Euer Valley Restoration Project
90% DRAFT Design Basis Memorandum



Prepared for

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TRUCKEE RIVER WATERSHED COUNCIL

Truckee River Watershed Council
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1. Introduction

The purpose of this memorandum is to summarize the data collection and field investigations, design analysis and methods used, and data results and rationale in support of the 90% plans for the Euer Valley Restoration Project (Project). The Project is being funded through and managed by the Truckee River Watershed Council (TRWC) with support from the Tahoe Donner Association (TDA). It is also a component of a larger Prosser Creek Watershed Assessment effort being done by others. This should be considered a working document that will continue to be updated through the design development process including continued coordination and information sharing with the parallel watershed assessment efforts.

2. Design Objectives

Our understanding of the original primary design objectives and restoration opportunities for the Project are as follows:

- Improve geomorphic function and channel stability;
- Improve floodplain condition and increase hydrologic connectivity;
- Improve water quality by reducing erosion potential and improving channel stability;
- Enhance ecosystem functionality and habitat availability; and
- Improve recreational access and provide a permanent creek crossing.

It should be noted following further investigations described below the goal of increasing hydrologic connectivity between South Fork Prosser Creek and the adjacent meadow floodplain became unnecessary due to the health and vigor of the meadow supported by subsurface spring flows.

3. Background

Euer Valley is located within the Prosser Creek basin, the third largest subwatershed of the Middle Truckee River watershed. South Fork Prosser Creek runs through the Project area (Figure 1) at an elevation just over 6500 feet (ft) and drains an approximate 5.5 square mile watershed before joining Prosser Creek and ultimately draining to the Truckee River. The Truckee River is 303(d) listed as impaired due to suspended sediment. South Fork Prosser Creek and Euer Valley have been subject to historic anthropogenic disturbances including grading, timber harvest and associated road development that likely contributed to channel relocation and aggravated incision and degradation. Recreation is now the dominant land use within the project area including earthen trails and a culverted crossing at one of the tortuous meander bends (Figure 2). The Project was first identified in the Tahoe Donner Association (TDA) Trails Master Plan due to desired improvements to the Coyote Crossing Trail, which transects the site.

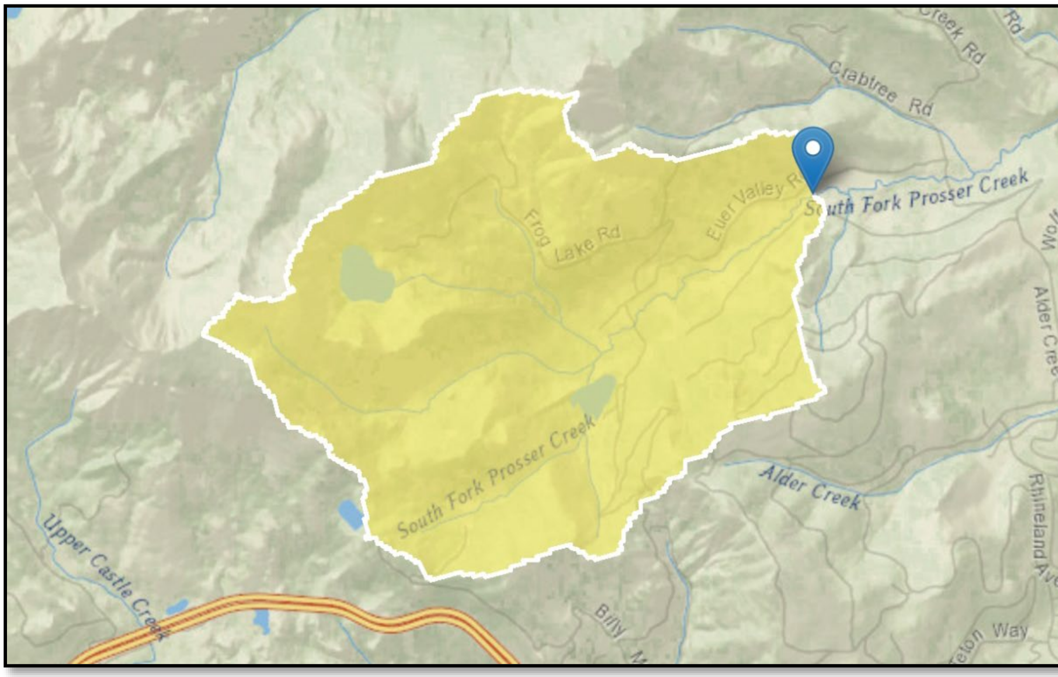


Figure 1. South Fork Prosser Creek Watershed at Project Site *(Source: USGS 2016)*

The Project area includes approximately 2,500 linear ft of South Fork Prosser Creek encompassed by 30 acres of stream, meadow, and upland habitat. Designs are intended to improve trail access through the Project area including replacement of non-optimal volunteer trails through the wet meadow with elevated boardwalks and a permanent bridge feature that will provide year-round access for pedestrians, bicyclists, equestrians, and winter cross-country grooming equipment.

Figure 2. View of South Fork Prosser Creek within Euer Valley looking N/E *(Source: TDA Drone Footage)*

4. Data Collection, Analysis and Results

Several desktop and field data collection efforts were conducted during the summer of 2020 by the design and planning teams including: 1) topographic survey, 2) geomorphic survey, 3) cultural survey, 4) biological resources survey, 5) plant resource survey, and 6) subsurface geotechnical investigation. In addition, a wetland delineation was completed in the summer 2021 and a visual and mapped assessment of South Euer Road to identify opportunities to improve drainage crossings and maintenance access in the fall of 2021. Key takeaways from these efforts are summarized below and several of the full reports are included as Attachments.

Topographic Survey

A topographic survey was conducted by Wildscape staff in September 2020 using RTK survey equipment. Due to the remoteness of the site and consequent lack of available established benchmarks, the primary project benchmark coordinate was set and determined via static collection and later adjusted using the Online Positioning User Service (OPUS) portal. The purpose of the topographic survey was to supplement the Tahoe National Forest LiDAR data available for the Project Area in the following areas based on input from Northwest Hydraulic Consultants (NHC), the firm providing the hydrology and hydraulic analyses for South Fork Prosser Creek:

- Along the existing trail corridor;
- Cross sections delineating bank top, toe, and thalweg along the river corridor from the property line to the end of the meanders directly downstream from the existing bridge crossing;
- Old channel scars and swales in the meadow, and;
- A valley cross section

Differences were observed between the field survey data and the LiDAR data where they overlapped. To determine the cause of these discrepancies Wildscape staff confirmed the field data collected and the OPUS solution for final coordinates, and then compared the field survey topography to the LiDAR topography for areas with no vegetative cover. These areas of bare ground allowed Wildscape to compare survey elevations to LiDAR elevations without the interference of vegetation. Vegetation can cause considerable error in LiDAR data collection since the airborne laser will intercept the vegetation never reaching the ground surface. This is especially true in areas of thick cover such as the dense meadow graminoids (dominated by species of *Carex*) encountered at the project site. The technical report for the 2014 USDA Tahoe National Forest LiDAR data was also reviewed and it was learned that the 2014 collection was not compared to field collected survey elevations but was compared to the previous LiDAR collection where the two data collections overlapped, with the resulting reported "accuracy" in the range of 0.16 to 1.15 ft. Given this range, a mean difference of approximately 0.5 ft on trail edge and center (Figure 3) is well within the error of the LiDAR. In summary the LiDAR data is not necessarily more accurate than the field survey data and the differences can be rectified by either adjusting the survey data to match the LiDAR data or adjusting the LiDAR data to match the survey data.

This adjustment step was not taken during the initial hydraulic model set up in order to expedite results using the LiDAR topographic data set only. It may be a beneficial exercise to merge the two data sets, however given the dense meadow vegetation had skewed the LiDAR data to be inconsistently higher in elevation than the field survey data and the LiDAR data set was reported to have a fairly wide range in "accuracy" from 0.16 to 1.15 ft per the technical report, it would likely be a challenging and time consuming effort. This combined with the lesser need to design for increased channel overbanking per reasons described in later sections and budget limitations the field survey data was not merged with the LiDAR and instead used in design development and as a "check" on the channel size, shape, and slope. Modeled water surface and overbanking may be slightly higher and sooner respectively given the LiDAR data did not always show the full depth of the channel and velocity and shear in the channel may be slightly lower than actual given containment in the channel. Therefore, designing the bridge span freeboard height to the model results is considered conservative and the channel bank treatment elements were designed to withstand the predicted velocities and shears with an increased factor of safety to account for the potential discrepancy.

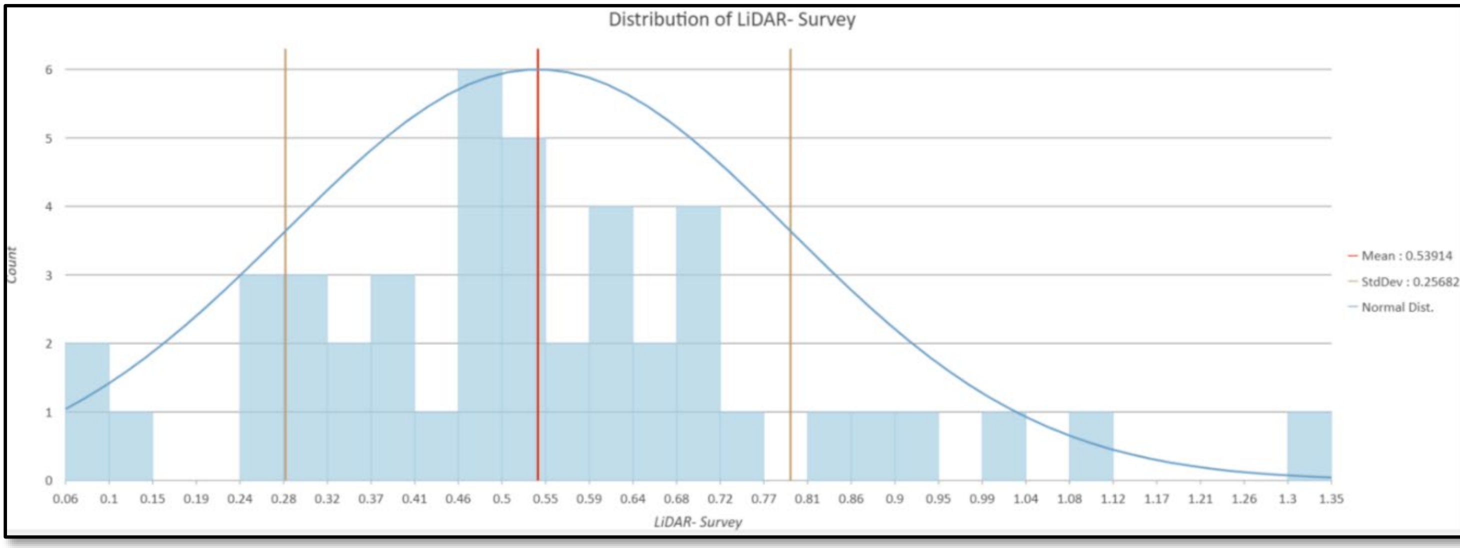


Figure 3. Distribution of the difference between the LiDAR and RTK Field Survey for 45 points collected on the trail.

Cultural Survey

The cultural resources study (Attachment 2) completed by Far Western Anthropological Research Group, Inc. (Far Western) included archival research, literature reviews, assessment of archaeological sensitivity of the Project area and a pedestrian survey of the Option 1 and 2 trail alignments in early October 2020. A few historically significant features were identified along the Project area's southern boundary, however no further consideration was recommended for these given they did not reach the caliber of important resource under CEQA or they lacked integrity to the period of significance. The subsurface geotechnical study showed a low potential for buried archaeological deposits within the Project area thereby eliminating the need for any additional pre-construction subsurface exploration. The pedestrian survey did not reveal any cultural resources along the Option 1 and 2 trail alignments, however given the low surface visibility and chance that resources could be obscured by heavy duff, grasses or other impediments, Far Western recommended that any ground disturbing activities in the slightly elevated areas on the fringes of the meadow be monitored by a qualified professional archaeologist. Far Western also recommended that a representative of the Washoe Tribe of Nevada and California be invited to observe the ground-disturbing activities associated with the trail rehabilitation project, and that the Tribal Historic Preservation Officer, Mr. Darrel Cruz, be kept informed of project planning and activities.

Biological Resources Report

A biological survey was conducted by Sierra Ecosystem Associates (SEA) in late August 2020 that included a desktop database review and field survey of the area. Observations were captured in a Biological Resources Report for the Project. Several biological features within the Project area were mapped and assessed including vegetation, listed species locations, critical habitat as designated by the US Fish and Wildlife Service and wetlands and hydrology. The Biological Resources Report describes the Project area as a seasonally wet meadow with uniform wetland graminoids mixed with clumps of small Lemmon's willow (*Salix lemmonii*) and lodgepole pines (*Pinus contorta*) along the edges and upland areas. South Fork Prosser Creek within the project area provides aquatic habitat for trout species including brown (*Salmo trutta*), rainbow (*Oncorhynchus mykiss*) and brook trout (*Salvelinus fontinalis*). The areas adjacent to the creek provide nesting and foraging habitat for several birds including willow flycatcher (*Empidonax traillii*), yellow warbler (*Setophaga petechia*) and several raptors. There is also evidence of prior American beaver (*Castor canadensis*) activity just downstream of the Project area. The Project area is adjacent to and roughly within 400 ft of designated critical habitat for the Sierra Nevada yellow-legged frog (*Rana sierrae)*.

A wetland Delineation in accordance with US Army Corps of Engineers was completed in the summer of 2021 (Attachment 4).

Plant Resource Survey

Julie Etra of Western Botanical Surveys, Inc. (WBS) conducted a plant resource survey to further inform vegetation conditions and provide recommendations on native materials for salvage and reuse as they relate to restoration and erosion control. Due to a late Project start, the plant survey was conducted on August 25, 2020, a suboptimum time for maximum identification of vegetation, but adequate for determining dominant plant species and community types. The community types, Wetland, Mesic Meadow/Wetland and Introduced/Transitional were identified and located via GPS (quantification of these community types was not conducted during this survey). Most notable was the almost monoculture of the obligate wetland species, *Carex utriculata* (beaked sedge) between North Euer Valley Road and South Fork Prosser Creek, a species that requires standing water for most of the growing season (Figure 4). Codominant species in the Wetland community at slightly higher elevations included *Juncus articus* (Baltic rush) and *Carex nebrascensis* (Nebraska sedge) (Figure 4).

WBS identified the following reusable resources and recommendations for incorporation into biotechnical treatments:

- *Carex nebrascensis* and *Juncus arcticus* are generally the preferred salvaged sod material due to root structure and cohesiveness. Sandy substrate/subsoil can make any salvageable sod more difficult to handle.
- *Carex utriculata* can be suitable but is not as cohesive or easy to handle as the other species and requires standing water.
- For all salvaged sod, soils should be moist but not saturated when the sod is harvested, and the material should not be stockpiled but replanted as soon as practicable.
- Less cohesive material can be harvested and re-used as topsoil with organic matter.
- The only willow species (*Salix lemmonnii*) was generally small in size, with little young, vigorous material useful as poles, fascines, or other biotechnical applications. Poles will need to be imported from off-site sources.
- All vegetation (willows and sod) in the footprint of construction, should be salvaged and replanted as clumps.
- Any major salvage and replanting efforts along the creek would require the use of heavy equipment which could be difficult given the current limited access.
- Large areas within the project footprint remain saturated until late in the season which may complicate implementation, particularly sequencing.
- All salvaged material will require initial irrigation following placement by pumping from the creek. Water rights and the feasibility of this type of diversion are being addressed by the TRWC.

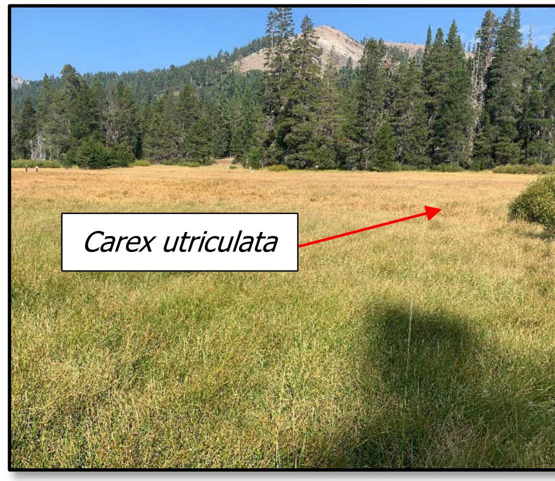


Figure 4. (Left) Monoculture of *Carex utriculata,* (Right). Transition from *Carex utriculata* to *C. nebrascensis* in the foreground.

Subsurface Geotechnical Investigation

A subsurface investigation was conducted by Mark Schroeder, PE of Bear Engineering, to evaluate the soil and geologic characteristics relevant to design and construction of the boardwalk and bridge abutments or piers. As part of the investigation available geologic and seismic reports and maps were researched, borings to depths of 20 to 25 ft were collected and soil classification per ASTM D 2487 and laboratory tests for in-situ moisture and density were conducted on soil samples in order to make geotechnical recommendations for the bridge and boardwalk supports.

The investigation concluded that the site is geotechnically suitable for the proposed improvements provided the recommendations in the report, including a helical anchor/pile foundation system as specified in Table 1 below are incorporated into the designs and adhered to during construction. The recommended Load Frame Test is planned for late spring or early summer 2023 prior to construction.

Table 1. Foundation Design Criteria

Shaft Size (Pipe) Square Stock NOT recommended **Pipe ASTM A500 Grade 80 steel tubing**	**Min. 3.5 in. OD**
Min Wall Thickness	**Min. 0.300 in.**
Helical Flight Diameter	**Single 16.0 in.**
Helical Pier Spacing	**Spacing determined by the Structural Engineer. However, no anchor shall be positioned within 6 feet center to center distance**
Depth	**The intent is to rest bearing flight on the gravel bed found between 12 and 16 feet. Load frame test recommended determining depth.**
Working Load	**25 Kips (TO BE VERIFIED IN THE FIELD) or as determined by structural engineer.** **Min. Torque gage pressure using a Kt value of 7**

- ***All grade beams must be cleaned of loose material and debris prior to placement of concrete.***
- ***The allowable bearing capacity is for dead plus live loads. The bearing capacity may be increased by 1/3 for wind and seismic***
- ***Torque coupling bolts between brackets, extension, and lead section with ASTMA193 Grade B7 or A325 high strength bolt, bolt firmly.***
- **Kt value of 7 shall be used with a safety factor of 2.0 for ultimate strength capacity of the torque loads**
- **All anchor capacity shall be determined in the field by the geotechnical engineer**
- **Each Helical Anchor shall come delivered to the site with a galvanized coating.**
- **The system recommend shall be used for pedestrian path in the areas of Borings 5 and 6.**

5. Geomorphic Setting

The following summary is largely taken from the Geomorphology Technical Memorandum, Attachment 1.

The Project site lies within the upper Euer Valley area which consists of an alluvial valley floor bounded by side valley alluvial fans and hillslopes to the north and south. The Coyote Trail is a single-track trail that trends north-south extending from the uplands on both sides of the valley and across the meadow that covers the Euer Valley floor. From the south the trail descends a moderately steep and hummocky slope before entering the floodplain at the south edge of the meadow. The trail crosses the east flowing South Fork Prosser Creek channel at the apex of a meander loop then crosses open meadow and an intermittent spring fed channel before leaving the meadow at the upland/forest edge at North Euer Valley Road.

The South Fork Prosser Creek (SFPC) channel forms a steep reach just upstream of the TDA property line and into the meadow about 200 ft downstream. Upon entering the valley floor meadow, the SFPC channel meanders through the Coyote Trail Crossing site and for about 600 ft before straightening and flowing along the upland hillslope south of the meadow and past a distinct oval shaped hillock. Past the hillock, SFPC makes a 400 ft long, broad curve before entering a highly meandering reach that flows along the south side hillslope that bounds the meadow floodplain and valley floor. In the last 3,700 ft, the meandering channel erosively impinges into an irregular 17 to 25 ft high bluff at several locations before entering a 120 ft wide constriction in the valley where the detailed study area ends.

Figure 5. (Left Image) Euer Valley meadow photo taken July 23, 2020.

The valley floor in the study area consists of a meadow floodplain. The meadow receives abundant hydrologic support from groundwater migration from the valley sides, although this appears to be primarily associated with the north side of the valley. **This level of inflow is so substantial that there are a number of seeps and small spring-fed ponds that persist well into the growing season (Figure 5). This groundwater inflow provides for a remarkably high level of vigor in the meadow vegetation.** Aerial photographs taken during the end of the snowmelt period show the "greening up" of the meadow while the immediate vicinity of the creek has not yet responded. This indicates that the primary hydrologic support of the meadow is lateral subsurface inflows, as opposed to overbank flooding from the creek. However, aerial photographs taken later in the growing season, July, and August, does show uniform green conditions, even along the stream itself indicating that the condition of the stream is not adversely affecting the vigor of the meadow (Figures 6 and 7). In fact, groundwater migration toward the creek may indicate that the stream is a gaining reach within the study area, i.e., the meadow may be supporting the stream as opposed to the stream supporting the meadow.

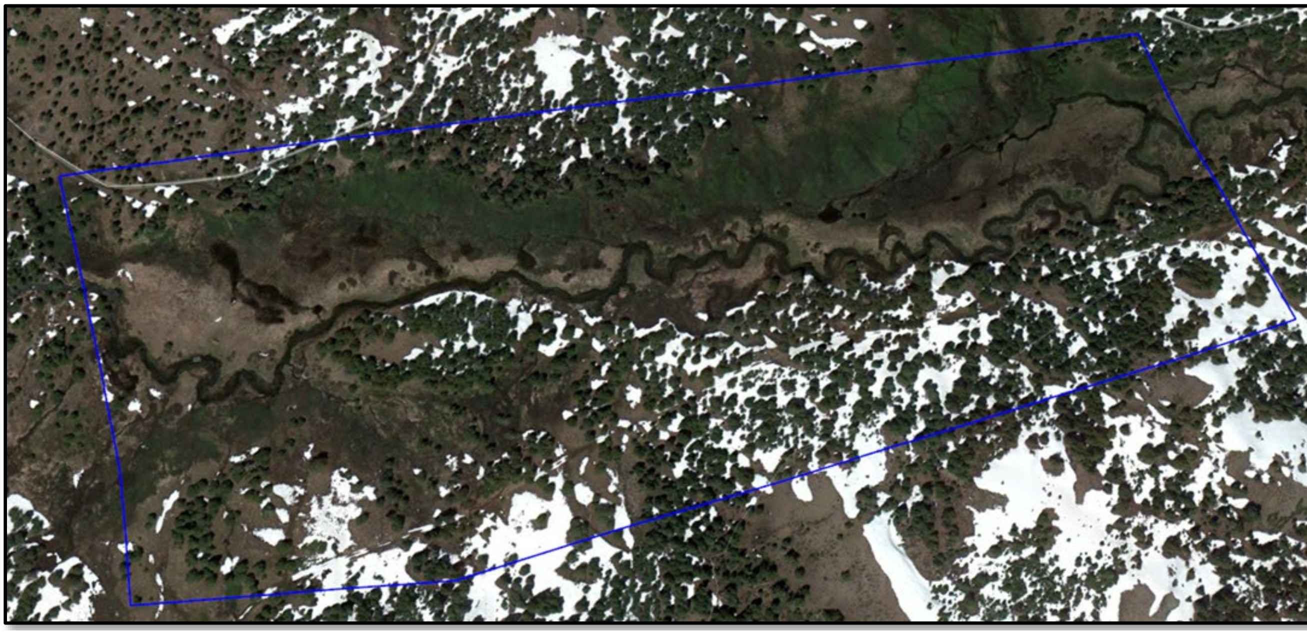


Figure 6: Euer Valley meadow June 2011 aerial image (Source: Google Earth). Note the surface water in the swales likely fed by springs while the immediate area along the creek does not appear to have any sustained saturation by an overbanking event.

Figure 7. Euer Valley meadow August 11, 2017, showing actively growing vegetation throughout the meadow.

The exposure of lacustrian clay within the channel bottom versus its deeper position in the valley center may indicate that the channel has been moved, perhaps in the 1800s. The lower depth of that material in the valley center would be expected to have been eroded out by the pre-settlement stream alignment. Additionally, there are a number of locations in the valley where the valley bottom is two or more feet lower than the channel edge as can be seen in Figure 8 where the modeled existing water surface under the varying recurrence intervals slopes northward toward the valley center Regardless of whether the stream has been moved to the south edge of the valley or not, the wet conditions in the valley bottom indicate that the existing overbank flow regime and stream water surface during the growing season is not a requisite condition in establishing or maintaining meadow vigor. In other words, the meadow is truly a different yet healthy meadow system hydrologically and floristically and preserving and protecting the springs rather than trying to increase overbanking of SFPC is key.

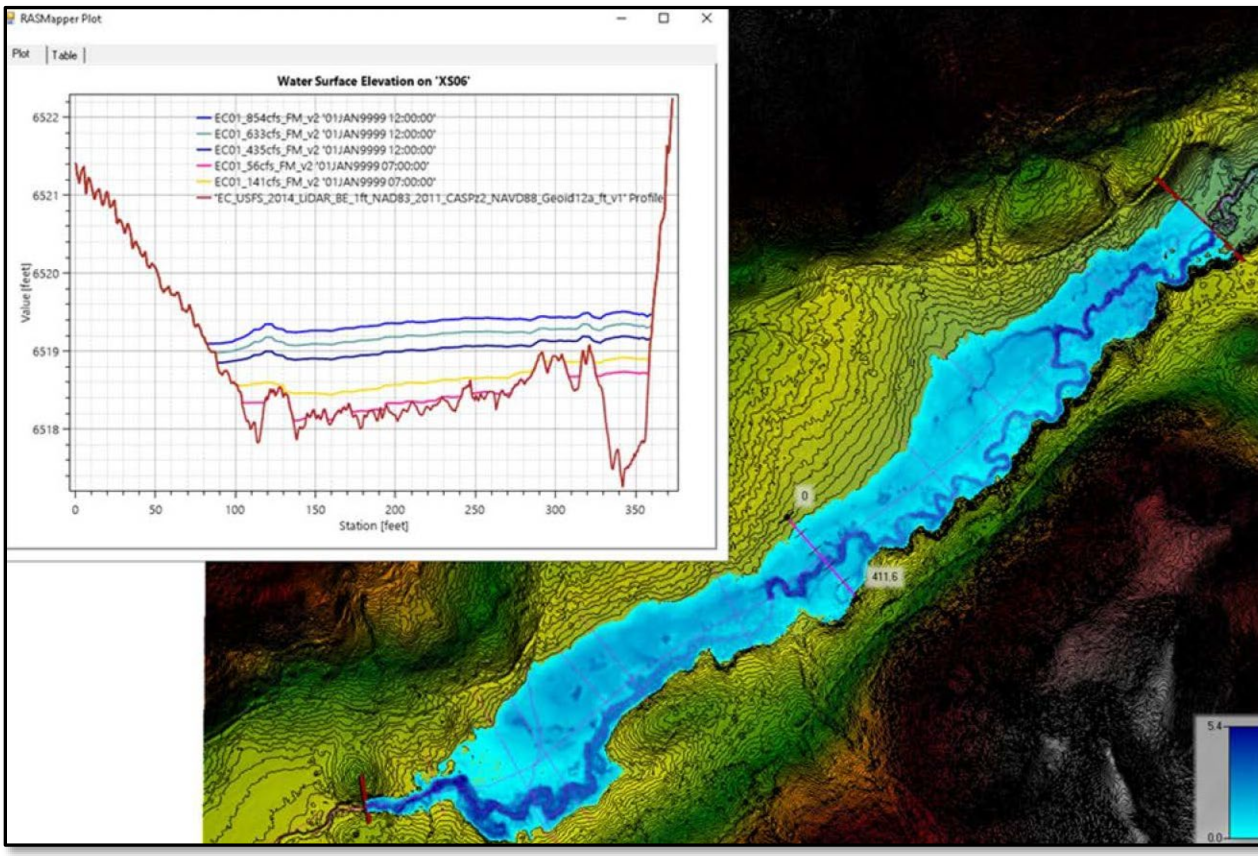


Figure 8. Existing Valley Cross-Section Showing Elevated Channel Alignment

Using 67 years of instantaneous peak flow data from nearby Sagehen Creek, and adjusting for drainage area, the estimated 2-year peak flow in the project reach is estimated to be 56 cubic ft/second (cfs). Based on the existing LiDAR data, and use of the HEC RAS 2D hydraulic model, the 2-year peak is largely contained within the streambanks. Overbank flooding at that flow does occur behind a relic beaver dam, but meadow flooding elsewhere is sparse. In contrast, a stream in proper functioning condition will result in incipient overbank flooding between the 1.5 to 2-year recurrence intervals which indicates that the stream is incised. Seven cross-valley sections generated from the hydraulic model showed that, on average, the water surface elevation for the 2-year event would have to rise approximately 0.6 ft to result in general incipient overflow. **Thus, while the stream is incised, the degree of incision is relatively minor.**

Eleven cross-sections were surveyed in the study reach to assess the bankfull width and depth. The mean depth was 1.7 ft. Hydraulic geometry relationships of Central Sierra streams yielded a bankfull depth estimate of 1.4 ft, whereas regional relationships presented by Rosgen (1996) for the Upper Salmon River basin, which is believed to be the most representative of conditions in Euer Valley, give a bankfull depth of 1.0 ft. While these relationships have a considerable degree of uncertainty, they also indicate some degree of incision.

The stability of the channel was assessed by comparing the centerline alignment from a 1953 aerial photograph compared to the 2018 aerial photograph from Google Earth. Such an analysis is approximate because of the differences in the altitude and angle in the two images. The estimated average reliability of actual centerline is +/- 10 ft. The channel has indeed migrated in the 66 years between the two images. Most of the migration might be characterized as minor to modest and most of it has occurred in the more sinuous lower portion of the study reach. At 22 locations where there had been movement, the distance required to shift the centerline of the meander to approximately overlay its original location was 23.8 ft. Where the channel did migrate, it did so through a downstream shift in the alignment, which is consistent with "normal" migration of alluvial channels.

The evidence for incision and migration might suggest a downward trend in channel condition. However, one of the principals of proper functioning alluvial channels is that, although the channel may migrate, it will maintain its bankfull geometry (Leopold 1994). There is no evidence of channel widening based on inspection of the 1953 and 2018 images. Furthermore, the same hydraulic geometry relationships used to evaluate bankfull depth were used to assess the current bankfull width and found that the mean channel width of 13.2 ft is bracketed by the Central Sierra regional relationship, 12 ft, and the Upper Salmon River basin relationship at 14 ft.

A streambank erodibility survey was conducted using the "Bank Erodibility Hazard Index" developed by Rosgen (1996). The study area was broken into five reaches. The computed streambank erodibility hazard was ranked as low to very low in the four upstream reaches, and moderate in the most downstream reach. There are individual locations where there are high eroding banks. These include seven locations where the stream is eroding into the bluff on the lower end of the south valley side. The primary reason for the low erodibility hazard is the common occurrence of what might be described as an "inset" narrow floodplain, typically 1 to 3 ft below the adjacent meadow surface. This surface appears to be largely associated with sod blocks eroded out of the meadow and dropping vertically into the active channel or bending downward from the meadow surface. Once the sod is lowered, the perennial flow in the channel gives rise to dense vigorous sod which cannot be readily eroded, and as the width of the inset floodplain increases, the erosive stress on the inset floodplain/meadow interface progressively decreases.

Overall, there are markers (greater than normal depth, and migration) that the channel may have been relocated which would suggest that it is still actively seeking a new dynamic equilibrium. However, the low bank erodibility and maintenance of bankfull width over the last 66 years, and bankfull dimensions consistent with regional hydraulic geometry relationships points to a stable channel. Given its current stability and low erodibility there is no rationale for extensive stream restoration. This is especially valid in this case since raising the stream profile would not yield any benefits to a meadow that already is very wet.

Instream there appears to be plenty of cover, instream clay blocks, undercut low banks and densely vegetated banks along most areas of the Project reach. However, adding in some beaver dam analogs or similar may be desirable to increase in-stream habitat and resilience in the channel profile. Certainly, the relic beaver dam had a significant influence on the upstream gradient and taking measures to ensure that the loss of that channel dam/grade control feature would not initiate a headcut response is justified. There may also be a rationale to improve aquatic habitat through point application of biotechnical measures, although care should be taken to avoid those in the vicinity of the bridge crossing. Additionally, biotechnical bank stabilization measures composed of willow and meadow sod on eroding banks using small equipment and hand crews may be further considered, with the preference for creating a narrow inset floodplain at the base of existing eroding slopes and taking similar measures where the bank erodibility is low to offset the loss of channel length elsewhere.

It should be noted that the maximum snow depth at the Independence Creek SNOTEL station, which is approximately eight miles away and 100 ft lower than the project site is 9.3 ft. This depth was recorded at the peak of snowpack accumulation, as opposed to much earlier, December-early February, when large rain-on-snow floods occur, and the snowpack depth is typically much less. Several of the recent flood events, including 2017, 2006, 1997 and 1986 likely occurred when there was still two to three ft of snow on the ground in the project area. This would result in channel banks being extended another 2 to 3 vertical ft with the snowpack increasing flow depth and hydraulic forces on the channel bed and banks. In other words, the flow shear stress on the channel would have been increased due to the flow depth and gradient being increased by the artificially steepened and confining snowbanks. The potential for further bed scour may be minimized to some degree by an erosion resistant dense clay layer that runs through the channel at shallow depths and observed in the field in several locations where it is exposed on channel bed and banks. This aspect is critical to bridge and boardwalk designs, given they need to be set high enough above the meadow and creek to facilitate free flow of large floods underneath that include the snowpack assumptions, or they need to be designed and built to withstand the direct forces of the anticipated flood flows. In order to achieve a balance of allowing some proportion of flows to pass under while keeping boardwalks and bridge height to elevations that are aesthetically acceptable and do not require railings (30-inch vertical height or less for boardwalks) or an exorbitant amount of fill to ramp up to the bridge crossing, the designs will likely need to withstand overtopping and direct flow forces and logs and debris will also need to be considered.

In setting up the hydraulic model it was discovered the hydraulic control for the bridge site(s) is well over 1,500 ft downstream. According to the geomorphologist, the maximum flow velocity under a 100-year event is around 4.3 ft per second (fps) in the channel just upstream of the culverts and water surface height is roughly one foot above existing ground immediately north and south of the channel. In addition, the geomorphologist reported that the tortuous meander bend in the vicinity of the existing crossing that appears to be eroding westward towards the trail on the south end has been in the same location as far back as 1993 and has moved roughly 10 ft over the past twenty-five years or more.

In order to increase flow conveyance area and mitigate the potential for erosion on the right bank bar under high flow events if the Option 1 bridge location described in Section 9 is carried forward, it is advised that the inside bar/bench be lowered slightly from the south side and coupled with measures to protect the abutments/piers given they will have greater exposure within the water column.

6. Recreational Use and Needs

The Project is located entirely on lands owned by TDA and primarily used for recreation including biking, hiking, and equestrian use in the summer (Figures 9 - 11), and cross-country skiing and snowshoeing in the winter. With 25,000 TDA members, and trails and open space available to the public, the area experiences frequent use year-round.

Figure 9. Trail approach looking towards SF Prosser Creek from North Euer Valley Road

Figure 10. North side of Coyote Crossing Trail showing clear signs of braiding at locations of spring fed swales, August 2017 (Google Earth)

The existing creek crossing (Coyote Crossing) consists of 3 CMP culverts covered by an anchored wooden walkway and a constructed access ramp which allows summer and winter recreationists and groomers to cross (Figure 12). As a result of the spring fed swales, the north trail approach to the culverted crossing remains saturated with persistent standing water often into July making access difficult and detrimental to the wetland surface.

Due to the persistent standing water well into peak recreation months, multiple volunteer trails are formed (Figure 10). This is especially apparent where it crosses the spring fed swales as recreationists avoid getting their ft wet. This behavior likely exacerbates erosion in the saturated meadow area, compacts soil, and stunts vegetation growth within the vicinity of the existing trail alignment. TDA has indicated disturbance by equestrians is especially concerning and would like to discourage equestrians from fording the river at locations other than a developed crossing. Coyote Crossing is a key part of TDA's existing trail system because it is the only crossing on the South Fork Prosser Creek until the access road, Alder Creek Road over 2 miles to the East. There is a warming hut, i.e., Coyote Hut, just northwest of Coyote Crossing that is primarily used by cross-country skiers in the winter season.

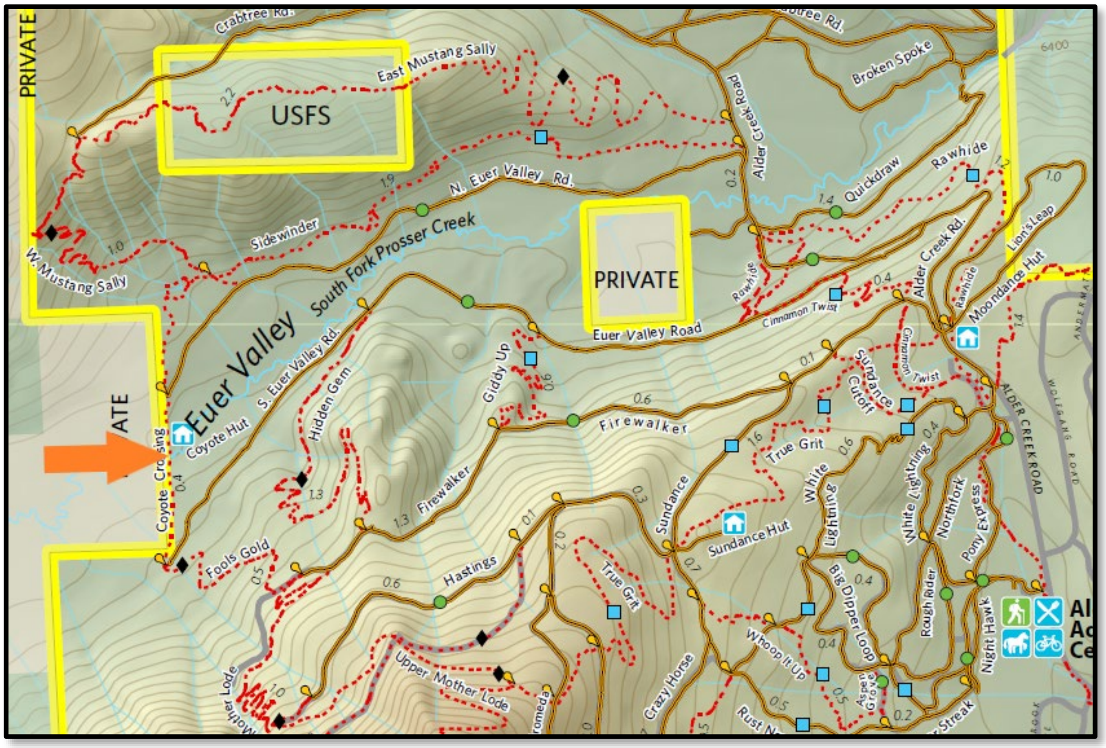


Figure 11.TDA Summer Trail Map 2019. Orange arrow points to Coyote Crossing.

Figure 12. View of existing culverted crossing (Coyote Crossing). (Source: TDA Drone Footage)

Recreation improvement goals for the Project are as follows:

- Provide accessible trail over wetted meadow earlier in the year that will minimize impacts to the meadow and wetland areas.
- Provide year-round access across the creek that will not impact the creek and is usable by recreationists and grooming equipment.
- If possible, provide equestrian access to the creek for watering the horses without damaging creek channel bed or banks.
- Maintain close proximity to the existing trail alignment and grooming pattern for continuity and wider use/enjoyment of the valley.

7. Land Ownership

TDA purchased 482 acres of the Euer Valley in 2011, although the land was previously leased for recreation access. While TDA currently owns most of the surrounding area there is a patchwork of public and private land in the Project area. Immediately adjacent, to the West of the project area, is private land (APN 016-060-009-000) that is accessed via North Euer Valley Road. It will be important throughout Project activities and construction to maintain access to this road for the private landowners. Other adjacent landowners include the USDA Forest Service, Tahoe National Forest, Sierra Pacific Industries, the Euer family, the Donner Euer Valley Corporation, and the Truckee Donner Land Trust.

8. Hydrology and Hydraulic Analysis

The following summarizes the hydrology and hydraulic data used to develop 30% and 65% bridge, boardwalk, and creek restoration designs. See Attachment 1 for the technical report that this information is summarized from.

Design Flows

The design flow results in Table 2 were determined by NHC via StreamStats (USGS 2016).

Table 2. Recurrence Interval Flows for South Fork Prosser Creek (NHC 2020)

RI (years)	Peak flow (cfs)
2	145
5	292
10	435
20	633
50	854
100	1,060

Existing Conditions 2-D Hydraulic Model Results

Critical to bridge and boardwalk foundation supports and height requirements are the output from the HEC-RAS 2D hydraulic model. NHC provided the model to the design team who were able to use the model to pull the output needed for design development of these elements as well as the creek treatment measures. Table 3 summarizes the approximate average water surface elevations and velocities from the model output used starting at 30% design development. Of most interest is the 100-year recurrence event, as the design of the bridge and boardwalk is intended to withstand a flood event of similar caliber. The water surface heights assumed for design were rounded up to 6526 ft for Option 1 bridge crossing and 6525 ft for Option 2 bridge crossing.

Per County of Nevada Road Standards (Nevada County, California, Land Use and Development Code) two ft of freeboard under a 100-year flow event is required for bridge crossings. For 30% design we have met this requirement. However, it appears the intent of the County requirement is to minimize interaction with the hydraulic forces rather than design for them. Therefore, there may be an opportunity to reduce this height requirement to some degree for aesthetic or constructability reasons, for example if there is an interest in lowering the height of the bridge to reduce the amount of fill required to ramp up to the bridge deck. Specific site conditions and structural remedies to bring to the County consultation include:

1. Avoiding restricting the flow. In our case the valley is nearly a pond at a 100-year flow event with low velocity and an expansive wetland area for the water flow to spread out.
2. Given the flow is not expected to remain in the active flow channel during such an event, the bridge will be designed to be structurally sound when the abutments will be surrounded by water.
3. The bridge is also being designed to withstand debris flows.

Table 3. HEC RAS 2D Model Output used in Design Development

2 Year Recurrence Event					10 Year Recurrence Event			
	WSE	Velocity	Shear			WSE	Velocity	Shear
	ft.	fps	psf			ft.	fps	psf
Option 1 LB	6524.2	0.9			Option 1 LB	6525.2	1.5	
Option 1 RB	6524.2	1.4			Option 1 RB	6525.2	2.5	
Option 1 Center	6524.2	1.2			Option 1 Center	6525.2	2.3	
Option 2 LB	6523.55	1.8			Option 2 LB	6524	2	
Option 2 RB	6523.55	1.2			Option 2 RB	6524	2	
Option 2 Center	6523.55	2			Option 2 Center	6524	2	
25 Year Recurrence Event					100 Year Recurrence Event			
	WSE	Velocity	Shear			WSE	Velocity	Shear
	ft.	fps	psf			ft.	fps	psf
Option 1 LB	6525.44	2.1			Option 1 LB	6525.75	2.4	
Option 1 RB	6525.44	2.9			Option 1 RB	6525.75	3.5	
Option 1 Center	6525.44	2.6			Option 1 Center	6525.75	3.1	
Option 2 LB	6524.3	2.1			Option 2 LB	6524.73	2.25	
Option 2 RB	6524.3	2.2			Option 2 RB	6524.68	2.3	
Option 2 Center	6524.3	2.1			Option 2 Center	6524.71	2.35	

9. 30%, 65% and 90% Design Development

This section describes the process by which decisions were made for each of the three design components at the 30% conceptual stage and how the designs were carried forward through 90%. The three design components were as follows: 1) location of the trail alignment and creek crossing, and considerations related to identifying potential locations; 2) structural design components for the boardwalk and bridge for each of the alignment options; and 3) creek restoration elements. This section also reviews general construction details including access and staging locations, and factors to consider for construction timing, dewatering and dust abatement.

Trail Alignments Considered

Three trail alignment options were presented to the client and stakeholders at 30% for review, consideration, and discussion in early September 2020 (Attachment 4). The Option 1 trail and bridge alignment closely followed the existing trail alignment through the valley. Option 2 avoided as much of the wetted spring fed swale as possible and crossed a straighter reach of the creek while still staying at the western end of the valley. Option 3 was the shortest path along the wet meadow before crossing the creek but located much further east within the Project area.

Option 1 and Option 2 Comparison at 30%

The following highlights design opportunities and constraints associated with the Option 1 and Option 2 trail and bridge alignments to support further discussion during 30% design review and ultimately selection of a single trail and bridge alignment to move forward into 65% designs. A matrix that includes additional considerations is provided as Attachment 7.

Opportunities

- Option 1 trail and bridge alignment more closely follow the existing trail alignment through the valley meadow so remain a likely preferential trail alignment for users.
- Option 2 bridge crossing is located at a straighter, more stable channel reach and requires a shorter bridge span.

Constraints

- Option 1 bridge location requires a longer span and center bents (i.e., is not free spanning).
- Option 1 bridge is located on the edge of a landslide/alluvial fan surface and crosses at a tortuous meander bend. This brings increased risk of bridge undermining under a significant flood event such as 1997 where the river could potentially cut off the meander and cut a more direct channel in the vicinity of the south bridge abutment.
- Option 2 bridge and trail alignment requires a second boardwalk crossing at an existing drainage swale on the south side.

As a result of stakeholder input, trail alignment Option 3 was discarded in large part due to it eliminating a substantial portion of the meadow for access and enjoyment and Options 1 and 2 were carried forward to 30% designs. Following 30% design review and moving into 65% design development the team was directed by TDA to move forward with the Option 1 bridge and trail location and measures were incorporated into the designs to mitigate the potential risk of a cut-off meander impacting the south bridge abutment and bent.

The design team proposed two boardwalk pullout locations along the boardwalk north of the bridge. These serve two functions: to allow for a scenic resting area without degrading the meadow and to allow faster users to pass without exiting the boardwalk. The northern pullout is about 200 feet south of the north edge of the meadow and the southern pullout is about 200 feet south of that. There is approximately 150 feet remaining south of the southern pullout. This spacing allows for a multitude of passing opportunities, which is important given the variety of user types expected along the boardwalk. Linchpin developed the design for the pullouts to allow for structural stability while adding on to the boardwalk.

Further Considerations

One consideration introduced during the conceptual design stage by the geomorphologist would be to have two bridge crossings, one designated solely for recreational users at the Option 2 location with boardwalk approaches and a much narrower, elevated span and the other strictly for the groomers to cross that could be a lower profile steel deck design that could withstand being overtopped by creek flow in larger events. It was decided that a single bridge crossing would be carried forward to 65% that had two separate north bridge approaches; 1) a boardwalk segment to the bridge deck for recreational users and 2) a wingwall confined earthen/rock ramp for the groomer equipment to use in the wintertime.

Equestrian Users

One unique challenge to this site is finding a way to allow equestrians to access and potentially cross the creek without causing damage to the creek bed and banks.

Options presented at 30% design included 1) a controlled access point to the river that is clearly designated and stabilized with pavers or similar or 2) a "dipping" bucket system at the riverbank and trough located away from the riverbank to allow horse watering outside of the creek. The TDA provided input following discussions with their equestrian users and as a result the 65% designs included an offramp from the north boardwalk bridge approach that led to a creek access in the location of the current degraded access. In order to stabilize this area and prevent further erosion a 5-ft wide concrete paver surface enclosed by revegetated banks at 2:1 side slope was proposed.

Following further input from TDA during 65% review, the team moved forward with a full horse crossing on the west side of the bridge. The horse trail will continue straight off of the boardwalk about 40 feet north of the bridge crossing. At this point, the boardwalk will turn off to the east and begin ascending to meet the bridge elevation. This section of boardwalk will be up to 18" above existing ground at the split, and it will ascend at 10% up to the elevation of the bridge deck. The ascending ramp to the bridge will require hand rails until it reaches the bridge deck. The horse trail will be stepped down from as high as 18" to existing ground using a modified crib ladder. The steps here are required to be at least 5 feet long to keep the descent comfortable for equestrians. The trail will be natural meadow surface until it meets the north bank and then the entire length after it ascends out of the new lowered floodplain. Across the channel and in the floodplain the trail will be rocked in order to ensure there is no wash out. The trail will continue ascending up the south floodplain area and then swing east at the south end of the bridge to meet back up with the proposed trail.

Two options were considered for the left bank trail: one where there is cut and one with fill into the channel. Increasing the amount of fill within the channel is determined not to be a viable option given the likelihood of increased erosivity during high flow events, so the decision was made to move forward with the cut option. Cut will be minor, but care will need to be taken to make sure the trail rock is properly keyed in since it is likely that water will route down this trail from the meadow surface. The trail will consist of 3 crib ladder steps, each dropping 6 inches and being 5 feet long. This will get the trail down to the existing ground, at which point the trail will be keyed in rock to prevent erosion. Trail slopes are kept to less than 12%, which is much more manageable for equestrians than the >20% slope on the existing bank. The two options can be seen below in Figure 13.

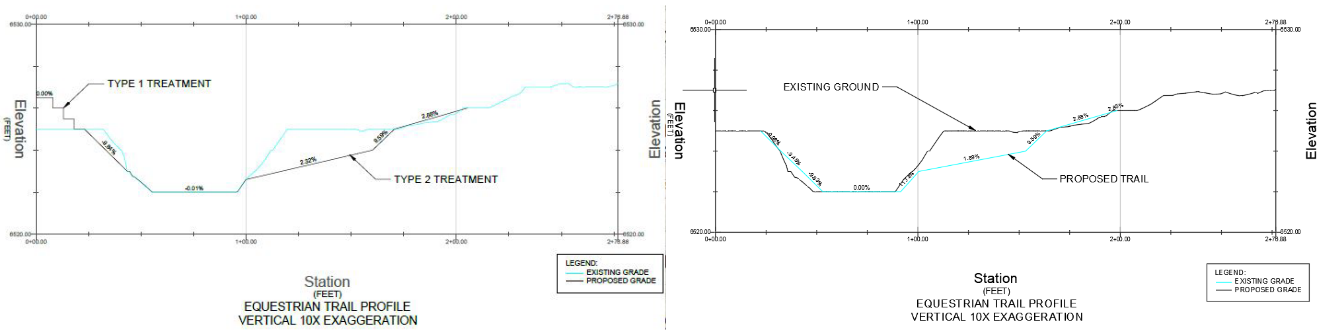


Figure 13. Cut Profile on the left & Fill Profile on the Right to Accommodate Equestrian Creek Crossing

Structural Designs

The following summarizes the structural design considerations and options for the boardwalk trail and bridge installations largely provided by Linchpin Structural Engineering, Inc., including options presented at the 30%, 65% and current 90% design phase.

Boardwalk

The boardwalk designs remain generally the same for either of the trail alignment options considered.

- Foundation: Foundations will consist of helical piers to support boardwalk framing, similar to bridge foundation however with smaller 12-inch diameter helical bearing plates for cost savings. The smaller size should also minimize any potential encounters with subsurface boulders.

- Framing: Wood-framed vs. steel-framed or combination of both sees little cost difference based on previous boardwalk designs. Alaskan Yellow Cedar is recommended for wood stringers, as it is naturally resistant to decay. Weathering steel is the recommended material for steel framing as its surface will patina to provide a protective coating, resulting in minimal maintenance. The increased strength of steel allows for shallower beams resulting in a lower boardwalk elevation profile. We assume pressure treated Douglas fir is not permitted in this sensitive environment due to its chemical make-up, but we note that it would provide a significantly less-expensive wood option. Weathering steel framing is shown on the 90% design drawings.

- Decking: Wood can be Douglas fir, as used elsewhere at Tahoe Donner, or cedar or redwood, which is naturally decay resistant. Pressure treated wood is assumed to not be permittable due to the environmental sensitivity in the wetland. Modest improvements in the durability of Douglas fir could include pre-staining the wood. Untreated Douglas fir is expected to require (relatively easy) replacement more often than naturally durable wood. The 90% design drawings specify Douglas fir for the decking material.

- Approach: The boardwalk approaches to the bridge crossings were separated from the winter groomed trail in order to keep grooming equipment off the boardwalk. A very robust boardwalk section that could withstand the weight of the groomer could be designed, however concerns remain that the lateral force caused by the groomer driving on and off could be quite large. In order to allow room for the grooming equipment to access the bridge crossing the boardwalk trail swings out and runs adjacent to the groomer access ramp, coming in from the side to meet the bridge decking.

- Elevation: The boardwalk elevation should be kept to 30 inches or less above grade in order to eliminate the need for guardrails which would increase the cost of construction and be less visually appealing. Note that a short section of the boardwalk will require railing where it ascends to meet the bridge.

Bridge

Independent of the trail alignment options presented at the 30% phase, design of the bridge will be relatively similar, with the spans varying in lengths to keep the foundations out of the active channel. Two options are available for the design and construction of the bridge, including locally designed and fabricated or pre-manufactured.

Manufacturers of bridges offer design, fabrication, and installation services. In either case, portions of the bridge would be fabricated off-site and then assembled on-site. Either method of delivery provides similar structure types as discussed below. It may be beneficial to secure a contractor in this early phase to help determine the most cost-effective design.

- Bridge Superstructure: Three bridge cross-section options were initially presented at the 30% design phase, as discussed below. The five-girder design was selected to move forward with into the 65% and 90% design stage. Steel is the only logical option for the bridge structure. Weathering steel is recommended for the bridge framing as it is preferred by the forest service for lack of maintenance. Although it is a bit more costly upfront, it is cheaper in the long run.

    - The two-girder assembly provides a lower overall deck height by placing the deck on secondary members that span between the two main girders. A concern with this option is the groomer navigating between the two girders, which may be quite tall. The potential arises for the groomer blade to accidentally come in contact with the girder, possibly causing damage to the structure.

    - The five-girder option places the bridge deck on top of the main girders. This option is ideal, as it provides an un-obstructed platform (with the guardrails removed seasonally) for the groomer to maintain the winter cross-country ski trail. The five-girder design is beneficial as the bridge loads are distributed along the width of the bridge at the supports, more evenly distributing the loads to the soil.

    - The truss option has similar design aspects as the two-girder option, including placement of the deck between the main structural members. Typically, the design of a truss bridge is more efficient in terms of weight as the taller truss assemblies provide more strength with less material. Although the truss bridge may be more aesthetically appealing, there is concern of the groomer navigating between the truss members as discussed in the two-girder option.

- Span length: A 150-ft single clear span bridge was considered but ruled out due to the resulting forces at the bridge supports that would have to transfer to the soil. The helical piles (discussed below) would not have the capacity for these loads. A clear span would require exceptionally large concrete footings which are not desirable in the wetland. Adding a single interior support does not resolve this, as the interior support would see the same high load as the ends of a single span. Therefore, we recommend a minimum of 3, 50-ft spans (4 supports) to transmit bridge loads into the soil. In addition to the span length reductions to minimize loads at the supports, the shorter spans reduce the bending stresses in the bridge superstructure members. The 3 span option reduces the required girder or truss depth, which is aimed to be kept minimal to reduce excessive trail approach grading and consideration of freeboard requirements.

- Foundations: Helical piles will support the bridge girders at abutments and intermediate bents as described in the geotechnical study. The geotechnical study recommends load frame testing of the helical pile at the site which may show additional capacity of the helical piles, reducing the number of helical piles required. The number and layout of the helical piers currently shown on the design drawings is based on dimensional constraints of the geotechnical report and bridge dimensions. The required design loads for this layout are provided on the design drawings and a load frame test will be required to verify this design. Alternatively, a contractor could provide design-build services for the helical piles, design loads are included for this option on the specifications sheet.

- Decking: Options include wood, steel, or aluminum. Wood can be Douglas fir, cedar, or redwood as discussed in the boardwalk section. Steel or aluminum decking may be ideal for winter operations; however, these materials are not recommended for summertime use. For example, steel can be quite slick and unsafe for bicyclist or pedestrians during wet conditions. Another option may be a hybrid deck with a wood path down the centerline and steel decking at the track path of the groomers, although this may add complexity and construction cost. The hybrid option may be ideal if equestrian users are expected to use the bridge where an overlay of longitudinal wood is preferred by horses. Guard post may slot in either side of this reduced width walkway. The 90% design drawings specify Douglas fir for the decking material, installed the full width of the bridge.

- Railing: The bridge will require railing during summertime use and may be removable for winter operations. We understand the county has approved previous projects with removable railing for maintenance due to snow. Removable railings are ideal as lateral forces may be imparted to the railings from the groomer pushing snow across the bridge, which may be greater than forces typically used to design a pedestrian bridge railing. The current design drawings show Douglas fir railings consisting of 6x6 posts and a 3x8 top rail with steel cable railing below. Other options include steel posts, and top rails. Other options for the lower horizontal rails include Douglas fir or steel mesh. Railing for the truss design can be wood or steel integrated into the truss members, likely options would be steel slats or stainless steel cables. Additional items added to the 65% and shown on the 90% design plans, as requested by Tahoe Donner Association, include snow retention curbs along the length of the bridge and railing at the north end of the bridge to direct summertime users towards the boardwalk.
- Approach: The snow groomer will require access to the bridge from grade in the winter months. Three viable ramp construction options were proposed by the structural engineers and included large cobble-fill, earth-fill, or rib-reinforced steel plate. Both large cobble and earth-fill ramps are ideal for providing double curvature to the ramp to ease the transition to the bridge. A ramp built of large cobble-fill may be preferred as it may help deter and prevent summertime motor vehicles from crossing the bridge, while still providing a surface for wintertime snow accumulation. The rib-reinforced steel plate includes a hinged connection at the abutment and sloping to grade. This option may be least desirable as the steel plate would need to be quite thick and require additional fabrication to weld the rib-reinforcement. Building a ramp to the bridge completely of snow was discussed, however, this would likely not be achievable in early or late winter and/or low snow years. The 65% and 90% plans show a ramp built up with earth fill contained within concrete wing walls. In order to reduce fill requirements this slope could potentially be steepened and the ramp shortened in consultation with the TDA groomer operators.

Creek Design Elements

During field reconnaissance efforts, the restoration team consisting of the geomorphologist, restoration ecologist and restoration engineer all agreed that the meadow area was already of high quality due to the spring fed water source and did not justify significant alterations to the creek channel in order to increase overbanking frequency and duration or raise groundwater surface levels to further "wet" the meadow. This is also emphasized in the Geomorphology section above. As a result, the objectives of the project changed and the proposed channel treatments address localized bank erosion, provide aquatic habitat, and maintain vertical channel stability where a potential headcut could re-activate at the relic beaver dam location rather than raising water surface levels. Based on the geomorphic data however, the relic beaver dam appears to have significantly held the channel grade and contributed to aggradation upstream (Figure 15). In order to mitigate any potential future incision from migrating upstream of this location given the beaver dam is no longer active, we recommend a series of boulder cascade weirs to hold channel grade while stepping down from the higher elevation reach above the location of the former beaver dam to the reach below.

Figure 14. Prosser Creek downstream of Coyote Crossing.

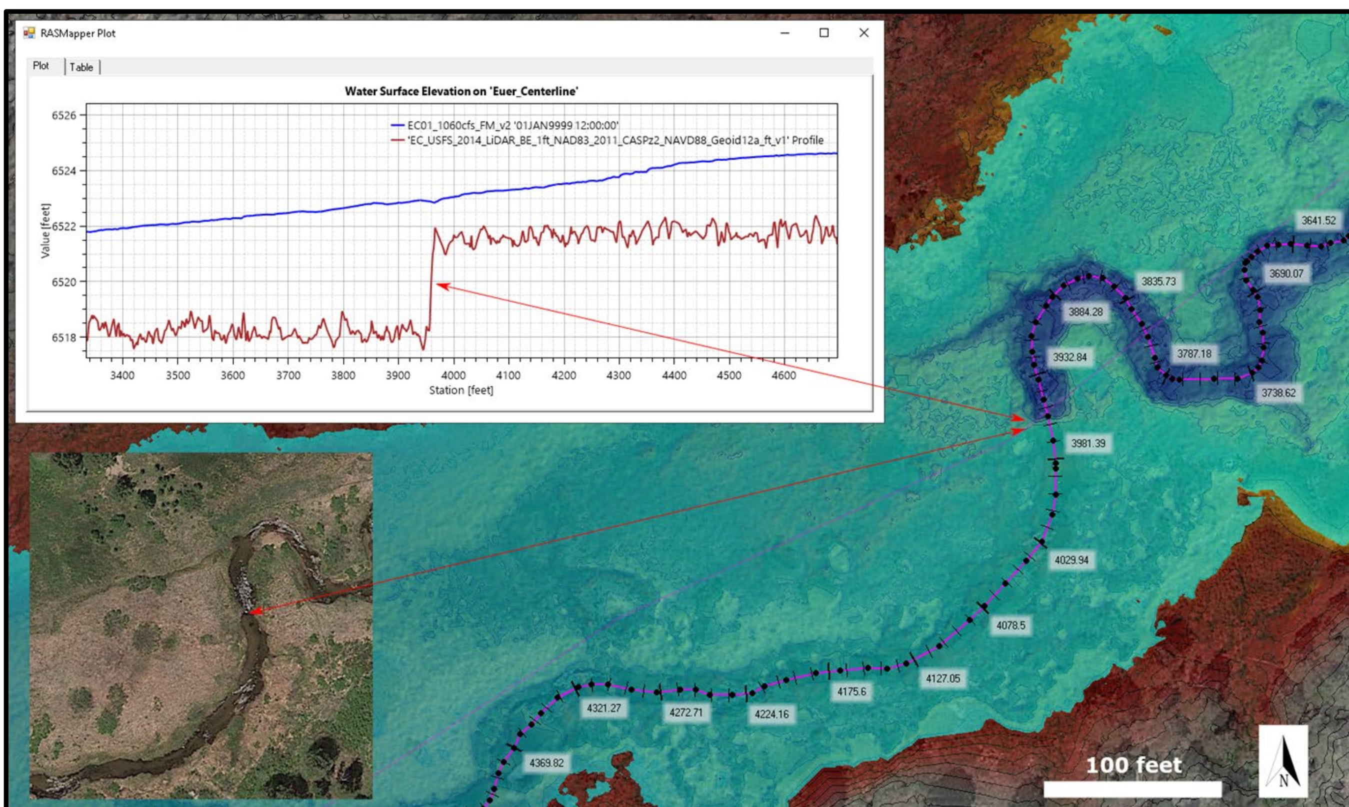


Figure 15. Location where relic beaver dam held grade and resulted in 4 feet of drop (Source NHC 2020)

Intermittent bank treatment measures and in-channel structures to increase in-channel habitat complexity and/or prevent further channel bed incision or aggravated bank erosion were discussed during conceptual design development as possible restoration elements that should be considered. Instream there appears to be plenty of cover, instream clay blocks, undercut low banks and densely vegetated banks along most areas of the Project reach, however adding in some beaver dam analogs (BDAs) or similar may be desirable to increase in-stream habitat. This option was further examined during 65% design development and the following explains why BDAs were not pursued.

Design Elements Considered and Rejected

From a system-wide perspective, there is no compelling case to be made for either channel abandonment and construction of a new channel or implementation of measures which can aggrade the existing channel, such as beaver dam analogues. An examination of channel changes based on analysis of 1953 and 2018 aerial photographs, a span of 66 years, shows no evidence of negative channel trends, such as changes in channel pattern or width. Additionally, comparison of regional relationships of channel widths and depths indicates that while the channel is slightly incised compared to the mean value for basins of similar size, its width is comparable, and, as stated there has been no observable increase over the span of 66 years. By all accounts, the condition of the meadow itself is excellent, primarily because of migration of subsurface lateral flows from the uplands on the north side of the valley. As such there is no impetus to aggrade the channel to raise the groundwater elevations within the meadow or to increase the frequency and duration of overbank flows, which indeed, is typically a principal objective of channel restoration. The fact that the channel has a slightly lower width/depth ratio than might otherwise be expected is a reflection of the stable banks brought about by the wet conditions in the meadow. Further evidence of the bank stability can be seen in the development and persistence of narrow inset floodplains common throughout the project reach initiated as sod-block failures. Secondarily, the available willows in the area are small in size and extent and therefore not conducive to the large volume of willow salvage material needed for BDA construction.

Design Elements Carried Forward

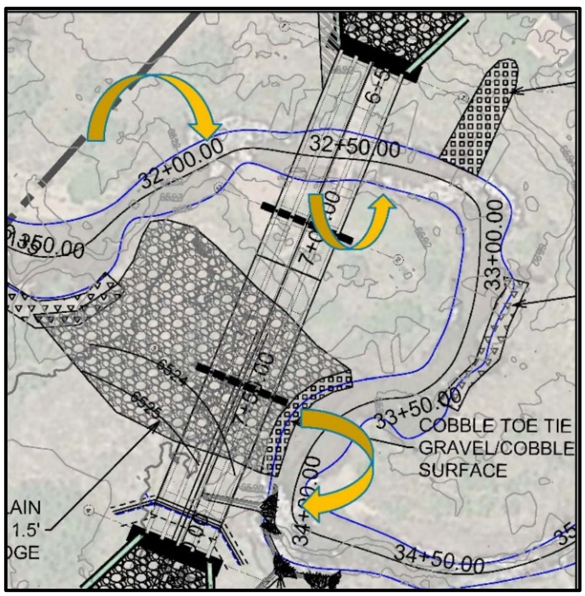
Following discussion and review of the geomorphology results, biotechnical bank treatments composed of meadow sod and staked with wood or willows were proposed in the 30% plans where the hydraulic model velocities are higher and erosion more likely. During 65% design development, these areas were further assessed in the field and updated based on the localized occurrence and potential for continued bank degradation. Factors for biotechnical designs included design flow water surface elevations, velocities and shears highlighted in the section below, conveyance requirements and scour potential particularly in the vicinity of the new bridge crossing and the relic beaver dam. A boulder weir riffle with buried rock sill was incorporated to maintain the channel grade and eliminate and prevent a significant headcut at the relic beaver dam from propagating upstream. A backwater weir was added downstream of the boulder weir riffle to further dissipate the energy through this reach.

- Biotechnical bank and floodplain protection measures were further developed and incorporated in the vicinity of the bridge crossing to protect the bridge support structures and maintain the meander. These included rootwad toe protection on an existing eroding right (south) bank to prevent continued accelerated erosion that could ultimately undermine the southwest abutment and intermediate bent and also provide pool habitat. Lowering of the robust right bank bar by a foot and armoring it with a combination of keyed in cobbles and native sod with gravel will allow it to still function as a floodplain surface but also reduce the erosional energy through this location that could predispose it for a meander cut off in a large flood event A combination of ripping, seeding and installing coir logs with willow poles on the existing left bank creek access were further developed and incorporated to stabilize and revegetate this disturbed area. Some areas previously identified for biotechnical treatments downstream of the bridge crossing were eliminated based on a current stable or self-restoring condition observed during follow up field visits and some areas have willow pole plantings prescribed to aid in increasing bank vegetation cover and shading. A few log habitat structures are proposed in specific areas with a small amount of bank erosion to provide bank stabilization while creating local scoured pool habitat

Existing Conditions Hydraulic Model Results Used in Designs

As introduced earlier, the existing conditions model results from the NHC 2-D hydraulic model were used to inform the recreational and creek treatment elements in addition to the bridge requirements. The following highlights some of the key existing condition results and design responses to the 2-, 10- and 100-yr recurrence events at the location of the proposed bridge and the relic beaver dam that is currently holding channel grade.

Bridge Crossing



2-year event

STA	WSE	LEFT FP VELOCITY	RIGHT FP VELOCITY	CHANNEL VELOCITY	LEFT FP SHEAR	RIGHT FP SHEAR	CHANNEL SHEAR
32+20	6524.2	0.6-1.1	1.6-2.0	1.1-1.6	0.02-0.03	0.07-0.09	0.04-0.07
32+73	6524.2	0.2-0.8	0.85-1.4	0.8-0.85	0.00-0.02	0.03-0.06	0.03-0.04
34+01	6524.16	0.01-0.3	0.04-0.06	0.04-0.06	0.00	0.00	0.00

10-year event

STA	WSE	LEFT FP VELOCITY	RIGHT FP VELOCITY	CHANNEL VELOCITY	LEFT FP SHEAR	RIGHT FP SHEAR	CHANNEL SHEAR
32+20	6525.2	1.1-2.0	2.7-3.2	2.1-2.7	0.05-0.15	0.18-0.22	0.1-0.2
32+73	6525.18	0.7-1.5	1.8-2.6	1.5-1.7	0.01-0.1	0.1-0.2	0.05-0.15
34+01	6525.06	0.1-0.5	0.1-0.15	0.14-0.16	0.00-0.05	0.00	0.00

100-year event							
STA	WSE	LEFT FP VELOCITY	RIGHT FP VELOCITY	CHANNEL VELOCITY	LEFT FP SHEAR	RIGHT FP SHEAR	CHANNEL SHEAR
32+20	6525.76	1.9-3.0	3.7-4.1	3.1-3.7	0.1-0.2	0.3-0.35	0.2-0.4
32+73	6525.75	1.7-2.2	2.5-3.4	2.3-2.5	0.1-0.15	0.2-0.3	0.15-0.25
34+01	6525.61	0.5-0.7	0.35-0.45	0.3-0.6	0.0-0.05	0.00-0.01	0.00-0.01

Figure 16. Range of values for 2-, 10- and 100-yr recurrence events for approximate station locations shown by yellow arrows. Velocity results are presented as fps and shear stress as psf.

- For average more recurrent events the channel and floodplain velocities and shears are generally mild, <3.2 fps velocity and <0.22 psf shear range.
- At bridge approach and crossing, the right bank floodplain has as high to slightly higher values than the active channel with slightly greater scour potential.
- Left floodplain velocities in area of boardwalk are 0.2 to 1.6 fps in a 10-yr event
- Left floodplain velocities in area of boardwalk are 1.0 to 3.0 fps in 100-yr event
- Elevated new bridge deck has 2 feet of freeboard over the modeled 100-yr water surface elevation.
- Right bank floodplain lowered to 2-yr water surface elevation to improve conveyance capacity through new bridge crossing and prevent aggravated erosion.
- Structural elements including the rootwad bank protection and habitat structures that use trunk key depths and if needed boulder ballasts are designed to withstand the higher modeled velocity and shear results of 4.1 fps and 0.35 psf shear.
- With permissible velocities of 3 to 6 fps for 2-inch and 4 to 7.5 fps for 6-inch cobble/gravel (Table 4), keying in a composite surface of cobble, gravel, and salvaged sod in the lowered right bank bench at the bridge crossing should be sufficient to withstand the 4 fps velocities during the more extreme flow events.
- The sod reinforced floodplain benches secured with willow poles should be sufficient to withstand the 3 fps channel velocities per Table 4.

Boundary Category	Boundary Type	Permissible Shear Stress (lb/sq ft)	Permissible Velocity (ft/sec)	Citation(s)
Soils	Fine colloidal sand	0.02 - 0.03	1.5	A
	Sandy loam (noncolloidal)	0.03 - 0.04	1.75	A
	Alluvial silt (noncolloidal)	0.045 - 0.05	2	A
	Silty loam (noncolloidal)	0.045 - 0.05	1.75 – 2.25	A
	Firm loam	0.075	2.5	A
	Fine gravels	0.075	2.5	A
	Stiff clay	0.26	3 – 4.5	A, F
	Alluvial silt (colloidal)	0.26	3.75	A
	Graded loam to cobbles	0.38	3.75	A
	Graded silts to cobbles	0.43	4	A
	Shales and hardpan	0.67	6	A
Gravel/Cobble	1-in.	0.33	2.5 – 5	A
	2-in.	0.67	3 – 6	A
	6-in.	2.0	4 – 7.5	A
	12-in.	4.0	5.5 – 12	A
Vegetation	Class A turf	3.7	6 – 8	E, N
	Class B turf	2.1	4 - 7	E, N
	Class C turf	1.0	3.5	E, N
	Long native grasses	1.2 – 1.7	4 – 6	G, H, L, N
	Short native and bunch grass	0.7 - 0.95	3 – 4	G, H, L, N
	Reed plantings	0.1-0.6	N/A	E, N
	Hardwood tree plantings	0.41-2.5	N/A	E, N
Temporary Degradable RECPs	Jute net	0.45	1 – 2.5	E, H, M
	Straw with net	1.5 – 1.65	1 – 3	E, H, M
	Coconut fiber with net	2.25	3 – 4	E, M
	Fiberglass roving	2.00	2.5 – 7	E, H, M
Non-Degradable RECPs	Unvegetated	3.00	5 – 7	E, G, M
	Partially established	4.0-6.0	7.5 – 15	E, G, M
	Fully vegetated	8.00	8 – 21	F, L, M
Riprap	6 – in. d_{50}	2.5	5 – 10	H
	9 – in. d_{50}	3.8	7 – 11	H
	12 – in. d_{50}	5.1	10 – 13	H
	18 – in. d_{50}	7.6	12 – 16	H
	24 – in. d_{50}	10.1	14 – 18	E
Soil Bioengineering	Wattles	0.2 – 1.0	3	C, I, J, N
	Reed fascine	0.6-1.25	5	E
	Coir roll	3 - 5	8	E, M, N
	Vegetated coir mat	4 - 8	9.5	E, M, N
	Live brush mattress (initial)	0.4 – 4.1	4	B, E, I
	Live brush mattress (grown)	3.90-8.2	12	B, C, E, I, N
	Brush layering (initial/grown)	0.4 – 6.25	12	E, I, N
	Live fascine	1.25-3.10	6 – 8	C, E, I, J
	Live willow stakes	2.10-3.10	3 – 10	E, N, O
Hard Surfacing	Gabions	10	14 – 19	D
	Concrete	12.5	>18	H

[1] Ranges of values generally reflect multiple sources of data or different testing conditions.

A. Chang, H.H. (1988).
B. Florineth. (1982)
C. Gerstgraser, C. (1998).
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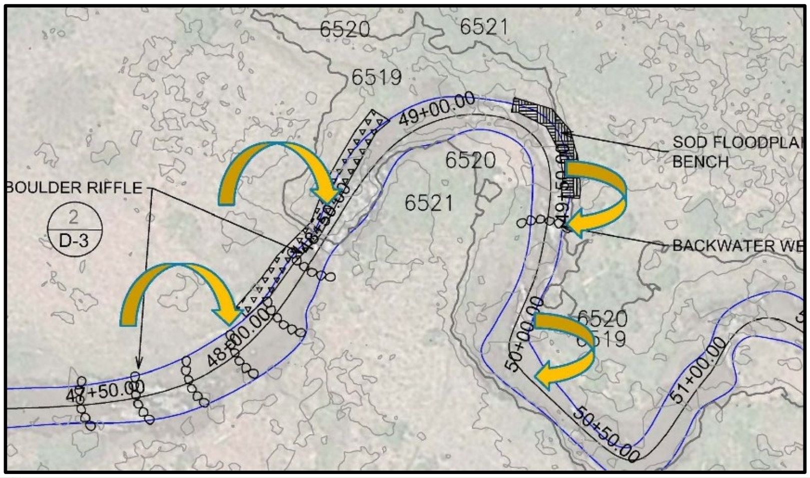
E. Gray, D.H., and Sotir, R.B. (1996).
F. Julien, P.Y. (1995).
G. Kouwen, N.; Li, R. M.; and Simons, D.B., (1980).
H. Norman, J. N. (1975).
I. Schiechtl, H. M. and R. Stern. (1996).
J. Schoklitsch, A. (1937).
K. Sprague, C.J. (1999).
L. Temple, D.M. (1980).
M. TXDOT (1999)
N. Data from Author (2001)
O. USACE (1997).

ERDC TN-EMRRP SR-29

Table 4. Permissible Shear Stresses and Velocities (Source: Fischenich 2001)

Relic Beaver Dam Grade Control



2-year event

STA	WSE	LEFT FP VELOCITY	RIGHT FP VELOCITY	CHANNEL VELOCITY	LEFT FP SHEAR	RIGHT FP SHEAR	CHANNEL SHEAR
48+05	6521.93	0.5-0.75	0.3-0.6	0.45-0.65	0.01-0.03	0.01-0.03	0.01-0.03
48+65	6521.21	1.5-2.7	0.4-1.1	0.1-0.5	0.1-0.4	0.01-0.04	0.01-0.10
49+67	6521.16	1.6-2.0	1.0-1.8	1.8-2.1	0.09-0.12	0.04-0.1	0.10-0.14
50+24	6521.11	1.5-1.7	0.7-1.3	1.3-1.7	0.09-0.12	0.01-0.07	0.07-0.12

10-year event

STA	WSE	LEFT FP VELOCITY	RIGHT FP VELOCITY	CHANNEL VELOCITY	LEFT FP SHEAR	RIGHT FP SHEAR	CHANNEL SHEAR
48+05	6522.37	1.5-1.9	1.3-1.7	1.4-1.6	0.1-0.15	0.1-0.2	0.1-0.15
48+65	6522.04	0.6-3.6	0.1-1.6	0.7-2.3	0.1-0.5	0.02-0.15	0.05-0.2
49+67	6521.91	2.7-3.5	1.8-2.2	2.2-2.7	0.2-0.5	0.1-0.15	0.15-0.25
50+24	6521.78	2.1-2.8	0.9-1.3	1.4-2.2	0.15-0.3	0.01-0.1	0.1-0.2

100-year event

STA	WSE	LEFT FP VELOCITY	RIGHT FP VELOCITY	CHANNEL VELOCITY	LEFT FP SHEAR	RIGHT FP SHEAR	CHANNEL SHEAR
48+05	6523.02	2.5-2.6	2.4-3.0	2.3-2.5	0.2-0.25	0.2-0.3	0.2-0.25
48+65	6522.9	2.5-4.4	2.0-4.1	2.0-2.8	0.2-0.6	0.1-0.5	0.1-0.4
49+67	6522.73	3.5-4.3	2.0-3.3	2.0-3.1	0.2-0.6	0.2-0.3	0.2-0.4
50+24	6522.56	2.5-3.2	1.5-2.0	2.0-2.5	0.2-0.4	0.05-0.15	0.15-0.25

Figure 17. Range of values for 2-, 10- and 100-yr recurrence events for approximate station locations shown by yellow arrows. Velocity results are presented as fps and shear stress as psf.

- For average more recurrent events the channel and floodplain velocities and shears are slightly higher than at the bridge location, <3.6 fps velocity and <0.5 psf shear range.
- The left bank floodplain has as high to slightly higher values than the active channel, possibly due to confluence with the swale.
- Boulder elements (i.e., ¼ to ½ ton) are sized to withstand the modeled velocity and shear results, up to 4.4 fps and 0.6 psf plus an added factor of safety.
- Buried rock sill at the upstream end is provided as extra insurance against incision.
- The backwater weir at the downstream end will help dissipate energy.
- Using these results combined with proposed condition model results to fine tune boulder weir placement and configuration to maintain fish passage.

With the exception of the bridge work and grade control element at the relic beaver dam location, work in the river is to be done by small equipment and hand labor. When larger equipment such as an excavator is necessary, a controlled spur road access point and meadow protection measures such as encapsulated roads, timber mats or Duradeck mats will be required as shown in the plans in order to allow heavy equipment to cross the meadow without causing any damage.

Proposed Condition Model Results to Check Designs

Existing and proposed model results show that the floodplain valley is nearly a pond at the 100-year flow with low velocity and an expansive wetland area for flows to spread out therefore the bridge abutments are designed to be structurally sound when surrounded by flood waters including debris flows. The bridge was designed to meet the two feet of freeboard under a 100-year event per the County of Nevada Road Standards (Nevada County, California, Land Use and Development Code).

SFPC in the Project area is designated as a Special Flood Hazard Area (SFHA) under the Federal Emergency Management Agency (FEMA) so the existing and proposed model results for the 100-year recurrence event were reviewed to verify there are no detrimental impacts due to floodplain encroachment. Model results show flooding extents between existing and proposed (includes the new bridge and boardwalk modeled as a bridge) are essentially the same (Figure 18). There is little to no change to water surface elevations in the meadow and in the vicinity of the bridge as shown by Figures 19 to 21. There is a localized rise in water surface elevation (WSE) between 0.2 and 0.3 feet between the bridge center piers as shown by the orange area and a similarly sized area where the WSE drops between 0.2 and 0.3 feet as shown by turquoise and not surprising a larger drop at the abutments and ramp as shown by dark blue (Figure 19). A slight mismatch in the proposed terrain could be causing the localized changes in WSE. Overall, however there is no impactful increase in WSE and there are no adjacent properties in the vicinity of the minor increase in WSE.

The higher velocities in the vicinity of the bridge remain 4 fps or less for proposed. There is a noticeable shift in higher velocity values in the area of the lowered right bank floodplain of up to 3.2 fps between existing and proposed.

Figure 18. 100-year Flood Inundation Existing versus Proposed

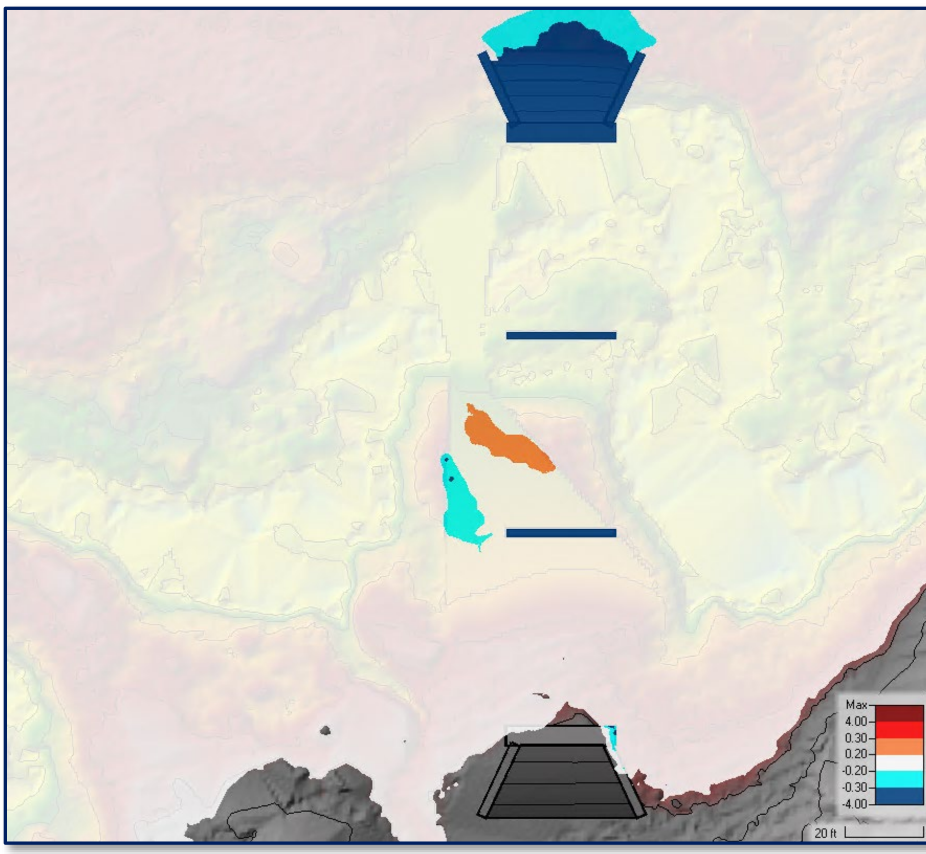


Figure 19. Plan View 100-year Water Surface Elevation Change

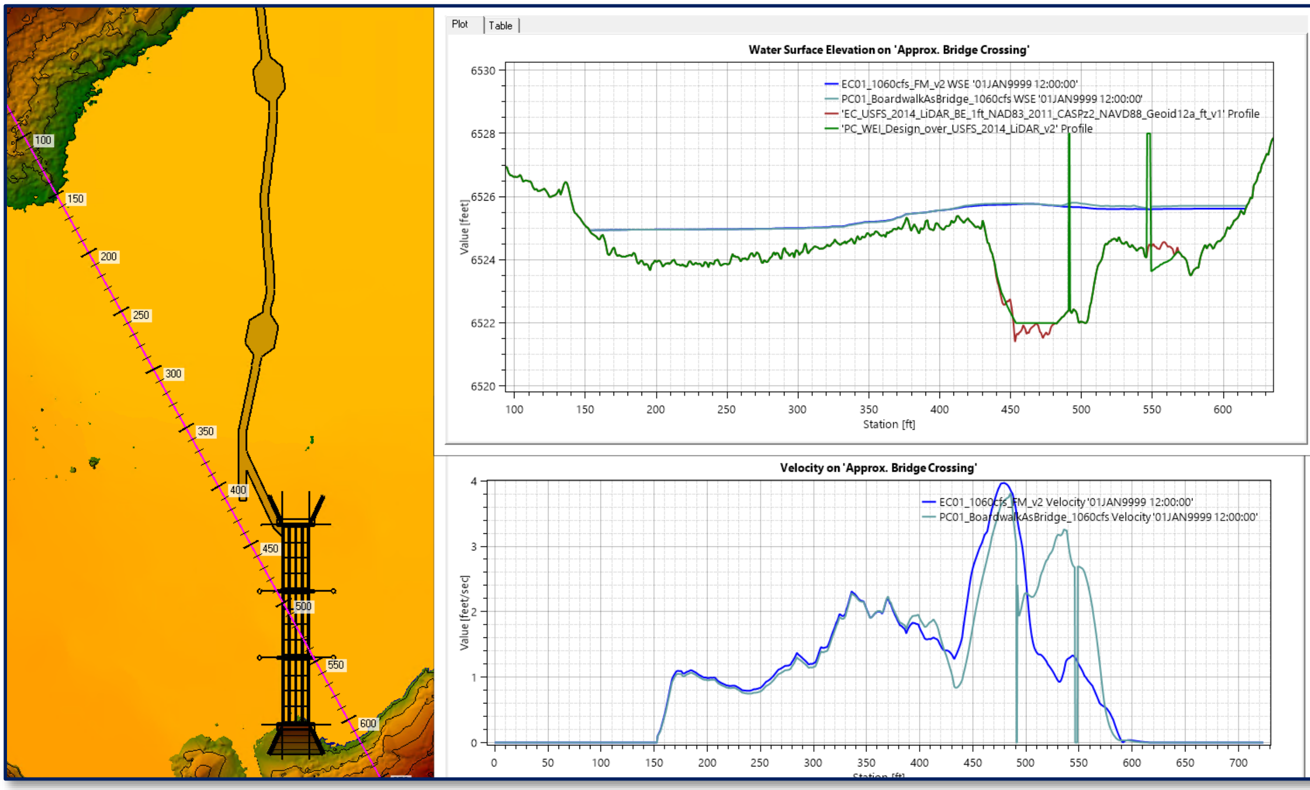


Figure 20. Cross-Valley Profile 100-year Water Surface Elevation and Velocities

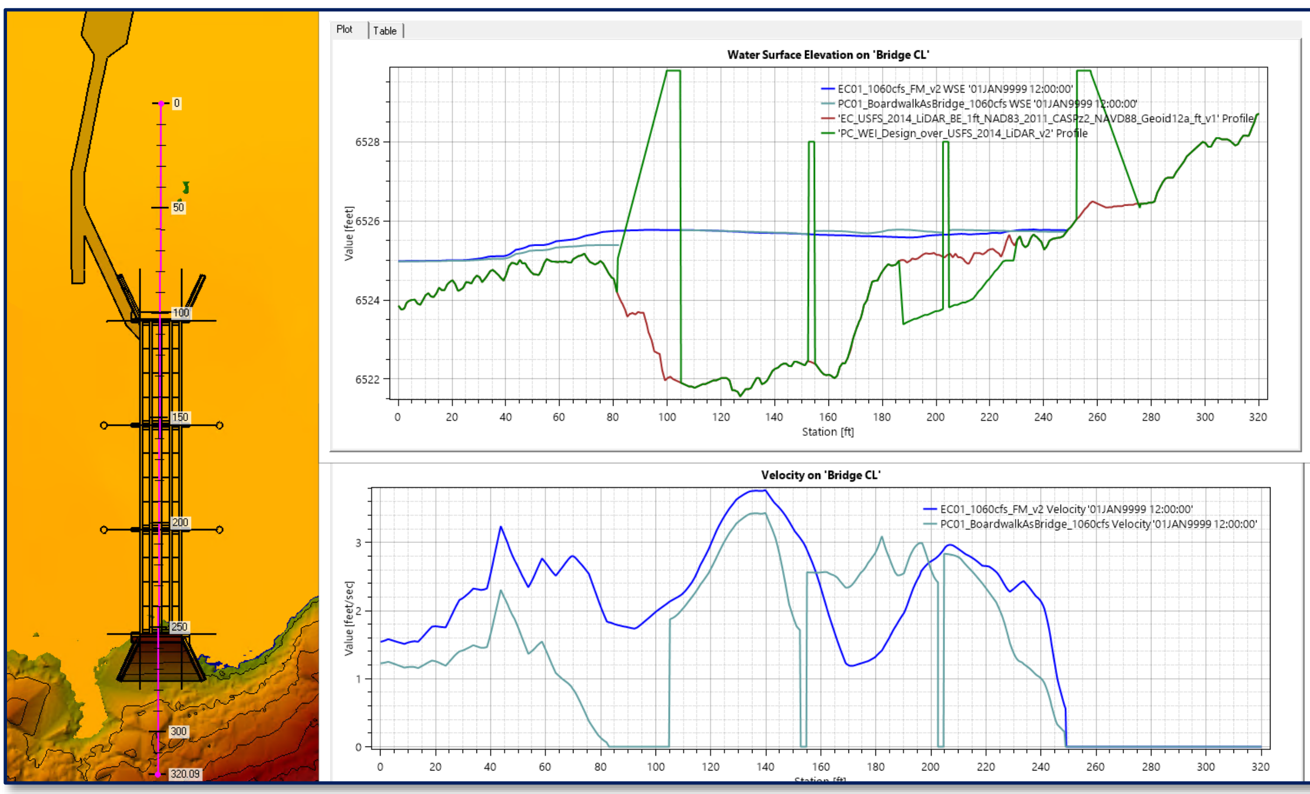


Figure 21. Bridge Centerline Profile 100-year Water Surface Elevation and Velocities

Access and Staging

Three optional temporary staging locations in upland areas along the temporary South Euer Valley Road access were shown on 30% Plans Sheet C-3 and later refined during 65% to avoid the more sensitive sloped areas on either side of the existing south single track trail. Two additional staging areas were located adjacent to and south of North Euer Road. These locations provide better access to the relic beaver dam improvement area and are situated within mostly flat open upland, however, would require limited vehicle access along North Euer Valley Road.

South Euer Road will be improved as part of the project in order to provide equipment and truck/trailer access to the site while avoiding conflicts with private landowners' access on North Euer Road. Per discussions with TDA, the design team intends to make the road passable for construction equipment and emergency vehicles but will maintain more natural conditions to allow for continued growth of native grasses and vegetation. The goal of the design team is to meet TDAs need while improving drainages going across the road and reducing potential erosion that would create the need for extensive road maintenance in the future. The road will be made passable by the Contractor for construction access and then the full suite of road maintenance and improvements shown on the plans will be completed as the Contractor demobilizes from the site.

The majority of work will be done within the existing road prism (i.e., no widening of the existing road) aiming to redirect and spread flow away from the road. Per field investigations (Attachment 8) the designs are intended to be compatible with the existing terrain in order to minimize the overall disturbance footprint. As an example, outsloping is the desirable condition and initial aim, however in some locations the road is inset or insloped so severely that insloping and conveying via an enhanced v-ditch to an outlet reduces the grading and disturbance to such a degree it takes precedent over outsloping. Rolling dips and rocked low water crossings are the targeted treatments where ephemeral channels intersect with the road alignment, however in four locations there are existing undersized and/or damaged culverts that will be replaced with appropriately sized and aligned pipe arch culverts. Given South Euer Road is an earthen access road on Tahoe Donner Association lands used largely for trail use and maintenance access, we sized the culverts for the 25-year recurrence event. A rough hydraulic analysis was done as a check on the sizes calculated in Attachment 5 estimating the normal depth in the culverts, then computing the specific energy for that flow and depth. The specific energy was compared to the height of the proposed culvert to ensure that it is less than or equal to the culvert rise (for arch-type culverts). This check provides some confidence that the inlet will not submerge and cause orifice flow at the inlet which would result in increased headwater depth. The culvert outlets will be armored with rock to prevent erosion. These calculations and proposed culvert sizes will be confirmed using FHWA HY8 (culvert design/analysis software) between 90% and 100% design to check if any minor adjustments need to be made prior to construction.

In one specific instance where road capture has resulted in significant redirection of current flow paths, willow wattles and keyed logs are proposed in a reactivated channel below a replaced culvert in order to spread flows and continue to water a wetland that has been created by road capture of the existing undersized culvert. Only small erosion areas were observed in a few locations below these drainage crossings during the initial field assessment, however in order to spread flows and prevent future aggravated erosion below the proposed water crossings and culvert replacements, additional field assessment will be done at each location during construction and additional willow wattles and/or coir log/willow installations will be field directed as called out on the 90% plans.

Creek Diversion/Dewatering

A majority of the bridge and creek work will initiate later in the season to take advantage of a drier meadow and low base flows and possibly negate the need for a creek diversion; however, a diversion may still be needed and was incorporated into 65% and 90% designs. Two types of diversions are proposed; 1) a visqueen encased coffer dam with diversion pipe to intake flows and reroute around the work area for the more extensive channel bed and bank work, and 2) a simple diversion constructed of gravel bags stacked in a linear formation to redirect flows away from the banks being restored. Dewatering may also be needed for pier/abutment installations and has been incorporated into the 90% plan specifications.

10. REFERENCES CITED

Nevada County, California, Land Use and Development Code (Title 3), Chapter XVII: Road Standards, Article 5, Storm Drainage. Available at: http://qcode.us/codes/nevadacounty/view.php?topic=3-xvii-5-l__1&frames=off

USGS U.S. Geological Survey, 2016, The StreamStats program, online at http://streamstats.usgs.gov, accessed on November 11, 2020.

ATTACHMENTS

Attachment 1- Geomorphology Technical Memo

Attachment 2 - Cultural Report

Attachment 3 – Geotechnical Report

Attachment 4 – Wetland Delineation Report

Attachment 5 – South Euer Road Culvert Calculations

Attachment 6 - Trail Alignment Memorandum and Meeting Minute

Attachment 7 – Trail and Bridge Alignment Matrix

Attachment 8 – South Euer Road Conditions Map and Photo Log