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November 10, 2017

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RE: Donner Creek Site 1 Final Restoration (DRAFT) Design Guidance Letter Report

The enclosed Final Design Plans (DRAFT) for Donner Creek Site 1 Restoration are a result of 2017 field investigations, engineering analysis and client and stakeholder input and discussions during Conceptual Design and Draft Advanced Conceptual Design meetings held in August and September 2017. The designs as presented are intended to restore and stabilize the significantly eroded hillside, provide water quality protection, and enhance riparian habitat. The following summarizes the design approach and methodology including a summary of the hydraulic modeling results, and provides pertinent data for use in preparing environmental permit applications.

Also included as part of this submittal under separate cover is a flash drive with the project CAD files, design spreadsheet, cost estimate spreadsheet, and digital copies of past submittals.

Design Approach

As introduced in the earlier watershed assessment (cbec 2016), the existing railroad culvert crossing immediately upstream from the outer bend bank at Site 1 is the cause of bank erosion problems at that location. Flows emanating from the railroad culvert during flood events have resulted in extensive erosion and continued risk of bank failure along the mobile home park property. Rather than slope back the bank, which would require cutting into private property and could redirect high flow erosional forces to the upper bank, we propose restoring the bank to approximately a 1.5:1 slope and stabilizing the new bank with large boulders and rock. In order to soften the appearance of the rock and enhance riparian habitat while maintaining slope stability, we incorporated rootwad revetments within the boulder toe and willow and other riparian and upland species planted within the placed rock. Onsite boulder, fill, and plant material will be used to the extent possible, including borrowing material from and regrading a spoils site (excavated material from trailer park grading) just to the south of the bank repair and incorporating existing boulders, willow poles, and downed trees from the immediate area.

Design Methodology

A maximum restored bank slope of 1.5:1 is proposed to provide long-term bank stability while avoiding the need to cut back into private property, relocate infrastructure, remove existing stabilizing vegetation, or eliminate the existing stable floodplain bench below the eroded upper bank. Survey data confirmed that site conditions (bank height, horizontal distance between top of bank and toe of bank) allowed restoration of the bank to 1.5:1 slope, and less for some sections, without significantly filling at the toe or cutting back the top of bank.

We used results from a HEC-RAS 1-Dimensional Hydraulic Model developed for existing and proposed conditions and described in the next section to size the boulders, rootwads, and rock and to determine the vertical elevation we could begin to transition from rock protection to a vegetated slope. Rock was needed in this case, because a slope of 2:1 is the steepest slope that can be reliably stabilized through vegetation establishment (Coburn et al., 2010), especially when the slope will be subject to severe erosive forces such as those resulting from the jet effect of the railroad culvert during peak storm runoff events in Donner Creek. As such, vegetation alone cannot effectively stabilize the eroded bank and "harder" features must be incorporated.

The proposed design incorporates 2-ton and 1-ton boulders at the toe, sized using Caltrans RSP equations (Caltrans 2000) and Table 1 to withstand the predicted velocities and associated scour forces under a 20-year event, which generally range from 11 to 13 feet per second (fps) and 2 to 3 pounds per square foot (psf). The exception to this range however occurs in the location where the bulk of the culvert discharge force is directly aimed and shows high velocity and shear rates upwards of 25 fps and 12 psf respectively. Rather than specify 5-ton or even larger boulders which are cumbersome and difficult to effectively install, we are countering the localized spike in velocity by reducing the rootwad spacing and recommending close engineering supervision in order to ensure proper placement, coverage, and keyed in depth of boulders and rootwads that will stabilize and armor the bank and push the higher velocity flows more towards channel center.

The base layer of 1- to 2-ton boulders tapers to ½-ton and ¼-ton moving up the bank once the vertical height is above the model-predicted maximum water surface elevations for a 100-year event. These boulders will be keyed into a clean granular base layer and backfilled with native fill material (from adjacent spoils pile and imported as needed) and planted with willow poles, Woods rose, and bitterbrush to enhance habitat and provide added stability (prevent soil erosion in pore space between rocks and possibility of bank sloughing). The top of bank will be stabilized with erosion control blanket, keyed in at the top of the bank and rolled down and keyed beneath the uppermost layer of placed rock and seeded with native and adapted colonizing and climax species of grasses, forbs, and shrubs.

The rootwad installations are a hybrid of a rootwad/bendway weir installation placed in the vicinity of the existing stable cobble toe where essentially the rootwad face is angled upstream to aid in redirecting flows towards the channel centerline and away from the bank. Complete bendway weirs that typically extend a third of the way into the active channel were eliminated to avoid encroaching too far into the creek and reducing the flow conveyance area. The hybrid rootwad installations are also elevated slightly to avoid disturbing the existing stable cobble toe. They are designed to increase bank roughness and provide more bank protection under the higher flows while still providing some increased habitat under the lesser flows. Six rootwad installations are proposed, with the first three in the location of the highest forces furthest upstream spaced more tightly at about 15 feet on center and the other four spaced at about 30 feet on center.

A layer of Caltrans #3 backing is proposed beneath the rock to prevent piping and soil loss and all installations will be field directed, including willow pole installation and containerized plantings amongst the placed boulders and rock. Careful installation of the plants within the placed rock, along with irrigation, will be key to the vegetation success and supporting the long term stability of the bank.

`Table 1. Permissible Velocities and Shears for Various Materials

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.

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ERDC TN-EMRRP SR-29

(Source: Fischenich 2001)

Hydraulic Modeling

The USACE's Hydraulic Engineering Center River Analysis System (HEC-RAS) Version 4.1.0 (USACE, 2010) was used to develop Existing Conditions and Proposed Conditions hydraulic models. The models were developed using field survey data, field measurements, and 2014 Tahoe National Forest LiDAR data. The models were used to inform boulder size and rootwad anchoring requirements and to assess the hydraulic effects of the proposed bank repair. The design discharges for Donner Creek were derived by fitting a log-normal distribution to the annual peak series data collected by USGS at the State Highway 89 stream gaging station (USGS Station 10338700). Statistical distribution fit to the SH89 streamgage were compared to the FEMA Flood Insurance Study regulatory discharges for Donner Creek and were in reasonable agreement with FEMA-published results. All modeling data and digital files are included on the submitted flash drive. The most pertinent data (existing and proposed condition 20- and 100-year water surface elevations, shear, and flow velocities) are shown in Table 2 below.

Table 2. 100-year Water Surface and 20-year Velocity and Shear Results for Site 1

Approx. River Station	Existing Conditions Water Surface Elevation[1] (NAVD88)	Proposed Conditions Water Surface Elevation[1] (NAVD88)	Change in WS Elevation (ft)	Existing Conditions Velocity[2] (fps)	Proposed Conditions Velocity[2] (fps)	Existing Conditions Shear Stress[3] (psf)	Proposed Conditions Shear Stress[3] (psf)
954.6 (upper boundary)	5867.3	5863.8	-3.5	13.14	10.9	3.2	2.1
929.6 (middle)	5858.2	5861.4	3.2	24.98	16.44	12.33	4.86
816.5 (lower boundary)	5856.1	5858.2	2.1	8.05	8.74	1.15	1.4

1. Values for Water Surface Elevation shown from HEC-RAS Model outputs for 100-year flowrate (3,385 cfs)
2. Values for Velocity shown from HEC-RAS Model outputs for 20-year flowrate (2,103 cfs)
3. Values for Shear Stress shown from HEC-RAS Model outputs for 20-year flowrate (2,103 cfs).

The water-surface profile (Site 1 is shown circled) in Figure 1 is rather busy in the design reach with the proposed condition water surface slightly increased from existing in a large portion of the project reach. This however is considered a positive change since there is no risk of flooding at this location with the increase in stage and the change from supercritical to subcritical flow results in dramatically reduced velocities, particularly in the area of concern (i.e. Station 929.6) as shown in Table 2.

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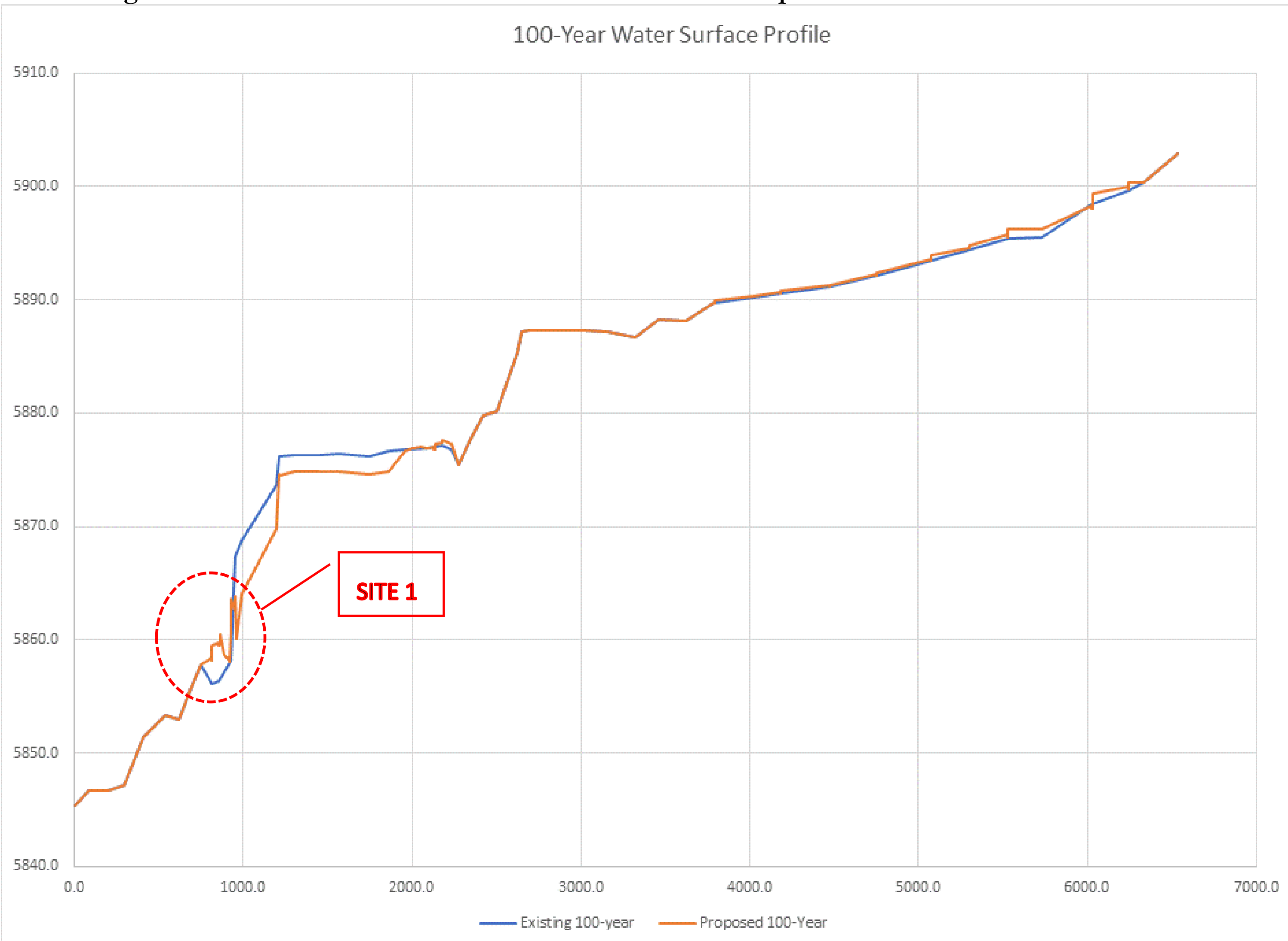
Figure 1. 100-Year Water Surface Profiles of Donner Creek per HEC RAS 1-Dimensional Model



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Quantities

Tables 3 and 4 summarize the earthwork quantities and areas of disturbance and enhancement that will be key information for the permit applications. Material quantities, including boulders and rock will be incorporated into the Engineer's Estimate for bidding purposes.

Table 3. Donner Creek Site 1 Cut & Fill Estimates

Location	Description	Cut (CY)	Fill (CY)	Net (CY)
	Restore eroded south bank (excludes boulders)		400	
	Remove and regrade spoils in upland area	50		350
Total				**350**

Table 4. Donner Creek Site 1 Disturbance and Enhancement by Habitat Type

Donner Creek Restoration Projects **Disturbance and Habitat Enhancement by Type** **Habitat Type Classification - Cowardin et. al 1979[1] (and General Classification)**			
Habitat Type	**Disturbance** (Bank, Spoils Pile, Access)	**Habitat Enhancement** (Bank Stabilization Downstream of Railroad Culvert)	**NET**
PSSC (Riparian/Scrub Shrub Seasonally Flooded)	0.17 ac (Minimally Vegetated)	0.14 ac (Restoration)	0.03 ac

1. Habitat Type Classification per Cowardin et. al 1979 and as described in the "Donner Creek Sties #1-4 Pre-Project Monitoring and General Habitat Study (Wildscape Engineering, Inc. 2017)

Remaining Questions

At this time there is one remaining question we would like to discuss with the stakeholders and is as follows: Could some of the antiquated infrastructure along the upper west side of the bank repair be removed as part of the restoration construction?

Please don't hesitate to contact me if you have any immediate questions. We look forward to going over these plans with you and the stakeholders next week.

Regards,

Carol W Beahan

Carol Beahan, PE, Project Manager
CC: Lisa Wallace, TRWC

Works Cited

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