Lower Entiat 1D Reach (RM 4.3 – 4.8) Habitat Enhancement Project

Preliminary Basis of Design Report

Chelan County Natural Resource Department
411 Washington St #201
Wenatchee, WA 98801

Natural Systems Design | CGS COASTAL GEOLOGIC SERVICES

1900 N. Northlake Way, Suite 211
Seattle, WA 98103

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

THIS PAGE INTENTIONALLY LEFT BLANK

INTRODUCTION

The Chelan County Natural Resource Department (CCNRD) is leading restoration efforts to support the recovery of Endangered Species Act (ESA) listed salmonids within the Entiat River. This project is focused on Reach 1D between River Miles (RM) 4.3 – 4.8 of the Entiat River, bounded upstream by the Hanan-Detwiler diversion structure and downstream by Dinkelman Canyon Road bridge. The project's designs focus on habitat enhancement of ESA-listed species using engineered logjams to increase adult holding and juvenile rearing habitats, and riparian enhancement to improve stream shade and long-term wood recruitment potential. See Figure 1 for project area map.

This report presents the basis of design for restoration associated with the Lower Entiat 1D project. The draft preliminary designs are presented in Appendix A.

PROJECT BACKGROUND

The Lower Entiat River 1D project reach (RM 4.3 – 4.8) is located within the Entiat River-Mills Creek Assessment Unit (AU) which extends from the Entiat River confluence with the Columbia River up to the confluence with the Mad River tributary at RM 10.7. Within this AU, the project reach is located within reach 5 which extends from RM 4.0 – 5.8 (UCSRB 2020). In 2020, the Upper Columbia Salmon Recovery Board (UCSRB) provided prioritization of salmon restoration and protection actions within the Upper Columbia basin (UCRTT 2020). This work included the prioritization of habitat action types at a reach scale within the Lower Entiat reach 5. Overall, the Entiat River-Mills Creek AU is a Tier 1 restoration reach for steelhead, a Tier 2 reach for both Spring Chinook and bull trout (UCSRB 2020a).

In the fall of 2020, in collaboration with the CCNRD, Natural Systems Design (NSD) initiated development of a reach-scale assessment of restoration opportunities within the Lower Entiat River within reach 5. The primary purpose of the effort was to describe a suite of potential salmon habitat enhancement and restoration actions that contribute to the recovery of ESA-listed species by directly addressing "at risk" reach-scale ecosystem indicators (REI) (NSD 2021).

To support this evaluation, NSD conducted an assessment of existing conditions and potential restoration opportunities through collecting field data and combining it with existing available information the Entiat River-Mills Creek AU and specifically Reach 5. Existing available information utilized in the assessment includes, but was not limited to, the Bureau of Reclamation (Reclamation) Lower Entiat Reach Assessment (Reclamation 2012), the Habitat Action Prioritization Strategy and supporting data sources (UCRTT 2020, UCSRB 2020a, UCSRB 2020b, UCSRB 2021), the Upper Columbia Biological Strategy (UCRTT 2021), and available digital LiDAR data (WDNR 2015). The conclusions presented in the 2021 document provide an overview of project opportunities within the lower Entiat River 1D reach. Those project opportunities were used to provide the framework for developing the preliminary plans as presented in this report.

Salmonid Use in the Project Reach

The lower Entiat River is utilized by multiple life history stages of Upper Columbia River spring Chinook salmon (*Oncorhynchus tshawytscha*) (ESA Endangered), Upper-Columbia Summer Steelhead (*Oncorhynchus mykiss*) (ESA Endangered), and Columbia River bull trout (*Salvelinus confluentus*) (ESA Threatened) (Andonaegui, C. 2001, UCRTT 2017). In the study area the highest use is associated with juvenile salmonids, primarily steelhead, during summer and winter rearing months. Spring Chinook juveniles also are present and use winter rearing habitats. The Lower Entiat River 1D Reach (RM 4.3 – 6.3) characterization is based on the US Bureau of Reclamation report that analyzed the lower 26 miles of the Entiat River (USBR 2009). The USBR reported Reach 1D as having

a “lack of spawning habitat, juvenile rearing habitat, and adult holding habitat” for Upper Columbia steelhead, and a “lack of juvenile rearing habitat and adult holding habitat” as well as a habitat limiting factor of summer and winter water temperatures for Upper Columbia spring Chinook salmon. Table 1 outlines the use for each critical life history stage within the study area.

Table 1: ESA-listed salmonid status and life history stage use in the Lower Entiat River, Entiat River-Mills Creek AU, Reach 5 (UCSRB 2021)

SPECIES/LIFE HISTORY	ESA STATUS	ADULT MIGRATION	ADULT HOLDING	SPAWNING	FRY	SUMMER REARING	WINTER REARING	SMOLT
SPRING CHINOOK	Endangered	Low	Not Supported	Not Supported	Not Supported	***Low****	***High****	Low
STEELHEAD	Threatened	Low	***Low****	Medium	Medium	***High****	***High****	Medium
BULL TROUT	Threatened	Low	Not Supported	Not Supported	NA	NA	NA	NA

Salmonid life history targeted to improve with this project

Existing Conditions

The project reach (RM 4.3 – 4.8) is bounded by the abandoned Hanan-Detwiler diversion structure at the upstream end of this project, and the Dinkelman Canyon Road bridge at the downstream. The project reach includes private landowners on both sides of the river. See Figure 1: Project Area Existing Conditions below for an overview of the project reach.

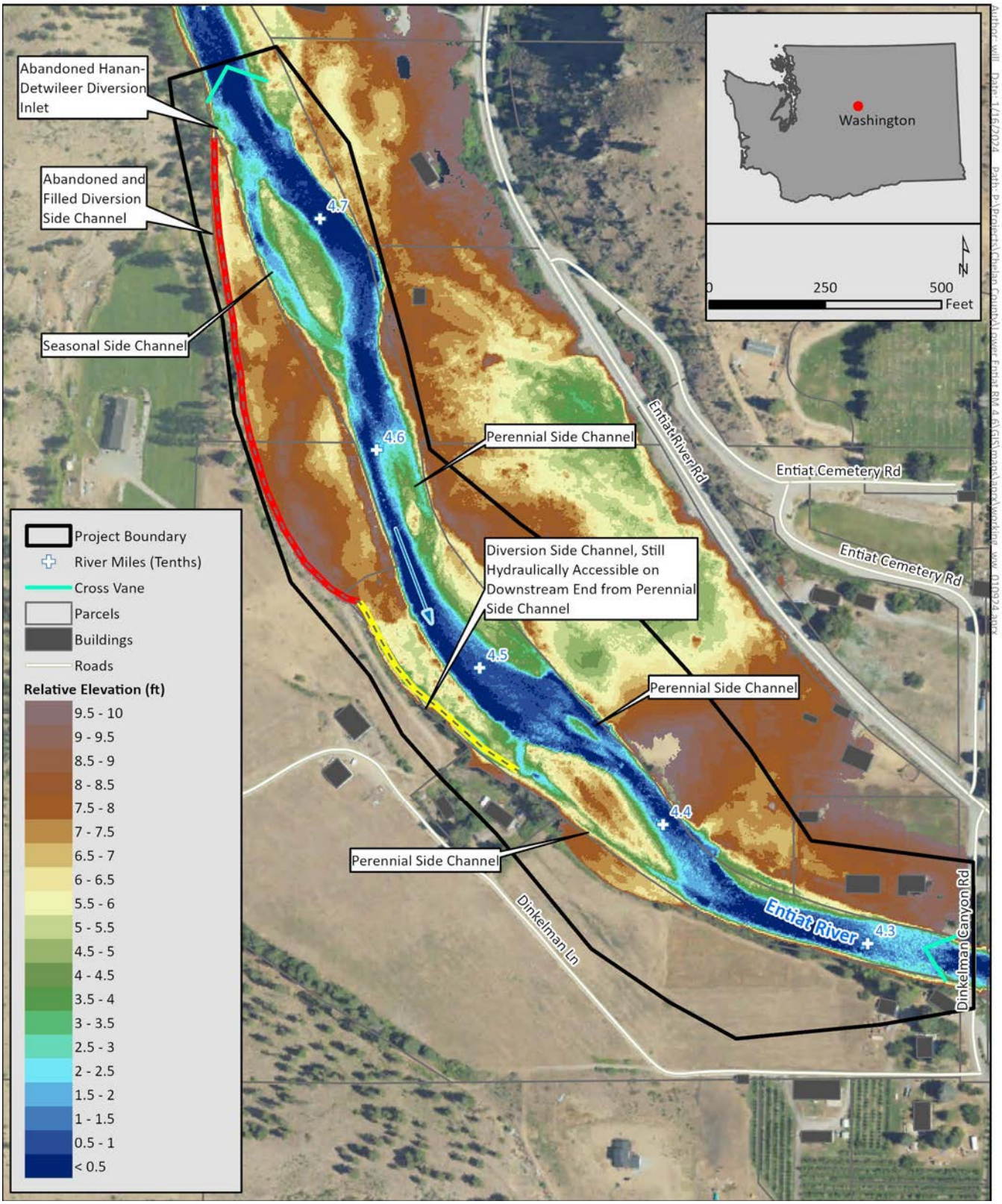


Figure 1: Project Area Existing Conditions

Within the project reach the river channel morphology is plane bed, and is relatively straight (sinuosity 1.1), and moderately steep (slope 1.1%). The channel substrate consists of armored/embedded coarse glacial outwash, with cemented banks. The channel features rifles, runs, an existing cross vane, and seasonal and perennial side channels (Figure 2). The channel maintains a largely single-threaded planform with occasional split flows around islands and has maintained a very narrow channel migration corridor due to confinement by terraces composed of erosion-resistant glacial outwash (Reclamation 2012). Steep bedrock slopes form the channel margin in several places and provide angular boulders to the reach. Side channels are generally located along the inside of channel bends and are predominantly activated at higher spring flows; however, two perennially flowing side channels do persist at RM 4.7 and 4.5. Accumulations of LWD are typically located at the head of island features, with additional LWD racked in existing vegetation or on gravel/boulder bars. Aside from these few channel islands and side channel inlets, few other locations have significant accumulations of LWD. Scour and pool formation is limited, with the few deep pools within the reach associated with thalweg scour along the bedrock margins of the valley wall. The existing riparian buffer consists of willow and red-osier dogwood shrub communities with a narrow band of mature cottonwood. The LWD recruitment potential is limited due to the naturally armored banks, lack of LWD forcing agents, and lack of large trees along the corridor (Reclamation 2012).

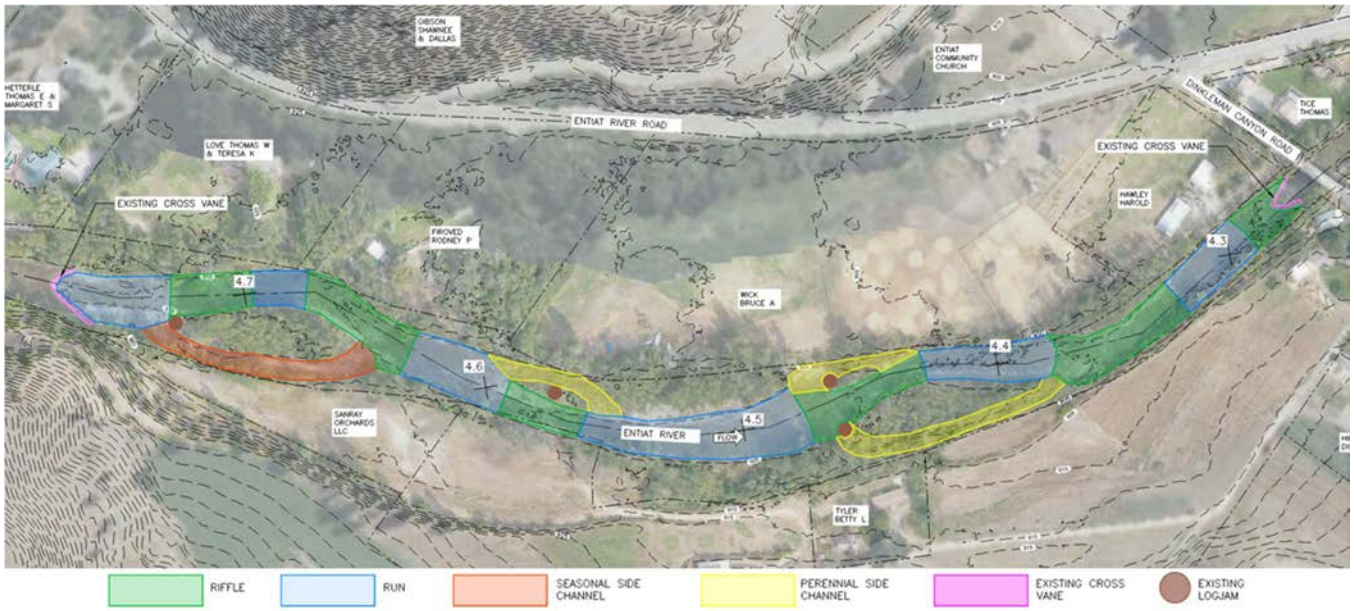


Figure 2: Project Area Existing Stream Features

The lower Entiat River has a recent history of anthropogenic impacts to instream habitat, floodplain connectivity, and riparian communities have degraded the habitat forming and maintaining processes that support aquatic and terrestrial species. Impacts associated with logging, log drives, dams (the former Mill dam at RM 3.6 is downstream from the study reach), flood control dredging, agriculture and irrigation, road construction, fire, the removal of beaver, and the removal of riparian vegetation have all contributed to degraded habitat.

The Reach-based Ecosystem Indicators (REI) analysis (Reclamation 2012) found that within Lower Entiat River, water quality (temperature); habitat quality (large woody debris, pools, off-channel habitat), floodplain connectivity, and riparian vegetation were in an “at risk” condition due to historic anthropomorphic impacts, including floodplain development, bed armoring (embeddedness), and a lack of large wood recruitment potential. Table 4 below presents the UCSRB (2020b) evaluation of Reach 5 REIs and a crosswalk with those REIs

that ranked “unacceptable” and “at risk” with the target salmonid life history stage, and potential restoration actions.

Table 2: Unacceptable and At-Risk Reach-Based Ecosystem Indicators, Life History Stage Target, and Action Crosswalk for Entiat River-Mills Creek AU, Reach 5 (UCSRB 2020b).

GENERAL CHARACTERISTIC	GENERAL INDICATOR	ATTRIBUTE	LIFE HISTORY STAGE TARGET	ACTION CROSSWALK
Watershed Condition	Water Quantity and Quality	Temperature	Summer Rearing	Increase Riparian Shade and Hyporheic Flows
Habitat Quality				
	Large Woody Debris	Cover	Summer and Winter Rearing	Increase Wood Structure and Sources
	Pools	Pool frequency and quality	Summer Rearing	Create Pools with Instream Structure
	Off-Channel Habitat	Side Channels	Summer and Winter Rearing	Side Channel/Off-Channel Habitat Restoration
	Undercut Banks	Cover	Summer Rearing	Improve Riparian Health and Root Cohesion
Channel Condition	Floodplain Connectivity	Riparian Structure/Canopy Cover	NA	Riparian Planting
	Substrate	Embeddedness	Winter Rearing	Increase Sediment Sorting
	Channel Complexity	Cover, Pools, LWD	Summer and Winter Rearing	Increase LWD and Pool Formation and Maintenance

Past restoration actions near the project reach have been limited to the construction of the John Small Pond and side channel at RM 5.0, led by the Washington Department of Fish and Wildlife (WDFW) in 2004, the abandonment of the Hanan-Detwiler diversion and the construction of channel spanning cross-vanes at RM 4.75 and RM 4.6 in 2007. The upstream cross vane was installed at the Hanan-Detwiler diversion intake to create pool habitat and maintain the fish bypass channel. The downstream cross vane at Dinkelman Canyon Rd bridge was installed to provide pool habitat. In 2014, the project reach was designated as a temporary control reach for monitoring efforts which prevented any additional restoration actions from occurring up to 2020. Currently restoration actions can now be taken to improve current instream and floodplain conditions that directly benefit those key juvenile salmonid life history stages that rely on summer and winter rearing habitats.

In August 2023 NSD and CCNRD staff conducted a reconnaissance of the project reach to evaluate examine geomorphic and habitat conditions, evaluate potential conceptual restoration actions, and evaluate construction feasibility for restoration actions. Figure 3 through Figure 11 provide examples of existing conditions observed by the NSD team.

Figure 3: Left panel: example of coarse bed material at RM 4.6 facing downstream. Right panel: riffle crest above plane bed channel at RM 4.65.

Figure 4: Perennial side channel on left bank facing upstream at RM 4.57

Figure 5: Typical bank armoring with coarse cobble and root cohesion.

Figure 6: Natural wood accumulation at island head near right bank side channel at RM 4.73.

Figure 7: Perennial side channel on river right at RM 4.73. Left panel: Wood jam at right bank side channel inlet at RM 4.47. Right Panel: Side channel conditions during low fall flows.

Figure 8: Seasonal side channel on river right at RM 4.73 below the Hanan-Detwiler cross vane. Left panel is November 2021 with shallow flow, right panel is dry in August 2023.

The Hanan-Detwiler diversion was constructed in 2007 and includes a channel-spanning cross vane weir (Figure 9), two rootwad structures downstream of the cross vane on the banks of the main channel, and a 1,500-foot-long fish return channel. The project was intended to improve fish passage, conserve water, and minimize diversion operation and maintenance on the Entiat River. However, sometime in early 2011 the diversion was plugged with soil and boulders from the cross vane, rendering the diversion ditch dry (USBR 2012). A downstream cross vane (Figure 10), approximately 75 feet upstream of Dinkelman Canyon Road bridge, was constructed in 2001 to provide pool habitat but the excavated pool on the downstream end has since partially filled in.

Figure 9: Upstream cross vane at Hanan-Detwiler diversion at RM 4.78.

Figure 10: Downstream cross vane by Dinkelman Canyon Road bridge at RM 4.28

The existing riparian habitat is limited to narrow bands of primarily deciduous tree and shrub species directly adjacent to the river channel. These bands of native species include black cottonwood, ponderosa pine, willow, alder, poison oak, and snowberry. The majority of the wider floodplain areas have been cleared of woody vegetation for orchard and pasture (Figure 11)

Figure 11: Right bank open pasture near RM 4.7.

PROJECT GOALS AND OBJECTIVES

In 2012, Reclamation concluded that habitat restoration in the lower Entiat River "should be aimed at improving and enhancing those forms and processes that currently exist, rather than attempting to create wholly new conditions that may not be appropriate or sustainable" (Reclamation 2012). Human impacts within the lower Entiat River have had a large and detrimental effect on instream habitat. Due to existing conditions the river lacks the ability to readily create new habitat through natural processes alone. As a result of the confined river channel and limited floodplain habitats, the majority of habitat that historically existed on the lower Entiat River was instream habitat; therefore, re-establishing instream habitat is vitally important to salmon and steelhead (Reclamation 2012).

Overall, restoration measures should focus on recovering, to the extent possible, the impaired processes identified in Table 2. Although the proposed restoration measures are expected to benefit a large suite of native aquatic and terrestrial species, the primary purpose of this project is to propose a suite of potential salmon habitat restoration design elements that contribute to the recovery of ESA-listed species by directly addressing "at risk" reach-scale ecosystem indicators.

The following are the project goals and objectives:

- Goal: Improve side channel hydraulic connectivity and habitat quality for juvenile salmonids.
  - Objective: Improve existing seasonal and perennial side channel features through the strategic construction of ELJs to increase flow interaction and provide cover.
  - Objective: Remove human-constructed barriers to existing habitat to reconnect flows to side channels and floodplain features.
- Goal: Improve instream habitat for juvenile salmonids.
  - Objective: Install ELJs to provide cover, pool formation, and sediment sorting.

- Objective: Enhance hydraulic variability and provide instream cover.

- Goal: Increase riparian buffer structure and function related to stream shading and large wood recruitment potential.
  - Objective: Restore riparian mature riparian forested vegetation located within the 2-year floodplain or within 50 feet of the existing banks.
- Goal: Reduce instream water temperatures.
  - Objective: Increase main channel shade through riparian revegetation planting and long-term shading.
  - Objective: Increase hyporheic and floodplain flow storage and discharge through strategically constructing engineered log jams (ELJs) to deflect and increase flows into adjacent floodplain and gravel bar features.

HYDROLOGIC AND HYDRAULIC ASSESSMENT

The primary goals of NSD's hydrologic assessments and hydraulic modeling are to evaluate current low flow and flood conditions, as well as the impact of flooding on adjacent properties. Additionally, NSD aims to iteratively assess the proposed design and gain an understanding of habitat-forming processes.

Hydrology

Peak flows are shown in Table 3 were estimated from USGS Gage Station 12452990 "Entiat River nr Entiat, WA" near Keystone Bridge (USGS 2001) and from the FEMA Flood Insurance Study at Fish Hatchery Road (FEMA 2004). The USGS gage data was available from 1996-2022 was used to estimate peak flows for the 1.25-, and 2-year recurrence intervals. Daily mean flow values during the summer months of 2023 were averaged to estimate a typical summer flow. The weighted skew method using regional skew values from Mastin et al. (2016) were applied to these flows for a more accurate estimation for the specific area. These flows were then scaled using the Drainage Area Ratio Method in Mastin et al. (2016) to produce model inflows near the Entiat Fish Hatchery upstream. This was necessary because the model inflow is located approximately 3 mi upstream of the gage, and thus has a smaller drainage area (391 sq mi compared to 419 sq mi) and therefore lower peak flows. For the 10- and 100-year flows, the estimates from the FEMA FIS study were used because it is upstream of the model inflow and is more similar to the USGS gage flow than the scaled estimate.

Table 3: Estimated Flows for Recurrence Intervals for model runs

RECURRENCE INTERVAL (YR)	FLOW AT USGS GAGE (CFS)	FLOW FROM FEMA FIS STUDY (CFS)	SCALED ENTIAT RIVER FLOW (CFS)	ENTIAT RIVER MODEL INFLOW (CFS)
Typical Summer Flow	112	-	100	100
1.25	2,412	-	2,370	2,370
2	3,174	-	3,130	3,130
10	5,125	5,600	4,030	5,600
100	8,020	8,300	5,460	8,300

Hydraulic Model Development

A 2-D unsteady hydraulic model was developed using the United States Army Corps Hydrologic Engineering Center's (HEC) River Analysis System (RAS) 6.4.1. The model domain spans approximately 1.5 river miles, beginning approximately 0.5 miles upstream of the cross vane within the project area and ending approximately

0.75 miles downstream of Dinkleman Canyon Rd. The model geometry utilizes topobathymetric data from 2022 provided by the Department of Natural Resources. The mesh consists of various refinement regions that have cell sizes spanning from 10 ft to 30 ft, depending on the location within the floodplain.

The model domain includes two bridges: Dinkelman Rd bridge and the upstream Entiat River Rd bridge. These structures were put into the model using as much information as possible from as-built designs that were available, and estimations were made for the rest from point cloud data and photos.

Roughness

Hydraulic resistance is characterized in the model by polygons that represent different land cover areas such as buildings, crops, or vegetation. Each roughness type is assigned a manning's n roughness coefficient. The roughness values for each category were determined through the calibration process described below. Roughness categories for the model were assigned by hand based on aerial imagery.

The nine roughness categories – main channel, vegetated bars, engineered log jams, dense mature vegetation, sparse vegetation, crops, bare ground, roads, and buildings – were assigned discharge-varying roughness values (Table 4) due to the large span of discharge values used in model simulations.

Table 4: Calibrated manning's n roughness values for three flow regimes.

LAND COVER TYPE	LESS THAN 1,000 CFS	2,000-5,500 CFS	>5,500 CFS
Bare Ground	0.025	0.025	0.025
Building	0.015	0.015	0.015
Crop	0.04	0.04	0.04
Dense-Mat Veg	0.07	0.07	0.07
Main Channel	0.055	0.035	0.03
Road	0.02	0.02	0.02
Sparse Veg	0.07	0.05	0.038
Veg Bar	0.075	0.055	0.04
Side Channel ELJ	0.20	0.20	0.20

Calibration

The model was calibrated by comparing the modeled (or simulated) discharge and water surface elevation at the USGS gage location to the USGS rating curve (Figure 12). This was done for three different flow regimes since manning's n varies based on water depth. The roughness was adjusted to get the closest fit to the USGS rating curve.

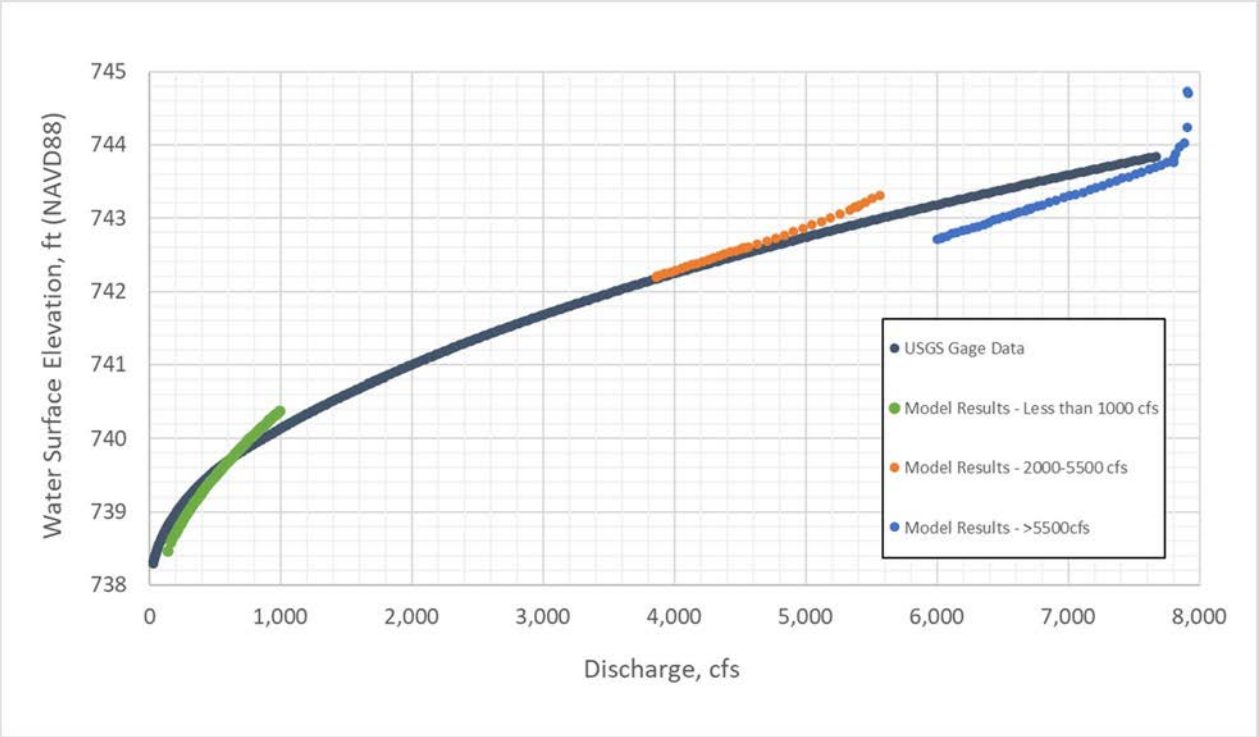


Figure 12. Roughness was calibrated for the model by comparing the USGS rating curve at gage 12452990 to the modeled rating curve for three different flow regimes.

Preliminary Hydraulic Model Results

The 2D hydraulic model was used to verify field observations and inform design development. Differences in hydraulic conditions between current existing conditions and proposed conditions after ELJ placement were evaluated for a typical summer low flow (100 cfs), 1.25-yr (2,370 cfs), 2-yr (3,130 cfs), 10-yr (5,600), and 100-yr (8,300 cfs) recurrence intervals. Visual depictions of hydraulic model outputs are provided in Appendix B.

Results indicate minimal effects on depth and velocity during a typical summer flow but show significant differences localized around proposed ELJs during the recurrence intervals that were evaluated. Localized trends indicate an average increase in depth of up to one foot around ELJs throughout the reach. Furthermore, the ELJs tend to reduce velocity in the main channel and increase velocity/conveyance in the floodplain, which occurs when discharge is around 5,000 cfs. Depths and velocities were averaged for the entire reach, including the floodplain, and can be viewed in Table 5. Overall, proposed ELJs resulted in no change in average depths except for the 100-year recurrence interval, where average depths decreased due to depths increasing in the floodplain. Averaged proposed velocities remained the same as existing in the Summer and 2-year recurrence intervals, but decreased in the 1.25-year, 10-year, and 100-year intervals. Results show no impact from ELJs on water surface elevation at either the Dinkelman Road Bridge or the Entiat Road Bridge downstream of the project area for any of the modeled scenarios.

Table 5. Reach-Averaged Depth and Velocity from Existing Conditions and Proposed Conditions Model Simulations

Flow	Existing Conditions Reach-Averaged Depth, ft	Proposed Conditions Reach-Averaged Depth, ft	Existing Conditions Reach-Averaged Velocity, ft/s	Proposed Conditions Reach-Averaged Velocity, ft/s
Typical Summer (100 cfs)	0.8	0.8	1.8	1.8
1.25 yr (2,370 cfs)	2.7	2.7	7.0	6.9
2 yr (3,3130 cfs)	3.1	3.1	7.4	7.4
10 yr (5,600 cfs)	3.4	3.4	8.2	8.1
100 yr (8,300 cfs)	3.3	3.1	7.0	6.6

Typical Summer Flow Event Results Summary

The Summer Flow event inundates one side channel, and depth is not larger than three feet for both existing and proposed. Depth and velocity change is very minimal and localized to the proposed ELJ locations in the main channel.

1.25-year Recurrence Interval Event Results Summary

The 1.25-year flow event inundates three side channels. Depth in the side channels is 4 feet and lower, and the main channel ranges from 1 to 7 feet deep. The proposed ELJs generally influence hydraulics locally. The ELJs increase depth upstream up to 2 feet, and decrease depth immediately downstream around 0.5 feet. The most upstream proposed deflector on the left bank increases flow to the right bank side channel, increasing the water depth around 1 foot. See Figure 13.

100-year Recurrence Interval Event Results Summary

The 100-year flow increases water depth in the main channel around 1 to 2 feet upstream of the proposed ELJs. Depths are also increased on the floodplain, up to 1 feet, see Figure 14. Structures on the left bank are currently inundated in the existing conditions 100-year event, but depth is slightly increased in proposed conditions at the structures by 0.25 feet. ELJ placement and modeling updates will need to be further investigated at future design phases to understand the ultimate effects of the project on local landowners.

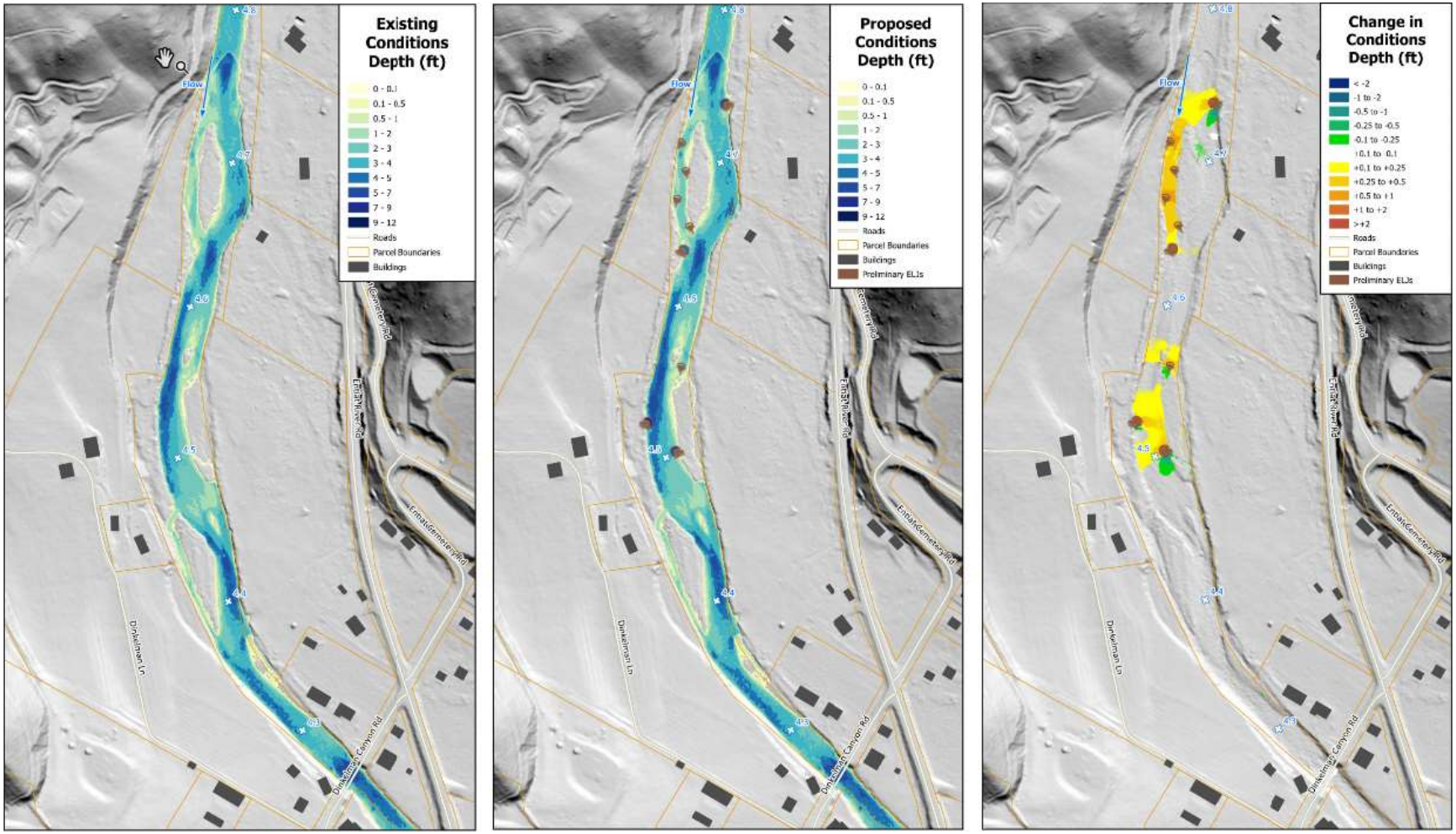


Figure 13: EC and PC 1.25-year hydraulic depth and change in depth

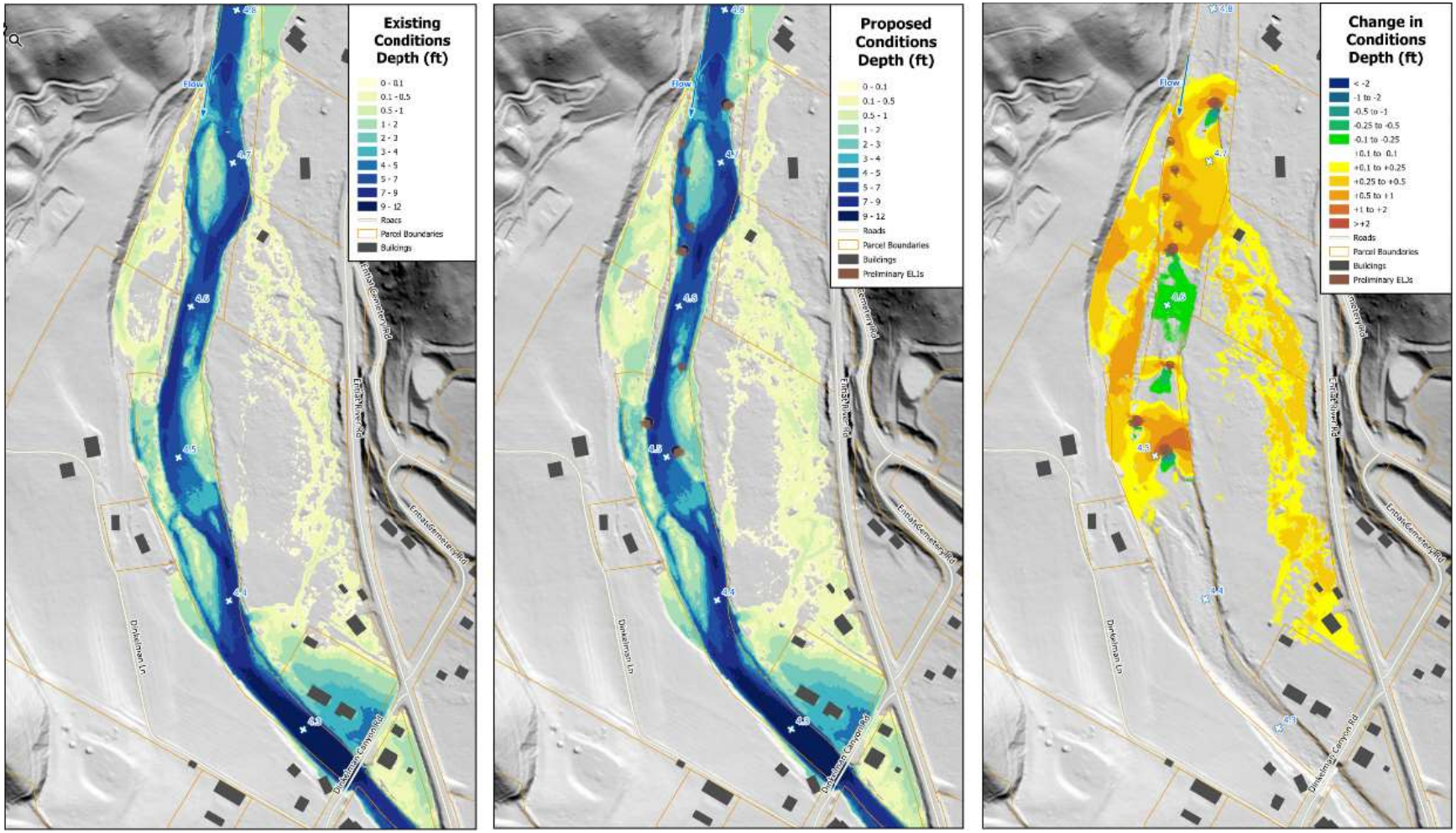


Figure 14: EC and PC 100-year hydraulic depth and change in depth

DESIGN DEVELOPMENT

Design History

Alternatives Analysis

In 2021 NSD presented key considerations for design and construction for the project reach (NSD 2021). Opportunities identified in the project reach included large swaths of riparian plantings, apex jams at island heads, and deflector jams at side channel outlets. The analysis also recommended looking into restoring the Hanan-Detwiler fish return channel.

These recommendations were used to guide the development of conceptual and preliminary plans and ELJ layout.

Conceptual Design

The conceptual design included 17 ELJs, divided into seven design groups, that function independently from one another. The design groupings were arranged so the County and stakeholders could choose which treatments to move forward with in future design phases. Similarly, the riparian treatment options include two scenarios of planting areas of high and low priority. The higher priority plantings are closest to the river's edge with optional secondary plantings extending farther into the floodplain. See Figure 15 below.

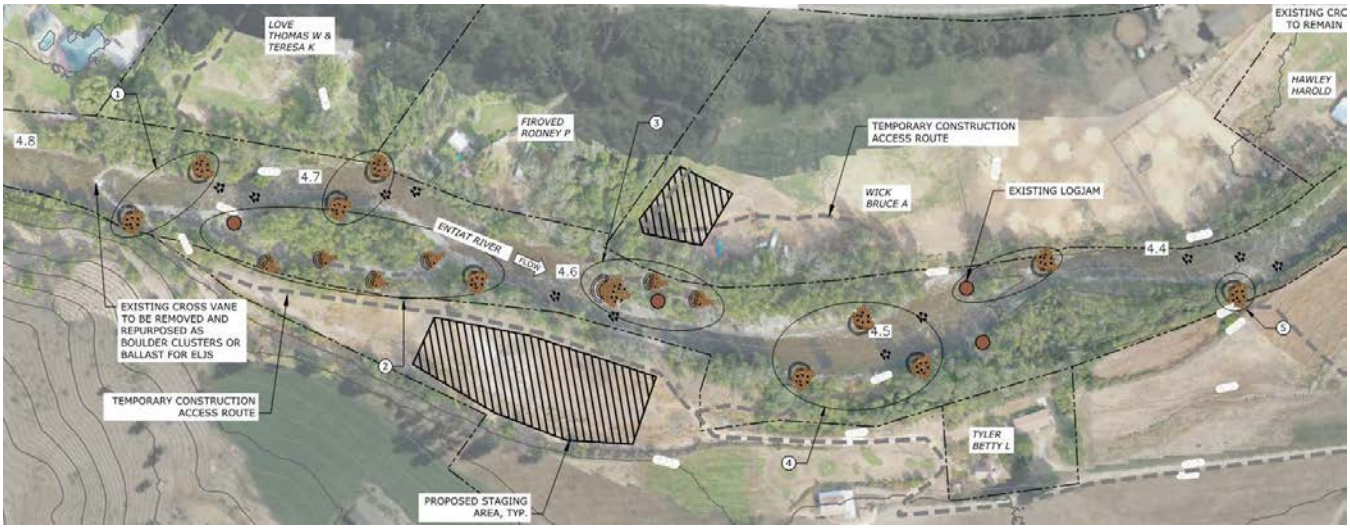


Figure 15: Conceptual Design overview from sheet 5 of the plans dated January 4, 2024

Deflector groups

The deflector groups include an array of 2-3 structures per group on the banks to provide in-stream complexity and allow wood to rack on the front of the structure. The deflector groups will provide cover, slow water down and increase pool habitat and placed in sections of the river that are deeper and slower, to have the most impact on river hydraulics and allow the formation of pools.

Side channel groups

The side channel groups proposed during the conceptual phase consisted of an apex at the head of each island (two of the three side channels have an existing island head jam, so no apex was proposed at those island

heads), and, where appropriate, smaller bank jams within the side channel. Additionally, a deflector was proposed at the outlet of each side channel. The apex jam was intended to split flows and rack loose wood. The smaller jams within the side channel were proposed to provide hydraulic complexity within the side channels and help form pools for resting areas. Deflector jams at the outlet of each side channel will encourage backwater and form pools.

Boulder clusters

The first upstream cross vane was proposed to be taken out and repurposed as boulder clusters to provide in-stream complexity or ballast for the ELJs. The downstream cross vane 75 ft upstream of Dinkleman Canyon Road bridge was proposed to stay in place.

Riparian Planting

Native trees and shrubs were proposed to be planted to increase riparian health and stream shading, establish wood recruitment potential, and provide an enhanced habitat corridor. High priority planting was proposed to extend at least 50 feet from the rivers edge to provide a buffer. Additional lower priority planting 100-200 feet further onto the floodplain was recommended pending landowner approval.

Preliminary Design

Preliminary designs were developed for the Lower Entiat based on an understanding of current geomorphic processes, the project goals and objectives, as well as basin-specific knowledge and expertise pertaining to similar projects. All project actions included in the preliminary design are intended to address specific project objectives directly or indirectly, and ultimately, the documented ecological concerns. Preliminary design plans are attached in Appendix A.

The preliminary design included the following analyses and updates:

- Updated hydraulic analysis and refinement of ELJ placement to further optimize desired hydraulic effects. This included building the ELJs into the surface to better understand expected effects.
- Refinement of ELJ structure design to improve structure stability and increase habitat benefits.

The hydraulic updates made during the preliminary design process show an increase in water surface elevation on the floodplain, with some rise to surrounding homeowners. Due to the confined area with private landowners on both sides of the river, water surface elevation rise is sensitive. To reduce rise, the ELJ count went from seventeen ELJs in conceptual to thirteen ELJs at the start of the preliminary process.

After discussions with the County, additional design adjustments were made to account for difficult construction access, culturally sensitive areas, and landowner restrictions. These updates resulted in a final ELJ count of nine. Figure 16 shows the water surface elevation for the Conceptual, Preliminary 1, and Preliminary 2 design stages. In summary, the following changes and updates were made for the final preliminary design:

- Keep the upstream cross vane in place to limit permitting hurdles and difficult construction access.
- Eliminate the boulder clusters that were proposed as they were planned to be sourced from the cross vane removal.
- The removal of the Group One right bank deflector ELJ, due to keeping the cross vane.
- The removal of the Group Three deflectors because of increased water surface elevation rise at the Firoved property.
- The removal of the Group Four apex ELJ due to increased left bank floodplain water surface elevation rise.

- The removal of the most downstream Group Five right bank deflector ELJ to encourage more flow to the downstream right bank side channel.
- The removal of the Group Six deflector because of increased left bank floodplain water surface elevation rise.
- The removal of the Group Seven deflector due to a culturally sensitive area.
- The limiting of priority riparian buffer on the left bank to 25 feet from the river's edge, down from 50 ft. The right bank secondary riparian buffer was removed, and priority planting buffers were changed to cluster planting due to landowner plans to establish land for cattle.

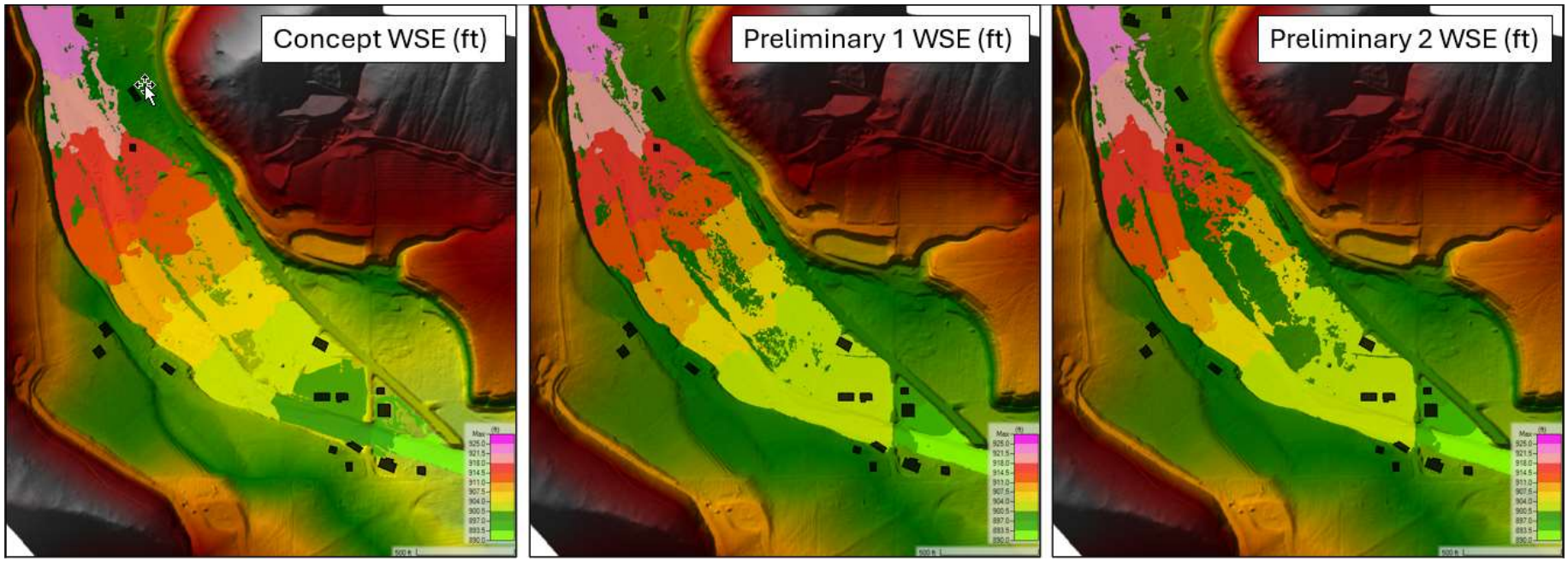


Figure 16 : Concept, Preliminary 1, and Preliminary 2 design 100-year WSE (ft).

Engineered Log Jam Design

The goals of the ELJs remain the same from the conceptual design; The deflector groups will provide cover, slow water down and increase pool habitat and placed in sections of the river that are deeper and slower, to have the most impact on river hydraulics and the maintain the scour pool that will be constructed. The smaller jams within the side channel will provide hydraulic complexity within the side channels and help form pools for resting areas while slowing down flows. Both types of jams include a scour pool that will be excavated in front of the structure to provide immediate pool habitat.

The ELJs will utilize rootwad posts with some installed at a batter angle. The ELJs will need to be excavated prior to post placement. Post elevations (10 ft below thalweg for the side channel ELJs, and 15 ft below thalweg for the deflector ELJs) were determined based on stability calculations. Rootwad posts are recommended to be used instead of piles due to the large cobbles within the streambed. For both the side channel and deflector ELJs, racking and slash material is placed particularly on the upstream end and flanks of the ELJ to provide complex instream cover. The structures are designed such that scour will not destabilize the structure. If scour occurs, the structure is intended to "self-settle", essentially lowering the overall elevation of the structure in conjunction with scour; however the racking material at the front of the structure which is countersunk below the bed elevation should serve as a buffer against potential scour. The deflectors will include three bolted connections, at the final (top) layer of the ELJ with the large rootwads pinned to the rootwad posts. This is to prevent the top logs from floating away.

Reviewing the Reach Assessment report by the BOR, they recommend that to have the best impact, structures need to occupy at least 30% of active/bankfull channel and force significant flow divergence to maintain scour pools because of the coarse bed armor (USBR 2009). For the deflectors, the average active channel is approximately 100 feet in width, using the 1.25-year flow. This results in a structure that protrudes at least 30 feet perpendicular to flow. The design team updated the deflector jam design to extend 30 feet into the active channel and updated the location and increased the size of the scour pool based on this recommendation. To verify the effectiveness of this structure size in maintaining pool scour, we cross-checked this recommendation with our hydraulic model outputs, confirming that the proposed design should sustain pool scour under the anticipated flow conditions.

ELJ Risk-Based Design Analysis and ELJ Stability Factors of Safety

NSD applied the basic risk evaluation method as outlined in the Bureau of Reclamation (Reclamation) Large Woody Material - Risk Based Design Guidelines (Reclamation 2014) to broadly assess risk to the public and property associated with ELJ elements of the project. The Risk Guidelines make use of two risk matrices which quantify risk associated with ELJ project elements: The Property Damage Risk Matrix, and the Public Safety Risk Matrix. The Matrices quantify general characteristics of the project reach, structure setting, recreational use, and channel characteristics to categorize risk to the public and property as a result of project actions. Ratings for risks associated with public safety concerns and potential property damages result in a low or high and low, moderate, or high risks, respectively (Reclamation 2014). The ratings then result in recommended factors of safety for horizontal and vertical loads which are then applied to ELJ design.

The evaluation resulted in a public safety risk rating of "low", and a property damage risk rating of "moderate". Per the RBDG, these risk factors correspond to a 25-year design event with factors of safety of 1.5 and 1.75 for sliding and buoyancy, respectively. Factors of safety for rotation and overturning were determined to be not applicable for all structure types and were not considered. A summary of ELJ design parameters is provided in Table 6, a summary of required and calculated factors of safety (FOS) for the various ELJ types is included in Table 7.

Table 6. Summary of Risk-based ELJ Design (Reclamation 2014) Ratings and Resulting Factors of Safety

Design parameter	Design Factor
Design Event, RI, year	25
Design Event, Q, cfs	6,500
Public Safety Risk	Low
Property Damage Risk	Moderate
Buoyancy Factor of Safety, Required	1.75
Sliding Factor of Safety, Required	1.5

Table 7. ELJ Factors of Safely

Structure Type	Required Buoyancy FOS	Calculated Buoyancy FOS	Required Sliding FOS	Calculated Sliding FOS
Deflector Jam	1.75	2.58	1.5	1.5
Side Channel Jam	1.75	2.92	1.5	2.5

Site Restoration and Enhancement

A site restoration plan was developed for preliminary design which includes various forms of stabilization for areas disturbed during construction activities, as well as the enhancement of existing riparian areas that can benefit from diversification of forested cover, particularly through the reintroduction of coniferous species. Plant species schedules and planting quantities will be developed at a later design stage. The following site restoration and enhancement types are included in the preliminary design:

- **Floodplain Planting** – Primarily comprised of floodplain areas that currently have little to no existing vegetation. These areas are located along the river's edge, close to newly constructed ELJs. Areas would be revegetated with native trees and shrubs to be selected for adaptation to fluctuating levels of inundation and drought tolerance. The goal of this planting area is to reestablish mixed deciduous and coniferous riparian forest cover along with a dense shrub understory. Top dressing with wood chip mulch is recommended for areas that are not frequently inundated with overbank flows to retain moisture while canopy cover develops. Coordination with landowners to locate appropriate clusters for floodplain planting will be necessary.
- **Seeding** – Seeding is proposed for any areas not planted immediately following construction activities. For any seeding activities, a regionally appropriate permanent native seed mix of grasses and forbs will be used to stabilize exposed soils. Following application, certified weed-free straw mulch will be applied to seeded areas at a rate of 2,000 pounds per acre

Future Design Considerations

The following bullets are recommendations for the next phase of design:

- Complete wetland delineation survey to inform side channel and floodplain enhancement design and permitting pathways.
- Complete a cultural assessment within the project limits. Adjust restoration design, construction access and staging to minimize impacts as needed.
- Determine ESA permitting pathway to incorporate design and construction criteria into the next design phase.

- Continue to engage landowners on project updates, construction access and locations for riparian restoration opportunities.
- Continue refining ELJ placement and modeling updates to better understand project influence on local landowners.
- Within the project reach, the Entiat River is a regulatory floodway with adjacent Zone A areas and includes a mapped 100-year flood boundary and base flood elevations. Based on preliminary proposed model outputs and current design elements, a Conditional Letter of Map Revision (CLOMR) will likely need to be pursued.

ESTIMATED CONSTRUCTION COSTS AND METHODS

The preliminary level construction cost estimate is provided in Appendix C. The primary assumptions incorporated into the construction cost estimate are:

- All preliminary ELJs are being constructed and the riparian buffer and cluster planting areas are being planted.
- 35% contingency is added to all items to account for design and construction uncertainties.
- 8.5% sales tax is included in the construction subtotal.
- An assumed 10% (non-compounding) annual inflation rate is applied to estimate construction cost in 2026.
- 10% mobilization is included in the construction subtotal.
- Wood prices are included in the unit costs for each structure type and are based on similar projects in the region and can greatly vary by the time construction occurs.

REFERENCES

Andonaegui, C. 2001. Salmon, steelhead, and bull trout habitat limiting factors for the Wenatchee Subbasin (WRIA 45) and portions of WRIA 40 within Chelan County (Squilchuck, Stemilt, and Colockum drainages). Washington State Conservation Commission.

Federal Emergency Management Agency (FEMA). 2004. *Flood Insurance Study Number 530015V000B*. Chelan County, Washington, Unincorporated Areas. US Department of Homeland Security.

U.S. Bureau of Reclamation Technical Services Center (USBR). January 2009. *Entiat Tributary Assessment, Chelan County, Washington.* Department of the Interior.

U.S. Bureau of Reclamation Pacific northwest Region (USBR). April 2012. *Existing Projects Review, Lower Entiat River*. Department of the Interior.

U.S. Geological Surveys (USGS). 2001. National Water Information System data available on the World Wide Web (Water Data for the Nation). https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS& site_no= 12452990. Accessed October 9, 2024.

Upper Columbia Regional Technical Team (UCRTT). 2021. *A biological strategy to protect and restore salmonid habitat in the Upper Columbia Region*. A Draft Report to the Upper Columbia Salmon Recovery Board from The Upper Columbia Regional Technical Team.

UCSRB. 2020b. Step 2 Habitat Analysis Spreadsheet. https://www.ucsrb.org/mdocs-posts/step-2-habitat-analysis-spreadsheet_12102020/. Accessed March 30, 2021

UCSRB. 2020a Upper Columbia AU Prioritization Web Map. https://ucsrb.maps.arcgis.com/apps/webappviewer/index.html?id=d0cc3689fb534b7c94fade0dd2ea7b8e. Accessed March 30, 2021

UCSRB. 2021a. Life Stage Prioritization by AU Spring Chinook Wenatchee and Entiat Basins, Washington. January 2021. https://www.ucsrb.org/mdocs-posts/upper-columbia-prioritization-life-stage-priority-by-au/ Accessed March 30, 2021.

UCSRB. 2021b. Life Stage Prioritization by AU Steelhead Wenatchee and Entiat Basins, Washington. January 2021. https://www.ucsrb.org/mdocs-posts/upper-columbia-prioritization-life-stage-priority-by-au/ Accessed March 30, 2021.

APPENDICES

Appendix A: Preliminary Design Plans

Appendix B: Preliminary Hydraulic Model Results

Appendix C: Preliminary Construction Cost Estimate

Appendix A

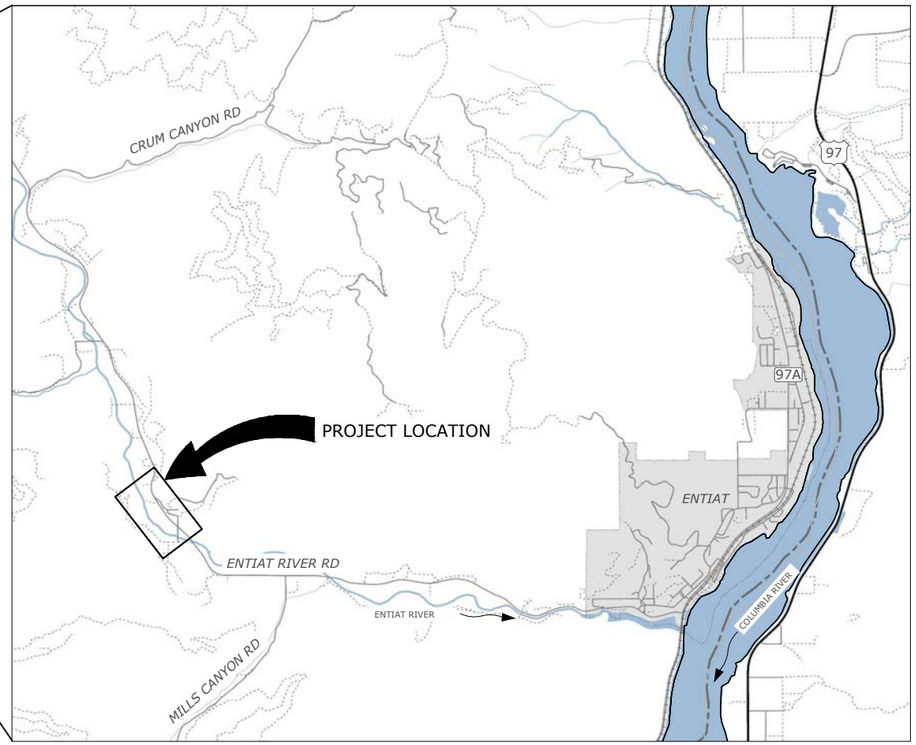
Preliminary Design Plans

LOWER ENTIAT 1D REACH

RIVER MILE 4.3 - 4.8 HABITAT ENHANCEMENT PROJECT

CHELAN COUNTY NATURAL RESOURCE DEPARTMENT

STATE OF WASHINGTON
SCALE: 1" = 50 MILES



3000' 0 3000' 6000'

VICINITY MAP
SCALE: 1" = 3000'

N

SHEET LIST	
SHEET #	TITLE
1	COVER SHEET
2	GENERAL NOTES
3	LEGEND
4	EXISTING CONDITIONS
5	PROPOSED CONDITIONS
6	DEFLECTOR ELJ
7	DEFLECTOR LAYERING PLAN
8	DEFLECTOR LAYERING PLAN
9	SIDE CHANNEL ELJ
10	SIDE CHANNEL ELJ LAYERING PLAN
11	STABILIZE EXISTING LOGJAM
12	ACCESS, STAGING, AND SITE ISOLATION PLAN
13	REVEGETATION PLANS
14	ELJ DETAILS
15	SITE ISOLATION DETAILS
16	TESC DETAILS

CONTACT INFORMATION

ENGINEER: NATURAL SYSTEMS DESIGN, INC
1900 N NORTHLAKE WAY, SUITE 211
SEATTLE, WA 98103
(206) 834-0175

CONTRACTING AGENCY: CHELAN COUNTY NATURAL RESOURCE DEPARTMENT
411 WASHINGTON STREET, SUITE 201
WENATCHEE, WA 98801
(509) 667-6533

Natural Systems Design + Coastal Geologic Services

GRACE CATHERINE RACCI
STATE OF WASHINGTON
22008901
REGISTERED PROFESSIONAL ENGINEER

60% DESIGN
NOT FOR CONSTRUCTION

CHELAN COUNTY NATURAL RESOURCE DEPARTMENT
LOWER ENTIAT 1D REACH (RM 4.3 - 4.8) HABITAT ENHANCEMENT PROJECT
COVER SHEET
PRELIMINARY

DATE 12/23/2024
COUNTY CHELAN COUNTY
LATITUDE 47°40'20"N
LONGITUDE 120°18'27"W
TN/SC/RG T25N/S10/R20E
DESIGN GB DRAWN KS
CHECK NT CHECK NT

0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT PLOTTED TO ORIGINAL SCALE.

SHEET
1 OF 16

P:\PROJECTS\CHELAN COUNTY\LOWER ENTIAT RM 4.6\DESIGN\CAD\COVER SHEET.DWG Grace 12/31/2024 12:22:25 PM

GENERAL NOTES

1. THESE PLANS HAVE BEEN PREPARED FOR THE EXCLUSIVE USE OF CHELAN COUNTY NATURAL RESOURCE DEPARTMENT (CCNRD), HEREAFTER REFERRED TO AS "OWNER", AND THEIR AUTHORIZED AGENTS.
2. NATURAL SYSTEMS DESIGN, HEREAFTER REFERRED TO AS "ENGINEER" IS RESPONSIBLE FOR THE PREPARATION OF THESE ORIGINAL PLANS AND ASSOCIATED SPECIFICATIONS; AND WILL NOT BE RESPONSIBLE FOR, OR LIABLE FOR, UNAUTHORIZED CHANGE, OR USE, OF THESE PLANS WHICH INCLUDES ALTERATION, DELETION, OR EDITING OF THIS DOCUMENT WITHOUT EXPLICIT WRITTEN PERMISSION FROM THE ENGINEER. ANY OTHER UNAUTHORIZED USE OF THIS DOCUMENT IS PROHIBITED.
3. THE LOCATION OF ALL FEATURES SHOWN IS APPROXIMATE. FINAL LOCATIONS SHALL BE FLAGGED IN THE FIELD BY THE ENGINEER PRIOR TO CONSTRUCTION.

PERMIT NOTES

1. THE CONTRACTOR SHALL CONDUCT THE ACTIVITIES SHOWN IN THESE PLANS IN A MANNER THAT MINIMIZES THE ADVERSE IMPACT ON WATER QUALITY, FISH AND WILDLIFE, AND THE NATURAL ENVIRONMENT.
2. ALL WORK SHALL BE IN COMPLIANCE WITH PERMIT CONDITIONS. IT IS THE CONTRACTOR'S RESPONSIBILITY TO HAVE COPIES OF ALL PERMITS ON THE JOB SITE, UNDERSTAND AND COMPLY WITH ALL PERMIT CONDITIONS.
3. IF AT ANY TIME FISH ARE OBSERVED IN DISTRESS, A FISH KILL OCCURS, OR WATER QUALITY PROBLEMS DEVELOP (INCLUDING EQUIPMENT LEAKS OR SPILLS), OPERATIONS SHALL CEASE AND THE OWNER SHALL BE NOTIFIED IMMEDIATELY.
4. AVOID AND MINIMIZE ADVERSE IMPACTS TO WATERS OF THE UNITED STATES, INCLUDING MINIMIZING THE NUMBER, DURATION, AND EXTENT OF WORK BELOW ORDINARY HIGH WATER AND EQUIPMENT CROSSINGS OF WETTED CHANNELS.
5. IF, DURING CONSTRUCTION, ARCHAEOLOGICAL REMAINS ARE ENCOUNTERED, CONSTRUCTION IN THE VICINITY SHALL BE HALTED, AND THE STATE OFFICE OF HISTORIC PRESERVATION AND THE OWNER SHALL BE NOTIFIED IMMEDIATELY.

SURVEY NOTES

1. SURVEY/LIDAR FOR THIS PROJECT WAS COLLECTED IN 2022 AND IS REPRESENTATIVE OF 2021 CONDITIONS. THE VERTICAL DATUM IS NAVD88 (FT). THE HORIZONTAL DATUM IS NAD83 WASHINGTON STATE PLANE NORTH AND THE UNIT IS US SURVEY FEET.
2. GATES, FENCELINES, AND UTILITIES WERE NOT SURVEYED. CONTRACTOR TO VERIFY IN FIELD.
3. PARCEL BOUNDARIES ARE FROM CHELAN COUNTY AND ARE NOT SURVEYED.
4. AERIAL IMAGERY WAS COLLECTED IN 2023 (CCNRD).

CONSTRUCTION NOTES

1. THE CONTRACTOR SHALL ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR JOB SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION OF THIS PROJECT, INCLUDING SAFETY OF ALL PERSONS AND PROPERTY.
2. CONSTRUCTION HOURS SHALL BE WEEKDAYS BETWEEN 7:00 A.M. AND 6:30 P.M. UNLESS PRIOR APPROVAL IS RECEIVED FROM THE OWNER.
3. ANY DISCREPANCIES ARE TO BE BROUGHT TO THE ATTENTION OF THE OWNER PRIOR TO PROCEEDING WITH THE WORK.
4. THE CONTRACTOR SHALL PROTECT ALL EXISTING STRUCTURES, VEGETATION, AND IMPROVEMENTS NOT INDICATED FOR REMOVAL.
5. THE CONTRACTOR SHALL KEEP THE JOB SITE CLEAN AND HAZARD FREE.
6. THE CONTRACTOR SHALL DISPOSE OF ALL DIRT, DEBRIS, AND RUBBISH GENERATED BY THE WORK. UPON COMPLETION OF WORK, CONTRACTOR SHALL REMOVE ALL MATERIAL AND EQUIPMENT NOT SPECIFIED AS REMAINING ON THE PROPERTY.
7. NO TREES OR VEGETATION SHALL BE REMOVED UNLESS NOTED ON THE PLANS OR SPECIFIED ON-SITE BY THE OWNER OR THE ENGINEER. NO GRADING SHALL TAKE PLACE WITHIN THE DRIP LINE OF TREES NOT TO BE REMOVED UNLESS OTHERWISE APPROVED.
8. THE CONTRACTOR SHALL MAINTAIN A SET OF PLANS ON THE JOB SHOWING "AS-CONSTRUCTED" CHANGES MADE TO DATE. UPON COMPLETION OF THE PROJECT, THE CONTRACTOR SHALL SUPPLY TO OWNER A SET OF PLANS, MARKED UP TO THE SATISFACTION OF THE OWNER, REFLECTING THE AS-CONSTRUCTED MODIFICATIONS.

ELJ NOTES

1. ALL LOGS SHALL BE DOUGLAS FIR OR WESTERN RED CEDAR.
2. ALL ROOTWAD POSTS SHALL BE DOUGLAS FIR. POSTS SHALL BE FREE FROM DEFECTS, CRACKS, AND SPLITTING AT THE TIME OF PLACEMENT.
3. LOGS SHALL HAVE SPECIFIED DIAMETERS AS MEASURED AT DBH, DEFINED AS 4.5 FEET ABOVE GROUND WHEN TREE WAS STANDING.
4. EXISTING WOODY MATERIAL AT THE STRUCTURE LOCATION SHALL BE MOVED OR PROTECTED FROM CONSTRUCTION ACTIVITIES AND THEN INCORPORATED INTO THE STRUCTURE AS DIRECTED BY THE CONTRACTING OFFICER.
5. POST EMBEDMENT DEPTH FOR EACH ELJ SHALL BE MEASURED RELATIVE TO THE CHANNEL THALWEG. EXCAVATION DEPTHS AND QUANTITIES IN THE STRUCTURE SCHEDULE ARE BASED ON LIDAR COLLECTED IN 2022, AND EXISTING GRADE ELEVATIONS AND ASSOCIATED EXCAVATION DEPTHS MAY BE OFF BY SEVERAL FEET. ACTUAL EXCAVATION DEPTHS SHALL BE PROVIDED BY THE ENGINEER WHEN THE STRUCTURE LOCATION IS STAKED PRIOR TO CONSTRUCTION.
6. KEY LOGS, FRAMING LOGS, AND PILES SHALL HAVE AN ALUMINUM TAG AFFIXED PER RCW 77.85.050(5E). ALUMINUM TAGS SHALL BE A MINIMUM OF 1 ¼ INCHES IN DIAMETER. AT CONSTRUCTION COMPLETION, A RECORD OF THE TAG NUMBERS BROKEN DOWN BY STRUCTURE ID SHALL BE PROVIDED TO THE OWNER.

SUMMARY OF QUANTITIES

ITEM #	ITEM DESCRIPTION	QTY	UNIT
1	MOBILIZATION	1	LS
2	TEMPORARY EROSION AND SEDIMENT CONTROL	1	LS
3	ACCESS & STAGING	1	LS
4	SEEDING	1	LS
5	DEFLECTOR ELJ	4	EA
6	SIDE CHANNEL ELJ	5	EA
7	STABILIZE EXISTING LOGJAM	1	EA

NSD CGS
Natural Systems Design
+ Coastal Geologic Services

GRACE CATHERINE PACCI
STATE OF WASHINGTON
22008901
REGISTERED
PROFESSIONAL ENGINEER

60% DESIGN SUBMISSION
NOT FOR CONSTRUCTION

CHELAN COUNTY NATURAL RESOURCE DEPARTMENT
LOWER ENTIAT 1D REACH (RM 4.3 - 4.8) HABITAT
ENHANCEMENT PROJECT

GENERAL NOTES

PRELIMINARY

DATE 12/23/2024
COUNTY CHELAN COUNTY
LATITUDE 47°40'20"N
LONGITUDE 120°18'27"W
TN/SC/RG T25N/S10/R20E
DESIGN GB DRAWN KS
CHECK NT CHECK NT

0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT PLOTTED TO ORIGINAL SCALE.

SHEET
2 OF 16

P:\PROJECTS\CHELAN COUNTY\LOWER ENTIAT RM 4.6\DESIGN\CAD\GENERAL NOTES.DWG Grace 12/31/2024 12:22:32 PM

GENERAL LEGEND

SITE FEATURES

EXISTING NATURALLY OCCURRING LOGJAM

SURVEY AND LEGAL BOUNDARIES

EXISTING PROPERTY LINE

EXISTING RIGHT OF WAY

EXISTING BUILDING FOOTPRINTS

TOPOGRAPHY & GRADING

EXISTING MINOR CONTOUR

EXISTING MAJOR CONTOUR

NATURAL RESOURCES

LOW FLOW CHANNEL

ORDINARY HIGH WATER LINE

EXISTING WETLAND

EXISTING CHANNEL THALWEG

RIVER MILE

SITE PREPARATION AND DEWATERING

TEMPORARY ACCESS ROUTE

STAGING AREA

COFFERDAM

HIGH VISIBILITY FENCE

HABITAT STRUCTURES

DEFLECTOR ENGINEERED LOGJAM

SIDE CHANNEL ENGINEERED LOGJAM

STABILIZED EXISTING LOGJAM

VEGETATION & SITE RESTORATION

PRIMARY RESTORATION AREA

SEEDING

SECTION LINE

SECTION LINE WITH SHEET REFERENCE

NSD CGS
Natural Systems Design
+ Coastal Geologic Services

GRACE CATHERINE PACCI
STATE OF WASHINGTON
22008901
REGISTERED
PROFESSIONAL ENGINEER

60% DESIGN
NOT FOR CONSTRUCTION

CHELAN COUNTY NATURAL RESOURCE DEPARTMENT
LOWER ENTIAT 1D REACH (RM 4.3 - 4.8) HABITAT
ENHANCEMENT PROJECT

LEGEND

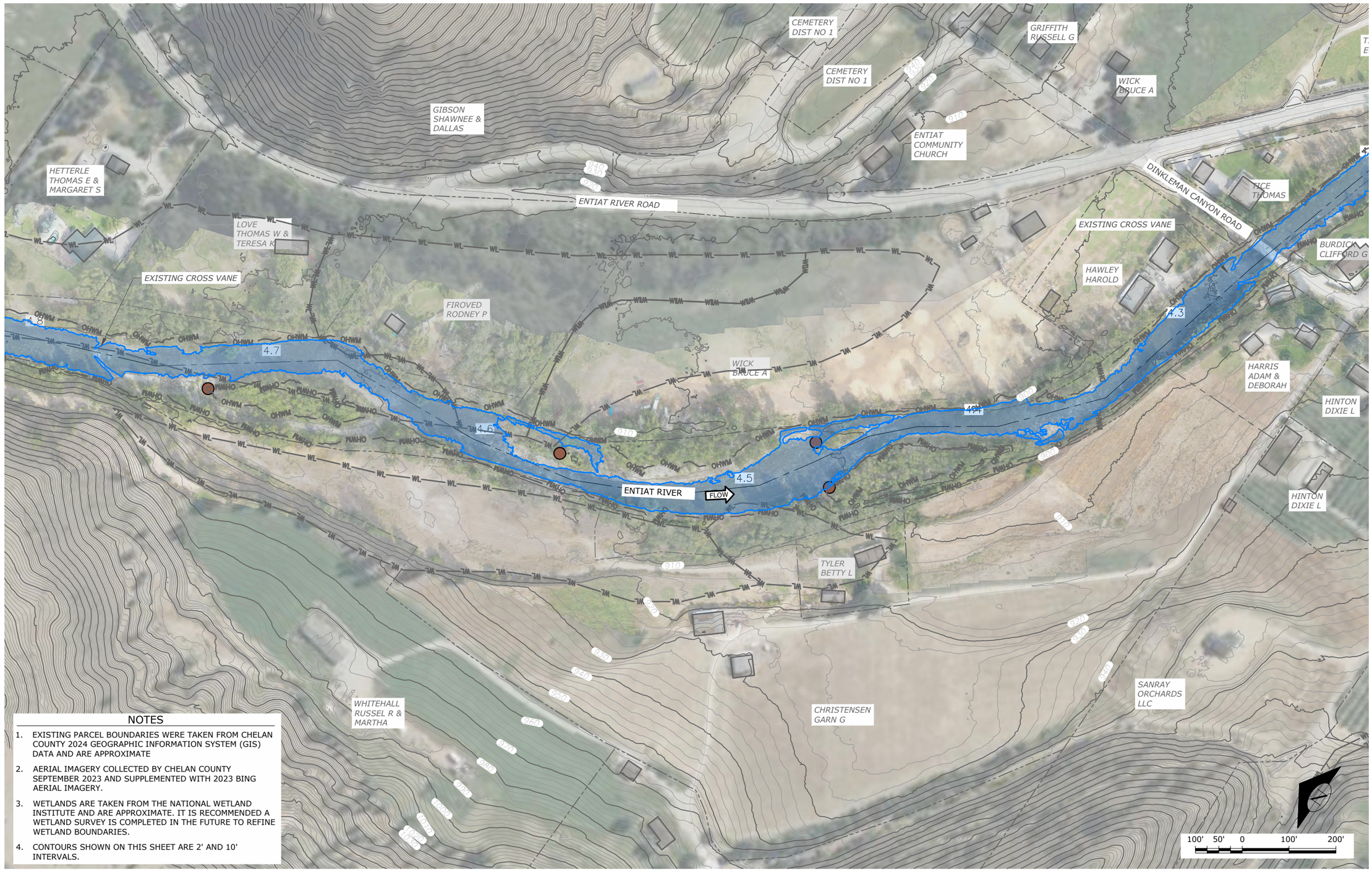
PRELIMINARY

DATE 12/23/2024
COUNTY CHELAN COUNTY
LATITUDE 47°40'20"N
LONGITUDE 120°18'27"W
TN/SC/RG T25N/S10/R20E
DESIGN GB DRAWN KS
CHECK NT CHECK NT

0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT PLOTTED TO ORIGINAL SCALE.

SHEET
3 OF 16

P:\PROJECTS\CHELAN COUNTY\LOWER ENTIAT RM 4.6\DESIGN\CAD\LEGEND.DWG Grace 12/31/2024 12:22:40 PM



NOTES

1. EXISTING PARCEL BOUNDARIES WERE TAKEN FROM CHELAN COUNTY 2024 GEOGRAPHIC INFORMATION SYSTEM (GIS) DATA AND ARE APPROXIMATE
2. AERIAL IMAGERY COLLECTED BY CHELAN COUNTY SEPTEMBER 2023 AND SUPPLEMENTED WITH 2023 BING AERIAL IMAGERY.
3. WETLANDS ARE TAKEN FROM THE NATIONAL WETLAND INSTITUTE AND ARE APPROXIMATE. IT IS RECOMMENDED A WETLAND SURVEY IS COMPLETED IN THE FUTURE TO REFINE WETLAND BOUNDARIES.
4. CONTOURS SHOWN ON THIS SHEET ARE 2' AND 10' INTERVALS.

NSD CGS
Natural Systems Design
+ Coastal Geologic Services

GRACE CATHERINE RAGGI
STATE OF WASHINGTON
22008901
REGISTERED PROFESSIONAL ENGINEER

60% DESIGN SUBMISSION
NOT FOR CONSTRUCTION

CHELAN COUNTY NATURAL RESOURCE DEPARTMENT
LOWER ENTIAT 1D REACH (RM 4.3 - 4.8) HABITAT ENHANCEMENT PROJECT

EXISTING CONDITIONS

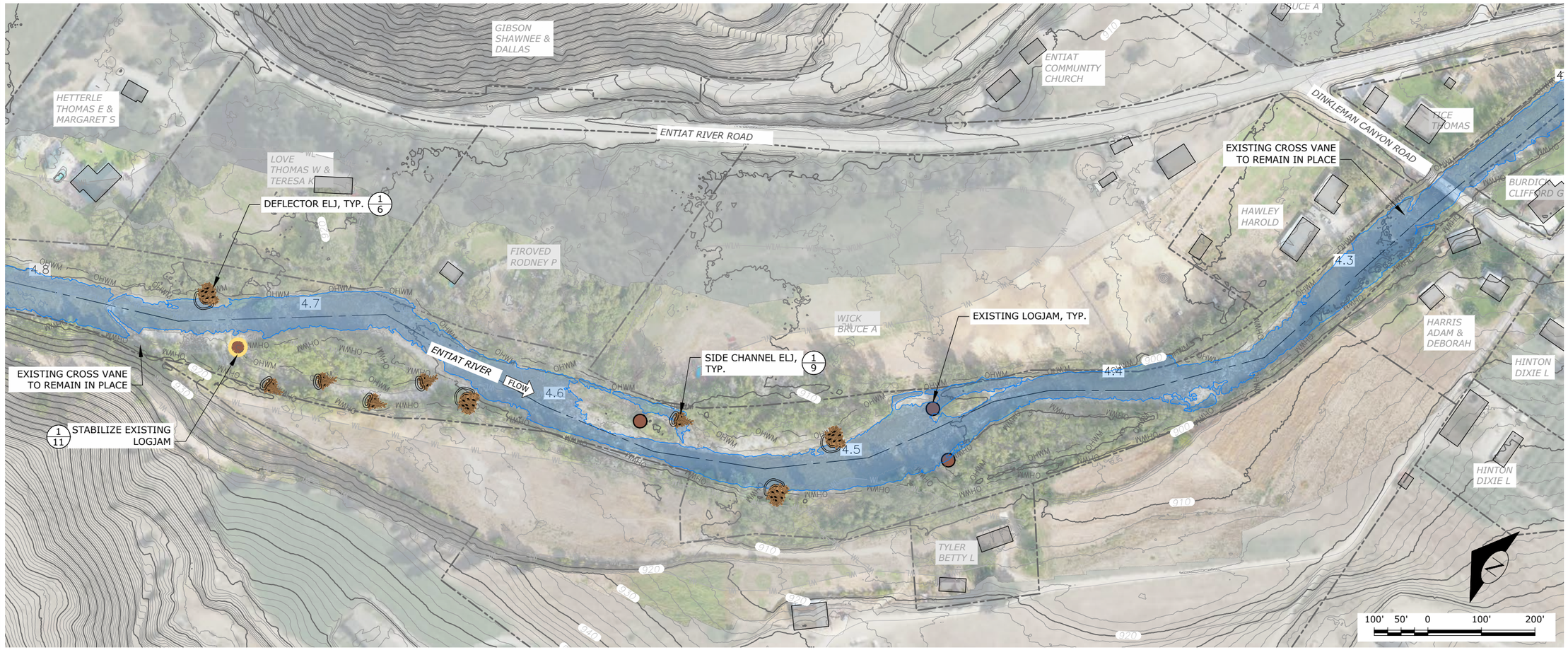
PRELIMINARY

DATE 12/23/2024
COUNTY CHELAN COUNTY
LATITUDE 47°40'20"N
LONGITUDE 120°18'27"W
TN/SC/RG T25N/S10/R20E
DESIGN GB DRAWN KS
CHECK NT CHECK NT

0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT PLOTTED TO ORIGINAL SCALE.

SHEET
4 OF 16

P:\PROJECTS\CHELAN COUNTY\LOWER ENTIAT RM 4.6\DESIGN\CAD\EXISTING CONDITIONS.DWG Grace 12/31/2024 12:24:34 PM



PROPOSED CONDITIONS
SCALE: 1" = 100'

NOTES

1. LOCATIONS SHOWN ARE APPROXIMATE AND WILL BE ADJUSTED IN THE FIELD BY THE ENGINEER.
2. AERIAL IMAGERY COLLECTED BY CHELAN COUNTY SEPTEMBER 2023 AND SUPPLEMENTED WITH 2023 BING AERIAL IMAGERY.
3. WETLANDS ARE TAKEN FROM THE NATIONAL WETLAND INSTITUTE AND ARE APPROXIMATE. IT IS RECOMMENDED A WETLAND SURVEY IS COMPLETED IN THE FUTURE TO REFINE WETLAND BOUNDARIES.
4. CONTOURS SHOWN ON THIS SHEET ARE 2' AND 10' INTERVALS.

NSD CGS
Natural Systems Design
+ Coastal Geologic Services

GRACE CATHERINE PAGET
STATE OF WASHINGTON
22008901
REGISTERED PROFESSIONAL ENGINEER

60% DESIGN SUBMISSION
NOT FOR CONSTRUCTION

CHELAN COUNTY NATURAL RESOURCE DEPARTMENT
LOWER ENTIAT 1D REACH (RM 4.3 - 4.8) HABITAT ENHANCEMENT PROJECT

PROPOSED CONDITIONS

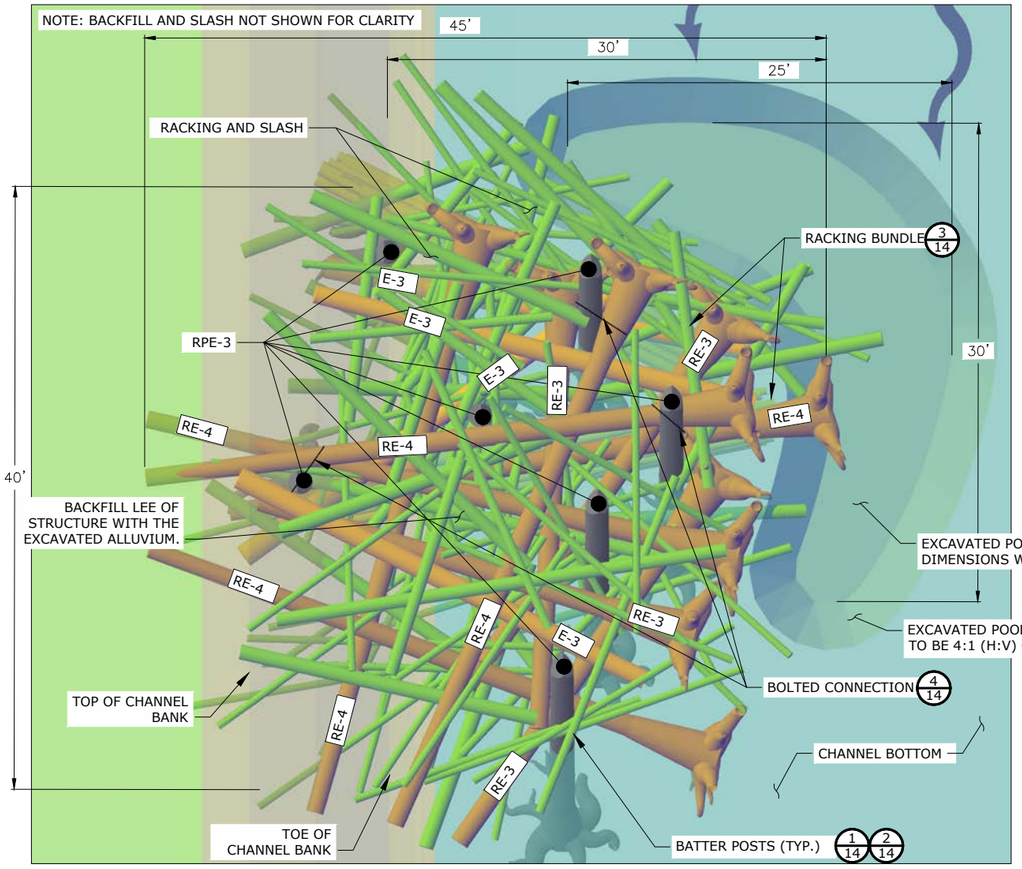
PRELIMINARY

DATE 12/23/2024
COUNTY CHELAN COUNTY
LATITUDE 47°40'20"N
LONGITUDE 120°18'27"W
TN/SC/RG T25N/S10/R20E
DESIGN GB DRAWN KS
CHECK NT CHECK NT

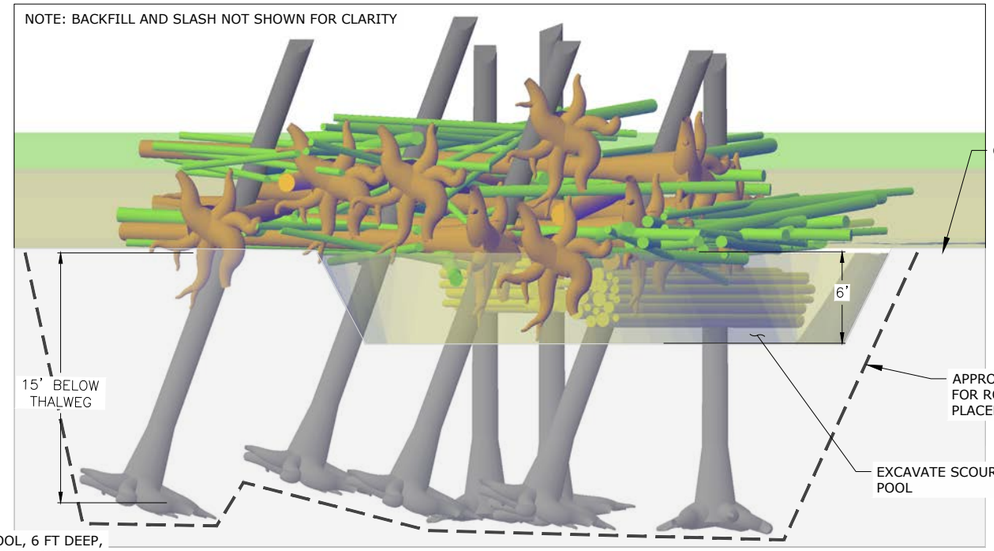
0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT PLOTTED TO ORIGINAL SCALE.

SHEET
5 OF 16

P:\PROJECTS\CHELAN COUNTY\LOWER ENTIAT RM 4.6\DESIGN\CAD\PROP_CONDITIONS.DWG Grace 12/31/2024 12:26:11 PM



DEFLECTOR ELJ PLAN
SCALE: 1" = 5'



DEFLECTOR ELJ PROFILE
SCALE: 1" = 5'

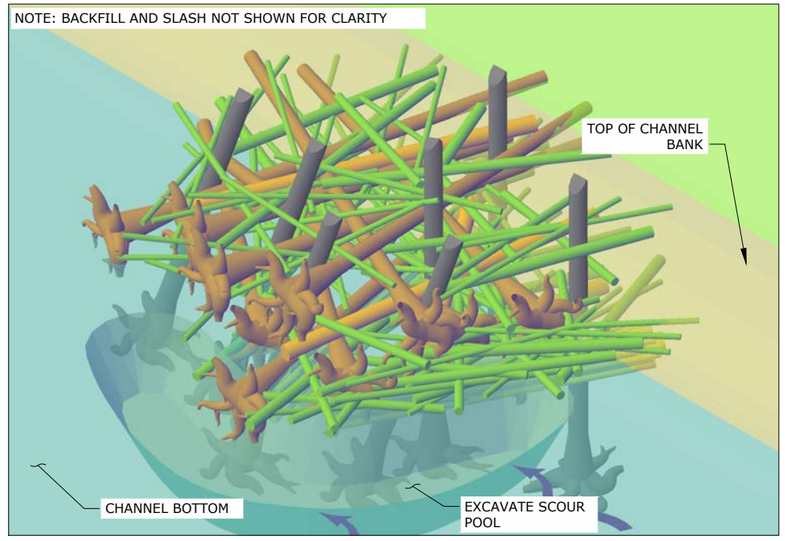
DEFLECTOR ELJ MATERIALS SCHEDULE

LOG ID	DIA (INCHES)	LENGTH (FT)	ROOTWAD (Y/N)	QUANTITY PER STRUCTURE
RPE-3	18	30	YES	7
RE-4	18	40	YES	6
RE-3	18	30	YES	4
E-3	18	30	NO	4
RACKING BUNDLE	36	30	NO	2
RACKING	6-12	20-40	NO	100
SLASH	1-3	N/A	NO	50 CY
BOLTED CONNECTION	N/A	N/A	N/A	3

EXAMPLE OF COMPLETED DEFLECTOR ELJ

NOTES

1. EXTENT AND LOCATION OF SCOUR POOL IS APPROXIMATE.
2. SOIL EXCAVATED DURING CONSTRUCTION SHALL BE TEMPORARILY STOCKPILED, AND USED AS BACKFILL ON BACKSIDE OF STRUCTURE.
3. BACKFILL EXTENTS MAY VARY.
4. ALL LOGS, SLASH MATERIAL, AND RACKING PIECES REQUIRED SHALL BE PROVIDED BY THE CONTRACTING AGENCY AND ARE STOCKPILED AT THE PROJECT SITE.
5. CAREFULLY HANDLE, TRANSPORT, AND STAGE PROVIDED WOODY MATERIAL FOR ELJ CONSTRUCTION. ANY WOODY MATERIAL DAMAGED AS A DIRECT RESULT OF CONTRACTOR ACTIONS SHALL BE REPLACED IN-KIND AT NO ADDITIONAL COST TO THE CONTRACTING AGENCY.
6. FINAL LOCATIONS OF EACH ELJ WILL BE DETERMINED IN THE FIELD BY THE ENGINEER. THE CONTRACTING AGENCY WILL INSTALL STAKES AT TWO STAKEOUT POINTS FOR EACH ELJ. THE CONTRACTOR SHALL EXPAND THIS STAKING AS NECESSARY TO DEFINE THE STRUCTURE EXTENTS, POST LOCATIONS, EXCAVATION EXTENTS, AND DESIGN ELEVATIONS.
7. THE CONTRACTOR SHALL DETERMINE THE EXCAVATION LIMITS TO MAINTAIN A SAFE EXCAVATION DURING ELJ INSTALLATION. TEMPORARY AND PERMANENT EXCAVATION SPOILS SHALL BE PLACED TO MINIMIZE DISTURBANCE TO EXISTING VEGETATION.
8. NO EXCAVATION WITHIN THE ACTIVELY FLOWING CHANNEL SHALL OCCUR UNTIL THE WORK AREA HAS BEEN ISOLATED AND AQUATIC LIFE HAS BEEN REMOVED FROM THE INTERIOR OF THE ISOLATION.
9. THE EXCAVATION SHALL BE SUFFICIENTLY DEWATERED TO ALLOW COMPLETION AND INSPECTION OF ELJ INSTALLATION IN A CONTROLLED MANNER.
10. EXISTING WOODY MATERIAL AT THE STRUCTURE CONSTRUCTION SITE SHALL BE MOVED OR PROTECTED FROM CONSTRUCTION ACTIVITIES AND THEN INCORPORATED INTO THE STRUCTURE AND BACKFILL AS APPROVED BY THE CONTRACTING OFFICER.



DEFLECTOR ELJ PERSPECTIVE
SCALE: 1" = 5'

DEFLECTOR ELJ
SCALE: AS NOTED

1
6

NSD CGS
Natural Systems Design
+ Coastal Geologic Services

GRACE CATHERINE RAGGI
STATE OF WASHINGTON
22008901
REGISTERED PROFESSIONAL ENGINEER

60% DESIGN
NOT FOR CONSTRUCTION

CHELAN COUNTY NATURAL RESOURCE DEPARTMENT
LOWER ENTIAT 1D REACH (RM 4.3 - 4.8) HABITAT ENHANCEMENT PROJECT

DEFLECTOR ELJ

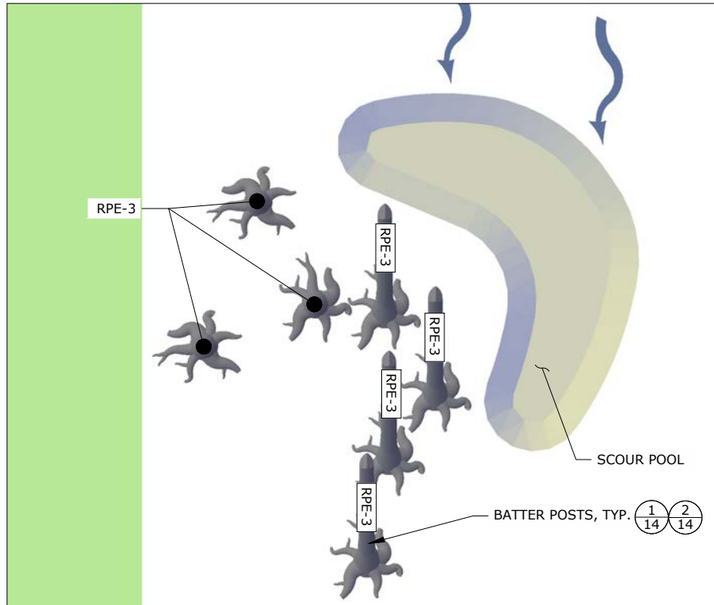
PRELIMINARY

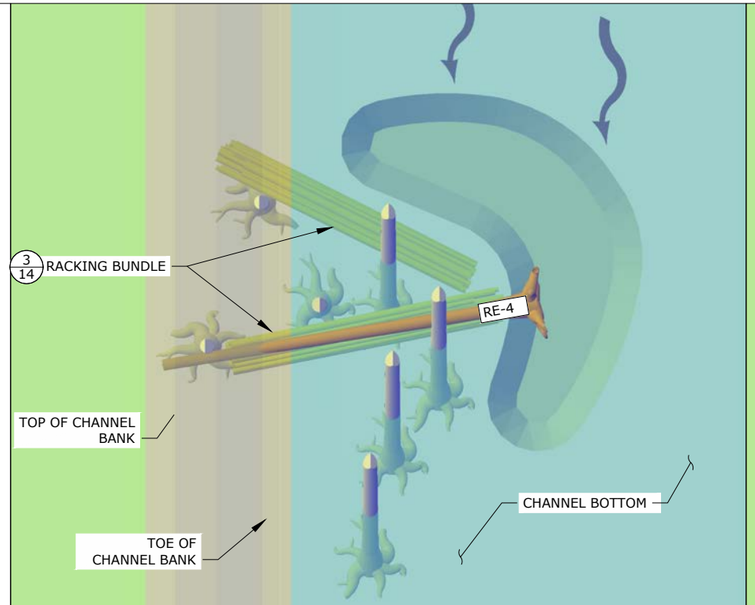
DATE 12/23/2024
COUNTY CHELAN COUNTY
LATITUDE 47°40'20"N
LONGITUDE 120°18'27"W
TN/SC/RG T25N/S10/R20E
DESIGN GB DRAWN KS
CHECK NT CHECK NT

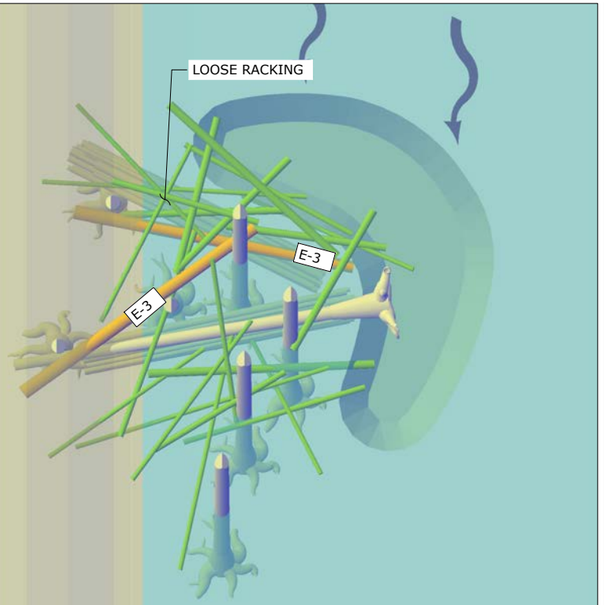
0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT PLOTTED TO ORIGINAL SCALE.

SHEET
6 OF 16

P:\PROJECTS\CHELAN COUNTY\LOWER ENTIAT RM 4.6\DESIGN\CAD\DEFLECTOR ELJ.DWG Grace 12/31/2024 12:26:31 PM

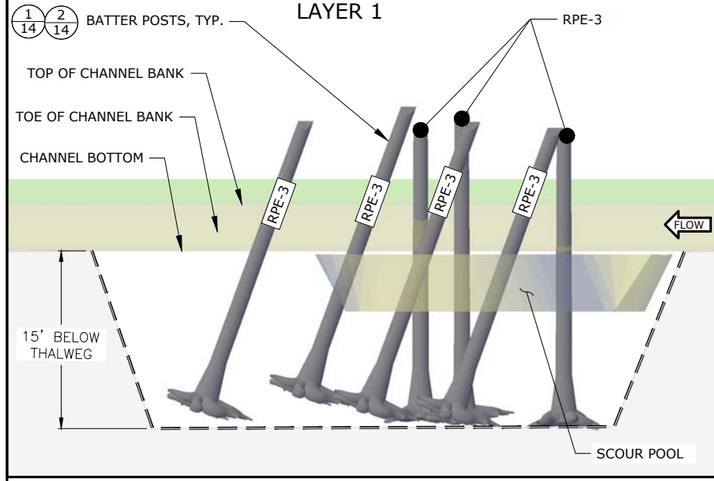






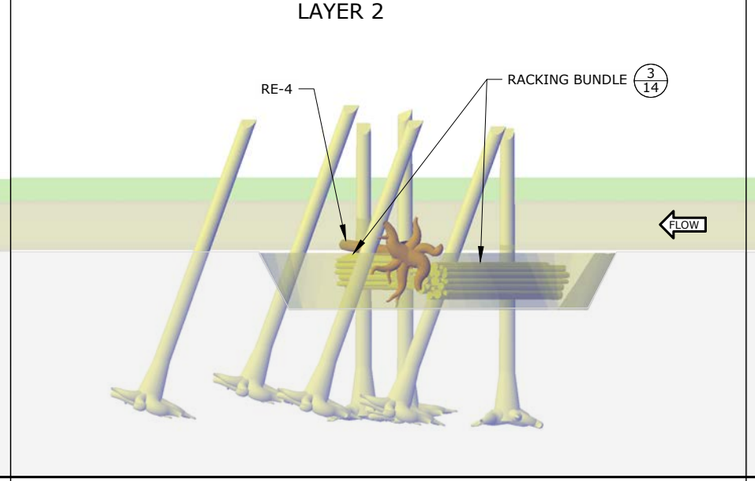
PLAN VIEWS 8' 4' 0 8' 16'

LAYER 1



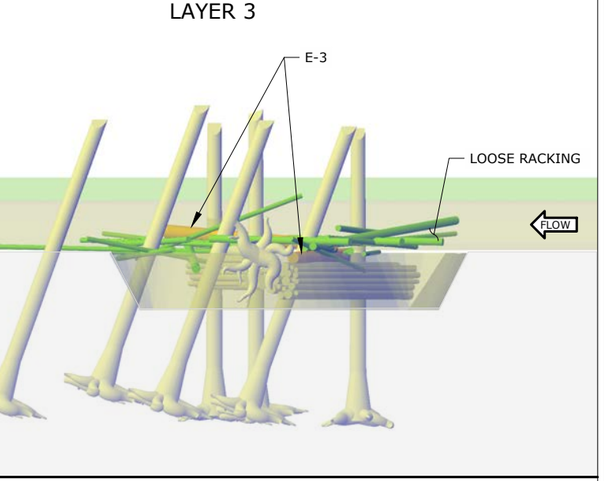
1. EXCAVATE 15 FEET BELOW THALWEG FOR ROOTWAD POST PLACEMENT.
2. EXCAVATE SCOUR POOL.
3. PLACE SEVEN (7) RPE-3 ROOTWAD POSTS, BATTER FOUR (4) POSTS AS SHOWN.
4. BACKFILL TO APPROXIMATELY 4 FEET BELOW GROUND SURFACE.

LAYER 2



1. PLACE TWO (2) 30-FOOT LONG RACKING BUNDLES.
2. PLACE ONE (1) RE-4 ROOTWAD ON TOP OF BUNDLE.

LAYER 3



1. BACKFILL TO APPROXIMATELY 2 FEET BELOW GROUND SURFACE.
2. PLACE TWO (2) E-3 LOGS.
3. FILL SPACE IN BETWEEN ROOTWAD POSTS WITH LOOSE RACKING.
4. BACKFILL TO GROUND SURFACE.

SECTION VIEWS 8' 4' 0 8' 16'

NSD CGS
Natural Systems Design
+ Coastal Geologic Services

GRACE CATHERINE RACCI
STATE OF WASHINGTON
22008901
REGISTERED
PROFESSIONAL ENGINEER

60% DESIGN
NOT FOR CONSTRUCTION

CHELAN COUNTY NATURAL RESOURCE DEPARTMENT
LOWER ENTIAT 1D REACH (RM 4.3 - 4.8) HABITAT
ENHANCEMENT PROJECT

DEFLECTOR LAYERING PLAN

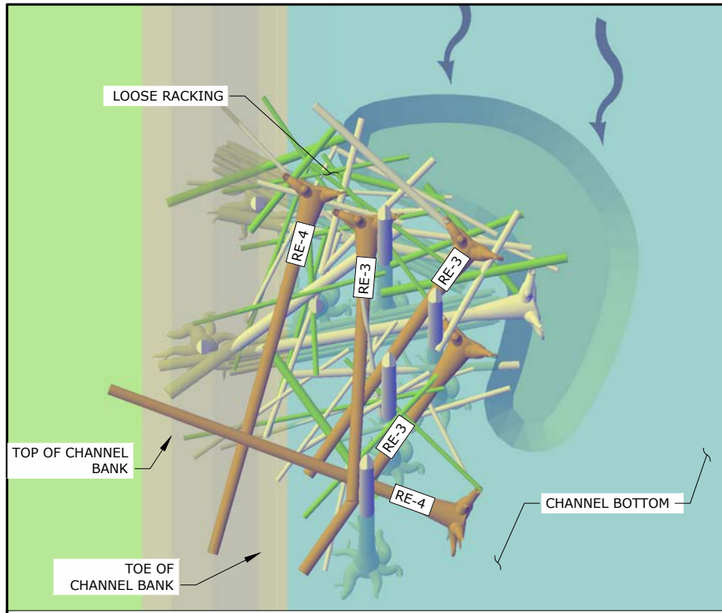
PRELIMINARY

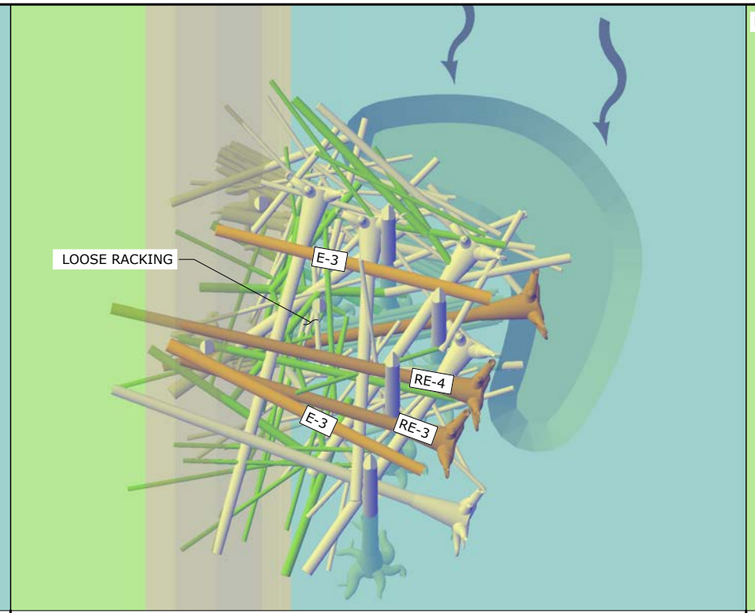
DATE 12/23/2024
COUNTY CHELAN COUNTY
LATITUDE 47°40'20"N
LONGITUDE 120°18'27"W
TN/SC/RG T25N/S10/R20E
DESIGN GB DRAWN KS
CHECK NT CHECK NT

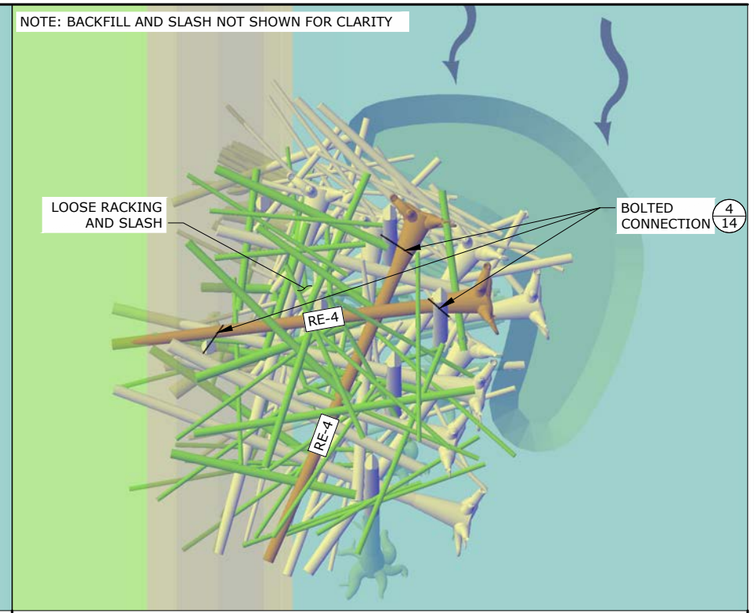
0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT PLOTTED TO ORIGINAL SCALE.

SHEET
7 OF 16

P:\PROJECTS\CHELAN COUNTY\LOWER ENTIAT RM 4.6\DESIGN\CAD\DEFLECTOR ELJ.DWG Grace 12/31/2024 12:26:35 PM



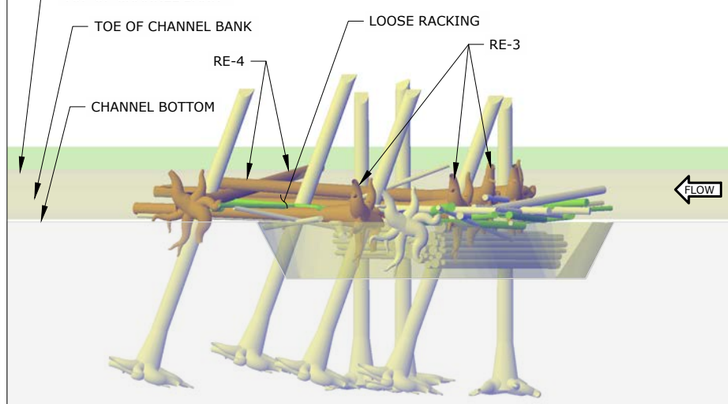




PLAN VIEWS

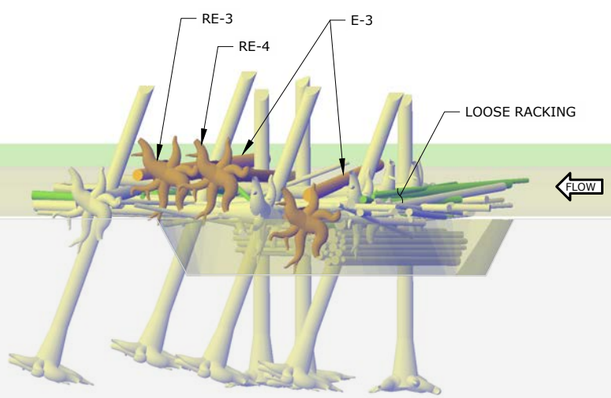
8' 4' 0 8' 16'

LAYER 4



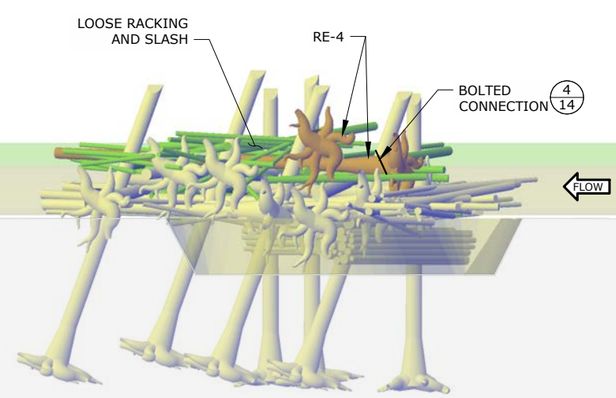
1. WEAVE AND PLACE LOOSE RACKING BETWEEN LOGS.
2. PLACE THREE (3) RE-3 ROOTWADS.
3. PLACE TWO (2) RE-4 ROOTWADS.

LAYER 5



1. WEAVE AND PLACE LOOSE RACKING BETWEEN LOGS.
2. PLACE ONE (1) RE-3 ROOTWAD.
3. PLACE ONE (1) RE-4 ROOTWAD.
4. PLACE TWO (2) E-3 LOGS.

LAYER 6



1. PLACE TWO (2) RE-4 ROOTWADS.
2. ADD THREE (3) BOLTED CONNECTIONS BETWEEN BATTER POSTS AND RE-4 ROOTWADS AS SHOWN.
3. PLACE LOOSE RACKING AND SLASH IN GAPS OF ELJ.
4. CUT PILES 5 FEET ABOVE HIGHEST ROOTWAD.
5. BACKFILL APPROXIMATELY 1-FOOT ABOVE HIGHEST ROOTWAD.

SECTION VIEWS

8' 4' 0 8' 16'

NOTE: BACKFILL AND SLASH NOT SHOWN FOR CLARITY

NSD CGS
Natural Systems Design
+ Coastal Geologic Services

GRACE CATHERINE RACCI
STATE OF WASHINGTON
22008901
REGISTERED
PROFESSIONAL ENGINEER

60% DESIGN
NOT FOR CONSTRUCTION

CHELAN COUNTY NATURAL RESOURCE DEPARTMENT
LOWER ENTIAT 1D REACH (RM 4.3 - 4.8) HABITAT
ENHANCEMENT PROJECT

DEFLECTOR LAYERING PLAN

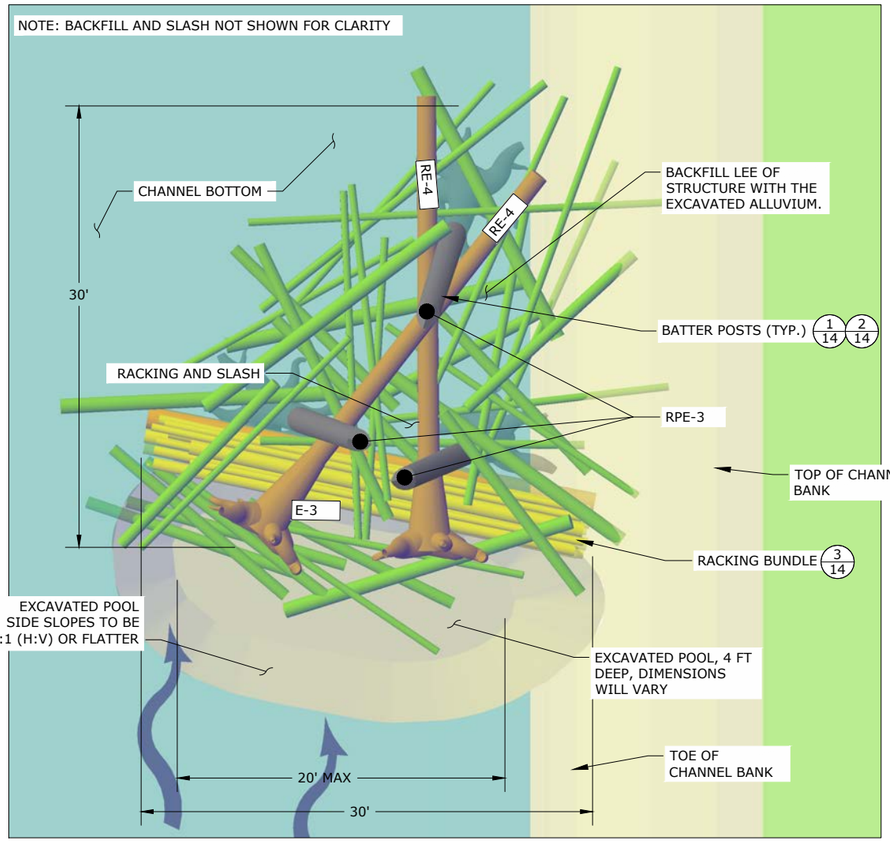
PRELIMINARY

DATE 12/23/2024
COUNTY CHELAN COUNTY
LATITUDE 47°40'20"N
LONGITUDE 120°18'27"W
TN/SC/RG T25N/S10/R20E
DESIGN GB DRAWN KS
CHECK NT CHECK NT

0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT PLOTTED TO ORIGINAL SCALE.

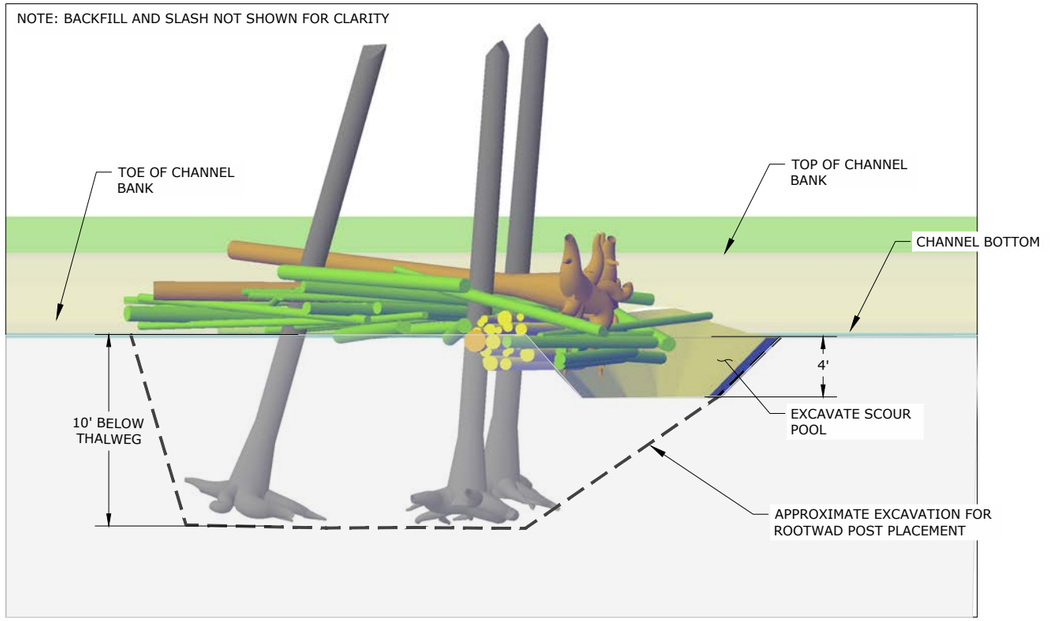
SHEET
8 OF 16

P:\PROJECTS\CHELAN COUNTY\LOWER ENTIAT RM 4.6\DESIGN\CAD\DEFLECTOR ELJ.DWG Grace 12/31/2024 12:26:41 PM



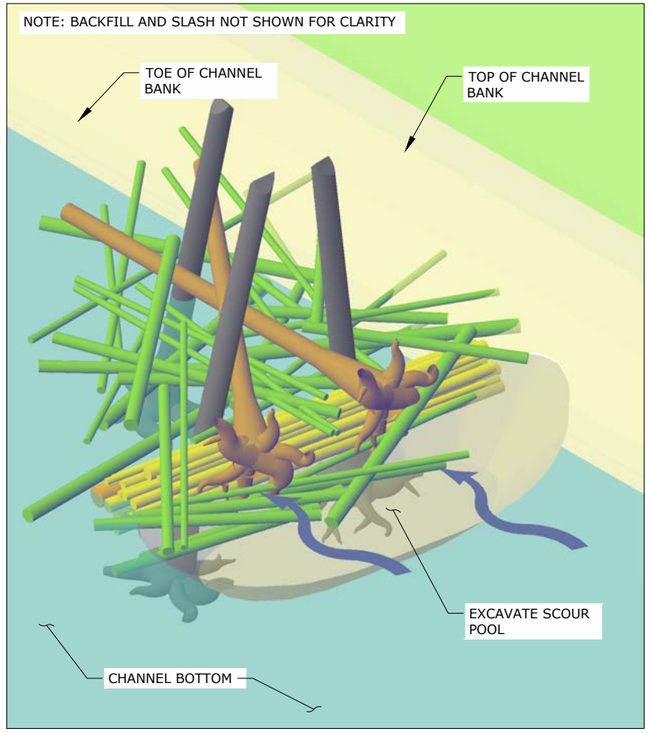
SIDE CHANNEL ELJ PLAN
SCALE: 1" = 5'

5' 0 5' 10'



SIDE CHANNEL ELJ PROFILE
SCALE: 1" = 5'

5' 0 5' 10'



SIDE CHANNEL ELJ PERSPECTIVE
NTS

SIDE CHANNEL ELJ MATERIALS SCHEDULE

LOG ID	DIA (INCHES)	LENGTH (FT)	ROOTWAD (Y/N)	QUANTITY PER STRUCTURE
RPE-3	18	30	YES	3
RE-4	18	40	YES	2
E-3	18	30	NO	1
RACKING BUNDLE	36	30	NO	1
RACKING	6-12	20-40	NO	40
SLASH	1-3	N/A	NO	12 CY

NOTES

1. EXTENT AND LOCATION OF SCOUR POOL IS APPROXIMATE, ELJ SHOULD SPAN ROUGHLY HALF THE WIDTH OF THE SIDE CHANNEL.
2. SOIL EXCAVATED DURING CONSTRUCTION SHALL BE TEMPORARILY STOCKPILED, AND USED AS BACKFILL ON BACKSIDE OF STRUCTURE.
3. BACKFILL EXTENTS MAY VARY.
4. ALL LOGS, SLASH MATERIAL, AND RACKING PIECES REQUIRED SHALL BE PROVIDED BY THE CONTRACTING AGENCY AND ARE STOCKPILED AT THE PROJECT SITE.
5. CAREFULLY HANDLE, TRANSPORT, AND STAGE PROVIDED WOODY MATERIAL FOR ELJ CONSTRUCTION. ANY WOODY MATERIAL DAMAGED AS A DIRECT RESULT OF CONTRACTOR ACTIONS SHALL BE REPLACED IN-KIND AT NO ADDITIONAL COST TO THE CONTRACTING AGENCY.
6. FINAL LOCATIONS OF EACH ELJ WILL BE DETERMINED IN THE FIELD BY THE ENGINEER. THE CONTRACTING AGENCY WILL INSTALL STAKES AT TWO STAKEOUT POINTS FOR EACH ELJ. THE CONTRACTOR SHALL EXPAND THIS STAKING AS NECESSARY TO DEFINE THE STRUCTURE EXTENTS, POST LOCATIONS, EXCAVATION EXTENTS, AND DESIGN ELEVATIONS.
7. THE CONTRACTOR SHALL DETERMINE THE EXCAVATION LIMITS TO MAINTAIN A SAFE EXCAVATION DURING ELJ INSTALLATION. TEMPORARY AND PERMANENT EXCAVATION SPOILS SHALL BE PLACED TO MINIMIZE DISTURBANCE TO EXISTING VEGETATION.
8. NO EXCAVATION WITHIN THE ACTIVELY FLOWING CHANNEL SHALL OCCUR UNTIL THE WORK AREA HAS BEEN ISOLATED AND AQUATIC LIFE HAS BEEN REMOVED FROM THE INTERIOR OF THE ISOLATION.
9. THE EXCAVATION SHALL BE SUFFICIENTLY DEWATERED TO ALLOW COMPLETION AND INSPECTION OF ELJ INSTALLATION IN A CONTROLLED MANNER.
10. EXISTING WOODY MATERIAL AT THE STRUCTURE CONSTRUCTION SITE SHALL BE MOVED OR PROTECTED FROM CONSTRUCTION ACTIVITIES AND THEN INCORPORATED INTO THE STRUCTURE AND BACKFILL AS APPROVED BY THE CONTRACTING OFFICER.

SIDE CHANNEL ELJ
SCALE: AS SHOWN

NSD CGS
Natural Systems Design
+ Coastal Geologic Services

GRACE CATHERINE RACCI
STATE OF WASHINGTON
22008901
REGISTERED PROFESSIONAL ENGINEER

60% DESIGN SUBMISSION
NOT FOR CONSTRUCTION

CHELAN COUNTY NATURAL RESOURCE DEPARTMENT
LOWER ENTIAT 1D REACH (RM 4.3 - 4.8) HABITAT ENHANCEMENT PROJECT
SIDE CHANNEL ELJ
PRELIMINARY

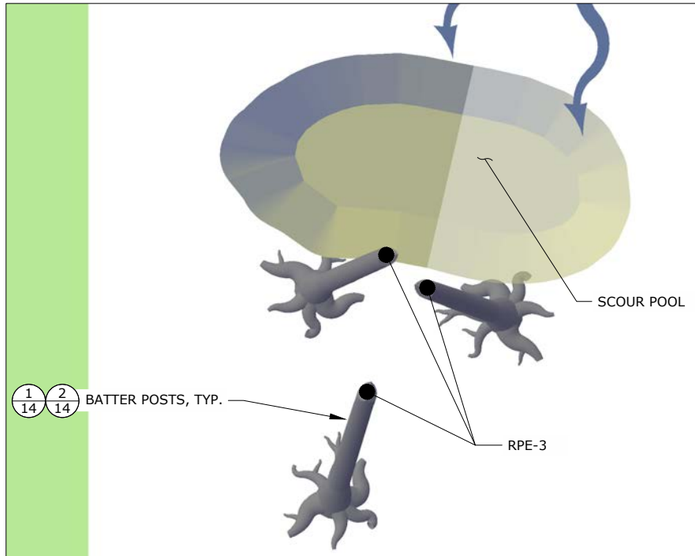
DATE 12/23/2024
COUNTY CHELAN COUNTY
LATITUDE 47°40'20"N
LONGITUDE 120°18'27"W
TN/SC/RG T25N/S10/R20E
DESIGN GB DRAWN KS
CHECK NT CHECK NT

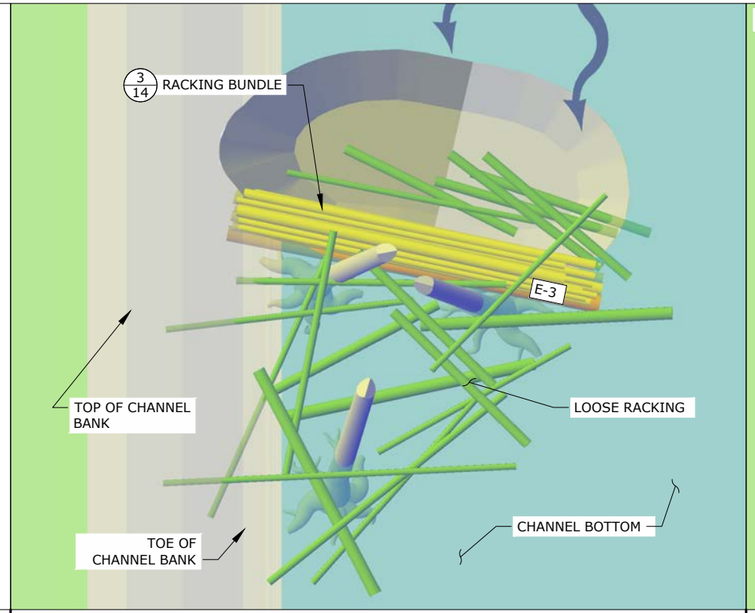
0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT PLOTTED TO ORIGINAL SCALE.

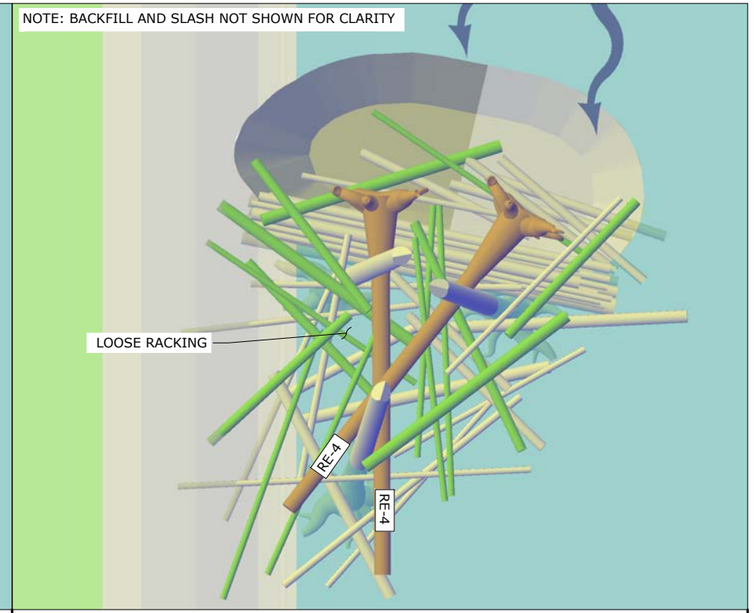
SHEET
9 OF 16

1
9

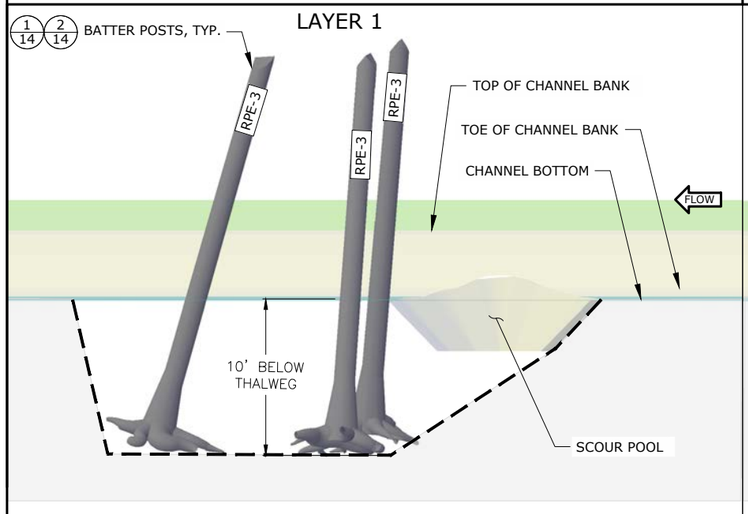
P:\PROJECTS\CHELAN COUNTY\LOWER ENTIAT RM 4.6\DESIGN\CAD\SIDE CHANNEL ELJ LAYERING PLAN.DWG Grace 12/31/2024 12:26:57 PM

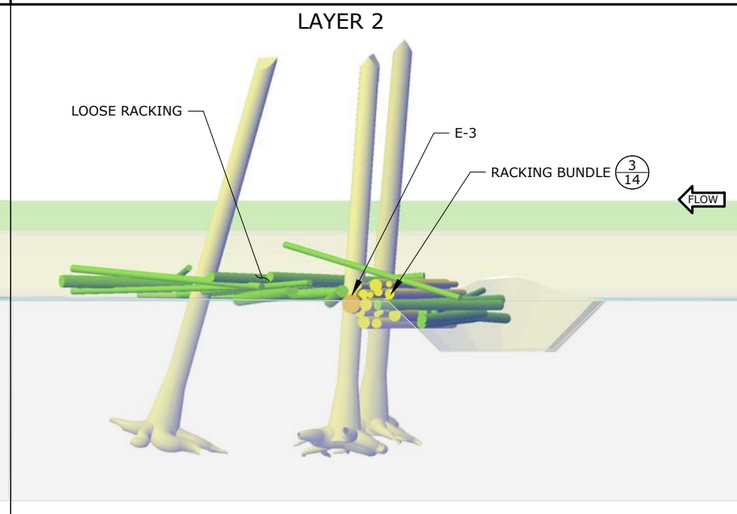


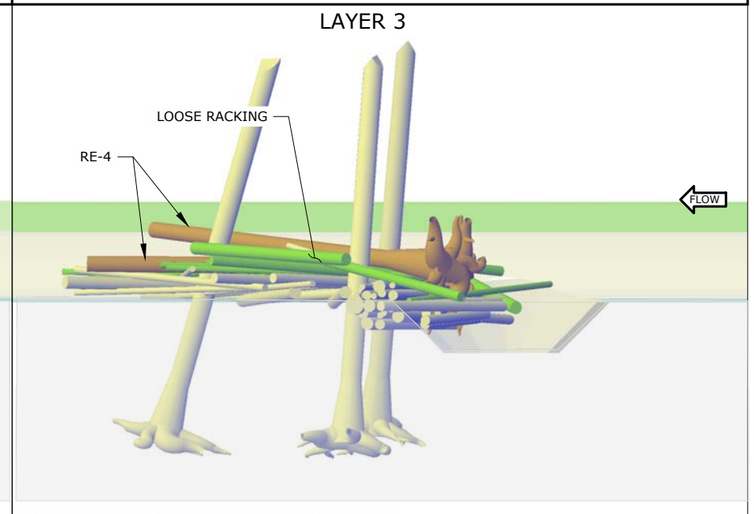




PLAN VIEWS 6' 3' 0 6' 12'







SECTION VIEWS 6' 3' 0 6' 12'

NOTE: BACKFILL AND SLASH NOT SHOWN FOR CLARITY

1. EXCAVATE 10 FEET BELOW THALWEG FOR ROOTWAD POST PLACEMENT.
2. EXCAVATE SCOUR POOL.
3. BATTER THREE (3) RPE-3 ROOTWAD POSTS AS SHOWN.
4. BACKFILL TO ONE FOOT BELOW GROUND SURFACE.

1. PLACE ONE (1) E-3 LOG IN FRONT OF TWO POSTS AT BASE OF SCOUR POOL.
2. PLACE ONE (1) 30-FOOT LONG RACKING BUNDLE IN FRONT OF E-3 LOG.
3. WEAVE AND PLACE LOOSE RACKING BETWEEN POSTS

1. PLACE TWO (2) RE-4 ROOTWADS.
2. PLACE LOOSE RACKING AND SLASH IN GAPS OF ELJ.
3. CUT PILES 5 FEET ABOVE HIGHEST ROOTWAD.
4. BACKFILL APPROXIMATELY 1-FOOT ABOVE HIGHEST ROOTWAD.

NSD CGS
Natural Systems Design
+ Coastal Geologic Services

GRACE CATHERINE RACCI
STATE OF WASHINGTON
22008901
REGISTERED
PROFESSIONAL ENGINEER

60% DESIGN
NOT FOR CONSTRUCTION

CHELAN COUNTY NATURAL RESOURCE DEPARTMENT
LOWER ENTIAT 1D REACH (RM 4.3 - 4.8) HABITAT ENHANCEMENT PROJECT

SIDE CHANNEL ELJ LAYERING PLAN

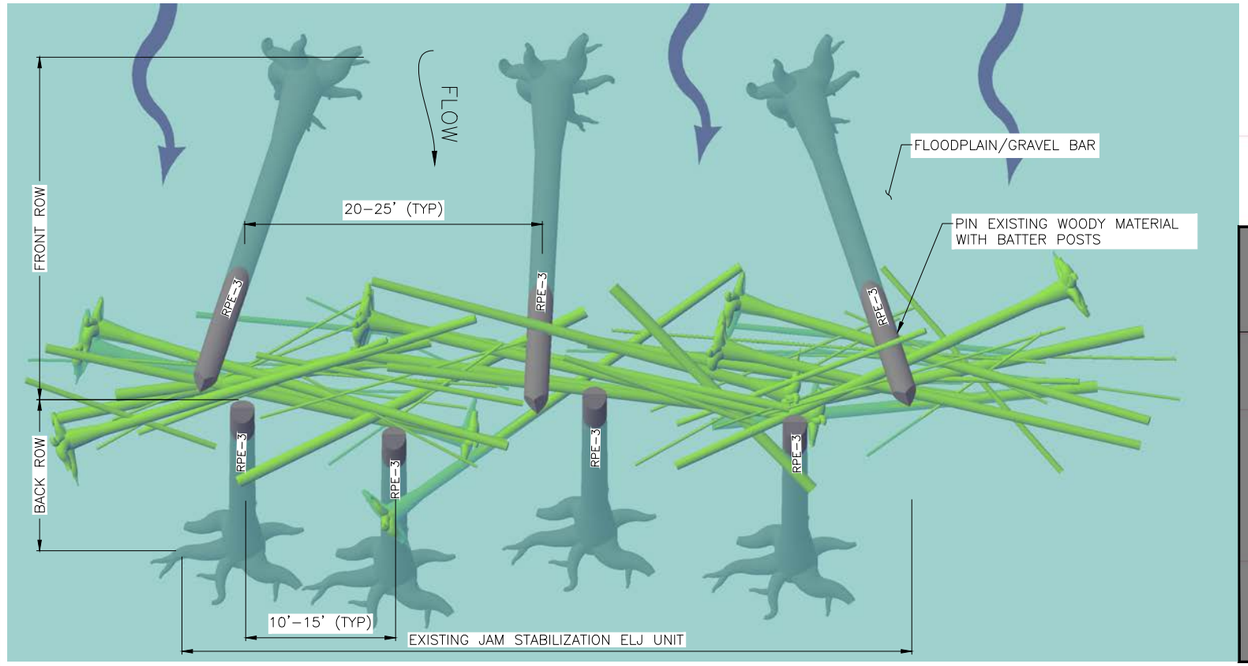
PRELIMINARY

DATE 12/23/2024
COUNTY CHELAN COUNTY
LATITUDE 47°40'20"N
LONGITUDE 120°18'27"W
TN/SC/RG T25N/S10/R20E
DESIGN GB DRAWN KS
CHECK NT CHECK NT

0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT PLOTTED TO ORIGINAL SCALE.

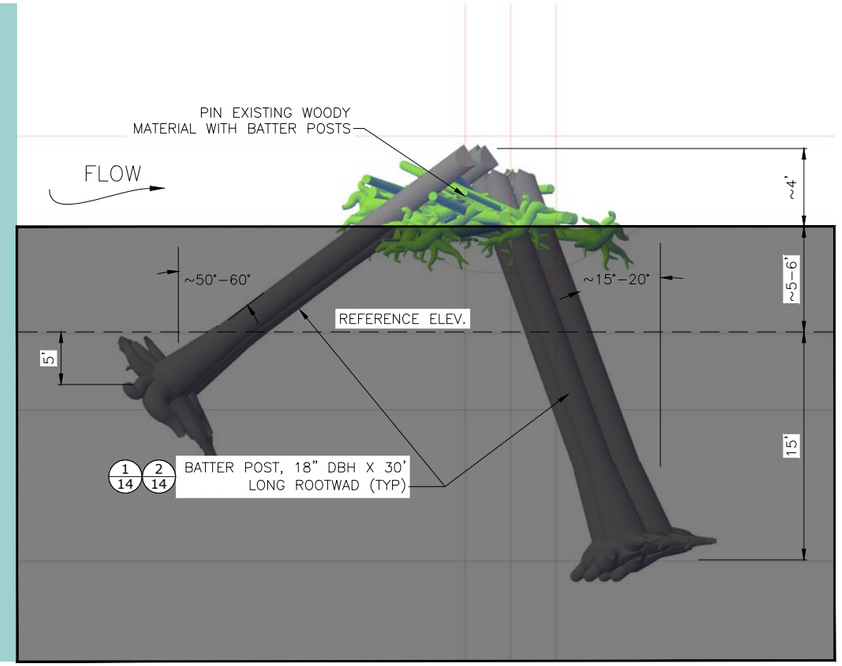
SHEET
10 OF 16

P:\PROJECTS\CHELAN COUNTY\LOWER ENTIAT RM 4.6\DESIGN\CAD\SIDE CHANNEL ELJ LAYERING PLAN.DWG Grace 12/31/2024 12:27:02 PM



5' 0 5' 10'
SCALE: 1"=5'–0"

STABILIZE EXISTING LOGJAM PLAN
SCALE: 1" = 5'



STABILIZE EXISTING LOGJAM PROFILE
SCALE: 1" = 5'

5' 0 5' 10'
SCALE: 1"=5'–0"

NOTES

1. ALL LOGS REQUIRED HAVE BEEN PROVIDED BY THE CONTRACTING AGENCY AND ARE STOCKPILED AT THE PROJECT SITE.
2. CAREFULLY HANDLE, TRANSPORT, AND STAGE PROVIDED WOODY MATERIAL FOR ELJ CONSTRUCTION. ANY WOODY MATERIAL DAMAGED AS A DIRECT RESULT OF CONTRACTOR ACTIONS SHALL BE REPLACED IN-KIND AT NO ADDITIONAL COST TO THE CONTRACTING AGENCY.
3. FINAL LOCATIONS OF EACH ELJ WILL BE DETERMINED IN THE FIELD BY THE ENGINEER. THE CONTRACTING AGENCY WILL INSTALL STAKES AT TWO STAKEOUT POINTS FOR EACH ELJ AT THE START AND END OF THE ELJ. THE CONTRACTOR SHALL EXPAND THIS STAKING AS NECESSARY TO DEFINE THE POST LOCATIONS, EXCAVATION EXTENTS, AND DESIGN ELEVATIONS.
4. POSTS SHALL BE INSTALLED WITH THE TYPICAL SPACING, BATTER, AND EXCAVATION DEPTHS SHOWN ON THIS SHEET. POST LOCATIONS MAY BE FIELD FIT BASED ON CONDITIONS AT THE TIME OF CONSTRUCTION. THE NUMBER OF ELJ UNITS INSTALLED AT EACH LOCATION WILL VARY DEPENDING ON SITE CONDITIONS. THE CONTRACTOR SHALL BE PREPARED TO INSTALL A TOTAL OF 2 UNITS (8 BACK ROW POSTS AND 6 FRONT ROW POSTS) AT THE APPROXIMATE LOCATIONS SHOWN ON THE PLANS.
5. THE CONTRACTOR SHALL DETERMINE THE EXCAVATION LIMITS TO MAINTAIN A SAFE EXCAVATION DURING ELJ INSTALLATION AND ACHIEVE THE DESIGN ELEVATIONS INCLUDED ON THIS SHEET. TEMPORARY AND PERMANENT EXCAVATION SPOILS SHALL BE PLACED TO MINIMIZE DISTURBANCE TO EXISTING VEGETATION.
6. NO EXCAVATION WITHIN THE ACTIVELY FLOWING CHANNEL SHALL OCCUR UNTIL THE WORK AREA HAS BEEN ISOLATED AND AQUATIC LIFE HAS BEEN REMOVED FROM THE INTERIOR OF THE ISOLATION.
7. THE EXCAVATION SHALL BE SUFFICIENTLY DEWATERED TO ALLOW COMPLETION AND INSPECTION OF ELJ INSTALLATION IN A CONTROLLED MANNER.
8. EXISTING WOODY MATERIAL AT THE STRUCTURE CONSTRUCTION SITE SHALL BE MOVED OR PROTECTED FROM CONSTRUCTION ACTIVITIES AND THEN INCORPORATED INTO THE STRUCTURE AND BACKFILL AS APPROVED BY THE CONTRACTING OFFICER.
9. BACKFILL EXCAVATED POSTS TO THE ORIGINAL GROUND LINE, INCORPORATING ANY REMOVED WOODY MATERIAL INTO THE STRUCTURE AS SHOWN, PINNING IT IN PLACE WITH THE INSTALLED POSTS.
10. TRIM POST TOPS FOLLOWING INSTALLATION AND BACKFILL.

STABILIZE EXISTING LOGJAM
SCALE: AS NOTED

1/11

NSD CGS
Natural Systems Design + Coastal Geologic Services

GRACE CATHERINE RACCI
STATE OF WASHINGTON
22008901
REGISTERED PROFESSIONAL ENGINEER

60% DESIGN
NOT FOR CONSTRUCTION

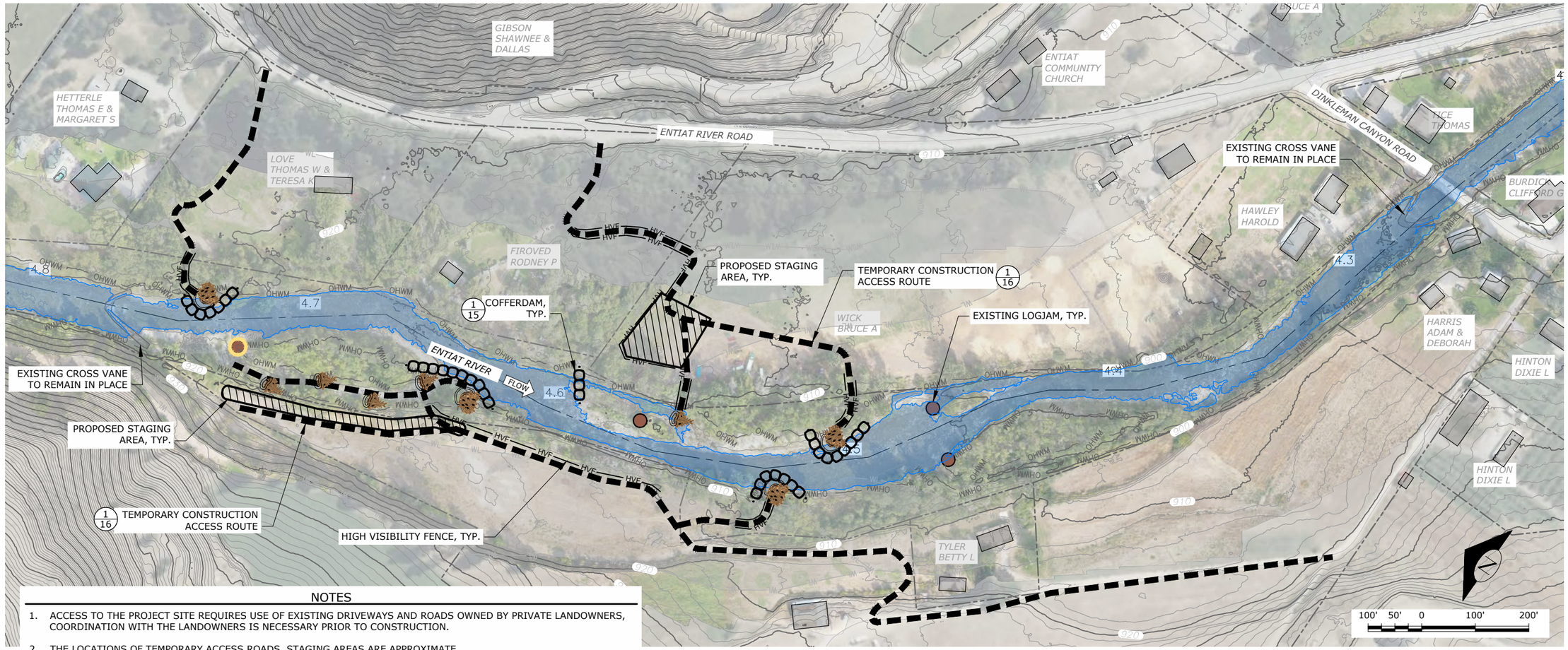
CHELAN COUNTY NATURAL RESOURCE DEPARTMENT
LOWER ENTIAT 1D REACH (RM 4.3 - 4.8) HABITAT ENHANCEMENT PROJECT
STABILIZE EXISTING LOGJAM
PRELIMINARY

DATE 12/23/2024
COUNTY CHELAN COUNTY
LATITUDE 47°40'20"N
LONGITUDE 120°18'27"W
TN/SC/RG T25N/S10/R20E
DESIGN GB DRAWN KS
CHECK NT CHECK NT

0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT PLOTTED TO ORIGINAL SCALE.

SHEET
11 OF 16

P:\PROJECTS\CHELAN COUNTY\LOWER ENTIAT RM 4.6\DESIGN\CAD\STABILIZE EXISTING LOGJAM.DWG Grace 12/31/2024 12:27:24 PM



ACCESS, STAGING, AND SITE ISOLATION PLAN

SCALE: 1" = 100'

NOTES

1. ACCESS TO THE PROJECT SITE REQUIRES USE OF EXISTING DRIVEWAYS AND ROADS OWNED BY PRIVATE LANDOWNERS, COORDINATION WITH THE LANDOWNERS IS NECESSARY PRIOR TO CONSTRUCTION.
2. THE LOCATIONS OF TEMPORARY ACCESS ROADS, STAGING AREAS ARE APPROXIMATE.
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR EXAMINING THE PROJECT SITE AND BECOMING FAMILIAR WITH THE NATURE OF TEMPORARY IMPROVEMENTS REQUIRED TO COMPLETE THE WORK ON THESE PLANS.
4. CONTRACTOR TO VERIFY ALL OVERHEAD AND UNDERGROUND UTILITIES BEFORE CONSTRUCTION.
5. EXISTING ROADS THAT WILL BE USED AS ACCESS SHALL BE STABILIZED AS NEEDED TO ACCOMMODATE EQUIPMENT.
6. PROPOSED STAGING AREAS MAY REQUIRE VEGETATION REMOVAL PRIOR TO STAGING OF MATERIALS. ALL CLEARED NATIVE TREES AND VEGETATION ARE TO BE STOCKPILED AND UTILIZED IN ELJ STRUCTURES AS DIRECTED BY THE ENGINEER.
7. ALL TEMPORARY ACCESS ROADS AND STAGING AREAS SHALL BE RESTORED AND REVEGETATED FOLLOWING CONSTRUCTION.
8. DEWATERING IN SOME LOCATIONS MAY BE NECESSARY. A DEWATERING PLAN INCLUDING POTENTIAL INFILTRATION LOCATIONS WILL BE DEVELOPED AT A FUTURE PHASE BASED ON SURROUNDING SITE CONDITIONS.
9. SITE ISOLATION MAY BE MODIFIED BASED ON SITE CONDITIONS AT THE TIME OF CONSTRUCTION. COFFERDAMS SHOWN MAY NOT BE NECESSARY.
10. FISH SHALL BE REMOVED AND ISOLATED FROM WORK AREAS FOR THE DURATION OF CONSTRUCTION.
11. AERIAL IMAGERY COLLECTED BY CHELAN COUNTY SEPTEMBER 2023 AND SUPPLEMENTED WITH 2023 BING AERIAL IMAGERY.
12. WETLANDS ARE TAKEN FROM THE NATIONAL WETLAND INSTITUTE AND ARE APPROXIMATE. IT IS RECOMMENDED A WETLAND SURVEY IS COMPLETED IN THE FUTURE TO REFINE WETLAND BOUNDARIES.
13. CONTOURS SHOWN ON THIS SHEET ARE 2' AND 10' INTERVALS.

NSD CGS
Natural Systems Design
+ Coastal Geologic Services

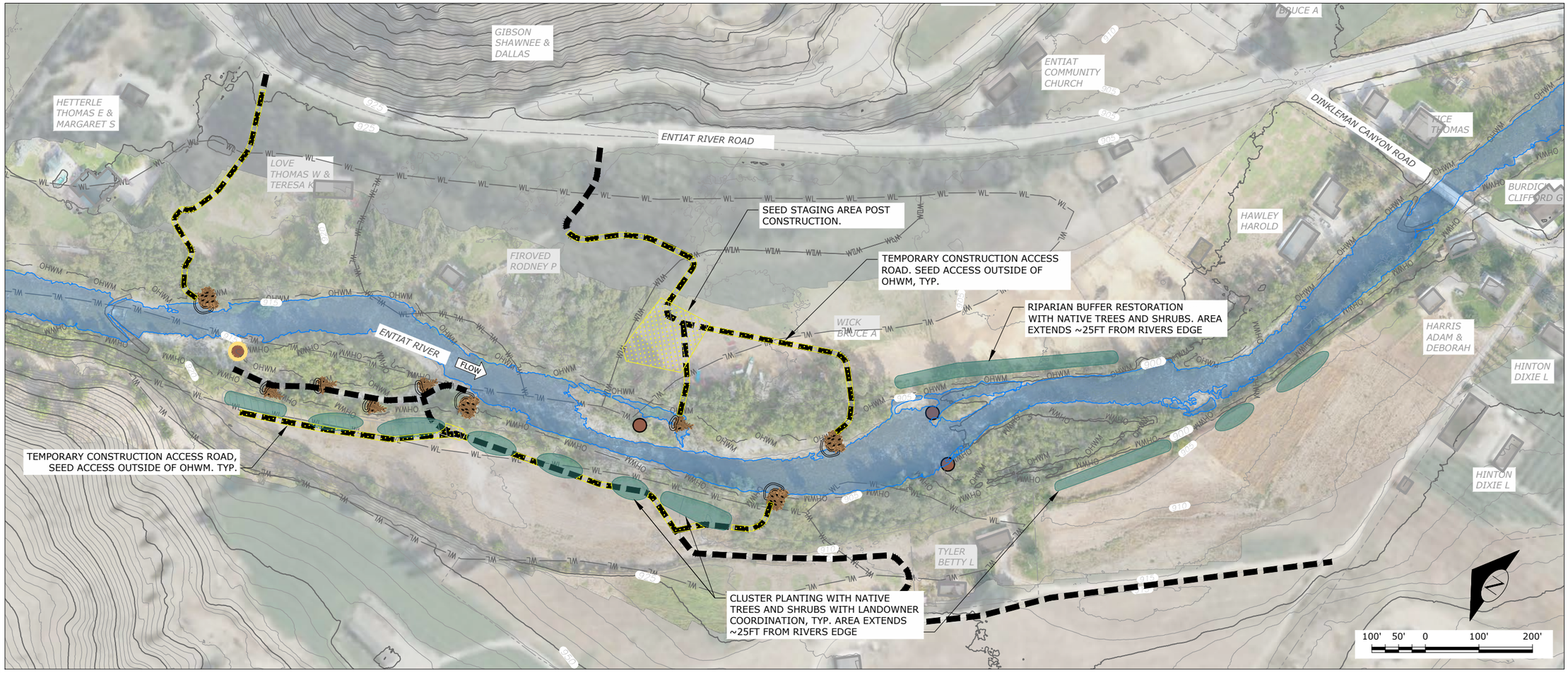
CHELAN COUNTY NATURAL RESOURCE DEPARTMENT
LOWER ENTIAT 1D REACH (RM 4.3 - 4.8) HABITAT ENHANCEMENT PROJECT
ACCESS, STAGING, AND SITE ISOLATION PLAN
PRELIMINARY

DATE 12/23/2024
COUNTY CHELAN COUNTY
LATITUDE 47°40'20"N
LONGITUDE 120°18'27"W
TN/SC/RG T25N/S10/R20E
DESIGN GB DRAWN KS
CHECK NT CHECK NT

0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT PLOTTED TO ORIGINAL SCALE.

SHEET
12 OF 16

P:\PROJECTS\CHELAN COUNTY\LOWER ENTIAT RM 4.6\DESIGN\CAD\SITE PREP.DWG Grace 12/31/2024 12:29:33 PM



REVEGETATION PLAN
SCALE: 1" = 100'

NOTES

1. ALL AREAS ABOVE THE ORDINARY HIGH WATER MARK DISTURBED DURING CONSTRUCTION, INCLUDING STAGING AREAS AND TEMPORARY CONSTRUCTION ACCESS ROUTES, SHALL BE SEEDED.
2. REVEGETATION BOUNDARIES ARE THE EXPECTED LIMITS OF DISTURBANCE RESULTING FORM CONSTRUCTION ACTIVITIES. BOUNDARIES MAY VARY AT THE TIME OF PLANT INSTALLATION.
3. REVEGETATION AND SEEDING BOUNDARIES SHALL BE APPROVED BY THE CONTRACTING OFFICER OR REPRESENTATIVE PRIOR TO INSTALLATION.
4. AERIAL IMAGERY COLLECTED BY CHELAN COUNTY SEPTEMBER 2023 AND SUPPLEMENTED WITH 2023 BING AERIAL IMAGERY.
5. WETLANDS ARE TAKEN FROM THE NATIONAL WETLAND INSTITUTE AND ARE APPROXIMATE. IT IS RECOMMENDED A WETLAND SURVEY IS COMPLETED IN THE FUTURE TO REFINE WETLAND BOUNDARIES.
6. CONTOURS SHOWN ON THIS SHEET ARE 2' AND 10' INTERVALS.

NSD CGS
Natural Systems Design
+ Coastal Geologic Services

GRACE CATHERINE PACCI
STATE OF WASHINGTON
22008901
REGISTERED PROFESSIONAL ENGINEER

60% DESIGN SUBMISSION
NOT FOR CONSTRUCTION

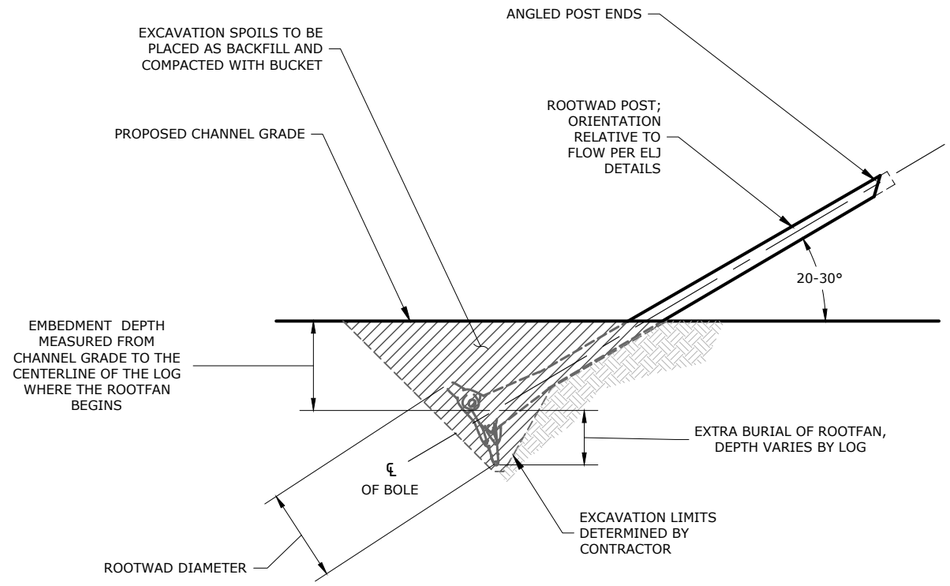
CHELAN COUNTY NATURAL RESOURCE DEPARTMENT
LOWER ENTIAT 1D REACH (RM 4.3 - 4.8) HABITAT ENHANCEMENT PROJECT
REVEGETATION PLANS
PRELIMINARY

DATE 12/23/2024
COUNTY CHELAN COUNTY
LATITUDE 47°40'20"N
LONGITUDE 120°18'27"W
TN/SC/RG T25N/S10/R20E
DESIGN GB DRAWN KS
CHECK NT CHECK NT

0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT PLOTTED TO ORIGINAL SCALE.

SHEET
13 OF 16

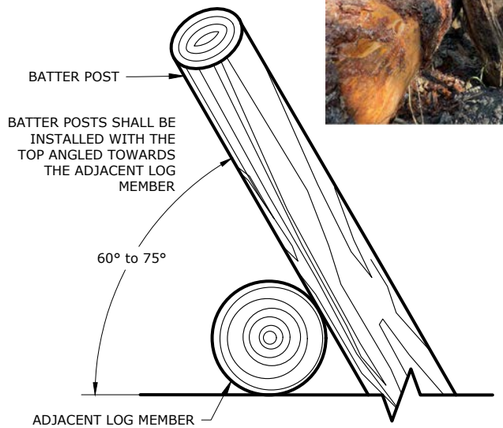
P:\PROJECTS\CHELAN COUNTY\LOWER ENTIAT RM 4.6\DESIGN\CAD\REVEGETATION PLANS.DWG Grace 12/31/2024 12:31:01 PM



BATTER POST PLACEMENT

SCALE: 1":6'

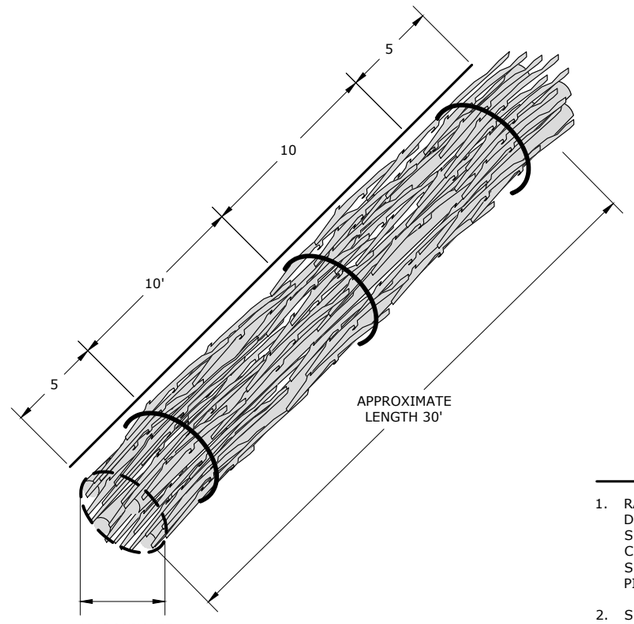
1 / 14



BATTER POST DETAIL

SCALE: 1":1'

2 / 14



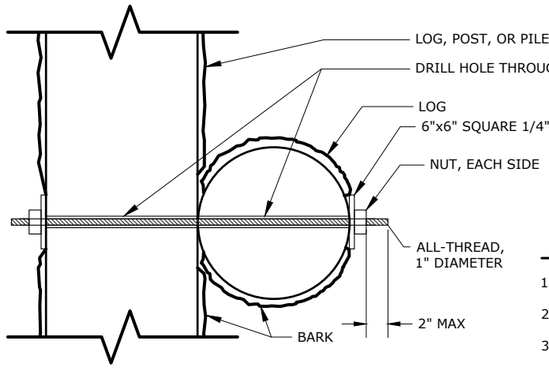
NOTES

1. RACKING BUNDLES SHALL BE SECURED WITH A MIN 1" DIA MANILA ROPE WRAPPED TWICE AROUND AND SECURED WITH A TRUCKERS HITCH OR COMPARABLE CONSTRICTOR KNOT AT MINIMUM 3 LOCATIONS AS SHOWN. BUNDLES SHALL BE TESTED TO ENSURE PIECES ARE SECURE FOR TRANSPORT.
2. SLASH SHALL BE SANDWICHED INTO THE CENTER OF THE BUNDLE.

RACKING BUNDLE

SCALE: 1":4'

3 / 14



NOTES

1. REMOVE BARK AT CONNECTION POINTS.
2. DRILL HOLE THROUGH CENTER OF LOGS.
3. TIGHTEN SUFFICIENTLY TO ELIMINATE GAP BETWEEN LOGS BUT NOT CRUSH BOLES. PEEN THREADS OR TACK WELD NUT TO ALL-THREAD FOLLOWING TIGHTENING.
4. ALL-THREAD TO BE ASTM TYPE A 307, GRADE A. LENGTH VARIES BY CONNECTION.
5. MULTIPLE LOG CONNECTIONS AT SAME JOINT WILL USE SINGLE PIECE OF ALL-THREAD TO MINIMIZE HOLES IN POSTS.

BOLTED CONNECTION

SCALE: 1":1'

4 / 14

NSD CGS
Natural Systems Design
+ Coastal Geologic Services

GRACE CATHERINE PACCI
STATE OF WASHINGTON
22008901
REGISTERED
PROFESSIONAL ENGINEER

60% DESIGN
NOT FOR CONSTRUCTION

CHELAN COUNTY NATURAL RESOURCE DEPARTMENT
LOWER ENTIAT 1D REACH (RM 4.3 - 4.8) HABITAT ENHANCEMENT PROJECT

ELJ DETAILS

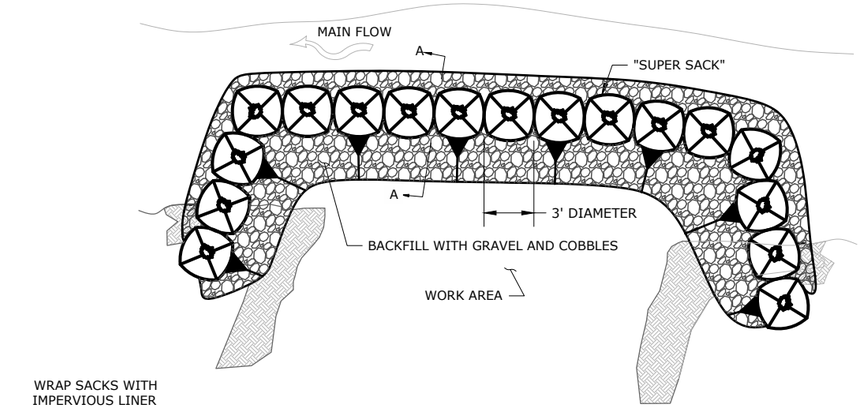
PRELIMINARY

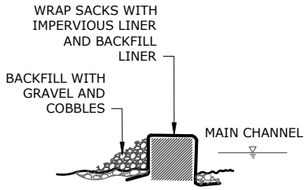
DATE 12/23/2024
COUNTY CHELAN COUNTY
LATITUDE 47°40'20"N
LONGITUDE 120°18'27"W
TN/SC/RG T25N/S10/R20E
DESIGN GB DRAWN KS
CHECK NT CHECK NT

0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT PLOTTED TO ORIGINAL SCALE.

SHEET
14 OF 16

P:\PROJECTS\CHELAN COUNTY\LOWER ENTIAT RM 4.6\DESIGN\CAD\TESC DETAILS.DWG Grace 12/31/2024 12:31:37 PM





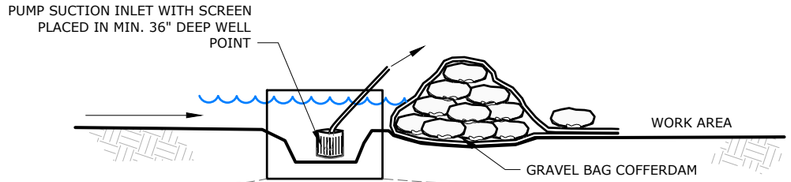
SECTION A-A

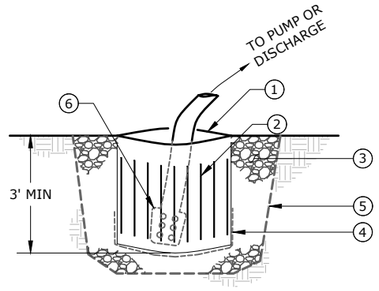
NOTES

1. WRAP "SUPER SACKS" WITH IMPERVIOUS PLASTIC LINER TO PREVENT SEEPAGE.
2. BACKFILL THE DOWNSTREAM SIDE COFFER DAM WITH NATIVE, ADJACENT ALLUVIUM FROM SIDE CHANNEL EXCAVATION.
3. USE "SUPER SACKS" AS BUTTRESSES AS REQUIRED.
4. "SUPER SACKS" MAY BE REPLACED WITH SAND BAGS IF FLOWS ALLOW AND APPROVED BY THE ENGINEER. SAND BAGS MAY BE FILLED WITH EXCAVATION FROM THE SIDE CHANNEL AND FILL MATERIAL MAY BE PLACED IN THE LBSN FOLLOWING USE. REMOVE ALL PLASTIC FROM THE SITE.

COFFERDAM
SCALE: 1":5'

1
15



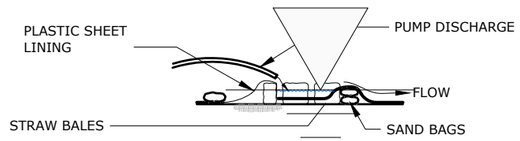


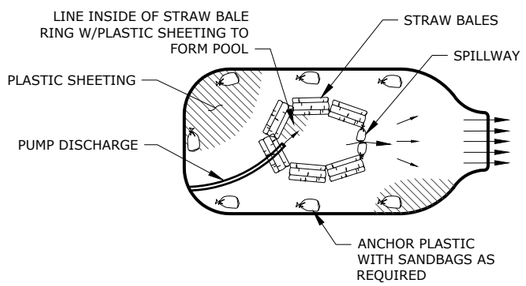
NOTES:

1. CORRUGATED PLASTIC OR METAL PIPE 36" MIN DIAMETER, ONE PER EACH PUMP.
2. ¼" SLOTS 24" LONG AT 4" SPACING ALL THE WAY AROUND PIPE.
3. STREAMBED SEDIMENT
4. WIRE SCREEN ½" MESH COVERING PIPE BOTTOM, ANCHORED TO PIPE.
5. LIMIT OF EXCAVATION. INSTALL PIPE AND BACKFILL WITH STREAMBED SEDIMENT.
6. PUMP SUCTION INTAKE OR ELECTRIC SUBMERSIBLE PUMP WITH 1" SCREEN INSTALLED AT INLET OR PUMP SUCTION FACE, OR OTHER SIZE RECOMMENDED BY PUMP SUPPLIER.
7. PUMP SUCTION SHALL BE OPERATIONAL ONLY WHILE ALL CREEK FLOW IS FULLY FILTERED BY FISH BLOCK NETS AND AFTER FISH EXCLUSION IS COMPLETED. BYPASS PUMPS SHALL BE SHUTDOWN DURING ANY FAILURE OF THE FISH BLOCK NET OR ANY CONDITION THAT CAN ALLOW FISH TO ENTER THE PUMP INTAKE.

PUMP
SCALE: 1":2'

2
15





ENERGY DISSIPATOR
SCALE: 1":10'

3
15

NSD CGS
Natural Systems Design
+ Coastal Geologic Services

GRACE CATHERINE PACCI
STATE OF WASHINGTON
22008901
REGISTERED
PROFESSIONAL ENGINEER

60% DESIGN
NOT FOR CONSTRUCTION

CHELAN COUNTY NATURAL RESOURCE DEPARTMENT
LOWER ENTIAT 1D REACH (RM 4.3 - 4.8) HABITAT
ENHANCEMENT PROJECT

SITE ISOLATION DETAILS

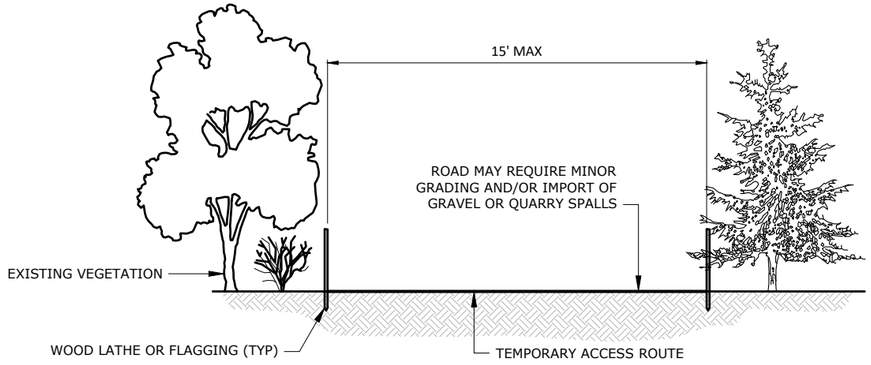
PRELIMINARY

DATE 12/23/2024
COUNTY CHELAN COUNTY
LATITUDE 47°40'20"N
LONGITUDE 120°18'27"W
TN/SC/RG T25N/S10/R20E
DESIGN GB DRAWN KS
CHECK NT CHECK NT

0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT PLOTTED TO ORIGINAL SCALE.

SHEET
15 OF 16

P:\PROJECTS\CHELAN COUNTY\LOWER ENTIAT RM 4.6\DESIGN\CAD\TESC DETAILS.DWG Grace 12/31/2024 12:31:54 PM

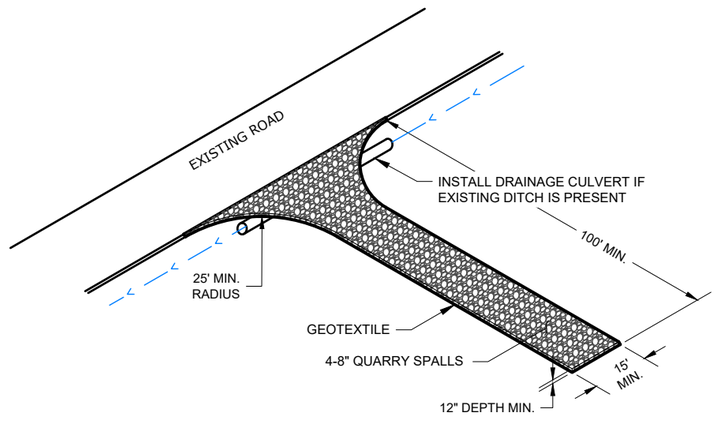


NOTES

1. CLEARED ACCESS TO BE ROUTED TO MINIMIZE VEGETATION DISTURBANCE AND FOREST CLEARING.
2. CONTRACTOR SHALL MARK CLEARING LIMITS WITH FLAGGING. CLEARING LIMITS TO BE APPROVED BY ENGINEER PRIOR TO ANY CLEARING ACTIVITIES.
3. ANY TREES GREATER THAN 12" ⌀ SHALL BE REMOVED W/ ROOTWADS INTACT AND STOCKPILED FOR USE IN LOGJAM CONSTRUCTION.
4. TREES AND SHRUBS WITH 2"-12" ⌀ SHALL BE STOCKPILED FOR USE AS RACKING MATERIAL IN LOGJAM CONSTRUCTION.
5. REMAINDER OF VEGETATION AND ORGANIC SOIL SHALL BE GRUBBED, STOCKPILED AND BROADCASTED ON ROAD ALIGNMENT FOLLOWING TERMINATION OF WORK.
6. ACCESS SHALL BE MAINTAINED BY MINOR GRADING AND IMPORTATION OF WOOD CHIPS, GRAVEL AND/OR QUARRY SPALLS, OR OTHER APPROVED BMPS.
7. CLEARED ACCESS SHALL BE SCARIFIED AND FULLY DECOMMISSIONED PER DIRECTION OF THE ENGINEER AT THE TERMINATION OF WORK.
8. REVEGETATION OF DISTURBED AREAS OUTSIDE OF THE APPROVED CLEARING AND ACCESS LIMITS SHALL BE PERFORMED BY CONTRACTOR AT NO COST TO THE OWNER.
9. ALL GRAVEL OR QUARRY SPALLS PLACED SHALL BE UNDERLAIN WITH A GEOTEXTILE AND REMOVED AT TERMINATION OF WORK IF UTILIZED.

TEMPORARY ACCESS ROAD
SCALE: 1":3'

1
16



CONSTRUCTION ENTRANCE
SCALE: 1":20'

2
16

NSD CGS
Natural Systems Design
+ Coastal Geologic Services

GRACE CATHERINE PACCI
STATE OF WASHINGTON
22008901
REGISTERED
PROFESSIONAL ENGINEER

60% DESIGN
NOT FOR CONSTRUCTION

CHELAN COUNTY NATURAL RESOURCE DEPARTMENT
LOWER ENTIAT 1D REACH (RM 4.3 - 4.8) HABITAT
ENHANCEMENT PROJECT

TESC DETAILS

PRELIMINARY

DATE	12/23/2024
COUNTY	CHELAN COUNTY
LATITUDE	47°40'20"N
LONGITUDE	120°18'27"W
TN/SC/RG	T25N/S10/R20E
DESIGN	GB
DRAWN	KS
CHECK	NT
CHECK	NT

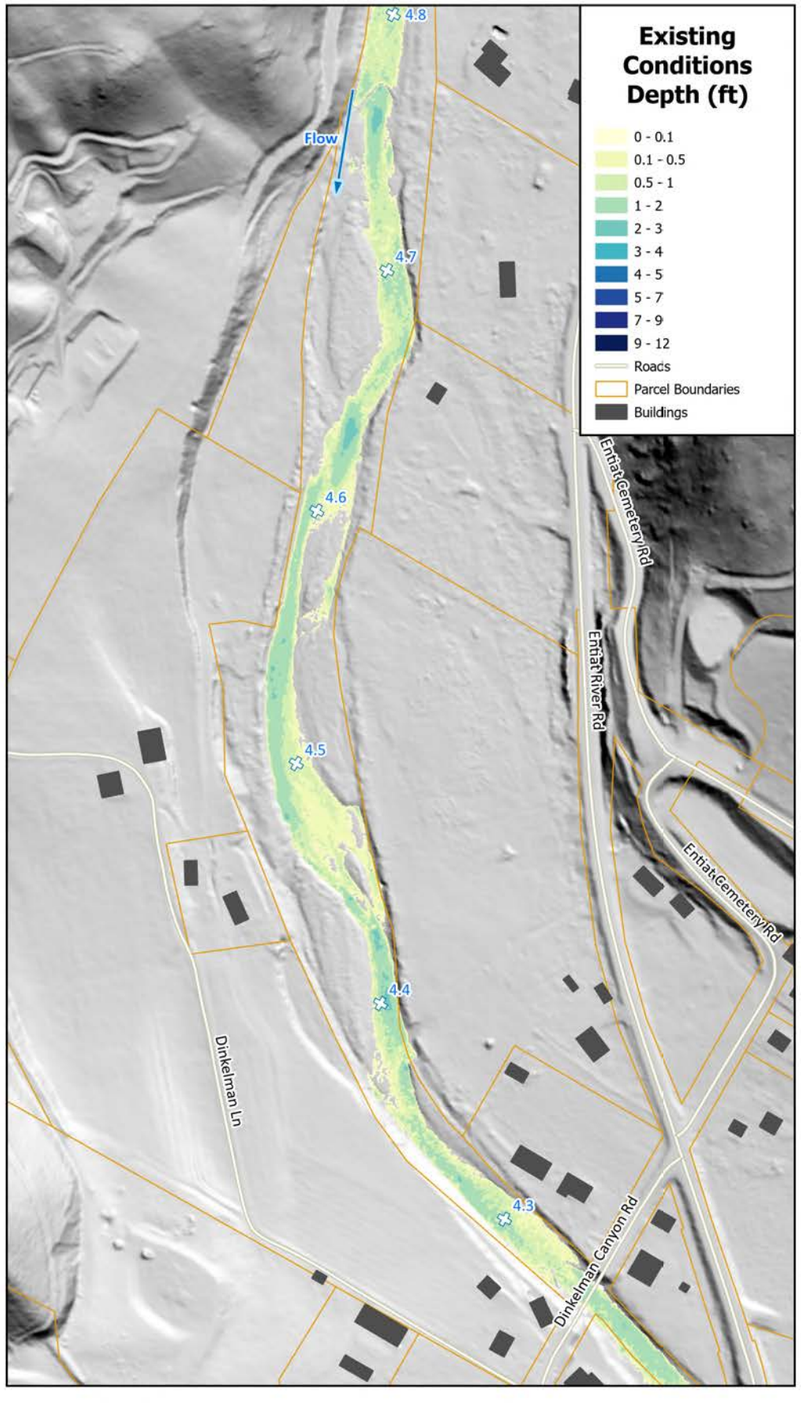
0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT PLOTTED TO ORIGINAL SCALE.

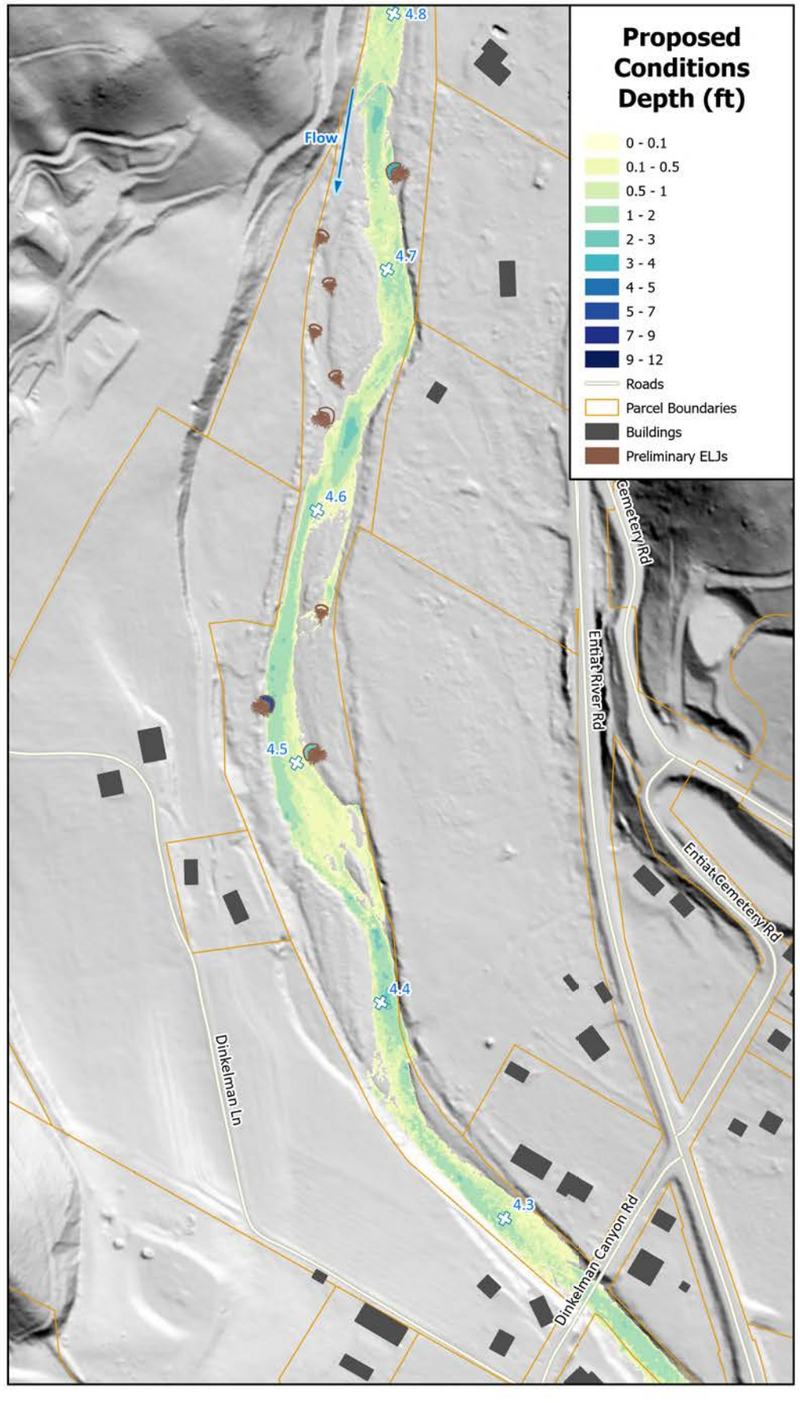
SHEET
16 OF 16

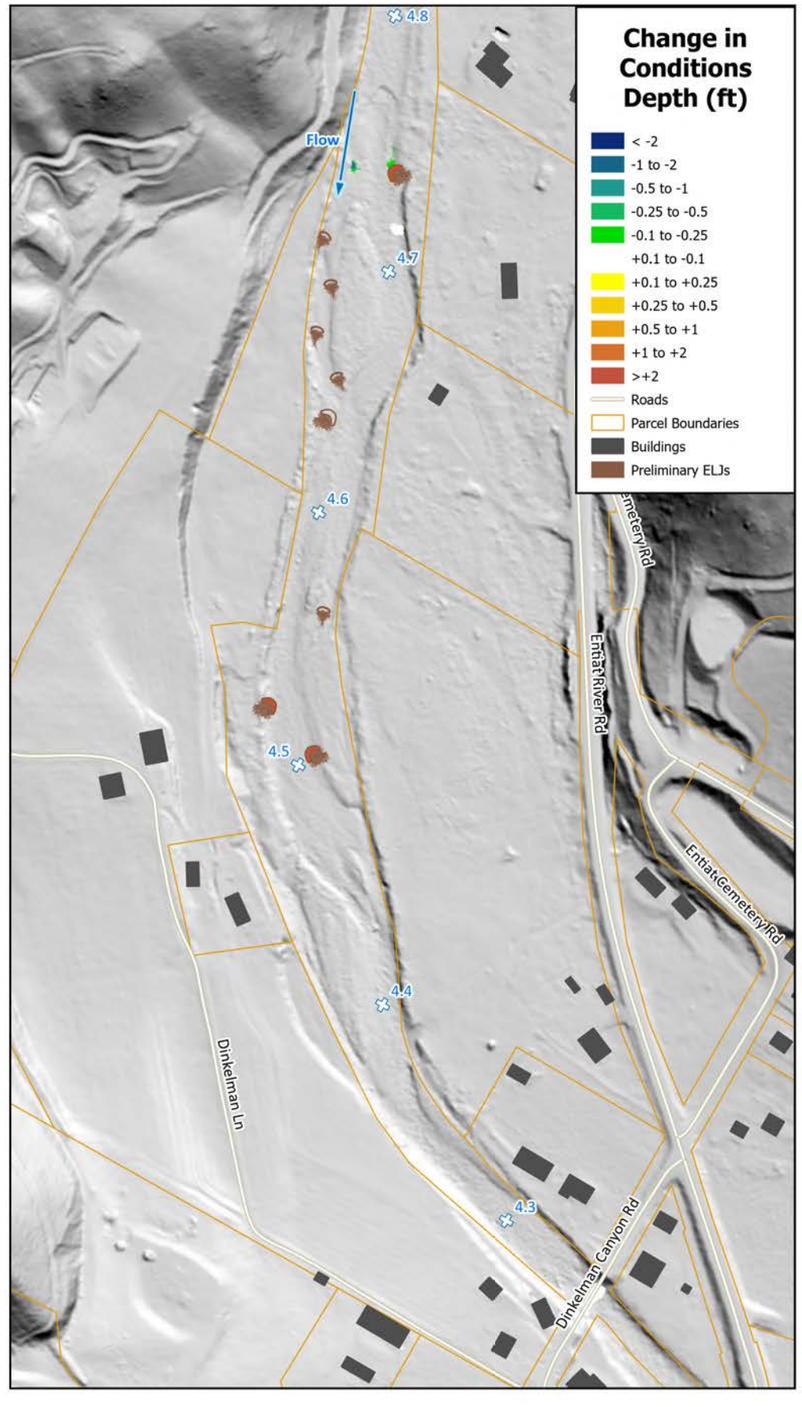
P:\PROJECTS\CHELAN COUNTY\LOWER ENTIAT RM 4.6\DESIGN\CAD\TESC DETAILS.DWG Grace 12/31/2024 12:32:06 PM

Appendix B

Hydraulic Model Results







Author: will Date: 12/18/2024 Path: P:\Projects\Chelan County\Lower Entiat RM 4.6\GIS\maps\aprx\Hydraulic Output\PrelimHydOutput.aprx

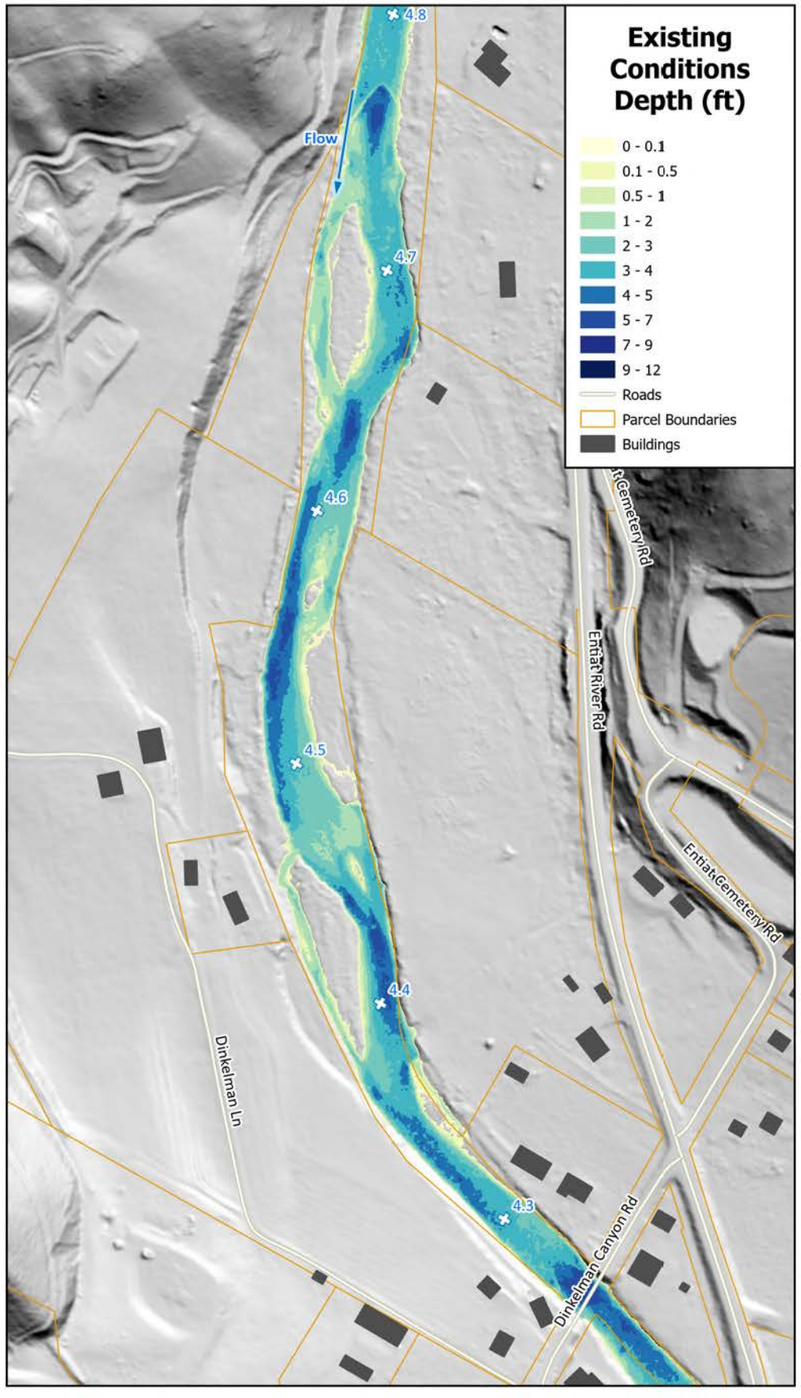
Lower Entiat 1D Reach (RM 4.3 - 4.8)

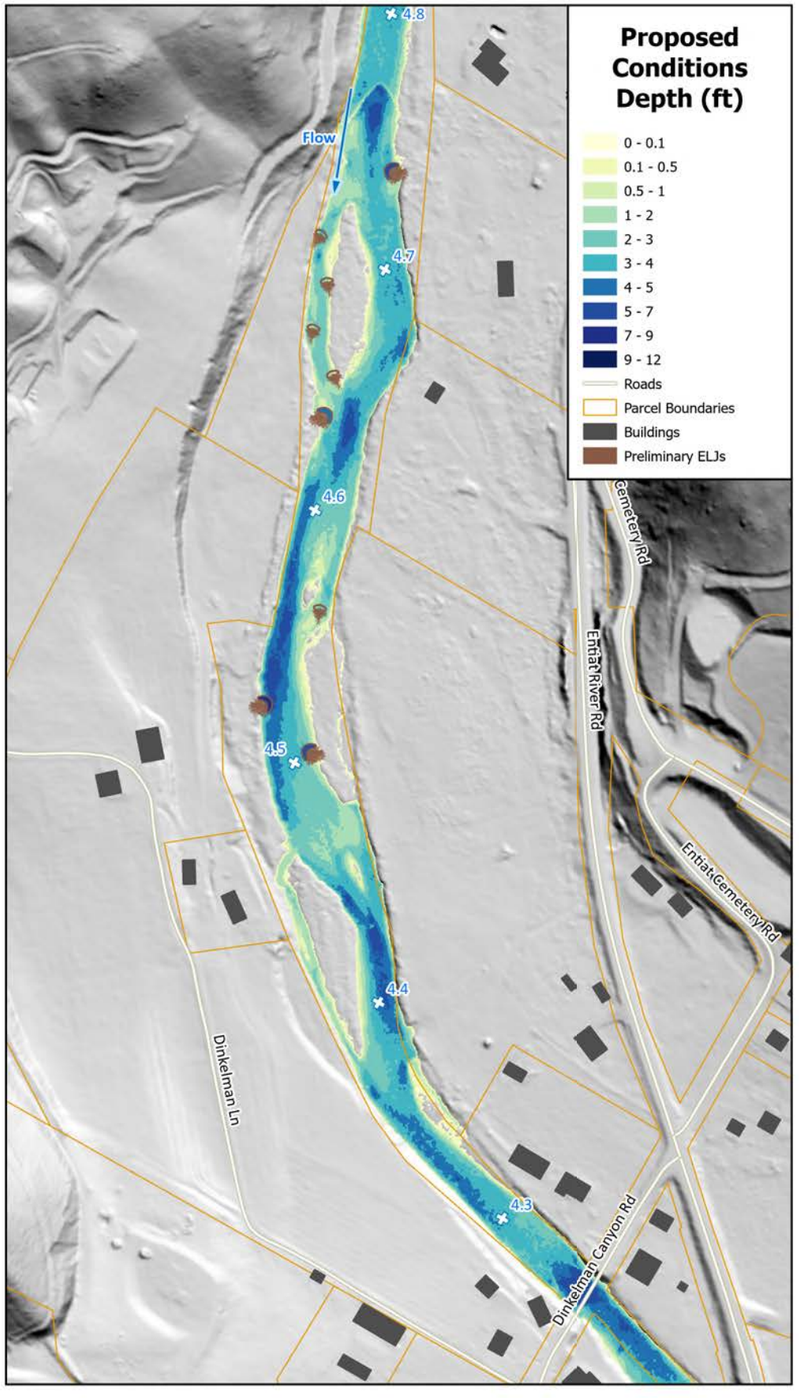
Hydraulic Model Output - Summer Flow (100 cfs)

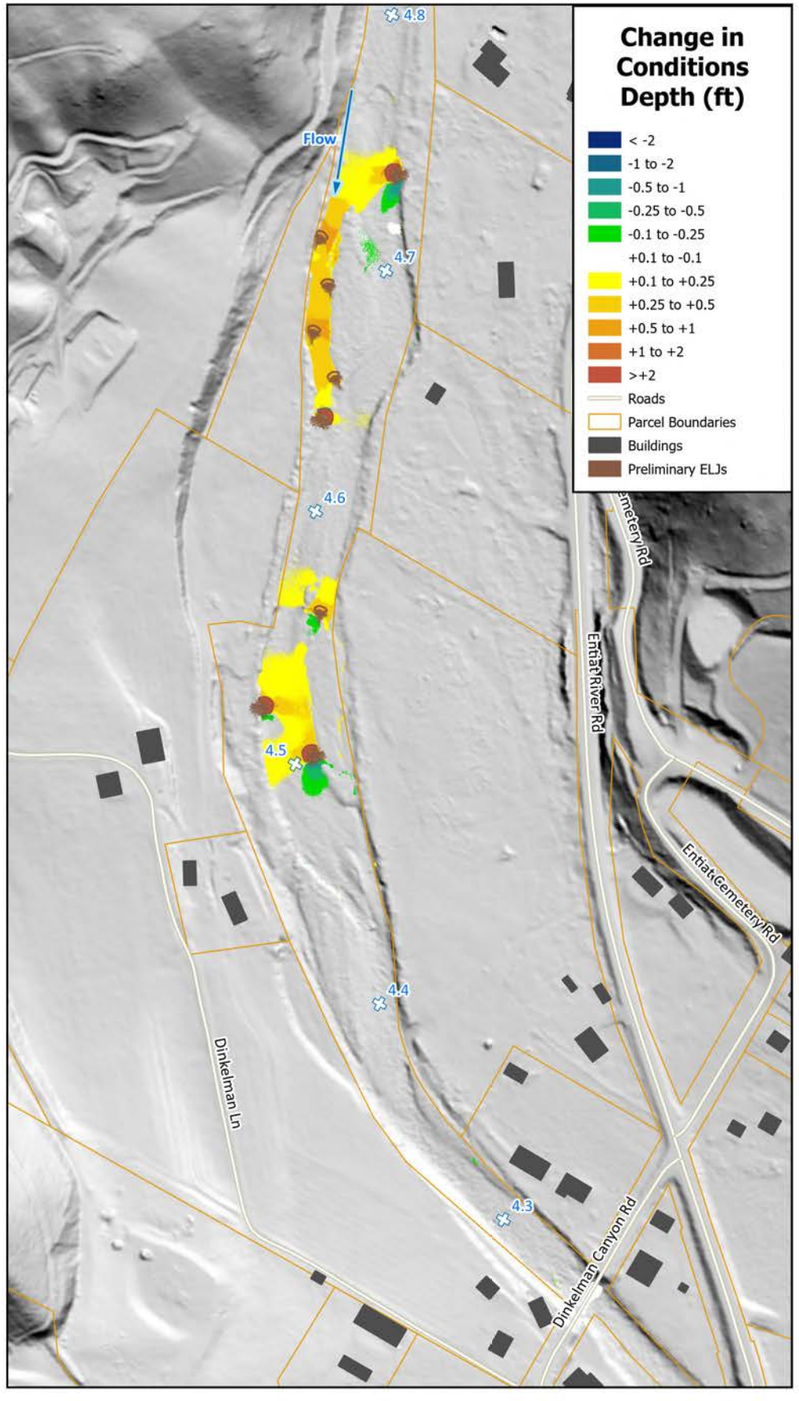
HEC-RAS 2D Hydraulic Model Results
Topobathymetric DEM generated using NV5 Geospatial (2022)
Lambert conformal conic projection, NAD 1983 State Plane Coordinate System (WA North Zone).

NSD CGS Natural Systems Design + Coastal Geologic Services

0 500 1,000 Feet







Lower Entiat 1D Reach (RM 4.3 - 4.8)

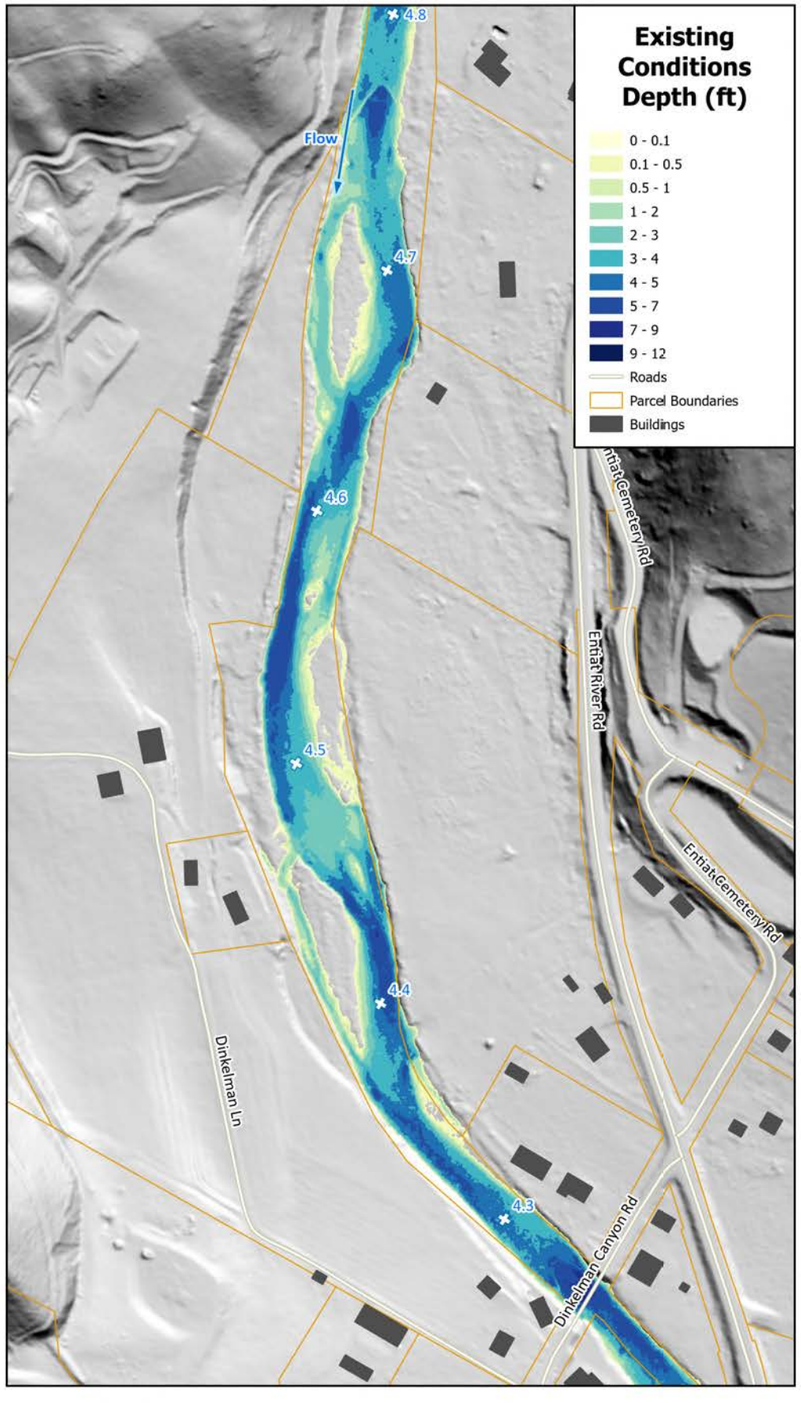
Hydraulic Model Output - 1.25yr Flow (2,370 cfs)

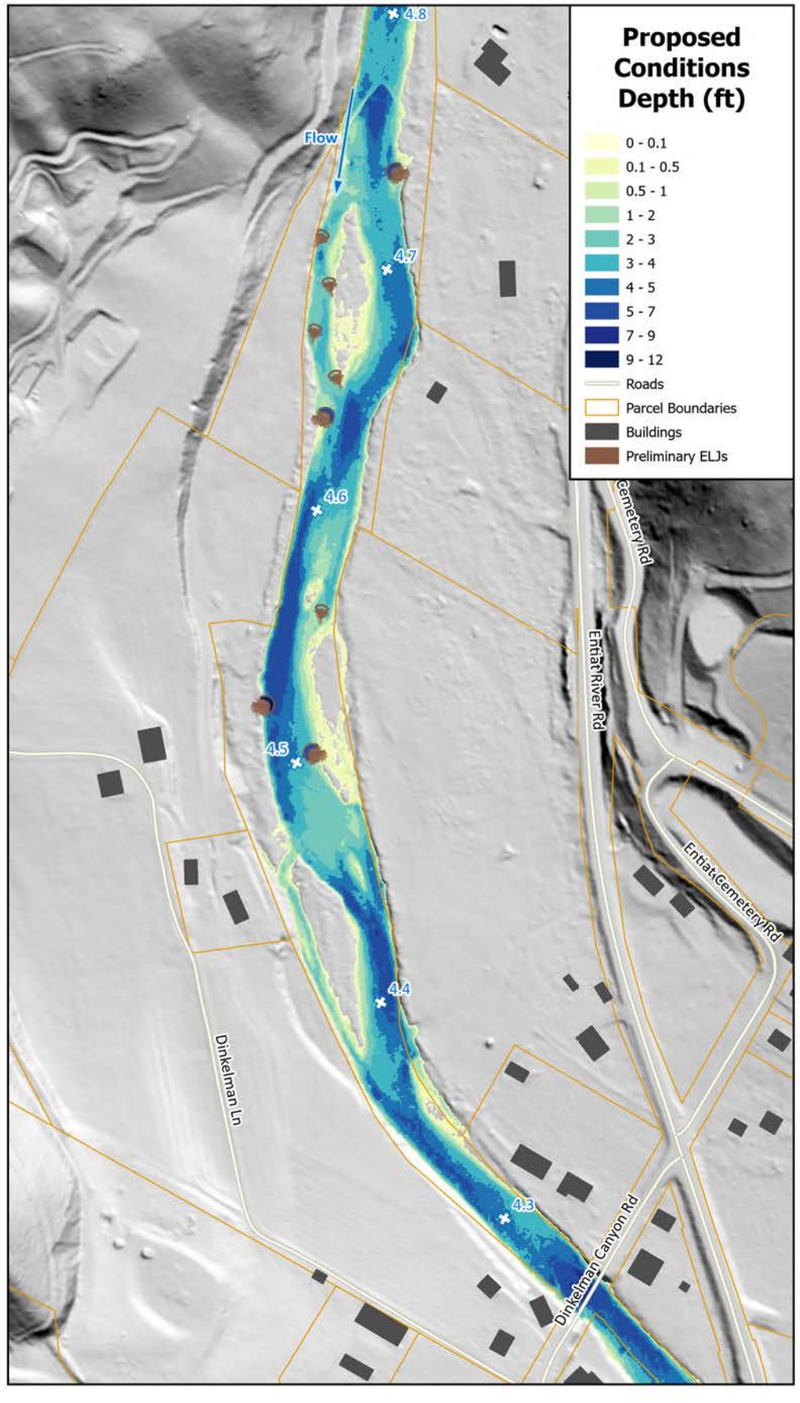
HEC-RAS 2D Hydraulic Model Results
Topobathymetric DEM generated using NV5 Geospatial (2022)
Lambert conformal conic projection, NAD 1983 State Plane Coordinate System (WA North Zone).

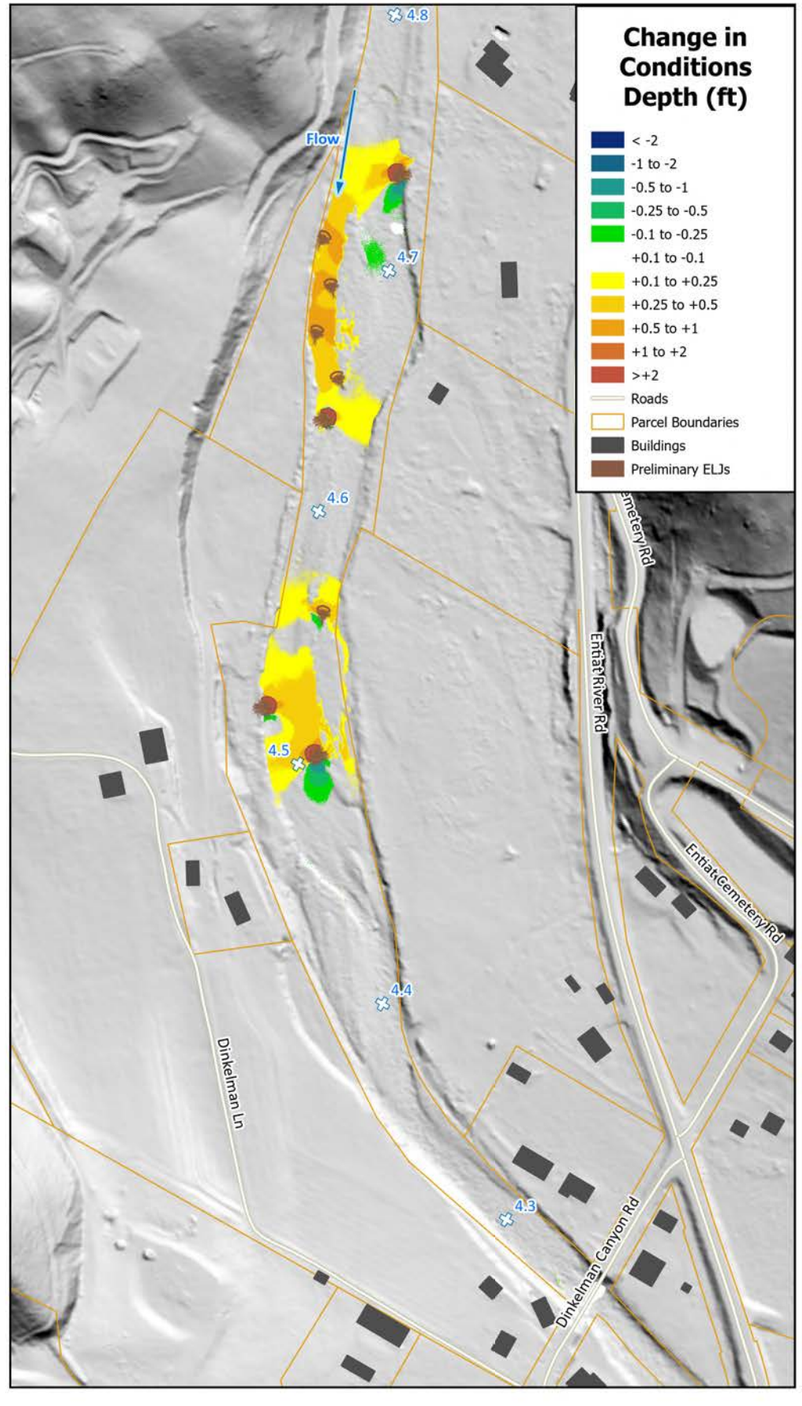
NSD CGS Natural Systems Design + Coastal Geologic Services

0 500 1,000 Feet

Author: will Date: 12/18/2024 Path: P:\Projects\Chelan County\Lower Entiat RM 4.6\GIS\maps\aprx\Hydraulic Output\PrelimHydOutput.aprx







Lower Entiat 1D Reach (RM 4.3 - 4.8)

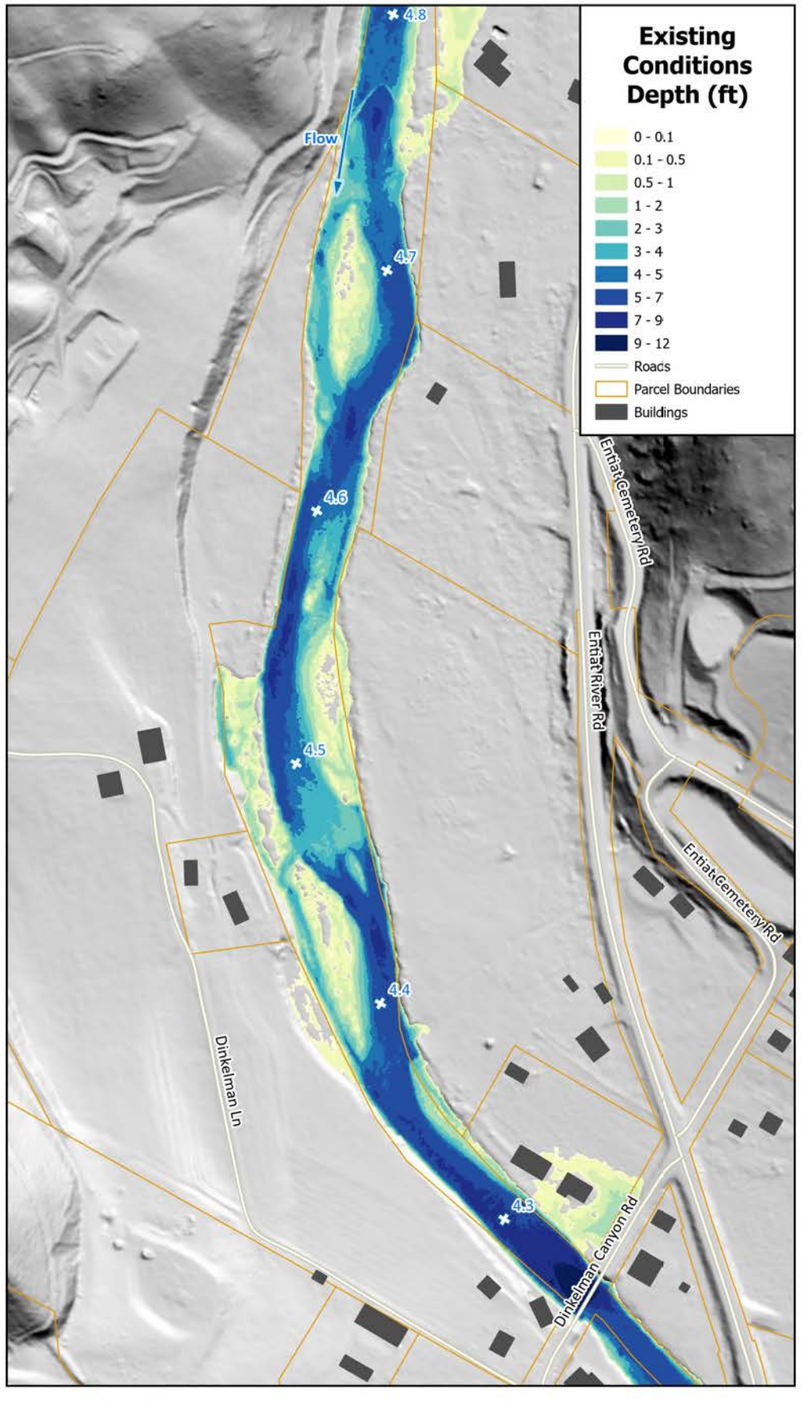
Hydraulic Model Output - 2yr Flow (3,130 cfs)

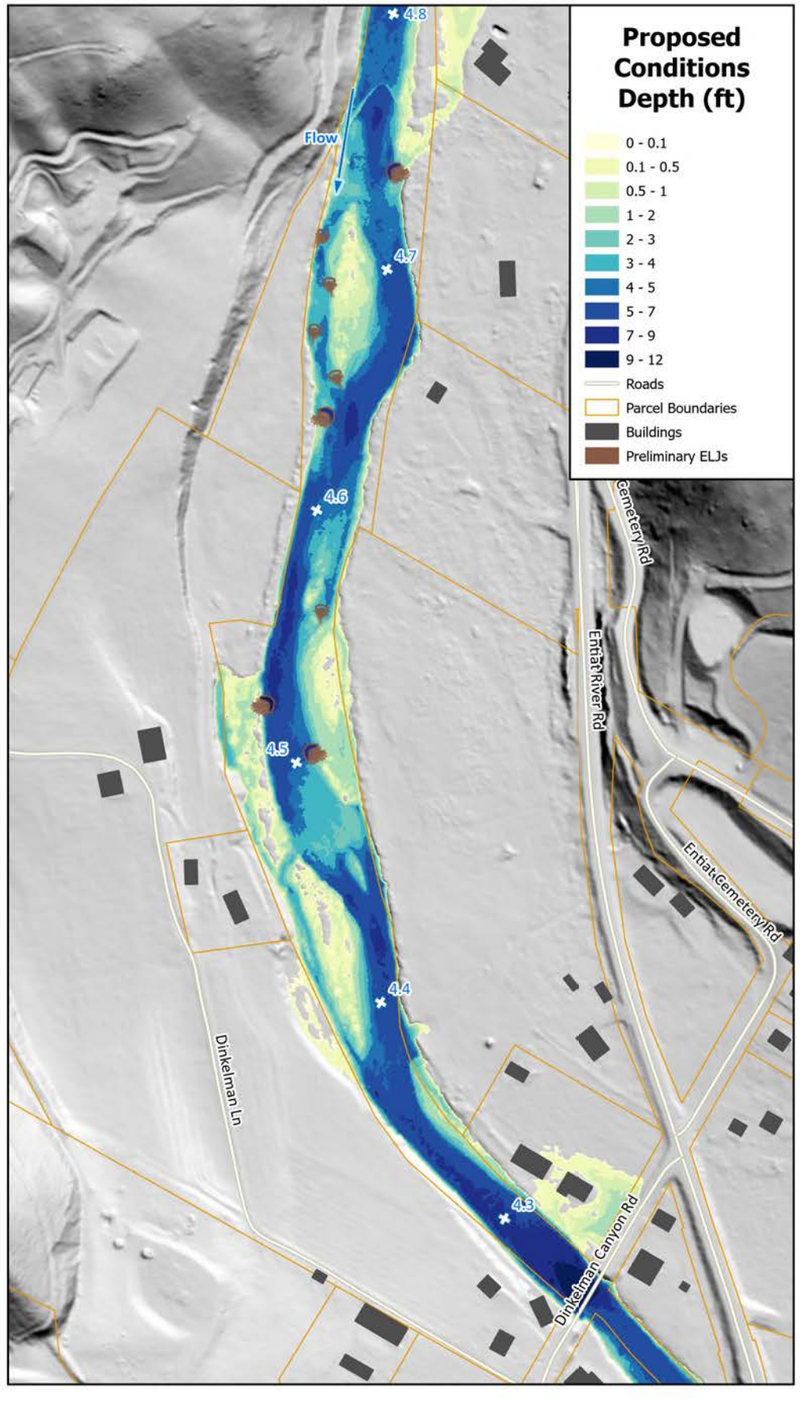
HEC-RAS 2D Hydraulic Model Results
Topobathymetric DEM generated using NV5 Geospatial (2022)
Lambert conformal conic projection, NAD 1983 State Plane Coordinate System (WA North Zone).

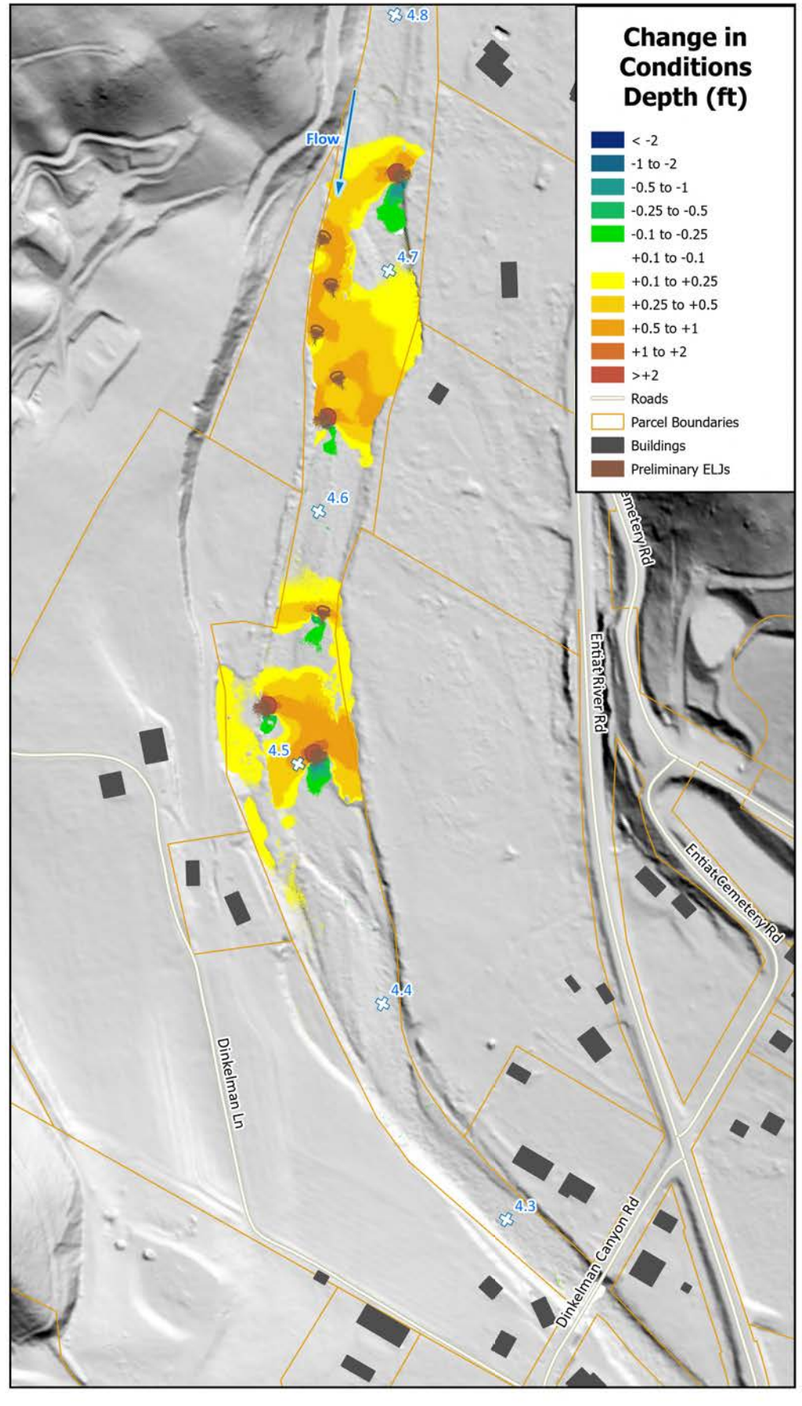
NSD CGS Natural Systems Design + Coastal Geologic Services

0 500 1,000 Feet

Author: will Date: 12/18/2024 Path: P:\Projects\Chelan County\Lower Entiat RM 4.6\GIS\maps\aprx\Hydraulic Output\PrelimHydOutput.aprx







Author: will Date: 12/18/2024 Path: P:\Projects\Chelan County\Lower Entiat RM 4.6\GIS\maps\aprx\Hydraulic Output\PrelimHydOutput.aprx

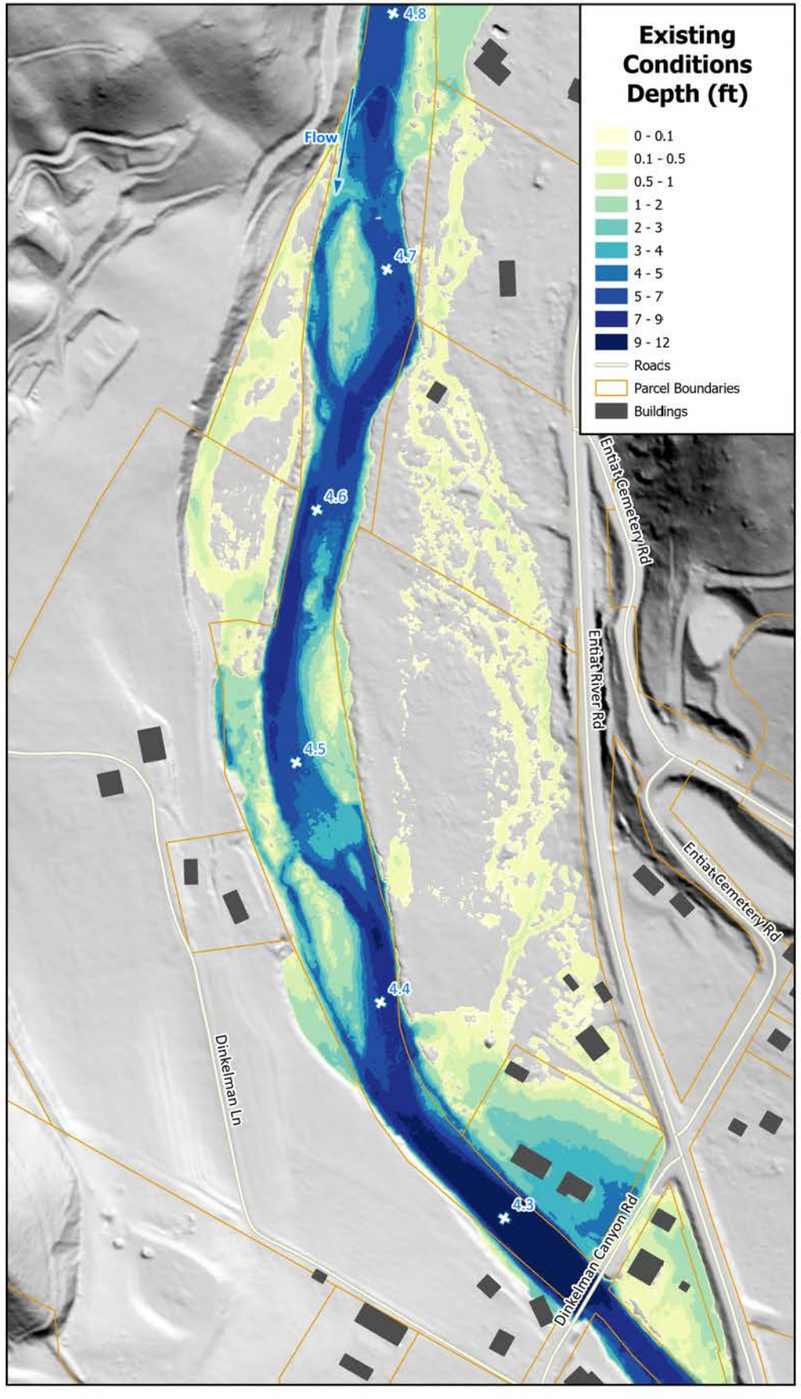
Lower Entiat 1D Reach (RM 4.3 - 4.8)

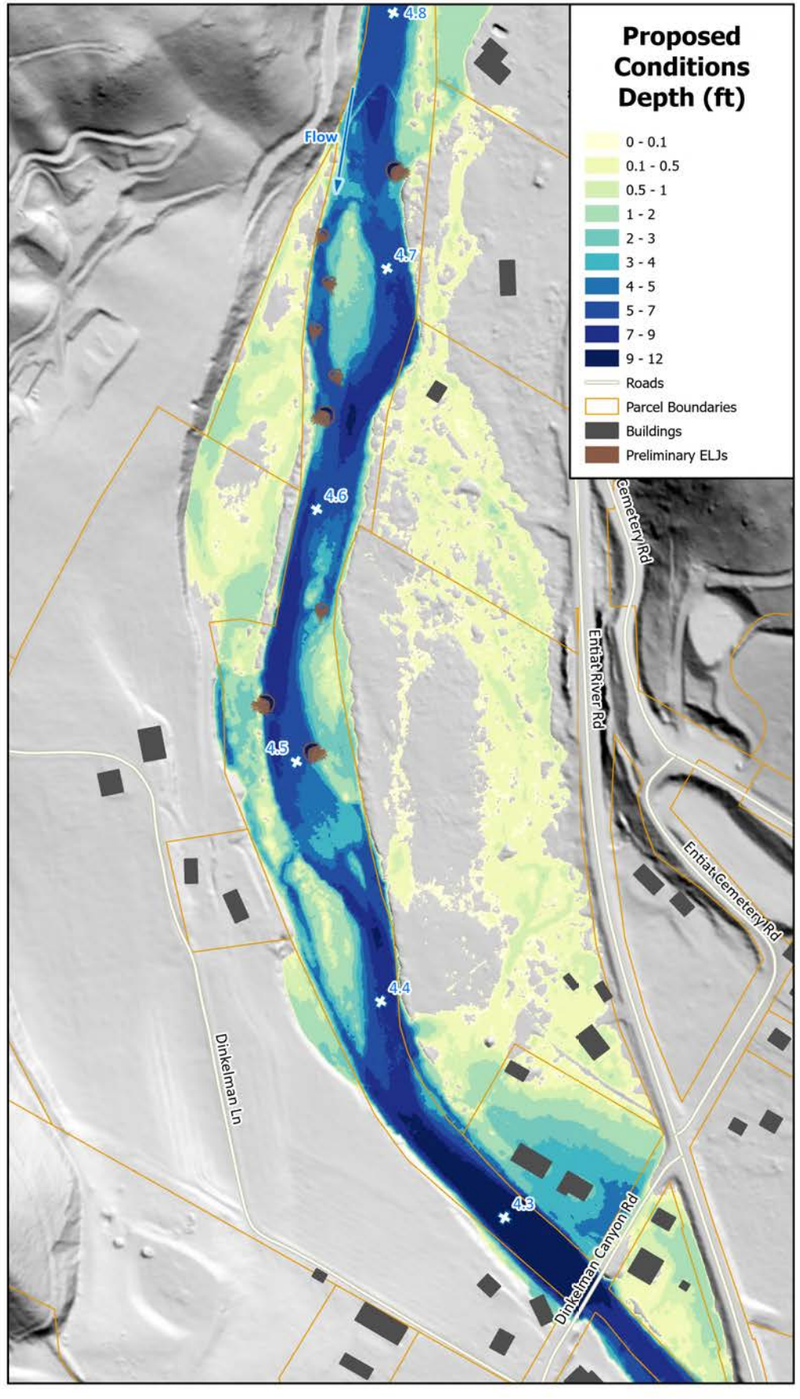
Hydraulic Model Output - 10yr Flow (5,600 cfs)

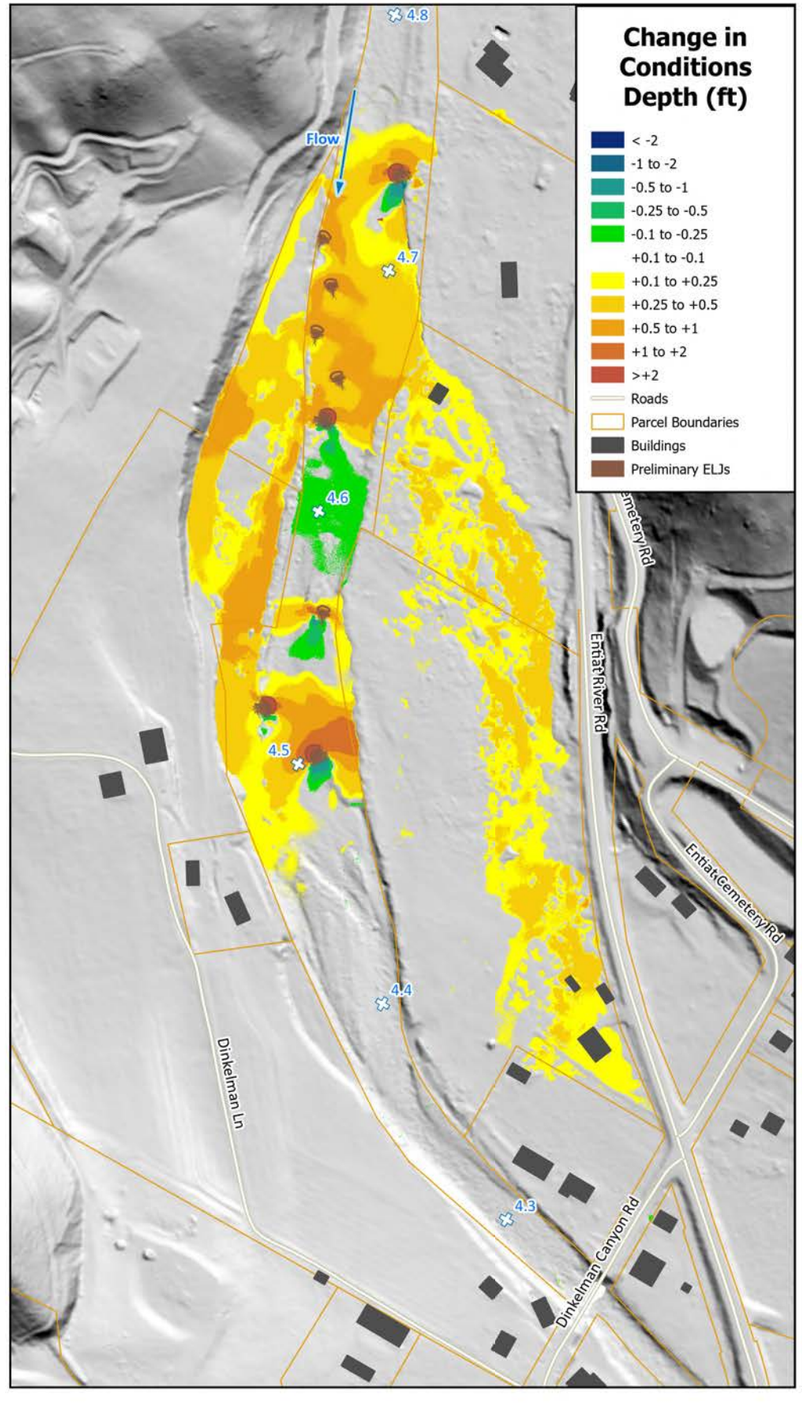
HEC-RAS 2D Hydraulic Model Results
Topobathymetric DEM generated using NV5 Geospatial (2022)
Lambert conformal conic projection, NAD 1983 State Plane Coordinate System (WA North Zone).

NSD CGS Natural Systems Design + Coastal Geologic Services

0 500 1,000 Feet







Author: will Date: 12/18/2024 Path: P:\Projects\Chelan County\Lower Entiat RM 4.6\GIS\maps\aprx\Hydraulic Output\PrelimHydOutput.aprx

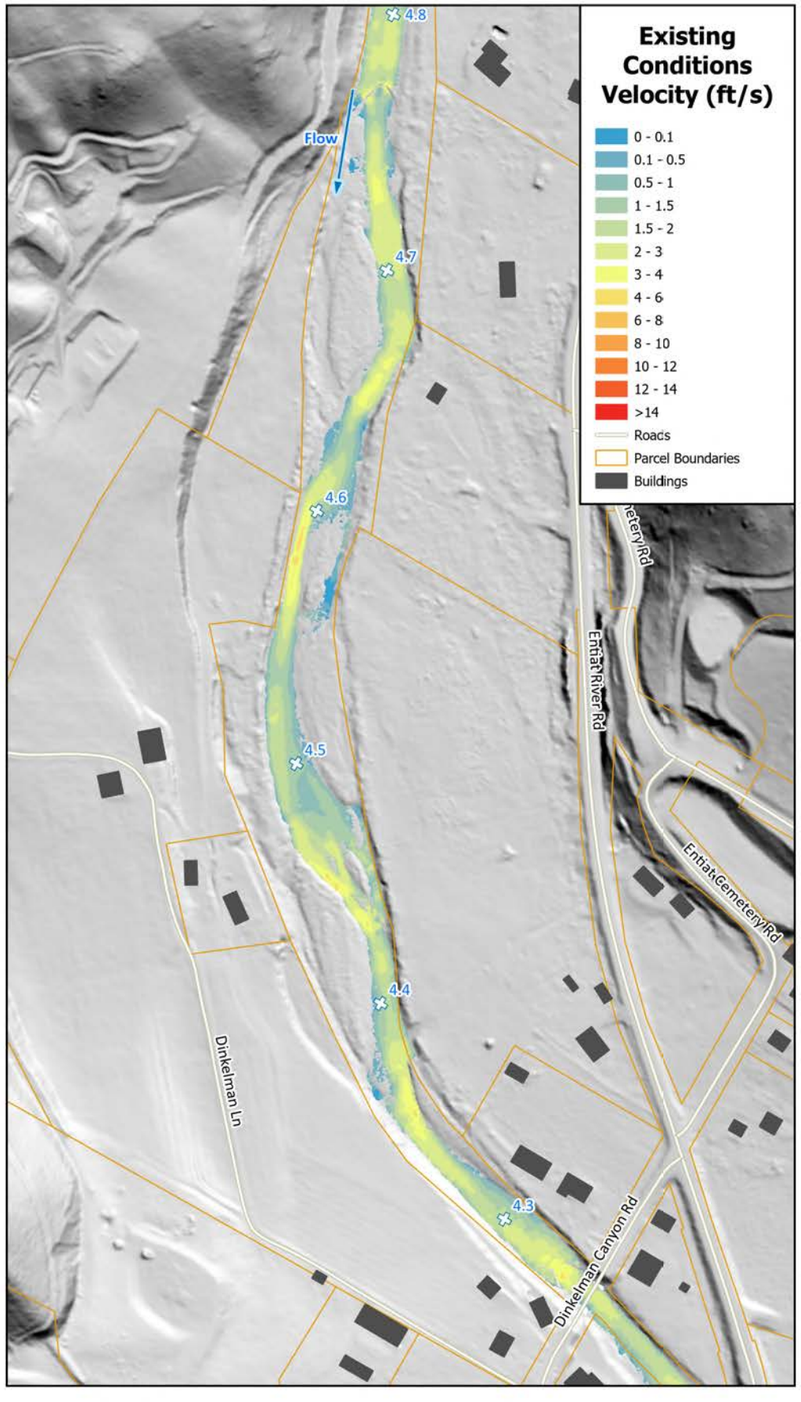
Lower Entiat 1D Reach (RM 4.3 - 4.8)

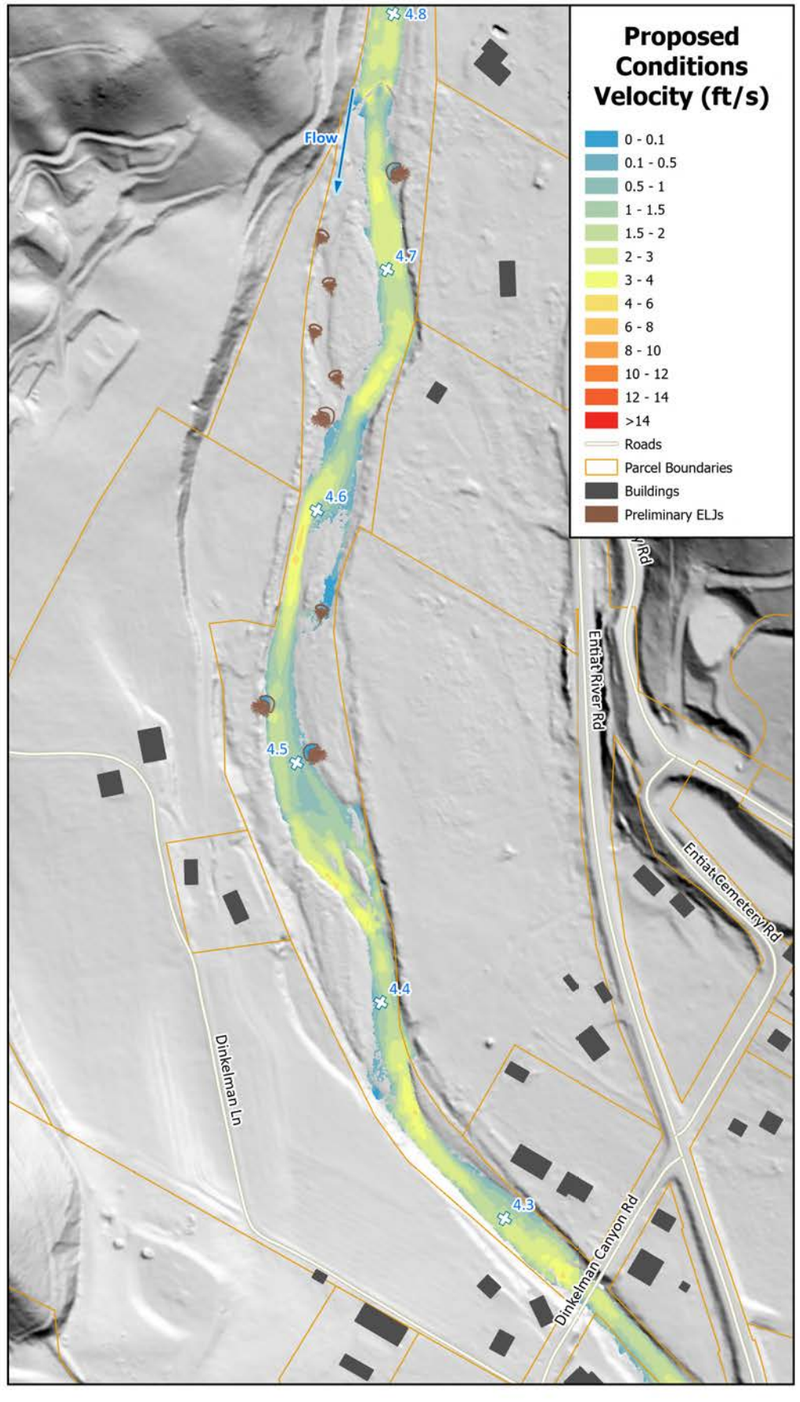
Hydraulic Model Output - 100yr Flow (8,300 cfs)

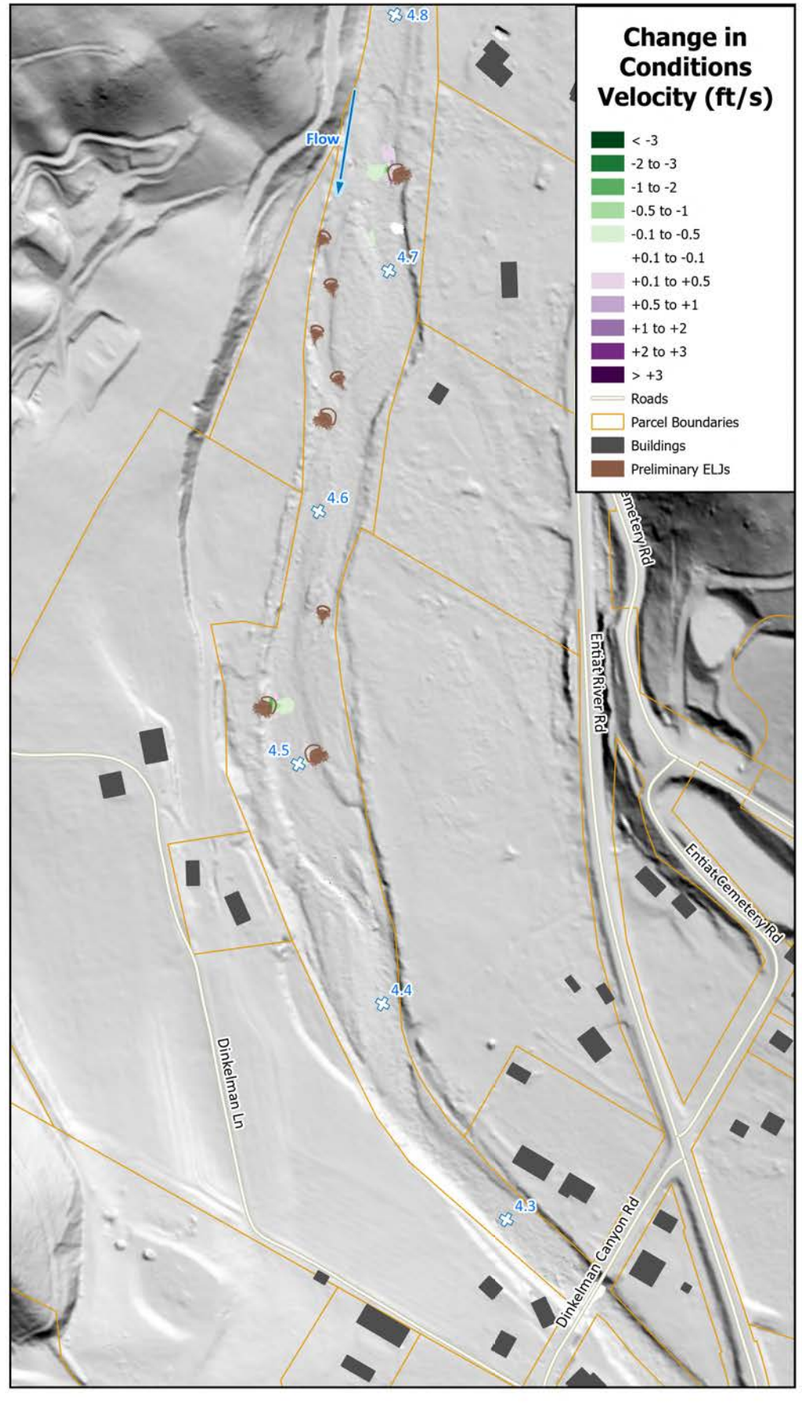
HEC-RAS 2D Hydraulic Model Results
Topobathymetric DEM generated using NV5 Geospatial (2022)
Lambert conformal conic projection, NAD 1983 State Plane Coordinate System (WA North Zone).

NSD CGS Natural Systems Design + Coastal Geologic Services

0 500 1,000 Feet







Lower Entiat 1D Reach (RM 4.3 - 4.8)

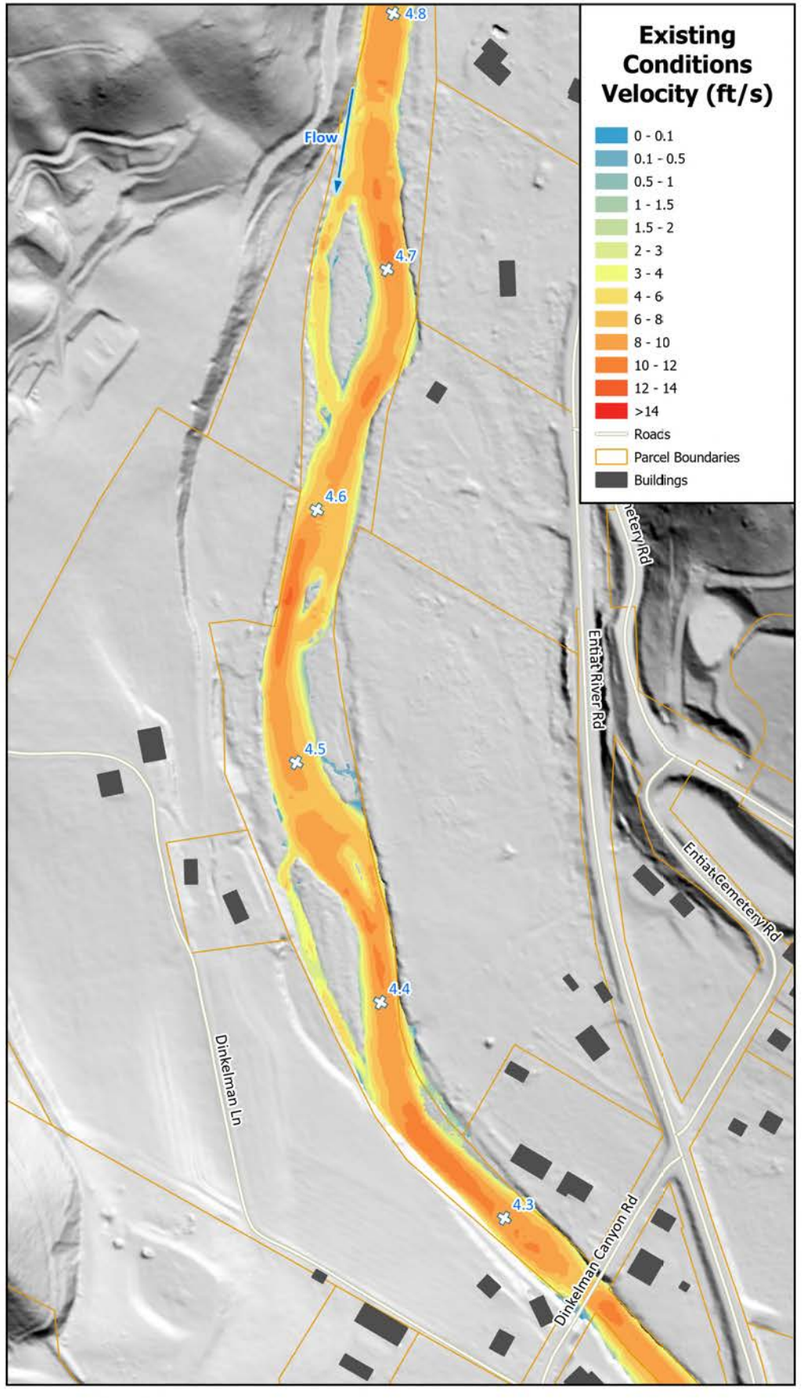
Hydraulic Model Output - Summer Flow (100 cfs)

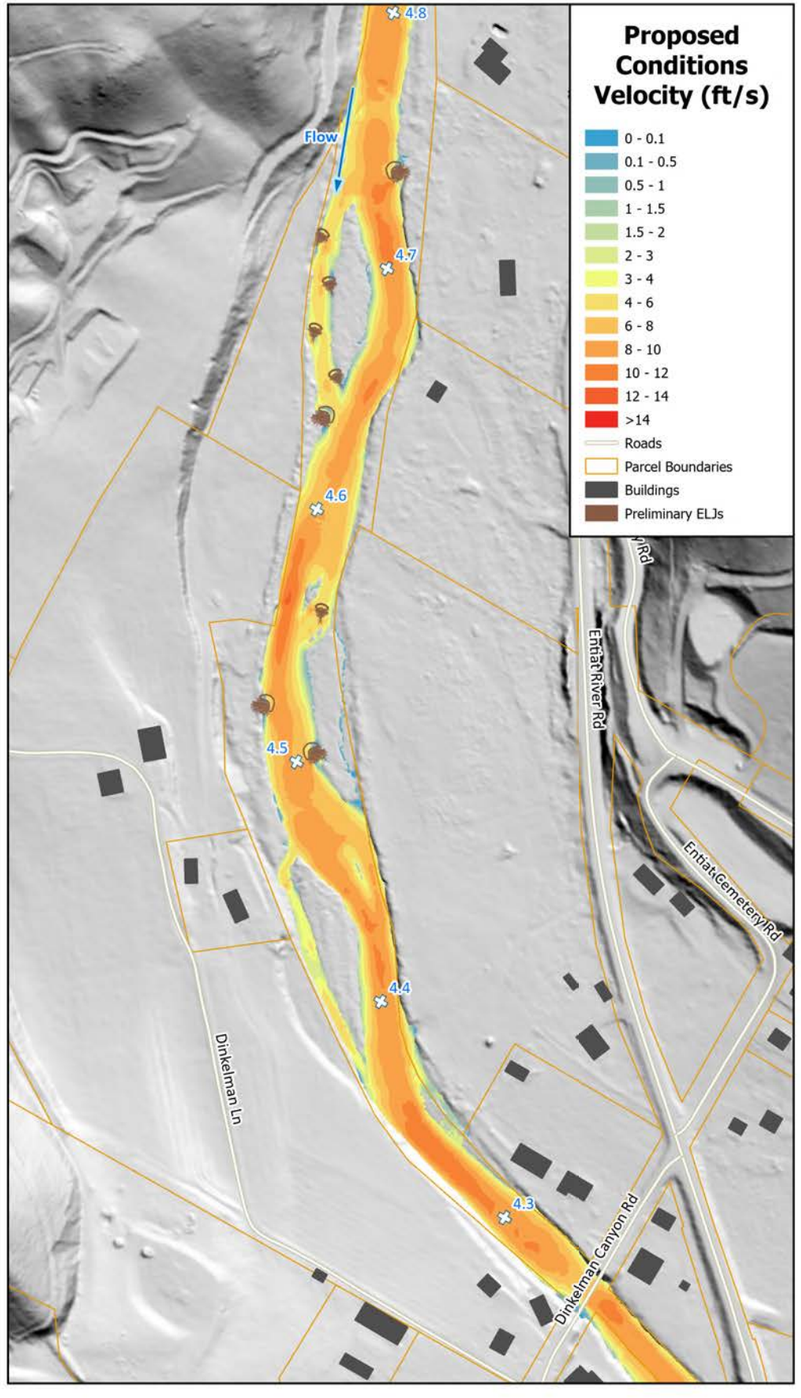
HEC-RAS 2D Hydraulic Model Results
Topobathymetric DEM generated using NV5 Geospatial (2022)
Lambert conformal conic projection, NAD 1983 State Plane Coordinate System (WA North Zone).

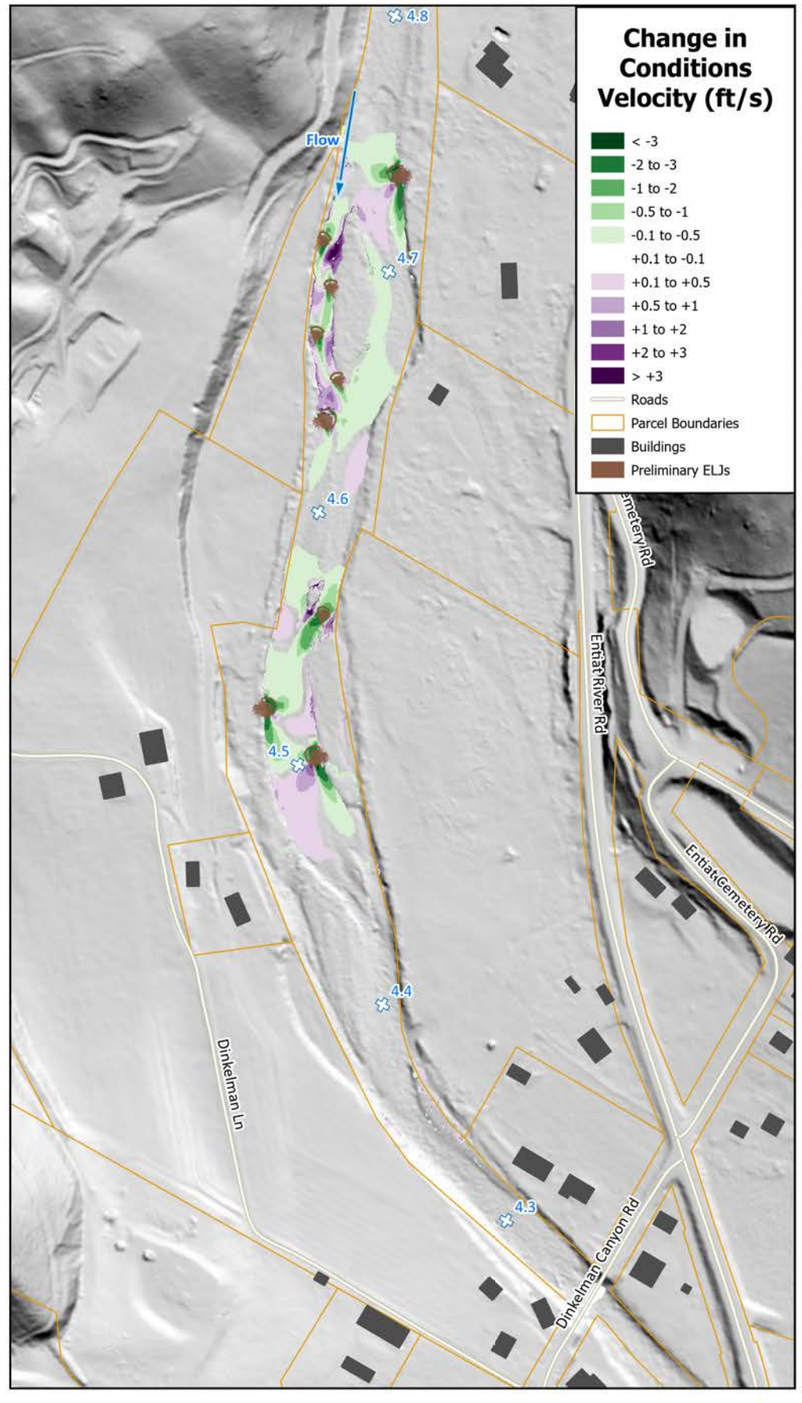
NSD CGS Natural Systems Design + Coastal Geologic Services

0 500 1,000 Feet

Author: will Date: 12/18/2024 Path: P:\Projects\Chelan County\Lower Entiat RM 4.6\GIS\maps\aprx\Hydraulic Output\PrelimHydOutput.aprx







Lower Entiat 1D Reach (RM 4.3 - 4.8)

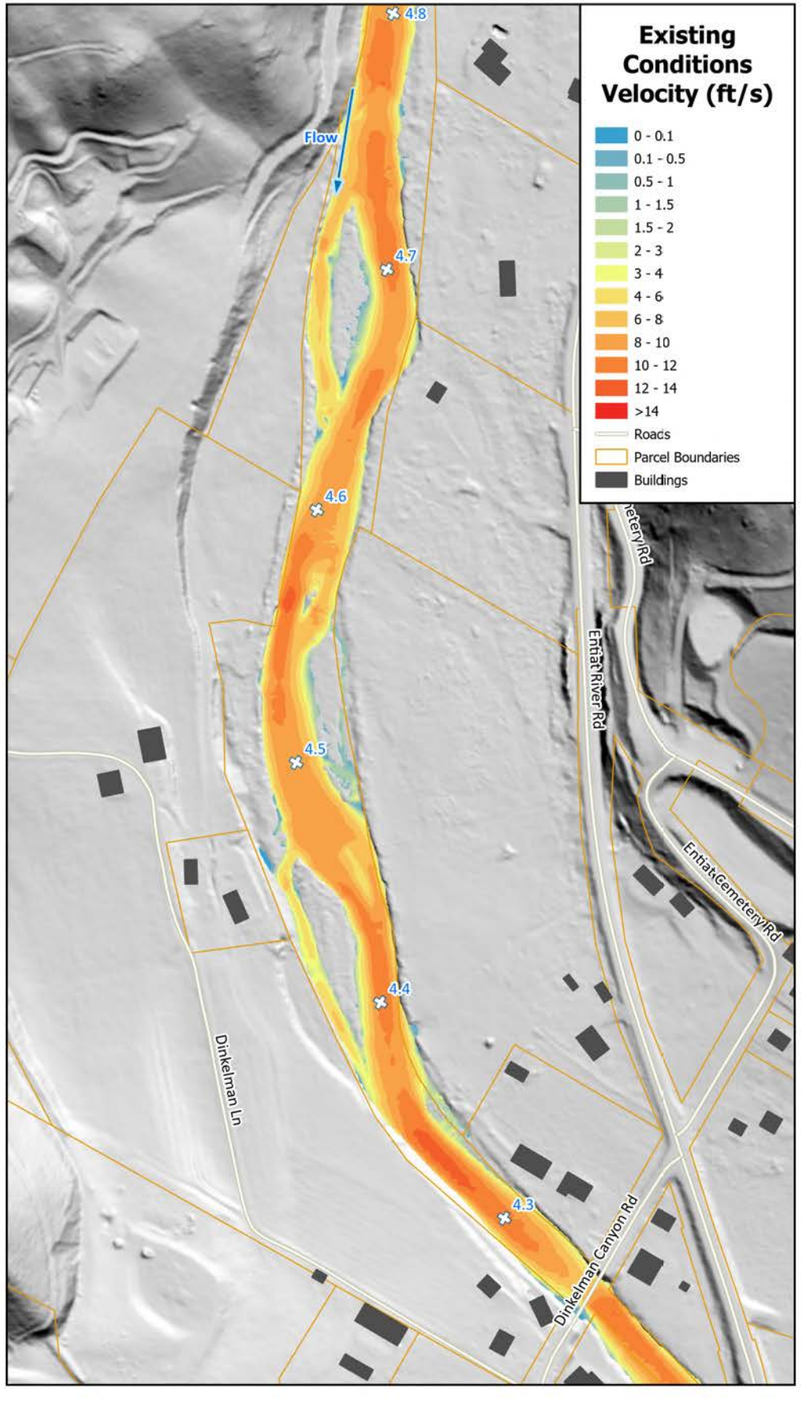
Hydraulic Model Output - 1.25yr Flow (2,370 cfs)

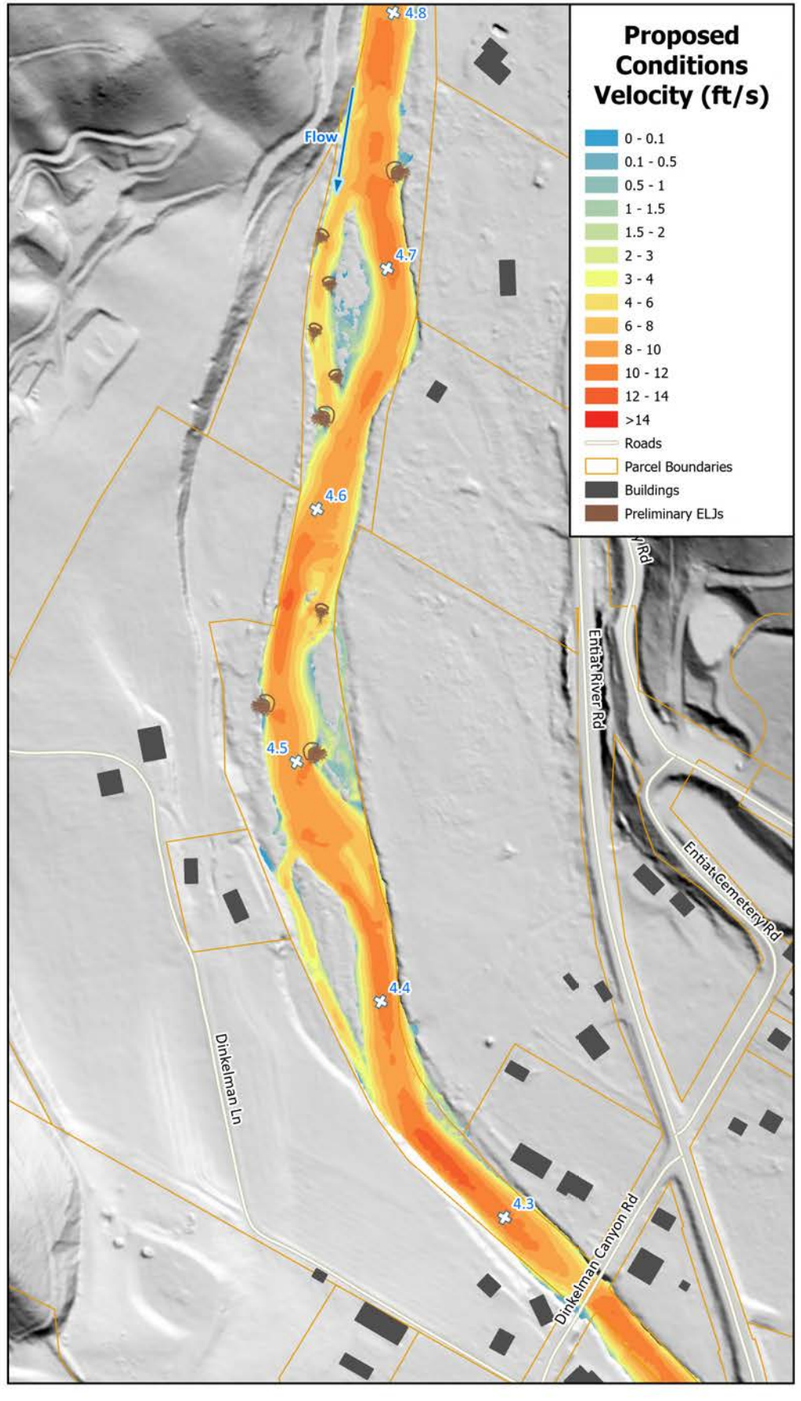
HEC-RAS 2D Hydraulic Model Results
Topobathymetric DEM generated using NV5 Geospatial (2022)
Lambert conformal conic projection, NAD 1983 State Plane Coordinate System (WA North Zone).

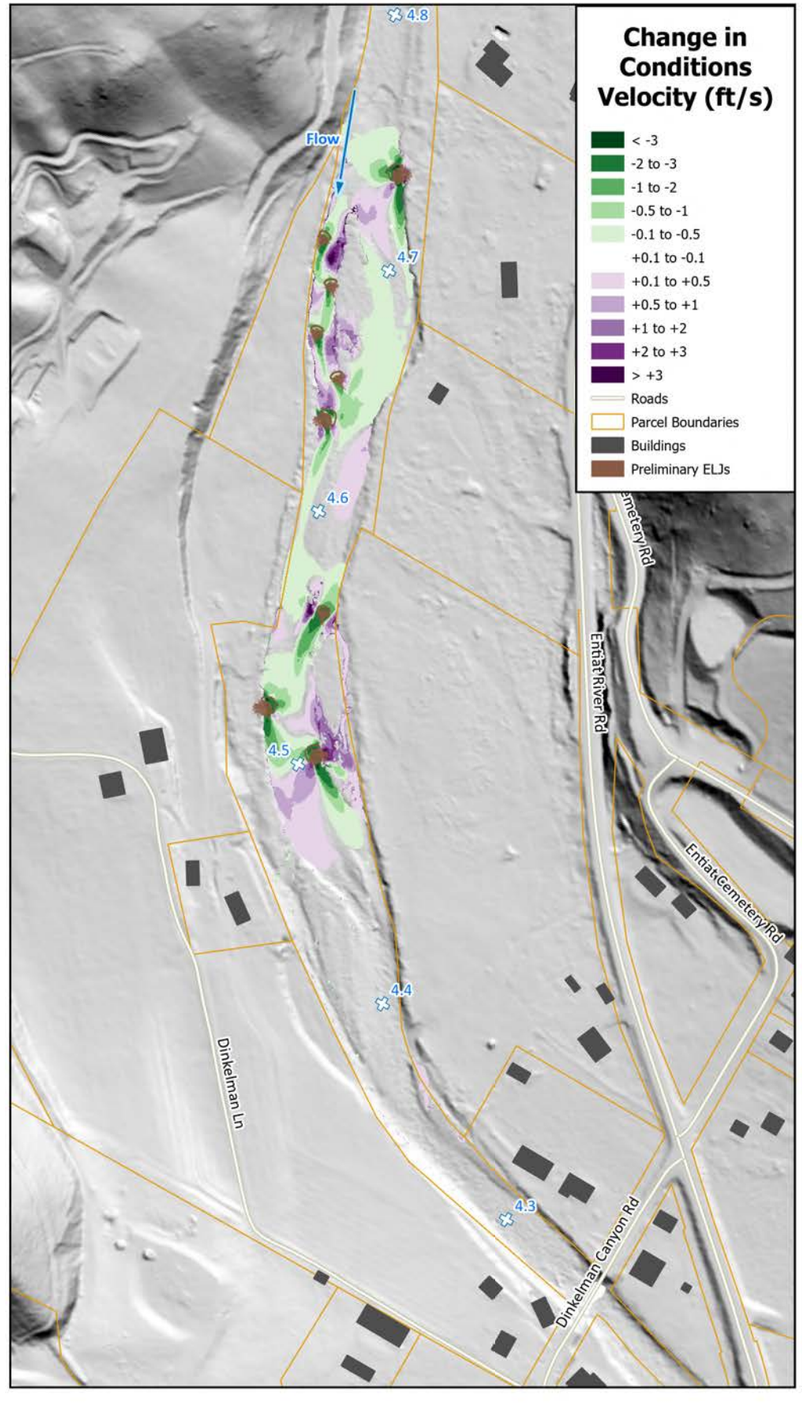
NSD CGS Natural Systems Design + Coastal Geologic Services

0 500 1,000 Feet

Author: will Date: 12/18/2024 Path: P:\Projects\Chelan County\Lower Entiat RM 4.6\GIS\maps\aprx\Hydraulic Output\PrelimHydOutput.aprx







Lower Entiat 1D Reach (RM 4.3 - 4.8)

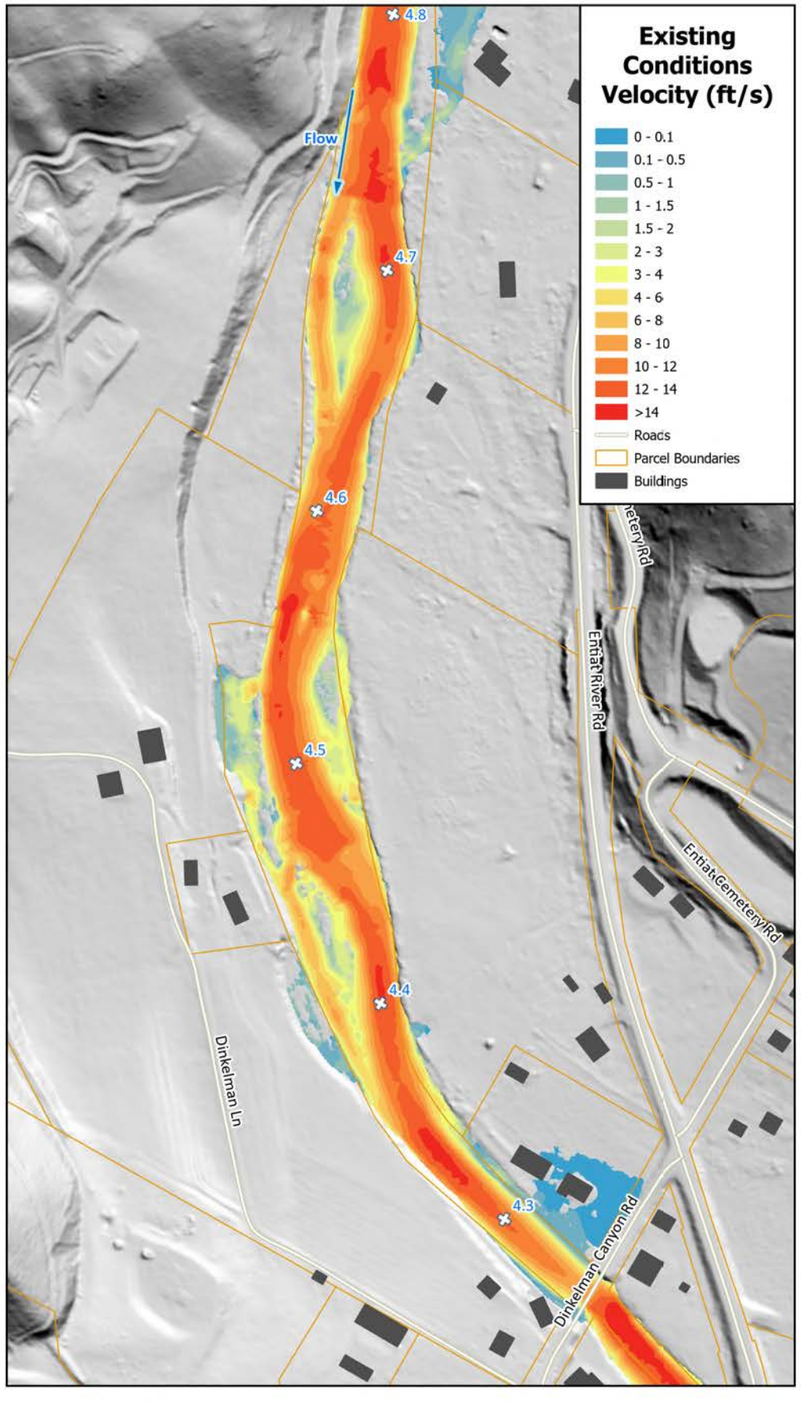
Hydraulic Model Output - 2yr Flow (3,130 cfs)

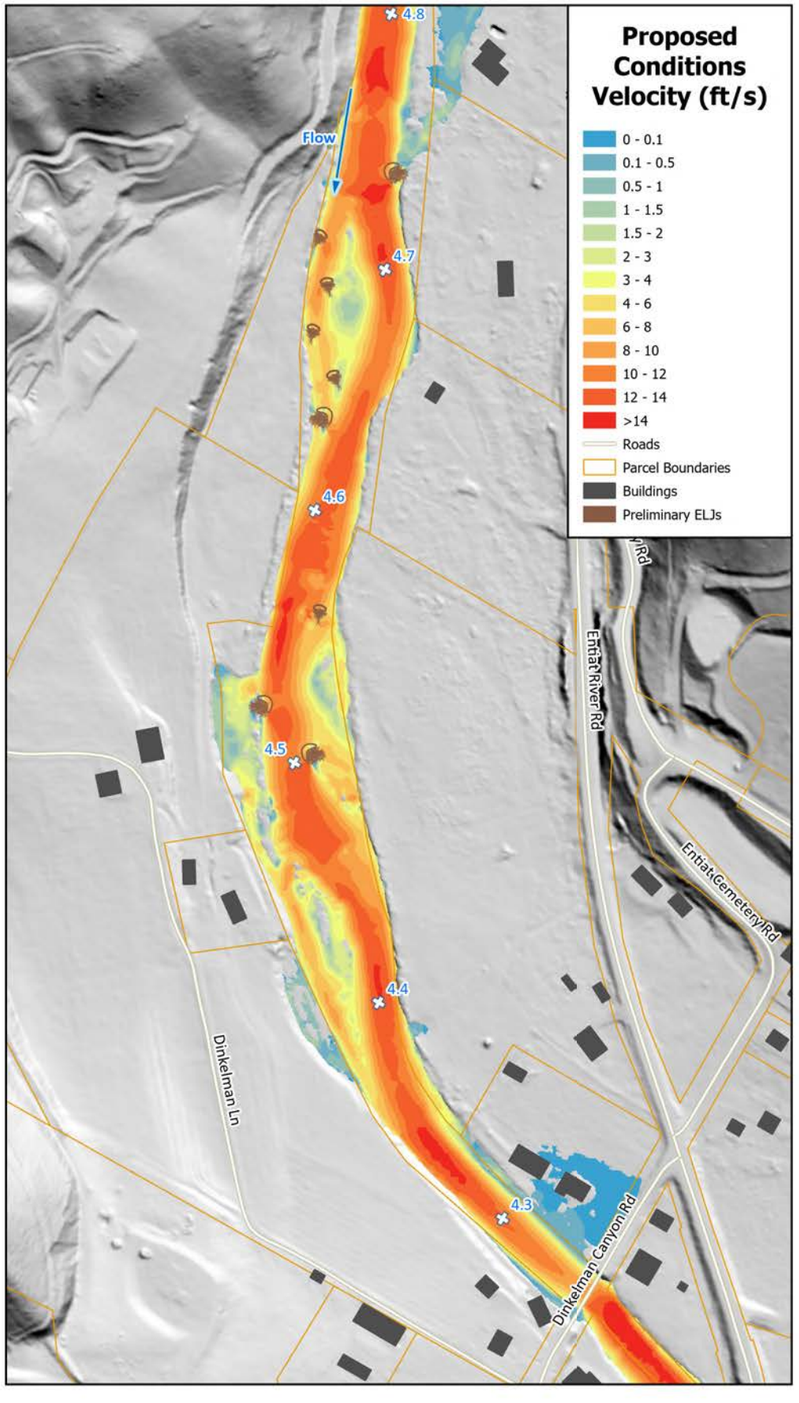
HEC-RAS 2D Hydraulic Model Results
Topobathymetric DEM generated using NV5 Geospatial (2022)
Lambert conformal conic projection, NAD 1983 State Plane Coordinate System (WA North Zone).

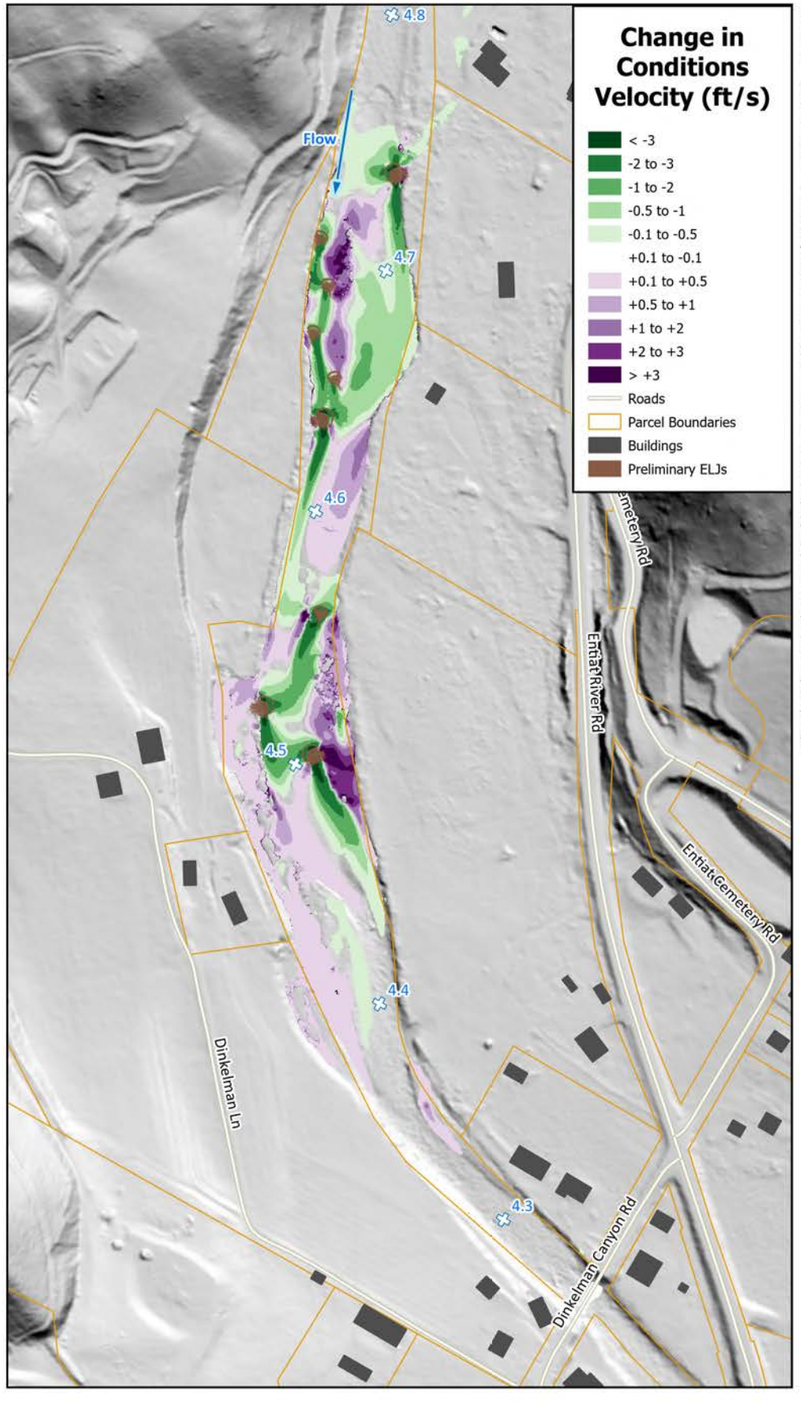
NSD CGS Natural Systems Design + Coastal Geologic Services

0 500 1,000 Feet

Author: will Date: 12/18/2024 Path: P:\Projects\Chelan County\Lower Entiat RM 4.6\GIS\maps\aprx\Hydraulic Output\PrelimHydOutput.aprx







Lower Entiat 1D Reach (RM 4.3 - 4.8)

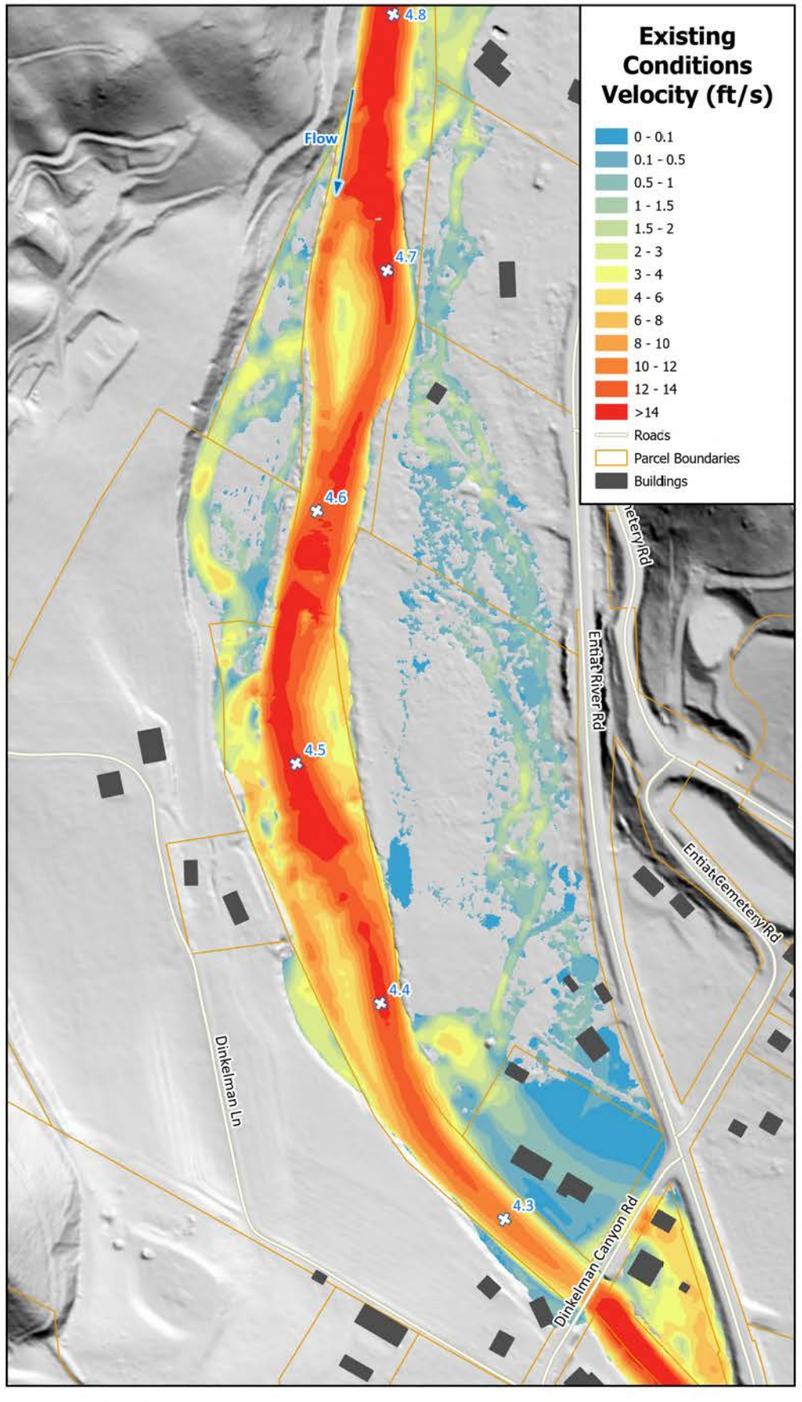
Hydraulic Model Output - 10yr Flow (5,600 cfs)

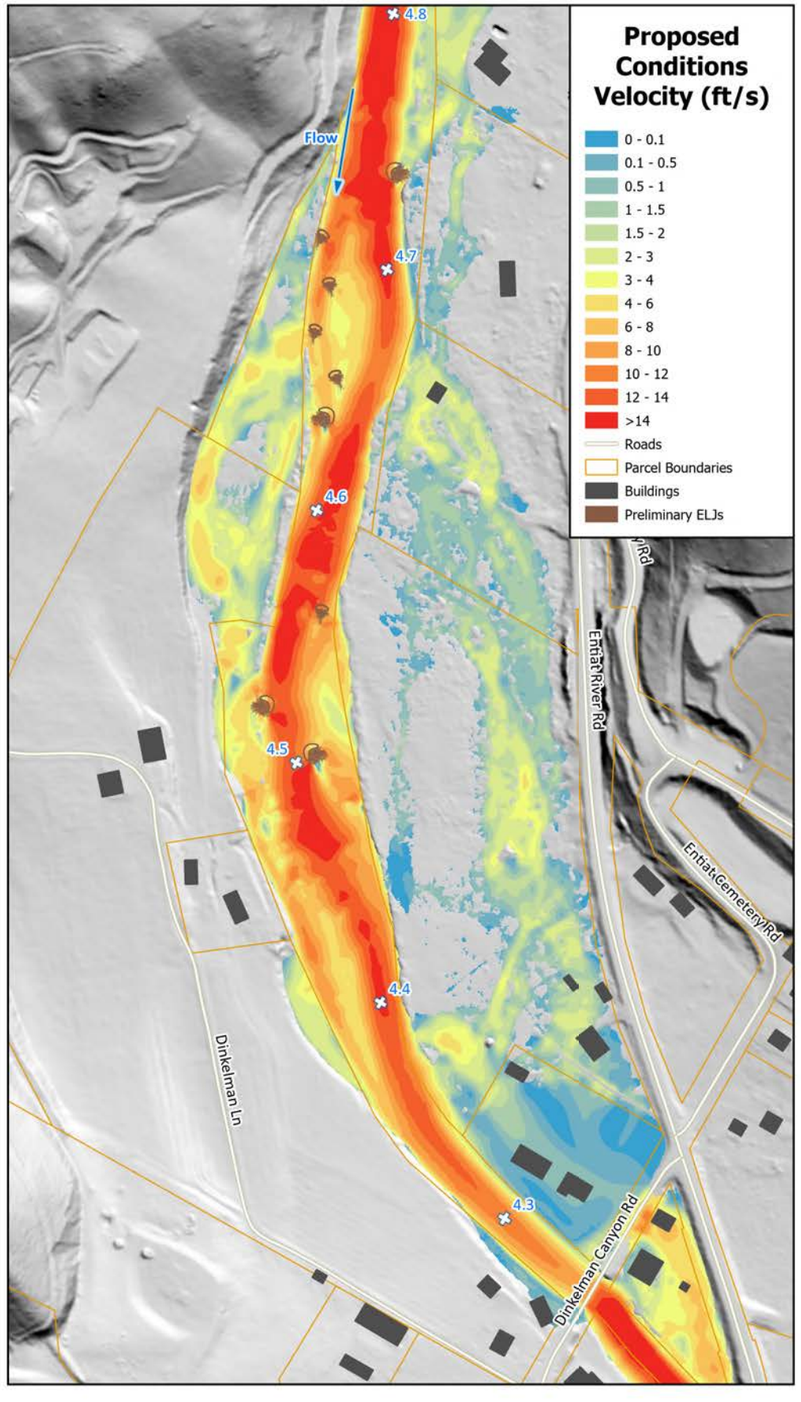
HEC-RAS 2D Hydraulic Model Results
Topobathymetric DEM generated using NV5 Geospatial (2022)
Lambert conformal conic projection, NAD 1983 State Plane Coordinate System (WA North Zone).

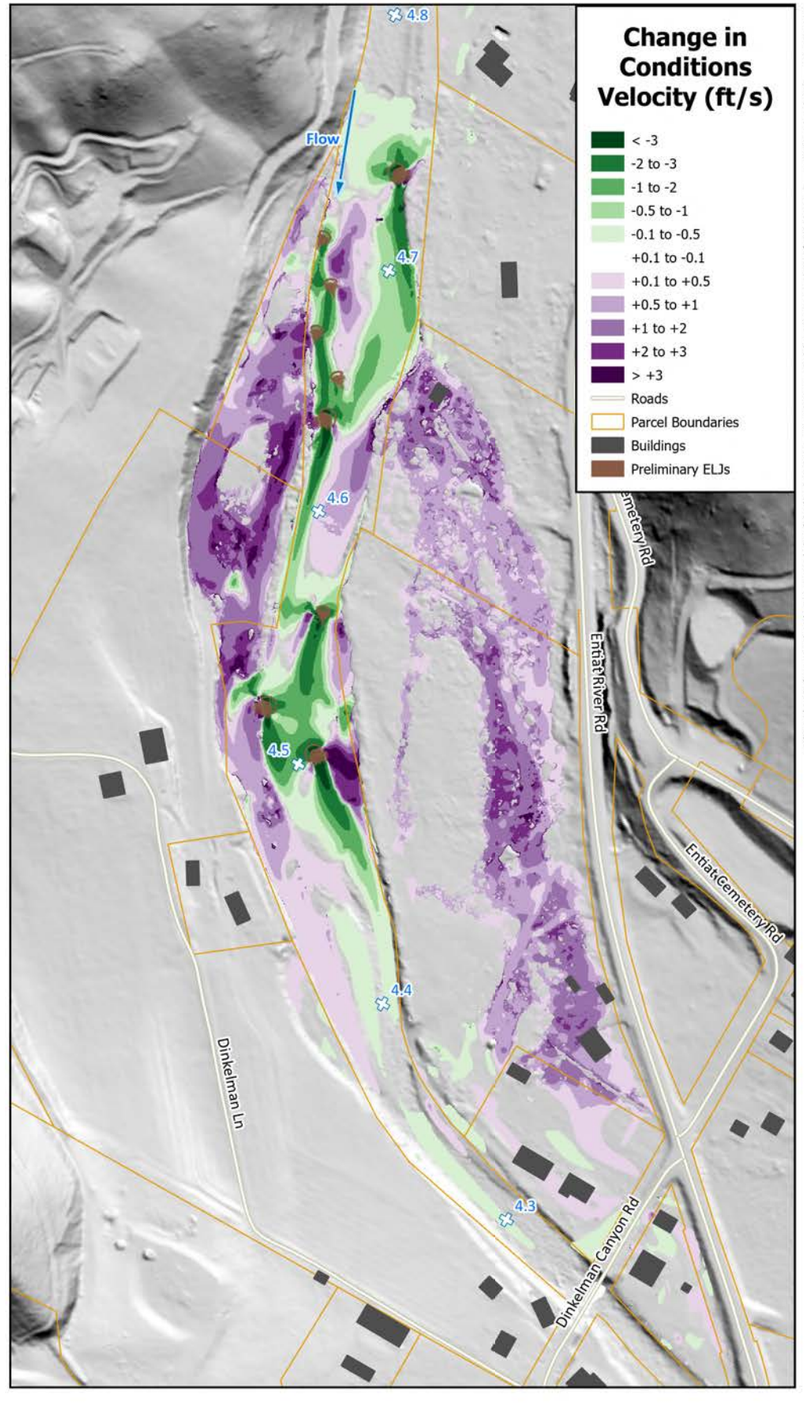
NSD CGS Natural Systems Design + Coastal Geologic Services

0 500 1,000 Feet

Author: will Date: 12/18/2024 Path: P:\Projects\Chelan County\Lower Entiat RM 4.6\GIS\maps\aprx\Hydraulic Output\PrelimHydOutput.aprx







Lower Entiat 1D Reach (RM 4.3 - 4.8)

Hydraulic Model Output - 100yr Flow (8,300 cfs)

HEC-RAS 2D Hydraulic Model Results
Topobathymetric DEM generated using NV5 Geospatial (2022)
Lambert conformal conic projection, NAD 1983 State Plane Coordinate System (WA North Zone).

NSD CGS Natural Systems Design + Coastal Geologic Services

0 500 1,000 Feet

Author: will Date: 12/18/2024 Path: P:\Projects\Chelan County\Lower Entiat RM 4.6\GIS\maps\aprx\Hydraulic Output\PrelimHydOutput.aprx

Appendix C

Preliminary Construction Cost Estimate

Construction Cost Estimate

Natural Systems Design

Project: Lower Entiat Reach 1D (RM 4.3-4.8)
Client: CCNRD
Project No: CCNRD-047

Analyst: G. Bacci
Latest Revision: 12/18/2024
Allowance for Indeterminates Included in Bid Items: 35%
Inflation to 2026 included in Item Cost: 10%

Construction

ITEM #	ITEM DESCRIPTION	WSDOT REF	QTY	UNIT	UNIT COST	ITEM COST
CO-1	MOBILIZATION		1	LS	$ 60,800.00	$ 60,800.00
CO-3	EROSION/ WATER POLLUTION CONTROL MEASURES		1	LS	$ 84,100.00	$ 84,100.00
CO-4	TEMPORARY ACCESS & STAGING		1	LS	$ 34,753.60	$ 34,753.60
CO-6	SEEDING		1	LS	$ 7,435.24	$ 7,435.24
	Subtotal					$ 187,088.84
	Taxes (as % of Construction Sub-Total)		8.5%			$ 15,902.55
	Total (Construction)					**$ 202,991.40**

Deflector Group 1

ITEM #	ITEM DESCRIPTION	WSDOT REF	QTY	UNIT	UNIT COST	ITEM COST
G1-1	DEFLECTOR ELJ		1	EA	$ 76,630.53	$ 76,630.53
	Subtotal					$ 76,630.53
	Taxes (as % of Construction Sub-Total)		8.5%			$ 6,513.59
	Total (Deflector Group 1)					**$ 83,144.12**

Side Channel Group 2

ITEM #	ITEM DESCRIPTION	WSDOT REF	QTY	UNIT	UNIT COST	ITEM COST
G2-1	STABILIZE EXISTING APEX		1	EA	$ 24,404.89	$ 24,404.89
G2-2	SIDE CHANNEL ELJ		4	EA	$ 30,123.46	$ 120,493.84
G2-3	DEFLECTOR ELJ		1	EA	$ 76,630.53	$ 76,630.53
	Subtotal					$ 221,529.26
	Taxes (as % of Construction Sub-Total)		8.5%			$ 18,829.99
	Total (Side Channel Group 2)					**$ 240,359.25**

Side Channel Group 3

ITEM #	ITEM DESCRIPTION	WSDOT REF	QTY	UNIT	UNIT COST	ITEM COST
G4-2	SIDE CHANNEL ELJ		1	EA	$ 30,123.46	$ 30,123.46
	Subtotal					$ 30,123.46
	Taxes (as % of Construction Sub-Total)		8.5%			$ 2,560.49
	Total (Side Channel Group 3)					**$ 32,683.95**

Deflector Group 4

ITEM #	ITEM DESCRIPTION	WSDOT REF	QTY	UNIT	UNIT COST	ITEM COST
G5-1	DEFLECTOR ELJ		2	EA	$ 76,630.53	$ 153,261.06
	Subtotal					$ 153,261.06
	Taxes (as % of Construction Sub-Total)		8.5%			$ 13,027.19
	Total (Deflector Group 4)					**$ 166,288.25**

Grand Total ***$725,466.97***