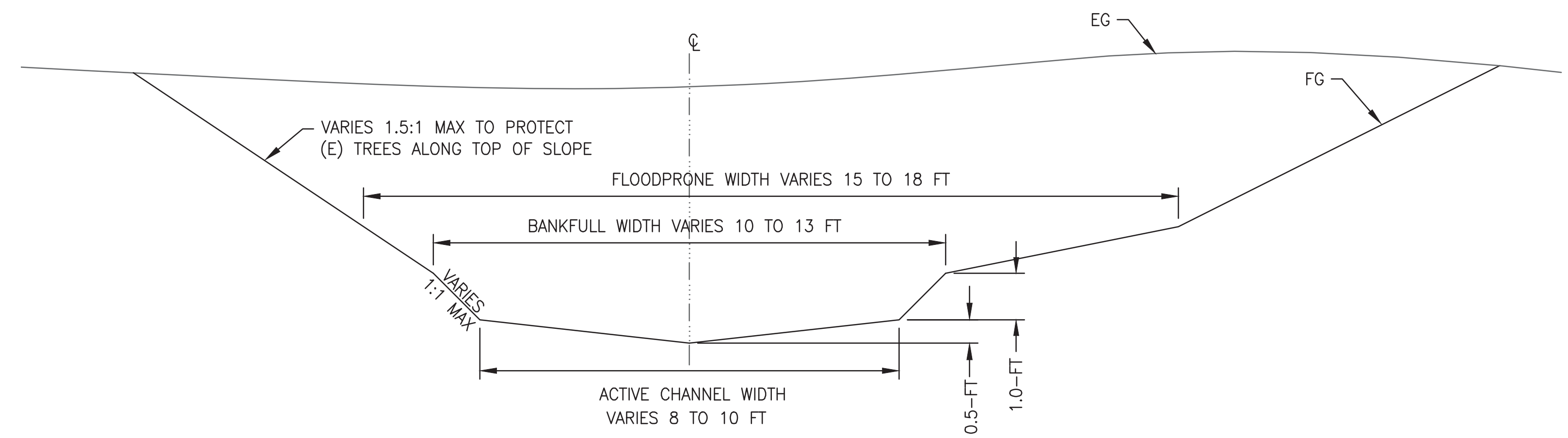
PROFILE

(N) HOTELLING GULCH ALIGNMENT



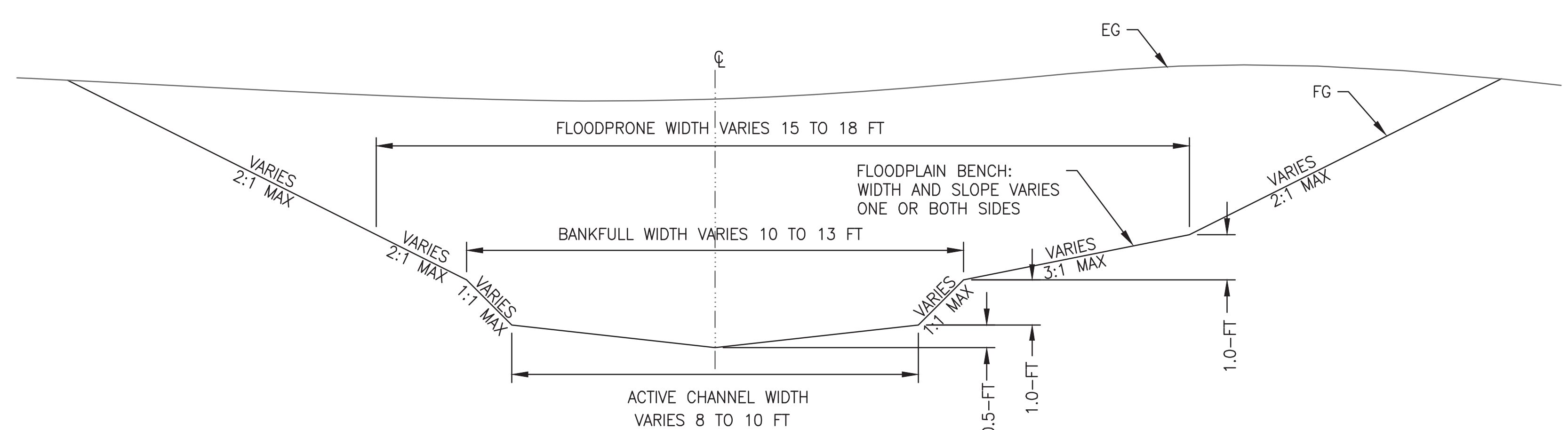
TYPICAL CROSS SECTION

STATIONS 1+00 TO 1+80 (NTS)
(LOOKING DOWNSTREAM)



TYPICAL CROSS SECTION

STATIONS 1+80 TO 2+55 (NTS)
(LOOKING DOWNSTREAM)



TYPICAL CROSS SECTION

STATIONS 2+55 TO 6+40 (NTS)
(LOOKING DOWNSTREAM)

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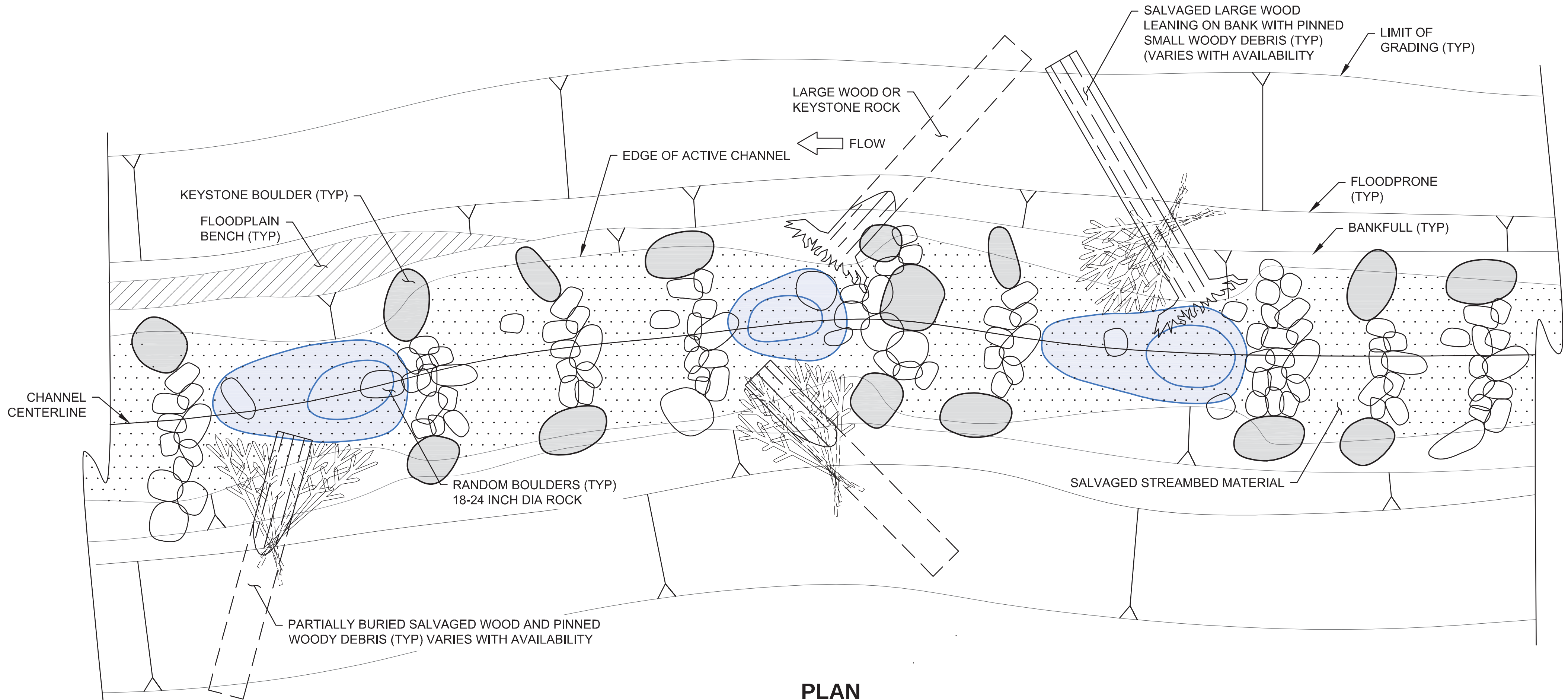
HOTELLING GULCH FISH ACCESS
AND CHANNEL RESTORATION PROJECT

DESIGN PROFILE AND TYPICAL SECTIONS

DATE	JUNE. 2016
SUBMITTAL	30% DESIGN
DESIGN	RS / ML
DRAWN	AL / NN
SHEET	5 of 6

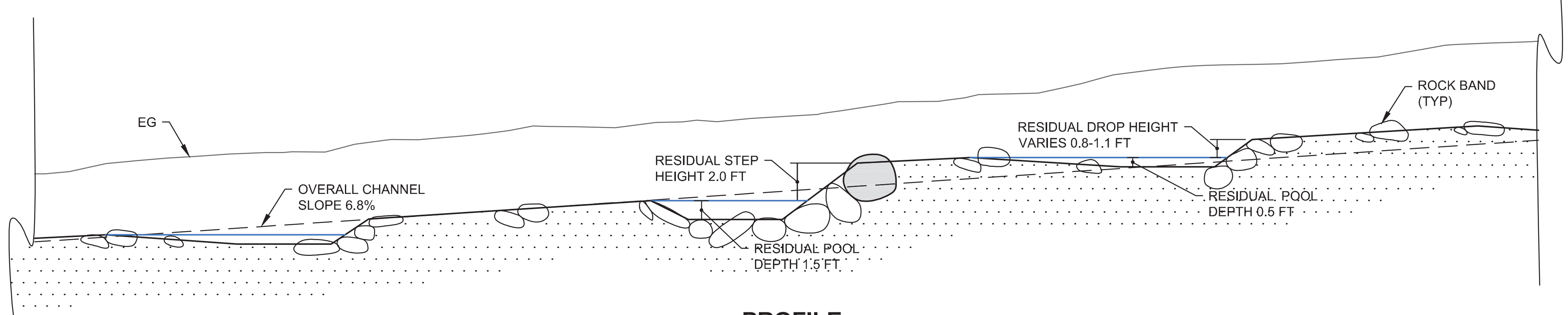
Q:\hotelling Gulch\05_CAD\2_Sheets\3_CONCEPTUAL.dwg



NOTES:
1. ROCK BANDS SHALL CONSIST OF 1 TO 2 18 TO 30 INCH DIAMETER KEYSTONE BOULDERS INTERSPERSED WITH 10 TO 18 INCH DIAMETER BOULDERS.
2. STEPS SHALL CONSIST OF 2 TO 3 30 TO 40 INCH DIAMETER KEYSTONE BOULDERS INTERSPERSED WITH10 TO 24 INCH DIAMETER BOULDERS

PLAN

CASCADE POOL SERIES	STEP-POOL SERIES (TYP OF TWO)			CASCADE POOL SERIES (TYP OF SEVERAL)	
	POOL LENGTH APPROX 7 FT	STEP LENGTH APPROX 4 FT	RIFFLE LENGTH APPROX 6 FT	POOL (TYP) LENGTH VARIES 14-16 FT	CASCADE (TYP) LENGTH VARIES 6-15 FT SLOPE VARIES 5.0-6.5%



PROFILE

BOULDER CASCADE, STEP AND POOL
TYPICAL **NTS**

PRELIMINARY
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Salmon River Restoration Council
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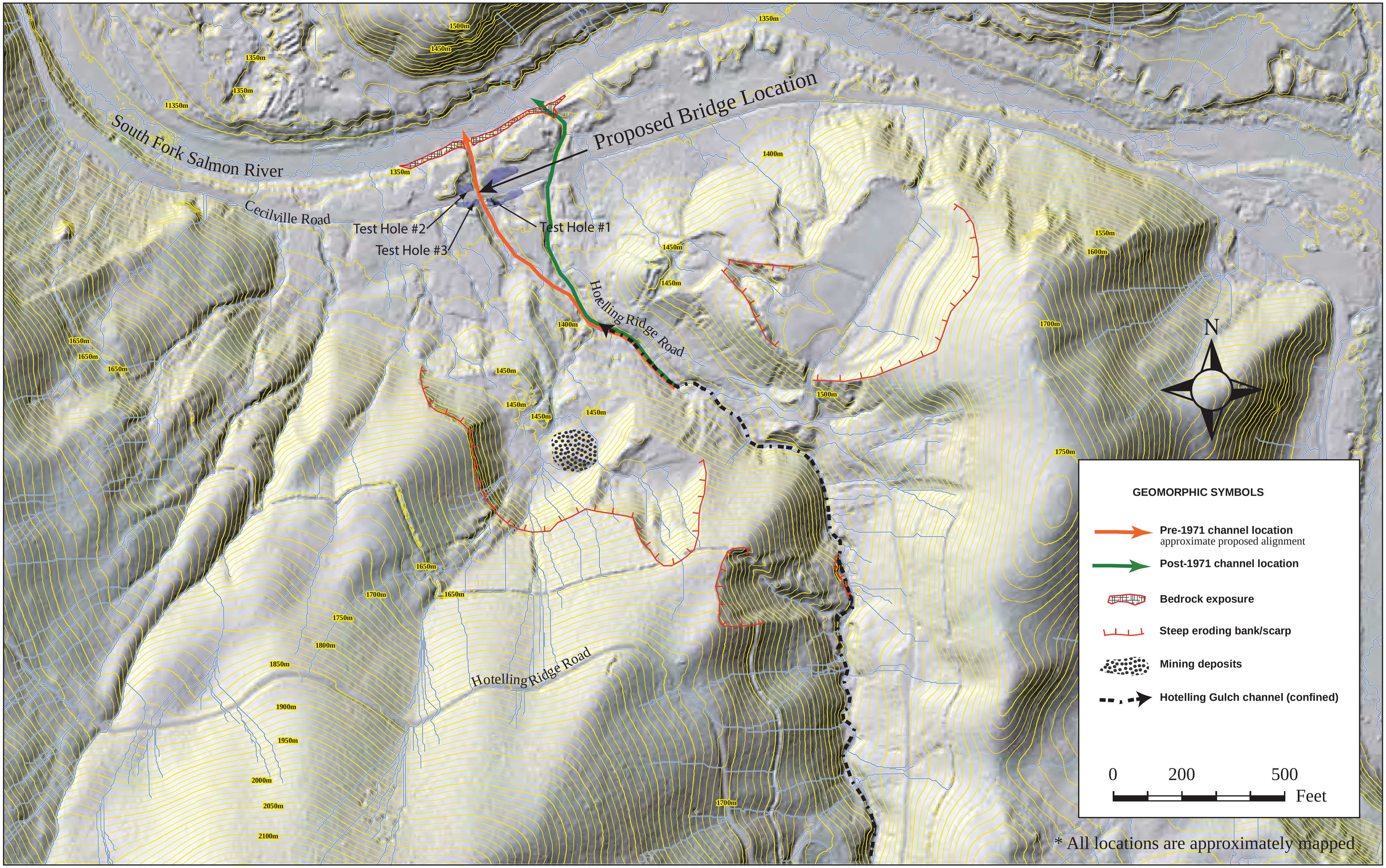
HOTELLING GULCH FISH ACCESS
AND CHANNEL RESTORATION PROJECT
BOULDER CASCADE, STEP AND POOL TYPICALS

DATE
JUNE. 2016
SUBMITTAL
30% DESIGN
DESIGN
RS / ML
DRAWN
AL / NN
SHEET
6 of 6

Appendix B

Boring logs for Test Holes 1-3

Report of Geotechnical Exploration- Bridge Foundation Report Hotelling Gulch Fish Access and Channel Restoration Design Project Cecilville Road, Siskiyou County, California



Location map of the geotechincal boring locations for the *Report of Geotechnical Exploration- Bridge Foundation Report Hotelling Gulch Fish Access and Channel Restoration Design Project Cecilville Road, Siskiyou County, California*

Project: Hotelling	Project Number: 10245	Client: SRRC	Boring No. Test Hole#1
Address, City, State		Drilling Contractor: Taber	Drill Rig Type: CME 55
Logged By: THL/LBJ	Date — Started: Oct 4 2016	Bit Type: 4" HSA	Diameter:
Drill Crew:	Date — Completed: Oct 4 2016	Hammer Type: auto hammer	
USA Ticket Number:	Date — Backfilled: Oct 4 2016	Hammer Weight:	Hammer Drop:
	Groundwater Depth: N/A	Elevation: BGS	Total Depth of Boring: 6'

Depth (feet)	Sample Type	Sample Interval	Blow Counts	Graphic Log	Lithology **Soil Group Name:** modifier, color, moisture, density/consistency, grain size, other descriptors **Rock Description:** modifierm color, hardness/degree of concentration, bedding and joint characteristics, solutions, void conditions.	Dry Density (pcf)	Moisture Content (%)	Additional Test
					Organic soil- Brown, dry unconsolidated soil composed mostly of organic litter			
					Reddish brown sandy gravel with fines. Fine grained material moderately cohesive. Moist. Large boulders reduce advancement rate. Gravel ranges in size from .25"-3"+.			
5	SPT-1.1		17-50					
					Complete refusal of auger at 6'. Refusal probably at large rock in alluvium.			
10								

Boring Log: Sheet 1 of 1

Note- SPT-1.1- 17 blows first 6"; next 50 blows driven 5.5"

Project: Hotelling	Project Number: 10245	Client: SRRC	Boring No. Test Hole#2
Address, City, State		Drilling Contractor: Taber	Drill Rig Type: CME 55
Logged By: THL/LBJ	Date — Started: Oct 4 2016	Bit Type: 4" HSA	Diameter:
Drill Crew:	Date — Completed: Oct 4 2016	Hammer Type: auto hammer	
USA Ticket Number:	Date — Backfilled: Oct 4 2016	Hammer Weight:	Hammer Drop:
	Groundwater Depth: 8.5' BGS	Elevation: BGS	Total Depth of Boring: 21'

Depth (feet)	Sample Type	Sample Interval	Blow Counts (blows/foot)	Graphic Log	Lithology	Dry Density (pcf)	Moisture Content (%)	Additional Test
					Soil Group Name: modifier, color, moisture, density/consistency, grain size, other descriptors **Rock Description:** modifierm color, hardness/degree of concentration, bedding and joint characteristics, solutions, void conditions.			
0–8.5					Reddish brown Gravelly sand with minor fines (SW). Fine grained material moderately cohesive and generally heterogenious throughout boring. Relatively rapid augering compared to Test Hole #1. Retrieval of freshly broken rock chips 1"-3" increase with depth. Based on random intermittent auger advancement rates and drill rig shaking, there are likely Large (>6") clasts within the aluvium.			
5	SPT-2.1		11-12-18					
8.5					Groundwater at 8.5'		Dry	
8.5–							Wet	
10	SPT-2.2		17-13-08					

Boring Log: Sheet 1 of 2

Note- SPT-2.1- 11 blows first 6"; 12 blows 2nd 6"; 18 blows 3rd 6"; 10% recovery of sample

Note- SPT-2.2- 17 blows first 6"; 13 blows 2nd 6"; 08 blows 3rd 6"; 40% recovery of sample

Project: Hotelling	Project Number: 10245	Client: SRRC	Boring No. Test Hole#2
Address, City, State		Drilling Contractor: Taber	Drill Rig Type: CME 55
Logged By: THL/LBJ	Date — Started: Oct 4 2016	Bit Type: 4" HSA	Diameter:
Drill Crew:	Date — Completed: Oct 4 2016	Hammer Type: auto hammer	
USA Ticket Number:	Date — Backfilled: Oct 4 2016	Hammer Weight:	Hammer Drop:
	Groundwater Depth: 8.5' BGS	Elevation: BGS	Total Depth of Boring: 21'

Lithology

Soil Group Name: modifier, color, moisture, density/consistency, grain size, other descriptors

Rock Description: modifierm color, hardness/degree of concentration, bedding and joint characteristics, solutions, void conditions.

Depth (feet)	Sample Type	Sample Interval	RQD Value	Graphic Log	Dry Density (pcf)	Moisture Content (%)	Additional Test
						Wet	
	RQD		.41				
15	RQD		.41				
	RQD		0.0				
20	RQD		.53				

Reddish brown Gravelly sand with minor fines (SW). Fine grained material moderately cohesive and generally heterogenious throughout boring. Relatively rapid augering compared to Test Hole #1. Rrerieval of freshly broken rock chips 1"-3" increase with depth. Based on random intermittent auger advancement rates and drill rig shaking, there are likely Large (>6") clasts within the aluvium. Complete refusal of auger at 13' BGS

Bluish grey bedrock, minimal weathering, relatively hard, no apparent jointing in upper section. Fractures appear to be from coring process in upper section. Calcite filled fractures increase in frequency with depth. Some fractures filled with serpentinite.

The cores retrieved from the test pit are consistent with exposed proximal bedrock outcrops which are fractured highly lithified meta-sedimentary argillites.

Boring Log: Sheet 2 of 2

Project: Hotelling	Project Number: 10245	Client: SRRC	Boring No. Test Hole#3
Address, City, State		Drilling Contractor: Taber	Drill Rig Type: CME 55
Logged By: THL/LBJ	Date — Started: Oct 4 2016	Bit Type: 4" HSA	Diameter:
Drill Crew:	Date — Completed: Oct 4 2016	Hammer Type: auto hammer	
USA Ticket Number:	Date — Backfilled: Oct 4 2016	Hammer Weight:	Hammer Drop:
	Groundwater Depth: 7.5' BGS	Elevation: BGS	Total Depth of Boring: 11'

Depth (feet)	Sample Type	Sample Interval	Blow Counts (blows/foot)	Graphic Log	Lithology	Dry Density (pcf)	Moisture Content (%)	Additional Test
0–7.5					Reddish brown clayey sand with gravels (SC). Gravel content increases with depth and ranges in size from 0.5"-3"+. Based on random intermittent auger advancement rates and drill rig shaking, there are likely large (>6") clasts within the aluvium. Unit sitting directly on bedrock.		Dry	
5	SPT-3.1	5–6.5	06-04-05					
7.5					Groundwater at 7.5'		Wet	
10	SPT-3.2	10–11	07-50		Bluish grey bedrock chips retrieved in sampler. Chips are consistent in nature with observd bedrock in Test Hole #2 and local outcrops.			

Lithology

Soil Group Name: modifier, color, moisture, density/consistency, grain size, other descriptors

Rock Description: modifierm color, hardness/degree of concentration, bedding and joint characteristics, solutions, void conditions.

Boring Log: Sheet 1 of 1

Note- SPT-3.1- 06 blows first 6"; 04 blows 2nd 6"; 05 blows 3rd 6"; 50% recovery of sample

Note- SPT-3.2- 07 blows first 6"; 50 blows next 5.5"; several bedrock chips recovered in sample

USGS Design Maps Summary Report

User–Specified Input

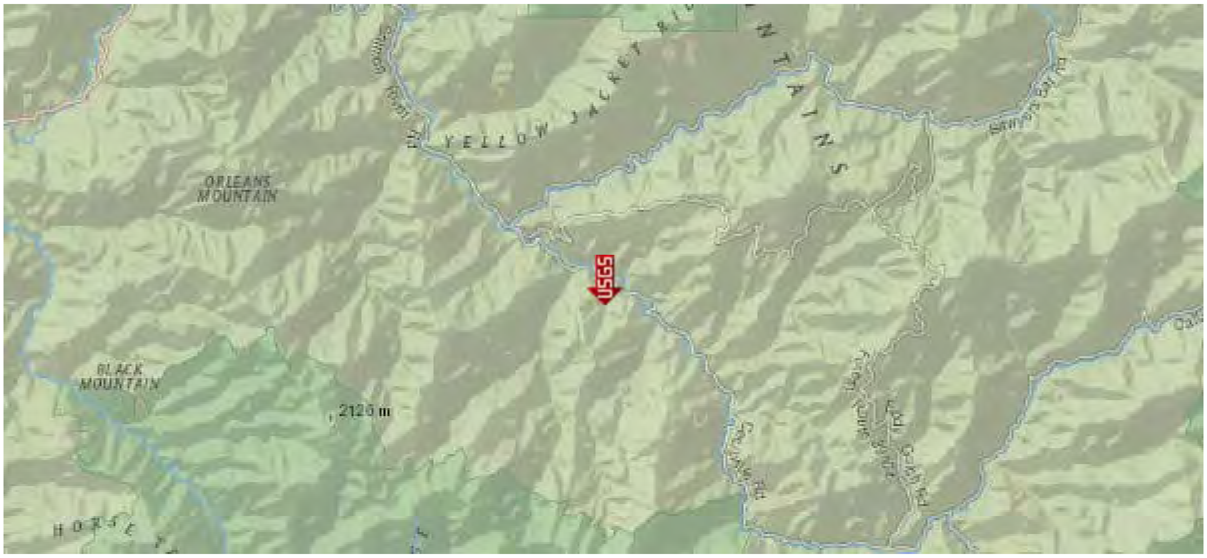
Report Title Hotelling Gulch Fish Access and Channel Restoration Design
Tue July 25, 2017 20:05:17 UTC

Building Code Reference Document 2012/2015 International Building Code
(which utilizes USGS hazard data available in 2008)

Site Coordinates 41.23889°N, 123.27776°W

Site Soil Classification Site Class D – "Stiff Soil"

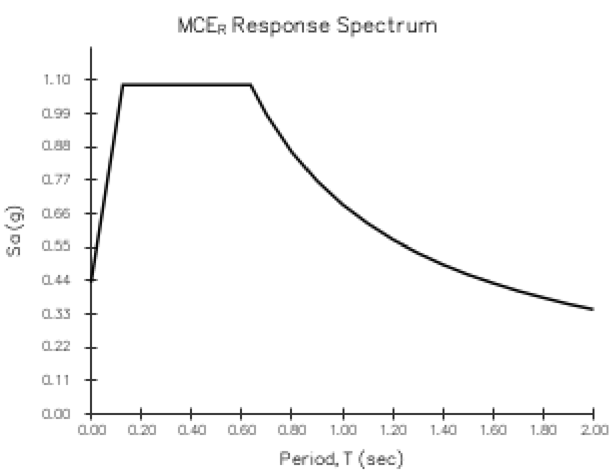
Risk Category I/II/III

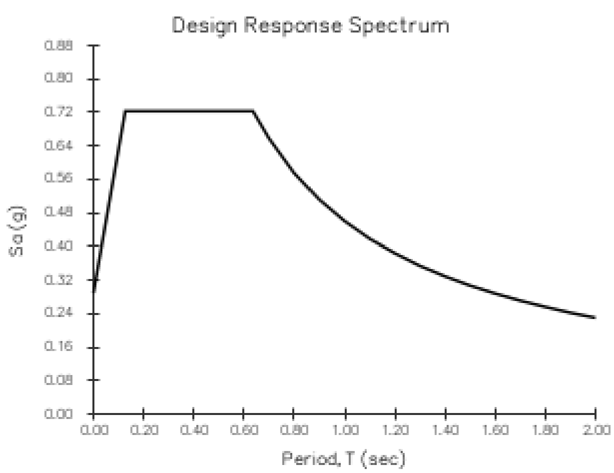


USGS–Provided Output

S_S =	0.979 g	S_{MS} =	1.085 g	S_{DS} =	0.723 g
S_1 =	0.444 g	S_{M1} =	0.690 g	S_{D1} =	0.460 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.





Although this information is a product of the U.S. Geological Survey, we provide no warranty, expressed or implied, as to the accuracy of the data contained therein. This tool is not a substitute for technical subject-matter knowledge.

USGS Design Maps Detailed Report

2012/2015 International Building Code (41.23889°N, 123.27776°W)

Site Class D – "Stiff Soil", Risk Category I/II/III

Section 1613.3.1 — Mapped acceleration parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_S) and 1.3 (to obtain S_1). Maps in the 2012/2015 International Building Code are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 1613.3.3.

From Figure 1613.3.1(1) [1]	S_S = 0.979 g
From Figure 1613.3.1(2) [2]	S_1 = 0.444 g

Section 1613.3.2 — Site class definitions

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Section 1613.

2010 ASCE-7 Standard – Table 20.3-1
SITE CLASS DEFINITIONS

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index *PI* > 20, • Moisture content *w* ≥ 40%, and • Undrained shear strength $\bar{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 1613.3.3 — Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters

TABLE 1613.3.3(1)
VALUES OF SITE COEFFICIENT F_a

Site Class	Mapped Spectral Response Acceleration at Short Period				
	$S_S \le 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \ge 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = D and S_S = 0.979 g, F_a = 1.108

TABLE 1613.3.3(2)
VALUES OF SITE COEFFICIENT F_v

Site Class	Mapped Spectral Response Acceleration at 1–s Period				
	$S_1 \le 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \ge 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = D and S_1 = 0.444 g, F_v = 1.556

Equation (16-37):	$S_{MS} = F_aS_S = 1.108 \text{ x } 0.979 = 1.085$ g
Equation (16-38):	$S_{M1} = F_vS_1 = 1.556 \text{ x } 0.444 = 0.690$ g

Section 1613.3.4 — Design spectral response acceleration parameters

Equation (16-39):	$S_{DS} = ⅔\, S_{MS} = ⅔ \text{ x } 1.085 = 0.723$ g
Equation (16-40):	$S_{D1} = ⅔\, S_{M1} = ⅔ \text{ x } 0.690 = 0.460$ g

Section 1613.3.5 — Determination of seismic design category

TABLE 1613.3.5(1)
SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD (0.2 second) RESPONSE ACCELERATION

VALUE OF S_{DS}	RISK CATEGORY		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \le S_{DS} < 0.33g$	B	B	C
$0.33g \le S_{DS} < 0.50g$	C	C	D
$0.50g \le S_{DS}$	D	D	D

For Risk Category = I and S_{DS} = 0.723 g, Seismic Design Category = D

TABLE 1613.3.5(2)
SEISMIC DESIGN CATEGORY BASED ON 1-SECOND PERIOD RESPONSE ACCELERATION

VALUE OF S_{D1}	RISK CATEGORY		
	I or II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g \le S_{D1} < 0.133g$	B	B	C
$0.133g \le S_{D1} < 0.20g$	C	C	D
$0.20g \le S_{D1}$	D	D	D

For Risk Category = I and S_{D1} = 0.460 g, Seismic Design Category = D

Note: When S_1 is greater than or equal to 0.75g, the Seismic Design Category is **E** for buildings in Risk Categories I, II, and III, and **F** for those in Risk Category IV, irrespective of the above.

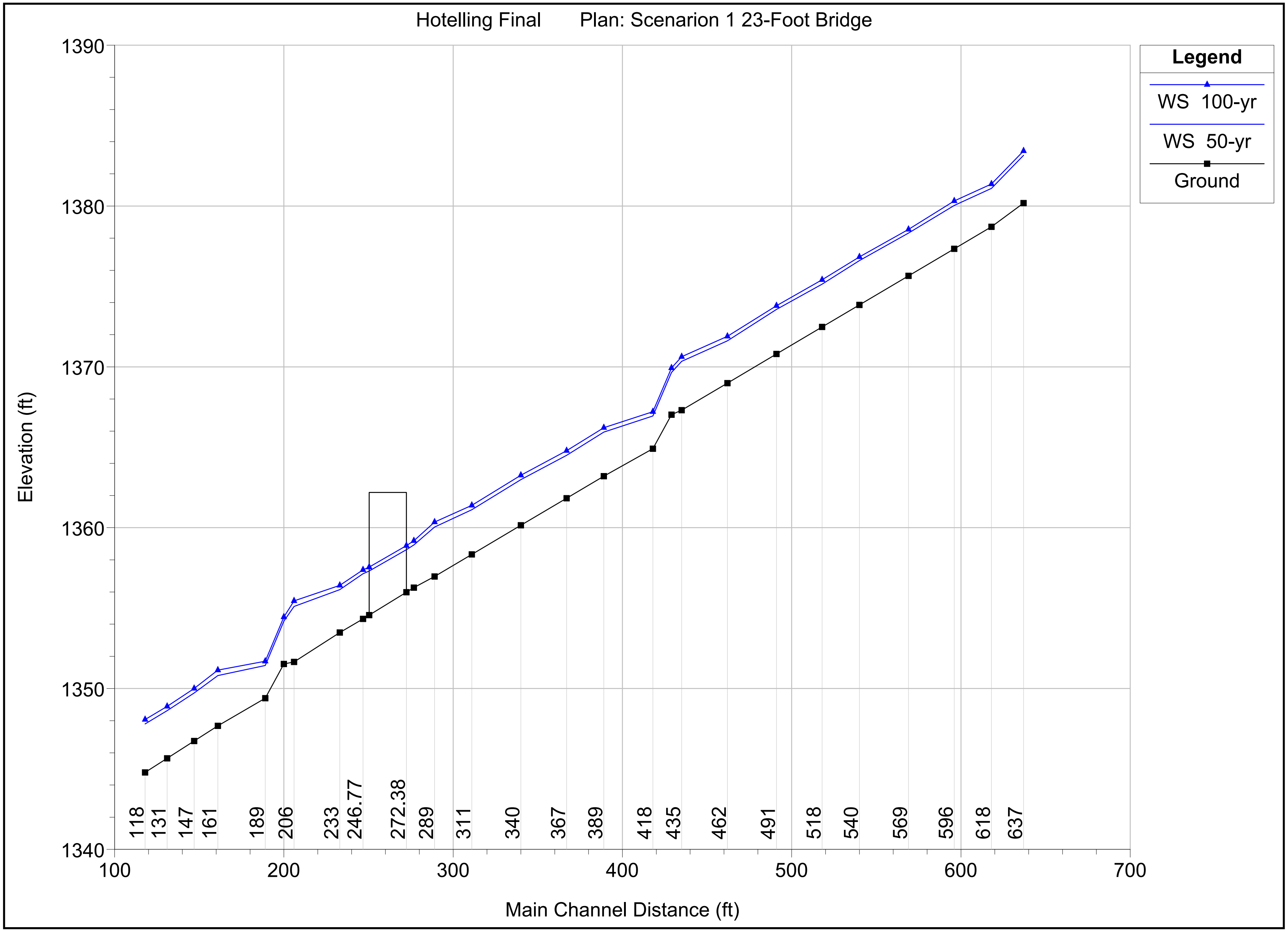
Seismic Design Category ≡ "the more severe design category in accordance with Table 1613.3.5(1) or 1613.3.5(2)" = D

Note: See Section 1613.3.5.1 for alternative approaches to calculating Seismic Design Category.

References

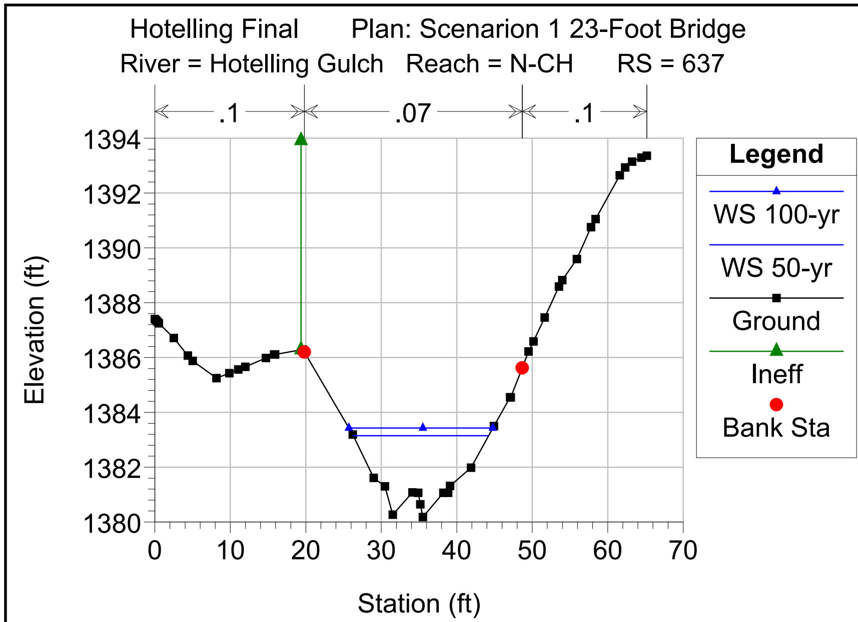
1. *Figure 1613.3.1(1)*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(1).pdf
2. *Figure 1613.3.1(2)*: https://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/IBC-2012-Fig1613p3p1(2).pdf

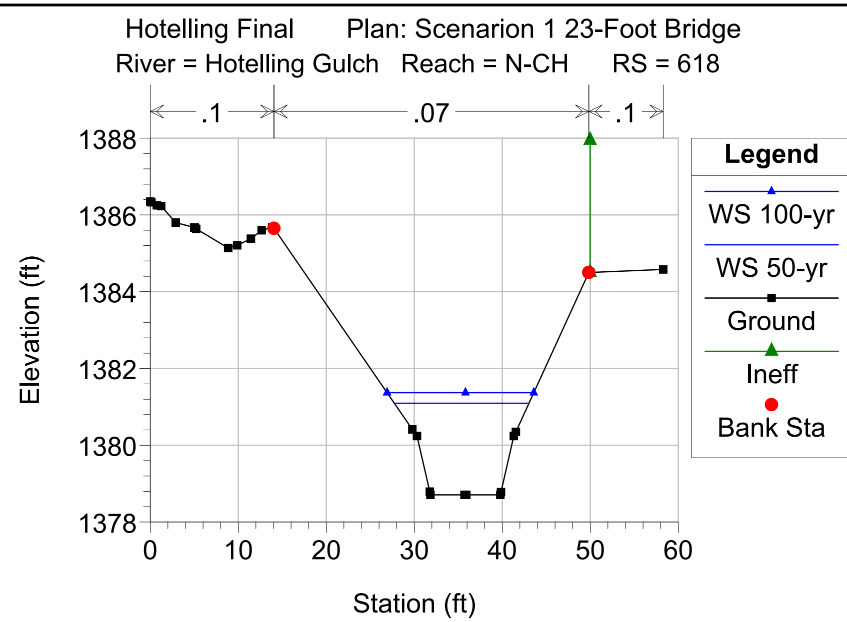
Appendix F – HEC-RAS Hydraulic Modeling

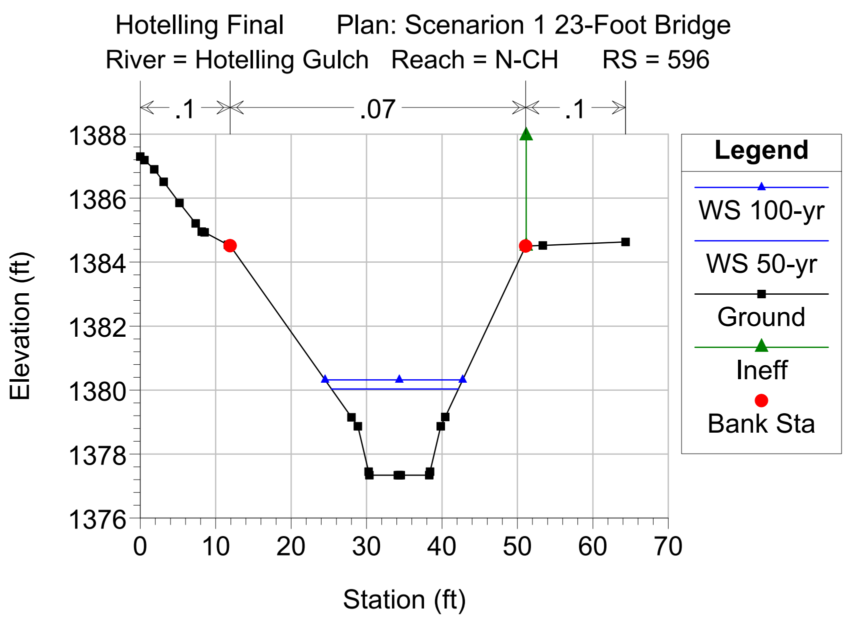

Hotelling Final Plan: Scenarion 1 23-Foot Bridge
Legend
WS 100-yr
WS 50-yr
Ground
Elevation (ft)
1390
1380
1370
1360
1350
1340
118
131
147
161
189
206
233
246.77
272.38
289
311
340
367
389
418
435
462
491
518
540
569
596
618
637
100
200
300
400
500
600
700
Main Channel Distance (ft)

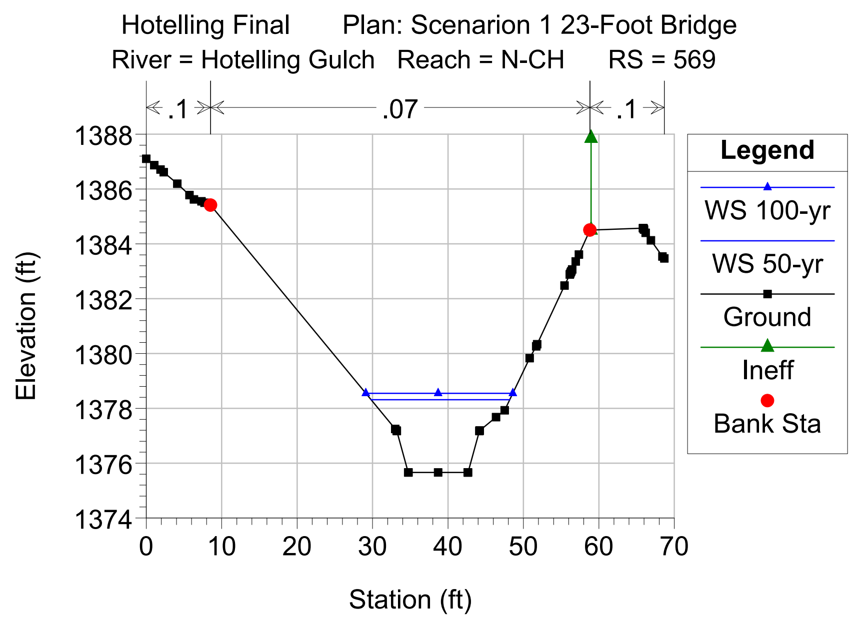
HEC-RAS Plan: Hotelling-23 Ft River: Hotelling Gulch Reach: N-CH

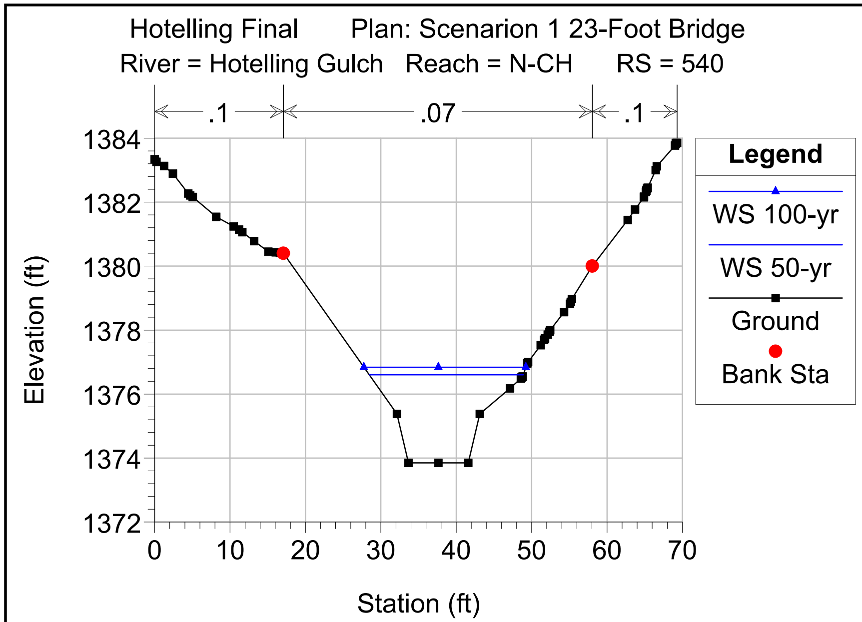
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
N-CH	637	50-yr	230.00	1380.18	1383.151	1383.151	1384.012	0.068889	7.44	30.89	17.95	1.00
N-CH	637	100-yr	281.00	1380.18	1383.428	1383.428	1384.373	0.066933	7.80	36.01	19.07	1.00
N-CH	618	50-yr	230.00	1378.71	1381.096	1381.383	1382.334	0.100950	8.93	25.76	15.30	1.21
N-CH	618	100-yr	281.00	1378.71	1381.368	1381.677	1382.720	0.100028	9.33	30.11	16.66	1.22
N-CH	596	50-yr	230.00	1377.34	1380.035	1380.007	1380.907	0.063715	7.50	30.69	16.82	0.98
N-CH	596	100-yr	281.00	1377.34	1380.319	1380.319	1381.283	0.064087	7.88	35.66	18.24	0.99
N-CH	569	50-yr	230.00	1375.66	1378.317	1378.301	1379.148	0.065106	7.32	31.44	18.39	0.99
N-CH	569	100-yr	281.00	1375.66	1378.550	1378.569	1379.503	0.067780	7.84	35.85	19.50	1.02
N-CH	540	50-yr	230.00	1373.85	1376.605	1376.501	1377.319	0.057358	6.78	33.93	20.44	0.93
N-CH	540	100-yr	281.00	1373.85	1376.840	1376.755	1377.652	0.058393	7.23	38.85	21.49	0.95
N-CH	518	50-yr	230.00	1372.48	1375.144	1375.118	1375.945	0.065599	7.18	32.02	19.50	0.99
N-CH	518	100-yr	281.00	1372.48	1375.411	1375.390	1376.286	0.064354	7.50	37.44	21.09	0.99
N-CH	491	50-yr	230.00	1370.80	1373.569	1373.438	1374.275	0.055225	6.74	34.11	20.08	0.91
N-CH	491	100-yr	281.00	1370.80	1373.797	1373.705	1374.610	0.058144	7.24	38.83	21.40	0.95
N-CH	462	50-yr	230.00	1368.99	1371.618	1371.618	1372.455	0.068706	7.34	31.32	19.07	1.01
N-CH	462	100-yr	281.00	1368.99	1371.900	1371.900	1372.801	0.065267	7.62	36.90	20.47	1.00
N-CH	435	50-yr	230.00	1367.31	1370.345	1369.940	1370.873	0.036763	5.83	39.47	21.32	0.75
N-CH	435	100-yr	281.00	1367.31	1370.630	1370.218	1371.215	0.036877	6.14	45.76	22.93	0.77
N-CH	429	50-yr	230.00	1367.03	1369.650	1369.650	1370.487	0.068116	7.34	31.34	18.98	1.01
N-CH	429	100-yr	281.00	1367.03	1369.931	1369.931	1370.832	0.065907	7.62	36.89	20.67	1.00
N-CH	418	50-yr	230.00	1364.91	1366.943	1367.591	1368.954	0.198517	11.38	20.21	13.84	1.66
N-CH	418	100-yr	281.00	1364.91	1367.210	1367.888	1369.324	0.186169	11.67	24.08	15.17	1.63
N-CH	389	50-yr	230.00	1363.20	1365.944	1365.855	1366.771	0.059290	7.30	31.53	17.05	0.95
N-CH	389	100-yr	281.00	1363.20	1366.213	1366.160	1367.144	0.061111	7.74	36.29	18.39	0.97
N-CH	367	50-yr	230.00	1361.83	1364.498	1364.485	1365.375	0.066589	7.51	30.61	17.38	1.00
N-CH	367	100-yr	281.00	1361.83	1364.784	1364.784	1365.740	0.065996	7.84	35.82	19.00	1.01
N-CH	340	50-yr	230.00	1360.15	1362.989	1362.807	1363.722	0.051880	6.87	33.47	18.53	0.89
N-CH	340	100-yr	281.00	1360.15	1363.262	1363.127	1364.081	0.051823	7.27	39.15	22.29	0.90
N-CH	311	50-yr	230.00	1358.34	1361.118	1361.118	1361.989	0.065677	7.51	30.75	42.32	1.00
N-CH	311	100-yr	281.00	1358.34	1361.386	1361.386	1362.359	0.064399	7.94	35.53	44.14	1.00
N-CH	289	50-yr	230.00	1356.97	1360.041	1359.503	1360.348	0.023238	4.45	51.68	50.66	0.60
N-CH	289	100-yr	281.00	1356.97	1360.351	1359.688	1360.678	0.020462	4.59	61.24	51.54	0.58
N-CH	276.77	50-yr	230.00	1356.27	1358.928	1358.922	1359.746	0.066475	7.26	31.68	19.11	0.99
N-CH	276.77	100-yr	281.00	1356.27	1359.187	1359.187	1360.093	0.065252	7.64	36.79	20.26	1.00
N-CH	272.38		Bridge									
N-CH	246.77	50-yr	230.00	1354.33	1357.134	1356.976	1357.823	0.052091	6.66	34.51	19.66	0.89
N-CH	246.77	100-yr	281.00	1354.33	1357.376	1357.226	1358.168	0.052789	7.14	39.35	20.27	0.90
N-CH	233	50-yr	230.00	1353.48	1356.151	1356.151	1356.975	0.066682	7.28	31.59	18.98	0.99
N-CH	233	100-yr	281.00	1353.48	1356.412	1356.412	1357.322	0.065632	7.66	36.70	20.21	1.00
N-CH	206	50-yr	230.00	1351.65	1355.105	1353.878	1355.324	0.011467	3.75	61.27	27.31	0.44
N-CH	206	100-yr	281.00	1351.65	1355.448	1354.137	1355.691	0.011682	3.95	71.05	29.72	0.45
N-CH	200	50-yr	230.00	1351.53	1354.186	1354.186	1355.006	0.066648	7.27	31.65	19.10	0.99
N-CH	200	100-yr	281.00	1351.53	1354.443	1354.443	1355.352	0.065644	7.65	36.73	20.26	1.00
N-CH	189	50-yr	230.00	1349.40	1351.433	1352.114	1353.465	0.199072	11.44	20.10	13.64	1.66
N-CH	189	100-yr	281.00	1349.40	1351.700	1352.412	1353.829	0.193677	11.71	24.00	15.51	1.66
N-CH	161	50-yr	230.00	1347.68	1350.806	1350.246	1351.368	0.031213	6.01	38.25	16.41	0.69
N-CH	161	100-yr	281.00	1347.68	1351.145	1350.538	1351.780	0.031410	6.40	43.92	17.09	0.70
N-CH	147	50-yr	230.00	1346.74	1349.723	1349.706	1350.645	0.065997	7.71	29.85	15.74	0.99
N-CH	147	100-yr	281.00	1346.74	1350.003	1350.003	1351.044	0.065358	8.19	34.32	16.24	0.99
N-CH	131	50-yr	230.00	1345.66	1348.625	1348.624	1349.569	0.068253	7.80	29.50	15.67	1.00
N-CH	131	100-yr	281.00	1345.66	1348.889	1348.918	1349.969	0.068862	8.34	33.69	16.12	1.02
N-CH	118	50-yr	230.00	1344.78	1347.798	1347.749	1348.689	0.063015	7.58	30.35	15.88	0.97
N-CH	118	100-yr	281.00	1344.78	1348.073	1348.036	1349.086	0.063013	8.07	34.80	16.39	0.98

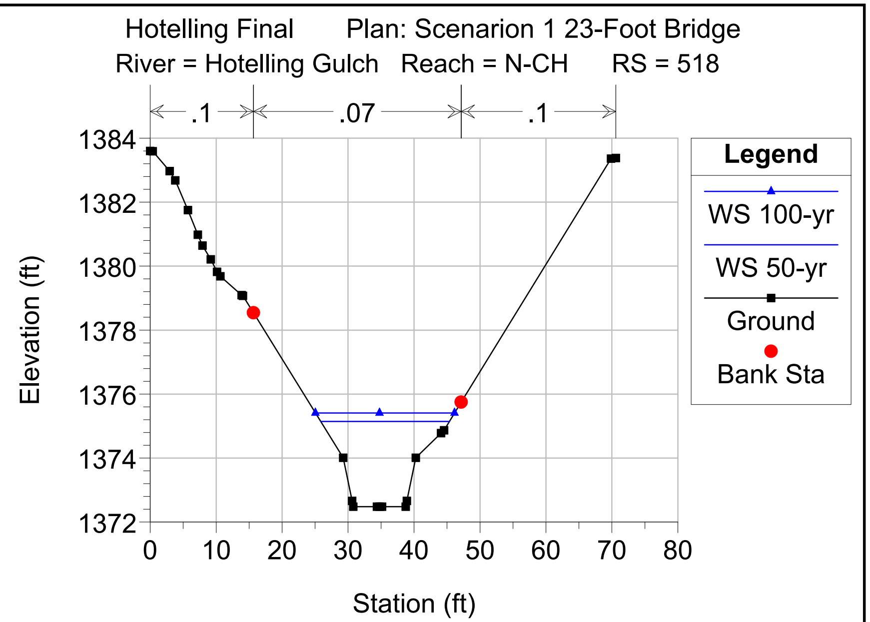

Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 637
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Ineff
Bank Sta

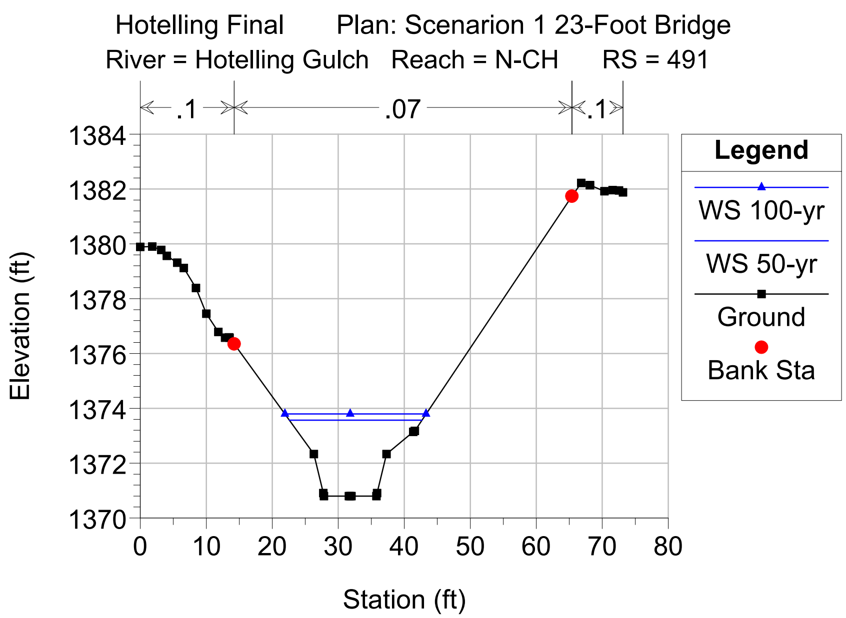

Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 618
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Ineff
Bank Sta

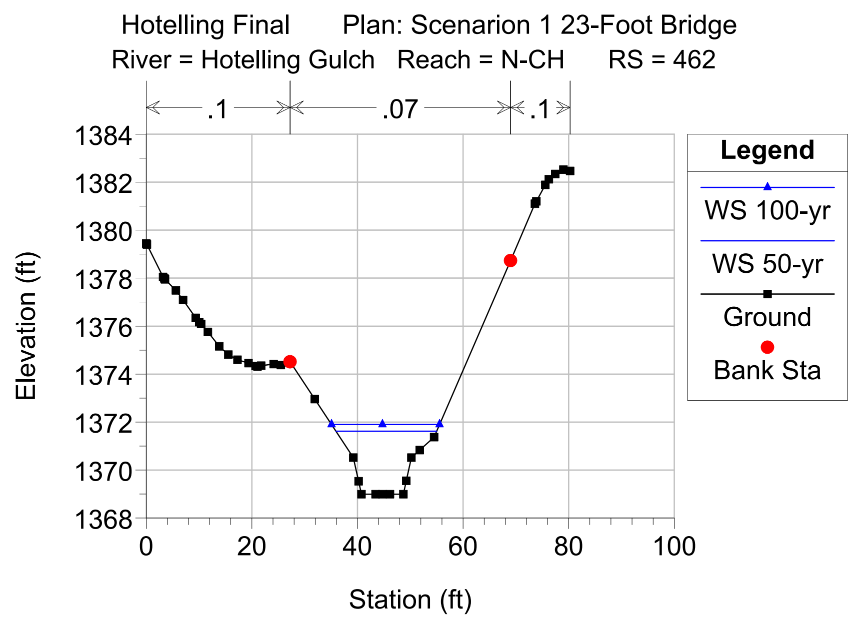

Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 596
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Ineff
Bank Sta

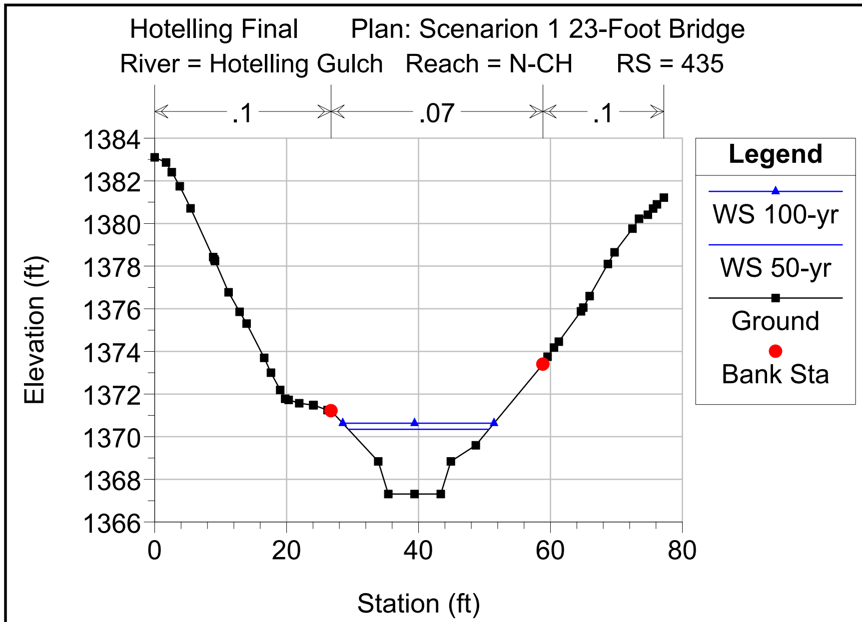

Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 569
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Ineff
Bank Sta

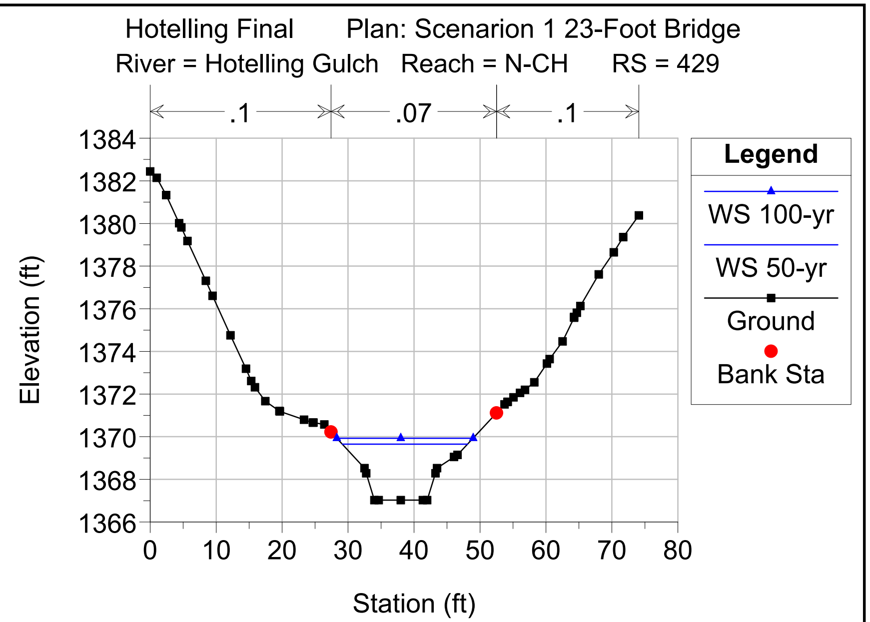

Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 540
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Bank Sta

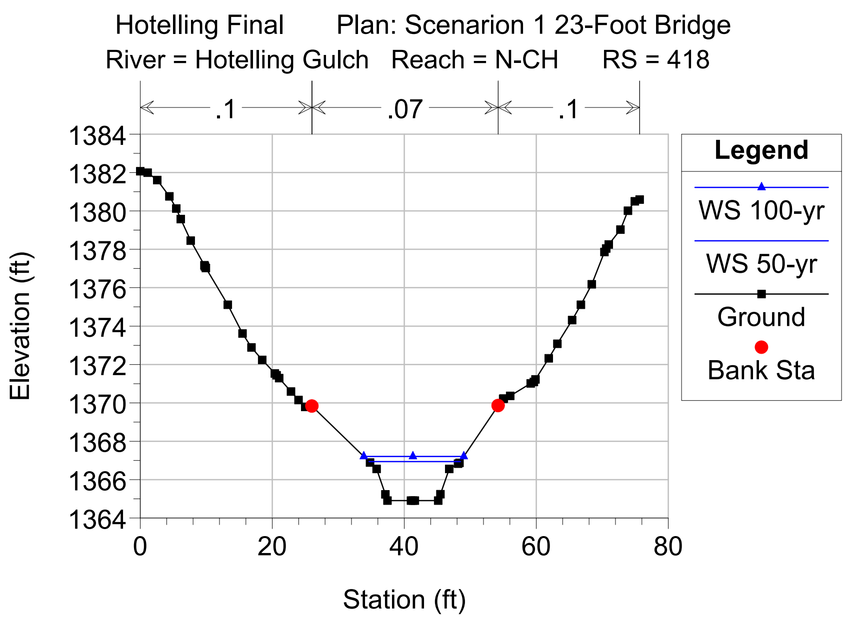

Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 518
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Bank Sta

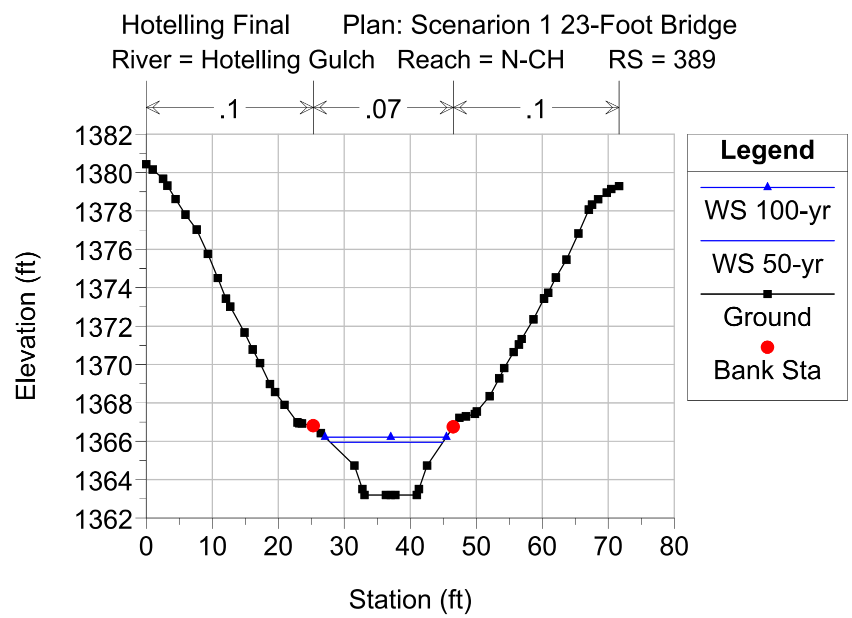

Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 491
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Bank Sta

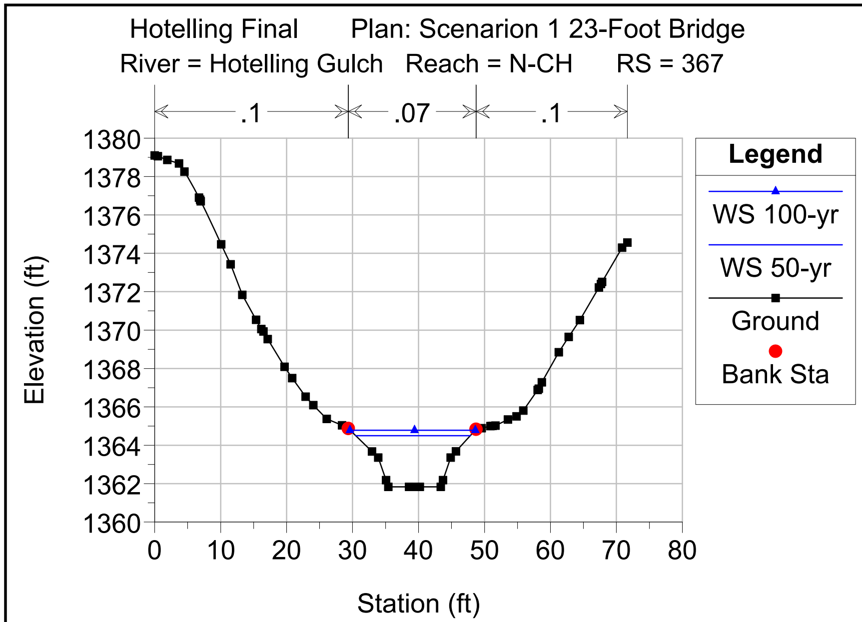

Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 462
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Bank Sta

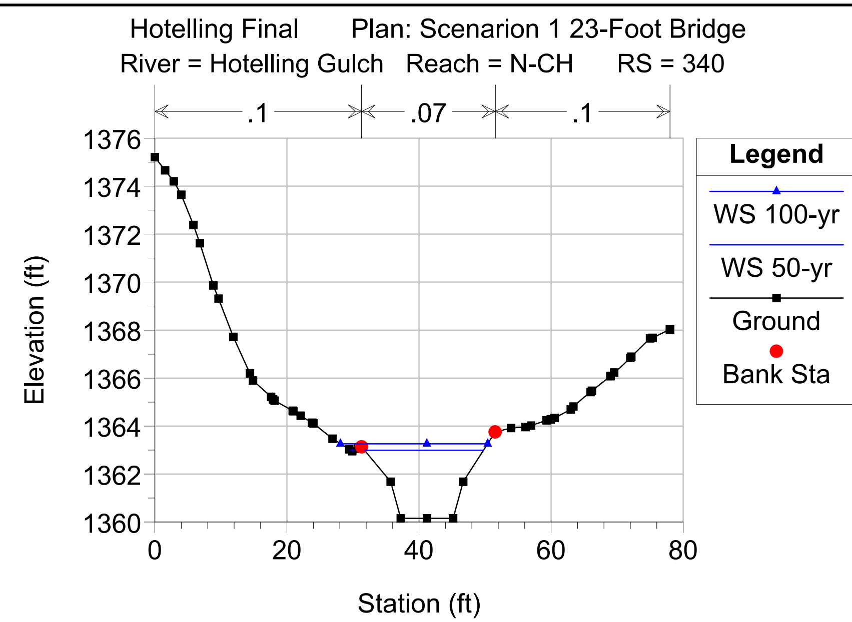

Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 435
.1
.07
.1
Elevation (ft)
1384
1382
1380
1378
1376
1374
1372
1370
1368
1366
0
20
40
60
80
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Bank Sta

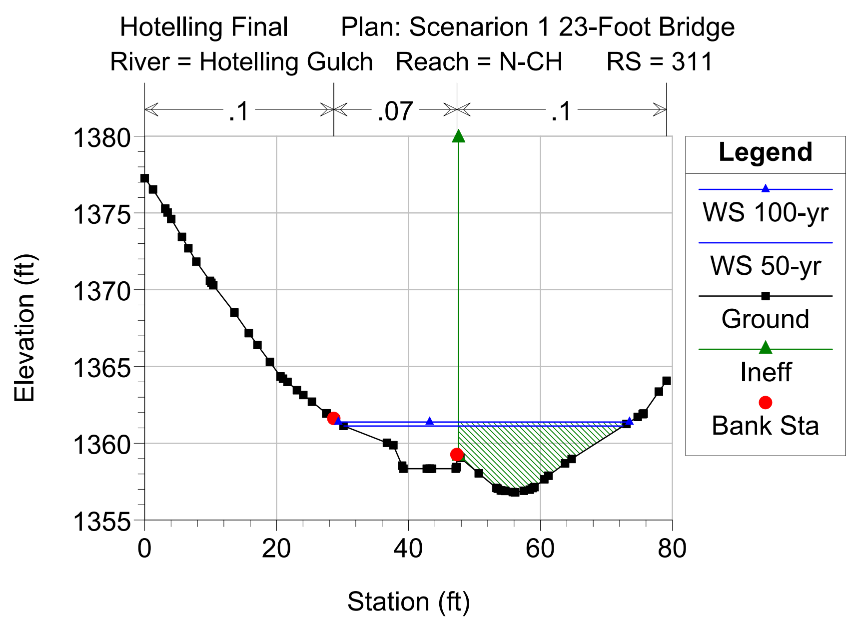

Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 429
.1
.07
.1
Elevation (ft)
1384
1382
1380
1378
1376
1374
1372
1370
1368
1366
0
10
20
30
40
50
60
70
80
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Bank Sta

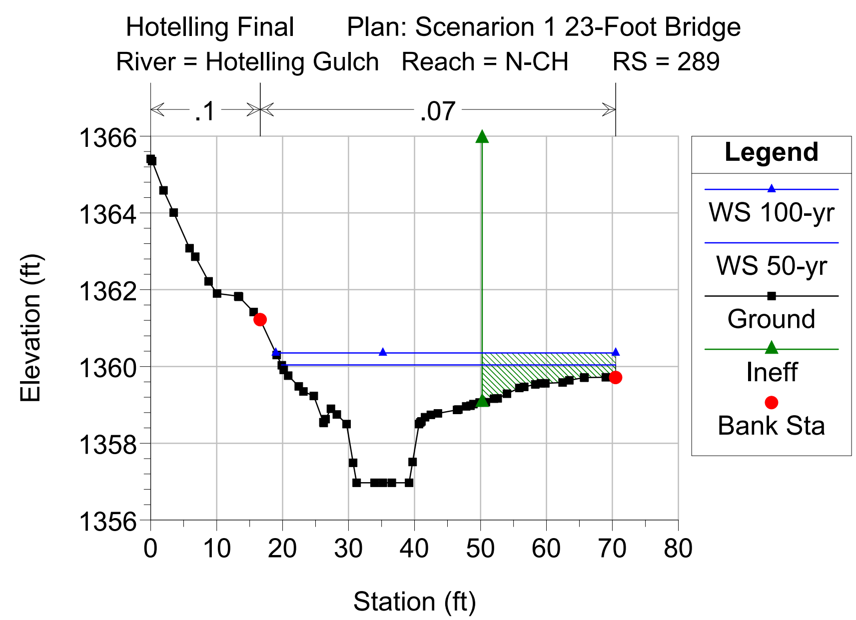

Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 418
.1
.07
.1
Elevation (ft)
1384
1382
1380
1378
1376
1374
1372
1370
1368
1366
1364
0
20
40
60
80
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Bank Sta

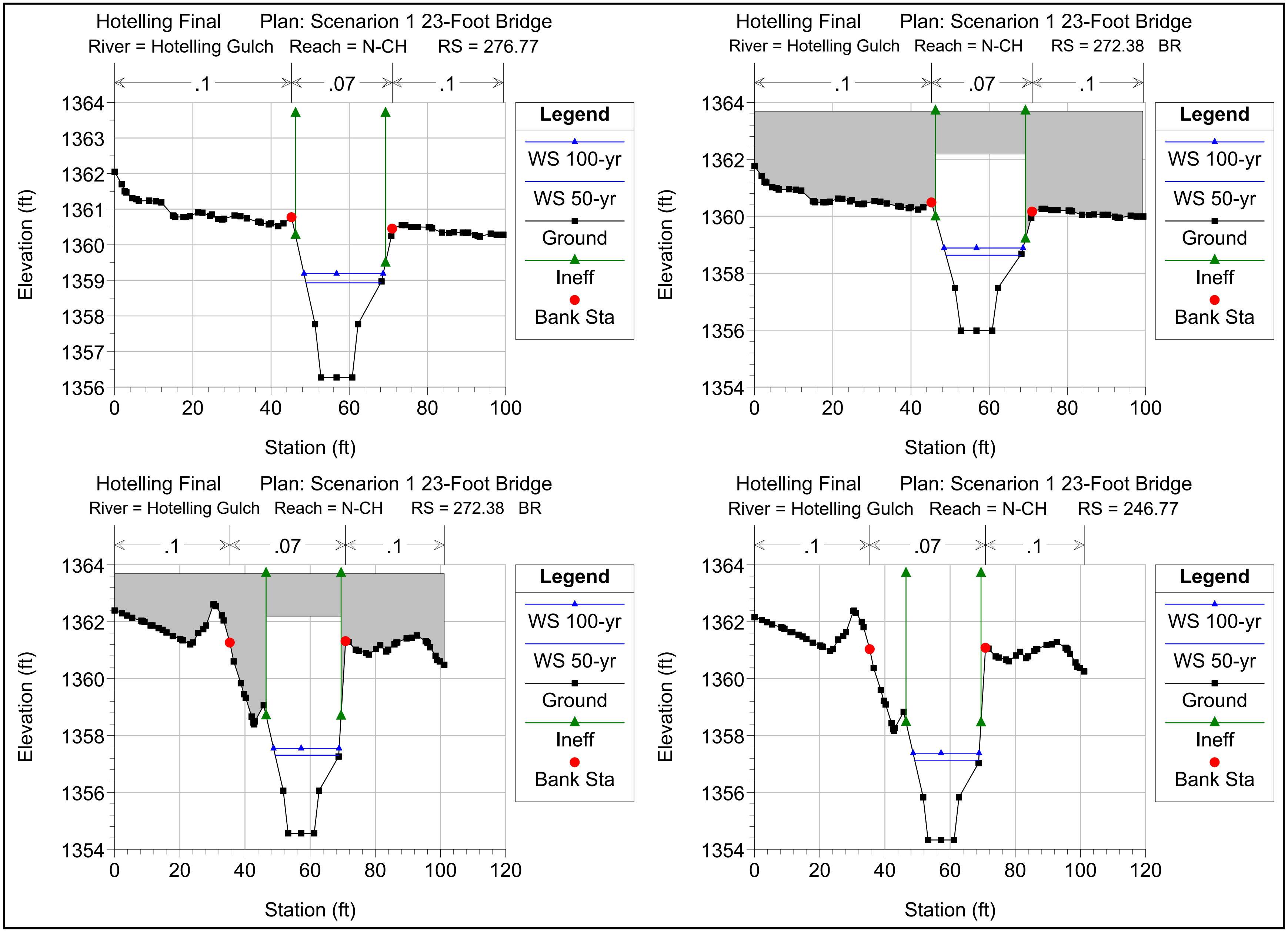

Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 389
.1
.07
.1
Elevation (ft)
1382
1380
1378
1376
1374
1372
1370
1368
1366
1364
1362
0
10
20
30
40
50
60
70
80
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Bank Sta

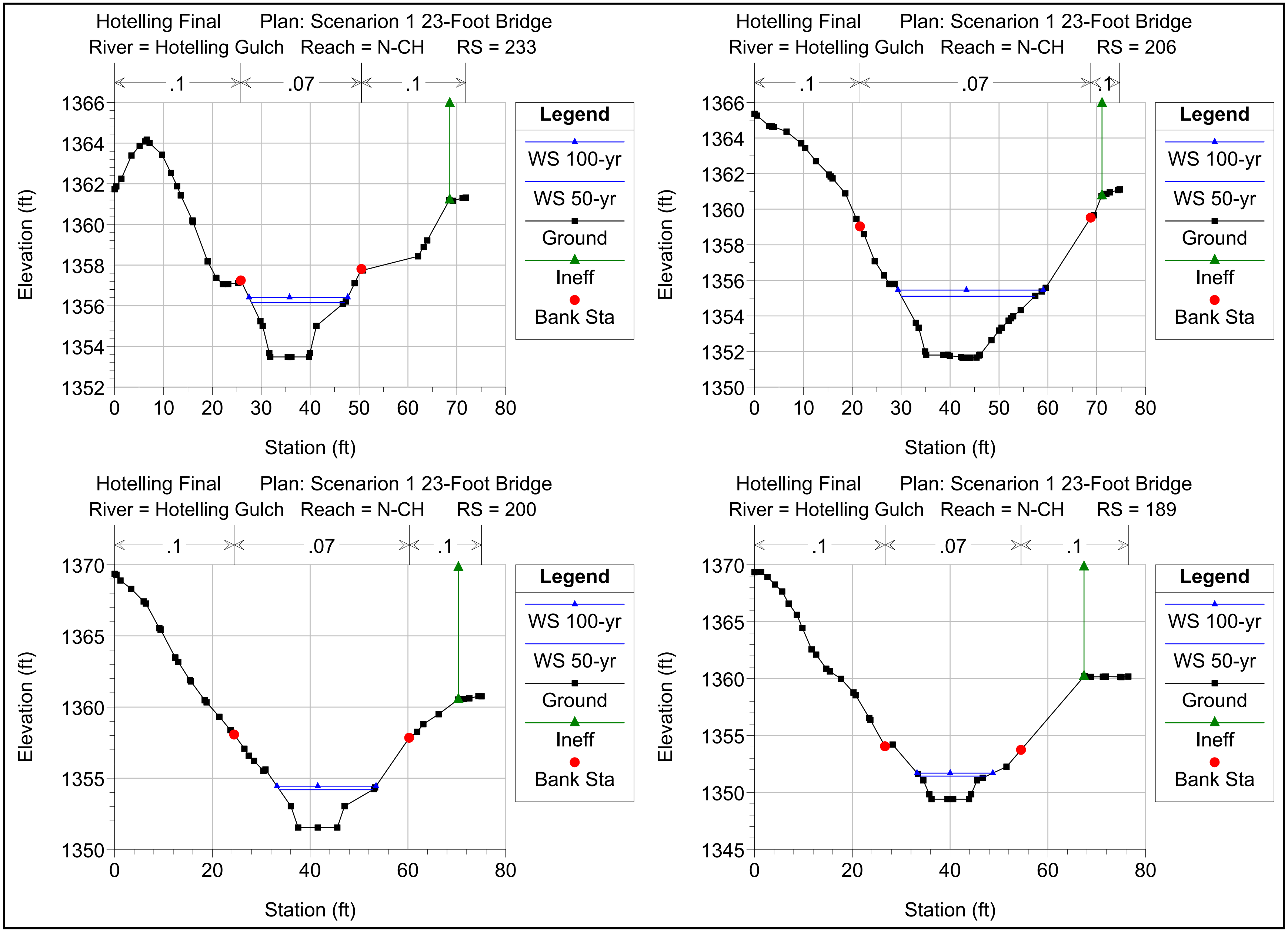

Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 367
.1
.07
.1
Elevation (ft)
1380
1378
1376
1374
1372
1370
1368
1366
1364
1362
1360
0
10
20
30
40
50
60
70
80
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Bank Sta

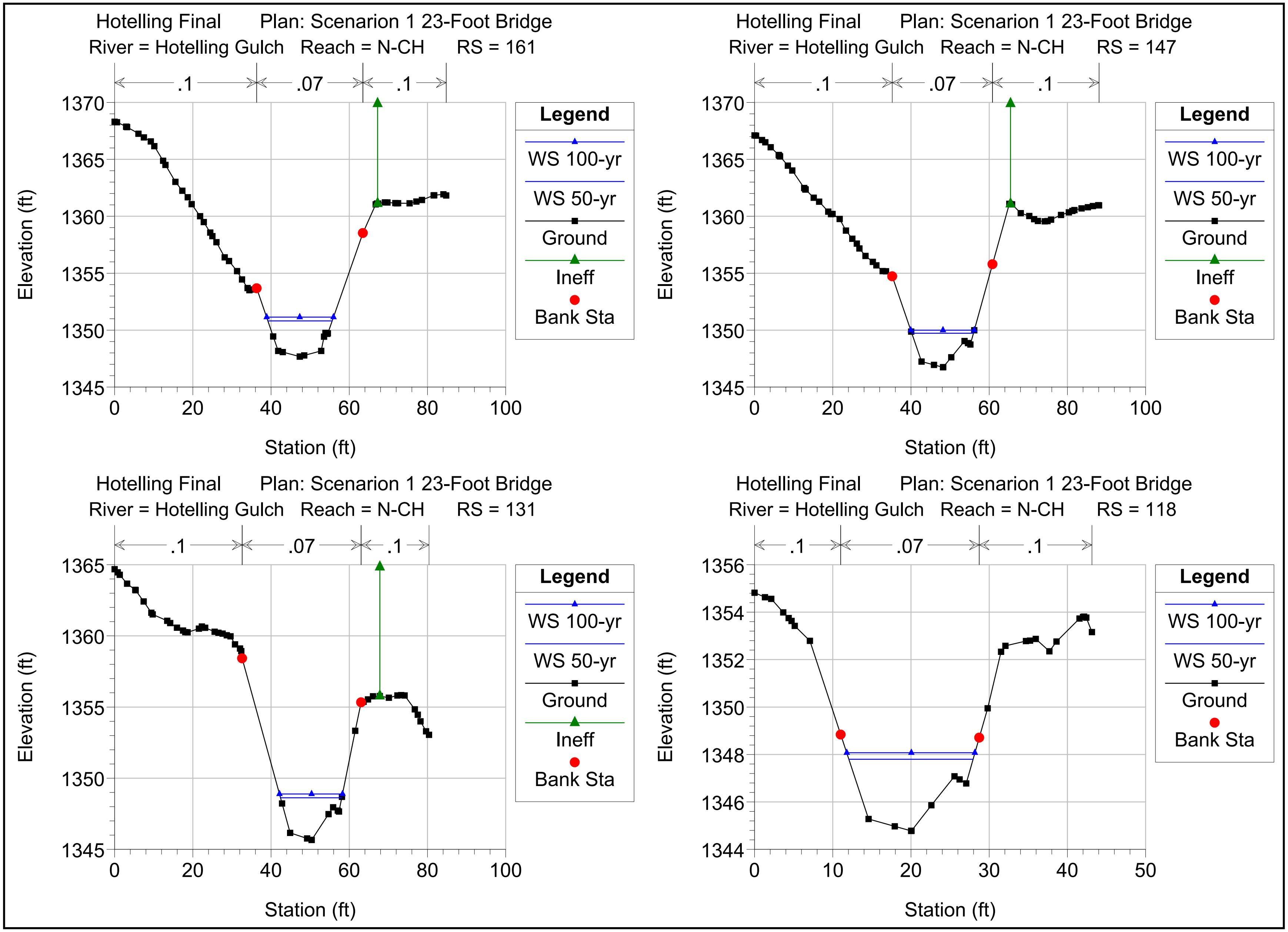

Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 340
.1
.07
.1
Elevation (ft)
1376
1374
1372
1370
1368
1366
1364
1362
1360
0
20
40
60
80
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Bank Sta

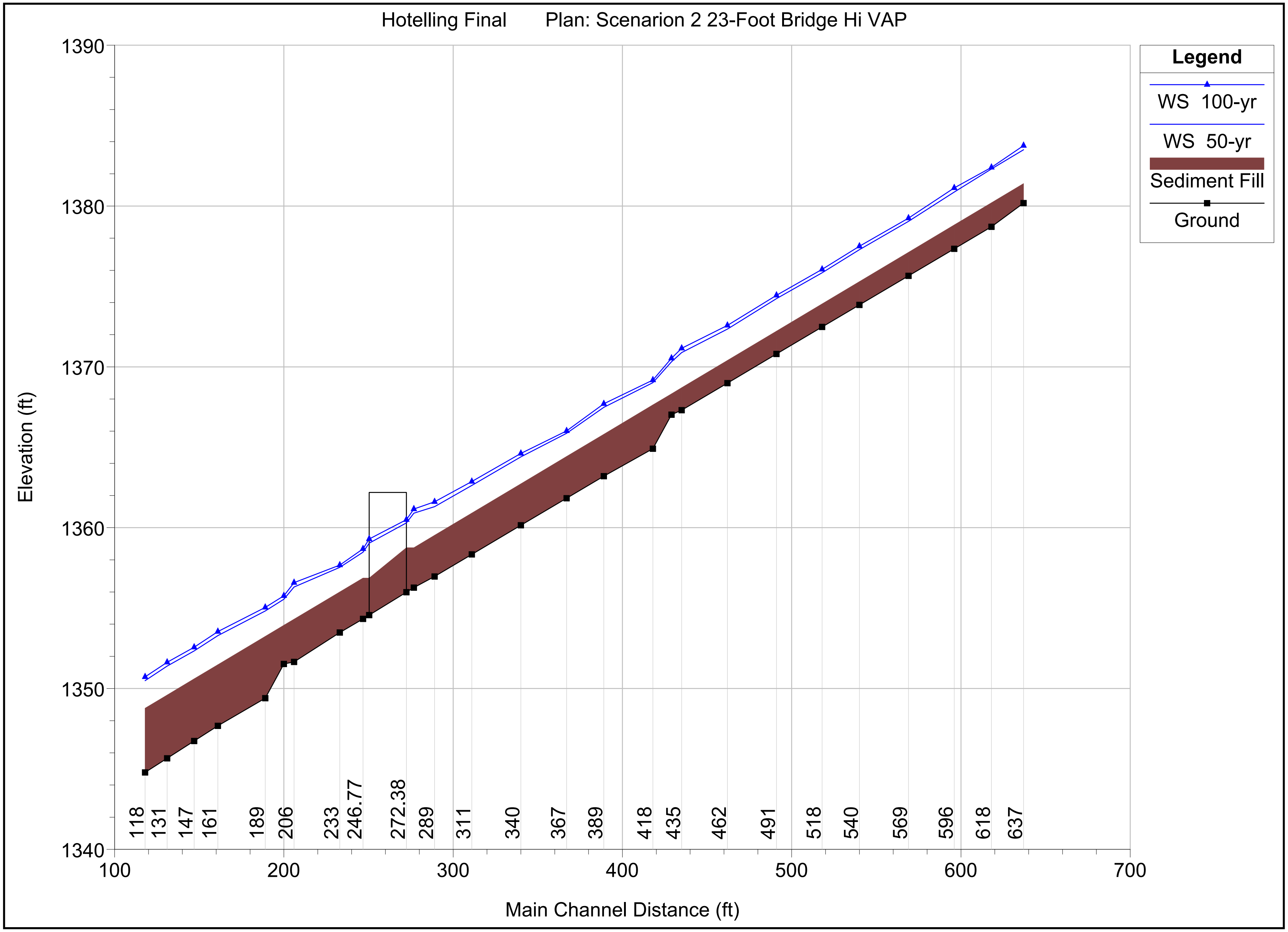

Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 311
.1
.07
.1
Elevation (ft)
1380
1375
1370
1365
1360
1355
0
20
40
60
80
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Ineff
Bank Sta


Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 289
.1
.07
Elevation (ft)
1366
1364
1362
1360
1358
1356
0
10
20
30
40
50
60
70
80
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Ineff
Bank Sta


Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 276.77
.1 .07 .1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Ineff
Bank Sta
Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 272.38 BR
.1 .07 .1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Ineff
Bank Sta
Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 272.38 BR
.1 .07 .1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Ineff
Bank Sta
Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 246.77
.1 .07 .1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Ineff
Bank Sta


Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 233
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Ineff
Bank Sta
Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 206
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Ineff
Bank Sta
Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 200
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Ineff
Bank Sta
Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 189
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Ineff
Bank Sta

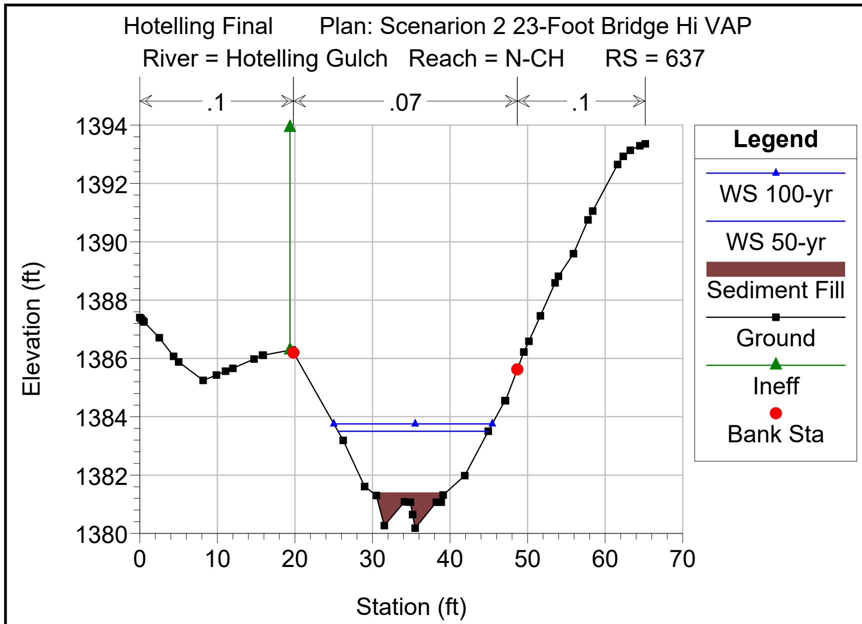

Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 161
.1 .07 .1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Ineff
Bank Sta
Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 147
.1 .07 .1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Ineff
Bank Sta
Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 131
.1 .07 .1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Ineff
Bank Sta
Hotelling Final Plan: Scenario 1 23-Foot Bridge
River = Hotelling Gulch Reach = N-CH RS = 118
.1 .07 .1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Ground
Bank Sta



Hotelling Final Plan: Scenarion 2 23-Foot Bridge Hi VAP
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Elevation (ft)
1390
1380
1370
1360
1350
1340
100
200
300
400
500
600
700
Main Channel Distance (ft)
118 131 147 161 189 206 233 246.77 272.38 289 311 340 367 389 418 435 462 491 518 540 569 596 618 637

HEC-RAS Plan: Scen 2 Hi VAP River: Hotelling Gulch Reach: N-CH

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)	
N-CH	637	50-yr	230.00	1381.40	1383.502	1383.502	1384.315	0.064018	7.24	31.78	19.38	1.00
N-CH	637	100-yr	281.00	1381.40	1383.755	1383.755	1384.660	0.063102	7.63	36.81	20.43	1.00
N-CH	618	50-yr	230.00	1380.21	1382.308	1382.252	1383.025	0.058452	6.80	33.84	21.36	0.95
N-CH	618	100-yr	281.00	1380.21	1382.405	1382.506	1383.354	0.073633	7.82	35.94	21.84	1.07
N-CH	596	50-yr	230.00	1378.82	1380.870	1380.870	1381.648	0.065372	7.08	32.50	20.99	1.00
N-CH	596	100-yr	281.00	1378.82	1381.123	1381.123	1381.973	0.062971	7.40	37.98	22.26	1.00
N-CH	569	50-yr	230.00	1377.13	1379.048	1379.080	1379.832	0.069354	7.11	32.37	21.86	1.03
N-CH	569	100-yr	281.00	1377.13	1379.249	1379.321	1380.152	0.071320	7.62	36.85	22.81	1.06
N-CH	540	50-yr	230.00	1375.30	1377.290	1377.221	1377.945	0.057958	6.50	35.41	24.04	0.94
N-CH	540	100-yr	281.00	1375.30	1377.497	1377.451	1378.244	0.059214	6.93	40.52	25.31	0.97
N-CH	518	50-yr	230.00	1373.92	1375.850	1375.843	1376.572	0.065508	6.82	33.75	23.70	1.00
N-CH	518	100-yr	281.00	1373.92	1376.065	1376.065	1376.876	0.063427	7.23	38.98	24.99	1.00
N-CH	491	50-yr	230.00	1372.22	1374.240	1374.162	1374.890	0.056945	6.47	35.55	23.97	0.94
N-CH	491	100-yr	281.00	1372.22	1374.447	1374.392	1375.190	0.058211	6.92	40.63	25.16	0.96
N-CH	462	50-yr	230.00	1370.40	1372.346	1372.346	1373.086	0.065940	6.90	33.33	22.68	1.00
N-CH	462	100-yr	281.00	1370.40	1372.576	1372.576	1373.396	0.064159	7.26	38.68	23.82	1.00
N-CH	435	50-yr	230.00	1368.70	1370.892	1370.662	1371.433	0.043195	5.90	38.96	24.42	0.82
N-CH	435	100-yr	281.00	1368.70	1371.156	1370.894	1371.745	0.041394	6.16	45.61	25.92	0.82
N-CH	429	50-yr	230.00	1368.33	1370.316	1370.316	1371.059	0.066503	6.92	33.25	22.98	1.01
N-CH	429	100-yr	281.00	1368.33	1370.534	1370.534	1371.370	0.064493	7.34	38.41	24.28	1.01
N-CH	418	50-yr	230.00	1367.64	1369.014	1369.256	1370.022	0.118592	8.06	28.55	24.12	1.31
N-CH	418	100-yr	281.00	1367.64	1369.181	1369.467	1370.332	0.118725	8.61	32.64	24.94	1.33
N-CH	389	50-yr	230.00	1365.81	1367.486	1367.486	1368.188	0.057741	6.79	35.73	28.11	0.96
N-CH	389	100-yr	281.00	1365.81	1367.701	1367.701	1368.482	0.054699	7.20	41.88	29.08	0.95
N-CH	367	50-yr	230.00	1364.43	1365.871	1366.006	1366.677	0.080058	7.53	35.04	31.35	1.12
N-CH	367	100-yr	281.00	1364.43	1366.016	1366.200	1366.963	0.083563	8.21	39.64	32.06	1.16
N-CH	340	50-yr	230.00	1362.73	1364.401	1364.340	1364.954	0.047805	6.28	43.31	38.71	0.88
N-CH	340	100-yr	281.00	1362.73	1364.619	1364.536	1365.211	0.044072	6.57	52.07	41.51	0.86
N-CH	311	50-yr	230.00	1360.91	1362.630	1362.630	1363.411	0.057504	7.16	33.37	51.21	0.97
N-CH	311	100-yr	281.00	1360.91	1362.867	1362.867	1363.747	0.054599	7.62	38.67	52.28	0.97
N-CH	289	50-yr	230.00	1359.53	1361.305	1360.763	1361.569	0.019499	4.13	55.74	54.32	0.57
N-CH	289	100-yr	281.00	1359.53	1361.609	1360.928	1361.890	0.016570	4.26	66.34	55.94	0.54
N-CH	276.77	50-yr	230.00	1358.76	1360.899	1360.345	1361.281	0.022063	4.96	46.37	83.74	0.62
N-CH	276.77	100-yr	281.00	1358.76	1361.160	1360.551	1361.607	0.021936	5.36	52.38	87.21	0.63
N-CH	272.38		Bridge									
N-CH	246.77	50-yr	230.00	1356.87	1358.476	1358.476	1359.201	0.066903	6.83	33.66	25.21	1.00
N-CH	246.77	100-yr	281.00	1356.87	1358.681	1358.681	1359.514	0.064576	7.33	38.36	27.26	1.00
N-CH	233	50-yr	230.00	1356.01	1357.536	1357.597	1358.254	0.071201	6.85	34.99	29.50	1.03
N-CH	233	100-yr	281.00	1356.01	1357.675	1357.807	1358.538	0.077026	7.54	39.12	30.08	1.09
N-CH	206	50-yr	230.00	1354.31	1356.313	1355.692	1356.559	0.018512	3.98	57.73	34.86	0.55
N-CH	206	100-yr	281.00	1354.31	1356.586	1355.881	1356.856	0.017324	4.17	67.44	36.16	0.54
N-CH	200	50-yr	230.00	1353.93	1355.553	1355.553	1356.238	0.065756	6.64	34.62	24.95	0.99
N-CH	200	100-yr	281.00	1353.93	1355.766	1355.766	1356.528	0.064856	7.01	40.11	26.35	1.00
N-CH	189	50-yr	230.00	1353.24	1354.818	1354.627	1355.284	0.040429	5.51	42.83	30.97	0.80
N-CH	189	100-yr	281.00	1353.24	1355.042	1354.808	1355.561	0.037486	5.82	49.84	31.71	0.79
N-CH	161	50-yr	230.00	1351.48	1353.291	1353.169	1353.945	0.052285	6.49	35.43	21.42	0.89
N-CH	161	100-yr	281.00	1351.48	1353.537	1353.388	1354.275	0.050895	6.89	40.77	22.27	0.89
N-CH	147	50-yr	230.00	1350.60	1352.337	1352.309	1353.102	0.064333	7.02	32.77	20.47	0.98
N-CH	147	100-yr	281.00	1350.60	1352.563	1352.542	1353.438	0.063818	7.50	37.45	20.88	0.99
N-CH	131	50-yr	230.00	1349.60	1351.396	1351.313	1352.106	0.057189	6.76	34.01	20.46	0.92
N-CH	131	100-yr	281.00	1349.60	1351.627	1351.541	1352.442	0.057186	7.25	38.78	20.86	0.94
N-CH	118	50-yr	230.00	1348.78	1350.486	1350.486	1351.312	0.059511	7.39	32.91	20.81	1.00
N-CH	118	100-yr	281.00	1348.78	1350.727	1350.727	1351.662	0.056749	7.88	37.97	21.23	0.99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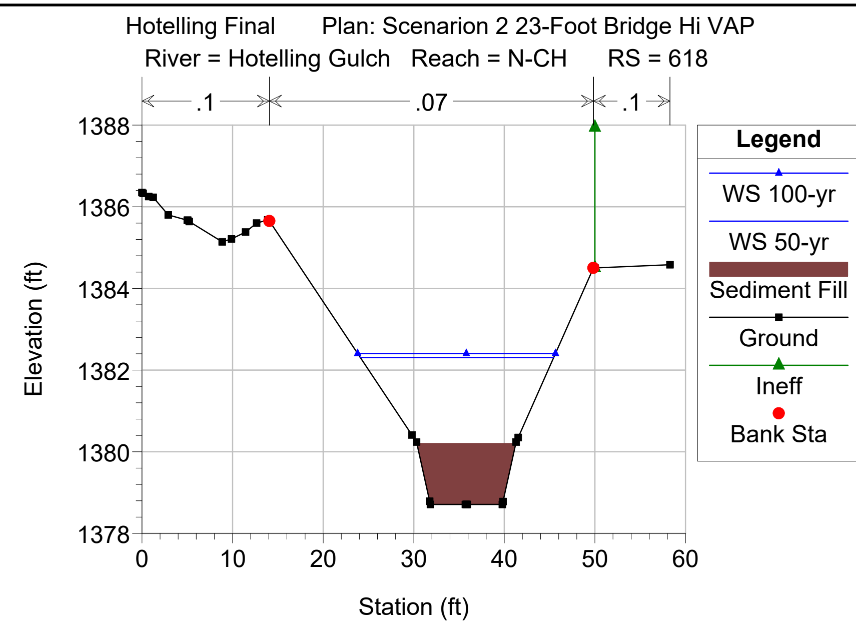
River = Hotelling Gulch Reach = N-CH RS = 637
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Ineff
Bank Sta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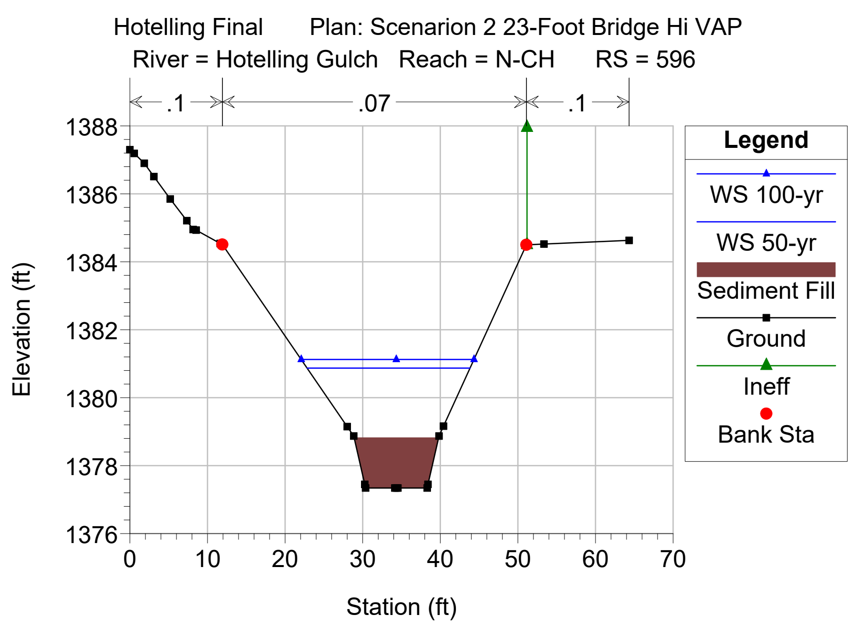
River = Hotelling Gulch Reach = N-CH RS = 618
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Ineff
Bank Sta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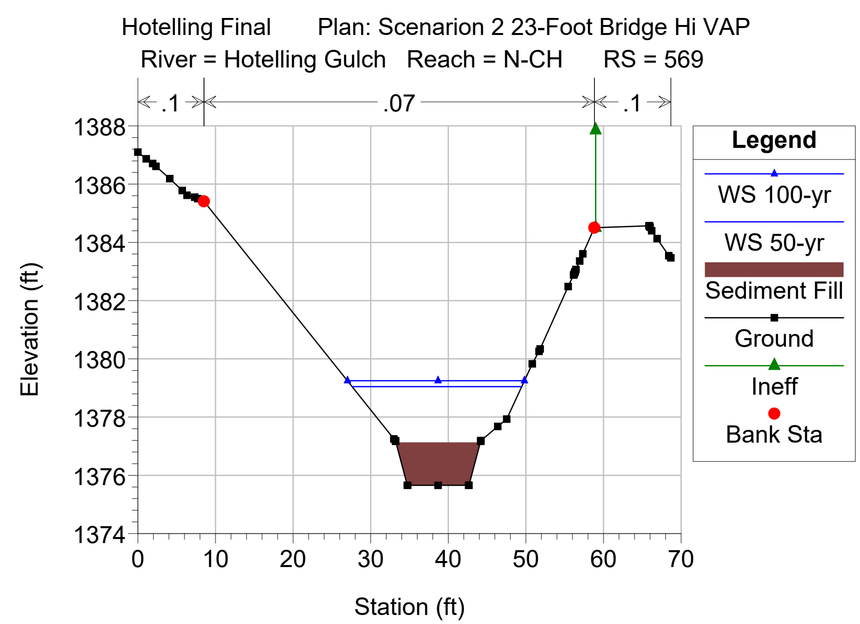
River = Hotelling Gulch Reach = N-CH RS = 596
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Ineff
Bank Sta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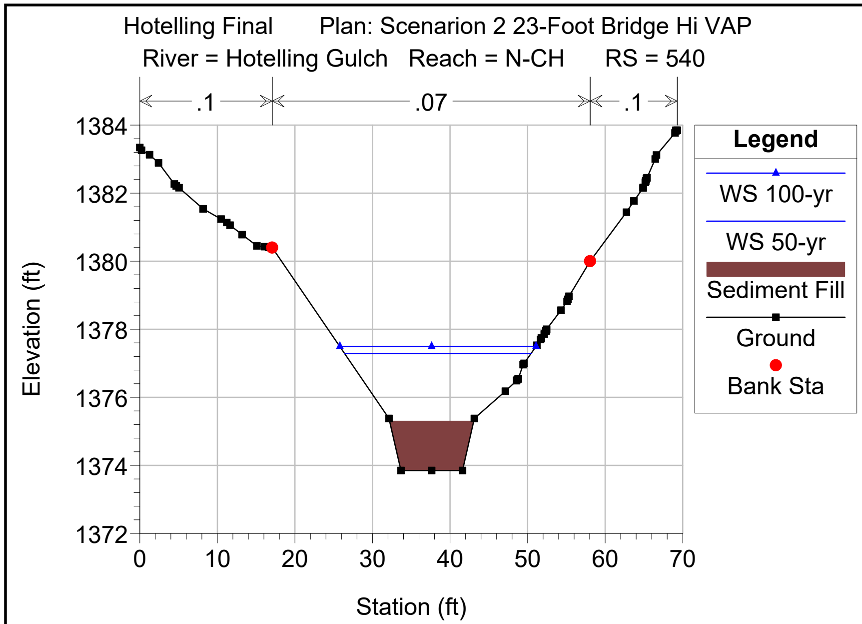
River = Hotelling Gulch Reach = N-CH RS = 569
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Ineff
Bank Sta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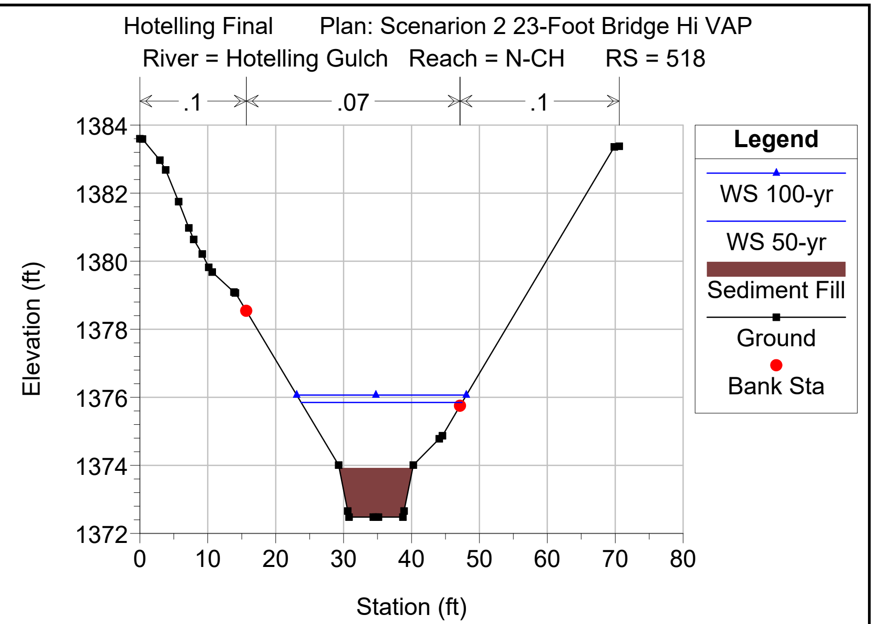
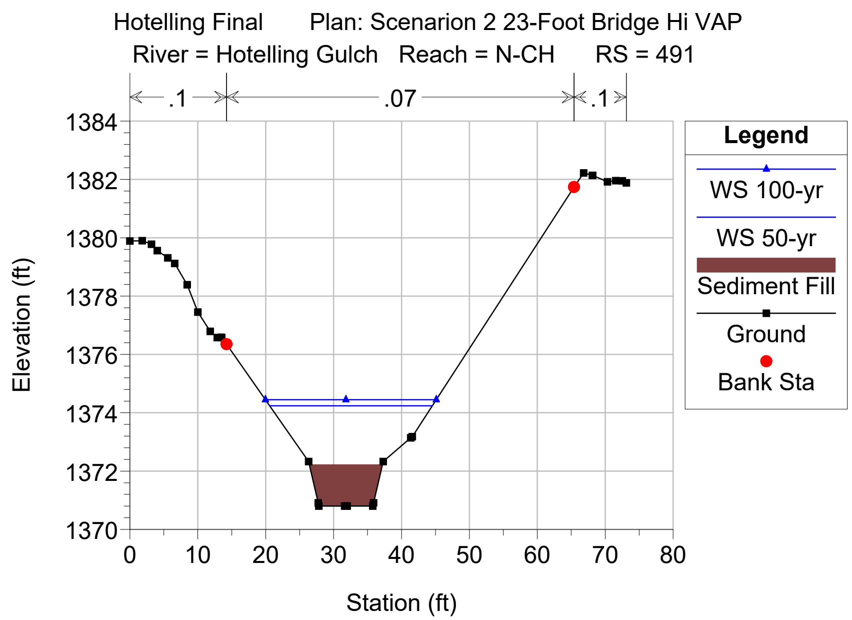
River = Hotelling Gulch Reach = N-CH RS = 540
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Bank Sta


Hotelling Final Plan: Scenarion 2 23-Foot Bridge Hi VAP
River = Hotelling Gulch Reach = N-CH RS = 518
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Bank Sta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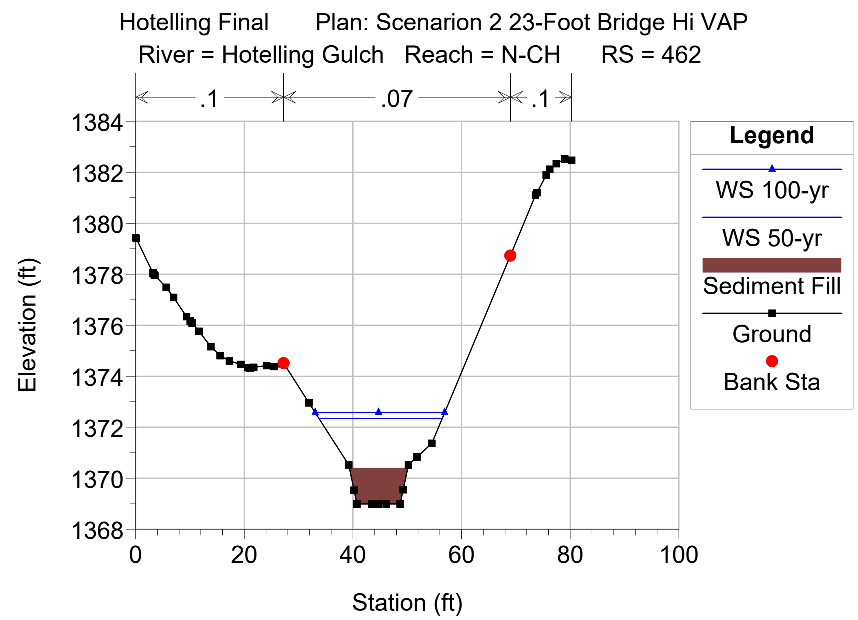
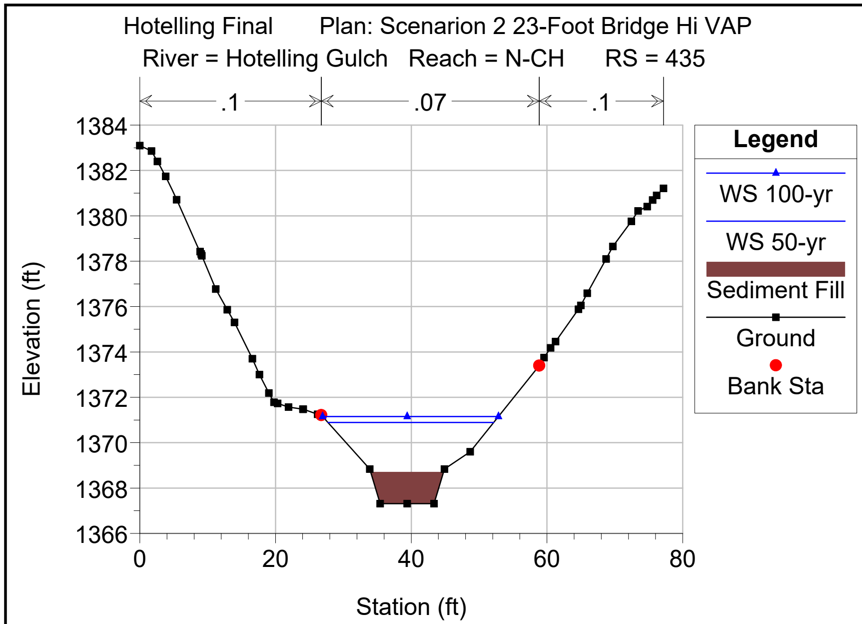
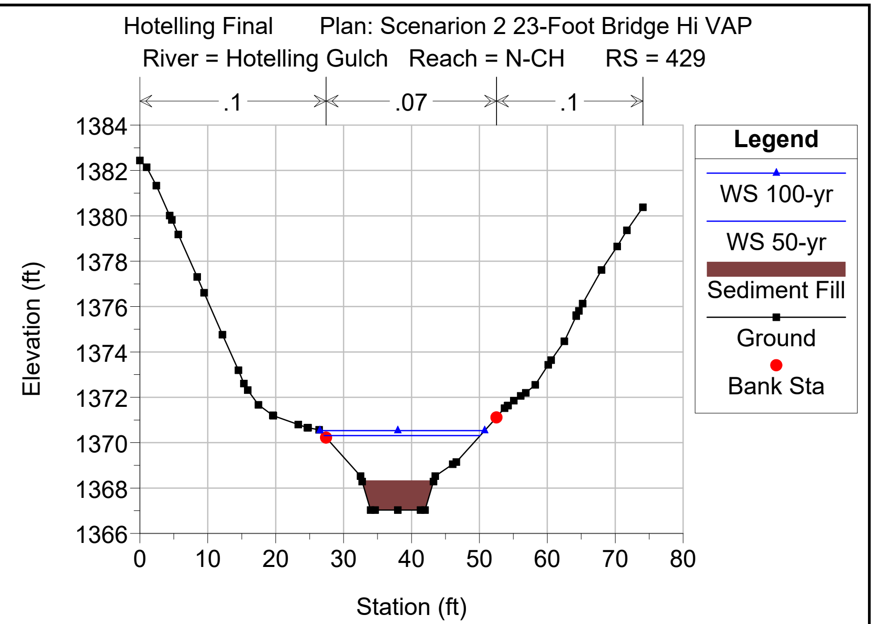
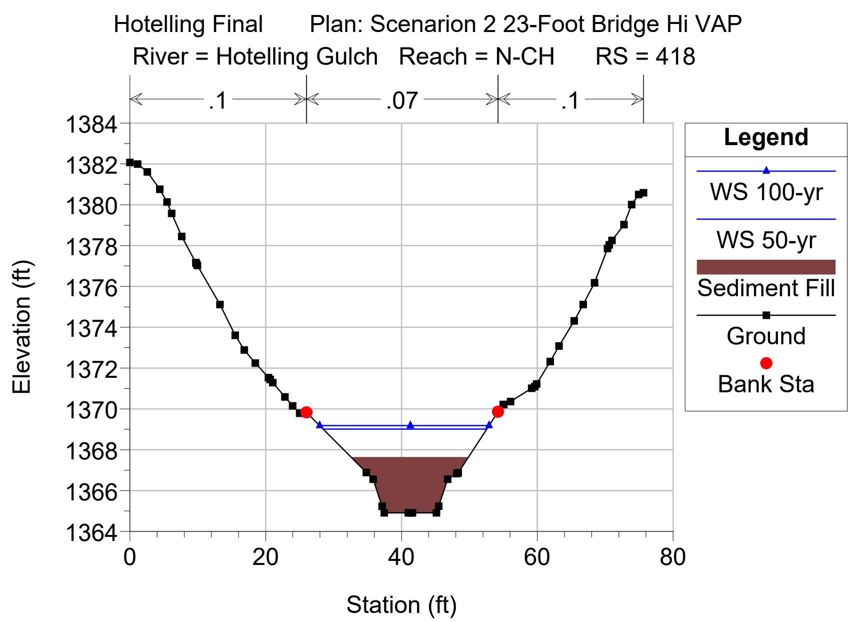
River = Hotelling Gulch Reach = N-CH RS = 491
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Bank Sta


Hotelling Final Plan: Scenarion 2 23-Foot Bridge Hi VAP
River = Hotelling Gulch Reach = N-CH RS = 462
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Bank Sta


Hotelling Final Plan: Scenarion 2 23-Foot Bridge Hi VAP
River = Hotelling Gulch Reach = N-CH RS = 435
.1 .07 .1
1384
1382
1380
1378
1376
1374
1372
1370
1368
1366
Elevation (ft)
0 20 40 60 80
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Bank Sta


Hotelling Final Plan: Scenarion 2 23-Foot Bridge Hi VAP
River = Hotelling Gulch Reach = N-CH RS = 429
.1 .07 .1
1384
1382
1380
1378
1376
1374
1372
1370
1368
1366
Elevation (ft)
0 10 20 30 40 50 60 70 80
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Bank Sta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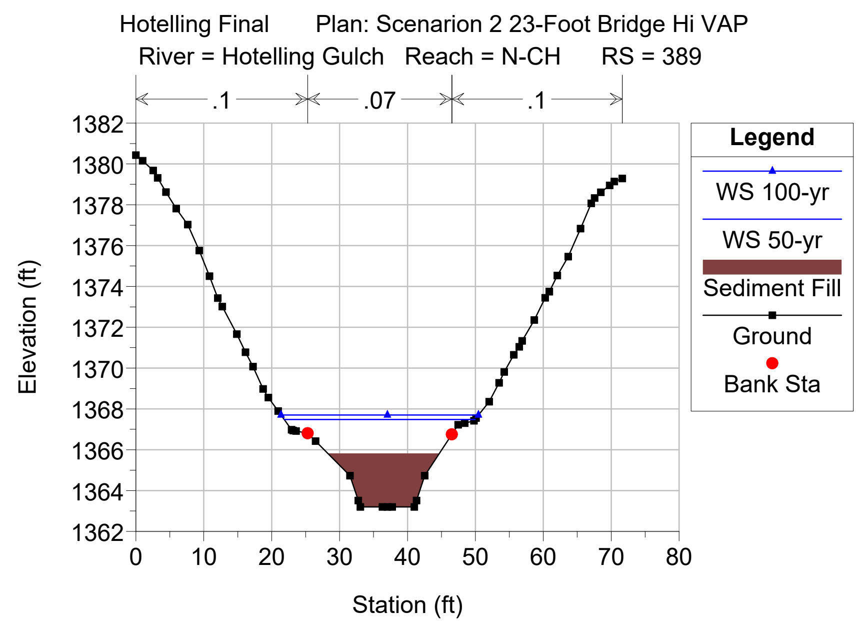
River = Hotelling Gulch Reach = N-CH RS = 418
.1 .07 .1
1384
1382
1380
1378
1376
1374
1372
1370
1368
1366
1364
Elevation (ft)
0 20 40 60 80
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Bank Sta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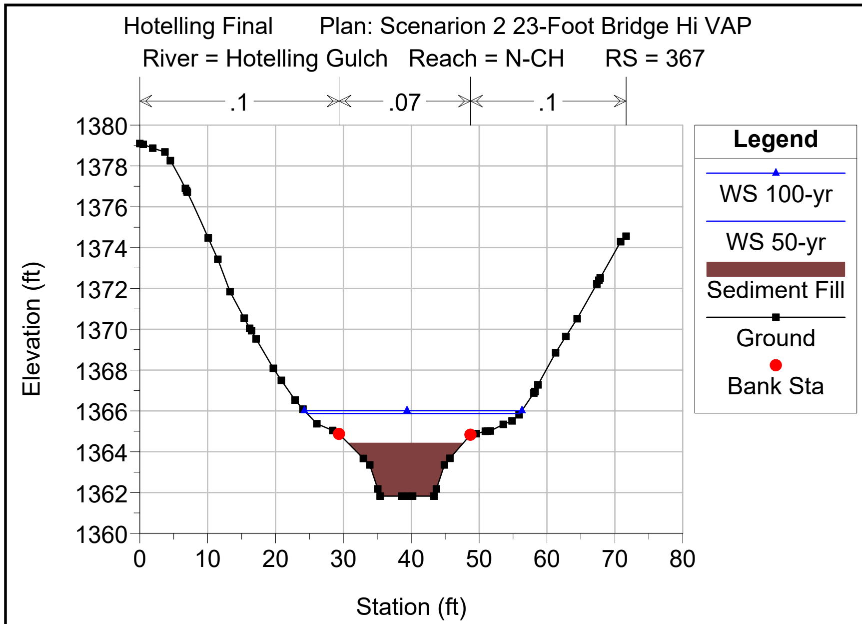
River = Hotelling Gulch Reach = N-CH RS = 389
.1 .07 .1
1382
1380
1378
1376
1374
1372
1370
1368
1366
1364
1362
Elevation (ft)
0 10 20 30 40 50 60 70 80
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Bank Sta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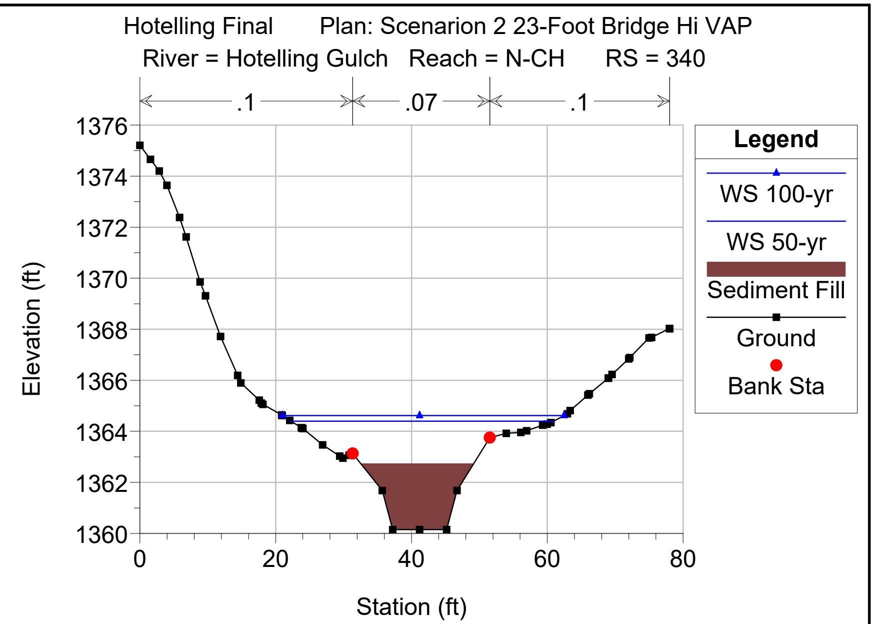
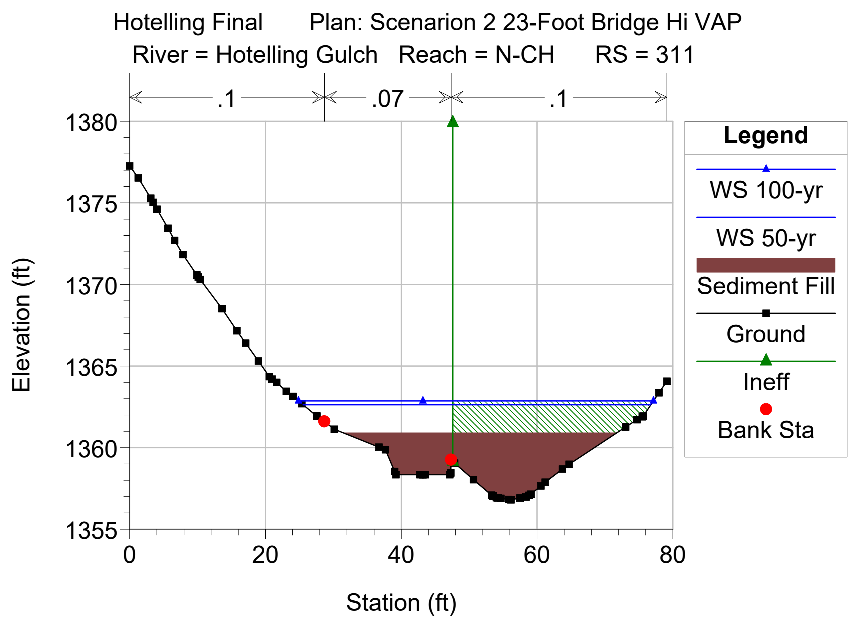
River = Hotelling Gulch Reach = N-CH RS = 367
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Bank Sta


Hotelling Final Plan: Scenarion 2 23-Foot Bridge Hi VAP
River = Hotelling Gulch Reach = N-CH RS = 340
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Bank Sta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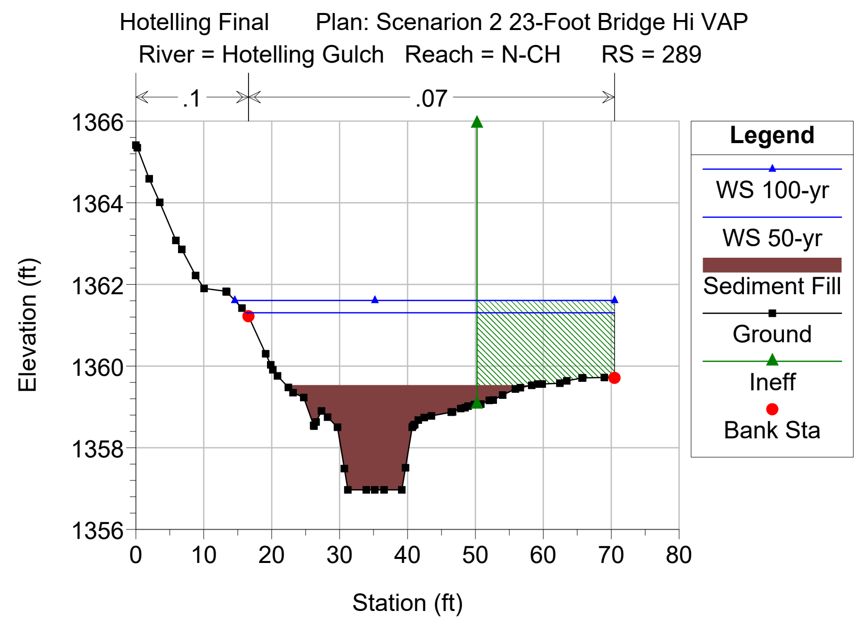
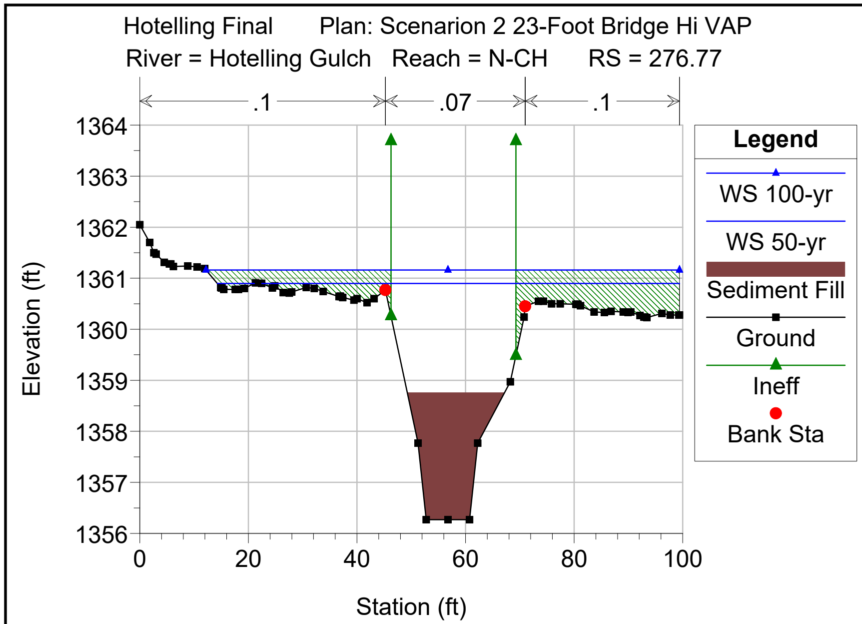
River = Hotelling Gulch Reach = N-CH RS = 311
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Ineff
Bank Sta


Hotelling Final Plan: Scenarion 2 23-Foot Bridge Hi VAP
River = Hotelling Gulch Reach = N-CH RS = 289
.1
.07
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Ineff
Bank Sta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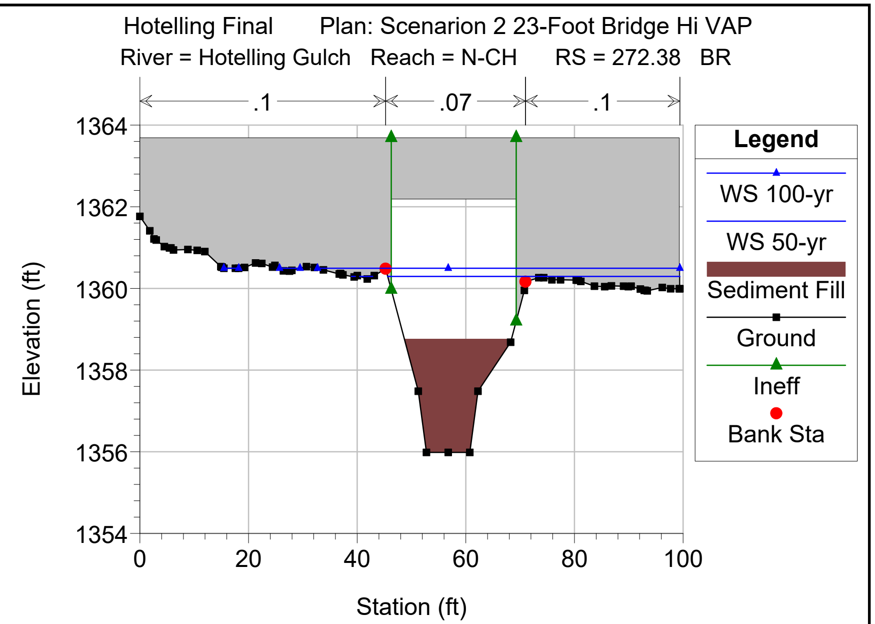
River = Hotelling Gulch Reach = N-CH RS = 276.77
.1
.07
.1
Elevation (ft)
1364
1363
1362
1361
1360
1359
1358
1357
1356
0
20
40
60
80
100
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Ineff
Bank Sta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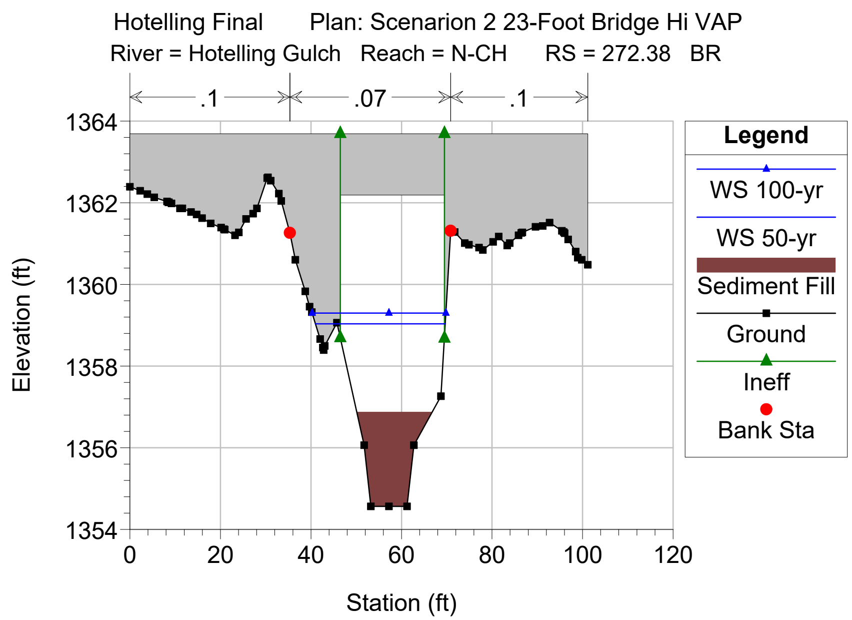
River = Hotelling Gulch Reach = N-CH RS = 272.38 BR
.1
.07
.1
Elevation (ft)
1364
1362
1360
1358
1356
1354
0
20
40
60
80
100
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Ineff
Bank Sta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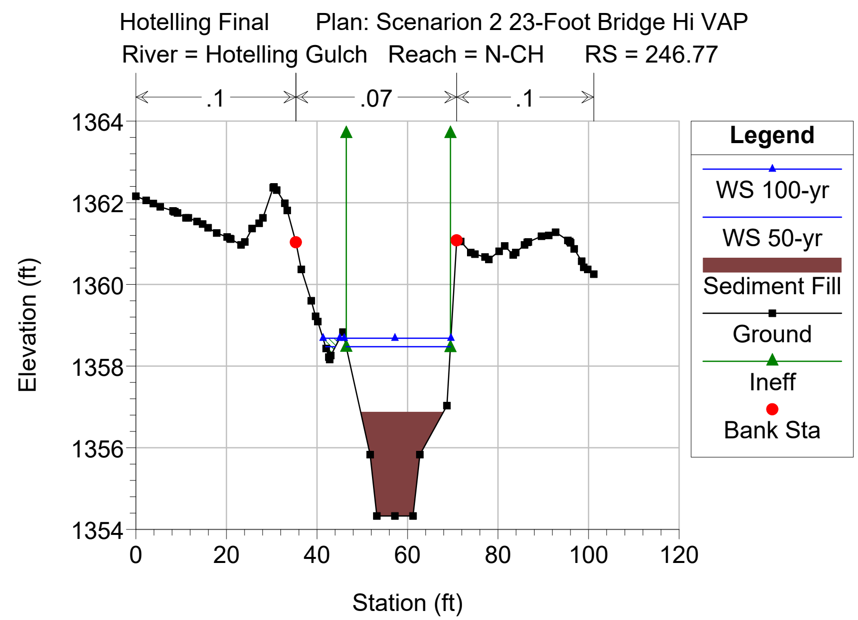
River = Hotelling Gulch Reach = N-CH RS = 272.38 BR
.1
.07
.1
Elevation (ft)
1364
1362
1360
1358
1356
1354
0
20
40
60
80
100
120
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Ineff
Bank Sta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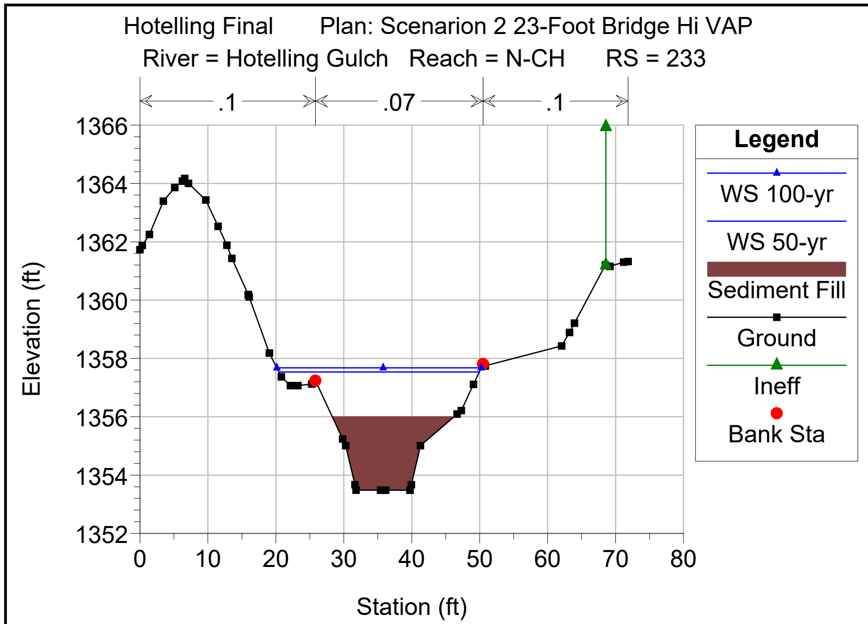
River = Hotelling Gulch Reach = N-CH RS = 246.77
.1
.07
.1
Elevation (ft)
1364
1362
1360
1358
1356
1354
0
20
40
60
80
100
120
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Ineff
Bank Sta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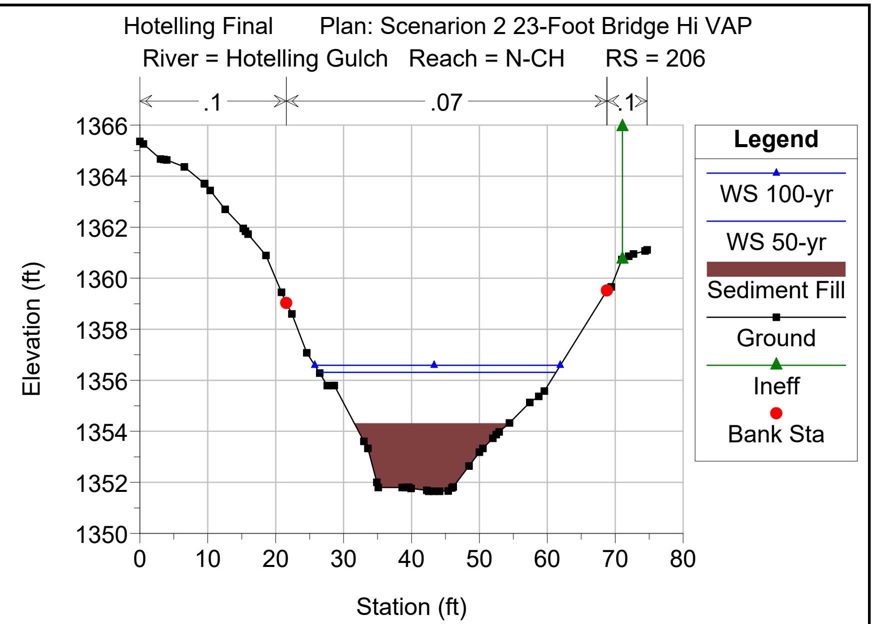
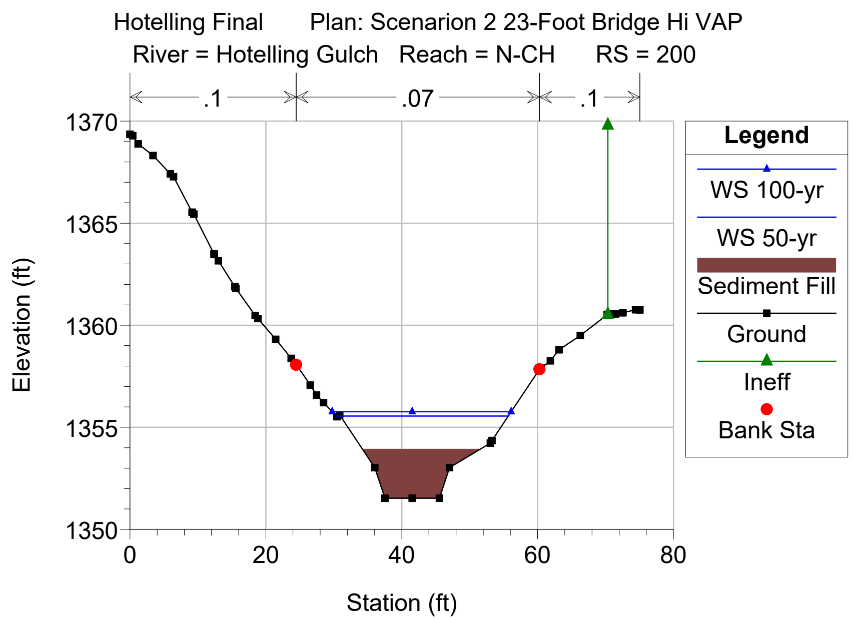
River = Hotelling Gulch Reach = N-CH RS = 233
.1 .07 .1
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Hotelling Final Plan: Scenarion 2 23-Foot Bridge Hi VAP
River = Hotelling Gulch Reach = N-CH RS = 206
.1 .07 .1
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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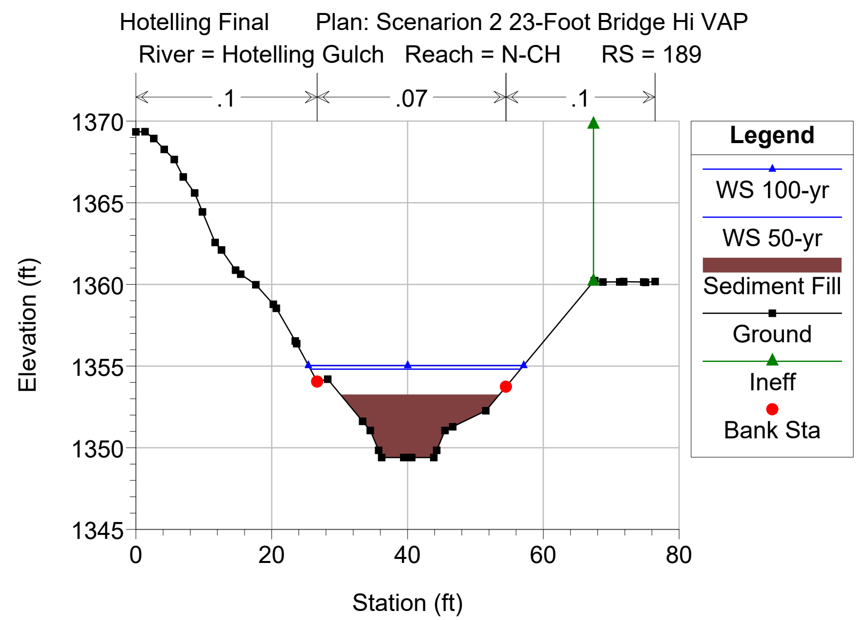
River = Hotelling Gulch Reach = N-CH RS = 200
.1 .07 .1
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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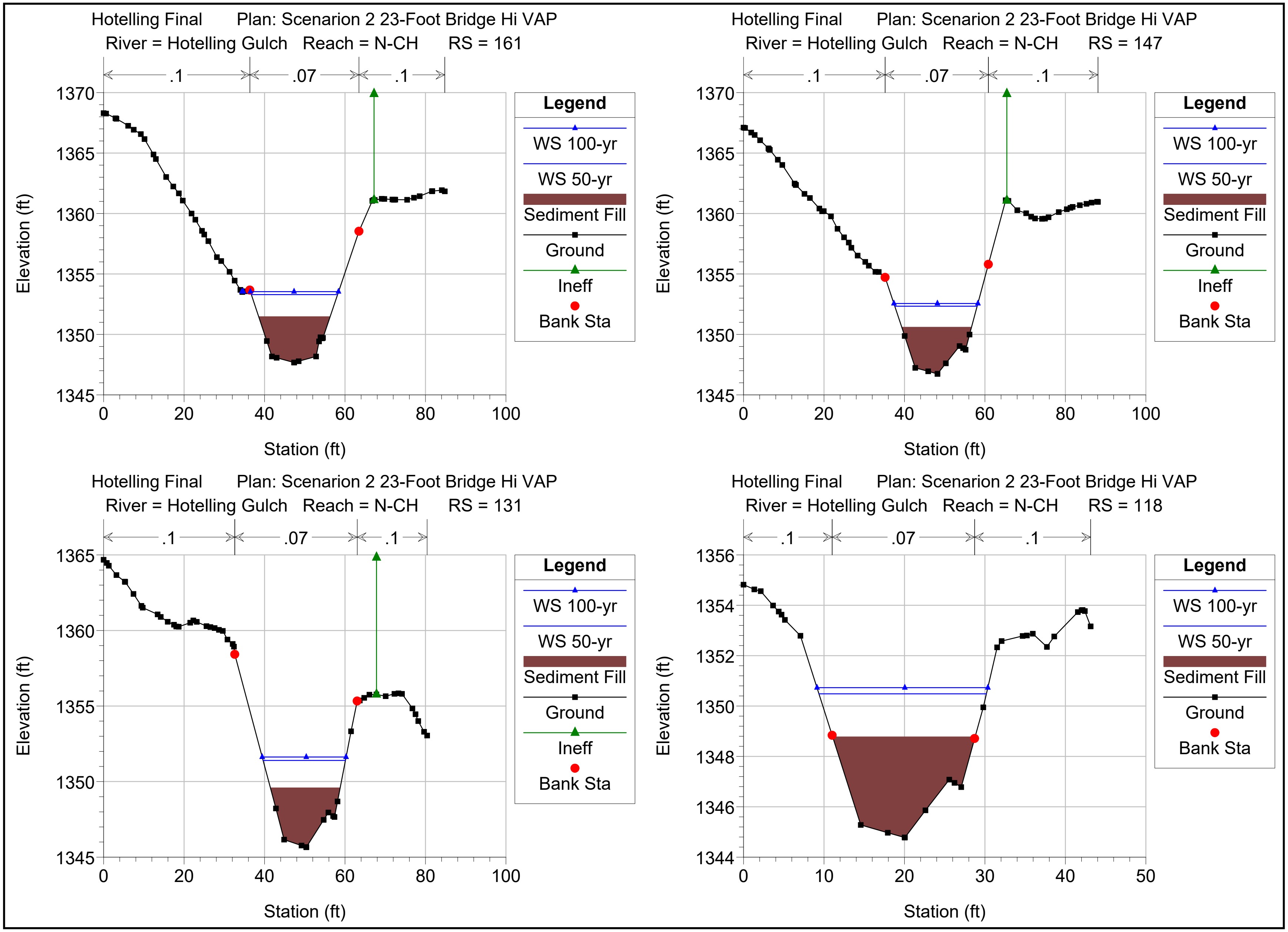
River = Hotelling Gulch Reach = N-CH RS = 189
.1 .07 .1
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)



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River = Hotelling Gulch Reach = N-CH RS = 161
.1
.07
.1
Elevation (ft)
Station (ft)
Legend
WS 100-yr
WS 50-yr
Sediment Fill
Ground
Ineff
Bank Sta
Hotelling Final Plan: Scenarion 2 23-Foot Bridge Hi VAP
River = Hotelling Gulch Reach = N-CH RS = 147
Hotelling Final Plan: Scenarion 2 23-Foot Bridge Hi VAP
River = Hotelling Gulch Reach = N-CH RS = 131
Hotelling Final Plan: Scenarion 2 23-Foot Bridge Hi VAP
River = Hotelling Gulch Reach = N-CH RS = 118

Appendix G – Scour Analysis

Hotelling Gulch Final Bridge Design
Bridge Scour Input Variables (Bridge at 2+74)

10/26/2018

Flow Scenario	**100 Yr**	
Upstream Cross Section (Uncontracted) (Average of RAS sections 340 to 596).		
Flow Upstream Transporting Sediment, cfs (Q1)	281.0	Total Flow
Top Width U/S, feet	20.0	
Avg Depth Upstream Channel (Hydraulic Depth, ft)	1.8	
Average flow depth on Floodplain, feet (ya)	0.0	
Froude number	1.0	
Average velocity	7.8	> Critical Velocity, bed mobliized
D50 grain size (mm)	76.0	
D50 grain size (ft)	0.249	
Critical Velocity of bed (fps)*	7.8	
Bridge Cross Section (Contracted) — **Flow Scenario**	**100 Yr**	
Flow through Bridge (cfs) (Q2)	281.0	Total Flow
Top width through contracted section, fee (W2)	23.0	Bridge Opening Width
Bottom Width Contracted section, feet (W2)	8.0	Active Channel Width
Avg Vel, through bridge opening (Va)	7.5	
Length of Abutment Projection into Flow Field (feet)	0.0	
Orentation of Embankmnet angle, degrees	90.0	
Avg Depth Contracted Channel, feet (yo, Hydraulic Depth, ft)	1.9	

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Contraction Scour Analysis Based on Flow Top Width

Prepared by: RS

Checked by: ML

From: FHWA. 2012. Evaluating Scour at Bridges, Fifth Edition. Hydraulic Engineering Circular No. 18. U.S. Department of Transportation, Federal Highway Administration. Publication FHWA-HIF-12-003.

Live Bed Scour (Laursen, 1960 modified by HEC-18)

	100-Year Event
	281
Flow in Upstream Channel transporting sediment (Q_1) cfs	281
Flow in the Contracted Channel (Q_2) cfs	281
Top width of the upstream channel transporting sediment (W_1) cfs	**20.0**
Top width of the contracted channel (W_2) cfs	23.0
K_1 Value	**0.59**
Average Depth in the Upstream Channel (y_1)(ft)	**1.8**
Average Depth in the Contracted Channel before Scour (y_o) (ft)	1.9
Average Depth in Contraction Section (y_2) ft	1.69
Drop in Contracted Channel Elev, feet (Ys)	**0.0**

$$\frac{y_2}{y_1} = \left(\frac{Q_2}{Q_1}\right)^{6/7}\left(\frac{W_1}{W_2}\right)^{k_1} \quad (6.2)$$

$$y_s = y_2 - y_o = \text{(average contraction scour depth)} \quad (6.3)$$

where:

- y_1 = Average depth in the upstream main channel, ft (m)
- y_2 = Average depth in the contracted section, ft (m)
- y_o = Existing depth in the contracted section before scour, ft (m) (see Note 7)
- Q_1 = Flow in the upstream channel transporting sediment, ft^3/s (m^3/s)
- Q_2 = Flow in the contracted channel, ft^3/s (m^3/s)
- W_1 = Bottom width of the upstream main channel that is transporting bed material, ft (m)
- W_2 = Bottom width of main channel in contracted section less pier width(s), ft (m)
- k_1 = Exponent determined below

V_*/T	k_1	Mode of Bed Material Transport
<0.50	0.59	Mostly contact bed material discharge
0.50 to 2.0	0.64	Some suspended bed material discharge
>2.0	0.69	Mostly suspended bed material discharge

- V_* = $(\tau_o/\rho)^{1/2} = (g y_1 S_1)^{1/2}$, shear velocity in the upstream section, ft/s (m/s)
- T = Fall velocity of bed material based on the D_{50}, m/s (Figure 6.8) For fall velocity in English units (ft/s) multiply T in m/s by 3.28
- g = Acceleration of gravity (32.2 ft/s^2) (9.81 m/s^2)
- S_1 = Slope of energy grade line of main channel, ft/ft (m/m)
- τ_o = Shear stress on the bed, (lb/ft^2) (Pa (N/m^2))
- ρ = Density of water (1.94 $slugs/ft^3$) (1000 kg/m^3)

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Contraction Scour Analysis

Prepared by: RS

Checked by: ML

From: FHWA. 2012. Evaluating Scour at Bridges, Fifth Edition. Hydraulic Engineering Circular No. 18. U.S. Department of Transportation, Federal Highway Administration. Publication FHWA-HIF-12-003.

Froehlich Equation

	100 Yr
Average flow depth on floodplain, feet (ya)	0.00
Length abutment projection into	0.10
K1	0.55
K2	1.00
Approach Froude number	1.02
Abutment Scour depth (y2) ft*	**0.00**

K1 values

1	vertical wall
0.82	vert wall with wingwalls
0.55	spill through

8.6.1 Froehlich's Abutment Scour Equation

Froehlich (TRB 1989) analyzed 170 live-bed scour measurements in laboratory flumes by regression analysis to obtain the following equation:

$$\frac{y_s}{y_a} = 2.27\, K_1 K_2 \left(\frac{L'}{y_a}\right)^{0.43} Fr^{0.61} + 1 \qquad (8.1)$$

where:

K_1 = Coefficient for abutment shape (Table 8.1)
K_2 = Coefficient for angle of embankment to flow
K_2 = $(\theta/90)^{0.13}$ (see Figure 8.5 for definition of θ)
$\theta<90°$ if embankment points downstream
$\theta>90°$ if embankment points upstream
L' = Length of active flow obstructed by the embankment, ft (m)
A_e = Flow area of the approach cross section obstructed by the embankment, ft^2 (m^2)
Fr = Froude Number of approach flow upstream of the abutment = $V_e/(gy_a)^{1/2}$
V_e = Q_e/A_e, ft/s (m/s)
Q_e = Flow obstructed by the abutment and approach embankment, ft^3/s (m^3/s)
y_a = Average depth of flow on the floodplain (A_e/L), ft (m)
L = Length of embankment projected normal to the flow, ft (m)
y_s = Scour depth, ft (m)

It should be noted that Equation 8.1 is not consistent with the fact that as L' tends to 0, y_s also tends to 0. The 1 was added to the equation so as to envelope 98 percent of the data. See Section 8.2.2 and Figure 8.4 for guidance on estimating L'.

Appendix H – Opinion of Probable Construction Costs

Opinion of Probable Construction Cost for 90% Design Submittal

Michael Love & Associates
Hydrologic Solutions
PO Box 4477 • Arcata, CA 95518 • (707) 822 -2411

Hotelling Gulch Fish Access and Channel Restoration Project

10/26/2018

Stream Restoration Item Description	Unit	Quantity	Unit Cost	Total Cost
Mobilization (10%)	LS	1	$33,980	$33,980
Salvaging Native Plants, Replanting (2 laborers)	Day	3.0	$1,600	$4,800
Construction Access, Clearing and Grubbing (Including salvage of trees < 1 foot DBH)	Day	2.0	$3,700	$7,400
Temporary Access Road (Salvaged Material)	Day	4.0	$6,700	$26,800
Individual Tree Removal and Salvage (>1-ft DBH)	EA	15	$1,000	$15,000
Erosion and Sediment Control	AC	1.0	$5,000	$5,000
Stream Diversion and Dewatering	Day	60	$500	$30,000
General Excavation of Channel and Placement for Plug and Spoiling	CY	2,640	$24	$63,360
Streambed Construction	Day	15	$5,900	$88,500
1/2 Ton RSP Under Bridge	Ton	165	$300	$49,350
Bedrock Removal	Hours	30	$350	$10,500
Unanchored Log Structures	EA	10	$2,000	$20,000
Live Willow Staking (2 rows at 2 ft OC)	EA	700	$10	$7,000
Riparian Plantings (1 Gal, 15 ft OC) (Excluding irrigation)	EA	200	$60	$12,000
Sub-Total Construction Costs (Excluding Bridge and Roadway)				$373,690
		Contingency	15%	$56,054
Road and Bridge Construction (See Attached)				$920,000
Total Stream, Road and Bridge Costs				$1,349,744
Total Construction Costs (With 2 year escalation @ 3% per year)				**$1,430,728**

Hotelling Gulch Stream Realignment & Restoration Project

90% ROAD & BRIDGE GENERAL PLAN ESTIMATE

Bridge	*Cecilville Road at Hotelling Gulch*		Br.No.	*TBD*					
Type	*CIP RC Slab on Diaph Abut Spread Ftgs*		District	*2*	Co.	*Sis*	Rte.	*CR*	P.M.
Length	*27*	Width *22*	Area	*594*	sq.ft.				

Design Section	*Quincy Engineering*	Quantities by:	AM / SB	Date	*10/15/18*	Estimate No.	*1*
Project Includes:	*1* structures	Quant. Checked by:	MK	Date	*10/17/18*	Price by:	*MLK*
	N/A	CU / EA	*N/A*			Cost Index	*2018*

	Contract Items	Unit	Quantity	Price	Amount
1	Structure Excavation (Bridge)	CY	234	$450.00	$105,120
2	Structure Excavation (Rock)	CY	62	$650.00	$40,300
3	Structure Backfill (Bridge)	CY	137	$200.00	$27,400
4	Structure Backfill (Slurry Cement)	CY	46	$450.00	$20,700
5	Structural Concrete, Bridge Footing	CY	38	$1,200.00	$45,960
6	Structural Concrete, Bridge	CY	72	$1,600.00	$115,200
7	Structural Concrete, Bridge (Polymer Fiber)	CY	36	$2,000.00	$72,000
8	Bar Reinforcing Steel (Bridge)	LB	11,092	$1.80	$19,966
9	Bar Reinforcing Steel (Epoxy Coated) (Bridge)	LB	3,657	$2.50	$9,143
10	Oregon 2-Tube Side Mount Rail	LF	130	$350.00	$45,500
11	Temporary Silt Fence	LF	468	$5.00	$2,340
12	Temporary High-Visiblity Fence	LF	608	$6.00	$3,648
13	Clearing and Grubbing	LS	1	$10,000.00	$10,000
14	Construction Staking	LS	1	$20,000.00	$20,000
15	Roadway Excavation	CY	166	$100.00	$16,600
16	Imported Borrow	CY	311	$130.00	$40,430
17	Hydromulch	SQFT	5,968	$0.50	$2,984
18	Fiber Rolls	LF	373	$5.00	$1,865
19	Hydroseed	SQFT	5,968	$0.50	$2,984
20	Class 2 Aggregate Base	CY	248	$160.00	$39,680
21	Hot Mix Asphalt (Type A)	TON	205	$250.00	$51,150
22	Place Hot Mix Asphalt Dike (Type A)	LF	123	$40.00	$4,920
23	Place Hot Mix Asphalt Dike (Type F)	LF	28	$40.00	$1,120
24	Place Hot Mix Asphalt (Miscellaneous Area)	SQYD	6	$500.00	$2,800
25	Temporary Pavement Marking (Paint)	SQFT	20	$10.00	$200
26	Remove Painted Pavement Marking	SQFT	20	$5.00	$100
27	Rock Slope Protection (No. 2, Method B)	CY	1	$2,000.00	$2,000
28	Rock Slope Protection Fabric (Class 8)	SQYD	6	$50.00	$275
29	Midwest Guardrail System	LF	126	$90.00	$11,340
30	Construction Area Signs	LS	1	$10,000.00	$10,000
31	Prepare Water Pollution Control Program	LS	1	$5,000.00	$5,000
32	Alternative Flared Terminal System	EA	2	$4,000.00	$8,000
33	Oregon 2-Tube Side Mount Transition (Mod)	EA	4	$4,000.00	$16,000

SUBTOTAL	$754,724
MOBILIZATION (___ *10* %)	$75,472.41
SUBTOTAL	$830,197
CONTINGENCIES (_____ %) *10* %)	$83,019.65
BRIDGE REMOVAL (Conting. incl.)	
WORK BY RAILROAD OR UTILITY FORCES	
GRAND TOTAL	$913,216
FOR BUDGET PURPOSES - SAY	**$920,000**

Comments: