Wednesday, March 11, 2026

Contact Information

2026 Upper Columbia Regional Project Pre-Application

* Pre-applications due March 11, 2026 (COB)

*Complete SRFB applications due in PRISM April 17, 2026 (COB)

*Revised SRFB proposals due in PRISM May 27, 2026 (COB)

*Final revised applications due in PRISM June 22, 2026 (noon)

Project Title	Nason Creek and State Route 207 Re-Alignment Fish Habitat Enhancement Project - Phases 1 & Phase 2
Sponsor	Confederated Tribes and Bands of the Yakama Nation
Primary Contact	Chris Butler
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Project Summary

Please provide a description or summary of the proposed project, including project goals. The goal of the project should be to solve identified problems by addressing the root causes. Then clearly state the desired future condition.

The Yakama Nation has developed a large scale habitat and fish passage restoration action within its Treaty Ceded Area that offers a rare opportunity to accomplish multiple resource objectives in a manner that truly restores natural processes that create and sustain Pacific Coast anadromous fish runs. Through the development of key partnerships with the Washington State Department of Transportation (WSDOT) and the United States Forest Service (U. S. Forest Service) Okanogan/Wenatchee Nation Forest (OWNF), this project proposes to remove 0.65 miles of WSDOT managed highway (State Route 207) out of the creek corridor and floodplain so that over 1.4 miles of stream habitat can be protected and restored as productive spawning and rearing habitat for endangered spring Chinook salmon and steelhead. This project will remove floodplain habitat fish passage impediments caused by State Route 207 and restore connectivity of roughly 14 acres of floodplain habitat, including groundwater fed side channels. Multiple WSDOT Chronic Environmental Deficiency sites identified along State Route 207 will be fully removed from the Nason Creek corridor, three non-fish passable culverts will be fully removed, and habitat restoration including the placement of many large habitat wood structures and improvement of 0.5 miles of side channel will occur.

What are the project objectives? Objectives support and refine biological goals, breaking them down into small steps. Objectives are specific, quantifiable actions the project will complete to achieve the stated goal. Each objective should be SMART (Specific, Measurable, Achievable, Relevant, and Time-bound). Note: This exact question is included in the PRISM application. Example format: The project seeks to address [specify limiting factor(s)] for [limiting life stage(s)] by [specific actions proposed] to create an estimated [include specific target metrics, as described below] upon implementation in [estimated year].

Collaborative agency goals between the Yakama Nation, U.S. Forest Service, and WSDOT for this project include: 1) restoring quality salmon habitat, fish passage, and habitat sustaining natural processes by addressing regionally identified top priority ecological concerns in a cost effective manner; 2) reducing or eliminating stream system impacts to the SR 207 roadway in a manner that preserves roadway integrity and protects the traveling public; 3) addressing WSDOT CED sites along SR 207 so that stream habitat and the roadway are no longer in conflict with each other; and 4) preventing unnatural creek channel avulsions from occurring adjacent to SR 207 so that productive spawning and rearing habitats can be maintained and enhanced in the broader project reach.

Budget Request

Values MAY be duplicative and do not have to equal TOTAL anticipated budget in pre-application.

Anticipated Request - SRFB	$750,000
Anticipated Request - Targeted Investment	$3,000,000
Anticipated or Actual Other Funding	$12,155,594
Anticipated TOTAL Budget	$15,905,594

Other Funding Source(s), please note if funding is anticipated or actual.

Actual - The YN has agreements for additional funding with Bonneville Power Admiration, Bureau of Reclamation, National Fish and Wildlife Foundation, NOAA-Restoration Center, WSDOT - Federal Highway Administration, and United States Forest Service.

Project Location

Briefly describe the location of the project	This project will occur in Chelan County near Coles Corner along Nason Creek between River Mile 3.9 and 4.6 and between mile post 0.20 to 0.85 along State Route 207.
Latitude (decimal degrees)	47.46'08"
Longitude (decimal degrees)	-120.43'27"
Project subbasin	Wenatchee
Wenatchee Assessment Unit(s)	Lower Nason Creek
Does the proposed project span multiple assessment units?	No
Reach(es) Name	Nason Creek Lower 03

Identify the reach(es) priority/ reach ranking. Note: If the project involves work in multiple reaches, select "Multiple" and include details in the text box that will appear below. Please reference the Prioritization Web Map: https://prioritization.ucsrb.org/.

Rank 2

Project Information

1. What species will the project benefit?

Spring Chinook

Steelhead

Bull Trout

Summer Chinook

Sockeye

2. Select the project's objectives and the associated tracking metrics

Instream Habitat (Includes Floodplain & Off-Channel Reconnection)

Water Quality

Wetlands

Instream Habitat: Reporting Code

Total miles of instream habitat treated

Miles of off-channel stream created or connected

Acres of channel/off-channel connected or added

Number of structures placed in channel

Pools created through channel structure placement

Miles of streambank stabilized

Water Quality: Reporting Code

Total acres feet of water treated for water quality

Wetlands: Reporting Code

Acres of wetland improvement/enhancement

4. Does this project already exist in Salmon Recovery Portal or PRISM?

Yes

5. Has this project been submitted previously for funding through the SRFB and/or other process(es)?

Yes

Please explain which process(es) and how this proposal differs from the previous submission (e.g., different phase, modified scope, etc.)

The previous project submittals were in the 2023 and 2024 SRFB Grant Rounds. In this 2026 grant round, the YN intends to submit for grant funding for both the SRFB funding and Targeted funding. The following identifies the differing of the past submission of 2023 & 2024 to that of what is being submitted for 2026: 1. Two funding opportunities exist for this project in the 2024 grant round which include the normal SRFB Grant funding and Targeted Grant funding, 2. For the SRFB funding, the YN received funds to secure 100% roadway final designs, and some additional funding for Mobilization and Clearing and Grubbing of the new roadway alignment outside the floodplain, Phase 1 construction, 3. The Targeted funding is identified for constructing the new roadway alignment in the uplands outside the floodplain, and the removal of the current old highway alignment and utilities out of the floodplain. 4. To aid in our descriptions of work, we will refer to each funding opportunity as either (SRFB) or (Target) prior to the response of our discussion when and where it is appropriate and needed for this application process. 5. The YNF-UCHRP will submit a budget for each grant opportunity that is labeled either, (SFRB budget) or (Target budget).

(SRFB) - This portion of the application is different as we will be requesting funding toward funds for Phase 1 Construction which includes additional funding towards clearing and grubbing, preloading, and storm water collection that ultimately benefits the local Ecosystem.

(Target) - The differing of this proposal than that of 2023 and 2024 request is the phase 1 portion of this project has additional completed test boring exploration and 60% designs and will have 100% Phase 1 completed design by the end of May 2026. Additionally, the YNF-UCHRP has received 3 million dollars from the NFWF - America the Beautiful for construction, 500 thousand dollars from BOR - WaterSMART for design of Phase 1, 6 million from the NOAA-Restoration Center for Phase 1 and Phase 2 for design and construction, 5 million from BPA for Phase 1 and Phase 2 design and construction funding, 1.2 million from the FHWA for Phase 1 for construction, and 500 thousand from USFS for Phase 1 construction. This project will be transitioning to 100% designs for the road relocation out of the floodplain by April 2026. Phase 1 of this project is the relocation of the SR 207out of the floodplain to an upland area in 2026 and 2027. Phase 2 of this project is the removal of the old highway alignment and utilities out of the floodplain and is planned for construction 2028.

6. What category is the project?

Restoration

If applicable, what is the secondary project category?

N/A

Design and Restoration Proposals

7. What project phase(s) are proposed for completion?

Construction

8. Is your project within a completed (or soon-to-be completed) Reach Assessment or other type of assessment (e.g., Rapid Site Assessment, other)?

Multiple assessments have been completed for the project area, including: • Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan, 2007 • A Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region, September 2021• Lower & Middle Nason Creek Reach Assessment & Restoration Strategy Update, January 2026 • Nason Creek Tributary Assessment, Bureau of Reclamation 2008 • Lower Nason Assessment of Geomorphic and Ecologic Indicators Nason Creek, Wenatchee Subbasin, Bureau of Reclamation 2011 • Nason Creek, RM 3.4- 4.6 Floodplain Enhancement, Interfluve Inc. 2019 • Feasibility Analysis SR 207 Realignment, Perteet 2021 • Nason Creek RM 3.3 to 4.6 Supplemental Alternatives Analysis, Interfluve Inc. 2022 • Nason Creek Watershed Analysis, USFS 1996, • Salmon and Steelhead Biological Assessment for the Nason Creek N1 Floodplain Reconnection Project, ICF International 2012 • Nason Creek N1/KDIZ3 Alternatives Analysis Report, CCNRD 2011 • Nason Creek River Mile 3.3-4.6 Feasibility Study, CCNRD 2012

9. Which limiting factors does the project propose to address?

Cover - Wood

Off-Channel - Floodplain

Off-Channel - Side-Channels

Pool Quantity & Quality

Temperature - Adult Holding
Temperature - Adult Spawning
Temperature - Rearing

10. Which life stages will the proposed project address?

Adult Migration
Subadult Rearing (Bull Trout)
Holding and Maturation
Summer Rearing
Winter Rearing

11. Freshwater Benefits - Describe how your project will improve survival, capacity and/or distribution for target species at the reach scale?

The project is being designed to remove a portion of State Route 207 from the floodplain and river corridor, which will eliminate hardened infrastructure from the aquatic environment and restore more natural physical habitat conditions that better support fish survival and production. In addition, extensive instream and floodplain restoration will occur meant to increase the quantity and quality of holding, spawning, and rearing habitats in the project reach, including increasing the amount of cover habitat, floodplain side channels and wetlands. Currently the existing highway and road protection infrastructure and on-going roadway management decreases vegetation cover, decreases stream bank roughness and complexity, introduces roadway contaminants from rainfall runoff and snow removal, and prohibits fish access to floodplain habitats such as side channels and wetlands where productive off-channel rearing habitats exist. The project will increase the active floodplain size and level of connectivity, increase ground water storage, create channel length and allow for the development of new meanders. Flood water attenuation and sediment storage capacity will increase; as will riparian vegetation cover over and adjacent to fish bearing waters. The amount of diverse and complex stream habitat will be significantly increased. All of these benefits should significantly increase the capacity of Nason Creek to support more rearing juvenile salmonids and more holding and spawning adults due to the increase in habitat availability and habitat quality.
In addition, the project will help prevent the likelihood of an unnatural channel avulsion occurring near the middle CED site, which is currently an elevated risk with on-going road and powerline maintenance at this location. If Nason Creek were to avulse into the current river right side channel downstream of the BPA power lines, significant productive spawning and rearing habitat would be lost, and the large oxbow side channel connected by the 2007 Chelan County NRD culverts would likely be disconnected. It is imperative from a habitat protection standpoint that this avulsion risk be addressed as soon as possible in coordination with removing the highway out of the floodplain so that maximum freshwater benefits can be obtained.
Lastly, this project will improve water quality over time for Nason Creek. Implementation of SR 207 in 1943 was prior to any stormwater, tire dust, or road grime toxics collection or treatment. Currently, SR 207 is not required to deal with stormwater, snow, or road grime issues. These identified toxins within the floodplain currently flow directly into Nason Creek or into the riparian zone where buildup of elements is filtered out by way of ground water filtration. The removal of a portion of SR 207 from the floodplain corridor must meet current guidelines for stormwater removal from the WSDOT's Design Approval, Manual M-22-01.23 and the America Association of State Highway and Transportation Office. This will ultimately improve water conditions for aquatic residents of Nason Creek over time due to 100% stormwater collection and treatment.

12. Temporal Effect - Briefly describe how and to what extent the project would promote natural stream/watershed process consistent with the geomorphology of the stream?

The geomorphology of Nason Creek in the project area has become artificially constrained and the river has been artificially straitened due to the placement of State Route 207 into the Nason Creek corridor and floodplain in 1943. The roadway is forcing Nason Creek’s energy and velocity into a direction that is not stable at these two locations. This has had a direct result of chronic highway and floodway interactions, which has resulted in extensive road damage and continuous road maintenance, as well as continuous negative impacts on fish habitat. This project seeks to remove the artificial geomorphic constraints imposed by SR 207 along Nason Creek so that natural stream/watershed processes that create and sustain quality salmon and steelhead habitat can be restored.

13. Temporal Effect - How long will it take for the project to achieve its intended response?

Less than or equal to 1 year

1-10 years

14. Temporal Effect - How long will the restoration action and its benefits persist?

50+ years

15. Temporal Effect - What level and/or interval of maintenance is anticipated? What is the plan for any anticipated maintenance?

Once the overall construction is completed in 2027, the Phase 1 work, (realignment of State Route 207 and stormwater collection) will be maintained by the Washington State Department of Transportation. The new highway alignment will occur outside of the Nason Creek floodplain, so roadway surface and embankment maintenance requirements should be substantially reduced compared to existing conditions at the current alignment of SR 207.
Phase 2 work, (stream restoration) will incorporate restoration efforts that are self-maintaining or similar to what you would expect to see naturally occurring in this type of landscape under a more natural unaltered setting. We expect annual maintenance needs to be low. Most of this work will occur on lands managed by the U.S. Forest Service, where the Yakama Nation and U.S. Forest Service will work cooperatively to ensure restored features are functioning as designed and accomplishing habitat restoration targets. The Yakama Nation will conduct monitoring at the site for up to five years to determine if any maintenance or construction interventions are needed to achieve project performance and objectives.

16. Methods - Briefly describe the potential (for design) or proposed restoration methods and how they will achieve project objectives.

The design for Phase 1 work, (realignment of State Route 207) will include mobilizing a qualified construction contractor to construct a new highway segment for SR 207 that circumvents the Nason Creek floodplain from highway mile 0.20 to roughly 0.85. The new roadway will be constructed to meet WSDOT's Design Approval and the AASHTO criteria and traffic will be rerouted once the new roadway alignment and utilities of Phase 1 construction are complete. These actions should be completed by December 31, 2027. Completion of this phase in 2027 will allow Phase 2 restoration work to take place in 2028, utilizing the old highway alignment as access into the floodplain and instream restoration zone to not disrupt the flow of traffic for SR 207, prior to the removal of the old highway alignment.
Phase 2 work, (Instream and floodplain restoration) will include mobilizing a qualified construction contractor to construct the restoration plans as designed by Professional Engineers, and adherence to BMPs and standard Conservation Measures described in the U.S. Forest Service Aquatic Restoration Biological Opinion (ARBO) and WDFW's Stream Habitat Restoration Guidelines. All of these actions should be completed by July 31, 2028. Phase 2 construction will include the removal of the existing alignment of SR 207 out of the floodplain, excavation and construction of new side channels and wetland areas, placement of engineered log structures and wood habitat cover features, excavation of new pool habitat, and planting of native riparian vegetation in all disturbed areas and will be completed by December 31, 2028. This work will ensure the project's intended habitat benefits are achieved and that the intended hydraulics created that will restore natural habitat forming processes and reduce unnatural channel avulsions risks downstream of the Phase 2 project area.

Assessment Proposals

Protection Proposals

Monitoring Proposals

Project Risk and Economic Benefits

1. What is the landownership?

United States Forest Service and Washington State Department of Transportation

2. Have you secured landowner participation in or acceptance for this project?

Yes

Please explain

The Yakama Nation has two project partners, the United States Forest Service, and the Washington Department of Transportation. Both project partners are supportive of this restoration action due to the environmental benefits contained in the project and the ability of the project to assist each agency in achieving regional environmental policy goals. Additionally, project partners have contributed land and funding for to this project.

3. Describe any land owner requirements (e.g., design elements, right-of-ways, access agreements, liability waivers, etc.) and if/how they could affect the project

The project has been proposed on federal lands managed by the United States Forest Service and within an easement managed by the Washington State Department of Transportation. Both entities are supportive of the project and are willing to engage in agreements and proceedings that may be needed to support the project action legally moving forward. Additionally, there are also powerline and utility franchises within the WSDOT ROW (CCPUD) and for Utility (Ziply Fiber and T-Mobile) that will require access permission and realignment once the new road alignment location is resolved. One other additional ROW easement within the jurisdiction of this project area is BPA power lines. All entities are working with one another to accomplish the goals of this project.

4. Will the project raise potential concerns for interest groups (e.g., recreational users) or the community at large (including upstream/ downstream/ adjacent landowners)?

The Yakama Nation is engaging in a public outreach campaign to raise awareness about this project, and to solicit feedback from interested parties regarding the proposed highway realignment. We expect both positive and negative responses from interested parties because of the magnitude of the project action, and the visible effect on the popular highway that accesses the Lake Wenatchee area. The Yakama Nation is using a documented supplemental alternatives analysis requested by the Chelan County Commissioners to demonstrate to the public the need for the project action, and why this particular highway realignment is the best alternative for resolving multiple existing conflicts including poor habitat conditions and an unstable transportation corridor caused by incessant flood/roadway interactions.

5. Who will have the responsibility to manage and maintain the project? What is the responsibility of current or future landowners?

The SR 207 realignment roadway will be built to WSDOTS Manual and the American Association of State Highway and Transportation Officials, (AASHTO) standards and this will become the management and responsibility of Washington State Department of Transportation. The United States Forest Service will manage the reconnected floodplain areas in conjunction with similar floodplain and upland lands that are currently managed by the Wenatchee River Ranger District in this project area.

6. Are other projects being proposed immediately upstream or downstream of worksite?

Yes

7. Please describe the risk of failure associated with this project.

Risk of failure for SR 207 realignment is low due to the support provided by USFS and WSDOT. The new highway segment will be engineered, designed, and constructed out of the floodplain to meet WSDOT and AASHTO standards to ensure public safety and longevity of the project. Funding is the largest hurdle for Phase 1 due to the high project cost. However, funding from the 2026 SRFB Grant round along with YN, WSDOT, NFWF, NOAA-RC, BOR, BPA, RCO, and USFS funding makes this project feasible.
A negative reaction from the public for this project could prevent the land management agencies from going forward, however the public will be informed that a “no action” alternative at these CED sites is a very high risk to causing further damage to the river and the highway. Through our public meetings and

comment periods, the YN has received the public support for this project. This is due to the balanced approach as we have provided all the project history and a list of all of the options that have been considered for this area.

8. Is there any public outreach planned during and/or after implementation? Does the project build community support for salmon recovery efforts?

The Yakama Nation and project partners had a public meeting on March 21, 2023 and July 1, 2025 to inform the public of the project area, project history, feasibility analysis, and supplemental alternatives analysis. We have presented the project concept at Wenatchee Watershed coordination meetings and to the Chelan County Commissioners. Chelan County, at that time, requested we create the supplemental alternatives analysis for the project that could be used to further demonstrate the project need and the appropriateness of the proposed action. The NOAA-RC has taken the federal lead for National Environmental Policy Act, which will additionally satisfy ESA Section 7 Consultation, and NHPA Section 106 Consultation for this project. The Yakama Nation and project partners will be engaging with the broader public about the outcomes of our NEPA process, the completed 60% designs for the roadway alignment and the restoration designs and the opportunity of another comment period.
This additional public meeting is planned for April or May of 2026 with our project partners to inform the public on project development and funds that are secured.

9. Does the project represent an opportunity for economic benefit? How much benefit does the project create for the dollars invested?

Current conditions in the project area routinely degrade fish habitat and cause damage to the Highway 207 road prism and embankment, necessitating constant maintenance spending by WSDOT. The proposed road realignment will reduce the maintenance cost burden of Highway 207 to WSDOT, which will benefit the WSDOT program budget and state taxpayers. In addition, local contractors will be hired to complete both the road construction and restoration construction work associated with this project, which will generate at least temporary economic benefits to Chelan County and the local community.

10. Describe any partnerships, their experience, and types of contributions supporting the project.

The Yakama Nation has 2 partnerships for this project, Washington State Department of Transportation and the United States Forest. The WSDOT has contributed both money and expertise to this project. The USFS has contributed the land, agreements, management, and funding towards Phase 1 of this project. Additionally, the Yakama Nation Fisheries has received 3 million dollars toward Phase 1 design and construction from NFWF, 500 thousand dollars from BOR-WaterSMart for phase 1 design, 5 million dollars toward Phase 1 and Phase 2 design and construction from BPA, 6 million dollars toward Phase 1 and Phase 2 for design and construction from NOAA-RC, and 1.2 million from the Federal Highway Administration for Phase 1 and Phase 2 Construction.

Optional Section - Preparation for PRISM (SRFB applications only)

The following questions are identical to the questions RCO requires in the PRISM application for SRFB projects. If desired, sponsors can complete associated questions early and copy responses into PRISM during the "Complete Application" phase due on April x, 2026

Do you want to review and/or pre-populate PRISM questions? Yes

1. Problem Statement: What are the problems your project seeks to address? Include the source and scale of each problem. Describe the site, reach, and watershed conditions. Describe how those conditions impact salmon populations. Include current and historical factors important to understand the problems.

Nason Creek has historically been a critically productive spring Chinook salmon and steelhead spawning and rearing tributary in the Wenatchee Subbasin. The reduction of salmonid abundance in the Wenatchee Subbasin correlates closely with increased habitat impairments induced in Nason Creek during railway, powerline, highway, logging, and residential development over the past century. Given its historic

importance and high geomorphic intrinsic potential to be productive salmonid habitat, the Lower Nason Creek Assessment Unit has consistently been identified as a logical top priority stream system to focus salmon habitat restoration efforts within the Upper Columbia Basin salmon recovery framework. The current Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region (UCRTT, 2021) identifies channel complexity restoration, floodplain reconnection, and side channel and off-channel habitat restoration as top priority restoration action categories needed in Nason Creek to contribute to improved status of the viable salmonid population parameters for spring Chinook salmon and steelhead.
In the proposed project area, Nason Creek has become significantly artificially constrained and cutoff from historically productive side channel and floodplain habitats by the placement of State Route 207 in the floodway in 1943. In total, the 1943 roadway project cutoff some 70 acres of floodplain and side channel habitats, although some previous restoration work has partially restored stream connectivity to around forty acres of habitat north of the BPA powerline crossing. The location and down valley alignment of State Route 207 in the floodway has become increasingly problematic in recent decades as the creek has attempted to naturally meander in the historic floodplain corridor. Repeated flood events starting in 1950's caused the natural channel migration trends to increasingly encounter the roadway prism which has now actively destroyed two different segments of the two-lane highway, causing the Department of Transportation to create new rock fortified streambanks along hundreds of feet of the creek body which diminish instream habitat quality and impede riparian vegetation growth. On average there are 2 to 3 emergency responses per-decade which results in more fortified rock and less aquatic habitat. Without some level of continued intervention that can decrease floodwater interactions with the roadway prism, it is expected and predicted that unnatural creek channel avulsions will occur along and adjacent to the roadway surface that will further degrade aquatic habitats and cause additional roadway damage.
This project seeks to provide practical long-term solutions to these problems by removing a substantially constricting component of State Route 207 infrastructure from the Nason Creek floodway so that 14.74 acres of cutoff floodplain and side channel habitat can be restored as viable fish and riparian habitat and the risks of future artificially induced creek avulsions can be prevented.

2. Describe the limiting factors, and/or ecological concerns, and limiting life stages (by fish species) that your project expects to address.

Limiting Life Stages and Limiting Factors from a Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region - Habitat Action Prioritization Within the Upper Columbia River Basin, 2021:
Nason Creek Lower 03 Reach Priority Life Stages:
spawning and incubation,
winter rearing,
summer rearing,
holding and maturation
Assessment Unit Life Stage Priorities:
Spring Chinook:
holding: high priority
spawning: high priority
summer rearing: high priority
winter rearing: high priority
Steelhead:
spawning: medium priority
winter rearing: high priority
Nason Creek Lower 03 Reach Limiting Factors Addressed:
temperature (rearing), temperature (adult spawning), temperature (adult holding), bank stability, floodplain connectivity, riparian (canopy cover), channel substrate (percent fines and embeddedness) Nason Creek Lower 03 Reach Priority Action Categories:
bank restoration, channel complexity restoration, channel modification, fine sediment management, floodplain reconnection, riparian restoration and management, side channel and off-channel habitat restoration, upland management, water quality improvement
Limiting Factors from a Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region, 2017:
1. Peripheral and Transitional Habitat (Side Channel and Wetland Connections)
2. Channel structure and form (Bed and Channel Form)
3. Riparian Condition (Riparian Condition)
4. Channel structure and form (Instream Structural Complexity)

5. Food (Altered Primary Productivity)
6. Sediment Conditions (Increased Sediment Quantity)

3. What are the project goals? The goal of the project should be to solve identified problems by addressing the root causes. Then clearly state the desired and future condition. Include which species and life stages will benefit from the outcome, and the time of year the benefits will be realized.

1. Restore quality salmon habitat & habitat sustaining natural processes by addressing the ecological concerns in a cost effective manner by;
- Restoring winter & summer low flow connectivity to available peripheral and transitional habitats necessary for rearing juvenile ESA listed species.
- Increase mainstem habitat complexity & channel roughness to increase surface water connectivity with adjacent floodplain for year round habitat availability.
- Increase surface water contributions to the disconnected floodplain to improve riparian & wetland vegetation conditions, & to enhance groundwater storage & hyporheic discharge.
- Decrease energy & velocities which will increase sediment fallout & improve spawning areas for returning adults.
2. Reduce or eliminate stream system impacts to the SR 207 roadway in a manner that preserves roadway integrity and protects the traveling public.
- Realign a 0.65 mile length of SR 207 infrastructure from out the floodplain.
- Collect and treat roadway stormwater runoff.
- Realign powerline & utilities infrastructure from the floodplain.
3. Address WSDOT CED sites along SR 207 Deficiency
- Remove 2 of WSDOT CED sites along Nason Creek with the proposed alignment.
4. Prevent unnatural creek channel avulsions from occurring adjacent to SR 207 so that productive spawning & rearing habitats can be maintained & enhanced in the broader project reach.
-Use habitat complexity treatments and new channel meander paths to stabilize hydraulic function.

4. What are the project objectives? Objectives support and refine biological goals, breaking them down into smaller steps. Objectives are specific, quantifiable actions the project will complete to achieve the stated goal. Each objective should be SMART (Specific, Measurable, Achievable, Relevant, and Time-bound).

1. (SRFB) - Complete final construction designs for Phases 1 based upon agreements between the project partners. (Addresses all Goals)
2. (SRFB) - Begin mobilization and clearing and grubbing of the roadway alignment out of the floodplain in late 2025. (Addresses all Goals)
3. (Target) - Begin and complete construction of the roadway alignment out of the floodplain between mile posts 0.20 and 0.85 while the original roadway remains in place for traffic access. This action includes realignment of utilities sited along the roadway once the new roadway construction is mostly completed. (Addresses Goals 2 & 3)
4. (Target) - Commission the new SR 207 segment for public use. (Addresses Goals 2 & 3)
5. (Target) - Removal of old highway bank protection and roadway fill from the floodplain (0.65 miles of fill removal) (Addresses Goals 2 & 3).
6. Begin all instream and floodplain habitat restoration actions in the Phase 2 project area, which includes, 10 habitat log structures, 10 pools, side channel and alcove construction (0.5 miles of reconnected and enhanced channels), 14.74 acres of floodplain reconnected to natural flood processes, elimination of two registered WSDOT CED sites, riparian vegetation and wetland plantings (5.5 acres of new native plantings), 0.5 miles of spawning habitat protected by preventing unnatural channel avulsions, and another 1 mile of side channel rearing habitat protected by preventing further unnatural channel avulsions. (Addresses all Goals).

5. Scope of work and deliverables. Provide a detailed description of each project task/element. With each task/element, identify who will be responsible for each, what the deliverables will be, and the schedule for completion.

(All items with “**” are tasks that include SRFB funding. All items with "***" are tasks for Target funding. All other tasks are funded by match funding)
- Engineer’s Design of the New Roadway, Phase 1 - 60% Preliminary design through 100% final Design - This work is being complete YN – spring 2026

- Engineer's Design of Instream Habitat Restoration, Phase 2 – 60% Preliminary design through 100% final Design – This work is already contracted by the YN – Spring 2026
- Public Outreach Process – Public meetings and outreach products – YN will be the lead along with WSDOT, and USFS – 2023 through 2028
- Review, and Acceptance of Phase 1, 30% Designs – The YN, BPA, WSDOT, and USFS – March 2024
- Utility realignment planning – The YN will lead the discussions and coordinate the work with WSDOT, and USFS - 2023- 2027
- WSDOT Easement Realignment on USFS Lands, (this includes franchise ROW) - USFS, WSDOT, and Utilities 2024-2027
- NEPA, ESA Section 7 Consultation, and NHPA Section 106 Consultation - The YN, BPA, and USFS – Spring or Summer 2026
- Review, Comment, and Acceptance of Phase 1, 60% Designs – The YN, BPA, WSDOT, and USFS – March 2026
- Review, Comment, and Acceptance of Phase 2, 60% Designs – The YN, BPA, and USFS – March 2026
- Environmental Permitting through WDFW, USCOE, WDOE, and Chelan County - The YN and WSDOT, USFS – 2025 through 2027
- Phase 1, Construction Contracting - The YN will create a competitive bid and hire a roadway construction contractor by August 2026.
- Begin Phase 1 by Mobilizing, Clearing and Grubbing - Construction Contractor with YN as Owner, Fall of 2026
** Begin Phase 1 construction Activities for building the new road segment – Construction contractor with YN as the Owner, Fall of 2026-2027.
*** Relocate utilities along the right of way – CCPUD, Ziply Fiber and T-Mobile - spring and fall 2026 - 2028.
** &*** Complete roadway construction and commission new roadway alignment for public use - YN and WSDOT – fall 2027.
- Phase 2, Construction Contracting - The YN will create competitive bid and hire a habitat restoration construction contractor by March 2028.
** &*** Phase 2, Begin Construction Activities for Instream Habitat Restoration – Construction contractor with YN as the Owner summer 2028.
*** Phase 2, Remove obsolete SR 207 original roadway alignment and Utilities from the Nason Creek Floodplain – summer and fall 2028.
- Site stabilization and plantings - The contractor hired by the YN will plant, seed and restore all staging areas, access routes and riparian areas – October/April 2027-2029.

6. What are the assumptions and physical constraints that could impact whether you achieve your objectives? Assumptions and constraints are external conditions that are not under the direct control of the project, but directly impact the outcome of the project. These may include ecological and geomorphic factors, land use constraints, public acceptance of the project, delays, or other factors. How will you address these issues if they arise?

1st constraint is funding. The current projected cost for planning/design and implementation of Phases 1 and 2 total to $15,905,594.00, hence a large contribution of SRFB Targeted funding to the project is necessary to ensure project feasibility. Yakama Nation Fisheries is also securing funding from WSDOT (CED funding), USFS (CWI, CFLRP, and BIL funding), BPA Fish Accords funding, NFWF-America the Beautiful, BOR-WaterSMART, NOAA-RC funding, USFS funding, and other potential funding sources. Current funding towards the project totals $12,155,594.00, but SRFB funding remains a critical piece of the funding puzzle for this project that will ensure full project feasibility.

2nd constraint is public support. The Yakama Nation is currently engaging in direct public outreach to raise awareness and solicit feedback from interested parties and the public about the full restoration proposal. Currently the project is being evaluated through NEPA and soon the SEPA processes where the project funders and land management agencies will have to make decisions on how to proceed based on public feedback. This project proposal has been developed in close coordination with the likely NEPA and SEPA leads, and we believe the purpose, needs, and cost/benefits of the proposal are clear and will be supported by the public. We are using a documented alternatives analysis requested by the Chelan County Commissioners to demonstrate the purpose, needs, and cost/benefits of the proposal, which should be very helpful in communicating this proposal to the public through the NEPA and SEPA processes.

3rd constraint is unforeseen environmental permitting requirements. The current road realignment proposal has taken into account likely impacts to sensitive areas like wetlands which could influence project construction techniques, project footprint standards, or require compensatory mitigation.

7. How have lessons learned from completed projects or monitoring studies informed this projects?

Regional and local project effectiveness monitoring consistently shows that properly placed floodplain and side channel reconnection work benefits ESA listed salmonids in the Upper Columbia Basin: Beechie et al. 2010; Beechie et al. 2013; Bellmore et al. 2013; Paillex et al. 2015; Roni et al. 2008; Hillman et al. 2016; Castella et al. 2015; Kaushal et al.2008; and Helfield et al. 2012. Yakama Nation Fisheries has been implementing salmon restoration projects in the Columbia Basin for more than a decade, and we utilize information gained from our project histories in all new projects. This Phase 1 project is being proposed based on our experience that the best biological outcomes from restoration will require that artificial infrastructure be removed from the floodplain so that natural hydraulic dynamics, flood water attenuation, and sediment transport can operate in an unimpeded manner which creates better habitat resiliency. In addition, our experience indicates that this segment of Nason Creek is at high-risk avulsion which could further capture the thread of Nason Creek directly along a longer portion of the highway 207 embankment. Yakama Nation Fisheries is proposing this project in part to prevent this channel avulsion scenario from happening so that more habitats can be restored and additional further habitat degradation can be avoided.

8. Describe the alternatives considered and why the preferred was chosen.

The Yakama Nation recently completed an updated Alternatives Analysis for this project area documenting many of the considerations that have been taken into account to support why this project is the preferred restoration alternative. Many other restoration alternatives have been conceptualized and evaluated by Yakama Nation Fisheries, Chelan County, WSDOT, USFS, WDFW, and others over the past decade. In short summary, this specific highway realignment alternative is being selected for implementation because it is the project that best addresses the biological impairments in a high impact manner while also avoiding previously identified constraints such as roadway safety, private land impacts, wetland/waterbody impacts, extremely high implementation and/or infrastructure maintenance costs, and other similar project feasibility factors. Please review the attached Nason Creek RM 3.3 to 4.6 Supplemental Alternatives Analysis report for more in-depth detail regarding our alternative selection process.

The project will completely remove 2 WSDOT CED sites from the Nason Creek floodway and will reconnect 14.74 acres of floodplain and side channel habitat. In addition, the project will help Yakama Nation Fisheries to prevent a negative channel avulsion event and will set the stage for possibly removing other segments of Highway 207 from the Nason Creek flood way if future conditions for upland roadway development and adequate funding allow.

Finally, when implementing projects such as this one that includes new roadway segments near waterbodies, the standard WSDOT's Manual and of the America Association of State Highway and Transportation Office (AASHTO) must be implemented and followed. This results in a new alignment segment being built to address stormwater and road grime/toxics. Ultimately this will improve water quality and water runoff to Nason Creek and or the floodplain.

9. How were stakeholders consulted in the development of this project? Identify the stakeholders, their concerns or feedback, and how the concerns were addressed.

WSDOT and USFS have been directly involved in all project design decisions undertaken since YN began developing restoration actions at this site in 2018. All of these entities are supportive of the proposed highway realignment alternative and are planning to engage in any NEPA/SEPA processes to inform their final decisions about the project as the project development moves forward.

Utilities in the project area have been informed and are working towards meeting the objectives of this project by spring of 2028.

Over the last several years YN has been coordinating with Chelan County regarding the highway realignment and habitat restoration proposals. The 2022 Nason Creek RM 3.3 to 4.6 Supplemental Alternatives Analysis report was created in direct response to feedback from the Chelan County

Commissioners for this project. YN is now working directly with Chelan County Natural Resources Department to develop restoration actions proposed to take place on the Nason Ridge Community Forest lands adjacent to the project area.

The Yakama Nation is currently engaged in a public outreach campaign to inform the public about this project action. We have had two public meetings, and we have an upcoming public meeting scheduled and we have previously presented the project concept at Wenatchee Watershed coordination meetings and to the Chelan County Commissioners.

10. Does your project address or accommodate the anticipated effects of climate change? How will your project be climate resilient given future conditions? How will your project increase species and habitat adaptability?

a. The project will remove a portion of SR 207 from the floodplain and river corridor, which will eliminate hardened infrastructure from the aquatic environment and restore a more natural physical habitat condition that better support fish survival, production, and water storerage through floodplain connection. Currently, the existing highway and road protection infrastructure and management decreases floodplain connection, decreases vegetation cover, decreases stream bank roughness and complexity, introduces roadway contaminants, and prohibits fish access to floodplain habitats. All of these benefits will combat climate change.

b. The project will restore more natural geomorphic conditions in a mile-long segment of Nason Creek in a manner that will remove infrastructure impediments from the creek channel and recover connectivity with the historic floodplain. 14.74 acres of floodplain and side channel habitat will be reconnected to the creek, resulting in 0.29 miles of side channel habitat becoming connected and available for rearing salmon. The project will increase 5.5 acres of wetland and off-channel habitat availability and will boost trophic productivity throughout the reach. Vegetation responses to the road removal will benefit riparian conditions which in turn will benefit aquatic habitats at the site through increased shading, wood recruitment, and increased allochthonous inputs. Flood water attenuation and sediment storage capacity will increase, improving localized and downstream habitat resiliency.

11. Describe the sponsor's experience managing this type of project. Describe other projects where the sponsors has successfully used a similar approach.

The Yakama Nation Fisheries completed the Skinney Creek channel reconstruction project in the Wenatchee Subbasin under a similar partnership framework with USFS and WSDOT. That project reconstructed 0.5 miles of highly sinuous Skinney Creek channel with inset vegetated floodplains in an old Highway 2 roadway alignment, and the project included replacing failed grade control weirs in a WSDOT wetland mitigation area with new constructed riffles that improved fish passage. In addition, in 2018 the YNF worked in the WSDOT right-of-way and road embankment on State Highway 20 along Beaver Creek to restore a WSDOT CED site and replace an undersized private bridge. Yakama Nation Fisheries has also conducted multiple levee removal projects in the Upper Columbia Basin including the Twisp Ponds Floodplain Restoration Project in 2017 and Horseshoe Side Channel Project in 2018.

12. Will veterans (including the veterans conservation corps) be involved in the project? If yes, please describe.

No, unless they are employed by one of the many subcontractors that is needed for this entire project scope of work.

Supporting Documents

Upper Columbia Process Guide 2026

SRFB Manual 18 (2026)

RCO Application Resources

PROJECT: 26-1718 PLAN,REST, NASON CREEK AND SR 207

Sponsor: Yakama Nation Program: Salmon Federal Projects Status: Application Submitted

Parties to the Agreement

PRIMARY SPONSOR

Confederated Tribes and Bands of the Yakama Nation

Address PO Box 151

City Toppenish **State** WA **Zip** 98948

Org Type Native American Tribe

Vendor # SWV0013063-00

UBI

Date Org created

Org Notes

link to Organization profile

☐ Org data updated

SECONDARY SPONSORS

No records to display

MANAGING AGENCY

Recreation and Conservation Office

LEAD ENTITY

Upper Columbia Salmon Rcy Bd L

QUESTIONS

#1: List project partners and their role and contribution to the project.

United States Forest Service (Land Manager) and Washington State Department of Transportation (Highway Manager)

External Systems

SPONSOR ASSIGNED INFO

Sponsor-Assigned Project Number

Sponsor-Assigned Regions

LINK AN EXISTING SRP PROJECT

Unlink

26-1718, Nason Creek and SR 207 , Salmon Federal Proj

Project Contacts

Contact Name Primary Org	Project Role	Work Phone	Work Email
Sabrina Subia Rec. and Conserv. Office	MAgy Fiscal Contact	(360) 725-3938	Sabrina.Subia@rco.wa.gov
Chris Butler Yakama Nation	Project Contact	(509) 996-5005	butlerc@yakamafish-nsn.gov
Hans Smith Twisp Town of	Alt Project Contact	(509) 449-2750	townmayor@townoftwisp.com
Ariel Edwards Upper Columbia Salmon Rcy Bd L	Lead Entity Contact	(208) 540-2691	ariel.edwards@ucsrb.org

Worksites & Properties

#	Worksite Name
#1	Nason Creek - State Route 207 - Chelan County

Planning/Restoration	Property Name
✓	Nason Creek - State Route 207

Worksite Map & Description

Worksite #1: Nason Creek - State Route 207 - Chelan County

WORKSITE ADDRESS

Street Address	Mile Marker 0.2 to 0.85 – Highway 207
City, State, Zip	Lake Wenatchee WA 98826

Worksite Details

Worksite #1: Nason Creek - State Route 207 - Chelan County

SITE ACCESS DIRECTIONS

Leaving Leavenworth, head west on highway 2 - turn right on State Route 207 at Coles Corner, (heading to Lake Wenatchee) - the project is between mile post 0.20 to 0.85.

TARGETED ESU SPECIES

Species by ESU	Egg Present	Juvenile Present	Adult Present	Population Trend
Chinook-Upper Columbia River Spring, Wenatchee River, Endangered	✓	✓	✓	Declining
Steelhead-Upper Columbia River, Wenatchee River, Threatened	✓	✓	✓	Declining

Reference or source used

TARGETED NON-ESU SPECIES

Species by Non-ESU	Notes
Bull Trout	As identified in the biological strategy.
Cutthroat	As identified in the biological strategy.

Questions

#1: Give street address or road name and mile post for this worksite if available.

State Route 207, mile post 0.20 to 0.85

Project Location

RELATED PROJECTS

Projects in PRISM

PRISM Number	Project Name	Program Name	Current Status	Relationship Type	Notes
24-1861 C	Nason Creek and SR 207	Salmon Federal IIJA Projects	Active	Copied From	

Related Project Notes

Project Application Report - 26-1718

Questions

#1: Did this project originate from the Shore Friendly program?

No

#2: Project location. Describe the geographic location, water bodies or habitat types, and the location of the project in the watershed, i.e. nearshore, tributary, main-stem, off-channel, etc.

The Project is located between River Mile 3.8 and 4.5 on Nason Creek, which is a major tributary to the Wenatchee River in the Wenatchee Subbasin. Nason Creek is 27 miles in length, drains nearly 8,000 square miles, and elevations range from 1,880 feet to 4,200 feet at the headwaters (project area is at 1,952 feet in elevation). The Project occurs in a moderate to unconfined post glacial valley bottom which involves broad forested floodplains, riverine wetlands and off-channel habitats, and side channels. Land owners include, private property upstream and downstream of the project area, Nason Ridge Community Forest to the west, and the United States Forest Service to the east. Phase 1 and Phase 2 of this project is being proposed only on USFS land. Opportunity exist on NRCF, however the contributions of that work is uncertain.

#3: How does this project fit within your regional recovery plan and/or local lead entity's strategy to restore or protect salmonid habitat? Cite section and page number.

Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan, August 2007
• Executive Summary – Wenatchee Core Area – pg xxii, line 26
• Executive Summary – Wenatchee – page xxix, line 2
• Executive Summary – Wenatchee – pg xxx, line 7
• Section – 1.3.1 - Definition of Recovery Plan – Wenatchee Subbasin, pg 7 – Line 14
• Section – 1. 8 - Major tributaries within the Wenatchee Subbasin, pg 19 – Figure 1.2
• Section – 2.3.2, 2.3.3 - Historic Population Characteristics – pg 32, 37, 42, 45 – line 14, 19, 3, 18 & 25
• Section - 2.3.3 – Current Population Characteristics – pg
• Section – 3.6 - Hydropower – pg 90 - line 22
• Section - 4.4.1 – Spring Chinook – pg 119, 122 – line 119, 7
• Section - 5.3 - Harvest Actions – pg 160, 162 line 23 & 38, 4 through 25
• Section - 5.5.5 - Habitat Recovery Actions – pg 206 - line 19
• Table 5.3 – pg 232 – Column Coho
• Table 5.10 – pg 242 – Column Wenatchee
• Appendix B: Spatial Structure and Diversity – pg 3, paragraph 2
• Appendix B: Spatial Structure and Diversity – pg 7 – paragraph 4
• Appendix B: Spatial Structure and Diversity – pg 14 – paragraph 3
• Appendix B: Spatial Structure and Diversity – pg 15 – paragraph 1
• Appendix F1: Analysis of Habitat Actions Using EDT – Table F1 – pg 6 – Column Lower Nason Creek and Upper Nason Creek
• Appendix F1: Analysis of Habitat Actions Using EDT – Table F3 – pg 9 – Column Confinement Natural
• Appendix F1: Analysis of Habitat Actions Using EDT – Priority Assessment Units – pg 18, 19 – paragraph 1 & 2
• Appendix F1: Analysis of Habitat Actions Using EDT – Interactions of Environmental Attribute Ratings and Actions Effectiveness, pg 90, 91 – paragraph 1
• Appendix G: Habitat Matrices – Table – Column 1 – Nason Creek – pg 15, 16
• Appendix H: Biological Strategy to Protect & Restore Salmonid Habitat – pg 10 – paragraph 2
• Appendix H: Biological Strategy to Protect & Restore Salmonid Habitat, Table 2 – pg 16
• Appendix H: Biological Strategy to Protect & Restore Salmonid Habitat, – pg 22 - Factors Affecting Habitat Conditions
• Appendix H: Biological Strategy to Protect & Restore Salmonid Habitat, – pg 40 – Factors Affecting Habitat Conditions
• Appendix H: Biological Strategy to Protect & Restore Salmonid Habitat, – pg 41 – Level of Certainty

A Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region -
Habitat Action Prioritization Within the Upper Columbia River Basin, 2021
• Assessment Unit: Lower Nason Creek

#4: Is this project part of a larger overall project?

Yes

#4a: How does this project fit into the sequencing of the larger project?

> Phase 1 proposes to remove 0.65 miles of roadway from the Nason Creek floodplain and relocate the highway in appropriate upland areas to the east. This action will allow Nason Creek to have full access to an additional 14.74 acres of floodplain and side channel habitat, and allow instream restoration work to occur. Phase 2 of this project is reliant on Phase 1 being implemented and proposes to implement instream and floodplain habitat restoration in the areas where the roadway is being removed. Phase 1 construction of the new highway alignment will take place in 2025-2026, while the removal of the old highway alignment and the instream and floodplain restoration will take place in 2027.
> We are also developing a Phase 3 restoration action directly downstream in 2028, which would include additional side channel and habitat complexity treatments from creek mile 3.2 to 3.8, but would not remove any additional roadway. Phase 3 is not part of this current funding request.

#5: Is the project on State Owned Aquatic Lands? Please contact the Washington State Department of Natural Resources to make a determination. **Aquatic Districts and Managers**

No

Property Details

Property: Nason Creek - State Route 207 (Worksite #1: Nason Creek - State Route 207 - Chelan County)

✓**Planning/Restoration**

LANDOWNER

Name	USFS Okanogan-Wenatchee NF
Address	600 Sherbourne St,
City	Leavenworth
State	WA Zip 98826
Type	Federal

CONTROL & TENURE

Instrument Type	Landowner Agreement
Timing	Proposed
Term Length	Fixed # of years
# Yrs	10
Expiration Date	12/31/2032
Note	

Project Proposal

Project Description

> The Nason Creek SR 207 Realignment and Restoration Project is a tribal led large scale salmon habitat restoration project taking place along Nason Creek near Lake Wenatchee in Chelan County, Washington. The Confederated Tribes and Bands of the Yakama Nation have partnered with WSDOT and the USFS to restore biologically productive side channel and floodplain habitats in critical spring Chinook salmon and steelhead spawning and rearing areas that were either impacted or disconnected by highway development in the early 1940s. The proposed project will remove a problematic 0.65-mile-long segment of SR 207 from the Nason Creek floodway in order to reconnect 14.74 acres of historic side channel and floodplain habitat. Removal of roadway will allow salmon habitat restoration efforts to take place that will create better main-channel habitat and reconnect and protect at-risk side channels that are important to multiple life stages of salmon and steelhead. The removal of SR 207 from the floodplain will directly address two WSDOT listed Chronic Environmental Deficiency Sites where the highway constantly erodes into Nason Creek during spring high flows, resulting in on-going aquatic habitat degradation and traffic disruption. The Yakama Nation intends to use SRFB grant funds along with other funding to create the stormwater collection for the new roadway realignment that will treat roadway toxins that normally would have found its way into Nason Creek and the adjacent floodplain.

Project Questions

#1: Problem statement. What are the problems your project seeks to address? Include the source and scale of each problem. Describe the site, reach, and watershed conditions. Describe how those conditions impact salmon populations. Include current and historic factors important to understand the problems.

Nason Creek has historically been a critically productive spring Chinook salmon and steelhead spawning and rearing tributary in the Wenatchee Subbasin. The reduction of salmonid abundance in the Wenatchee Subbasin correlates closely with increased habitat impairments induced in Nason Creek during railway, powerline, highway, logging, and residential development over the past century. Given its historic importance and high geomorphic intrinsic potential to be productive salmonid habitat, the Lower Nason Creek Assessment Unit has consistently been identified as a logical top priority stream system to focus salmon habitat restoration efforts within the Upper Columbia Basin salmon recovery framework. The current Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region (UCRTT, 2021) identifies channel complexity restoration, floodplain reconnection, and side channel and off-channel habitat restoration as top priority restoration action categories needed in Nason Creek to contribute to improved status of the viable salmonid population parameters for spring Chinook salmon and steelhead.

In the proposed project area, Nason Creek has become significantly artificially constrained and cutoff from historically productive side channel and floodplain habitats by the placement of State Route 207 in the floodway in 1943. In total, the 1943 roadway project cutoff some 70 acres of floodplain and side channel habitats, although some previous restoration work has partially restored stream connectivity to around forty acres of habitat north of the BPA powerline crossing. The location and down valley alignment of State Route 207 in the floodway has become increasingly problematic in recent decades as the creek has attempted to naturally meander in the historic floodplain corridor. Repeated flood events starting in 1950's caused the natural channel migration trends to increasingly encounter the roadway prism which has now actively destroyed two different segments of the two lane highway, causing the Department of Transportation to create new rock fortified streambanks along hundreds of feet of the creek body which diminish instream habitat quality and impede riparian vegetation growth. On average there are 2 to 3 emergency responses per-decade which results in more fortified rock and less aquatic habitat. Without some level of continued intervention that can decrease floodwater interactions with the roadway prism, it is expected and predicted that unnatural creek channel avulsions will occur along and adjacent to the roadway surface that will further degrade aquatic habitats and cause additional roadway damage.

This project seeks to provide practical long term solutions to these problems by
removing a substantially constricting component of State Route 207 infrastructure from the Nason Creek floodway so that 14.74 acres of cutoff floodplain and side channel habitat can be restored as viable fish and riparian habitat and the risks of future artificially induced creek avulsions can be prevented.

#2: Describe the limiting factors, and/or ecological concerns, and limiting life stages (by fish species) that your project expects to address.

Limiting Life Stages and Limiting Factors from a Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region - Habitat Action Prioritization Within the Upper Columbia River Basin, 2021:

Nason Creek Lower 03 Reach Priority Life Stages:

- spawning and incubation,
- winter rearing,
- summer rearing,
- holding and maturation

Assessment Unit Life Stage Priorities:

- Spring Chinook:
  adult migration: Low Priority
  holding: high priority
  spawning: high priority
  summer rearing: high priority
  winter rearing: high priority
  smolt emigration: low priority

- Steelhead:
  adult migration: low priority
  spawning: medium priority
  fry colonization: low priority
  summer rearing: low priority
  winter rearing: high priority
  smolt emigration: low priority

Nason Creek Lower 03 Reach Rank 1 Limiting Factors Addressed:
temperature (rearing), temperature (adult spawning), temperature (adult holding)

Nason Creek Lower 03 Reach Rank 2 Limiting Factors Addressed:
floodplain connectivity, channel substrate (percent fines and embeddedness)

Nason Creek Lower 03 Reach Priority Action Categories:
bank restoration, channel complexity restoration, channel modification, fine sediment management, floodplain reconnection, water quality improvement

Limiting Factors from a Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region, 2017:
1. Peripheral and Transitional Habitat (Side Channel and Wetland Connections)
2. Channel structure and form (Bed and Channel Form)
3. Riparian Condition (Riparian Condition)
4. Channel structure and form (Instream Structural Complexity)
5. Food (Altered Primary Productivity)
6. Sediment Conditions (Increased Sediment Quantity)

#3: **Project Goals.** What are the project goals? The goal of the project should be to solve identified problems by addressing the root causes. Then clearly state the desired future condition. Include which species and life stages will benefit from the outcome, and the time of year the benefits will be realized. **Example Goals and Objectives**

1. Restore quality salmon habitat & habitat sustaining natural processes by addressing the ecological concerns in a cost effective manner.
2. Reduce or eliminate stream system impacts to the SR 207 roadway in a manner that preserves roadway integrity and protects the traveling public.
3. Address WSDOT CED sites along SR 207 Deficiency.
4. Prevent unnatural creek channel avulsions from occurring adjacent to SR 207 so that productive spawning & rearing habitats can be maintained & enhanced in the broader project reach.

#4: **Project Objectives.** What are the project objectives? Objectives support and refine biological goals, breaking them down into smaller steps. Objectives are specific, quantifiable actions the project will complete to achieve the stated goal. Each objective should be SMART (Specific, Measurable, Achievable, Relevant, and Time-bound). **Example Goals and Objectives**

Goals 2 and 3 –
Realign the roadway out of the floodplain between mile posts 0.20 and 0.85 in 2025 and 2026.
- Realign a 0.65 mile length of SR 207 infrastructure (inlcuding utilities) into updlands.
- Collect and treat roadway stormwater runoff.
- Remove 2 of WSDOT CED sites along Nason Creek with the proposed alignment.

This action includes clearing and grubbing (funded by SRFB in 2025), as well as all pre-loading activities in late 2025 and all other construction activities in 2026 needed to complete construction of the roadway (funded by Targeted)

Goals 1, 2, 3, and 4 –
Perform habitat restoration in the Phase 2 project area in 2027, including removal of old roadway surface using Targeted funds in 2027. Create 10 new ELJ structures, 0.5 miles of reconnected side channels, 14.74 acres of floodplain reconnected, elimination of two WSDOT CED sites, 5.5 acres of riparian and wetland plantings, 0.5 miles of spawning habitat protected, and 1 mile of side channel rearing habitat protected by preventing unnatural avulsions.
- Restore winter & summer low flow connectivity to available floodplain habitats necessary for rearing juvenile ESA listed species.
- Increase creek surface water connectivity with adjacent floodplain for year round habitat availability, & to enhance groundwater storage & hyporheic discharge.
- Improve riparian & wetland vegetation conditions,
- Decrease energy & velocities which will increase sediment fallout & improve spawning areas for returning adults.

#5: **Scope of work and deliverables.** Provide a detailed description of each project task/element. With each task/element, identify who will be responsible for each, what the deliverables will be, and the schedule for completion.

(All items with "***" are project tasks requesting SRFB funding. "###" denotes Targeted funding tasks. All other tasks are funded by match funding)

*** Phase 1 Construction - New Roadway Clearing and Grubbing - Construction contractor with YN as the Owner, fall 2026
Phase 1 Construction - New Roadway Pre-Loading - Construction contractor with YN as the Owner, fall 2026
*** Phase 1 Construction, Creating the stormwater collections system and ponds within the new roadway alignment, - Construction contract with YN as the owner - fall 2026 / summer 2027
Phase 1 Construction – Construct new roadway road top- Construction contractor with YN as the Owner – Construction Season of 2027
Phase 2 Materials Procurement – Acquire habitat logs for Phase 2 Construction – YN will contract this deliverable – 2027
Phase 2 Construction - Remove obsolete SR 207 original roadway alignment and Utilities from the Nason Creek Floodplain – Construction contractor with YN as the Owner - Construction Season of 2028
• Phase 2 Construction – Construct large wood structures, side channels, wetland features, and install native plantings in the floodplain restoration area - Construction contractor with YN as the Owner - Construction Season of 2028

#6: **Assumptions and Constraints.** What are the assumptions and physical constraints that could impact whether you achieve your objectives? Assumptions and constrains are external conditions that are not under the direct control of the project, but directly impact the outcome of the project. These may include ecological and geomorphic factors, land use constraints, public acceptance of the project, delays, or other factors. How will you address these issues if they arise?

1st constraint is funding. The current projected cost for planning/design and implementation of Phases 1 and 2 total to roughly $15.95 million, hence a large contribution of SRFB Targeted funding to the project is necessary to ensure project feasibility. Yakama Nation Fisheries is also securing funding from WSDOT (CED funding), USFS (CWI, CFLRP, and BIL funding), BPA Fish Accords funding, NFWF-America the Beautiful, BOR-WaterSMART, NOAA Restoration Center, and many other potential funding sources. Current funding towards the project totals $12,155,594.00, but SRFB funding remains a critical piece of the funding puzzle for this project that will ensure full project feasibility.
2nd constraint is public support. The Yakama Nation is currently engaging in direct public outreach to raise awareness and solicit feedback from interested parties and the public about the full restoration proposal. Soon the project proposal will be evaluated through NEPA and SEPA processes where the project funders and land management agencies will have to make decisions on how to proceed based on public feedback. This project proposal has been developed in close coordination with the likely NEPA and SEPA leads, and we believe the purpose, needs, and cost/benefits of the proposal are clear and will be supported by the public. We are using a documented alternatives analysis requested by the Chelan County Commissioners to demonstrate the purpose, needs, and cost/benefits of the proposal, which should be very helpful in communicating this proposal to the public through the NEPA and SEPA processes.
3rd constraint is unforeseen environmental permitting requirements. The current road realignment proposal has taken into account likely impacts to sensitive areas like wetlands which could influence project construction techniques, project footprint standards, or require compensatory mitigation.

#7: **Previous Lessons Learned.** How have lessons learned from completed projects or monitoring studies informed this project?

Regional and local project effectiveness monitoring consistently shows that properly placed floodplain and side channel reconnection work benefits ESA listed salmonids in the Upper Columbia Basin: Beechie et al. 2010; Beechie et al. 2013; Bellmore et al. 2013; Paillex et al. 2015; Roni et al. 2008; Hillman et al. 2016; Castella et al. 2015; Kaushal et al.2008; and Helfield et al. 2012.
Yakama Nation Fisheries has been implementing salmon restoration projects in the Columbia Basin for more than a decade, and we utilize information gained from our project histories in all new projects. This Phase 1 project is being proposed based on our experience that the best biological outcomes from restoration will require that artificial infrastructure be removed from the floodplain so that natural hydraulic dynamics, flood water attenuation, and sediment transport can operate in an unimpeded manner which creates better habitat resiliency. In addition, our experience indicates that this segment of Nason Creek is at high risk avulsion which could further capture the thread of Nason Creek directly along a longer portion of the highway 207 embankment. Yakama Nation Fisheries is proposing this project in part to prevent this channel avulsion scenario from happening so that more habitat can be restored and additional further habitat degradation can be avoided.

#8: **Project Alternatives.** Describe the alternatives considered and why the preferred was chosen.

> The Yakama Nation recently completed an updated Alternatives Analysis for this project area documenting many of the considerations that have been taken into account to support why this project is the preferred restoration alternative. Many other restoration alternatives have been conceptualized and evaluated by Yakama Nation Fisheries, Chelan County, WSDOT, USFS, WDFW, and others over the past decade. In short summary, this specific highway realignment alternative is being selected for implementation because it is the project that best addresses the biological impairments in a high impact manner while also avoiding previously identified constraints such as roadway safety, private land impacts, wetland/waterbody impacts, extremely high implementation and/or infrastructure maintenance costs, and other similar project feasibility factors. Please review the attached Nason Creek RM 3.3 to 4.6 Supplemental Alternatives Analysis report for more in-depth detail regarding our alternative selection process. The project will completely remove 2 WSDOT CED sites from the Nason Creek floodway and will reconnect 14.74 acres of floodplain and side channel habitat. In addition, the project will help Yakama Nation Fisheries to prevent a negative channel avulsion event and will set the stage for possibly removing other segments of Highway 207 from the Nason Creek flood way if future conditions for upland roadway development and adequate funding allow. Finally, when implementing projects such as this one that includes new roadway segments near waterbodies, the standard of the WSDOT manual and the frame work of the America Association of State Highway and Transportation Office (AASHTO) must be implemented and followed. This results in a new alignment segment being built to address stormwater and road grime/toxics. Ultimately this will improve water quality and water runoff to Nason Creek and or the floodplain.

#9: How were stakeholders consulted in the development of this project? Identify the stakeholders, their concerns or feedback, and how those concerns were addressed.

> WSDOT and USFS have been directly involved in all project design decisions undertaken since YN began developing restoration actions at this site in 2018. All of these entities are supportive of the proposed highway realignment alternative and are planning to engage in any NEPA/SEPA processes to inform their final decisions about the project as the project development moves forward.
>
> Utilities in the project area have been informed of the proposal and none have identified any significant constraints to implementation. At the request of the utilities, additional engagement will occur once permit level designs have been prepared for Phase 1 of this project.
>
> Over the last several years YN has been coordinating with Chelan County regarding the highway realignment and habitat restoration proposals. The 2022 Nason Creek RM 3.3 to 4.6 Supplemental Alternatives Analysis report was created in direct response to feedback from the Chelan County Commissioners for this project. YN is now working directly with Chelan County Natural Resources Department to develop restoration actions proposed to take place on the Nason Ridge Community Forest lands adjacent to the project area.
> The Yakama Nation is currently engaged in a public outreach campaign to inform the public about this project action. Public meetings have been held at Lake Wenatchee in 2023, 2024, and again, June 2026 we will present our project to the public.

#10: **Climate Change.** Does your project address or accommodate the anticipated effects of climate change?

Yes

#10a: How will your project be climate resilient given future conditions?

The project will remove a portion of SR 207 from the floodplain and river corridor, which will eliminate hardened infrastructure from the aquatic environment and restore a more natural physical habitat condition that better support fish survival, production, and water storerage through floodplain connection. Currently, the existing highway and road protection infrastructure and management decreases floodplain connection, decreases vegetation cover, decreases stream bank roughness and complexity, introduces roadway contaminants, and prohibits fish access to floodplain habitats. All of these benefits will combat climate change.

#10b: How will your project increase habitat and species adaptability?

The project will restore more natural geomorphic conditions in a mile long segment of Nason Creek in a manner that will remove infrastructure impediments from the creek channel and recover connectivity with the historic floodplain. 14.74 acres of floodplain and side channel habitat will be reconnected to the creek, resulting in 0.29 miles of side channel habitat becoming connected and available for rearing salmon. The project will increase 5.5 acres of wetland and off-channel habitat availability and will boost trophic productivity throughout the reach. Vegetation responses to the road removal will benefit riparian conditions which in turn will benefit aquatic habitats at the site through increased shading, wood recruitment, and increased allochthonous inputs. Flood water attenuation and sediment storage capacity will increase, improving localized and downstream habitat resiliency.

#11: **Project Team Experience.** Describe the project management team's experience managing this type of project. Describe other projects where they have successfully used a similar approach.

Recently, Yakama Nation Fisheries completed the Skinney Creek channel reconstruction project in the Wenatchee Subbasin under a similar partnership framework with USFS and WSDOT. That project reconstructed 0.5 miles of highly sinuous Skinney Creek channel with inset vegetated floodplains in an old Highway 2 roadway alignment, and the project included replacing failed grade control weirs in a WSDOT wetland mitigation area with new constructed riffles that improved fish passage. In addition, in 2018 the YNF worked in the WSDOT right-of-way and road embankment on State Highway 20 along Beaver Creek to restore a WSDOT CED site and replace an undersized private bridge. Yakama Nation Fisheries has also conducted multiple levee removal projects in the Upper Columbia Basin including the Twisp Ponds Floodplain Restoration Project in 2017 and Horseshoe Side Channel Project in 2018.

#12: **Veteran Involvement.** Will veterans (including the veterans conservation corps) be involved in the project? If yes, please describe.

No

Planning/Restoration Supplemental

#1: Is the project an assessment / inventory?

No

#2: Is your project a Barrier / Screening Diversion Inventory Project?

No

#3: Is this a fish passage design / screening design project?

No

#4: What level of design (per Appendix D) have you completed? Please attach.
Final

#5: Is the primary activity of the project riparian planting?
No

#6: Will (or did) a licensed professional engineer design the project?
Yes

#7: Will the project develop a design?
Yes

#7a: Will a licensed professional engineer design of the project?
Yes

#7b: Will you apply for permits as part of the project scope?

The YN will acquire all permits for the Phase 1 and Phase 2 Construction. The YN has been working closely with all permitters. Some permits, such as construction stormwater permit, is transferable to the contractor.

#8: Does the project include measures to stabilize an eroding stream bank?
No

#9: Is the primary activity of the project invasive species removal?
No

#10: Describe the steps you will take to minimize the introduction of invasive species during construction and restoration. Consider how you will use un-infested materials and clean equipment entering and leaving the project area.

Prior to construction, a pre-treatment of known invasive species will be treated.

Prior to entering any work site, all vehicles and equipment will be power washed, allowed to fully dry, and be inspected to make sure no plants, soil or other organic material adheres to the surface.

All mulch and potted native plants installed at the site will come from a reputable, weed free source. All straw will be certified weed free/seed free straw.

For all of our projects we conduct post-implementation vegetation maintenance on the site until the native plant cover becomes better established. We will monitor for and remove any invasive plants encountered within the project footprint during the five year vegetation maintenance period.

#11: Describe the long-term stewardship and maintenance obligations for the project.

Long term stewardship and maintenance for the project will be the responsibility of WSDOT and USFS. The new roadway will be built to Washington State Department of Transportation standards and this will become the management responsibility of Washington State Department of Transportation. The US Forest Service will manage the reconnected floodplain areas in conjunction with similar floodplain lands managed by the Wenatchee River Ranger District upstream of the project area. The YNF-UCHRP post monitoring activities occur at years 1, 2, 3, and 5. If minimal change is noted after year 3, or following one 5-year or greater event, the schedule of monitoring may be relaxed.

Planning/Restoration Metrics

Worksite: Nason Creek - State Route 207 - Chelan County (#1)

Area Encompassed (acres) (B.0.b.1)	7.5
Miles of Stream and/or Shoreline Affected (B.0.b.2)	0.67
Miles of Stream and/or Shoreline Treated or Protected (C.0.b)	0.65
Project Identified In a Plan or Watershed Assessment (C.0.c)	Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan, August 2007 A Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region - Revised 2017 Habitat Action Prioritization Within the Upper Columbia River Basin, 2021 Reclamation, Managing Water in the West, Reach Assessment 2008 Lower & Middle Nason Creek Reach Assessment & Restoration Strategy Update, 2026 Nason Creek Supplemental Alternatives Analysis, 2022
Priority in Recovery Plan	Lower Nason Creek is a Tier 1 Assessment Unit for restoration and protection for spring Chinook salmon and steelhead. Nason Creek Lower 03 has a reach rank 2. (https://prioritization.ucsrb.org/)
Type Of Monitoring (C.0.d.1)	None
Monitoring Location (C.0.d.2)	No monitoring completed

DESIGN FOR SALMON RESTORATION

Final design and permitting (B.1.b.11.a RCO)

Total cost for Final design and permitting	$1,300,000 **Note:** Total expected cost for Phase 1 and Phase 2 final design, and acquiring permits.
Project Identified in a Plan or Watershed Assessment. (1221) (B.1.b.11.a)	Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan, August 2007 A Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region - Revised 2017 Habitat Action Prioritization Within the Upper Columbia River Basin, 2021 Reclamation, Managing Water in the West, Reach Assessment 2008 Lower & Middle Nason Creek Reach Assessment & Restoration Strategy Update, 2026 Nason Creek Supplemental Alternatives Analysis, 2022
Priority in Recovery Plan (1223) (B.1.b.11.b)	Lower Nason Creek is a Tier 1 Assessment Unit for restoration and protection for spring Chinook salmon and steelhead is a Tier 1 restoration and Tier 2 for protection. Nason Creek Lower 03 has a reach rank 2. (https://prioritization.ucsrb.org/)

INSTREAM HABITAT PROJECT

Total Miles Of Instream Habitat Treated (C.4.b)	0.65
Channel reconfiguration and connectivity (C.4.c.1)	
Total cost for Channel reconfiguration and connectivity	$800,097 **Note:** This is for channel bed restoration and side channel reconnection elements of the project.
Type of change to channel configuration and connectivity (C.4.c.2)	Channel Bed Restored Creation/Connection to Off-Channel Habitat Levee removal/Alteration Meanders Added
Miles of Stream Treated for channel reconfiguration and connectivity (C.4.c.3)	0.45
Miles of Off-Channel Stream Created or Connected (C.4.c.4)	0.43
Acres Of Channel/Off-Channel Connected Or Added (C.4.c.5)	14.7
Instream Pools Created/Added (C.4.c.6)	5
Channel structure placement (C.4.d.1)	
Total cost for Channel structure placement	$761,000 **Note:** This is for all habitat and ELJ placement elements of the project.
Material Used For Channel Structure (C.4.d.2)	Individual Logs (Anchored) Logs Fastened Together (Logjam) Stumps With Roots Attached (Rootwads)
Miles of Stream Treated for channel structure placement (C.4.d.3)	0.65
Acres Of Streambed Treated for channel structure placement (C.4.d.4)	0.4
Pools Created through channel structure placement (C.4.d.5)	8
Number of structures placed in channel (C.4.d.7)	11
UPLAND HABITAT AND SEDIMENT PROJECT	
Acres of Upland Habitat Area Treated (C.6.b.1)	7.5
Miles of Road Treated (C.6.b.2)	0.67
Road abandonment (C.6.d.1)	
Total cost for Road abandonment	$1,300,000 **Note:** This includes removal of roadway surfacing, fill, and riprap from the floodplain.
Miles of Road Abandoned (C.6.d.2)	0.50
Average width of road abandoned (in whole yards) (C.6.d.3)	30
Road drainage system improvements and reconstruction (C.6.c.1)	
Total cost for Road drainage system improvements and reconstruction	$10,818,497 **Note:** This $10,818,497 total is based on the construction cost estimate for a 45 mph roadway alignment located away from the floodplain.
Miles of Road Treated for drainage improvements and reconstruction (C.6.c.2)	0.67
WETLAND PROJECT	
Total Acres Of Wetland Area Treated (C.8.b)	3.5
Wetland improvement/ restoration (C.8.e.1)	
Total cost for Wetland improvement/ restoration	$350,000 **Note:** This includes work to restore hydrology and hydraulic function on floodplain surfaces and plant native wetland vegetation.
Acres of wetland Improved/Restored (C.8.e.2)	3.5
AGENCY INDIRECT COSTS	
Agency Indirect	
Total cost for Agency Indirect	$575,000 **Note:** 10% Indirect Rate to RCO Funding

Project Application Report - 26-1718

Overall Project Metrics

COMPLETION DATE

Projected date of completion	12/31/2027

Planning/Restoration Cost Estimates

Worksite #1: Nason Creek - State Route 207 - Chelan County

Category	Work Type	Estimated Cost	Note
Agency Indirect Costs	Agency Indirect	$575,000	10% Indirect Rate to RCO Funding
Design for Salmon restoration	Final design and permitting (B.1.b.11.a RCO)	$1,300,000	Total expected cost for Phase 1 and Phase 2 final design, and acquiring permits.
Instream Habitat Project	Channel reconfiguration and connectivity (C.4.c.1)	$800,097	This is for channel bed restoration and side channel reconnection elements of the project.
	Channel structure placement (C.4.d.1)	$761,000	This is for all habitat and ELJ placement elements of the project.
Upland Habitat And Sediment Project	Road abandonment (C.6.d.1)	$1,300,000	This includes removal of roadway surfacing, fill, and riprap from the floodplain.
	Road drainage system improvements and reconstruction (C.6.c.1)	$10,818,497	This $10,818,497 total is based on the construction cost estimate for a 45 mph roadway alignment located away from the floodplain.
Wetland Project	Wetland improvement/ restoration (C.8.e.1)	$350,000	This includes work to restore hydrology and hydraulic function on floodplain surfaces and plant native wetland vegetation.
	Subtotal:	$15,904,594	
	Total Estimate For Worksite:	$15,904,594	

Summary

Total Estimated Costs:	$15,904,594
Total Estimated Planning/Restoration Costs:	$15,904,594

Cost Summary

	Estimated Cost	Project %	Admin/AA&E %
Planning/Restoration Costs			
Planning/Restoration	$15,904,594		
SUBTOTAL	$15,904,594	100.00 %	
Total Cost Estimate	$15,904,594	100.00 %	

Funding Request and Match

FUNDING PROGRAM

Salmon Federal Projects	$750,000	4.715619 %

SPONSOR MATCH

OTHER MONETARY FUNDING — DONATED CASH

Amount	$1,488,266.00 **Note:** SRFB budget request only, which includes the Target funding as if we were awarded those funds. This does not include the targeted budget request. Please see attachments for a breakdown of cost
Funding Organization	Department of Transportation (WSDOT)

OTHER MONETARY FUNDING — DONATED CASH

Amount	$13,666,328.00
Funding Organization	Bonneville Power Administration (BPA)

Match Total:	$15,154,59495.284381 '
Total Funding Request (Funding + Match):	$15,904,594100.00000(

Questions

#1: Explain how you determined the cost estimates

Costs were estimated based on the Engineer’s Estimate of Probable Cost developed by Perteet, Inc. and InterFluve, Inc., for the roadway realignment project, and estimates of other project costs by Yakama Nation Fisheries project managers based on similar project scopes implemented in previous years.

Other Funding

OTHER FUNDING DETAILS

Cultural Resources

Cultural Resource Areas

Worksite #1: Nason Creek - State Route 207 - Chelan County

Area: NASON CREEK AND SR 207 PHASE 1 & 2 APE

#1: Provide a description of the project actions at this worksite (acquisition, development and/or restoration activities that will occur as a part of this project)

Phase 1 actions will include construction of a new highway alignment within the uplands southeast of the existing highway alignment. This will include, mobilization, preloading, clearing and grubbing, installation of a new roadway, drainage, embankments, stormwater treatment, and construction of associated utilities. The roadway will be built to WSDOT standard prior to WSDOT taking ownership in the fall of 2027.
Phase 2 includes removal of the old roadway materials from the floodplain and hauled off-site. Habitat restoration efforts will be done in Nason Creek, along the banks of Nason Creek, and within the extirpated floodplain. Side channels will be excavated, ELJs constructed, and 3.29 acres of wetland areas created and planted. Temporary construction access and staging areas occur within the APE identified.

#2: Describe all ground disturbing activities (length, width and depth of disturbance and equipment utilized) that will take place in the Area of Potential Effect (APE). Include the location of any construction staging or access roads associated with your project that will involve ground disturbance.

The new highway alignment will include exploration of geotechnical bore testing, clearing and excavation at 75 ft off the center line of the new roadway, plus excavation up to 6 feet in depth within the roadway alignment.
Side channel excavation will include clearing and excavation up to 50 ft off center line, plus excavation up to 8 feet in depth. ELJs will include clearing and excavation in 30' by 80' areas to a depth of 8 feet. Large excavators, dump trucks, bull dozers, and other similar equipment will be used to construct the project action. Temporary construction access and staging areas will be sited in already disturbed areas to avoid impacting large trees and intact vegetation when and where possible.

#3: Describe any planned ground disturbing pre-construction/restoration work. This includes geo-technical investigation, fencing, demolition, decommissioning roads, etc.

Geo-technical investigation has already been completed under Sec. 106 consultations performed by USFS and BPA.

#4: Describe the existing project area conditions. The description should include existing conditions, current and historic land uses and previous excavation/fill (if depths and extent is known, please describe).

Site currently includes the river corridor, highway 207, vegetated floodplains and wetlands, Rieche road and powerline utility corridors, and native upland forest areas.

#5: Will a federal permit be required to complete the scope of work on the project areas located within this worksite?

Yes

#5a: List the agency that will be issuing the permit and the date you anticipate applying for and receiving the permit. Will the federal permit cover ALL proposed ground disturbing activities included in the project?

> Clean Water Act Permits (404) will be issued by ACOE. Application process in spring of 2026 and receipt of permit in 2026. Not all ground disturbance will be covered by the ACOE permit.

#6: Are you utilizing Federal Funding to complete the scope of work? This includes funds that are being shown as match or not.

Yes

#6a: Please list the federal agency and funding sources.

> BPA/US BOR/NFWF/and USFS

#6b: Does the federal funding you are utilizing as match require you to receive state funding?

> No

#7: Do you have knowledge of any previous cultural resource review within the project boundaries during the past 10 years?

Yes

#7a: Summarize the previous cultural resource review; including lead agency and date of review, reference name and numbers, etc. If RCO, include the prior phase grant number. NOTE: Do not provide any site-specific information considered confidential. Attach previous surveys or other reference documents.

> USFS and BPA have reviewed and conducted Sec. 106 consultations for previous geotechncial studies in the project area.

#8: Is the worksite located within an existing park, wildlife refuge, natural area preserve, or other recreation or habitat site?

No

#9: Are there any structures over 45 years of age within this worksite? This includes structures such as buildings, tidegates, dikes, residential structures, bridges, rail grades, park infrastructure, etc.

Yes

#9a: List the structure(s) and the properties that are located within the project area. Identify which structures will be removed or altered as part of this proposal. Attach at least one photo of each structure. The photo must be labeled so that the structure may be geographically located within your project area.

> Rieche Road and SR 207

Project Permits

Permits and Reviews	Issuing Organization	Applied Date	Received Date	Expiration Date	Permit #
Cultural Assessment [Section 106]	DAHP	06/20/2024	06/15/2026		
Endangered Species Act Compliance [ESA]	US Fish & Wildlife	06/02/2025	06/15/2026		
Hydraulics Project Approval [HPA]	Dept of Fish & Wildlife	04/01/2024	04/30/2027	04/30/2030	
		Note: Discussions with state for the HPA determined that the best issue date should not be until restoration work will begin.			
Nationwide Permit	Army Corps of Eng.	06/02/2025	07/30/2026		
NEPA	Federal Agencies	06/20/2024	07/31/2026		
SEPA	Local or State	07/01/2026	11/30/2026		
		Note: WSDOT will be the lead for SEPA. This will be completed once a determination is received from the NEPA process.			
Shoreline Permit	City/County	04/01/2025	11/30/2027		
Water Quality Certification [Section 401]	County/Dept of Ecy.	06/20/2024	07/30/2026		

Permit Questions

#1: Are you planning to use the **Limit 8** streamlined Environmental Species Act consultation pathway?

Yes

Yes - NOAA-RC, Sec. 7 Programmatic BiOP for Habitat Restoration

Attachments

Required Attachments	8 out of 8 done
Applicant Resolution/Authorizations	✓
CCA Tribal Notification	✓
Cost Estimate	✓
Landowner Acknowledgement	✓
Map: Planning Area	✓
Map: Restoration Worksite	✓
Photo	✓
RCO Fiscal Data Collection Sheet	✓

PHOTOS (JPG, GIF)

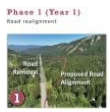
Photos (JPG, GIF)


529175 Primary


529176 Secondary


529173


529174



556073

PROJECT DOCUMENTS AND PHOTOS

Project Documents and Photos

File Type	Attach Date	Attachment Type	Title	Person	File Name, Number Associations	Shared
PDF	04/16/2026	Preliminary design report	Nason Floodplain Phase 2 - 60% BDR.pdf	ChrisB	Nason Floodplain Phase 2 - 60% BDR.pdf, 707736	✓
PDF	04/16/2026	Design document	SR207_NasonCreek_60% Plans.pdf	ChrisB	SR207_NasonCreek_60% Plans.pdf, 707734	✓

Project Application Report - 26-1718

File Type	Attach Date	Attachment Type	Title	Person	File Name, Number Associations	Shared
	04/16/2026	Design document	NasonCreek-Hwy207_Phase-2-60%Plans.pdf	ChrisB	NasonCreek-Hwy207_Phase-2-60%Plans.pdf, 707731	✓
	04/16/2026	Cost Estimate	(Target)-Budget_Nason Creek SR 207_2026-Final.XLSX	ChrisB	(Target)-Budget_Nason Creek SR 207_2026-Final.xlsx, 707717	✓
	04/16/2026	Cost Estimate	(SRFB)-Budget_Nason Creek SR 207_2026-Final.XLSX	ChrisB	(SRFB)-Budget_Nason Creek SR 207_2026-Final.xlsx, 707716	✓
	04/10/2025	Map: Area of Potential Effect (APE)	Project APE Report (04/10/25 16:00:35)	MollieL	Project APE Report - 24-1861 (04-10-2025_16-00-35).pdf, 665730	✓
	04/10/2025	Cultural Resource Screening Report	Project Cultural Resource Screening Report (04/10/25 16:00:3	MollieL	Project Cultural Resource Screening Report - 24-1861 (04-10-2025_16-00-34).pdf, 665729	✓
	04/09/2025	Agreement - State	24-1861 Agreement - Nason Creek	E-signedE	24-1861 Agreement - Nason Creek.pdf.pdf, 665423	✓
	04/09/2025	Applicant Resolution/Authorizations	Resolution T-053-25_Fisheries_RCO Agreement_Limited Waiver o	MollieL	Resolution T-053-25_Fisheries_RCO Agreement_Limited Waiver of Sovereign Immunity.pdf, 665421	✓
	01/21/2025	Land Ownership Certification Form	20250114USFSLandownerCertificationNa	ChrisB	20250114USFSLandownerCertificatio… 656137	
	11/05/2024	Map: Area of Potential Effect (APE)	Project APE Report (11/05/24 15:56:08)	MarkJ	Project APE Report - 24-1861 (11-05-2024_15-56-08).pdf, 647851	✓
	11/05/2024	Cultural Resource Screening Report	Project Cultural Resource Screening Report (11/05/24 15:56:0	MarkJ	Project Cultural Resource Screening Report - 24-1861 (11-05-2024_15-56-07).pdf, 647850	✓
	11/05/2024	Project Review Comments	Proj Review Comments Final, 24-1861C(compl 11/05/24 15:55)	MarkJ	Project Review Comments Report - 24-1861 (compl 11-05-2024_15-55-43).pdf, 647848	✓
	11/05/2024	Project Review Comments	Proj Review Comments Initial, 24-1861C(compl 11/05/24 15:55)	MarkJ	Project Review Comments Report - 24-1861 (compl 11-05-2024_15-55-38).pdf, 647847	✓
	10/23/2024	Map: Planning Area	YN_SR207_Concept_Pictures.pdf.PDF	AmeeB	YN_SR207_Concept_Pictures.pdf.pdf, 641096	✓
	10/04/2024	Map: Area of Potential Effect (APE)	Project APE Report (10/04/24 11:10:09)	SarahJ	Project APE Report - 24-1861 (10-04-2024_11-10-09).pdf, 638598	✓
	10/04/2024	Cultural Resource Screening Report	Project Cultural Resource Screening Report (10/04/24 11:10:0	SarahJ	Project Cultural Resource Screening Report - 24-1861 (10-04-2024_11-10-08).pdf, 638597	✓
	07/01/2024	Applicant Resolution/Authorizations	24-1861_Letter_Approving_Application.pdf	ChrisB	24-1861_Letter_Approving_Application.pdf, 625431	✓
	06/24/2024	Letters of Support	UC_Letter of Support_Targeted Investment 2024.pdf	ArielE	UC_Letter of Support_TI2024.pdf, 622889	✓
	05/23/2024	Project Review Comments	24-1861 - YNF Responses to RTT comments.pdf	HansS	24-1861 - YNF Responses to RTT comments.pdf, 617716	✓
	05/21/2024	Design document	NasonCrk_30p%_permit_plans.pdf	ChrisB	NasonCrk_30p%_permit_plans.pdf, 617344	✓
	05/02/2024	CCA Tribal Notification	Yakama Placeholder.docx	AmeeB	Yakama Placeholder.docx, 614224	✓
	05/01/2024	Project Review Comments	Project Review Comments Report, 24-1861R (05/01/24 08:33:51)	AmeeB	Project Review Comments Report - 24-1861 (05-01-2024_08-33-51).pdf, 612943	✓
	04/17/2024	Preliminary design report	SR207_NasonCreek_BOD.pdf	ChrisB	SR207_NasonCreek_BOD.pdf, 608031	✓
	04/17/2024	Inspection Report	SR 207 Geotechnical Report.pdf	ChrisB	SR 207 Geotechnical Report.pdf, 607974	✓
	01/16/2024	Map: Area of Potential Effect (APE)	Project APE Report (01/16/24 08:45:39)	MarkJ	Project APE Report - 23-1189 (01-16-2024_08-45-39).pdf, 592586	✓
	01/16/2024	Project Review Comments	Proj Review Comments Final, 23-1189R(compl 01/16/24 08:45)	MarkJ	Project Review Comments Report - 23-1189 (compl 01-16-2024_08-45-16).pdf, 592583	✓
	01/16/2024	Project Review Comments	Proj Review Comments Initial, 23-1189R(compl 01/16/24 08:45)	MarkJ	Project Review Comments Report - 23-1189 (compl 01-16-2024_08-45-12).pdf, 592582	✓
	06/23/2023	RCO Fiscal Data Collection Sheet	FiscalDataCollectionSheet_YN 2023.PDF	HansS	FiscalDataCollectionSheet_YN 2023.pdf, 567492	
	06/23/2023	Applicant Resolution/Authorizations	Letter_Approving_Application.pdf	HansS	Letter_Approving_Application.pdf, 567491	✓
	05/18/2023	Project Review Comments	PROJECT 23-1189 - RTT Comment	ChrisB	PROJECT 23-1189 - RTT Comment	✓

Project Application Report - 26-1718

File Type	Attach Date	Attachment Type	Title	Person	File Name, Number Associations	Shared
			Responses - 18May2023.pdf		Responses - 18May2023.pdf, 563355	
	05/12/2023	SRFB Review Panel Comment Form	22-1807 review panel comments.pdf	KatM	22-1807 review panel comments.pdf, 562863	✓
	05/10/2023	Project Review Comments	Project Review Comments Report, 23-1189R (05/10/23 17:40:15)	AmeeB	Project Review Comments Report - 23-1189 (05-10-2023_17-40-15).pdf, 562616	✓
	03/29/2023	Photo	Phase2.jpg	ChrisB	Phase2.jpg, 556074	✓
	03/29/2023	Photo	Phase1.jpg	ChrisB	Phase1.jpg, 556073	✓
	03/29/2023	Environmental Site Assessment Report	Wetland_Assessment_Nason_Creek_Repo	ChrisB	Wetland_Assessment_Nason_Creek_… 556072	✓
	03/29/2023	Environmental Site Assessment Report	Wetland_Assessment_ SR207_Realignment.pdf	ChrisB	Wetland_Assessment_ SR207_Realignment.pdf, 556071	✓
	03/29/2023	Environmental Site Assessment Report	NasonCreek_Botanical_Survey.pdf	ChrisB	NasonCreek_Botanical_Survey.pdf, 556070	✓
	03/29/2023	Design document	Phase 2_NasonCreek_Upstream.pdf	ChrisB	Phase 2_NasonCreek_Upstream.pdf, 556042	✓
	03/29/2023	Design document	Phase 2_NasonCreek BDR.pdf	ChrisB	Phase 2_NasonCreek BDR.pdf, 556041	✓
	03/29/2023	Preliminary design report	Supplemental Alterntives Analysis_Appendix B_CCNRD_Feasibili	ChrisB	Supplemental Alterntives Analysis_Appendix B_CCNRD_Feasibility_Study.pdf, 556040	✓
	03/29/2023	Preliminary design report	Supplemental Alterntives Analysis & App A.pdf	ChrisB	Supplemental Alterntives Analysis & App A.pdf, 556027	✓
	03/29/2023	Design document	Perteet_ SR 207 BDR-Concepts-Costs.pdf	ChrisB	Perteet_ SR 207 BDR-Concepts-Costs.pdf, 556010	✓
	03/29/2023	Map: Restoration Worksite	General_vicinity_map.pdf	ChrisB	General_vicinity_map.pdf, 556006	✓
	12/23/2022	Map: Area of Potential Effect (APE)	Project APE Report (12/23/22 14:39:50)	MarkJ	Project APE Report - 22-1807 (12-23-2022_14-39-50).pdf, 546026	✓
	12/23/2022	Project Review Comments	Proj Review Comments Final, 22-1807R(compl 12/23/22 14:38)	MarkJ	Project Review Comments Report - 22-1807 (compl 12-23-2022_14-38-56).pdf, 546023	✓
	12/23/2022	Project Review Comments	Proj Review Comments Initial, 22-1807R(compl 12/23/22 14:38)	MarkJ	Project Review Comments Report - 22-1807 (compl 12-23-2022_14-38-51).pdf, 546022	✓
	10/04/2022	Map: Area of Potential Effect (APE)	Project APE Report (10/04/22 08:30:14)	BrentH	Project APE Report - 22-1807 (10-04-2022_08-30-14).pdf, 532543	✓
	10/04/2022	Cultural Resource Screening Report	Project Cultural Resource Screening Report (10/04/22 08:25:0	BrentH	Project Cultural Resource Screening Report - 22-1807 (10-04-2022_08-25-05).pdf, 532352	✓
	08/30/2022	Project partnership form	SAL-ProjPartnerContributionForm_WSDOT.pdf	ChrisB	SAL-ProjPartnerContributionForm_WSDO… 529493	✓
	08/30/2022	Letters of Support	WSDOT_Yakama_Nason Cr_Grant Support.pdf	ChrisB	WSDOT_Yakama_Nason Cr_Grant Support.pdf, 529361	✓
	08/30/2022	Letters of Support	WDFW_Letter of support Nason Creek Floodplain.pdf	ChrisB	WDFW_Letter of support Nason Creek Floodplain.pdf, 529346	✓
	08/29/2022	Letters of Support	USFS_Letter of support Nason Creek floodplain.pdf	ChrisB	USFS_Letter of support Naosn Creek floodplain.pdf, 529283	✓
	08/29/2022	Landowner Acknowledgement	USFS_LandownerAcknowledgement_Naso	ChrisB	20220829LandownerAcknowledgeme… 529282	
	08/29/2022	Environmental Site Assessment Report	RAS - no road 5-year depth_3780cfs.pdf	ChrisB	RAS - no road 5-year depth_3780cfs.pdf, 529181	✓
	08/29/2022	Environmental Site Assessment Report	RAS - no road 2-year depth_2800cfs.pdf	ChrisB	RAS - no road 2-year depth_2800cfs.pdf, 529180	✓
	08/29/2022	Photo	WSDOT_CED_Site2.jpg	ChrisB	WSDOT_CED_Site2.jpg, 529176	✓
	08/29/2022	Photo	WSDOT_CED_Site1.jpg	ChrisB	WSDOT_CED_Site1.jpg, 529175	✓
	08/29/2022	Photo	Concept_road_alignment.jpg	ChrisB	Concept_road_alignment.jpg, 529174	✓
	08/29/2022	Photo	1995_Flood_Damage.JPG	ChrisB	199_Flood_Damage.jpg, 529173	✓

Project Application Report - 26-1718

Application Status

Application Due Date: null

Status Name	Status Date	Submitted By	Submission Notes
Application Submitted	04/16/2026	Chris Butler	Please recall that this application is for both SRFB and Targeted funding.
Preapplication	04/08/2026		

I certify that, to the best of my knowledge, all information in this application is true and complete, and if artificial intelligence (AI) was used to prepare this application, I accept full responsibility for ensuring its accuracy and compliance. I understand incomplete applications will be rejected by RCO and that I may be asked to submit additional documentation before evaluation or approval of this project. I understand that if a grant is awarded to my project, I will be bound by all representations and commitments in this application, which RCO may enforce to the fullest extent permitted by law. (Chris Butler, 04/16/2026)

Date of last change: 04/16/2026

RESTORATION

				OVERALL PROJECT	GRANT REQUEST	MATCH			
				Budget must account for all costs to complete the project	Enter only the amount of the grant request	The Grant Request and Match should equal the total project cost and Budget Check cell should be 0. Sponsors must account for all sources and types of match need to complete the project.			
				Amount	Grant Amount	Match in PRISM	Funding not reported in PRISM	Source (Grant, Cash, Materials, Labor, Volunteers, etc)	Match Type (federal, state, local)
Construction									
Category (choose one)	**Task Description**	**Qty**	**Rate**						
Phase 1 - 2025 - Construction	*Mobilize to and from (LS)*	1.00	$ 485,000.00	$ 485,000			$ 485,000	Cash	Federal/State (SRFB Funding Request)
Phase 1 - 2025 - Construction	*Clearing and Grubbing (AC)*	10.30	$ 13,000.00	$ 133,900			$ 133,900	Cash	Federal/State (SRFB Funding Request)
Phase 1 - 2025 Construction	*Over Excavation and Ground Preload (LS)*	1.00	$ 2,522,334.00	$ 2,522,334		$ 277,457	$ 2,244,877	Cash	Federal/State
Phase 1 -2026 Construction	*Roadside Cleanup (LS)*	1.00	$ 70,000.00	$ 70,000		$ 7,700	$ 62,300	Cash	Federal/State
Phase 1 -2026 Construction	*Roadway Excavation Incl. Haul (CY)*	41,400.00	$ 25.00	$ 1,035,000		$ 113,850	$ 921,150	Cash	Federal/State
Phase 1 -2026 Construction	*Comon Borrow Incl. Haul (TON)*	14,400.00	$ 25.00	$ 360,000		$ 39,600	$ 320,400	Cash	Federal/State
Phase 1 -2026 Construction	*Enbankment Compaction (CY)*	32,000.00	$ 9.00	$ 288,000		$ 31,680	$ 256,320	Cash	Federal/State
Phase 1 -2026 Construction	*Stormwater Treatment (LS)*	1.00	$ 1,800,000.00	$ 1,800,000	$ 750,000	$ 198,000	$ 852,000	Cash	Federal/State
Phase 1 -2026 Construction	*Crushed Surfacing Base Course (TON)*	10,770.00	$ 40.00	$ 430,800		$ 47,388	$ 383,412	Cash	Federal/State
Phase 1 -2026 Construction	*HMA CL. 1/2" PG 58H-22 (TON)*	11,760.00	$ 125.00	$ 1,470,000		$ 161,700	$ 1,308,300	Cash	Federal/State
Phase 1 -2026 Construction	*Erosion/Pollution Control (LS)*	1.00	$ 115,000.00	$ 115,000		$ 12,650	$ 102,350	Cash	Federal/State
Phase 1 -2026 Construction	*Silt Fence(LF)*	8,480.00	$ 6.00	$ 50,880		$ 5,597	$ 45,283	Cash	Federal/State
Phase 1 -2026 Construction	*Landscaping(LS)*	1.00	$ 103,000.00	$ 103,000		$ 11,330	$ 91,670	Cash	Federal/State
Phase 1 -2026 Construction	*Roadway Recessed Pavement Marker Type 2 (HUND)*	1.00	$ 600.00	$ 600		$ 66	$ 534	Cash	Federal/State
Phase 1 -2026 Construction	*Guidence Posts (EA)*	90.00	$ 8.00	$ 720		$ 79	$ 641	Cash	Federal/State
Phase 1 -2026 Construction	*Permanent Signing (LS)*	1.00	$ 10,000.00	$ 10,000		$ 1,100	$ 8,900	Cash	Federal/State
Phase 1 -2026 Construction	*Paint Lines(LF)*	17,520.00	$ 1.00	$ 17,520		$ 1,927	$ 15,593	Cash	Federal/State
Phase 1 -2026 Construction	*Temporary Traffic Control (LS)*	1.00	$ 150,000.00	$ 150,000		$ 16,500	$ 133,500	Cash	Federal/State
Phase 1 - 2026 Construction supervision	*Eng. Oversight (LS)*	1.00	$ 1,084,875.00	$ 1,084,875		$ 119,336	$ 965,539	Cash	Federal/State
Phase 1 - 2026 Surveys	*Roadway and Structure Surveying (LS)*	1.00	$ 129,000.00	$ 129,000		$ 14,190	$ 114,810	Cash	Federal/State
Phase 2 - Mobilization	*Mobilize to and from (LS)*	1.00	$ 165,000.00	$ 165,000		$ 18,150	$ 146,850	Cash	Federal/State
Phase 2 - 2027 Construction	*TESC, SPCC Plan and Implementation (LS)*	1.00	$ 94,000.00	$ 94,000		$ 10,340	$ 83,660	Cash	Federal/State
Phase 2 - 2027 Construction	*Clearing and Grubbing(AC)*	2.54	$ 15,000.00	$ 38,100		$ 4,191	$ 33,909	Cash	Federal/State
Phase 2 - 2027 Construction	*Roadway Excavation Incl. Haul (CY)*	33,075.00	$ 25.00	$ 826,875		$ 90,956	$ 735,919	Cash	Federal/State
Phase 2 - 2027 Construction	*Riprap Removal Incl. Haul (CY)*	1,000.00	$ 25.00	$ 25,000		$ 2,750	$ 22,250	Cash	Federal/State
Phase 2 - 2027 Construction	*Side Channel Excavation Incl. Haul (CY)*	24,000.00	$ 15.00	$ 360,000		$ 39,600	$ 320,400	Cash	Federal/State
Phase 2 - 2027 Construction	*ELJ and Wood Habitat Construction (LS)*	1.00	$ 1,927,990.00	$ 1,927,990		$ 212,079	$ 1,715,911	Cash	Federal/State
Phase 2 - 2027 Construction	*Coffering and Pumping (LS)*	1.00	$ 80,000.00	$ 80,000		$ 8,800	$ 71,200	Cash	Federal/State
Phase 2 - 2027 Construction	*Temporary Traffic Control (LS)*	1.00	$ 40,000.00	$ 40,000		$ 4,400	$ 35,600	Cash	Federal/State
Phase 2 - 2027 Construction	*Landscaping(LS)*	1.00	$ 250,000.00	$ 250,000		$ 27,500	$ 222,500	Cash	Federal/State
Phase 2 - Construction supervision	*Eng. Oversight (LS)*	1.00	$ 85,000.00	$ 85,000		$ 9,350	$ 75,650	Cash	Federal/State
			STotal	**$ 14,148,594**	**$ 750,000**	**$ 1,488,266**	**$ 11,910,328**		

Administrative, Architechtural & Engineering				Amount	Grant amount	Match in PRISM	Funding not reported in PRISM	Match Source	Match Type (federal, state, local)
Category	**Task Description**	**Qty**	**Rate**						
Phase 1 - Preliminary Design	*Roadway Civil Engineering & Design - 30% to preliminary 60% Designs*	1.00	$ 300,000.00	$ 300,000.00			$ 300,000	Cash	Federal
Phase 1 - Final Design	*Roadway Civil Engineering & Design -Preliminary to Final Design, (60% to 100%)*	1.00	$ 651,000.00	$ 651,000.00			$ 651,000	Cash	Federal/State
Survey	*Roadway Survey and Basemapping*	1.00	$ 65,000.00	$ 65,000.00			$ 65,000	Cash	State
Data collection	*Geotechnical Data Collection for Roadway*	1.00	$ 150,000.00	$ 150,000.00			$ 150,000	Cash	State
Final design	*WSDOT Engineering Review*	1.00	$ 90,000.00	$ 90,000.00			$ 90,000	Cash, Materials, Labor	State
Other	*WSDOT ROW Coordination*	1.00	$ 90,000.00	$ 90,000.00			$ 90,000	Cash, Materials, Labor	State
Phase 2 - Final design	*Instream Restoration Civil Engineering & Design drawnings permit level to Final*	1.00	$ 145,000.00	$ 145,000.00			$ 145,000	Cash	State (SRFB Funding Request) and Federal
Cultural resources	*Section 106 Compliance*	1.00	$ 25,000.00	$ 25,000.00			$ 25,000	Cash, Labor	Federal
Permits	*Wetland and Shoreline Permitting*	1.00	$ 10,000.00	$ 10,000.00			$ 10,000	Cash, Labor	Federal
Other	*Utilities ROW Coordination, CCPUD - T Mobile - Ziply Fiber*	1.00	$ 50,000.00	$ 50,000.00			$ 50,000	Cash, Materials, Labor	Local
Other	*YNF Project Management*	1.00	$ 160,000.00	$ 160,000.00			$ 160,000	Cash, Labor	Federal
Administrative	*YNF Bookkeeping*	1.00	$ 20,000.00	$ 20,000.00			$ 20,000	Cash,Labor	State (SRFB Funding Request)
			$ -	$ -					
			$ -	$ -					
			STotal	**$ 1,756,000**	**$ -**	**$ -**	**$ 1,756,000**		

Indirect Costs				Amount	Grant amount	Match in PRISM	Funding not reported in PRISM	Match Source	Match Type (federal, state, local)
	Description	**Approved Rate**	**Total Project Base**						
	Indirect	0.000%	$ -	$ -	$ -	$ -	$ -		
	Indirect	0.000%	$ -	$ -	$ -	$ -	$ -		
			STotal	$ -	$ -	$ -	$ -		

Totals	$ 15,904,594	$ 750,000	$ 1,488,266	$ 13,666,328
		PRISM Project Total	$ 2,238,266	
		RCO Percentage 33.508077%	**Match Percentage** 66.491923%	

AA&E Budget Check	
A&E maximum allowed in	*$ 671,479.90*
A&E validation	*671,480*

RESTORATION

				OVERALL PROJECT	GRANT REQUEST	MATCH			
				Budget must account for all costs to complete the project	*Enter only the amount of the grant request*	*The Grant Request and Match should equal the total project cost and Budget Check cell should be 0. Sponsors must account for all sources and types of match need to complete the project.*			
				Amount	Grant Amount	Match in PRISM	Funding not reported in PRISM	Source (Grant, Cash, Materials, Labor, Volunteers, etc)	Match Type (federal, state, local)
Construction									
Category (choose one)	**Task Description**	**Qty**	**Rate**						
Phase 1 - 2025 - Construction	*Mobilize to and from (LS)*	1.00	$ 485,000.00	$ 485,000			$ 485,000	Cash	Federal/State (SRFB Funding Request)
Phase 1 - 2025 - Construction	*Clearing and Grubbing (AC)*	10.30	$ 13,000.00	$ 133,900			$ 133,900	Cash	Federal/State (SRFB Funding Request)
Phase 1 - 2025 Construction	*Over Excavation and Ground Preload (LS)*	1.00	$ 2,522,334.00	$ 2,522,334	$ 939,561	$ 1,305,316	$ 277,457	Cash	Federal
Phase 1 - 2026 - Construction	*Roadside Cleanup (LS)*	1.00	$ 70,000.00	$ 70,000	$ 15,540	$ 46,760	$ 7,700	Cash	Federal/State
Phase 1 - 2026 - Construction	*Roadway Excavation Incl. Haul (CY)*	41,400.00	$ 25.00	$ 1,035,000	$ 229,770	$ 691,380	$ 113,850	Cash	Federal/State
Phase 1 - 2026 - Construction	*Comon Borrow Incl. Haul (TON)*	14,400.00	$ 25.00	$ 360,000	$ 79,920	$ 240,480	$ 39,600	Cash	Federal/State
Phase 1 - 2026 - Construction	*Enbankment Compaction (CY)*	32,000.00	$ 9.00	$ 288,000	$ 63,936	$ 192,384	$ 31,680	Cash	Federal/State
Phase 1 - 2026 - Construction	*Stormwater Treatment (LS)*	1.00	$ 1,800,000.00	$ 1,800,000		$ -	$ 1,800,000	Cash	Federal/State
Phase 1 - 2026 - Construction	*Crushed Surfacing Base Course (TON)*	10,770.00	$ 40.00	$ 430,800	$ 95,638	$ 287,774	$ 47,388	Cash	Federal/State
Phase 1 - 2026 - Construction	*HMA CL. 1/2" PG 58H-22 (TON)*	11,760.00	$ 125.00	$ 1,470,000	$ 326,340	$ 981,960	$ 161,700	Cash	Federal/State
Phase 1 - 2026 - Construction	*Erosion/Pollution Control (LS)*	1.00	$ 115,000.00	$ 115,000	$ 25,530	$ 76,820	$ 12,650	Cash	Federal/State
Phase 1 - 2026 - Construction	*Silt Fence(LF)*	8,480.00	$ 6.00	$ 50,880	$ 11,295	$ 33,988	$ 5,597	Cash	Federal/State
Phase 1 - 2026 - Construction	*Landscaping(LS)*	1.00	$ 103,000.00	$ 103,000	$ 22,866	$ 68,804	$ 11,330	Cash	Federal/State
Phase 1 - 2026 - Construction	*Roadway Recessed Pavement Marker Type 2 (HUND)*	1.00	$ 600.00	$ 600	$ 133	$ 401	$ 66	Cash	Federal/State
Phase 1 - 2026 - Construction	*Guidence Posts (EA)*	90.00	$ 8.00	$ 720	$ 160	$ 481	$ 79	Cash	Federal/State
Phase 1 - 2026 - Construction	*Permanent Signing (LS)*	1.00	$ 10,000.00	$ 10,000	$ 2,220	$ 6,680	$ 1,100	Cash	Federal/State
Phase 1 - 2026 - Construction	*Paint Lines(LF)*	17,520.00	$ 1.00	$ 17,520	$ 3,889	$ 11,703	$ 1,927	Cash	Federal/State
Phase 1 - 2026 - Construction	*Temporary Traffic Control (LS)*	1.00	$ 150,000.00	$ 150,000	$ 33,300	$ 100,200	$ 16,500	Cash	Federal/State
Phase 1- 2026 - Construction supervision	*Eng. Oversight (LS)*	1.00	$ 1,084,875.00	$ 1,084,875	$ 240,842	$ 724,697	$ 119,336	Cash	Federal/State
Phase 1 - 2026 - Surveys	*Roadway and Structure Surveying (LS)*	1.00	$ 129,000.00	$ 129,000	$ 28,638	$ 86,172	$ 14,190	Cash	Federal/State
					$ -				
Phase 2 - Mobilization	*Mobilize to and from (LS)*	1.00	$ 165,000.00	$ 165,000	$ 36,630	$ 110,220	$ 18,150	Cash	Federal/State
Phase 2 - 2027 Construction	*TESC, SPCC Plan and Implementation (LS)*	1.00	$ 94,000.00	$ 94,000	$ 20,868	$ 62,792	$ 10,340	Cash	Federal/State
Phase 2 - 2027 Construction	*Clearing and Grubbing(AC)*	2.54	$ 15,000.00	$ 38,100	$ 8,458	$ 25,451	$ 4,191	Cash	Federal/State
Phase 2 - 2027 Construction	*Roadway Excavation Incl. Haul (CY)*	33,075.00	$ 25.00	$ 826,875	$ 182,739	$ 553,179	$ 90,956	Cash	Federal/State
Phase 2 - 2027 Construction	*Riprap Removal Incl. Haul (CY)*	1,000.00	$ 25.00	$ 25,000	$ 5,525	$ 16,725	$ 2,750	Cash	Federal/State
Phase 2 - 2027 Construction	*Side Channel Excavation Incl. Haul (CY)*	24,000.00	$ 15.00	$ 360,000	$ 79,560	$ 240,840	$ 39,600	Cash	Federal/State
Phase 2 - 2027 Construction	*ELJ and Wood Habitat Construction (LS)*	1.00	$ 1,927,990.00	$ 1,927,990	$ 426,086	$ 677,022	$ 824,882	Cash	Federal/State
Phase 2 - 2027 Construction	*Coffering and Pumping (LS)*	1.00	$ 80,000.00	$ 80,000	$ 17,680	$ 53,520	$ 8,800	Cash	Federal/State
Phase 2 - 2027 Construction	*Temporary Traffic Control (LS)*	1.00	$ 40,000.00	$ 40,000	$ 8,840	$ 26,760	$ 4,400	Cash	Federal/State
Phase 2 - 2027 Construction	*Landscaping(LS)*	1.00	$ 250,000.00	$ 250,000	$ 55,250	$ 167,250	$ 27,500	Cash	Federal/State
Phase 2 - Construction supervision	*Eng. Oversight (LS)*	1.00	$ 85,000.00	$ 85,000	$ 18,785	$ 56,865	$ 9,350	Cash	Federal/State
			STotal	**$ 14,148,594**	**$ 2,980,000**	**$ 6,846,625**	**$ 4,321,969**		

Administrative, Architechtural & Engineering				Amount	Grant amount	Match in PRISM	Funding not reported in PRISM	Match Source	Match Type (federal, state, local)
Category	**Task Description**	**Qty**	**Rate**						
Phase 1 - Preliminary Design	*Roadway Civil Engineering & Design - 30% to preliminary 60% Designs*	1.00	$ 300,000.00	$ 300,000.00			$ 300,000	Cash	State
Phase 1 - Final Design	*Roadway Civil Engineering & Design -Preliminary to Final Design, (60% to 100%)*	1.00	$ 651,000.00	$ 651,000.00			$ 651,000	Cash	State (SRFB Funding Request)
Survey	*Roadway Survey and Basemapping*	1.00	$ 65,000.00	$ 65,000.00			$ 65,000	Cash	State
Data collection	*Geotechnical Data Collection for Roadway*	1.00	$ 150,000.00	$ 150,000.00			$ 150,000	Cash	State
Final design	*WSDOT Engineering Review*	1.00	$ 90,000.00	$ 90,000.00			$ 90,000	Cash, Materials, Labor	State
Other	*WSDOT ROW Coordination*	1.00	$ 90,000.00	$ 90,000.00			$ 90,000	Cash, Materials, Labor	State
Phase 2 - Final design	*Instream Restoration Civil Engineering & Design drawnings permit level to Final*	1.00	$ 145,000.00	$ 145,000.00			$ 145,000	Cash	Federal/State
Cultural resources	*Section 106 Compliance*	1.00	$ 25,000.00	$ 25,000.00			$ 25,000	Cash, Labor	Federal
Permits	*Wetland and Shoreline Permitting*	1.00	$ 10,000.00	$ 10,000.00			$ 10,000	Cash, Labor	Federal
Other	*Utilities ROW Coordination, CCPUD - T Mobile - Ziply Fiber*	1.00	$ 50,000.00	$ 50,000.00			$ 50,000	Cash, Materials, Labor	Local
Other	*YNF Project Management*	1.00	$ 160,000.00	$ 160,000.00			$ 160,000	Cash, Labor	Federal
Administrative	*YNF Bookkeeping*	1.00	$ 20,000.00	$ 20,000.00	$ 20,000				
			$ -	$ -	$ -				
			$ -	$ -	$ -				
			STotal	**$ 1,756,000**	**$ 20,000**	**$ -**	**$ 1,736,000**		

Indirect Costs				Amount	Grant amount	Match in PRISM	Funding not reported in PRISM	Match Source	Match Type (federal, state, local)
	Description	**Approved Rate**	**Total Project Base**						
	Indirect	0.000%	$ -	$ -	$ -	$ -	$ -		
	Indirect	0.000%	$ -	$ -	$ -	$ -	$ -		
			STotal	**$ -**	**$ -**	**$ -**	**$ -**		

Totals	$ 15,904,594	$ 3,000,000	$ 6,846,625	$ 6,057,969
		PRISM Project Total	$ 9,846,625	
		RCO Percentage	**Match Percentage**	
		30.467294%	**69.532706%**	

AA&E Budget Check	
A&E maximum allowed in $	*2,947,987.37*
A&E validation	*2,927,987*

CUMULATIVE TOTALS

This sheet contains automatic calculations

Project Name	NASON CREEK AND SR 207 PHASE 1 & 2 PROJECT
SRFB #	24-1861 - SRFB Request
Sponsor	CONFEDERATED TRIBES AND BANDS OF THE YAKAMA NATION

	OVERALL PROJECT Cost	GRANT REQUEST Amount	PRISM MATCH Amount	MATCH NOT IN PRISM Amount	*Budget Check*
Sheet #1 Acquisition					
Property Costs	$ -	$ -	$ -	$ -	0
Incidental Costs	$ -	$ -	$ -	$ -	0
Administrative Costs	$ -	$ -	$ -	$ -	0
Indirect Costs	$ -	$ -	$ -	$ -	
STotal	$ -	$ -	$ -	$ -	0
Sheet #2 Design					
Design Costs	$ -	$ -	$ -	$ -	
Indirect Costs	$ -	$ -	$ -	$ -	
STotal	$ -	$ -	$ -	$ -	0
Sheet #3 Restoration					
Construction Costs	$ 14,148,594	$ 750,000	$ 1,488,266	$ 11,910,328	0
AA&E	$ 1,756,000	$ -	$ -	$ 1,756,000	0
Indirect Costs	$ -	$ -	$ -	$ -	
STotal	$ 15,904,594	$ 750,000	$ 1,488,266	$ 13,666,328	0
Totals	$ 15,904,594	$ 750,000	$ 1,488,266	$ 13,666,328	0

CUMULATIVE TOTALS

This sheet contains automatic calculations

Project Name	NASON CREEK AND SR 207 PHASE 1 & 2 PROJECT
SRFB #	24-1861 Targeted Request
Sponsor	CONFEDERATED TRIBES AND BANDS OF THE YAKAMA NATION

	OVERALL PROJECT Cost	GRANT REQUEST Amount	PRISM MATCH Amount	MATCH NOT IN PRISM Amount	Budget Check
Sheet #1 Acquisition					
Property Costs	$ -	$ -	$ -	$ -	0
Incidental Costs	$ -	$ -	$ -	$ -	0
Administrative Costs	$ -	$ -	$ -	$ -	0
Indirect Costs	$ -	$ -	$ -	$ -	
STotal	$ -	$ -	$ -	$ -	0
Sheet #2 Design					
Design Costs	$ -	$ -	$ -	$ -	
Indirect Costs	$ -	$ -	$ -	$ -	
STotal	$ -	$ -	$ -	$ -	0
Sheet #3 Restoration					
Construction Costs	$ 14,148,594	$ 2,980,000	$ 6,846,625	$ 4,321,969	0
AA&E	$ 1,756,000	$ 20,000	$ -	$ 1,736,000	0
Indirect Costs	$ -	$ -	$ -	$ -	
STotal	$ 15,904,594	$ 3,000,000	$ 6,846,625	$ 6,057,969	0
Totals	$ 15,904,594	$ 3,000,000	$ 6,846,625	$ 6,057,969	0

WASHINGTON STATE
Recreation and Conservation Office

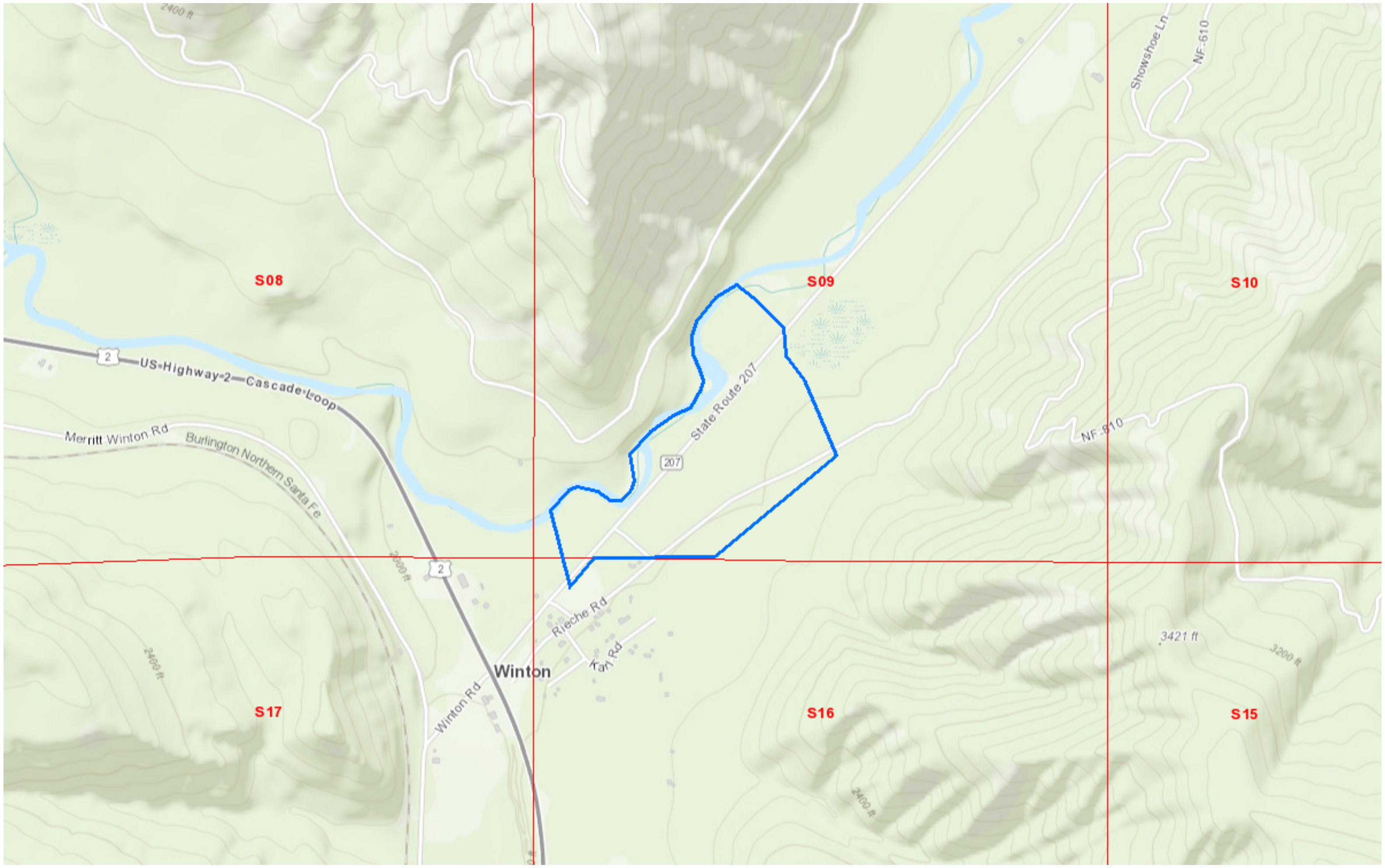
Project APE Maps Report

PROJECT: 24-1861 Planning & Restoration, Nason Creek and SR 207

Sponsor: Yakama Nation Program: Salmon Federal IIJA Projects

WORKSITE #1: Nason Creek - State Route 207 - Chelan County

Properties:	Nason Creek - State Route 207	City:	n/a	TRS:	26, 17E, 09
Address:	Mile Marker 0.2 to 0.85 – Highway 207	County:	Chelan	Lat/Long:	47.76086675, -120.73370739



Phase 1 (Year 1)

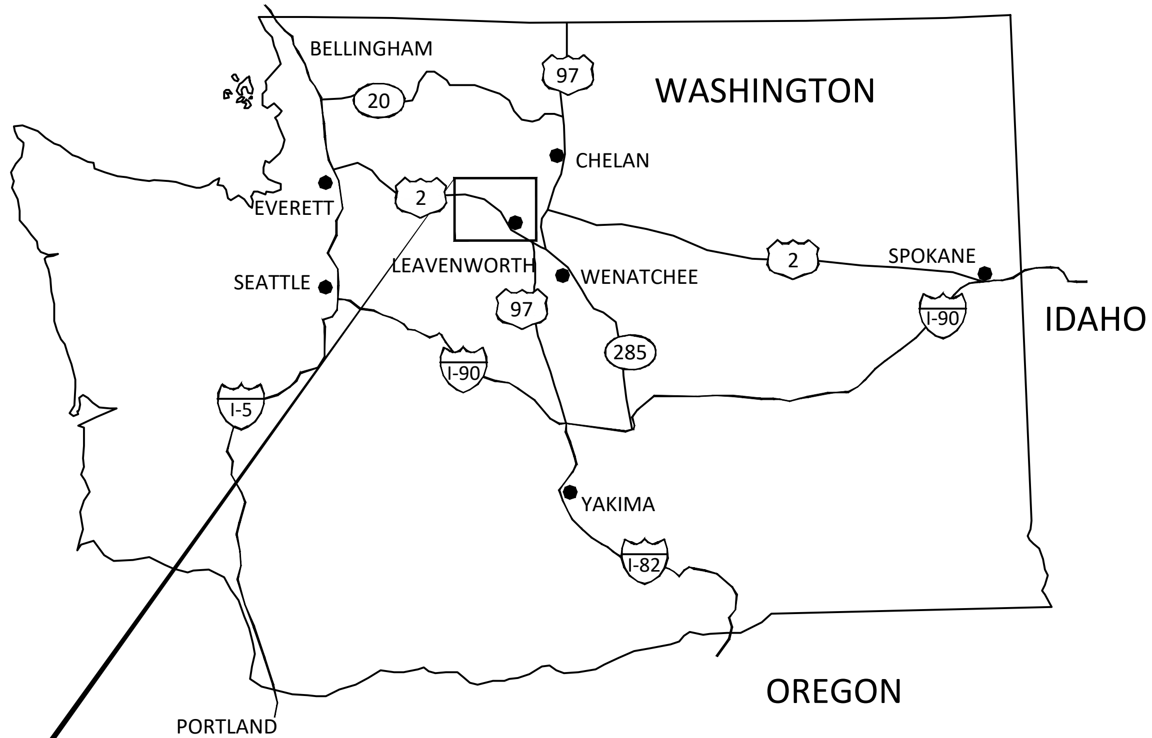
Road realignment

Phase 2 (Year 2)

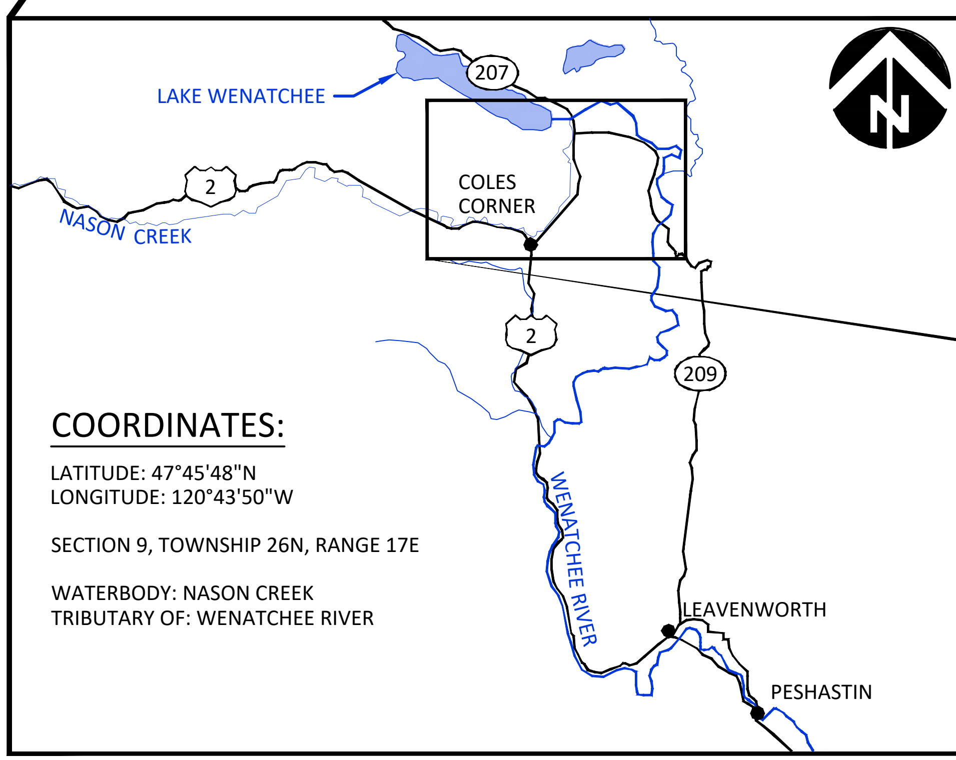
Old road infrastructure removal and instream restoration (upstream section)

NASON CREEK RM 3.6-4.6 FLOODPLAIN ENHANCEMENT
PHASE 2 - UPSTREAM STREAM ENHANCEMENT PROJECT
60% DESIGN

CHELAN COUNTY, WA
JANUARY13, 2026



LOCATION MAP
STATE OF WASHINGTON
NOT TO SCALE



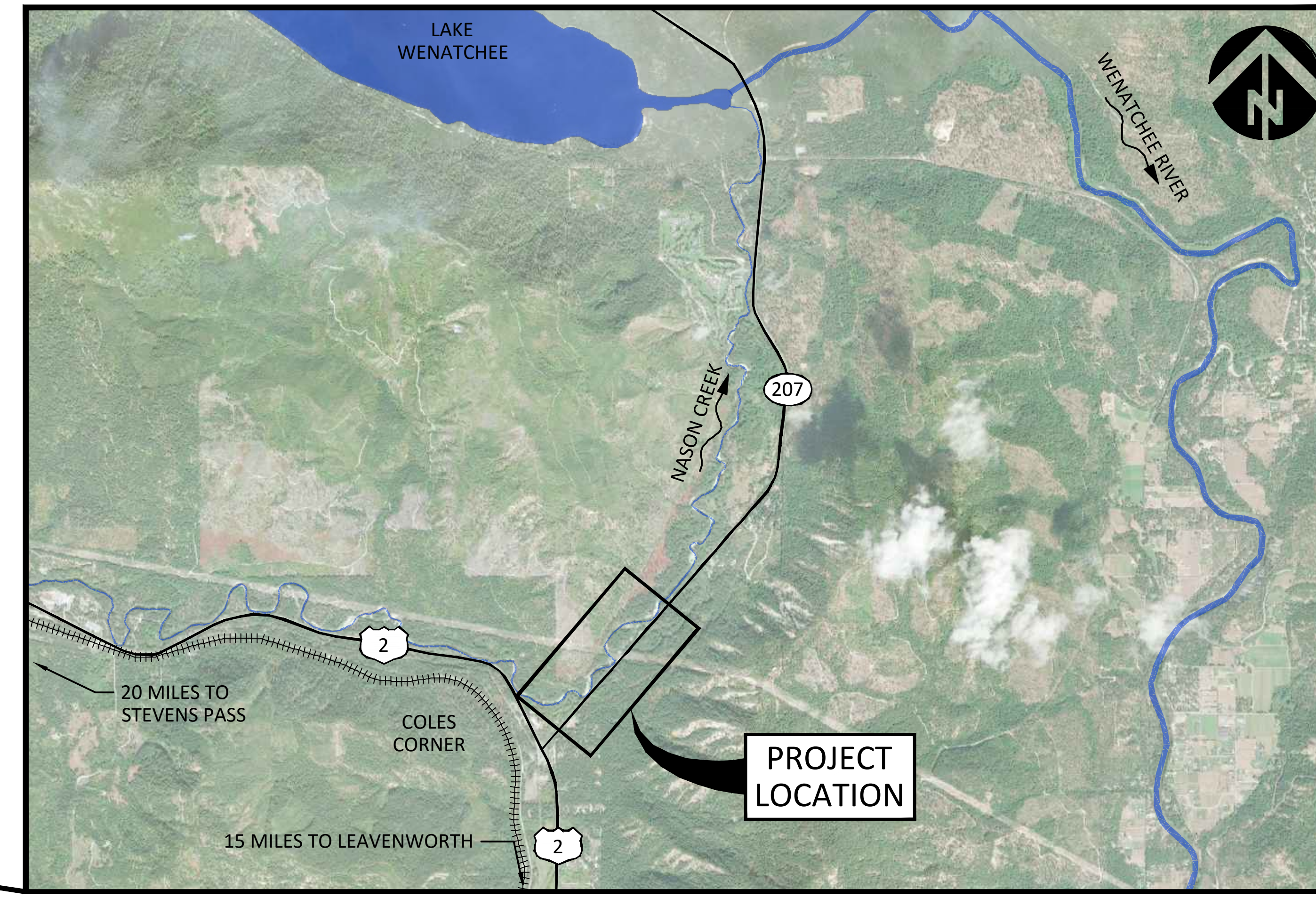
COORDINATES:

LATITUDE: 47°45'48"N
LONGITUDE: 120°43'50"W

SECTION 9, TOWNSHIP 26N, RANGE 17E

WATERBODY: NASON CREEK
TRIBUTARY OF: WENATCHEE RIVER

VICINITY MAP
NOT TO SCALE



SITE MAP
1" = 1 MILE

SHEET LIST:

1	COVER, SHEET INDEX & VICINITY MAPS
2	GENERAL NOTES (1 OF 2)
3	GENERAL NOTES (2 OF 2)
4	QUANTITIES ESTIMATES, & ABREVIATIONS
5	PERMITTING QUANTITIES
6	HIP IV GENERAL CONSERVATION MEASURES (1 OF 3)
7	HIP IV GENERAL CONSERVATION MEASURES (2 OF 3)
8	HIP IV GENERAL CONSERVATION MEASURES (3 OF 3)
9	TYPICAL DETAILS - EROSION CONTROL AND ENVIRONMENTAL PROTECTIONS
10	TYPICAL DETAILS - DIVERSION COFFERDAMS & TEMPORARY CROSSING
11	EXISTING CONDITIONS & PROPERTY OWNERSHIP
12	PROPOSED CONDITIONS AND SHEET INDEX
13	PROPOSED ACCESS, STAGING AND STOCKPILE AREAS
14	PROPOSED CONDITIONS (1 OF 5)
15	PROPOSED CONDITIONS (2 OF 5)
16	PROPOSED CONDITIONS (3 OF 5)
17	PROPOSED CONDITIONS (4 OF 5)
18	PROPOSED CONDITIONS (5 OF 5)
19	PROFILE - EXISTNG ROAD PRISM
20	ROAD CORSS SECTIONS
21	CROSS SECTIONS
22	LOW FLOW CHANNEL TYPICAL DETAIL
23	LARGE WOOD TYPICAL DETAILS (1 OF 5)
24	LARGE WOOD TYPICAL DETAILS (2 OF 5)
25	LARGE WOOD TYPICAL DETAILS (3 OF 5)
26	LARGE WOOD TYPICAL DETAILS (4 OF 5)
27	LARGE WOOD TYPICAL DETAILS (5 OF 5)
28	LOG PILE DETAILS
29	SPECIFICATIONS (1 OF 3)
30	SPECIFICATIONS (2 OF 3)
31	SPECIFICATIONS (3 OF 3)

Preliminary
Not for Construction

THIS PROJECT WAS DESIGNED IN ACCORDANCE WITH THE BPA HABITAT IMPROVEMENT PROGRAM, PROGRAMMATIC BIOLOGICAL OPINION (HIP IV).

G:\M-P\Nason Creek Floodplain RM 3.4-4.6 Phase 3 200237\Drawings\IFI_NasonFP_NoRD_C.dwg -- cmcconnell -- 1/13/26

NO.	BY	DATE	REVISION DESCRIPTION

CM	DM	DM
DRAWN	DESIGNED	CHECKED
DM	01/13/2026	200237
APPROVED	DATE	PROJECT

YAKAMA NATION FISHERIES
NASON CR. R.M. 3.6-4.6 FLOODPLAIN ENHANCEMENT
PHASE 2 60% DESIGN

inter-fluve
501 Portway Avenue, Suite 101
Hood River, OR 97031
541.386.9003
www.interfluve.com

Yakama Nation Fisheries
POST OFFICE BOX 151
FORT ROAD
TOPPENISH, WA 98948
(509)865-5121

COVER, SHEET INDEX & VICINITY MAPS

SHEET
1 OF 31

THE OWNER (YAKAMA NATION UCHRP) WILL PROVIDE A PRE-BID SITE TOUR. THE CONTRACTOR SHALL ATTEND THIS PRE-BID TOUR FOR SITE FAMILIARIZATION AND TO POSE QUESTIONS TO THE OWNER AND OWNER'S REPRESENTATIVE.

THE SELECTED CONTRACTOR SHALL ATTEND A PRE-CONSTRUCTION MEETING WITH OWNER AND OWNER'S REPRESENTATIVE PRIOR TO MOBILIZING TO SITE AND BEGINNING CONSTRUCTION.

ALL WORK SHALL CONFORM TO THE 2026 EDITION OF STANDARD PLANS AND SPECIFICATIONS OF THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WSDOT), AND LOCAL STANDARDS UNLESS INDICATED OTHERWISE BY THE CONTRACT DOCUMENTS. IN CASE OF A CONFLICT BETWEEN THE REGULATORY STANDARDS OR SPECIFICATIONS, THE MORE STRINGENT SHALL PREVAIL.

IN CASE OF DISCREPANCY, BETWEEN NOTES, LOCAL REGULATIONS, OR OTHER CONTRACT DOCUMENTATION, CONTRACTOR SHALL OBTAIN CLARIFICATION/DIRECTION FROM OWNER.

IN WATER WORK PERIODS

IN WATER WORK SHALL OCCUR DURING THE PERMITTED IN-WATER WORK PERIOD AS STATED IN THE APPLICABLE PERMITS. (JULY 1-31)

FISH RESCUE

ALL FISH RESCUE EFFORTS SHALL BE SUPERVISED BY A QUALIFIED YAKAMA NATION FISHERIES/AQUATIC BIOLOGIST EXPERIENCED WITH THE COLLECTION AND HANDLING OF SALMONID FISHES FROM CONSTRUCTION SITES.

ALL FISH TRAPPED IN RESIDUAL POOLS WITHIN THE PROJECT AREA SHALL BE CAREFULLY COLLECTED BY SEINE AND/OR DIP NETS AND PLACED IN CLEAN TRANSFER CONTAINERS WITH ADEQUATE VOLUME OF WATER AND HELD WITHIN NO LONGER THAN 10 MINUTES.

CAPTURED FISHES SHALL BE IMMEDIATELY RELEASED INTO THE RIVER.

CONTRACTOR WILL PROVIDE AGREED UPON ADVANCE NOTICE TO OWNER PRIOR TO FISH RESCUE. CONTRACTOR IS RESPONSIBLE FOR ISOLATING THE CONSTRUCTION LOCATION FROM THE STREAM.

EXISTING DATA

TOPOGRAPHIC DATA WAS COLLECTED BY INTER-FLUVE USING RTK GPS EQUIPMENT ON NOVEMBER 14 & 15, 2018 AND NOVEMBER 2 & 3, 2020. DATA ARE REFERENCED TO NAD83, STATE PLANE, WASHINGTON NORTH, NAVD88, US SURVEY FEET.

2015 LiDAR. 2022 USBR RED/GREEN LiDAR

HYDRAULIC MODELING BY INTER-FLUVE USING USACE HEC-RAS 6.6.

WATERS OF THE U.S.

THE ORDINARY HIGH WATER (OHW) LINES DISPLAYED IN THE DESIGN PACKAGE ARE BASED UPON ANALYSIS, MODELING AND BEST PROFESSIONAL JUDGEMENT.

SOILS

SOILS WITHIN THE PROJECT AREA CONSIST OF BEVERLY FINE SANDY LOAM, BRIEF GRAVELLY SANDY LOAM, ALLUVIAL LAND, RIVERWASH, PEOH SILT LOAM, GODDARD COBBLY FINE SANDY LOAM, AS MAPPED BY NRCS.

HIGHWAY 207 EMBANKMENT MATERIALS

CONTRACTOR SHALL CONDUCT OWN SOILS INVESTIGATIONS AS NEEDED, AT NO ADDITIONAL COST.

WETLANDS

WETLANDS DELINEATIONS WERE COMPLETED BY HAMER ENVIRONMENT (JANUARY 2021, JANUARY 14, 2022) AND TETRATECH (NOVEMBER 2025).

CULTURAL RESOURCES

CULTURAL RESOURCE MONITORING TO BE PROVIDED BY OWNER DURING GROUND DISTURBING ACTIVITIES. THE CONTRACTOR SHALL ACCOMMODATE THE MONITORING PERSONNEL AND COMPLY WITH THEIR DIRECTION RELATIVE TO INTERACTIONS WITH POTENTIAL CULTURAL RESOURCES.

- IF WORK ENCOUNTERS ANY OF THE FOLLOWING CULTURAL RESOURCES:
- NATIVE AMERICAN CULTURAL ARTIFACTS (EXAMPLE: FLAKES, ARROWHEADS, STONE TOOLS, BONE TOOLS, POTTERY, HEARTH FEATURES, ETC)
- HISTORIC ERA ARTIFACTS (EXAMPLE: BUILDING FOUNDATIONS, HOMESTEADS, MINING CAMPS, ETC)
- HUMAN SKELETAL REMAINS AND BONE FRAGMENTS

IMMEDIATELY DISCONTINUE ALL GROUND-DISTURBING ACTIVITY. DO NOT TOUCH OR MOVE THE OBJECTS AND MAINTAIN THE CONFIDENTIALITY OF THE SITE. FOLLOW THE PROCEDURES LISTED IN THE INADVERTENT DISCOVERY PROCEDURE. THEN AWAIT FURTHER DIRECTION FROM THE OWNER'S CULTURAL RESOURCES STAFF.

TREE SALVAGE

ALL SAPLING AND TREES TO BE REMOVED SHALL BE APPROVED AND CLEARLY MARKED BY OWNER OR THEIR CONTRACTED REPRESENTATIVE.

ALL REMOVED NATIVE VEGETATION SHALL BE INCORPORATED INTO LOG STRUCTURES AS DIRECTED BY OWNER OR THEIR CONTRACTED REPRESENTATIVE. IF EXCESS VEGETATION MATERIAL NEEDS DISPOSAL OUTSIDE OF CHANNEL WORK, IT SHALL BE DISTRIBUTED IN DESIGNATED AREAS ON THE FLOODPLAIN OR ON THE FLOODPLAIN AS DIRECTED BY OWNER'S REPRESENTATIVE.

ALL TREES REMOVED WITHIN CLEARING LIMITS SHALL BE REMOVED WHOLE WITH ROOTS INTACT AND UTILIZED IN THE SIDE CHANNEL CONSTRUCTION OR IN MAINSTEM WORK AS DIRECTED BY CONTRACTING AGENT'S REPRESENTATIVE.

REMOVE SOIL FROM ROOTS OF SALVAGED TREES BEFORE PLACEMENT IN THE WATERWAY.

LIVE TREES

ALL TREES NOT MARKED FOR REMOVAL SHALL BE PRESERVED AND UNDISTURBED. CONSTRUCTION ACTIVITY SHALL NOT DEBARK OR DAMAGE LIVE TREES.

KEEP OUT OF DRIP LINE OF ALL PRESERVED EXISTING TREES.

CONTRACTOR'S PLANS

CONTRACTOR SHALL PREPARE AND SUBMIT FOR APPROVAL BY THE OWNER PRIOR TO COMMENCING WORK THE FOLLOWING PLANS:

- ACCESS, TRAFFIC CONTROL AND TEMPORARY STREAM CROSSING PLAN
- STOCKPILE AND STAGING PLAN
- CONSTRUCTION SEQUENCING PLAN
- STREAM DIVERSION AND SITE DEWATERING PLAN
- EROSION, SEDIMENT AND DUST CONTROL PLAN
- EARTHWORKS EXCAVATION, PLACEMENT, SALVAGE & REUSE, AND DISPOSAL PLAN

DESIGNS BY OTHERS

PHASE 1 HIGHWAY 207 RELOCATION IS DESIGNED BY PERTEET.

REVEGETATION OF DISTURBED AREAS WILL BE DESIGNED BY OTHERS

UTILITIES

THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR HAVING UTILITIES LOCATED PRIOR TO CONSTRUCTION ACTIVITIES.

THE CONTRACTOR SHALL CALL (800-424-5555 OR 811) FOR UTILITY LOCATE PRIOR TO CONSTRUCTION

THE CONTRACTOR SHALL IMMEDIATELY CONTACT THE AFFECTED UTILITY SERVICE TO REPORT ANY DAMAGED OR DESTROYED UTILITIES.

THE CONTRACTOR SHALL PROVIDE EQUIPMENT AND LABOR TO AID THE AFFECTED UTILITY SERVICE IN REPAIRING DAMAGED OR DESTROYED UTILITIES AT NO ADDITIONAL COST.

EXISTING UTILITIES WILL BE DECOMMISSIONED AND REMOVED/ABANDONED IN PHASE 1.

CONTRACTOR SHALL REMOVE AND DISPOSE OF ABANDONED UTILITIES THAT ARE LOCATED WITH IN PROPOSED WORK AREAS.

CONSTRUCTION STAKING

OWNER'S REPRESENTATIVE WILL PROVIDE ELEVATION CONTROL POINTS.

CONTRACTOR SHALL MEET WITH THE OWNER AND OWNER'S REPRESENTATIVE TO DEFINE AND MARK LIMITS OF DISTURBANCE PRIOR TO MOBILIZATION OF EQUIPMENT OR MATERIALS ONTO THE SITE.

CONTRACTOR SHALL STAKE PROJECT LIMITS AND GRADE STAKES BASED ON PROJECT ELEVATION CONTROL POINTS. THE CONTRACTOR SHALL REPLACE DAMAGED OR DESTROYED CONSTRUCTION STAKES AT NO ADDITIONAL COST.

CONTRACTOR SHALL COORDINATE WITH ENGINEER FOR INITIAL AND PERIODIC CHECKING OF CONTRACTOR'S STAKEOUT. SOME FIELD ADJUSTMENTS TO THE LINES AND GRADES ARE TO BE EXPECTED.

CONSTRUCTION MATERIALS

OWNER PROVIDED LOGS, LOGS WITH ROOTWADS AND LOG PILES WILL BE LOCATED IN A DESIGNATED STOCKPILE/STAGING AREA. CONTRACTOR SHALL HAUL WOOD FROM STAGING AREA AND INSTALL PER PLANS. CONTRACTOR SHALL PROCURE, PROVIDE AND PLACE SLASH MATERIALS.

LOCATION, ALIGNMENT, AND ELEVATION OF LOGS AND LOGS WITH ROOTWADS ARE SUBJECT TO ADJUSTMENT BASED ON FIELD CONDITIONS AND MATERIAL SIZE, PER DIRECTION BY OWNER OR OWNER'S REPRESENTATIVE.

ANY EXCESS CONSTRUCTION MATERIALS SHALL BE NEATLY STORED AT AN APPROVED STAGING LOCATION. UPON COMPLETION OF THE PROJECT ANY EXCESS MATERIALS, WITH THE EXCEPTION OF ANY LARGE WOODY MATERIAL (LWM), WILL BECOME THE PROPERTY OF THE CONTRACTOR AND HAULED OFFSITE IN A TIMELY MANNER AND LEGALLY DISPOSED OF.

CONTRACTOR SHALL HAUL EXCESS LWM AND PLACE IN OWNER PROVIDED STOCKPILE AREA AT NO ADDITIONAL COST.

PHASE 1 CONSTRUCTION WILL INCLUDE RELOCATING HIGHWAY 207 ROADWAY AND UTILITIES, DECOMMISSIONING AND REMOVAL OF UTILITIES.

EXISTING HIGHWAY 207 EMBANKMENT TO BE ABANDONED WILL BE REMOVED IN THIS PHASE 2 WORK.

CONSTRUCTION ACCESS/TRAFFIC CONTROL

CONTRACTOR SHALL SUBMIT AN ACCESS, STAGING, AND STOCKPILE PLAN TO THE OWNER'S REPRESENTATIVE FOR APPROVAL PRIOR TO MOBILIZATION.

THE CONTRACTOR IS SOLELY RESPONSIBLE FOR PROVIDING ANY REQUIRED TRAFFIC CONTROL INCLUDING, BUT NOT LIMITED TO, SIGNAGE AND FLAGGERS.

THE CONTRACTOR IS SOLELY RESPONSIBLE FOR DEVELOPING A TRAFFIC CONTROL PLAN ACCEPTABLE TO CHELAN COUNTY AND WSDOT AND SUBMIT TRAFFIC CONTROL PLAN TO THE OWNER A MINIMUM OF 30 DAYS PRIOR TO WORK.

CONTRACTOR SHALL IMPLEMENT MEASURES TO CONTROL AND MINIMIZE WIND BLOWN DUST FROM THE SITE AND ACCESS ROUTES.

AT PROJECT COMPLETION, ROADS AND ACCESS ROUTES SHALL BE CLEANED, GRADED, AND RESURFACED TO PRE-PROJECT CONDITION PER WASHINGTON DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATION OR USFS STANDARDS PER JURISDICTION. WORK SHALL BE INCIDENTAL TO MOBILIZATION/DEMOBILIZATION.

ALL DISTURBED AREAS INCLUDING, BUT NOT LIMITED TO: ROADS, DRIVEWAYS, TEMPORARY ACCESS ROUTES, STAGING AREAS AND STRUCTURE LOCATIONS SHALL BE RESTORED TO PRE-PROJECT CONDITION OR BETTER. THIS WILL INCLUDE, BUT IS NOT LIMITED TO ANY GRADING/BLADING OF DISTURBED AREAS AS WELL AS REMOVAL OF ANY TRASH AND DEBRIS. THE OWNER'S REPRESENTATIVE WILL CONDUCT A FINAL WALK THROUGH WITH THE CONTRACTOR PRIOR TO DEMOBILIZATION.

CONTRACTOR SHALL SEED AND MULCH ALL DISTURBED SURFACES EXCEPT CHANNEL BETWEEN TOPS OF BANK AND EXISTING GRAVEL ROADS.

ALL DISTURBED AREAS OUTSIDE THE LIMITS OF DISTURBANCE SHALL BE RESTORED TO ORIGINAL CONDITION OR BETTER AT NO ADDITIONAL COST.

EROSION CONTROL

CONTRACTOR SHALL BE SOLELY RESPONSIBLE AT OWN EXPENSE FOR PROVIDING AND MAINTAINING ALL NECESSARY EROSION CONTROL FACILITIES TO COMPLY WITH APPLICABLE EROSION CONTROL REGULATIONS AND TO MAINTAIN CLEAN ACCESS ROUTES.

EROSION/SEDIMENTATION CONTROL (ESC) PLAN

THE EROSION AND SEDIMENT CONTROL (ESC) PLAN PROVIDED IS FOR INFORMATIONAL PURPOSES ONLY, THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR PROVIDING EROSION CONTROL MEASURES TO COMPLY WITH APPLICABLE REGULATIONS.

THE RECOMMENDATIONS FOR AN ESC PLAN INCLUDED HEREIN WILL PROVIDE GUIDELINES FOR THE CONTRACTOR TO DEVELOP AND IMPLEMENT AN ESC PLAN. THE CONTRACTOR'S ESC PLAN SHALL BE SUBMITTED TO THE OWNER FOR APPROVAL 30 DAYS PRIOR TO MOBILIZATION. ESC MEASURES SHALL BE IN PLACE PRIOR TO GROUND DISTURBANCE.

A. THE ESC FACILITIES SHOWN ON THIS PLAN ARE THE MINIMUM REQUIREMENTS FOR ANTICIPATED SITE CONDITIONS. DURING THE CONSTRUCTION PERIOD, THESE ESC FACILITIES SHALL BE UPGRADED AS NEEDED AT NO ADDITIONAL COST FOR UNEXPECTED STORM EVENTS AND TO ENSURE THAT SEDIMENT AND SEDIMENT-LADEN WATER DO NOT LEAVE THE SITE.

B. THE IMPLEMENTATION OF AN ESC PLAN AND THE CONSTRUCTION, MAINTENANCE, REPLACEMENT, AND UPGRADING OF THESE ESC FACILITIES IS THE RESPONSIBILITY OF THE CONTRACTOR UNTIL ALL CONSTRUCTION IS COMPLETED AND APPROVED AND VEGETATION/LANDSCAPING IS ESTABLISHED.

C. THE ESC FACILITIES ARE TO BE CONSTRUCTED PRIOR TO CLEARING AND GRADING ACTIVITIES, AND IN SUCH A MANNER AS TO ENSURE THAT SEDIMENT AND SEDIMENT LADEN WATER DO NOT ENTER THE DRAINAGE SYSTEM.

D. THE BOUNDARIES OF THE CLEARING LIMITS SHOWN ON THIS PLAN SHALL BE CLEARLY FLAGGED IN THE FIELD PRIOR TO CONSTRUCTION. DURING THE CONSTRUCTION PERIOD, NO DISTURBANCE BEYOND THE FLAGGED CLEARING LIMITS SHALL BE PERMITTED. THE FLAGGING SHALL BE MAINTAINED BY THE CONTRACTOR FOR THE DURATION OF CONSTRUCTION.

E. THE ESC FACILITIES SHALL BE INSPECTED DAILY BY THE CONTRACTOR AND MAINTAINED AS NECESSARY TO ENSURE THEIR CONTINUED FUNCTIONING.

F. THE ESC FACILITIES ON INACTIVE SITES SHALL BE INSPECTED AND MAINTAINED A MINIMUM OF ONCE A MONTH OR WITHIN THE 24 HOURS FOLLOWING A STORM EVENT.

G. STABILIZED CONSTRUCTION ENTRANCES AND ADDITIONAL MEASURES MAY BE REQUIRED AND SHALL BE MAINTAINED FOR THE DURATION OF THE PROJECT AT CONTRACTOR'S EXPENSE.

STABILIZE SOILS AND PROTECT SLOPES

FROM MAY 1 THROUGH SEPTEMBER 30, ALL EXPOSED SOILS SHALL BE PROTECTED FROM EROSION BY MULCHING, PLASTIC SHEETING, HYDROSEED COVERING, OR OTHER APPROVED MEASURES WITHIN THREE DAYS OF GRADING. FROM OCTOBER 1 THROUGH APRIL 30, ALL EXPOSED SOILS MUST BE PROTECTED WITHIN 2 DAYS OF GRADING. SOILS SHALL BE STABILIZED BEFORE A WORK SHUTDOWN, HOLIDAY OR WEEKEND IF NEEDED BASED ON THE WEATHER FORECAST. SOIL STOCKPILES MUST BE STABILIZED AND PROTECTED WITH SEDIMENT TRAPPING MEASURES. MULCH AS SOON AS PRACTICAL ALL DISTURBED AREAS NOT INDICATED IN THE CONTRACT DOCUMENTS FOR OTHER PERMANENT STABILIZATION MEASURES. HAY, STRAW, AND MULCH USED ON SITE MUST BE 99.9% WEED-FREE.

DESIGN, CONSTRUCT, AND PHASE CUT AND FILL SLOPES IN A MANNER THAT WILL MINIMIZE EROSION. REDUCE SLOPE VELOCITIES ON DISTURBED SLOPES BY PROVIDING TEMPORARY BARRIERS. STORMWATER FROM OFF SITE SHOULD BE HANDLED SEPARATELY FROM STORMWATER GENERATED ON SITE.

AFTER FINAL SITE STABILIZATION

ALL TEMPORARY EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE REMOVED WITHIN 30 DAYS AFTER FINAL SITE STABILIZATION IS ACHIEVED OR AFTER THE TEMPORARY BMPS ARE NO LONGER NEEDED. TRAPPED SEDIMENT SHALL BE REMOVED FROM THE SITE OR INCORPORATED INTO FINISHED GRADING. DISTURBED SOIL AREAS RESULTING FROM REMOVAL SHALL BE PERMANENTLY STABILIZED.

INVASIVE SPECIES CONTROL

THE FOLLOWING MEASURES WILL BE FOLLOWED TO AVOID INTRODUCTION OF INVASIVE PLANTS AND NOXIOUS WEEDS INTO PROJECT AREAS:

1. PRIOR TO ENTERING THE SITE, ALL VEHICLES AND EQUIPMENT WILL BE POWER WASHED, ALLOWED TO FULLY DRY, AND INSPECTED TO MAKE SURE NO PLANTS, SOIL, OR OTHER ORGANIC MATERIAL ADHERES TO THE SURFACE.

DUST CONTROL

THE CONTRACTOR SHALL CONTROL DUST FOR THE DURATION OF THE PROJECT. CONTROL MEASURES SHALL BE IN ACCORDANCE WITH APPLICABLE REGULATIONS, AND MAY INCLUDE WATERING, MULCH, AND SLOWER VEHICLE SPEEDS.

CONSTRUCTION DEWATERING

CONTRACTOR SHALL PERFORM CONSTRUCTION DEWATERING IN SUCH A MANNER AS TO AVOID THE RELEASE OF TURBID OR SEDIMENT-LADEN WATER IN ORDER TO PREVENT CONTAMINATION OR INCREASE TURBIDITY OF SURFACE WATERS. EXCAVATION OF DEWATERING SUMPS BEYOND LIMITS SHOWN SHALL BE AT NO ADDITIONAL COST. SEDIMENT LADEN WATER MAY BE PUMPED TO AN UPLAND DISCHARGE LOCATION AND ALLOWED TO SHEET FLOW THROUGH EXISTING VEGETATION BEFORE INFILTRATING INTO THE GROUND. IF THIS METHOD IS NOT SUFFICIENT TO PREVENT RETURN OF TURBID WATER TO SURFACE WATERS OR SENSITIVE FLOODPLAIN AREAS, A 'DIRT-BAG' OR SEDIMENT RETENTION STRUCTURE MAY BE REQUIRED AS NECESSARY TO COMPLY WITH LAWS AND PERMIT REQUIREMENTS AT NO ADDITIONAL COST.
CONTRACTOR SHALL PROVIDE, OPERATE, AND MAINTAIN NUMBER AND SIZE OF PUMPS AS NECESSARY TO ACHIEVE DEWATERING NEEDS. AT A MINIMUM, CONTRACTOR SHALL PROVIDE A 6" DRI-PRIME DIESEL POWERED PUMP AND A PORTABLE 2" PUMP. ADDITIONAL PUMPS AND OF DIFFERENT CAPACITIES MAY BE REQUIRED AT CONTRACTOR'S EXPENSE.

OWNER, OR REPRESENTATIVE SHALL APPROVE DEWATERING DISCHARGE LOCATION PRIOR TO IMPLEMENTATION.

SPILL PREVENTION, CONTROL, AND COUNTER MEASURES

THE USE OF MECHANIZED MACHINERY INCREASES THE RISK FOR ACCIDENTAL SPILLS OF FUEL, LUBRICANTS, HYDRAULIC FLUID, OR OTHER CONTAMINANTS INTO THE RIPARIAN ZONE OR DIRECTLY INTO THE WATER. THE CONTRACTOR SHALL ADHERE TO THE FOLLOWING MEASURES:

1. A DESCRIPTION OF HAZARDOUS MATERIALS THAT WILL BE USED, INCLUDING INVENTORY, STORAGE, AND HANDLING PROCEDURES SHALL BE AVAILABLE ON-SITE.

2. WRITTEN PROCEDURES FOR NOTIFYING ENVIRONMENTAL RESPONSE AGENCIES SHALL BE POSTED AT THE WORK SITE.

3. SPILL CONTAINMENT KITS (INCLUDING INSTRUCTIONS FOR CLEANUP AND DISPOSAL) ADEQUATE FOR THE TYPES AND QUANTITY OF HAZARDOUS MATERIALS USED AT THE SITE SHALL BE AVAILABLE AT THE WORK SITE.

4. WORKERS SHALL BE TRAINED IN SPILL CONTAINMENT PROCEDURES AND SHALL BE INFORMED OF THE LOCATION OF SPILL CONTAINMENT KITS.

5. ANY WASTE LIQUIDS GENERATED AT THE STAGING AREAS SHALL BE TEMPORARILY STORED UNDER AN IMPERVIOUS COVER, SUCH AS A TARPAULIN, UNTIL THEY CAN BE PROPERLY TRANSPORTED TO AND DISPOSED OF AT A FACILITY THAT IS APPROVED FOR RECEIPT OF HAZARDOUS MATERIALS.

6. VEGETABLE BASED HYDRAULIC FLUIDS (BIODEGRADABLE OIL) SHALL BE USED IN ANY VEHICLE THAT WILL BE OPERATED NEAR THE WATER.

INSPECTION AND MAINTENANCE

ALL ESC FACILITIES SHALL BE INSPECTED, MAINTAINED, AND REPAIRED AS NEEDED TO ASSURE CONTINUED PERFORMANCE OF THEIR INTENDED FUNCTION. ALL ESC FACILITIES SHALL BE INSPECTED DAILY AND WITHIN 24 HOURS AFTER ANY STORM EVENT GREATER THAN 0.5 INCHES OF RAIN PER 24 HOUR PERIOD AND AFTER EVENTS EXCEEDING 2 HOURS DURATION.

CONTRACTOR'S ESC RECORD

WEEKLY REPORTS SUMMARIZING THE SCOPE OF INSPECTIONS, THE PERSONNEL CONDUCTING THE INSPECTION, THE DATE(S) OF THE INSPECTION, MAJOR OBSERVATIONS RELATING TO THE IMPLEMENTATION OF THE CONTRACTOR'S EROSION AND SEDIMENT CONTROL PLAN, AND ACTIONS TAKEN AS A RESULT OF THESE INSPECTIONS SHALL BE PREPARED AND RETAINED ON SITE BY THE CONTRACTOR. IN ADDITION, A RECORD OF THE FOLLOWING DATES SHALL BE INCLUDED IN THE REPORTS:

1. WHEN MAJOR GRADING ACTIVITIES OCCUR,

2. DATES OF RAINFALL EVENTS EITHER EXCEEDING 2 HOURS DURATION OR MORE THAN 0.5 INCHES/24 HOURS,

3. WHEN CONSTRUCTION ACTIVITIES TEMPORARILY OR PERMANENTLY CEASE ON SITE, OR ON A PORTION OF THE SITE,

4. WHEN STABILIZATION MEASURES ARE INITIATED FOR PORTIONS OF THE SITE. ESC RECORDS SHALL BE MADE AVAILABLE TO THE OWNER AND OWNER'S REPRESENTATIVE ON REQUEST AND SHALL BE PROVIDED FOR REVIEW AND APPROVAL PRIOR TO APPLICATION FOR PAYMENT.

Preliminary
Not for Construction

QUANTITIES ESTIMATE - LARGE WOOD STRUCTURES

Location Structure	ID code	quantity	units	Item: size:	Log w/RW 18"dbh x 40'	Surface single log 18"dbh x 40'	Log pile 16" dbh x 20'	Slash dense bundle: 4' diameter x 12' long	Tipped/ Salvaged tree	Total earthworks per each Excavation (CY)	Total earthworks per each Backfill (CY)
Phase 2 - River Left											
Apex jams	Apex	2	ea		14		7	4		300	300
Bar roughness wood structures	BR	5	ea		5		5			50	50
FP roughness logs	FP	4	ea		1						
Tipped trees	TT	4	ea						1		
Phase 2 RL subtotal = Sum [(# of structures) * (Qty per structure)]					57	0	39	8	4	850	850
Phase 2 - River Right											
Apex jams	Apex	4	ea		14		7	4		300	300
Bank buried jam	BB	3	ea		9			4	2	300	300
Bank buried jam w/trees	BB	2	ea		9		4	4	6	300	300
Small bank buried jam	SM-BB	9	ea		2		2	2	1	40	40
Bank margin wood	M	7	ea		7		12	3	3	50	50
Bar roughness wood structures	BR	12	ea		5		5	1		42	42
BR and SM-BB racking wood	RW	4	ea		6		7		2	42	42
CED3 Bank barb structure	CED3	4	ea		12	1	14	3	6	0	590
Deflector jam	DFL	3	ea		2		9	2		0	0
Inlet structure	Inlet	2	ea		14		6	6		290	290
low flow channel floodplain roughness LW	LFFP	11	ea		7		8	1		70	70
low flow channel habitat cover logs	LFHC	11	ea		3		1	1		28	28
low flow channel floodplain roughness log	LFRL	18	ea		3		2			28	28
FP roughness logs	FP	9	ea		1						
Phase 2 RR subtotal = Sum [(# of structures) * (Qty per structure)]					507	4	456	139	80	6244	8604
Phase 2 Total = (RR + RL subtotals)					564	4	495	147	84	7094	9454

QUANTITIES ESTIMATE - EARTHWORKS

Item	Description	Quantity	Units	Notes
River Right project components				
	CED-1 & 2 Riprap removal and salvage	700	CY	Approximately 225+250LF x 3ft thick x 12ft high, plus barbs
	CED-1 & 2 Road embankment removal, low flow channel and wetland creation excavation and off site disposal	29300	CY	CADD volume
	CED-1 Mainstem Meander excavation	2950	CY	CADD volume minus volume of riprap removal
	CED-1 Mainstem Meander gravel bar alluvial material fill	2330	CY	CADD volume
	CED-1 Inlet swale	82	CY	CADD volume
	CED-3 Mainstem Meander gravel bar alluvial material excavation	1850	CY	CADD volume
	CED-2 bank revetment for Phase 1 road	1050	CY	42" thick Class B stone; approximately 400ft long

NOTES:

1. ESTIMATED MATERIAL VOLUMES ARE IN-PLACE QUANTITIES AND NOT FACTORED FOR EXPANSION OF EXCAVATED MATERIAL OR COMPACTION OF PLACED MATERIAL. MEASUREMENT AND PAYMENT SHALL NOT BE BASED ON WEIGHT TICKETS OR TRUCK MEASURE
2. PLANTING PLAN AND REVEGETATION ARE DESIGNED BY OTHERS.

ABBREVIATIONS

APPROX	APPROXIMATE
BMP	BEST MANAGEMENT PRACTICE
CY	CUBIC YARDS
°	DEGREE
DBH	DIAMETER AT BREAST HEIGHT
DIA	DIAMETER
EA	EACH
ELEV	ELEVATION
ESC	EROSION AND SEDIMENT CONTROL
' or FT	FOOT
GIS	GEOGRAPHIC INFORMATION SYSTEM
HWY	HIGHWAY
" or IN	INCH
LWM	LARGE WOODY MATERIAL
LWS	LARGE WOOD STRUCTURE
LS	LUMP SUM
MAX	MAXIMUM
MIN	MINIMUM
MP	MILEPOST
MSF	THOUSAND SQUARE FEET
NAD 83	NORTH AMERICAN DATUM OF 1983
NAVD88	NORTH AMERICAN VERTICAL DATUM OF 1988
NRCS	NATURAL RESOURCES CONSERVATION SERVICE
OHW	ORDINARY HIGH WATER
OLW	ORDINARY LOW WATER
%	PERCENT
LBS	POUNDS
RD	ROAD
RM	RIVER MILE
RTK GPS SYSTEM	REAL TIME KINEMATIC GLOBAL POSITIONING SYSTEM
STA	STATION
TBM	TEMPORARY BENCHMARK
TYP	TYPICAL
US	UNITED STATES
USACE	UNITED STATES ARMY CORPS OF ENGINEERS
USFS	UNITED STATES FOREST SERVICE
WDFW	WASHINGTON DEPARTMENT OF FISH AND WILDLIFE
WSDOT	WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

Preliminary
Not for Construction

PERMITTING QUANTITIES

Sheet	structure	cofferdam L (ft)	cofferdam Area (s.f.)	existing OHW impact Cut (cy)	existing OHW impact Fill (cy)	Wetland impact Area (s.f.)	Wetland impact Type (T/P)
14	BR-1	n/a	0	0	0	0	n/a
	BR-2	n/a	0	0	0	0	n/a
	BR-3	n/a	0	20	20	0	n/a
	TT-1	n/a	0	0	0	0	n/a
	TT-2	n/a	0	0	0	0	n/a
	TT-3	n/a	0	0	0	0	n/a
	TT-4	n/a	0	0	0	0	n/a
	FP-1	n/a	0	0	0	0	n/a
	FP-2	n/a	0	0	0	0	n/a
	FP-3	n/a	0	0	0	0	n/a
	FP-4	n/a	0	0	0	0	n/a
	BR-4	n/a	0	35	35	0	n/a
	BR-5	n/a	0	0	0	0	n/a
	BR-6	n/a	0	50	50	0	n/a
	BR-7	n/a	0	25	25	0	n/a
	BR-8	n/a	0	50	50	0	n/a
	BR-9	n/a	0	25	25	0	n/a
	BR-10	n/a	0	0	0	0	n/a
	BR-11	n/a	0	5	5	0	n/a
	Apex-1	87	1025	100	100	0	n/a
	M-1	n/a	0	0	0	0	n/a
	Inlet-1	n/a	0	0	0	1083	permanent
	BB-1	n/a	0	0	0	914	permanent
	BB-2	n/a	0	0	0	369	permanent
	BB-3	n/a	0	0	0	0	n/a
	BB-4	n/a	0	0	0	0	n/a
	Apex-2	80	970	60	60	0	n/a
	LFRL-1	n/a	0	0	0	0	n/a
	LFRL-2	n/a	0	0	0	0	n/a
	LFHC-1	n/a	0	0	0	0	n/a
	LFRL-3	n/a	0	0	0	0	n/a
	LFFP-1	n/a	0	0	0	0	n/a
	LFFP-2	n/a	0	0	0	0	n/a
	LFRL-4	n/a	0	0	0	0	n/a
	LFHC-2	n/a	0	0	0	0	n/a
	LFRL-5	n/a	0	0	0	0	n/a
	LFFP-3	n/a	0	0	0	0	n/a
	LFFP-4	n/a	0	0	0	0	n/a
	LFHC-3	n/a	0	0	0	0	n/a
	LFRL-6	n/a	0	0	0	0	n/a
	LFHC-4	n/a	0	0	0	0	n/a
	LFRL-7	n/a	0	0	0	0	n/a
	LFHC-5	n/a	0	0	0	0	n/a
	LFHC-6	n/a	0	0	0	0	n/a

Sheet	structure	cofferdam L (ft)	cofferdam Area (s.f.)	existing OHW impact Cut (cy)	existing OHW impact Fill (cy)	Wetland impact Area (s.f.)	Wetland impact Type (T/P)
15	BR-12	n/a	0	25	25	0	n/a
	BR-13	n/a	0	3	3	0	n/a
	Apex-3	142	2555	300	300	0	0
	BB-5	59	411	10	10	0	0
	BR-14	n/a	0	8	8	0	n/a
	Inlet-2	61	403	0	0	0	0
	BR-15	n/a	0	0	0	0	n/a
	SM_BB-1	68	449	0	0	0	n/a
	SM_BB-2	60	505	0	0	0	n/a
	BR-16	n/a	0	0	0	0	n/a
	BR-17	n/a	0	0	0	0	n/a
	Apex-4	88	966	75	75	0	n/a
	Apex-5	119	2011	75	75	0	n/a
	Apex-6	72	703	30	30	0	n/a
	LFRL-8	n/a	0	0	0	0	n/a
	LFHC-7	n/a	0	0	0	0	n/a
	LFHC-8	n/a	0	0	0	0	n/a
	LFRL-9	n/a	0	0	0	0	n/a
	LFHC-9	n/a	0	0	0	0	n/a
	LFRL-10	n/a	0	0	0	0	n/a
	LFHC-10	n/a	0	0	0	0	n/a
	LFRL-11	n/a	0	0	0	0	n/a
	LFFP-5	n/a	0	0	0	0	n/a
	LFRL-12	n/a	0	0	0	0	n/a
	LFHC-11	n/a	0	0	0	0	n/a
	LFRL-13	n/a	0	0	0	0	n/a
	LFRL-14	n/a	0	0	0	0	n/a
	LFRL-15	n/a	0	0	0	0	n/a
	LFRL-16	n/a	0	0	0	0	n/a
	LFRL-17	n/a	0	0	0	0	n/a
	LFRL-18	n/a	0	0	0	0	n/a
	LFFP-6	n/a	0	0	0	0	n/a
	LFFP-7	n/a	0	0	0	0	n/a
	LFFP-8	n/a	0	0	0	0	n/a
	LFFP-9	n/a	0	0	0	0	n/a
	LFFP-10	n/a	0	0	0	0	n/a
	LFFP-11	n/a	0	0	0	0	n/a
16	SM_BB-3	n/a	0	0	0	1218	permanent
	SM_BB-4	n/a	0	0	0	1649	permanent
	SM_BB-5	n/a	0	0	0	414	permanent
	SM_BB-6	n/a	0	0	0	336	permanent
	SM_BB-7	n/a	0	0	0	441	permanent
	SM_BB-8	n/a	0	0	0	336	permanent
	SM_BB-9	n/a	0	0	0	485	permanent
17	DFL-1	n/a	0	0	0	0	0
	M-2	116	1754	50	50	0	0
	M-3	155	3241	50	50	0	0
	DFL-2	n/a	0	0	0	0	0
	M-4	n/a	0	0	0	0	0
	M-5	109	1570	0	0	0	0
	M-6	n/a	0	0	0	0	0
	DFL-3	n/a	0	0	0	0	0
	M-7	112	1707	0	0	0	0

HIP IV GENERAL CONSERVATION MEASURES APPLICABLE TO ALL ACTIONS

THE ACTIVITIES COVERED UNDER THE HIP ARE INTENDED TO PROTECT AND RESTORE FISH AND WILDLIFE HABITAT WITH LONG-TERM BENEFITS TO ESA-LISTED SPECIES. THE FOLLOWING GENERAL CONSERVATION MEASURES (DEVELOPED IN COORDINATION WITH USFWS AND NMFS) WILL BE APPLIED TO ALL ACTIONS OF THIS PROJECT.

PROJECT DESIGN AND SITE PREPARATION.

1. STATE AND FEDERAL PERMITS.

A. ALL APPLICABLE REGULATORY PERMITS AND OFFICIAL PROJECT AUTHORIZATIONS WILL BE OBTAINED BEFORE PROJECT IMPLEMENTATION.

B. THESE PERMITS AND AUTHORIZATIONS INCLUDE, BUT ARE NOT LIMITED TO, NATIONAL ENVIRONMENTAL POLICY ACT, NATIONAL HISTORIC PRESERVATION ACT, THE APPROPRIATE STATE AGENCY REMOVAL AND FILL PERMIT, USACE CLEAN WATER ACT (CWA) 404 PERMITS, CWA SECTION 401 WATER QUALITY CERTIFICATIONS, AND FEMA NO-RISE ANALYSES.

2. TIMING OF IN-WATER WORK.

A. APPROPRIATE STATE (OREGON DEPARTMENT OF FISH AND WILDLIFE (ODFW), WASHINGTON DEPARTMENT OF FISH AND WILDLIFE (WDFW), IDAHO DEPARTMENT OF FISH AND GAME (IDFG), AND MONTANA FISH WILDLIFE AND PARKS (MFWP)) GUIDELINES FOR TIMING OF IN-WATER WORK WINDOWS (IWW) WILL BE FOLLOWED.

B. CHANGES TO ESTABLISHED WORK WINDOWS WILL BE APPROVED BY REGIONAL STATE BIOLOGISTS AND BPA'S EC LEAD.

C. BULL TROUT. FOR AREAS WITH DESIGNATED IN-WATER WORK WINDOWS FOR BULL TROUT OR AREAS KNOWN TO HAVE BULL TROUT, PROJECT PROPONENTS WILL CONTACT THE APPROPRIATE USFWS FIELD OFFICE TO INSURE THAT ALL REASONABLE IMPLEMENTATION MEASURES ARE CONSIDERED AND AN APPROPRIATE IN-WATER WORK WINDOW IS BEING USED TO MINIMIZE PROJECT EFFECTS.

D. LAMPREY. WORKING IN STREAM OR RIVER CHANNELS THAT CONTAIN PACIFIC LAMPREY WILL BE AVOIDED FROM MARCH 1 TO JULY 1 FOR REACHES <5,000 FEET IN ELEVATION AND FROM MARCH 1 TO AUGUST 1 FOR REACHES >5,000 FEET. IF EITHER TIMEFRAME IS INCOMPATIBLE WITH OTHER OBJECTIVES, THE AREA WILL BE SURVEYED FOR NESTS AND LAMPREY PRESENCE, AND AVOIDED IF POSSIBLE. IF LAMPREYS ARE KNOWN TO EXIST, THE PROJECT SPONSOR WILL UTILIZE DEWATERING AND SALVAGE PROCEDURES (SEE FISH SALVAGE AND ELECTROFISHING SECTIONS) TO MINIMIZE ADVERSE EFFECTS.

E. THE IN-WATER WORK WINDOW WILL BE PROVIDED IN THE CONSTRUCTION PLANS.

3. CONTAMINANTS.

A. EXCAVATION OF MORE THAN 20 CUBIC YARDS WILL REQUIRE A SITE VISIT AND DOCUMENTED ASSESSMENT FOR POTENTIAL CONTAMINANT SOURCES. THE SITE ASSESSMENT WILL BE STORED WITH PROJECT FILES OR AS AN APPENDIX TO THE BASIS OF DESIGN REPORT.

B. THE SITE ASSESSMENT WILL SUMMARIZE:

1. THE SITE VISIT, CONDITION OF THE PROPERTY, AND IDENTIFICATION OF ANY AREAS USED FOR VARIOUS INDUSTRIAL PROCESSES;
2. AVAILABLE RECORDS, SUCH AS FORMER SITE USE, BUILDING PLANS, AND RECORDS OF ANY PRIOR CONTAMINATION EVENTS;
3. INTERVIEWS WITH KNOWLEDGEABLE PEOPLE, SUCH AS SITE OWNERS, OPERATORS, OCCUPANTS, NEIGHBORS, OR LOCAL GOVERNMENT OFFICIALS; AND
4. THE TYPE, QUANTITY, AND EXTENT OF ANY POTENTIAL CONTAMINATION SOURCES.

4. SITE LAYOUT AND FLAGGING.

A. CONSTRUCTION AREAS TO BE CLEARLY FLAGGED PRIOR TO CONSTRUCTION.

B. AREAS TO BE FLAGGED WILL INCLUDE:

1. SENSITIVE RESOURCE AREAS, SUCH AS AREAS BELOW ORDINARY HIGH WATER, SPAWNING AREAS, SPRINGS, AND WETLANDS;
2. EQUIPMENT ENTRY AND EXIT POINTS;
3. ROAD AND STREAM CROSSING ALIGNMENTS;
4. STAGING, STORAGE, AND STOCKPILE AREAS; AND
5. NO-SPRAY AREAS AND BUFFERS.

5. TEMPORARY ACCESS ROADS AND PATHS.

A. EXISTING ACCESS ROADS AND PATHS WILL BE PREFERENTIALLY USED WHENEVER REASONABLE, AND THE NUMBER AND LENGTH OF TEMPORARY ACCESS ROADS AND PATHS THROUGH RIPARIAN AREAS AND FLOODPLAINS WILL BE MINIMIZED.

B. VEHICLE USE AND HUMAN ACTIVITIES, INCLUDING WALKING, IN AREAS OCCUPIED BY TERRESTRIAL ESA-LISTED SPECIES WILL BE MINIMIZED.

C. TEMPORARY ACCESS ROADS AND PATHS WILL NOT BE BUILT ON SLOPES WHERE GRADE, SOIL, OR OTHER FEATURES SUGGEST A LIKELIHOOD OF EXCESSIVE EROSION OR FAILURE. IF SLOPES ARE STEEPER THAN 30%, THEN THE ROAD WILL BE DESIGNED BY A CIVIL ENGINEER WITH EXPERIENCE IN STEEP ROAD DESIGN.

D. THE REMOVAL OF RIPARIAN VEGETATION DURING CONSTRUCTION OF TEMPORARY ACCESS ROADS WILL BE MINIMIZED. WHEN TEMPORARY VEGETATION REMOVAL IS REQUIRED, VEGETATION WILL BE CUT AT GROUND LEVEL (NOT GRUBBED).

E. AT PROJECT COMPLETION, ALL TEMPORARY ACCESS ROADS AND PATHS WILL BE OBLITERATED, AND THE SOIL WILL BE STABILIZED AND REVEGETATED. ROAD AND PATH OBLITERATION REFERS TO THE MOST COMPREHENSIVE DEGREE OF DECOMMISSIONING AND INVOLVES DECOMPACTING THE SURFACE AND DITCH, PULLING THE FILL MATERIAL ONTO THE RUNNING SURFACE, AND RESHAPING TO MATCH THE ORIGINAL CONTOUR.

F. HELICOPTER FLIGHT PATTERNS WILL BE ESTABLISHED IN ADVANCE AND LOCATED TO AVOID TERRESTRIAL ESA-LISTED SPECIES AND THEIR OCCUPIED HABITAT DURING SENSITIVE LIFE STAGES.

6. TEMPORARY STREAM CROSSINGS.

A. EXISTING STREAM CROSSINGS OR BEDROCK WILL BE PREFERENTIALLY USED WHENEVER REASONABLE, AND THE NUMBER OF TEMPORARY STREAM CROSSINGS WILL BE MINIMIZED.

B. TEMPORARY BRIDGES AND CULVERTS WILL BE INSTALLED TO ALLOW FOR EQUIPMENT AND VEHICLE CROSSING OVER PERENNIAL STREAMS DURING CONSTRUCTION. TREATED WOOD SHALL NOT BE USED ON TEMPORARY BRIDGE CROSSINGS OR IN LOCATIONS IN CONTACT WITH OR DIRECTLY OVER WATER.

C. FOR PROJECTS THAT REQUIRE EQUIPMENT AND VEHICLES TO CROSS IN THE WET:

1. THE LOCATION AND NUMBER OF ALL WET CROSSINGS SHALL BE APPROVED BY THE OWNER;
2. ONLY TRACKED EQUIPMENT SHALL CROSS THE STREAM;
3. VEHICLES AND MACHINERY SHALL CROSS STREAMS AT RIGHT ANGLES TO THE MAIN CHANNEL WHENEVER POSSIBLE;
4. NO STREAM CROSSINGS WILL OCCUR 300 FEET UPSTREAM OR 100 FEET DOWNSTREAM OF AN EXISTING REDD OR SPAWNING FISH; AND
5. AFTER PROJECT COMPLETION, TEMPORARY STREAM CROSSINGS WILL BE OBLITERATED AND BANKS RESTORED.

7. STAGING, STORAGE, AND STOCKPILE AREAS.

A. STAGING AREAS (USED FOR CONSTRUCTION EQUIPMENT STORAGE, VEHICLE STORAGE, FUELING, SERVICING, AND HAZARDOUS MATERIAL STORAGE) WILL BE 150 FEET OR MORE FROM ANY NATURAL WATER BODY OR WETLAND. STAGING AREAS CLOSER THAN 150 FEET WILL BE APPROVED BY THE EC LEAD.

B. NATURAL MATERIALS USED FOR IMPLEMENTATION OF AQUATIC RESTORATION, SUCH AS LARGE WOOD, GRAVEL, AND BOULDERS, MAY BE STAGED WITHIN 150 FEET IF CLEARLY INDICATED IN THE PLANS THAT AREA IS FOR NATURAL MATERIALS ONLY.

C. ANY LARGE WOOD, TOPSOIL, AND NATIVE CHANNEL MATERIAL DISPLACED BY CONSTRUCTION WILL BE STOCKPILED FOR USE DURING SITE RESTORATION AT A SPECIFICALLY IDENTIFIED AND FLAGGED AREA.

D. ANY MATERIAL NOT USED IN RESTORATION, AND NOT NATIVE TO THE FLOODPLAIN, WILL BE DISPOSED OF OUTSIDE THE 100-YEAR FLOODPLAIN.

8. EQUIPMENT.

A. MECHANIZED EQUIPMENT AND VEHICLES WILL BE SELECTED, OPERATED, AND MAINTAINED IN A MANNER THAT MINIMIZES ADVERSE EFFECTS ON THE ENVIRONMENT (E.G., MINIMALLY-SIZED, LOW PRESSURE TIRES; MINIMAL HARD-TURN PATHS FOR TRACKED VEHICLES; TEMPORARY MATS OR PLATES WITHIN WET AREAS OR ON SENSITIVE SOILS).

B. EQUIPMENT WILL BE STORED, FUELED, AND MAINTAINED IN AN CLEARLY IDENTIFIED STAGING AREA THAT MEETS STAGING AREA CONSERVATION MEASURES.

C. EQUIPMENT WILL BE REFUELED IN A VEHICLE STAGING AREA OR IN AN ISOLATED HARD ZONE, SUCH AS A PAVED PARKING LOT OR ADJACENT, ESTABLISHED ROAD (THIS MEASURE APPLIES ONLY TO GAS-POWERED EQUIPMENT WITH TANKS LARGER THAN 5 GALLONS).

D. BIODEGRADABLE LUBRICANTS AND FLUIDS WILL BE USED ON EQUIPMENT OPERATING IN AND ADJACENT TO THE STREAM CHANNEL AND LIVE WATER.

E. EQUIPMENT WILL BE INSPECTED DAILY FOR FLUID LEAKS BEFORE LEAVING THE VEHICLE STAGING AREA FOR OPERATION WITHIN 150 FEET OF ANY NATURAL WATER BODY OR WETLAND.

F. EQUIPMENT WILL BE THOROUGHLY CLEANED BEFORE OPERATION BELOW ORDINARY HIGH WATER, AND AS OFTEN AS NECESSARY DURING OPERATION, TO REMAIN GREASE FREE.

9. EROSION CONTROL.

A. TEMPORARY EROSION CONTROL MEASURES INCLUDE:

1. TEMPORARY EROSION CONTROLS WILL BE IN PLACE BEFORE ANY SIGNIFICANT ALTERATION OF THE ACTION SITE AND APPROPRIATELY INSTALLED DOWNSLOPE OF PROJECT ACTIVITY WITHIN THE RIPARIAN BUFFER AREA UNTIL SITE REHABILITATION IS COMPLETE;
2. IF THERE IS A POTENTIAL FOR ERODED SEDIMENT TO ENTER THE STREAM, SEDIMENT BARRIERS WILL BE INSTALLED AND MAINTAINED FOR THE DURATION OF PROJECT IMPLEMENTATION;
3. TEMPORARY EROSION CONTROL MEASURES MAY INCLUDE SEDGE MATS, FIBER WATTLES, SILT FENCES, JUTE MATTING, WOOD FIBER MULCH AND SOIL BINDER, OR GEOTEXTILES AND GEOSYNTHETIC FABRIC;
4. SOIL STABILIZATION UTILIZING WOOD FIBER MULCH AND TACKIFIER (HYDRO-APPLIED) MAY BE USED TO REDUCE EROSION OF BARE SOIL IF THE MATERIALS ARE NOXIOUS WEED FREE AND NONTOXIC TO AQUATIC AND TERRESTRIAL ANIMALS, SOIL MICROORGANISMS, AND VEGETATION;
5. SEDIMENT WILL BE REMOVED FROM EROSION CONTROLS ONCE IT HAS REACHED 1/3 OF THE EXPOSED HEIGHT OF THE CONTROL; AND
6. ONCE THE SITE IS STABILIZED AFTER CONSTRUCTION, TEMPORARY EROSION CONTROL MEASURES WILL BE REMOVED.

B. EMERGENCY EROSION CONTROLS. THE FOLLOWING MATERIALS FOR EMERGENCY EROSION CONTROL WILL BE AVAILABLE AT THE WORK SITE:

1. A SUPPLY OF SEDIMENT CONTROL MATERIALS; AND
2. AN OIL-ABSORBING FLOATING BOOM WHENEVER SURFACE WATER IS PRESENT.

10. DUST ABATEMENT.

A. THE PROJECT SPONSOR WILL DETERMINE THE APPROPRIATE DUST CONTROL MEASURES BY CONSIDERING SOIL TYPE, EQUIPMENT USAGE, PREVAILING WIND DIRECTION, AND THE EFFECTS CAUSED BY OTHER EROSION AND SEDIMENT CONTROL MEASURES.

B. WORK WILL BE SEQUENCED AND SCHEDULED TO REDUCE EXPOSED BARE SOIL SUBJECT TO WIND EROSION.

C. DUST-ABATEMENT ADDITIVES AND STABILIZATION CHEMICALS (TYPICALLY MAGNESIUM CHLORIDE, CALCIUM CHLORIDE SALTS, OR LIGNINSULFONATE) WILL NOT BE APPLIED WITHIN 25 FEET OF WATER OR A STREAM CHANNEL AND WILL BE APPLIED SO AS TO MINIMIZE THE LIKELIHOOD THAT THEY WILL ENTER STREAMS. APPLICATIONS OF LIGNINSULFONATE WILL BE LIMITED TO A MAXIMUM RATE OF 0.5 GALLONS PER SQUARE YARD OF ROAD SURFACE, ASSUMING MIXED 50:50 WITH WATER.

D. APPLICATION OF DUST ABATEMENT CHEMICALS WILL BE AVOIDED DURING OR JUST BEFORE WET WEATHER, AND AT STREAM CROSSINGS OR OTHER AREAS THAT COULD RESULT IN UNFILTERED DELIVERY OF THE DUST ABATEMENT MATERIALS TO A WATERBODY (TYPICALLY THESE WOULD BE AREAS WITHIN 25 FEET OF A WATERBODY OR STREAM CHANNEL; DISTANCES MAY BE GREATER WHERE VEGETATION IS SPARSE OR SLOPES ARE STEEP).

E. SPILL CONTAINMENT EQUIPMENT WILL BE AVAILABLE DURING APPLICATION OF DUST ABATEMENT CHEMICALS.

F. PETROLEUM-BASED PRODUCTS WILL NOT BE USED FOR DUST ABATEMENT.

NO.	BY	DATE	REVISION DESCRIPTION

BPA	BPA	BPA
DRAWN	DESIGNED	CHECKED
BPA		200237
APPROVED	DATE	PROJECT

YAKAMA NATION FISHERIES
NASON CR. R.M. 3.6-4.6 FLOODPLAIN ENHANCEMENT
PHASE 2 60% DESIGN

inter-fluve
501 Portway Avenue, Suite 101
Hood River, OR 97031
541.386.9003
www.interfluve.com

Yakama Nation Fisheries
POST OFFICE BOX 151
FORT ROAD
TOPPENISH, WA 98948
(509)865-5121

HIP IV GENERAL CONSERVATION MEASURES (1 OF 3)

PROJECT DESIGN AND SITE PREPARATION (CONTINUED).

11. SPILL PREVENTION, CONTROL, AND COUNTER MEASURES.

A. A DESCRIPTION OF HAZARDOUS MATERIALS THAT WILL BE USED, INCLUDING INVENTORY, STORAGE, AND HANDLING PROCEDURES WILL BE AVAILABLE ON-SITE.

B. WRITTEN PROCEDURES FOR NOTIFYING ENVIRONMENTAL RESPONSE AGENCIES WILL BE POSTED AT THE WORK SITE.

C. SPILL CONTAINMENT KITS (INCLUDING INSTRUCTIONS FOR CLEANUP AND DISPOSAL) ADEQUATE FOR THE TYPES AND QUANTITY OF HAZARDOUS MATERIALS USED AT THE SITE WILL BE AVAILABLE AT THE WORK SITE.

D. WORKERS WILL BE TRAINED IN SPILL CONTAINMENT PROCEDURES AND WILL BE INFORMED OF THE LOCATION OF SPILL CONTAINMENT KITS.

E. ANY WASTE LIQUIDS GENERATED AT THE STAGING AREAS WILL BE TEMPORARILY STORED UNDER AN IMPERVIOUS COVER, SUCH AS A TARPAULIN, UNTIL THEY CAN BE PROPERLY TRANSPORTED TO AND DISPOSED OF AT A FACILITY THAT IS APPROVED FOR RECEIPT OF HAZARDOUS MATERIALS.

F. PUMPS USED ADJACENT TO WATER SHALL USE SPILL CONTAINMENT SYSTEMS.

12. INVASIVE SPECIES CONTROL.

A. PRIOR TO ENTERING THE SITE, ALL VEHICLES AND EQUIPMENT WILL BE POWER WASHED, ALLOWED TO FULLY DRY, AND INSPECTED TO MAKE SURE NO PLANTS, SOIL, OR OTHER ORGANIC MATERIAL ADHERES TO THE SURFACE.

B. WATERCRAFT, WADERS, BOOTS, AND ANY OTHER GEAR TO BE USED IN OR NEAR WATER WILL BE INSPECTED FOR AQUATIC INVASIVE SPECIES.

C. WADING BOOTS WITH FELT SOLES ARE NOT TO BE USED DUE TO THEIR PROPENSITY FOR AIDING IN THE TRANSFER OF INVASIVE SPECIES UNLESS DECONTAMINATION PROCEDURES HAVE BEEN APPROVED BY THE EC LEAD.

WORK AREA ISOLATION AND FISH SALVAGE.

1. WORK AREA ISOLATION.

A. ANY WORK AREA WITHIN THE WETTED CHANNEL WILL BE ISOLATED FROM THE ACTIVE STREAM WHENEVER ESA-LISTED FISH ARE REASONABLY CERTAIN TO BE PRESENT, OR IF THE WORK AREA IS LESS THAN 300-FEET UPSTREAM FROM KNOWN SPAWNING HABITATS.

B. WORK AREA ISOLATION AND FISH SALVAGE ACTIVITIES WILL COMPLY WITH THE IN-WATER WORK WINDOW.

C. DESIGN PLANS WILL INCLUDE ALL ISOLATION ELEMENTS AND AREAS (COFFER DAMS, PUMPS, DISCHARGE AREAS, FISH SCREENS, FISH RELEASE AREAS, ETC.).

D. WORK AREA ISOLATION AND FISH CAPTURE ACTIVITIES WILL OCCUR DURING PERIODS OF THE COOLEST AIR AND WATER TEMPERATURES POSSIBLE, NORMALLY EARLY IN THE MORNING VERSUS LATE IN THE DAY, AND DURING CONDITIONS APPROPRIATE TO MINIMIZE STRESS AND DEATH OF SPECIES PRESENT.

2. FISH SALVAGE.

A. MONITORING AND RECORDING WILL TAKE PLACE FOR DURATION OF SALVAGE. THE SALVAGE REPORT WILL BE COMMUNICATED TO AGENCIES VIA THE PROJECT COMPLETION FORM (PCF).

B. SALVAGE ACTIVITIES SHOULD TAKE PLACE DURING CONDITIONS TO MINIMIZE STRESS TO FISH SPECIES, TYPICALLY PERIODS OF THE COOLEST AIR AND WATER TEMPERATURES WHICH OCCUR IN THE MORNING VERSUS LATE IN THE DAY.

C. SALVAGE OPERATIONS WILL FOLLOW THE ORDERING, METHODS, AND CONSERVATION MEASURES SPECIFIED BELOW:

1. SLOWLY REDUCE WATER FROM THE WORK AREA TO ALLOW SOME FISH TO LEAVE VOLITIONALLY.
2. BLOCK NETS WILL BE INSTALLED AT UPSTREAM AND DOWNSTREAM LOCATIONS AND MAINTAINED IN A SECURED POSITION TO EXCLUDE FISH FROM ENTERING THE PROJECT AREA.
3. BLOCK NETS WILL BE SECURED TO THE STREAM CHANNEL BED AND BANKS UNTIL FISH CAPTURE AND TRANSPORT ACTIVITIES ARE COMPLETE. BLOCK NETS MAY BE LEFT IN PLACE FOR THE DURATION OF THE PROJECT TO EXCLUDE FISH AS LONG AS PASSAGE REQUIREMENTS ARE MET.
4. NETS WILL BE MONITORED HOURLY DURING IN-STREAM DISTURBANCE.
5. IF BLOCK NETS REMAIN IN PLACE MORE THAN ONE DAY, THE NETS WILL BE MONITORED AT LEAST DAILY TO ENSURE THEY ARE SECURED AND FREE OF ORGANIC ACCUMULATION. IF BULL TROUT ARE PRESENT, NETS ARE TO BE CHECKED EVERY 4 HOURS FOR FISH IMPINGEMENT.
6. CAPTURE FISH THROUGH SEINING AND RELOCATE TO STREAMS.
7. WHILE DEWATERING, ANY REMAINING FISH WILL BE COLLECTED BY HAND OR DIP NETS.
8. SEINES WITH A MESH SIZE TO ENSURE CAPTURE OF THE RESIDING ESA-LISTED FISH WILL BE USED.
9. MINNOW TRAPS WILL BE LEFT IN PLACE OVERNIGHT AND USED IN CONJUNCTION WITH SEINING.
10. ELECTROFISH TO CAPTURE AND RELOCATED FISH NOT CAUGHT DURING SEINING PER ELECTROFISH CONSERVATION MEASURES.
11. CONTINUE TO SLOWLY DEWATER STREAM REACH.
12. COLLECT ANY REMAINING FISH IN COLD-WATER BUCKETS AND RELOCATED TO THE STREAM.
13. LIMIT THE TIME FISH ARE IN A TRANSPORT BUCKET.
14. MINIMIZE PREDATION BY TRANSPORTING COMPARABLE SIZES IN BUCKETS.
15. BUCKET WATER TO BE CHANGED EVERY 15 MINUTES OR AERATED.
16. BUCKETS WILL BE KEPT IN SHADED AREAS OR COVERED.
17. DEAD FISH WILL NOT BE STORED IN TRANSPORT BUCKETS, BUT WILL BE LEFT ON THE STREAM BANK TO AVOID MORTALITY COUNTING ERRORS.

D. SALVAGE GUIDELINES FOR BULL TROUT, LAMPREY, MUSSELS, AND NATIVE FISH.

1. CONDUCT SITE SURVEY TO ESTIMATE SALVAGE NUMBERS.
2. PRE-SELECT SITE(S) FOR RELEASE AND/OR MUSSEL BED RELOCATION.
3. SALVAGE OF BULL TROUT WILL NOT TAKE PLACE WHEN WATER TEMPERATURES EXCEED 15 DEGREES CELSIUS.
4. IF DRAWDOWN LESS THAN 48 HOURS, SALVAGE OF LAMPREY AND MUSSELS MAY NOT BE NECESSARY IF TEMPERATURES SUPPORT SURVIVAL IN SEDIMENTS.
5. SALVAGE MUSSELS BY HAND, LOCATING BY SNORKELING OR WADING.
6. SALVAGE LAMPREY BY ELECTROFISHING (SEE ELECTROFISHING FOR LARVAL LAMPREY SETTINGS AND LARVAL LAMPREY DRY SHOCKING SETTINGS).
7. SALVAGE BONY FISH AFTER LAMPREY WITH NETS OR ELECTROFISHING (SEE ELECTROFISHING FOR APPROPRIATE SETTINGS).
8. REGULARLY INSPECT DEWATERED SITE SINCE LAMPREY LIKELY TO EMERGE AFTER DEWATERING AND MUSSELS MAY BECOME VISIBLE.
9. MUSSELS MAY BE TRANSFERRED IN COOLERS.
10. MUSSELS WILL BE PLACED INDIVIDUALLY TO ENSURE ABILITY TO BURROW INTO NEW HABITAT.

3. ELECTROFISHING.

A. INITIAL SITE SURVEY AND INITIAL SETTINGS.

1. IDENTIFY SPAWNING ADULTS AND ACTIVE REDDS TO AVOID.
2. RECORD WATER TEMPERATURE. ELECTROFISHING WILL NOT OCCUR WHEN WATER TEMPERATURES ARE ABOVE 18 DEGREES CELSIUS.
3. IF POSSIBLE, A BLOCK NET WILL BE PLACED DOWNSTREAM AND CHECKED REGULARLY TO CAPTURE STUNNED FISH THAT DRIFT DOWNSTREAM.
4. INITIAL SETTINGS WILL BE 100 VOLTS, PULSE WIDTH OF 500 MICRO SECONDS, AND PULSE RATE OF 30 HERTZ.
5. RECORDS FOR CONDUCTIVITY, WATER TEMPERATURE, AIR TEMPERATURE, ELECTROFISHING SETTINGS, ELECTROFISHER MODEL, ELECTROFISHER CALIBRATION, FISH CONDITIONS, FISH MORTALITIES, AND TOTAL CAPTURE RATES WILL BE INCLUDED IN THE SALVAGE LOG BOOK.

B. ELECTROFISHING TECHNIQUE.

1. SAMPLING WILL BEGIN USING STRAIGHT DC. POWER WILL REMAIN ON UNTIL THE FISH IS NETTED WHEN USING STRAIGHT DC. GRADUALLY INCREASE VOLTAGE WHILE REMAINING BELOW MAXIMUM LEVELS.
2. MAXIMUM VOLTAGE WILL BE 1100 VOLTS WHEN CONDUCTIVITY IS <100 MILLISECONDS, 800 VOLTS WHEN CONDUCTIVITY IS BETWEEN 100 AND 300 MILLISECONDS, AND 400 VOLTS WHEN CONDUCTIVITY IS >300 MILLISECONDS.
3. IF FISH CAPTURE IS NOT SUCCESSFUL USING STRAIGHT DC, THE ELECTROFISHER WILL BE SET TO INITIAL VOLTAGE FOR PDC. VOLTAGE, PULSE WIDTH, AND PULSE FREQUENCY WILL BE GRADUALLY INCREASED WITHIN MAXIMUM VALUES UNTIL CAPTURE IS SUCCESSFUL.
4. MAXIMUM PULSE WIDTH IS 5 MILLISECONDS. MAXIMUM PULSE RATE IS 70 HERTZ
5. ELECTROFISHING WILL NOT OCCUR IN ONE AREA FOR AN EXTENDED PERIOD.
6. THE ANODE WILL NOT INTENTIONALLY COME INTO CONTACT WITH FISH. THE ZONE FOR POTENTIAL INJURY OF 0.5 M FROM THE ANODE WILL BE AVOIDED.
7. SETTINGS WILL BE LOWERED IN SHALLOWER WATER SINCE VOLTAGE GRADIENTS LIKELY TO INCREASE.
8. ELECTROFISHING WILL NOT OCCUR IN TURBID WATER WHERE VISIBILITY IS POOR (I.E. UNABLE TO SEE THE BED OF THE STREAM).
9. OPERATIONS WILL IMMEDIATELY STOP IF MORTALITY OR OBVIOUS FISH INJURY IS OBSERVED. ELECTROFISHING SETTINGS WILL BE REEVALUATED.

C. SAMPLE PROCESSING.

1. FISH SHALL BE SORTED BY SIZE TO AVOID PREDATION DURING CONTAINMENT.
2. SAMPLERS WILL REGULARLY CHECK CONDITIONS OF FISH HOLDING CONTAINERS, AIR PUMPS, WATER TRANSFERS, ETC.
3. FISH WILL BE OBSERVED FOR GENERAL CONDITIONS AND INJURIES
4. EACH FISH WILL BE COMPLETELY REVIVED BEFORE RELEASE. ESA-LISTED SPECIES WILL BE PRIORITIZED FOR SUCCESSFUL RELEASE.

D. BULL TROUT ELECTROFISHING.

1. ELECTROFISHING FOR BULL TROUT WILL ONLY OCCUR FROM MAY 1 TO JULY 31. NO ELECTROFISHING WILL OCCUR IN ANY BULL TROUT OCCUPIED HABITAT AFTER AUGUST 15. IN FMO HABITATS ELECTROFISHING MAY OCCUR ANY TIME.
2. ELECTROFISHING OF BULL TROUT WILL NOT OCCUR WHEN WATER TEMPERATURES EXCEED 15 DEGREES CELSIUS.

E. LARVAL LAMPREY ELECTROFISHING.

1. PERMISSION FROM EC LEAD WILL BE OBTAINED IF LARVAL LAMPREY ELECTROFISHER IS NOT ONE OF FOLLOWING PRE-APPROVED MODELS: ABP-2 "WISCONSIN", SMITH-ROOT LR-24, OR SMITH-ROOT APEX BACKPACK.
2. LARVAL LAMPREY SAMPLING WILL INCORPORATE 2-STAGE METHOD: "TICKLE" AND "STUN".
3. FIRST STAGE: USE 125 VOLT DC WITH A 25 PERCENT DUTY CYCLE APPLIED AT A SLOW RATE OF 3 PULSES PER SECOND. IF TEMPERATURES ARE BELOW 10 DEGREES CELSIUS, VOLTAGE MAY BE INCREASED GRADUALLY (NOT TO EXCEED 200 VOLTS). BURSTED PULSES (THREE SLOW AND ONE SKIPPED) RECOMMENDED TO INCREASE EMERGENCE.
4. SECOND STAGE (OPTIONAL FOR EXPERIENCED NETTERS): IMMEDIATELY AFTER LAMPREY EMERGE, USE A FAST PULSE SETTING OF 30 PULSES PER SECOND.
5. USE DIP NETS FOR VISIBLE LAMPREY. SIENES AND FINE MESH NET SWEEPS MAY BE USED IN POOR VISIBILITY.

WORK AREA ISOLATION AND FISH SALVAGE (CONTINUED).

6. SAMPLING WILL OCCUR SLOWLY (>60 SECONDS PER METER) STARTING AT UPSTREAM AND WORKING DOWNSTREAM.

7. MULTIPLE SWEEPS TO OCCUR WITH 15 MINUTES BETWEEN SWEEPS.

8. POST-DRAWDOWN "DRY-SHOCKING" WILL BE APPLIED IF LARVAL LAMPREY CONTINUE TO EMERGE. ANODES TO BE PLACED ONE METER APART TO SAMPLE ONE SQUARE METER AT A TIME FOR AT LEAST 60 SECONDS. FOR TEMPERATURES LESS THAN 10 DEGREES CELSIUS, MAXIMUM VOLTAGE MAY BE GRADUALLY INCREASED TO 400 VOLTS (DRY-SHOCKING ONLY).

4. DEWATERING.

A. DEWATERING WILL OCCUR AT A RATE SLOW ENOUGH TO ALLOW SPECIES TO NATURALLY MIGRATE OUT OF THE WORK AREA.

B. WHERE A GRAVITY FEED DIVERSION IS NOT POSSIBLE, A PUMP MAY BE USED. PUMPS WILL BE INSTALLED TO AVOID REPETIVE DEWATERING AND REWATERING.

C. WHEN FISH ARE PRESENT, PUMPS WILL BE SCREENED IN ACCORDANCE WITH NMFS FISH SCREEN CRITERIA. NMFS ENGINEERING REVIEW AND APPROVAL WILL BE OBTAINED FOR PUMPS EXCEEDING 3 CUBIC FEET PER SECOND.

D. DISSIPATION OF FLOW ENERGY AT THE BYPASS OUTFLOW WILL BE PROVIDED TO PREVENT DAMAGE TO THE STREAM CHANNEL AND RIPARIAN VEGETATION.

E. SEEPAGE WATER WILL BE PUMPED TO A TEMPORARY STORAGE AND TREATMENT SITE OF INTO UPLAND AREAS TO ALLOW WATER TO PERCOLATE THROUGH SOIL AND VEGETATION PRIOR TO REENTERING THE STREAM CHANNEL.

CONSTRUCTION AND POST CONSTRUCTION CONSERVATION MEASURES.

1. FISH PASSAGE.

A. FISH PASSAGE WILL BE PROVIDED FOR ADULT AND JUVENILE FISH LIKELY TO BE PRESENT DURING CONSTRUCTION UNLESS PASSAGE DID NOT EXIST BEFORE CONSTRUCTION, THE STREAM IS NATURALLY IMPASSABLE, OR PASSAGE WILL NEGATIVELY IMPACT ESA-LISTED SPECIES OR THEIR HABITAT.

B. FISH PASSAGE ALTERNATIVES WILL BE APPROVED BY THE OWNER UNDER ADVISEMENT BY THE NMFS HABITAT BIOLOGIST.

2. CONSTRUCTION AND DISCHARGE WATER.

A. SURFACE WATER MAY BE DIVERTED TO MEET CONSTRUCTION NEEDS ONLY IF DEVELOPED SOURCES ARE UNAVAILABLE OR INADEQUATE.

B. DIVERSIONS WILL NOT EXCEED 10% OF THE AVAILABLE FLOW.

C. CONSTRUCTION DISCHARGE WATER WILL BE COLLECTED AND TREATED TO REMOVE DEBRIS, NUTRIENTS, SEDIMENT, PETROLEUM HYDROCARBONS, METALS, AND OTHER POLLUTANTS.

3. TIME AND EXTENT OF DISTURBANCE.

A. EARTHWORK REQUIRING IN-STREAM MECHANIZED EQUIPMENT (INCLUDING DRILLING, EXCAVATION, DREDGING, FILLING, AND COMPACTING) WILL BE COMPLETED AS QUICKLY AS POSSIBLE.

B. MECHANIZED EQUIPMENT WILL WORK FROM TOP OF BANK UNLESS WORK FROM ANOTHER LOCATION WILL RESULT IN LESS HABITAT DISTURBANCE (TURBIDITY, VEGETATION DISTURBANCE, ETC.).

4. CESSATION OF WORK.

A. PROJECT OPERATIONS WILL CEASE WHEN HIGH FLOW CONDITIONS MAY RESULT IN INUNDATION OF THE PROJECT AREA (FLOOD EFFORTS TO DECREASE DAMAGES TO NATURAL RESOURCES PERMITTED).

B. WATER QUALITY LEVELS EXCEEDED. SEE CWA SECTION 401 WATER QUALITY CERTIFICATION AND TURBIDITY MEASURES.

5. SITE RESTORATION.

A. DISTURBED AREAS, STREAM BANKS, SOILS, AND VEGETATION WILL BE CLEANED UP AND RESTORED TO IMPROVED OR PRE-PROJECT CONDITIONS.

B. PROJECT-RELATED WASTE WILL BE REMOVED.

C. TEMPORARY ACCESS ROADS AND STAGING WILL BE DECOMPACTED AND RESTORED. SOILS WILL BE LOOSENED IF NEEDED FOR REVEGETATION OR WATER INFILTRATION.

D. THE PROJECT SPONSOR WILL RETAIN THE RIGHT OF REASONABLE ACCESS TO THE SITE TO MONITOR AND MAINTAIN THE SITE OVER THE LIFE OF THE PROJECT.

6. REVEGETATION.

A. PLANTING AND SEEDING WILL OCCUR PRIOR TO OR AT THE BEGINNING OF THE FIRST GROWING SEASON AFTER CONSTRUCTION.

B. A MIX OF NATIVE SPECIES (INVASIVE SPECIES NOT ALLOWED) APPROPRIATE TO THE SITE WILL BE USED TO REESTABLISH VEGETATION, PROVIDE SHADE, AND REDUCE EROSION. REESTABLISHED VEGETATION SHOULD BE AT LEAST 70% OF PRE-PROJECT CONDITIONS WITHIN THREE YEARS.

C. VEGETATION SUCH AS WILLOWS, SEDGES, OR RUSH MATS WILL BE SALVAGED FROM DISTURBED OR ABANDONED AREAS TO BE REPLANTED.

D. SHORT-TERM STABILIZATION MEASURE MAY INCLUDE THE USE OF NON-NATIVE STERILE SEED MIX (WHEN NATIVE NOT AVAILABLE), WEED-FREE CERTIFIED STRAW, OR OTHER SIMILAR TECHNIQUES.

E. SURFACE FERTILIZER WILL NOT BE APPLIED WITHIN 50 FEET OF ANY STREAM, WATE BODY, OR WETLAND.

F. FENCING WILL BE INSTALLED AS NECESSARY TO PREVENT ACCESS TO REVEGETATED SITES BY LIVESTOCK OR UNAUTHORIZED PERSONS.

G. INVASIVE PLANTS WILL BE REMOVED OR CONTROLLED UNTIL NATIVE PLANT SPECIES ARE WELL ESTABLISHED (TYPICALLY THREE YEARS POST-CONSTRUCTION).

7. SITE ACCESS AND IMPLEMENTATION MONITORING.

A. THE PROJECT SPONSOR WILL PROVIDE CONSTRUCTION MONITORING DURING IMPLEMENTATION TO ENSURE ALL CONSERVATION MEASURES ARE ADEQUATELY FOLLOWED, EFFECTS TO LISTED SPECIES ARE NOT GREATER THAN PREDICTED, AND INCIDENTAL TAKE LIMITATIONS ARE NOT EXCEEDED.

B. THE PROJECT SPONSOR OR DESIGNATED REPRESENTATIVE WILL SUBMIT THE PROJECT COMPLETION FORM (PCF) WITHIN 30 DAYS OF PROJECT COMPLETION.

8. CWA SECTION 401 WATER QUALITY CERTIFICATION.

A. THE PROJECT SPONSOR OR DESIGNATED REPRESENTATIVE WILL COMPLETE AND RECORD WATER QUALITY OBSERVATIONS (SEE TURBIDITY MONITORING) TO ENSURE IN-WATER WORK IS NOT DEGRADING WATER QUALITY.

B. DURING CONSTRUCTION, WATER QUALITY PROVISIONS PROVIDED BY THE OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY, WASHINGTON DEPARTMENT OF ECOLOGY, IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY WILL BE FOLLOWED.

STAGED REWATERING PLAN.

A. WHEN REINTRODUCING WATER TO DEWATERED AREAS AND NEWLY CONSTRUCTED CHANNELS, A STAGED REWATERING PLAN WILL BE APPLIED.

B. THE FOLLOWING WILL BE APPLIED TO ALL REWATERING EFFORTS. COMPLEX REWATERING EFFORTS MAY REQUIRE ADDITIONAL NOTES OR A DEDICATED SHEET IN THE CONSTRUCTION DETAILS.

1. TURBIDITY MONITORING PROTOCOL WILL BE APPLIED TO REWATERING EFFORTS.

2. PRE-WASH THE AREA BEFORE REWATERING. TURBID WASH WATER WILL BE DETAINED AND PUMPED TO THE FLOODPLAIN OR SEDIMENT CAPTURE AREAS RATHER THAN DISCHARGING TO FISH-BEARING STREAMS.

3. INSTALL SEINE NETS AT UPSTREAM END TO PREVENT FISH FROM MOVING DOWNSTREAM UNTIL 2/3 OF TOTAL FLOW IS RESTORED TO THE CHANNEL.

4. STARTING IN EARLY MORNING INTRODUCE 1/3 OF NEW CHANNEL FLOW OVER PERIOD OF 1-2 HOURS.

5. INTRODUCE SECOND THIRD OF FLOW OVER NEXT 1 TO 2 HOURS AND BEGIN FISH SALVAGE OF BYPASS CHANNEL IF FISH ARE PRESENT.

6. REMOVE UPSTREAM SEINE NETS ONCE 2/3 FLOW IN REWATERED CHANNEL AND DOWNSTREAM TURBIDITY IS WITHIN ACCEPTABLE RANGE (LESS THAN 40 NTU OR LESS THAN 10% BACKGROUND).

7. INTRODUCE FINAL THIRD OF FLOW ONCE FISH SALVAGE EFFORTS ARE COMPLETE AND DOWNSTREAM TURBIDITY VERIFIED TO BE WITHIN ACCEPTABLE RANGE.

8. INSTALL PLUG TO BLOCK FLOW INTO OLD CHANNEL OR BYPASS. REMOVE ANY REMAINING SEINE NETS.

9. IN LAMPREY SYSTEMS, LAMPREY SALVAGE AND DRY SHOCKING MAY BE NECESSARY.

TURBIDITY MONITORING.

A. RECORD THE READING, LOCATION, AND TIME FOR THE BACKGROUND READING APPROXIMATELY 100 FEET UPSTREAM OF THE PROJECT AREA USING A RECENTLY CALIBRATED TURBIDIMETER OR VIA VISUAL OBSERVATION (SEE THE HIP HANDBOOK TURBIDITY MONITORING SECTION FOR A VISUAL OBSERVATION KEY).

B. RECORD THE TURBIDITY READING, LOCATION, AND TIME AT THE MEASUREMENT COMPLIANCE LOCATION POINT.

1. 50 FEET DOWNSTREAM FOR STREAMS LESS THAN 30 FEET WIDE.

2. 100 FEET DOWNSTREAM FOR STREAMS BETWEEN 30 AND 100 FEET WIDE.

3. 200 FEET DOWNSTREAM FOR STREAMS GREATER THAN 100 FEET WIDE.

4. 300 FEET FROM THE DISCHARGE POINT OR NONPOINT SOURCE FOR LOCATIONS SUBJECT TO TIDAL OR COASTAL SCOUR.

C. TURBIDITY SHALL BE MEASURED (BACKGROUND LOCATION AND COMPLIANCE POINTS) EVERY 4 HOURS WHILE WORK IS BEING IMPLEMENTED.

D. IF THERE IS A VISIBLE DIFFERENCE BETWEEN A COMPLIANCE POINT AND THE BACKGROUND, THE EXCEEDANCE WILL BE NOTED IN THE PROJECT COMPLETION FORM (PCF). ADJUSTMENTS OR CORRECTIVE MEASURES WILL BE TAKEN IN ORDER TO REDUCE TURBIDITY.

E. IF EXCEEDANCES OCCUR FOR MORE THAN TWO CONSECUTIVE MONITORING INTERVALS (AFTER 8 HOURS), THE ACTIVITY WILL STOP UNTIL THE TURBIDITY LEVEL RETURNS TO BACKGROUND. THE OWNER WILL BE NOTIFIED OF ALL EXCEEDANCES AND CORRECTIVE ACTIONS AT PROJECT COMPLETION.

F. IF TURBIDITY CONTROLS (COFFER DAMS, WADDLES, FENCING, ETC.) ARE DETERMINED INEFFECTIVE, CREWS WILL BE MOBILIZED TO MODIFY AS NECESSARY. OCCURRENCES WILL BE DOCUMENTED IN THE PROJECT COMPLETION FORM (PCF).

G. FINAL TURBIDITY READINGS, EXCEEDANCES, AND CONTROL FAILURES WILL BE SUBMITTED TO THE OWNER USING THE PROJECT COMPLETION FORM (PCF).

Preliminary
Not for Construction

NO.	BY	DATE	REVISION DESCRIPTION

BPA DRAWN | BPA DESIGNED | BPA CHECKED
BPA APPROVED | DATE | 200237 PROJECT

YAKAMA NATION FISHERIES
NASON CR. R.M. 3.6-4.6 FLOODPLAIN ENHANCEMENT
PHASE 2 60% DESIGN

inter-fluve
501 Portway Avenue, Suite 101
Hood River, OR 97031
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Yakama Nation Fisheries
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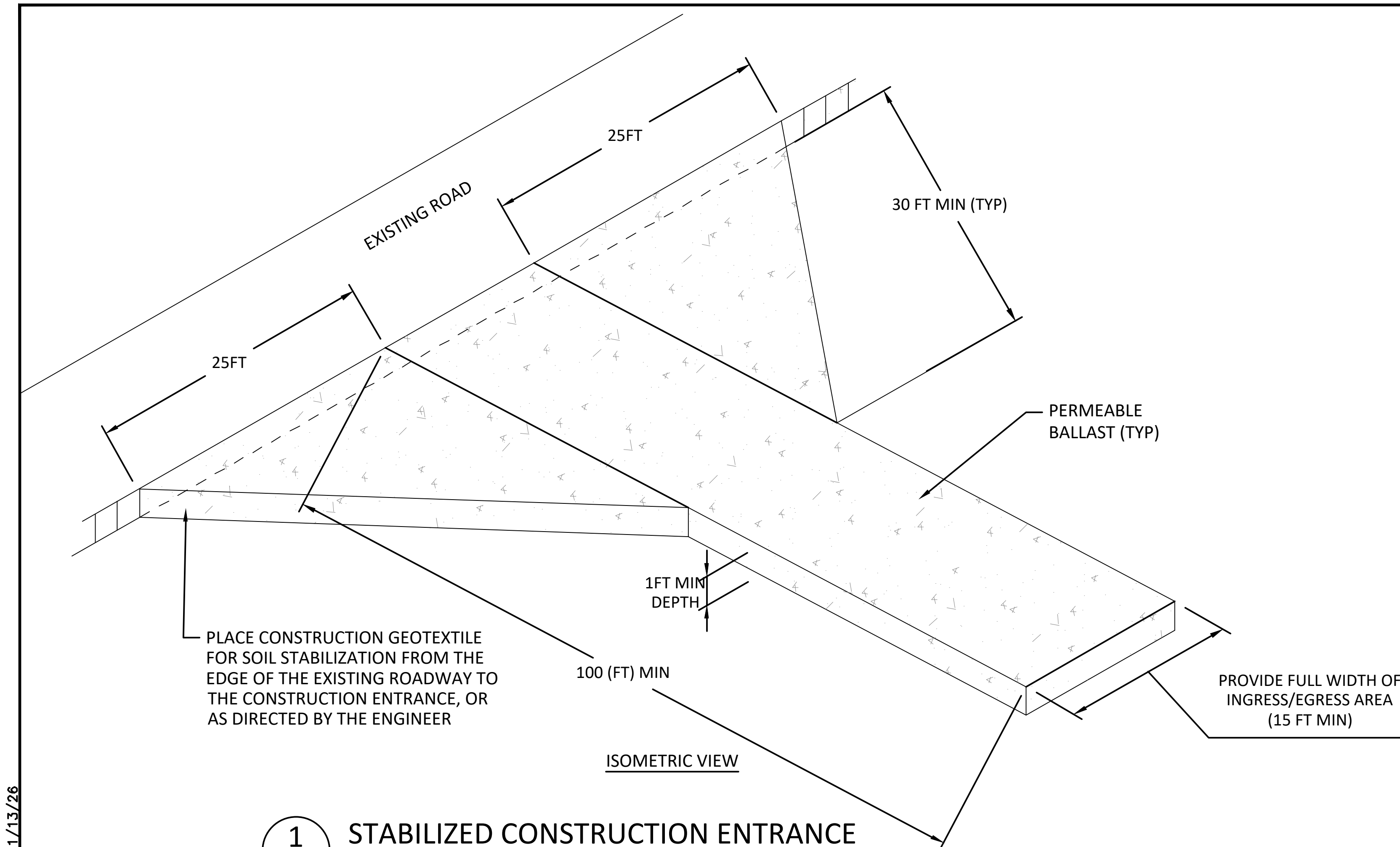
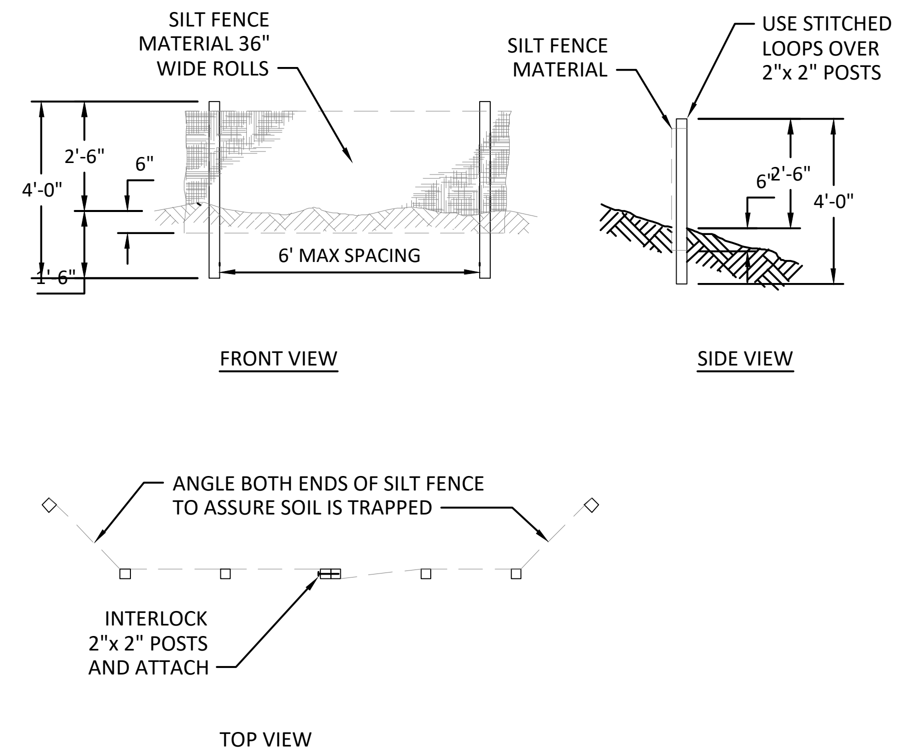
HIP IV GENERAL CONSERVATION MEASURES (3 OF 3)



1/9 STABILIZED CONSTRUCTION ENTRANCE

NOT TO SCALE



3/9 TYPICAL SILT FENCE DETAIL

NOT TO SCALE

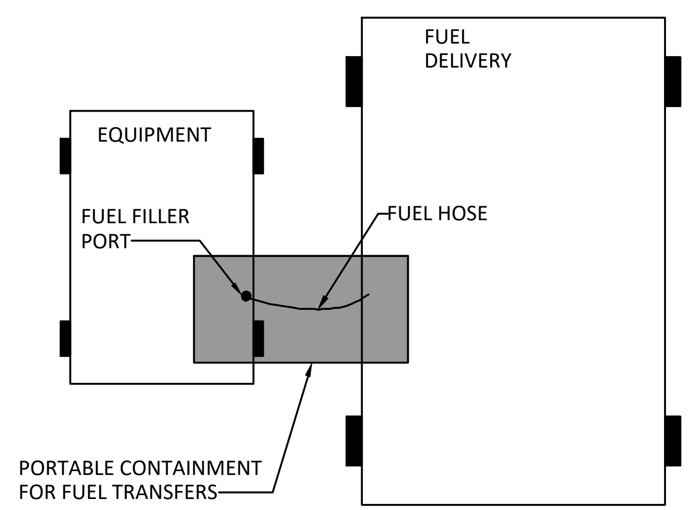
SILT FENCES:

1. THE SILT FENCE SHALL BE PURCHASED IN A CONTINUOUS ROLL CUT TO THE LENGTH OF THE BARRIER TO AVOID USE OF JOINTS. WHEN JOINTS ARE NECESSARY, SILT FENCE SHALL BE SPLICED TOGETHER ONLY AT A SUPPORT POST, WITH A MINIMUM 6 INCH OVERLAP, AND BOTH ENDS SECURELY FASTENED TO THE POST. ALTERNATIVELY, OVERLAP AND INTERLOCK TWO POSTS WITH ATTACHED FABRIC AS REQUIRED TO MEET APPLICABLE REGULATIONS.
2. THE SILT FENCE IS TO BE INSTALLED AT LOCATIONS SHOWN ON THE PLAN ALONG THE DOWNHILL PERIMETER OF CONSTRUCTION AREAS. THE FENCE POSTS SHALL BE SPACED A MAXIMUM OF 6 FEET APART AND DRIVEN SECURELY INTO THE GROUND A MINIMUM OF 24 INCHES.
3. THE SILT FENCE SHALL HAVE A MINIMUM VERTICAL BURIAL OF 6 INCHES. ALL EXCAVATED MATERIAL FROM SILT FENCE INSTALLATION SHALL BE BACK-FILLED AND COMPACTED ALONG THE ENTIRE DISTURBED AREA.
4. STANDARD OR HEAVY DUTY SILT FENCE SHALL HAVE MANUFACTURED STITCHED LOOPS FOR 2 INCHES X 2 INCHES POST INSTALLATION.
5. SILT FENCES SHALL BE REMOVED WHEN THEY HAVE SERVED THEIR USEFUL PURPOSE, BUT NOT BEFORE THE UPSLOPE AREA HAS BEEN PERMANENTLY PROTECTED AND STABILIZED, OR AS DIRECTED BY OWNER'S REPRESENTATIVE.

FUELING NOTES:

CONTRACTOR SHALL PROVIDE ADDITIONAL PROTECTION MEASURES AGAINST FUEL SPILLS WHEN REFUELING AREA IS WITHIN 150 FT OF A WETLAND AND THE RIVER. ADDITION PROTECTION MEASURES SHALL CONSIST OF:

1. CONTAINMENT EQUIPMENT SIZED TO CONTAIN THE MOST LIKELY VOLUME OF FUEL SPILLED DURING A FUEL TRANSFER.
2. PORTABLE CONTAINMENT EQUIPMENT SHALL BE POSITIONED TO CATCH ANY FUEL SPILLS DUE TO OVERFILLING THE EQUIPMENT AND ANY OTHER SPILLS THAT MAY OCCUR AT OR NEAR THE FUEL FILLER PORT TO THAT EQUIPMENT DURING EACH REFUELING ACTIVITY.
3. PERSONNEL MUST ATTEND TO THE FUELING PROCESS TO ENSURE THAT ANY SPILLS WILL BE OF LIMITED VOLUME.



2/9 FUELING AREA PROTECTION

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DM APPROVED | 01/13/2026 DATE | 200237 PROJECT

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TYPICAL DETAILS - EROSION CONTROL AND ENVIRONMENTAL PROTECTIONS

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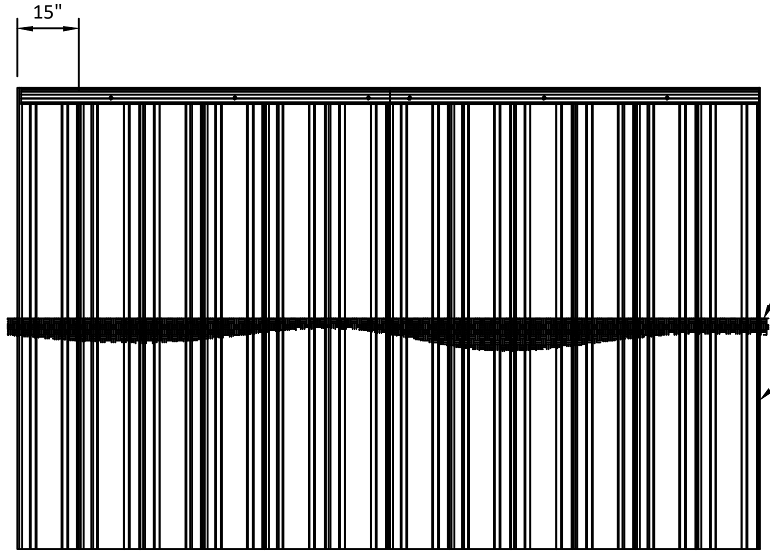
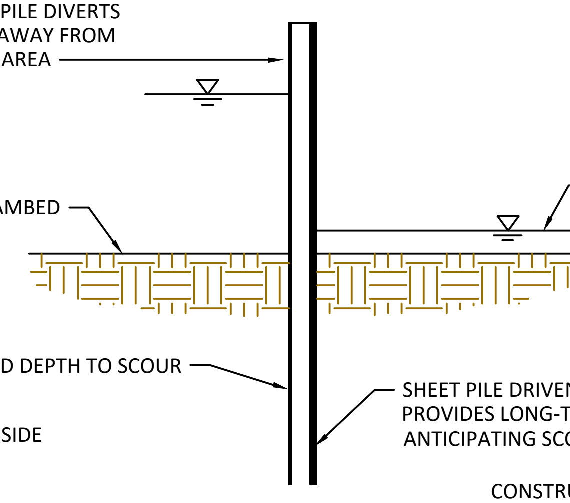


NOTE:
INDIVIDUAL SHEET WEIGHT 45 LBS PER LINEAR FOOT

ELEVATION



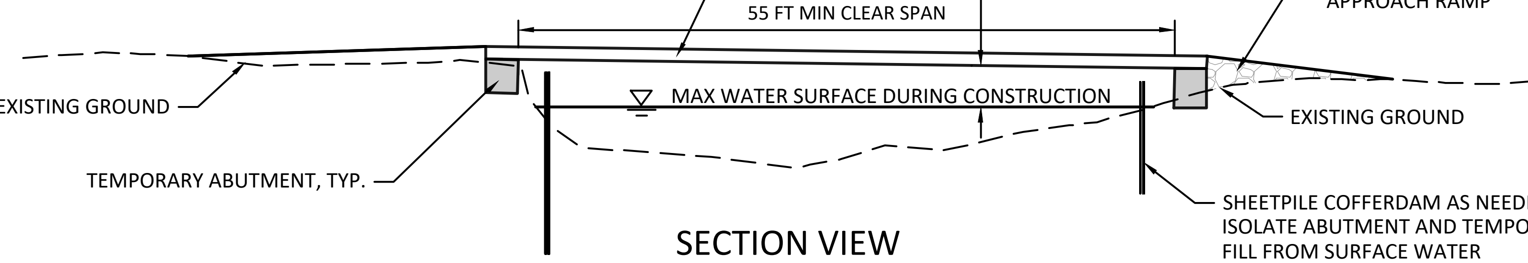
SECTION

1/10 TYPICAL DETAIL - SHEET PILE COFFERDAM

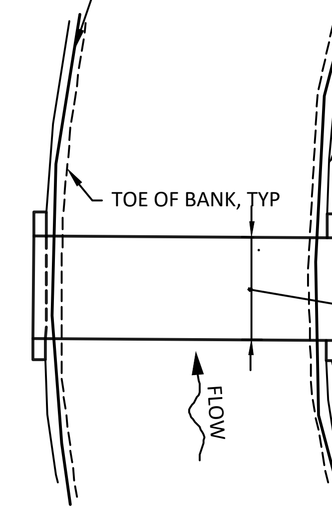
NOT TO SCALE

COFFERDAM NOTES:

1. TEMPORARY SHEET PILE IS REQUIRED TO ISOLATE CONSTRUCTION WATER FROM THE WATERWAY.
2. CONTRACTOR SHALL PROVIDE PUMPING SUFFICIENT FOR A NET INFLOW TO THE WORK AREA, AND DISCHARGE TURBID WATER TO UPLAND FLOODPLAIN.
3. COFFERDAM AND ALL MATERIALS SHALL BE COMPLETELY REMOVED FROM THE SITE AFTER CONSTRUCTION IS COMPLETED AND TURBIDITY HAS BEEN REMOVED.



SECTION VIEW



PLAN VIEW

NOTES:

1. TEMPORARY BRIDGE, ABUTMENTS, CLEAN GRAVEL/COBBLE FILL SHALL BE REMOVED AT PROJECT COMPLETION AND SITE RESTORED TO EXISTING GRADE AND CONDITIONS.
2. BRIDGE INSTALLATION AND REMOVAL, INCLUDING ABUTMENTS, SHALL BE ACCOMPLISHED WITH NO MORE THAN FOUR (4) EQUIPMENT CROSSINGS THROUGH THE CHANNEL.

2/10 TYPICAL DETAIL - TEMPORARY CROSSING

NOT TO SCALE

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DM	01/13/2026	200237

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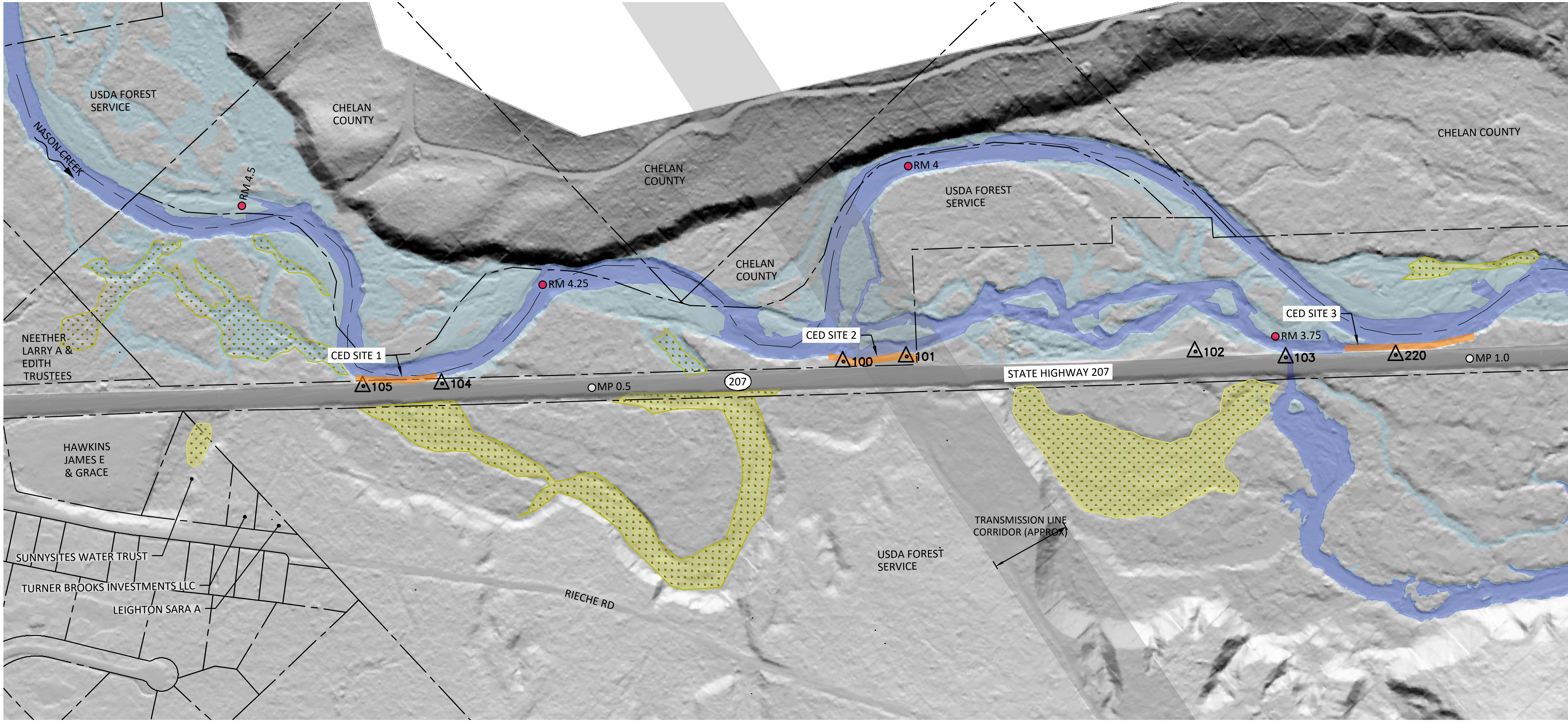
TYPICAL DETAILS - DIVERSION COFFERDAMS & TEMPORARY CROSSING



LEGEND

- APPROXIMATE 1.5-YEAR EVENT FLOW INUNDATION LIMITS FOR EXISTING CONDITIONS
- APPROXIMATE ORDINARY HIGH WATER
- EXISTING WETLANDS
- WSDOT CHRONIC ENVIRONMENT DEFICIENCY SITE (CED)
- TAXLOTS
- RM XX — NASON CREEK RIVER MILE
- MP XX — HIGHWAY 207 MILEPOST
- 100 — SURVEY CONTROL POINT

SURVEY CONTROL

Point #	Northing	Easting	Elevation	Description
220	279771.70	1666807.18	1945.45	NAIL
100	278552.01	1665695.91	1954.74	REBAR
101	278700.56	1665813.38	1952.82	STAKE
102	279340.25	1666390.48	1947.28	NAIL
103	279526.92	1666588.17	1946.14	REBAR
104	277630.52	1664927.19	1964.70	REBAR
105	277452.23	1664772.04	1966.58	REBAR

0 300 600
SCALE IN FEET

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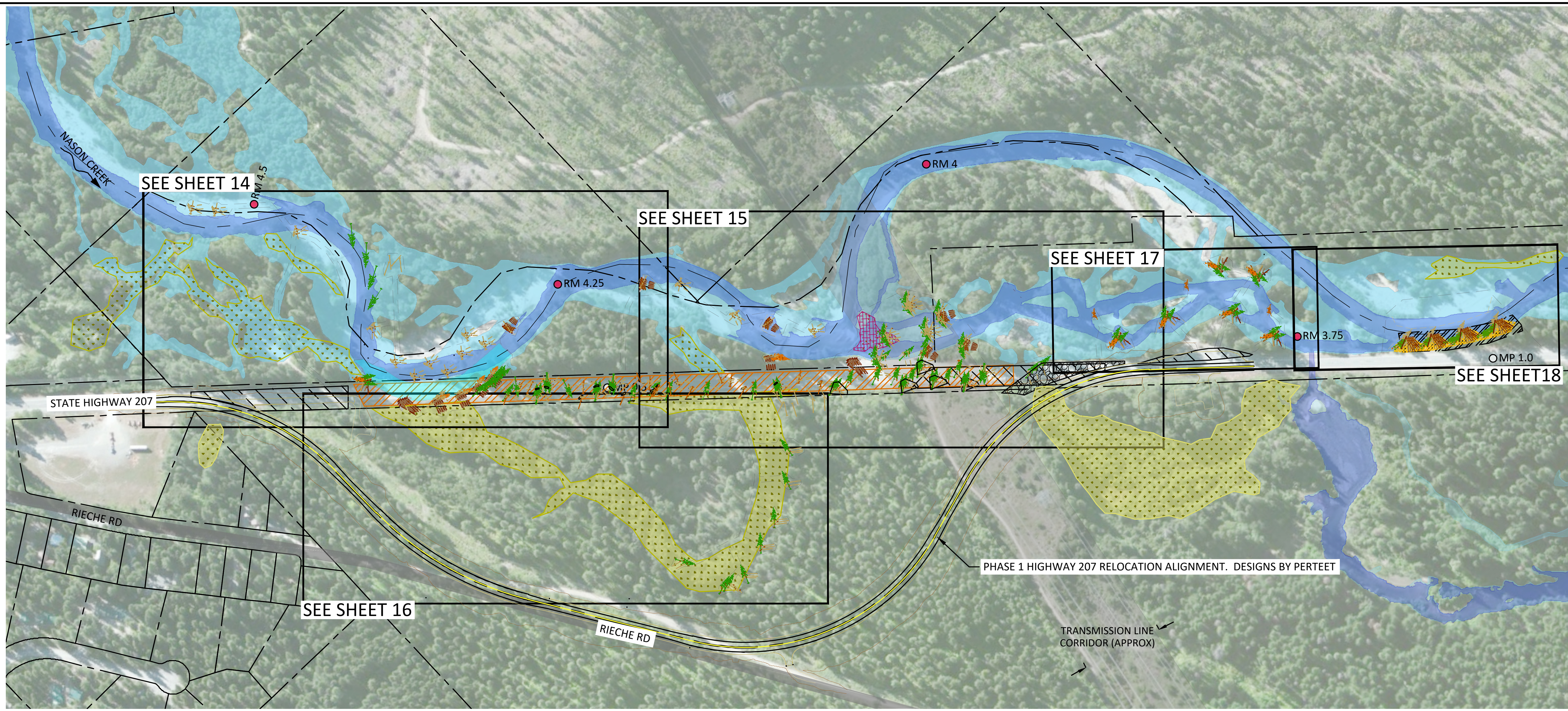
EXISTING CONDITIONS & PROPERTY OWNERSHIP



LEGEND

(light blue fill)	APPROXIMATE 1.5-YEAR EVENT FLOW INUNDATION LIMITS FOR EXISTING CONDITIONS
(purple fill)	APPROXIMATE ORDINARY HIGH WATER
(dotted yellow fill)	EXISTING WETLANDS
(dash line)	TAXLOTS
● RM XX	NASON CREEK RIVER MILE
○ MP XX	HIGHWAY 207 MILEPOST
(orange hatch)	EXISTING ROAD PRISM REMOVAL
(pink crosshatch)	STABILIZE EXISTING LOG JAM WITH LOG PILES
(wood symbols)	LARGE WOOD STRUCTURES (TYPE VARIES)
(black hatch)	STAGING AND STOCKPILE AREA
(heavy dashed line)	ACCESS ROUTE
(light dashed line)	LIMITS OF DISTURBANCE (LOD)
(yellow dashed line)	COFFERDAM

0 300 600

SCALE IN FEET

Preliminary
Not for Construction

G:\M-P\Nason Creek Floodplain RM 3.4-4.6 Phase 3 200237\Drawings\IFI NasonFP NoRD C.dwg -- cmcconnell -- 1/13/26

NO.	BY	DATE	REVISION DESCRIPTION

CM	DM	DM
DRAWN	DESIGNED	CHECKED
DM	01/13/2026	200237
APPROVED	DATE	PROJECT

YAKAMA NATION FISHERIES

NASON CR. R.M. 3.6-4.6 FLOODPLAIN ENHANCEMENT

PHASE 2 60% DESIGN

inter-fluve
501 Portway Avenue, Suite 101
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Yakama Nation Fisheries
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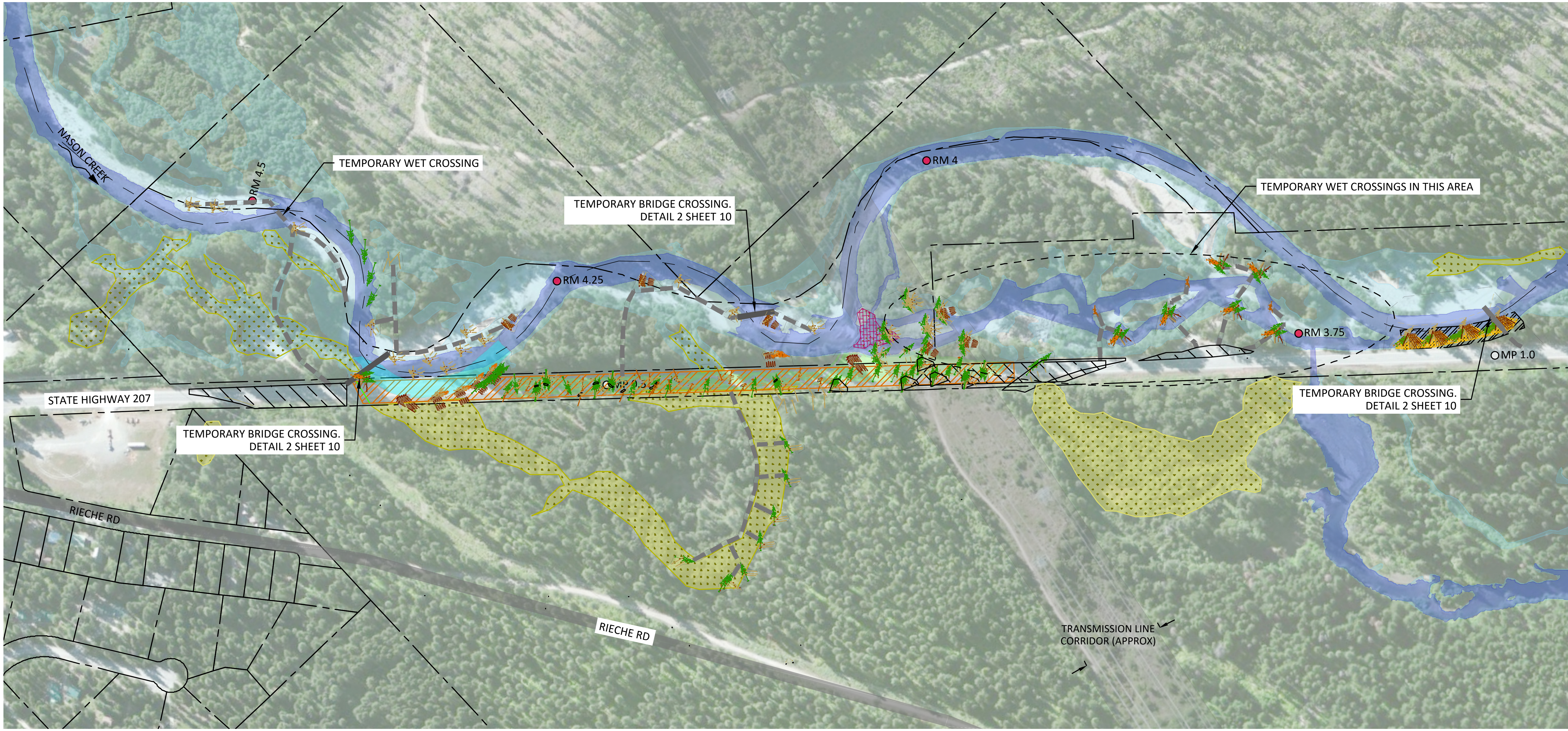
FORT ROAD
TOPPENISH, WA 98948
(509)865-5121

PROPOSED CONDITIONS AND SHEET INDEX



LEGEND

- APPROXIMATE 1.5-YEAR EVENT FLOW INUNDATION LIMITS FOR EXISTING CONDITIONS
- APPROXIMATE ORDINARY HIGH WATER
- EXISTING WETLANDS
- WETLAND CREATION
- TAXLOTS
- RM XX — NASON CREEK RIVER MILE
- MP XX — HIGHWAY 207 MILEPOST
- EXISTING ROAD PRISM REMOVAL
- STABILIZE EXISTING LOG JAM WITH LOG PILES
- LARGE WOOD STRUCTURES (TYPE VARIES)
- STAGING AND STOCKPILE AREA
- ACCESS ROUTE
- LIMITS OF DISTURBANCE (LOD)
- COFFERDAM

0 300 600

SCALE IN FEET

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APPROVED	**DATE**	**PROJECT**
DM	01/13/2026	200237

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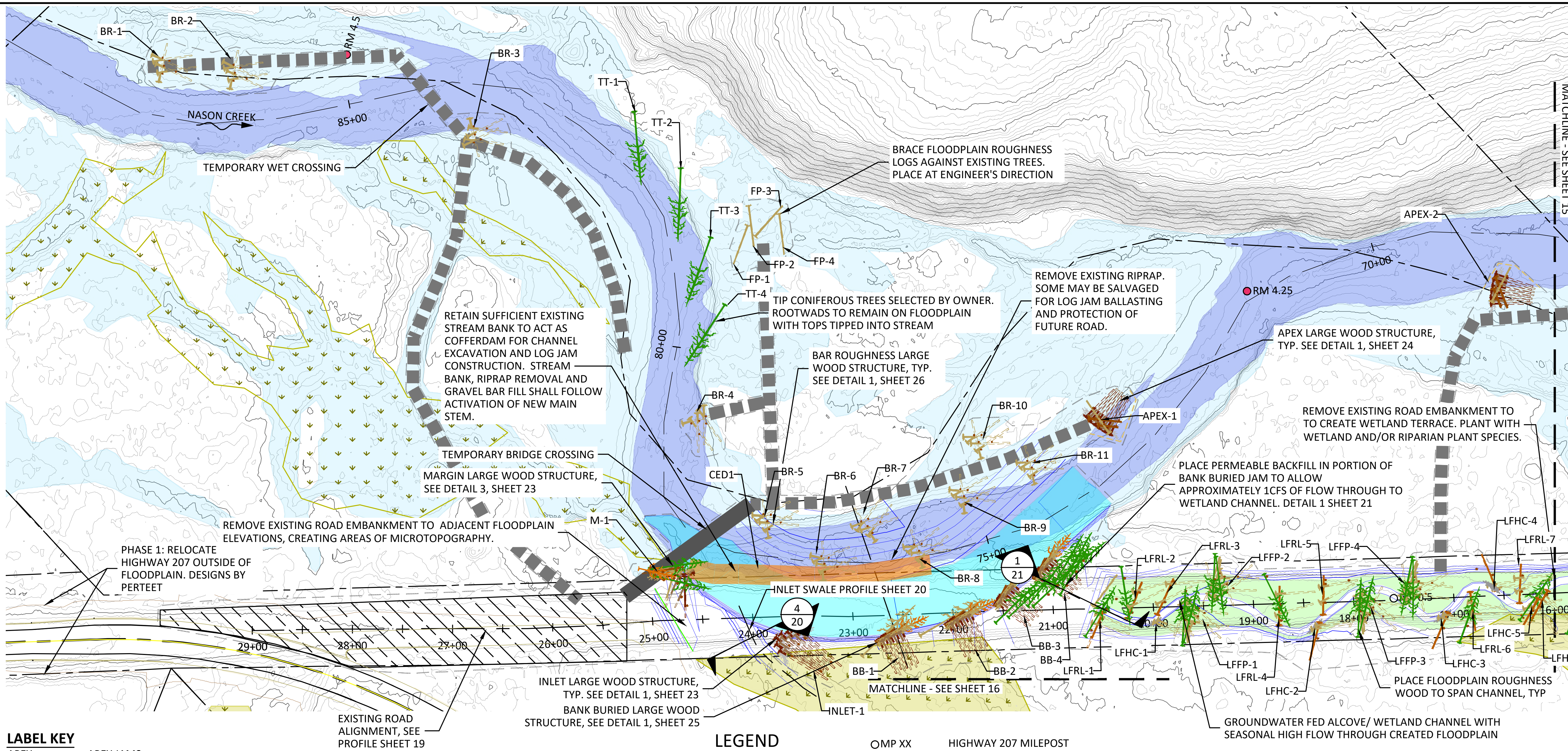
PROPOSED ACCESS, STAGING AND STOCKPILE AREAS



LABEL KEY

APEX	APEX JAMS
BB	BANK BURIED JAM
BBT	BANK BURIED JAM W/TREES
SM-BB	SMALL BANK BURIED JAM
M	BANK MARGIN WOOD
BR	BAR ROUGHNESS WOOD STRUCTURES
RW	BR AND SM-BB RACKING WOOD
CED3	CED3 BANK BARB STRUCTURE
DFL	DEFLECTOR JAM
FP	FLOODPLAIN ROUGHNESS LOGS
INLET	INLET STRUCTURE
LFFP	LOW FLOW CHANNEL FLOODPLAIN ROUGHNESS LW
LFHC	LOW FLOW CHANNEL HABITAT COVER LOGS
LFRL	LOW FLOW CHANNEL FLOODPLAIN ROUGHNESS LOG
TT	TIPPED TREE

LEGEND

- EXISTING CONTOURS (1 FT)
- PROPOSED CONTOURS (1 FT)
- APPROXIMATE 1.5-YEAR EVENT FLOW INUNDATION LIMITS FOR EXISTING CONDITIONS
- APPROXIMATE ORDINARY HIGH WATER
- EXISTING WETLANDS
- WETLAND CREATION
- TAXLOTS
- RM XX — NASON CREEK RIVER MILE
- MP XX — HIGHWAY 207 MILEPOST
- PROPOSED NEW CHANNEL
- LARGE WOOD STRUCTURES (TYPE VARIES)
- STAGING AND STOCKPILE AREA
- ACCESS ROUTE
- LIMITS OF DISTURBANCE (LOD)
- COFFERDAM

0 100 200

SCALE IN FEET

NOTE: DETAILS OF REMOVING ABANDONED UTILITIES TO BE PROVIDED IN THE NEXT PHASE.

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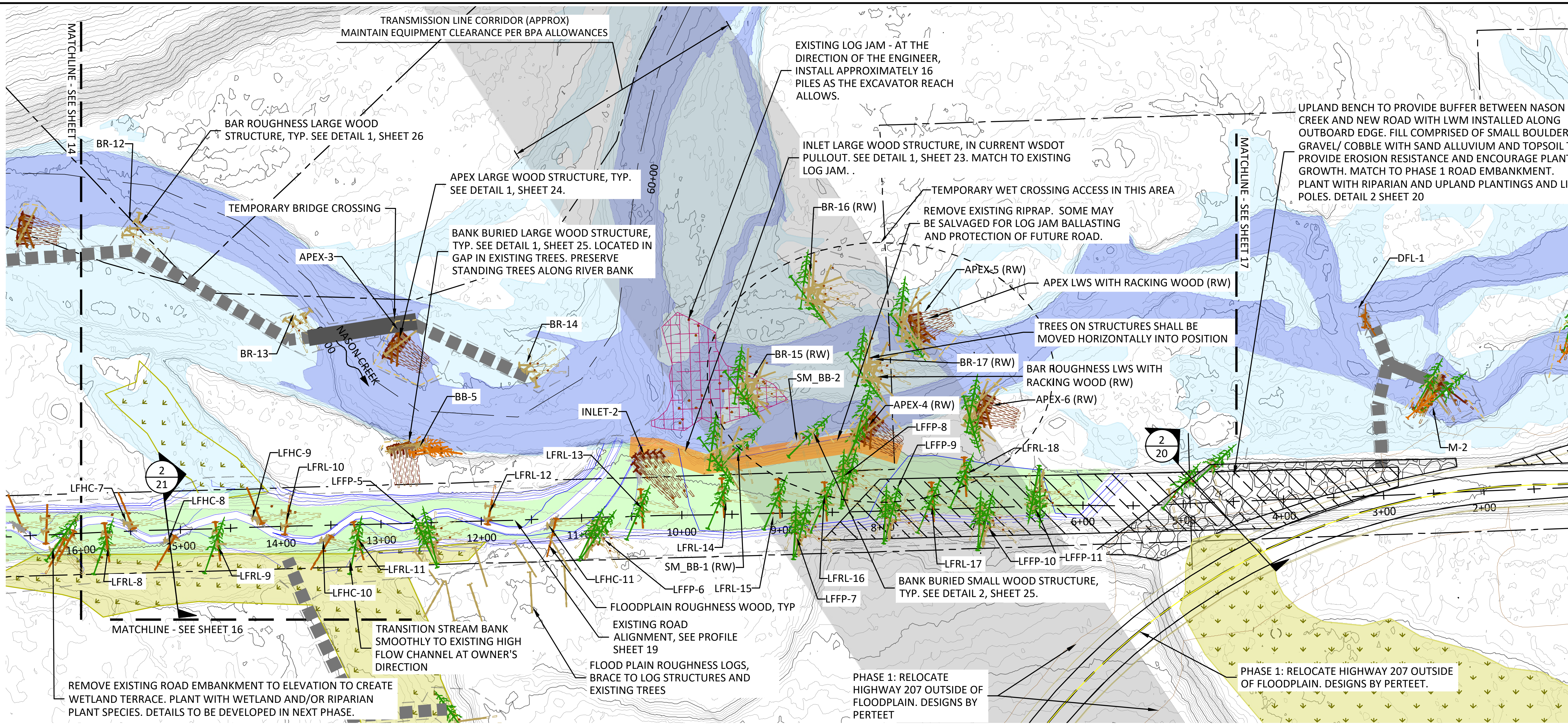
PROPOSED CONDITIONS
(1 OF 5)



LEGEND

(line)	EXISTING CONTOURS (1 FT)
(line)	PROPOSED CONTOURS (1 FT)
(fill)	APPROXIMATE 1.5-YEAR EVENT FLOW INUNDATION LIMITS FOR EXISTING CONDITIONS
(fill)	APPROXIMATE ORDINARY HIGH WATER
(fill)	EXISTING WETLANDS
(line)	TAXLOTS
● RM XX	NASON CREEK RIVER MILE
(fill)	WETLAND CREATION
○ MP XX	HIGHWAY 207 MILEPOST
(hatch)	STAGING AND STOCKPILE AREA
(line)	ACCESS ROUTE
(line)	LIMITS OF DISTURBANCE (LOD)
(line)	COFFERDAM
(hatch)	STABILIZE EXISTING LOG JAM WITH LOG PILES

LABEL KEY

APEX	APEX JAMS
BB	BANK BURIED JAM
BBT	BANK BURIED JAM W/TREES
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LFFP	LOW FLOW CHANNEL FLOODPLAIN ROUGHNESS LW
LFHC	LOW FLOW CHANNEL HABITAT COVER LOGS
LFRL	LOW FLOW CHANNEL FLOODPLAIN ROUGHNESS LOG
TT	TIPPED TREE

0 100 200
SCALE IN FEET

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Preliminary
Not for Construction

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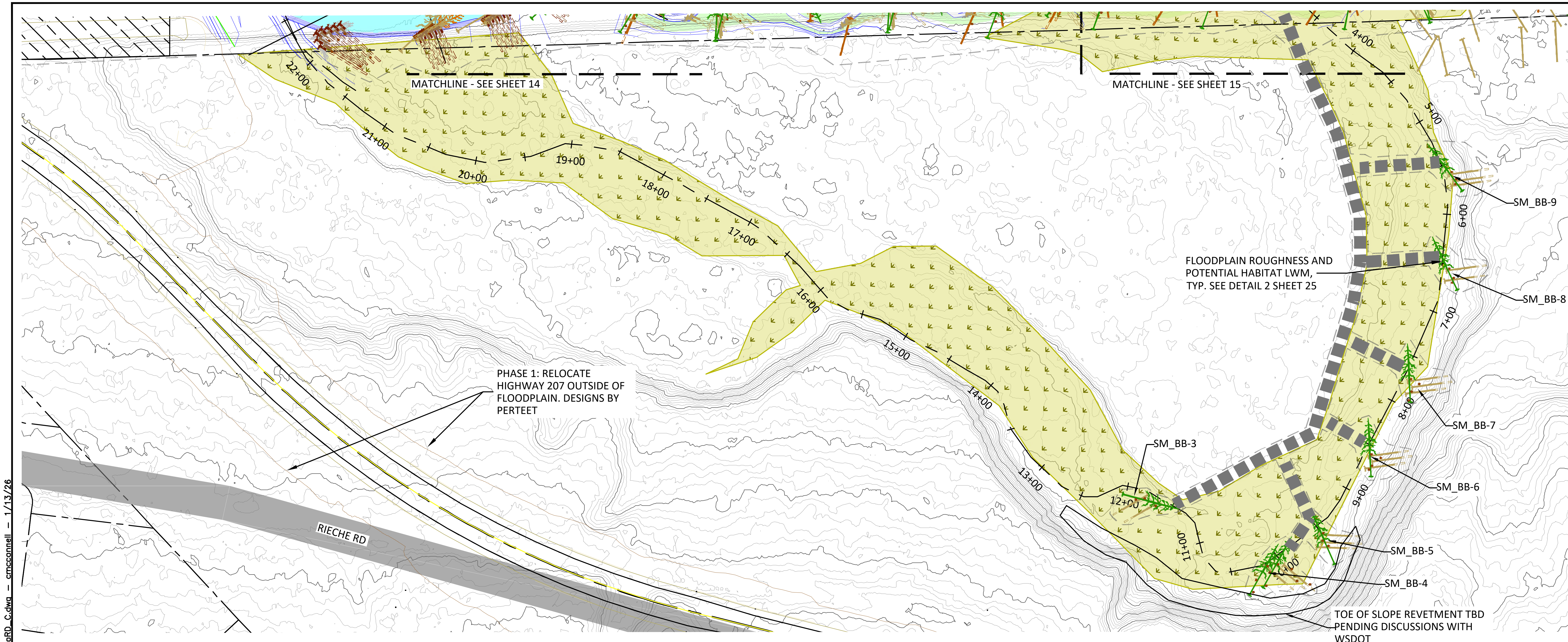
PROPOSED CONDITIONS (2 OF 5)



0 100 200

SCALE IN FEET

LEGEND

(thin grey line)	EXISTING CONTOURS (1 FT)
(thin blue line)	PROPOSED CONTOURS (1 FT)
(light blue fill)	APPROXIMATE 1.5-YEAR EVENT FLOW INUNDATION LIMITS FOR EXISTING CONDITIONS
(purple fill)	APPROXIMATE ORDINARY HIGH WATER
(yellow fill)	EXISTING WETLANDS
(dash line)	TAXLOTS
● RM XX	NASON CREEK RIVER MILE
○ MP XX	HIGHWAY 207 MILEPOST
(hatched box)	STAGING AND STOCKPILE AREA
(heavy dashed line)	ACCESS ROUTE
(grey dashed line)	LIMITS OF DISTURBANCE (LOD)
(yellow dashed line)	COFFERDAM

LABEL KEY

APEX	APEX JAMS
BB	BANK BURIED JAM
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LFRL	LOW FLOW CHANNEL FLOODPLAIN ROUGHNESS LOG
TT	TIPPED TREE

NOTE: DETAILS OF REMOVING ABANDONED UTILITIES TO BE PROVIDED IN THE NEXT PHASE.

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PROPOSED CONDITIONS
(3 OF 5)

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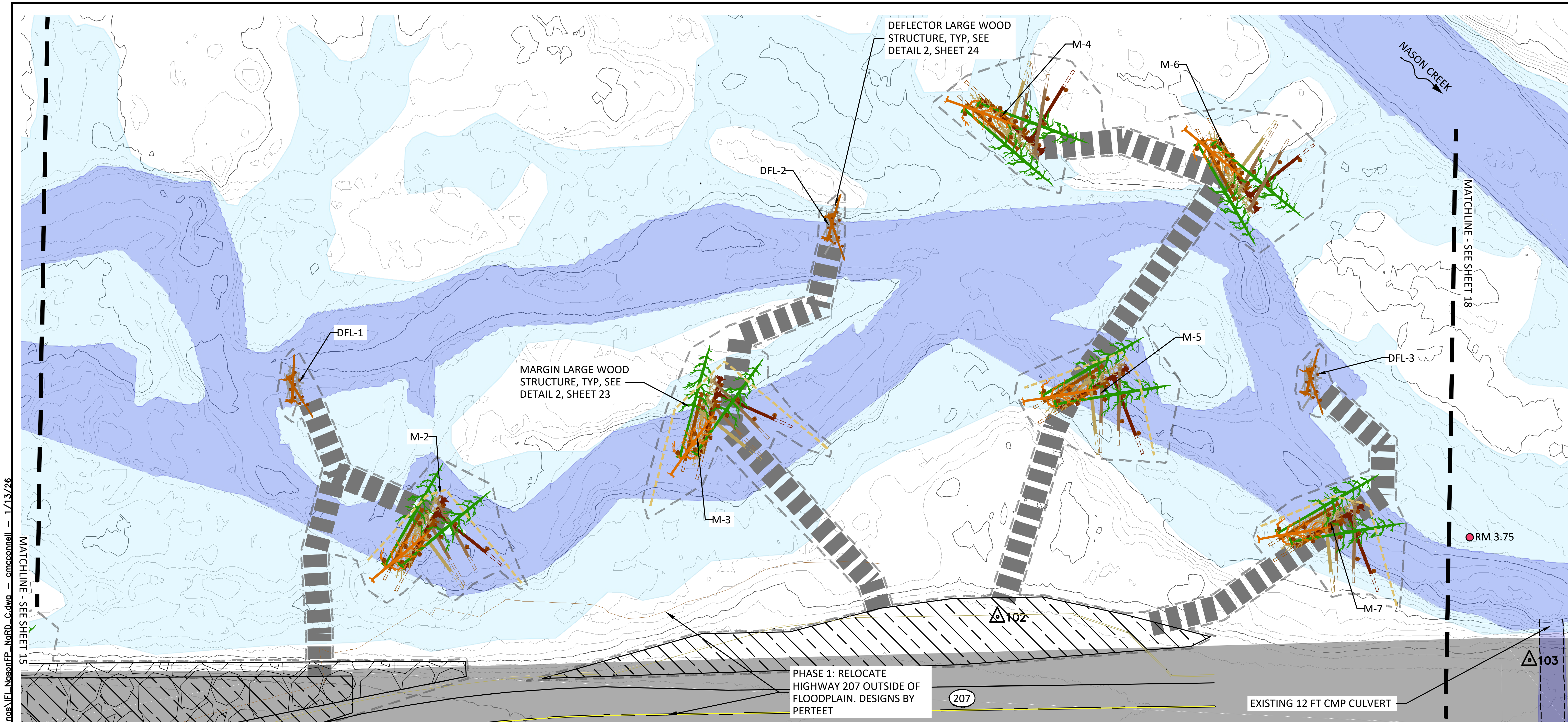

LEGEND

(line)	EXISTING CONTOURS (1 FT)
(light blue fill)	APPROXIMATE 1.5-YEAR EVENT FLOW INUNDATION LIMITS FOR EXISTING CONDITIONS
(purple fill)	APPROXIMATE ORDINARY HIGH WATER
● RM XX	NASON CREEK RIVER MILE
△100	SURVEY CONTROL POINT
(hatched)	STAGING AND STOCKPILE AREA
(heavy dashed)	ACCESS ROUTE
(grey dashed)	LIMITS OF DISTURBANCE (LOD)
(yellow dashed)	COFFERDAM

LABEL KEY

APEX	APEX JAMS
BB	BANK BURIED JAM
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TT	TIPPED TREE

NOTE: DETAILS OF REMOVING ABANDONED UTILITIES TO BE PROVIDED IN THE NEXT PHASE.

0 50 100
SCALE IN FEET

Preliminary
Not for Construction

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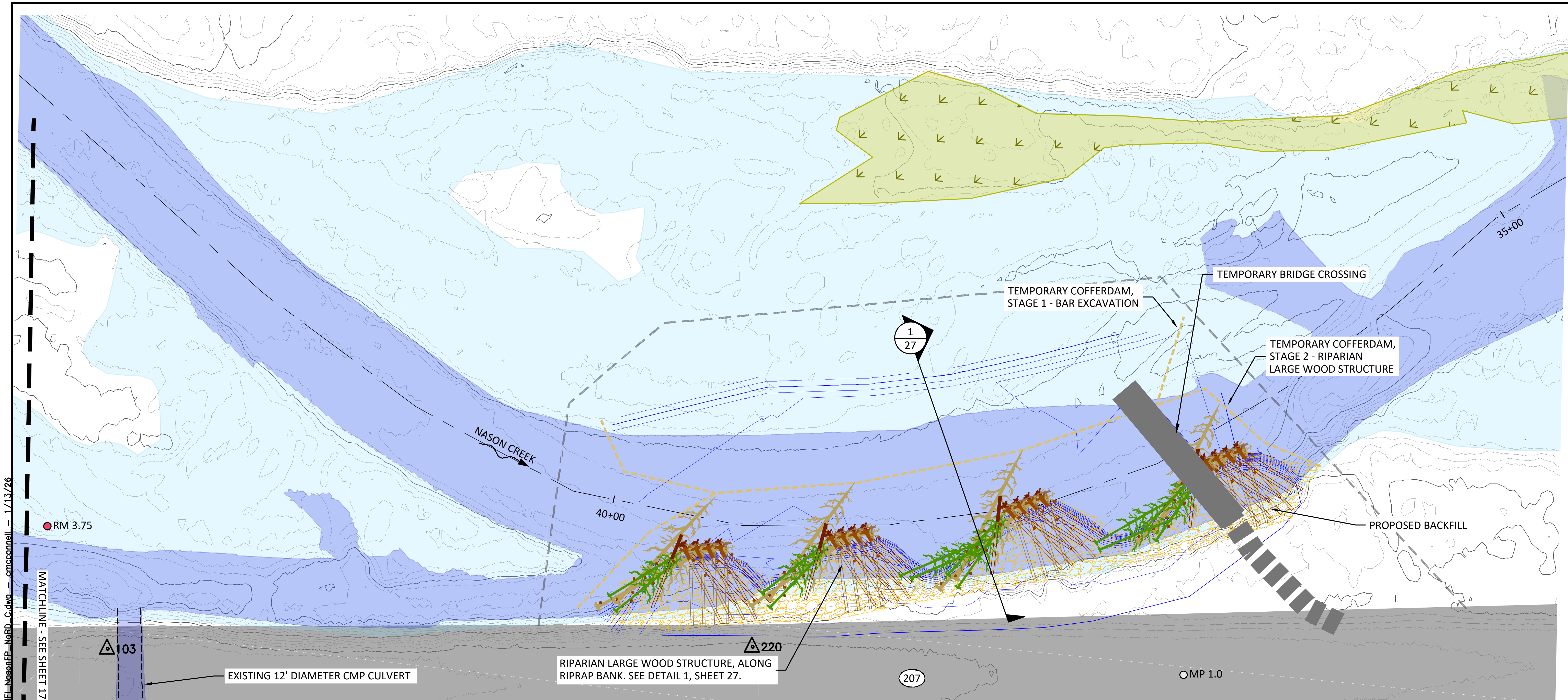
PROPOSED CONDITIONS (4 OF 5)



LEGEND

EXISTING CONTOURS (1 FT)	
PROPOSED CONTOURS (1 FT)	
APPROXIMATE 1.5-YEAR EVENT FLOW INUNDATION LIMITS FOR EXISTING CONDITIONS	
APPROXIMATE ORDINARY HIGH WATER	
EXISTING WETLANDS	
RM XX	NASON CREEK RIVER MILE
MP XX	HIGHWAY 207 MILEPOST
100	SURVEY CONTROL POINT
	STAGING AND STOCKPILE AREA
	ACCESS ROUTE
	LIMITS OF DISTURBANCE (LOD)
	COFFERDAM

0 50 100
SCALE IN FEET

NOTE: DETAILS OF REMOVING ABANDONED UTILITIES TO BE PROVIDED IN THE NEXT PHASE.

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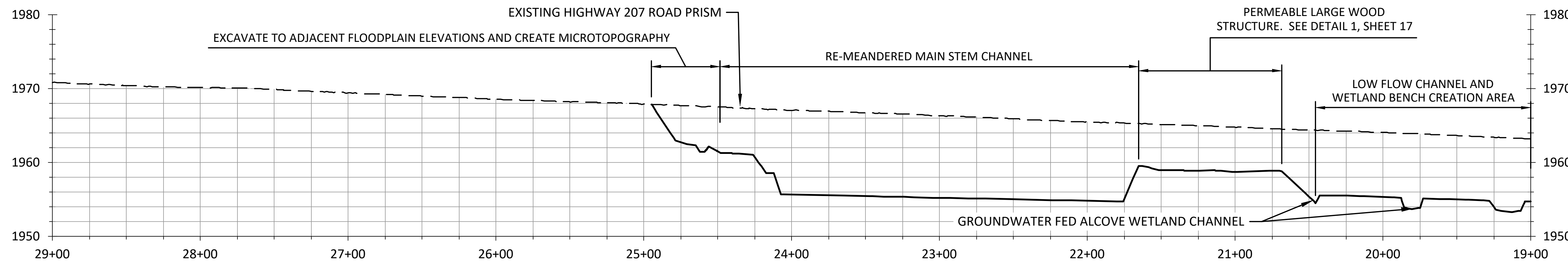
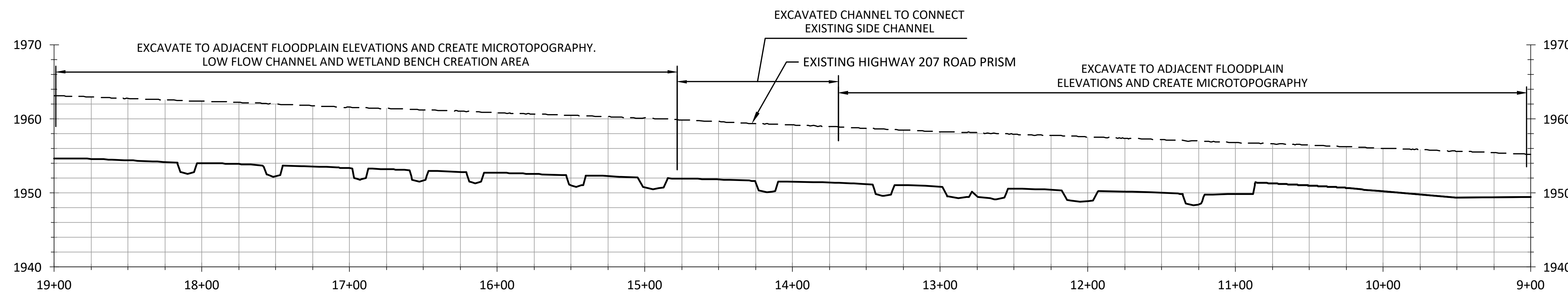
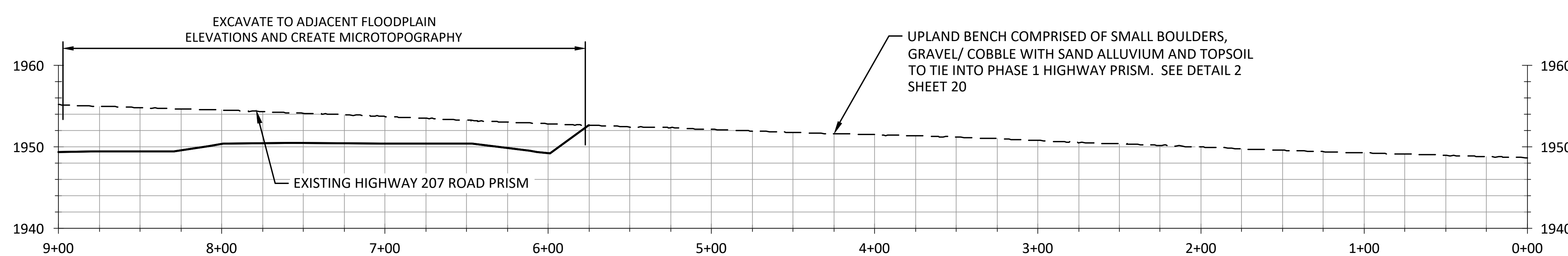
PROPOSED CONDITIONS
(5 OF 5)

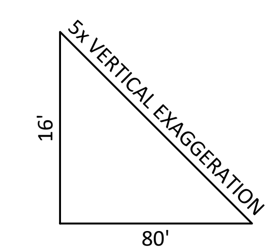


PROFILE - EXISTING ROAD PRISM, STA 29+00 - 19+00



PROFILE - EXISTING ROAD PRISM, STA 19+00 - 9+00





PROFILE - EXISTING ROAD PRISM, STA 9+00 - 0+00

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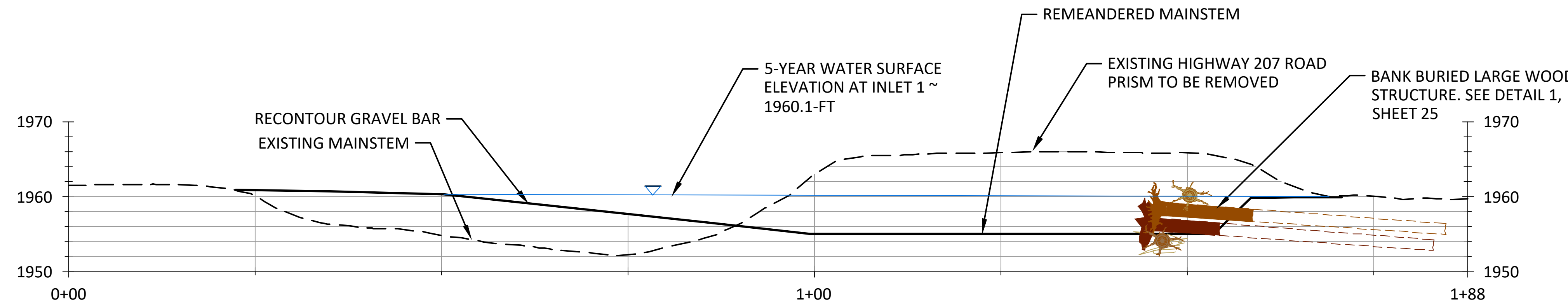
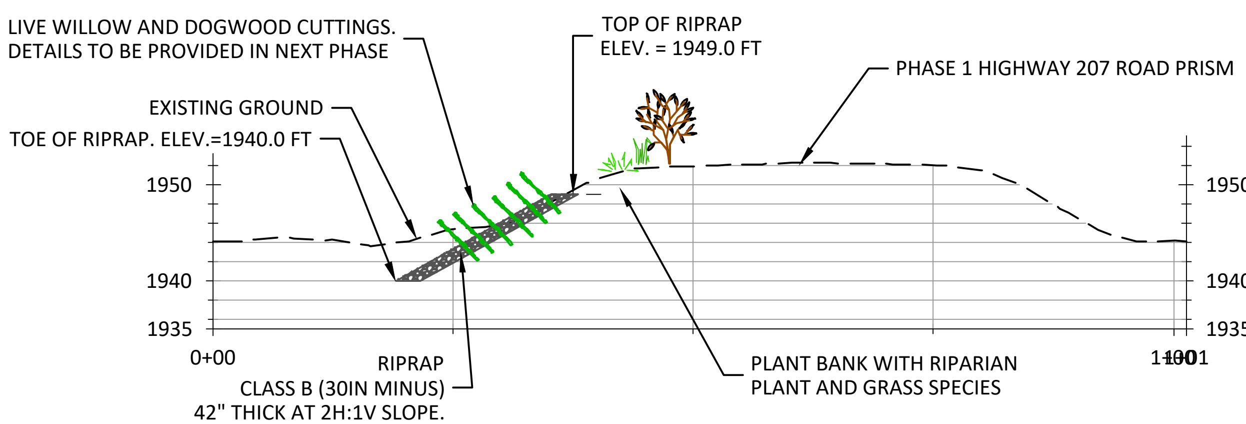
PROFILE - EXISTNG ROAD PRISM



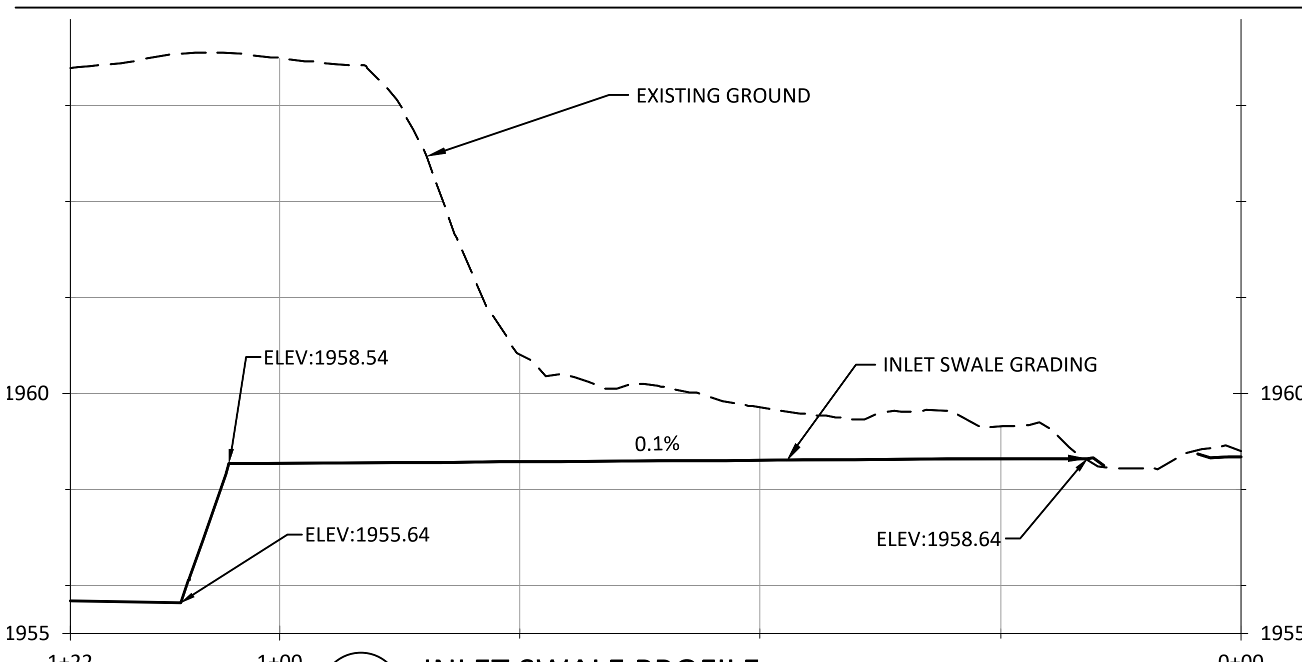
1/20 TYPICAL SECTION - MAINSTEM/ROAD REMOVAL

1"=20'



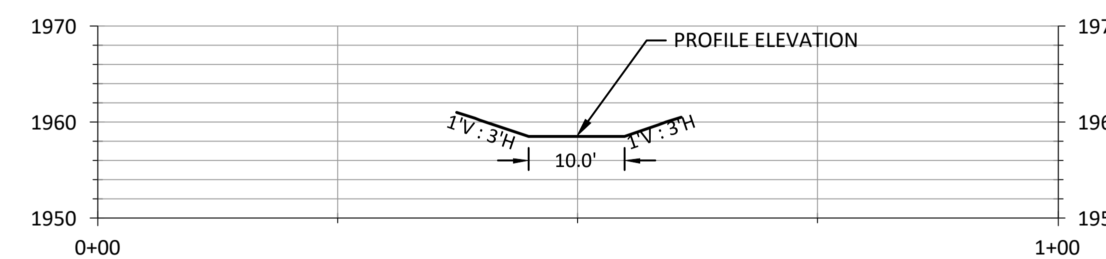
2/20 TYPICAL SECTION - ROAD BUFFER

1"=20'



3/20 INLET SWALE PROFILE

5 X VERTICAL EXAGERATION (1"=20')



4/20 TYPICAL SECTION - INLET SWALE

1"=20'

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DM — APPROVED; 01/13/2026 — DATE; 200237 — PROJECT

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ROAD CROSS SECTIONS & INLET SWALE PROFILE AND SECTION

SHEET 20 OF 31

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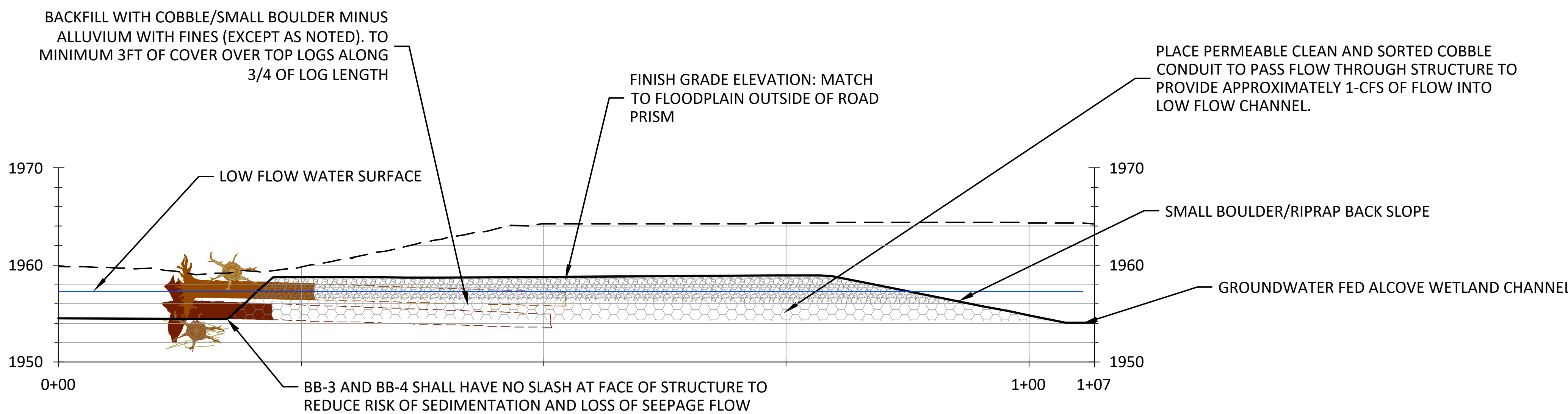
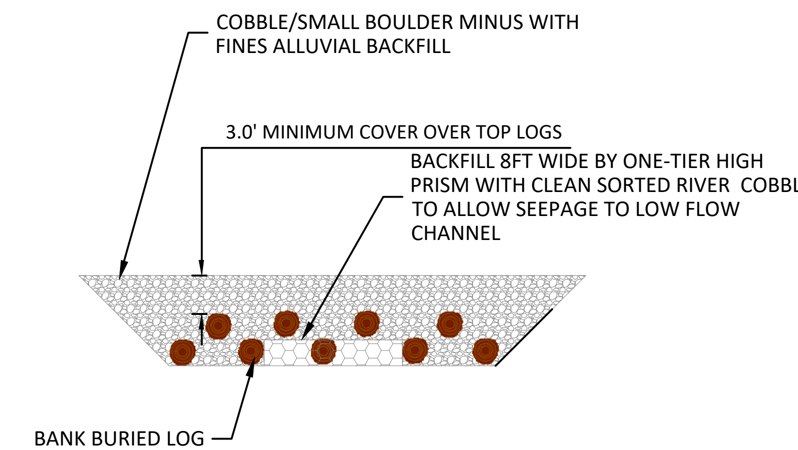


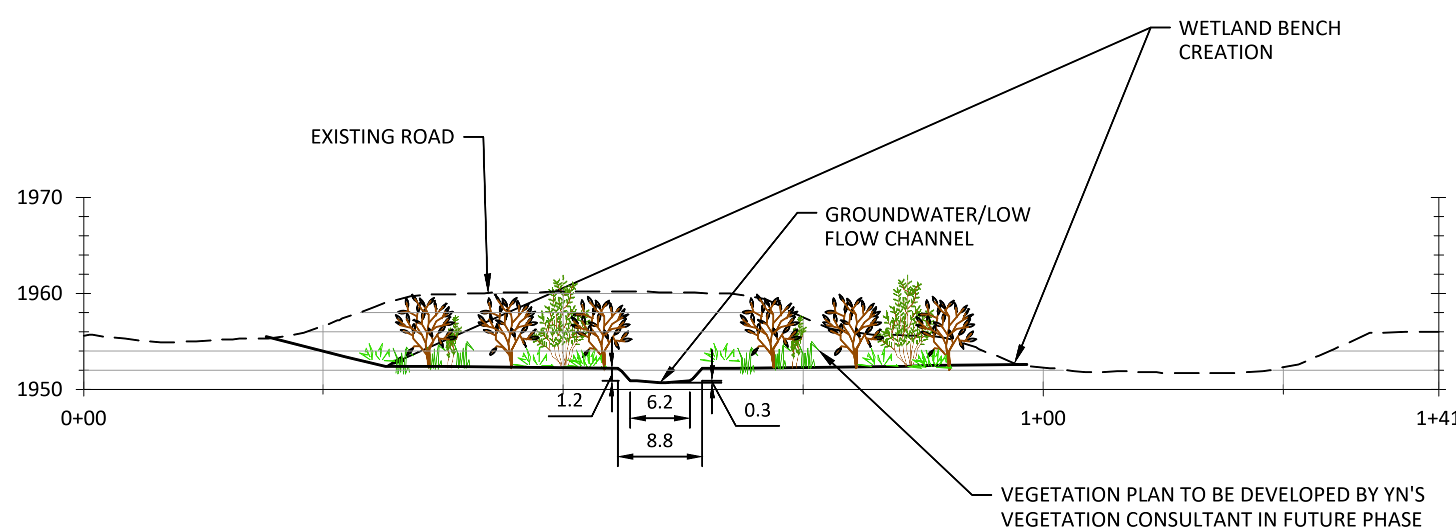


BANK BURIED INFILTRATION LARGE WOOD STRUCTURE SECTION VIEW

BANK BURIED JAM DETAILS FOR INLET TO GROUND WATER FED/WETLAND CHANNEL

1/21 GROUND WATER FED/WETLAND CHANNEL CONTROLLED INFLOW

1"=15'



2/21 TYPICAL SECTION - ROAD REMOVAL/WETLAND TERRACE

1"=20'

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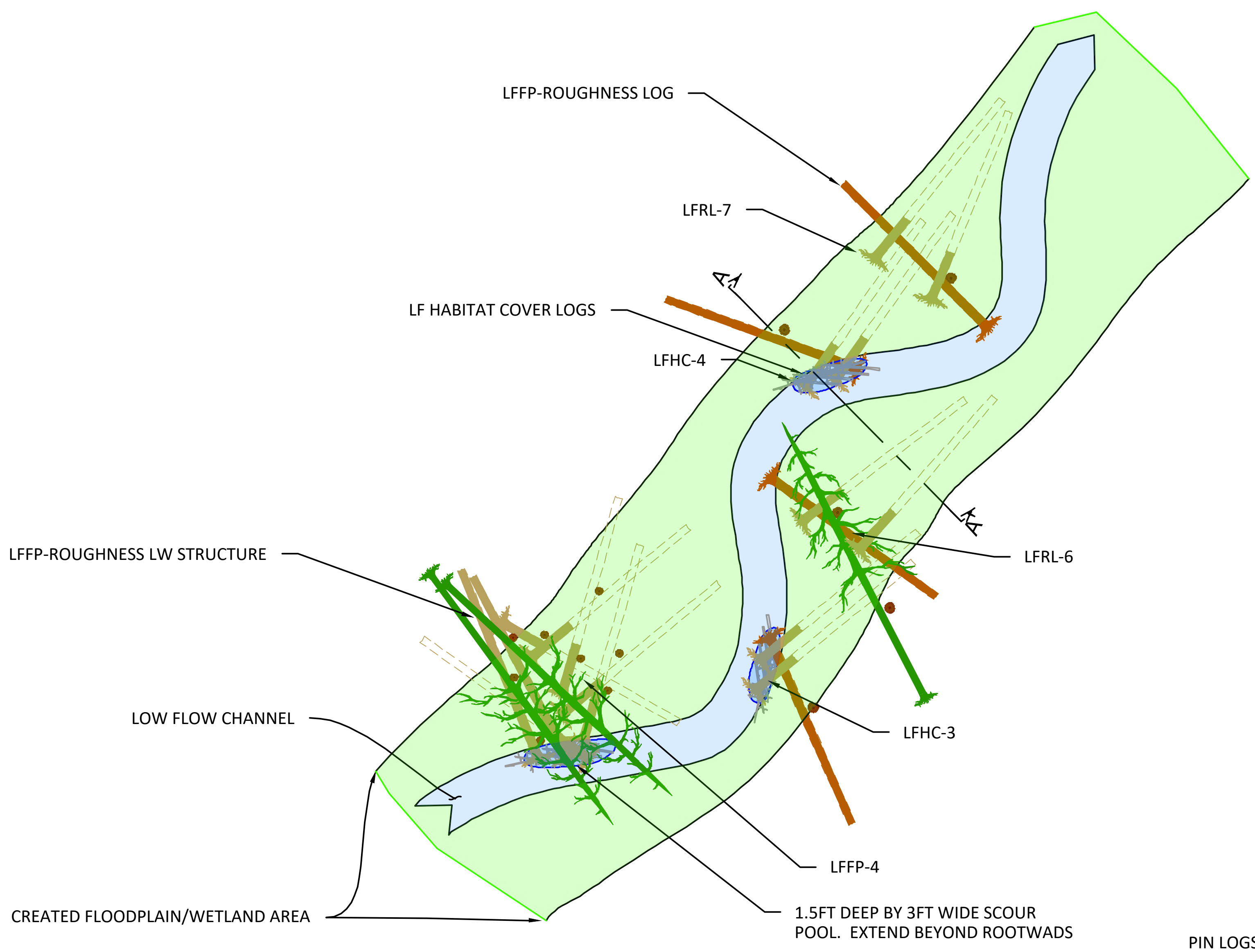
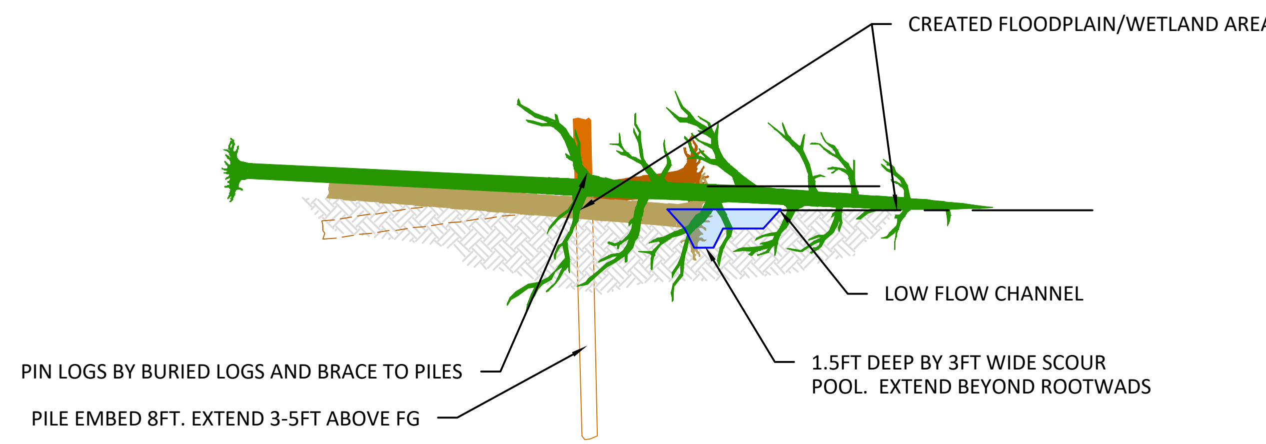
CROSS SECTIONS



PLAN



SECTION VIEW A-A'

1/22 LOW FLOW CHANNEL TYPICAL DETAIL

NOT TO SCALE

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LOW FLOW CHANNEL TYPICAL DETAIL

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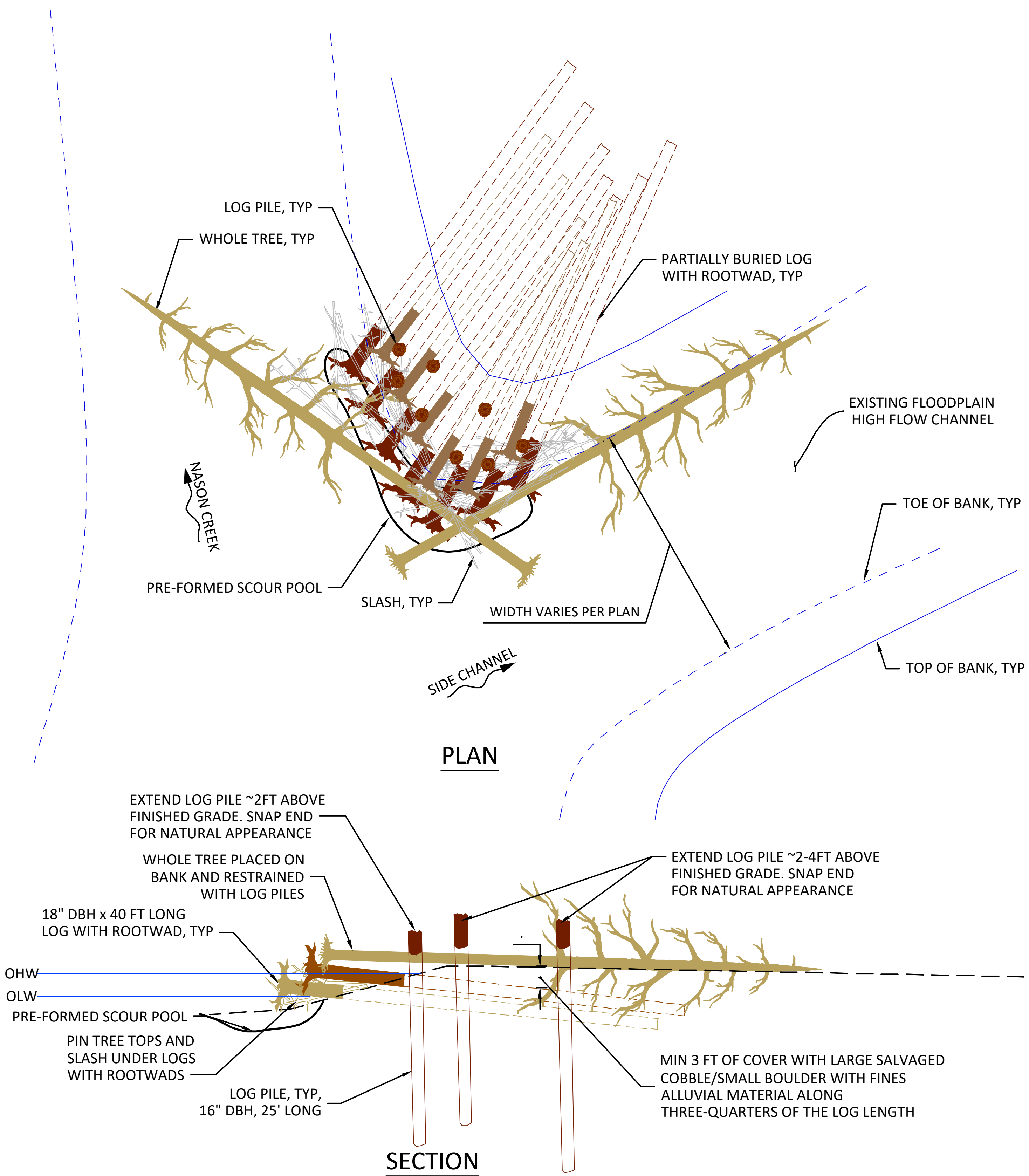
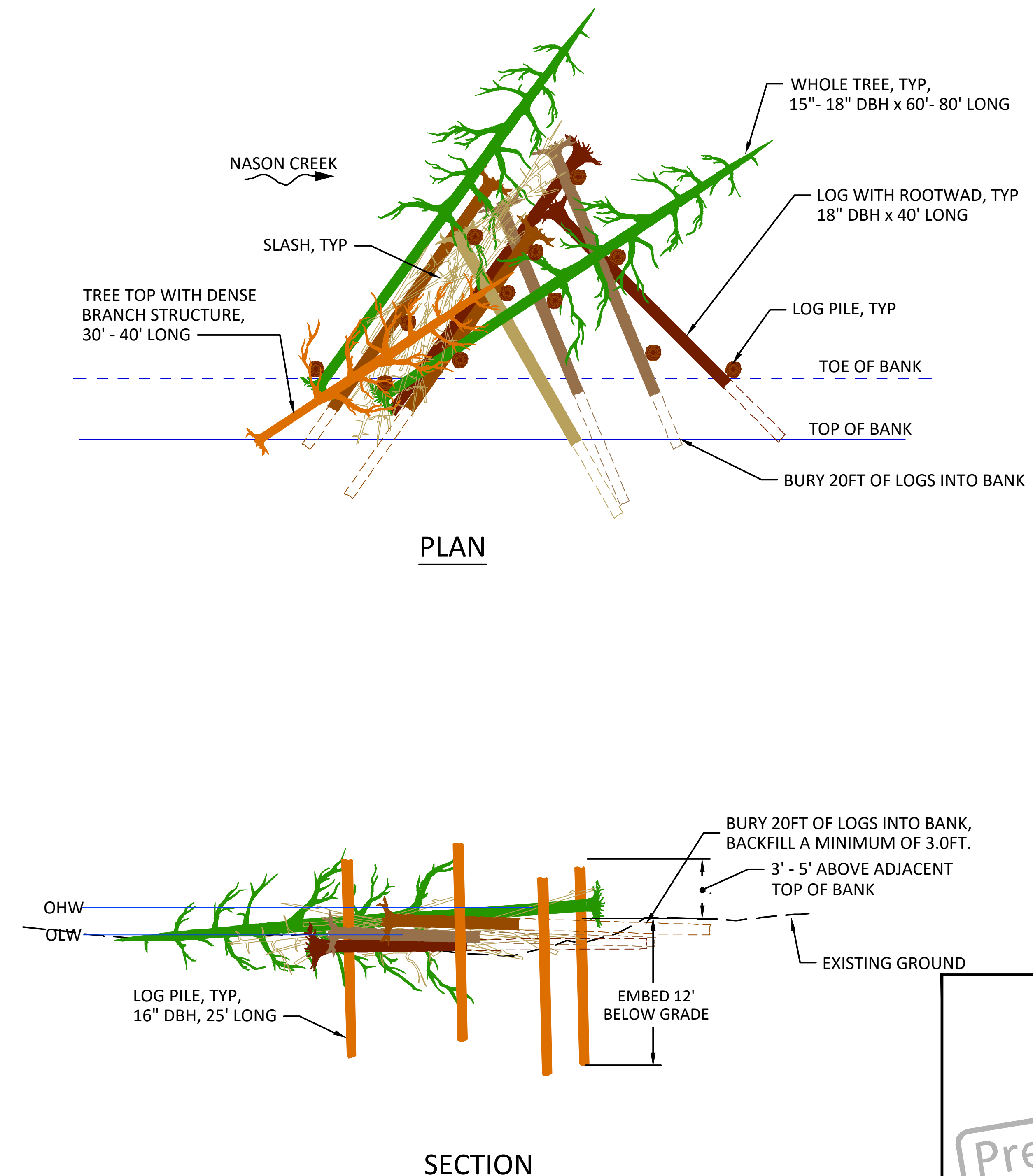


1/23 TYPICAL DETAIL - INLET LARGE WOOD STRUCTURE (INLET)

NOT TO SCALE



2/23 TYPICAL DETAIL - MARGIN LARGE WOOD STRUCTURE (M)

NOT TO SCALE

Preliminary
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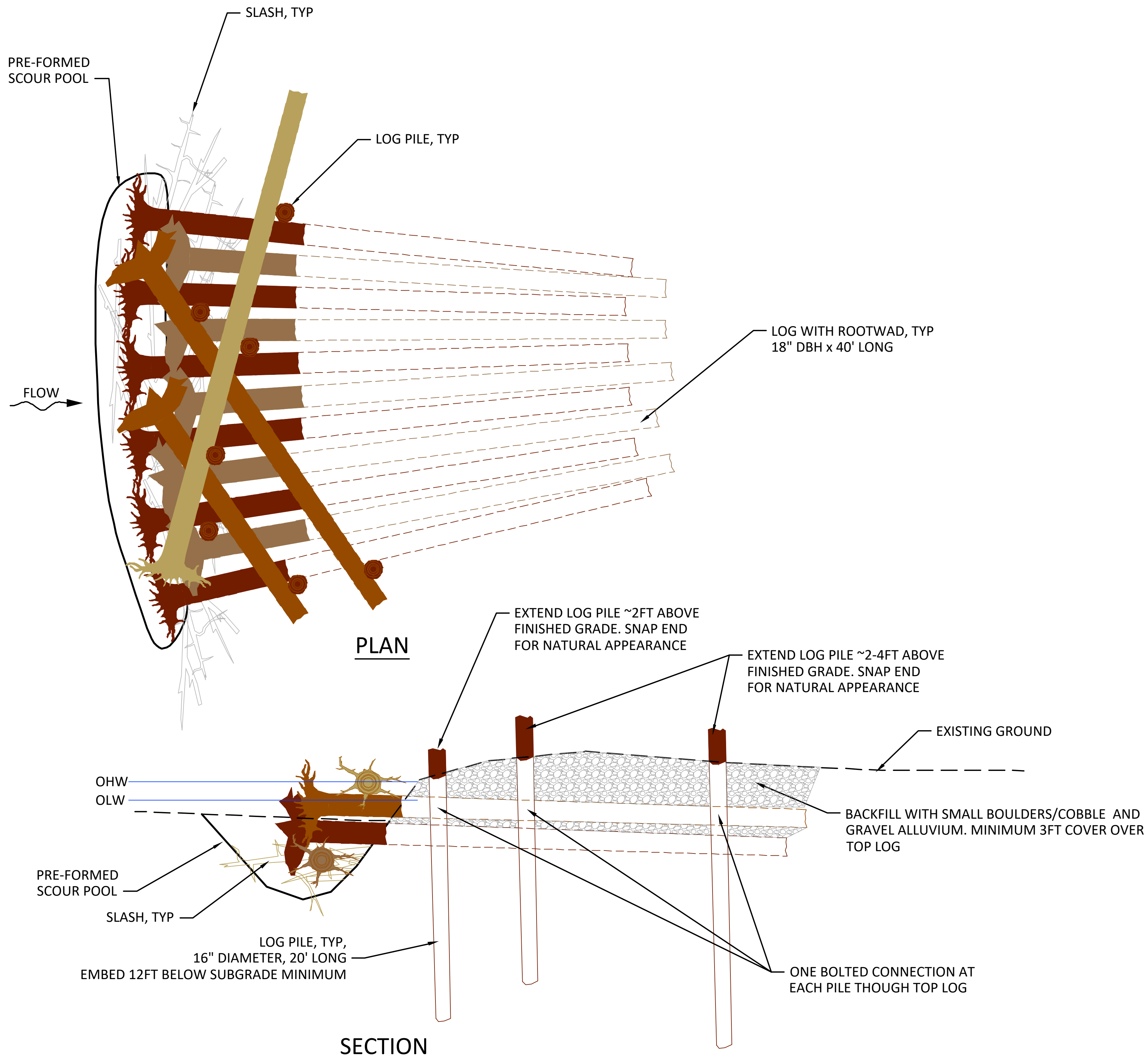
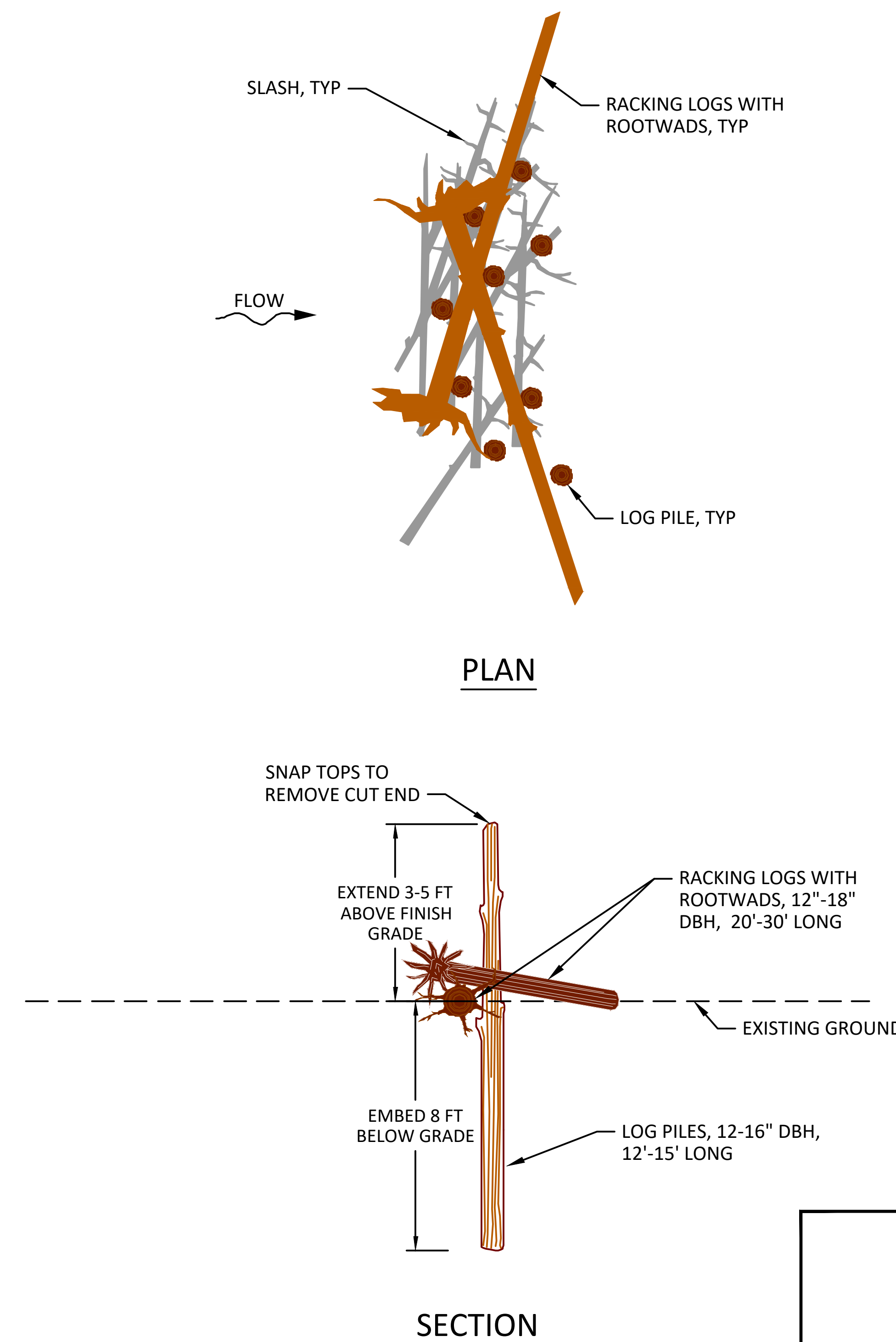
LARGE WOOD TYPICAL DETAILS (1 OF 5)



1/24 TYPICAL DETAIL - APEX LARGE WOOD STRUCTURE (APEX)

NOT TO SCALE



2/24 TYPICAL DETAIL - DEFLECTOR STRUCTURE (DFL)

NOT TO SCALE

G:\M-P\Nason Creek Floodplain RM 3.4-4.6 Phase 3 200237\Drawings\IFI_NasonFP_NoRD_C.dwg -- cmcconnell -- 1/13/26

NO.	BY	DATE	REVISION DESCRIPTION

CM	DM	DM
DRAWN	DESIGNED	CHECKED
DM	01/13/2026	200237
APPROVED	DATE	PROJECT

YAKAMA NATION FISHERIES
NASON CR. R.M. 3.6-4.6 FLOODPLAIN ENHANCEMENT
PHASE 2 60% DESIGN

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TOPPENISH, WA 98948
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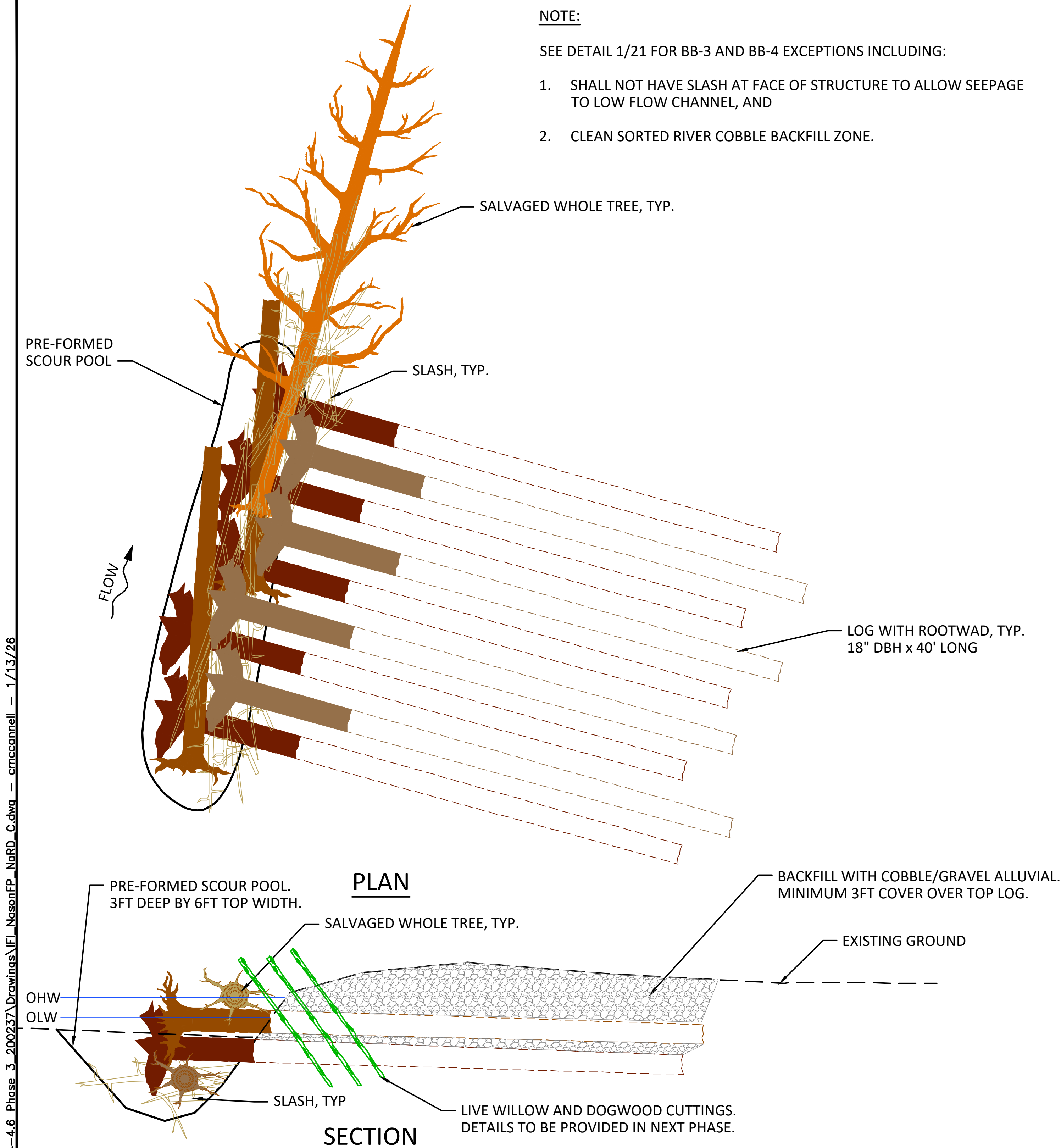
LARGE WOOD TYPICAL DETAILS
(2 OF 5)

NOTE:

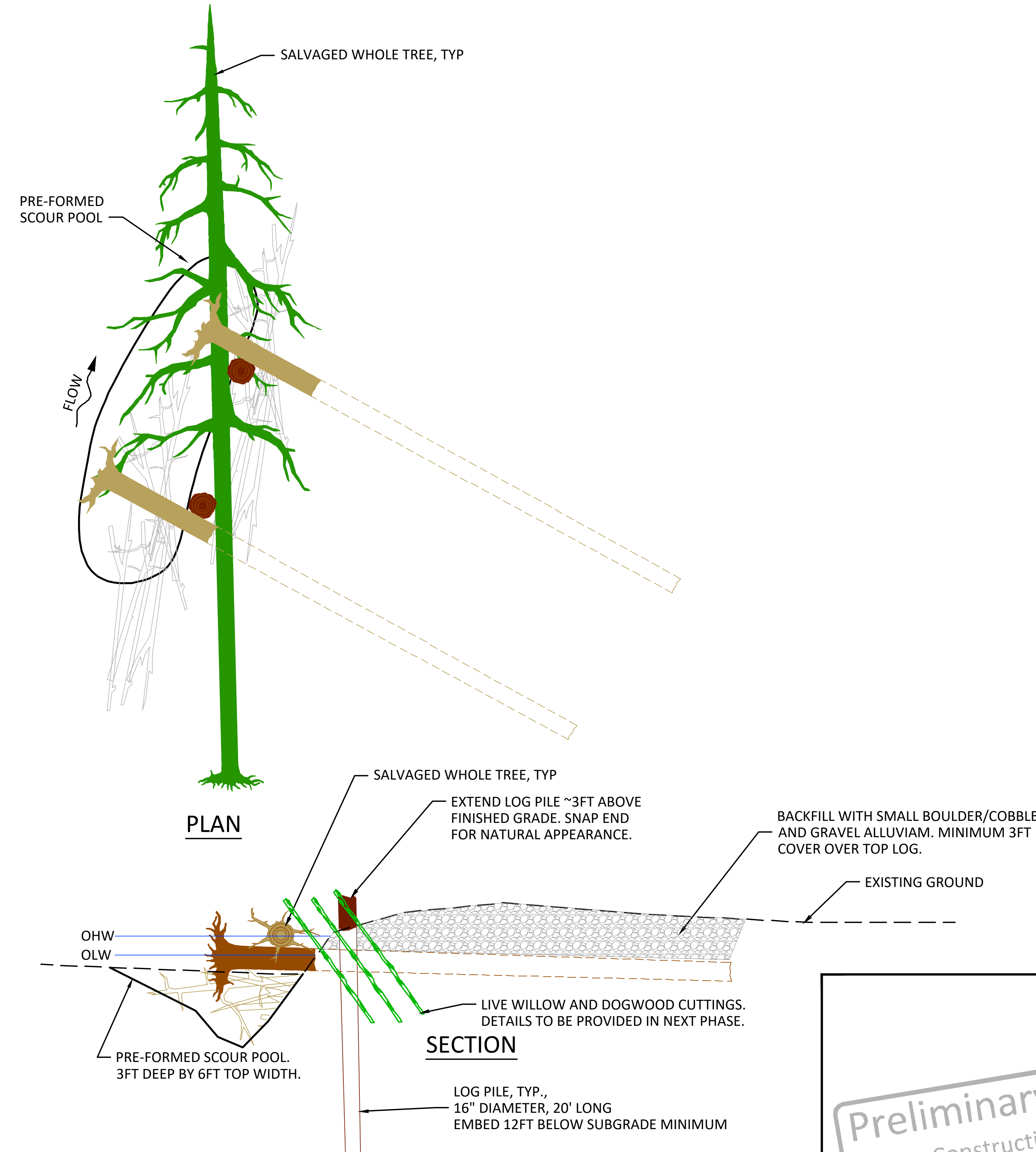
SEE DETAIL 1/21 FOR BB-3 AND BB-4 EXCEPTIONS INCLUDING:

1. SHALL NOT HAVE SLASH AT FACE OF STRUCTURE TO ALLOW SEEPAGE TO LOW FLOW CHANNEL, AND
2. CLEAN SORTED RIVER COBBLE BACKFILL ZONE.



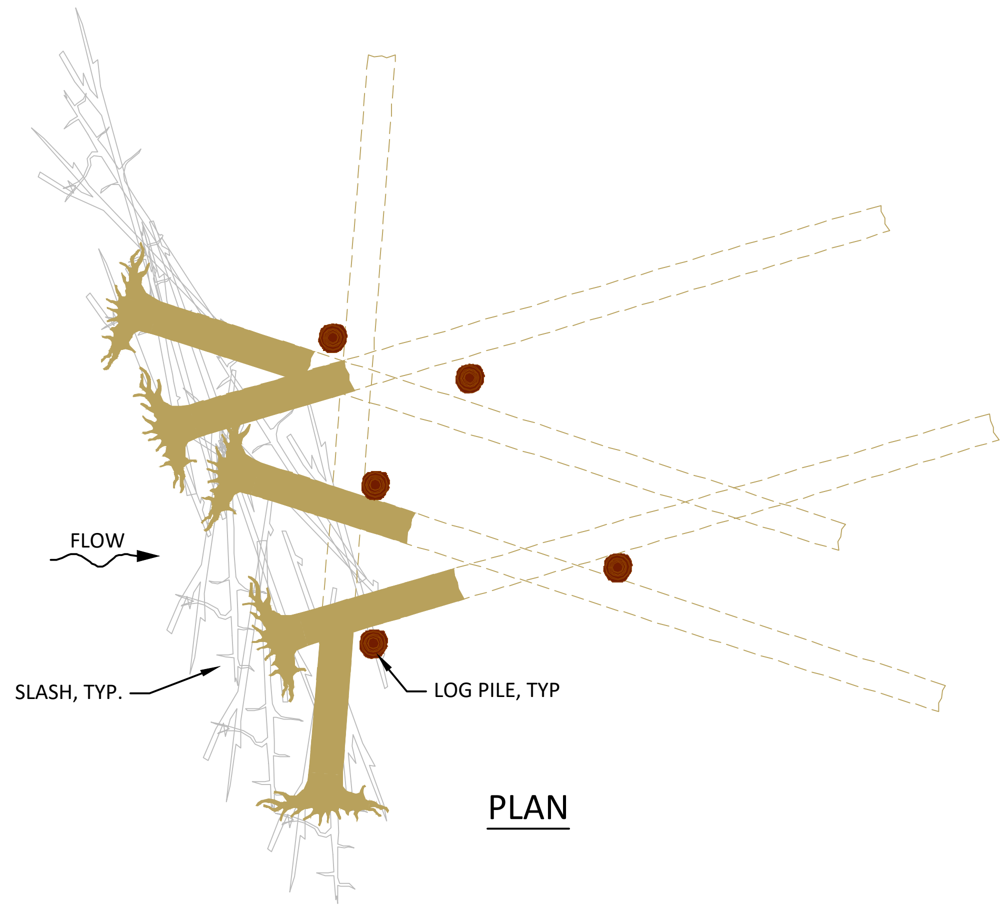
1/25 TYPICAL DETAIL - BANK BURIED LARGE WOOD STRUCTURE (BB)

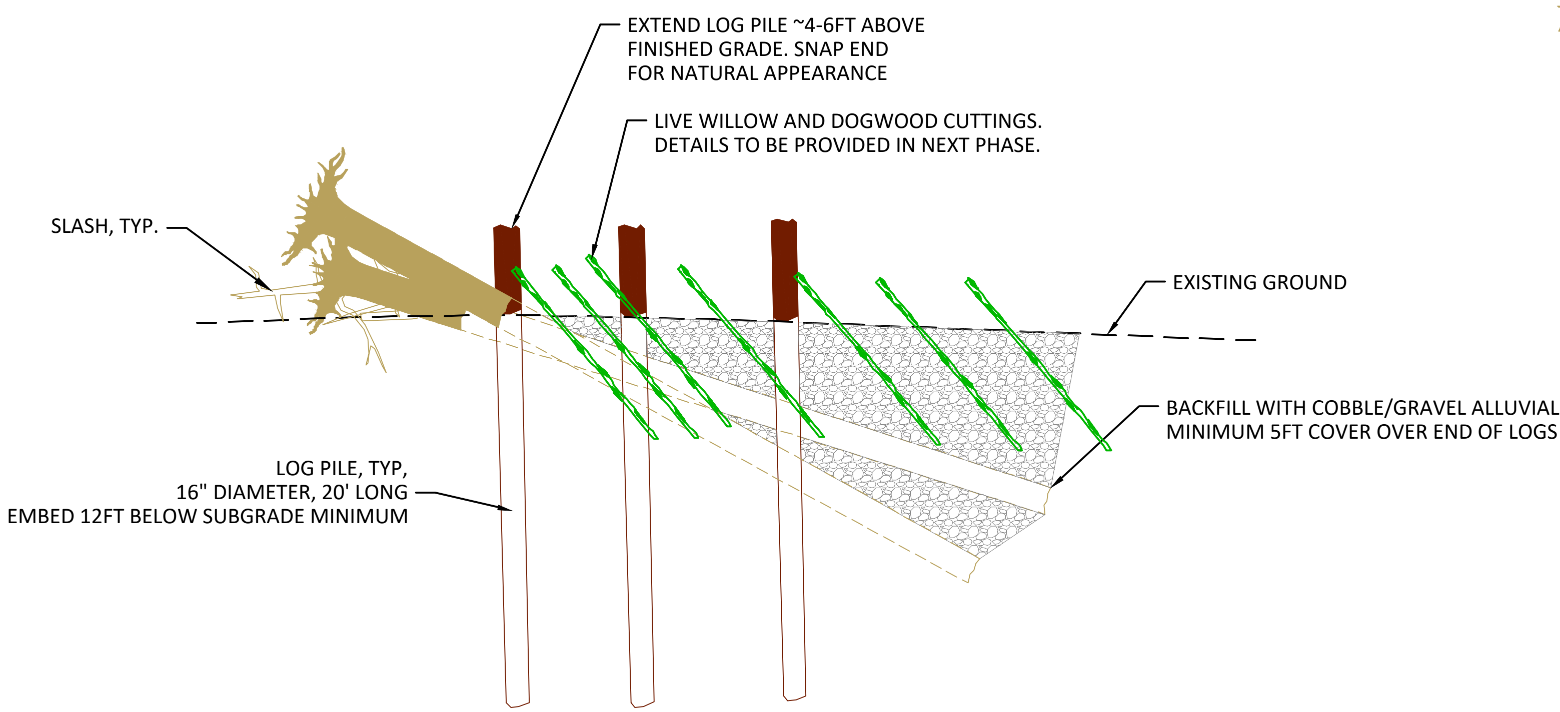
NOT TO SCALE



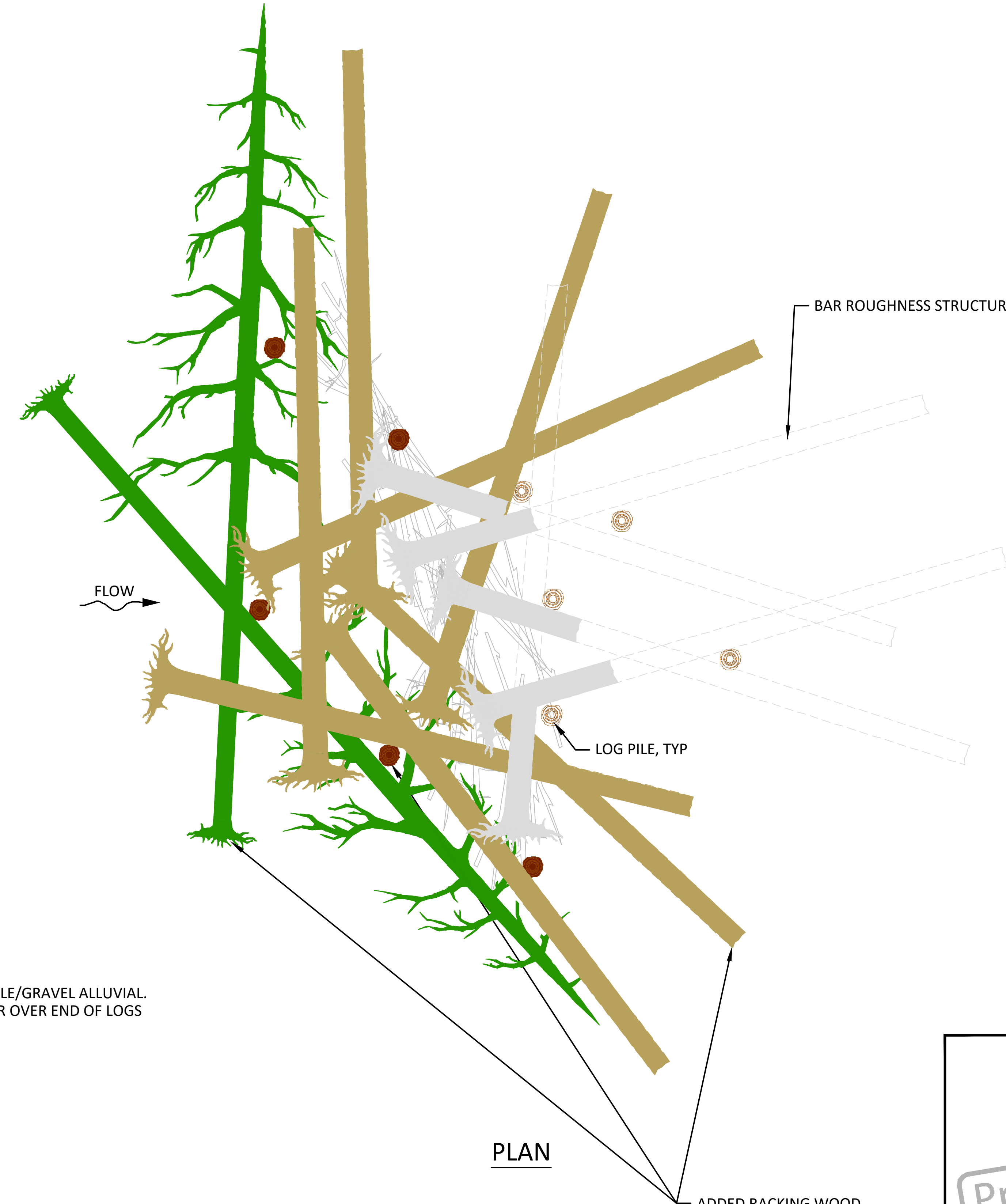
2/25 TYPICAL DETAIL - SMALL BANK BURIED LARGE WOOD STRUCTURE (SM-BB)

NOT TO SCALE





SECTION



BAR ROUGHNESS WITH ADDED RACKING WOOD

2/26 TYPICAL DETAIL - BAR ROUGHNESS LW STRUCTURE (BR)

NOT TO SCALE

Preliminary
Not for Construction

G:\M-P\Nason_Creek_Floodplain_RM_3.4-4.6_Phase_3_200237\Drawings\IFI_NasonFP_NoRD_C.dwg -- cmcconnell -- 1/13/26

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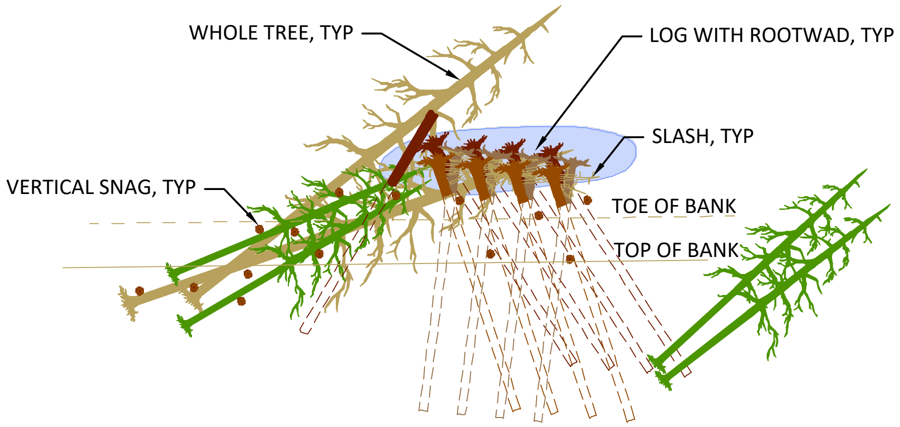
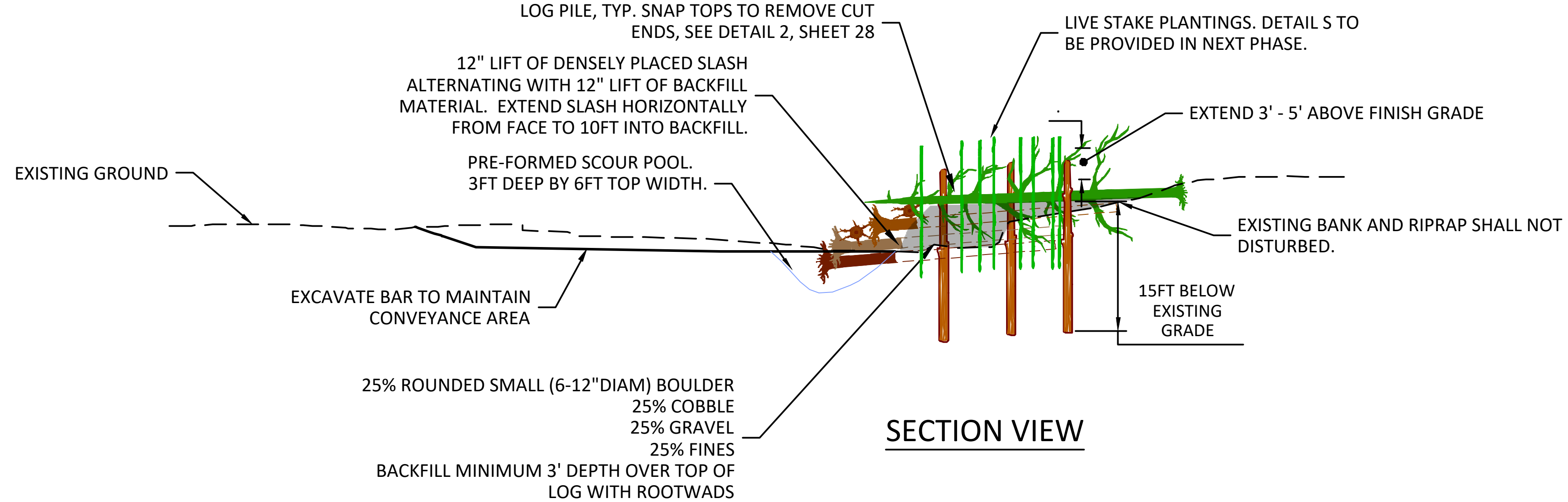
LARGE WOOD TYPICAL DETAILS
(4 OF 5)

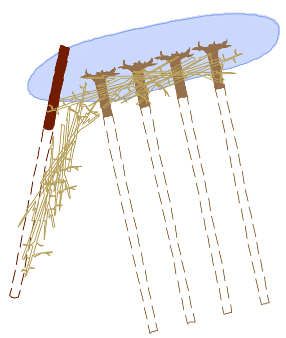
SHEET
26 OF 31



PLAN VIEW

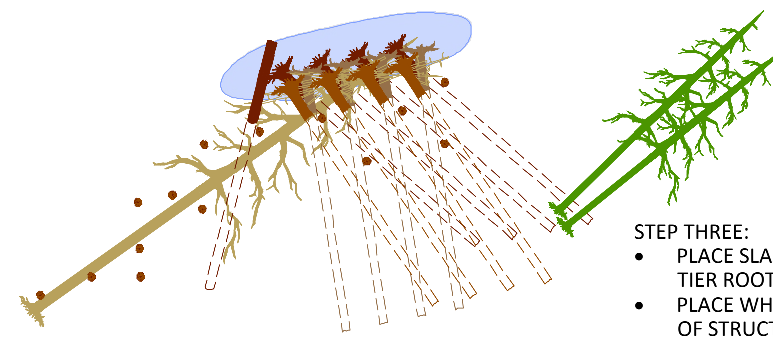


SECTION VIEW



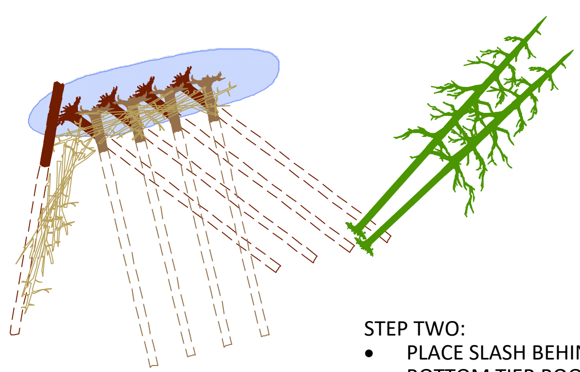
STEP ONE:
- EXCAVATE SCOUR POOL
- PLACE SLASH ALONG PERIMETER OF STRUCTURE
- PLACE BOTTOM TIER OF LOGS WITH ROOTWADS AND BUMPER LOG ON STREAMBED, PINNING SLASH UNDER AND BEHIND ROOTWADS
- BACKFILL TO TOPS OF LOGS

STEP 1



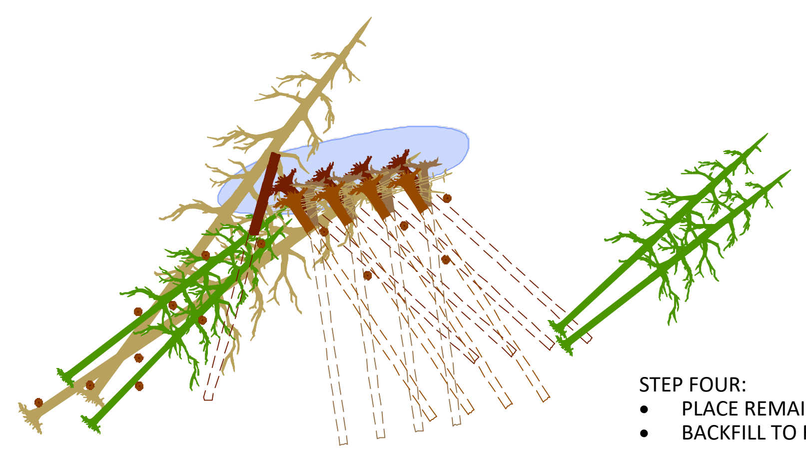
STEP THREE:
- PLACE SLASH BEHIND ROOTWADS OF MIDDLE TIER ROOTWADS
- PLACE WHOLE TREES ALONG UPSTREAM FACE OF STRUCTURE
- PLACE THIRD TIER OF LOGS WITH ROOTWADS, PINNING SLASH UNDER AND BEHIND ROOTWADS
- INSTALL LOG PILES
- BACKFILL TO TOPS OF LOGS

STEP 3



STEP TWO:
- PLACE SLASH BEHIND ROOTWADS OF BOTTOM TIER ROOTWADS
- PLACE DOWNSTREAM WHOLE TREES SPANNING BETWEEN STRUCTURES
- PLACE SECOND TIER OF LOGS WITH ROOTWADS, PINNING SLASH UNDER AND BEHIND ROOTWADS
- BACKFILL TO TOPS OF LOGS

STEP 2



STEP FOUR:
- PLACE REMAINING WHOLE TREES
- BACKFILL TO FINISHED GRADE

STEP 4

SEQUENCING

1
27
TYPICAL DETAIL - RIPARIAN LARGE WOOD STRUCTURE
NOT TO SCALE

Preliminary
Not for Construction

NO.	BY	DATE	REVISION DESCRIPTION

CM DRAWN | DM DESIGNED | DM CHECKED
DM APPROVED | 01/13/2026 DATE | 200237 PROJECT

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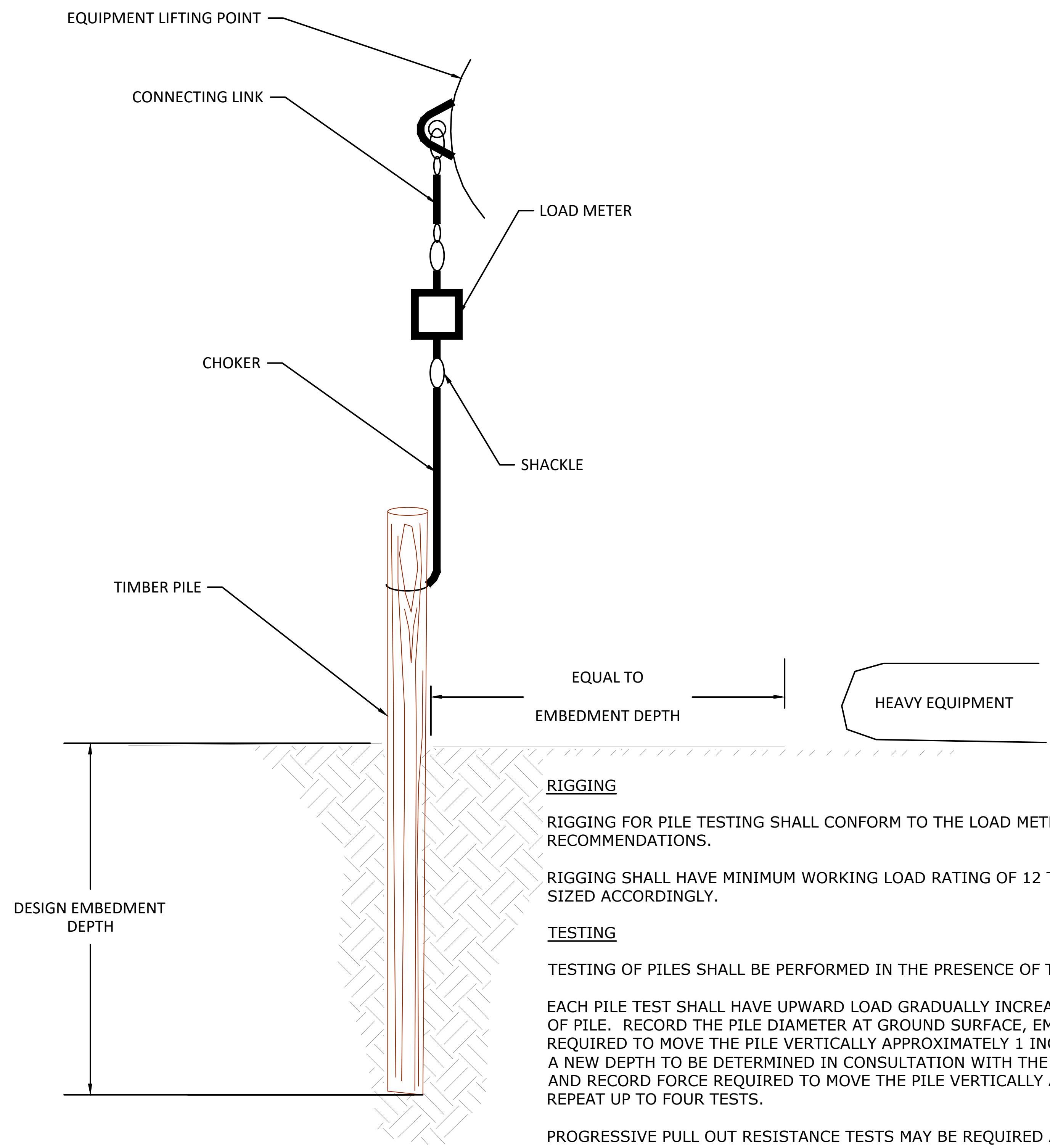
LARGE WOOD TYPICAL DETAILS
(5 OF 5)

G:\M-P\Nason Creek Floodplain RM 3.4-4.6 Phase 3 200237\Drawings\IFL NasonFP NoRD C.dwg -- cmcconnell -- 1/13/26



RIGGING

RIGGING FOR PILE TESTING SHALL CONFORM TO THE LOAD METER MANUFACTURER'S RECOMMENDATIONS.

RIGGING SHALL HAVE MINIMUM WORKING LOAD RATING OF 12 TONS. FITTINGS SHALL BE SIZED ACCORDINGLY.

TESTING

TESTING OF PILES SHALL BE PERFORMED IN THE PRESENCE OF THE ENGINEER.

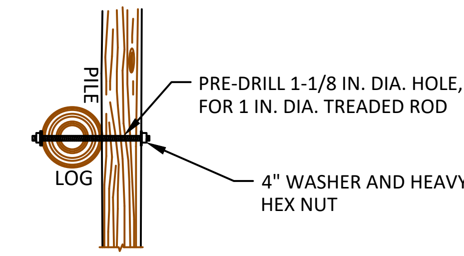
EACH PILE TEST SHALL HAVE UPWARD LOAD GRADUALLY INCREASED AND ALIGNED TO AXIS OF PILE. RECORD THE PILE DIAMETER AT GROUND SURFACE, EMBEDMENT DEPTH AND FORCE REQUIRED TO MOVE THE PILE VERTICALLY APPROXIMATELY 1 INCH. THEN DRIVE THE PILE TO A NEW DEPTH TO BE DETERMINED IN CONSULTATION WITH THE ENGINEER. APPLY NEW LOAD AND RECORD FORCE REQUIRED TO MOVE THE PILE VERTICALLY APPROXIMATELY 1 INCH. REPEAT UP TO FOUR TESTS.

PROGRESSIVE PULL OUT RESISTANCE TESTS MAY BE REQUIRED AT UP TO FOUR DEPTHS FOR EACH PILE PENDING RESULTS AND APPROVAL BY ENGINEER. DEPTHS SHALL BE DETERMINED IN THE FIELD. AS A GUIDELINE, TEST EMBEDMENT DEPTHS MAY INCLUDE 50%, 60%, 80% AND 100% OF THE DESIGN EMBEDMENT DEPTH. PULL OUT RESISTANCE TEST AT 80% AND 100% OF DESIGN EMBEDMENT DEPTH SHALL ONLY BE REQUIRED IF PULL OUT LOAD IS LESS THAN THE PROOF LOAD REQUIRED IN THE SPECIFICATIONS.

EQUIPMENT CONDUCTING PULL OUT LOADING SHALL BE POSITIONED NO CLOSER THAN EMBEDMENT DEPTH OF PILE, IF POSSIBLE. IF A CLOSER POSITIONING IS REQUIRED, EQUIPMENT SHALL BE NO CLOSER THAN THAT REQUIRED TO GENERATE REQUIRED LOADING WITH DISTANCE FROM PILE NOTED IN THE TEST RECORD. IF EQUIPMENT IS CLOSER THAN HALF THE EMBEDMENT DEPTH, DISTRIBUTE GROUND LOADING ON TIMBERS AND AWAY FROM THE PILE LOCATION. TIMBER DIMENSIONS AND LENGTHS SHALL BE NOTED IN THE TEST RECORD.

1/28 TYPICAL DETAIL - TIMBER PILE TESTING

NOT TO SCALE

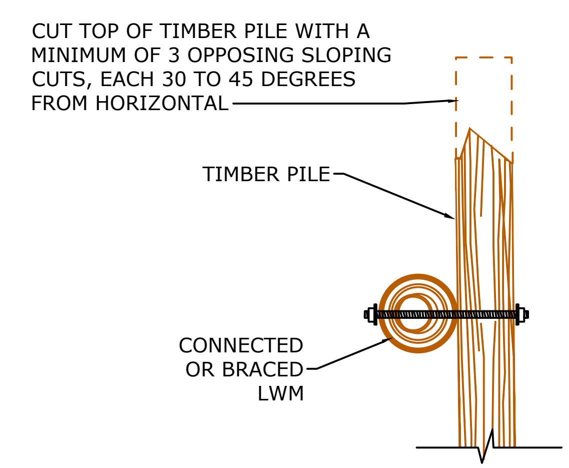


NOTES:

1. DRILL 1-1/8" DIA HOLE THROUGH LOGS.
2. INSERT 1" DIA THREADED ROD.
3. INSTALL 1/4" THICK BY 4" SQUARE OR ROUND STEEL WASHER AND HEAVY HEX NUTS. SECURE NUTS BY CHISELING THREADS OR MUSHROOMING EXPOSED ENDS OF ROD.
4. CUT BOLT TO EXTEND NO FURTHER THAN 2" PAST NUT.
5. FILE OR GRIND OFF SHARP EDGES

2/28 TYPICAL DETAIL - BOLTED CONNECTIONS

NOT TO SCALE



3/28 TYPICAL DETAIL - TIMBER PILE TOPS

NOT TO SCALE

NO.	BY	DATE	REVISION DESCRIPTION

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CM	DM	DM
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YAKAMA NATION FISHERIES

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LOG PILE DETAILS

INTRODUCTION

THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION'S STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION 2026 (WSDOT STANDARD SPECIFICATIONS) SHALL APPLY UNLESS OTHERWISE NOTED IN THE FOLLOWING PROVISIONS. IN CASE OF A CONFLICT BETWEEN THE REGULATORY STANDARDS OR SPECIFICATIONS, THE MORE STRINGENT WILL GOVERN. THE "CONTRACTING AGENCY" OR "OWNER" SHALL BE THE CONFEDERATED TRIBES AND BANDS OF THE YAKAMA NATION, UPPER COLUMBIA HABITAT RESTORATION PROJECT (UCHRP). ADDITIONAL SPECIFICATIONS IN THE FOLLOWING CONTRACT SECTIONS ARE INCLUDED FOR ITEMS NOT COVERED BY THE WSDOT STANDARD SPECIFICATIONS.

SECTIONS 1-02, 1-03, AND 1-08 (EXCEPT 1-08.6, 1-08.7, 1-08.8) OF THE STANDARD SPECIFICATIONS DO NOT APPLY.

THE IN-WATER WORK WINDOW FOR THIS PROJECT IS JULY 1 - AUGUST 15. WORK MAY OCCUR OUTSIDE OF WATER BEFORE OR AFTER THE IN-WATER WORK WINDOW.

FLOWS ARE RECORDED BY WASHINGTON DEPARTMENT OF ECOLOGY STREAM GAGE 45J070 NEAR MOUTH OF NASON CREEK

THIS PROJECT WAS DESIGNED IN ACCORDANCE WITH THE BPA HABITAT IMPROVEMENT PROGRAM (HIP). HIP GENERAL CONSERVATION MEASURES (CMS) ARE INCLUDED ON SHEETS 6-8 OF THE PLANS. SITE SPECIFIC DIRECTION IS ADDED TO THE FOLLOWING PROVISIONS. ANY VARIANCES FROM HIP CMS WILL BE REQUESTED BY OWNER. IN A CASE OF A CONFLICT BETWEEN THE REGULATORY STANDARDS OR SPECIFICATIONS, LOCAL REGULATIONS, OR OTHER CONTRACT DOCUMENTATION, THE MORE STRINGENT WILL GOVERN, UNLESS SPECIFIED IN WRITING BY THE OWNER.

ITEM 001 - MOBILIZATION

THIS ITEM SHALL CONSIST OF PREPARATION WORK AND OPERATIONS PERFORMED BY THE CONTRACTOR. THE PROVISIONS OF SECTION 2.01 OF THE WSDOT STANDARD SPECIFICATIONS, AND AS AMENDED BY THESE SPECIAL PROVISIONS.

CONSTRUCTION REQUIREMENTS

1. PRIOR TO ENTERING THE SITE, ALL EQUIPMENT SHALL BE POWER WASHED, BECOME FULLY DRY, AND INSPECTED TO MAKE SURE NO PLANTS, SOIL, OR OTHER ORGANIC MATERIAL ADHERES TO THE SURFACE. IF EQUIPMENT LEAVES THE SITE AND RETURNS, IT SHALL BE REWASHED AND INSPECTED PRIOR TO ACCESSING THE SITE.
2. TEMPORARY SITE ACCESS SHALL BE ALONG ACCESS ROUTES AND STAGING AREAS SHOWN IN THE PLANS. THESE ARE APPROXIMATE. ACTUAL DISTURBANCE LIMITS WILL BE STAKED AND FLAGGED IN THE FIELD BY THE OWNER. DESIGNATED DISTURBANCE LIMITS SHALL BE STRICTLY ADHERED TO AND NO LARGE TREES WILL BE IMPACTED WITHOUT PERMISSION FROM THE OWNER.
3. DESIGNATED RIVER CROSSINGS ARE SHOWN IN THE PLANS. A TEMPORARY BRIDGE AS SPECIFIED IN ITEM 0## TEMPORARY ACCESS BRIDGE SHALL BE USED TO CROSS FLOWING CHANNELS. TEMPORARY RIVER WET CROSSINGS ARE SHOWN ON THE PLANS. NO RIVER CROSSING SHALL BE MADE PRIOR TO APPROVAL BY OWNER.
4. PRIOR TO DEMOBILIZATION, RUTTING AND DISTURBED GROUND SHALL BE RIPPED TO 18INCHES DEEP TO DECOMPACT SOILS IF DIRECTED BY OWNER, AND GRADED SMOOTH TO BLEND WITH EXISTING TOPOGRAPHY. ACCESS ROUTES, AND STOCKPILE AND STAGING AREAS SHALL BE RETURNED TO ORIGINAL OR BETTER CONDITION. ANY REMOVED OR DAMAGED FENCES SHALL BE REPAIRED OR REPLACED TO PRE-PROJECT CONDITION OR BETTER.
5. EXISTING ROADS SHALL BE RESTORED TO PRE-PROJECT OR BETTER CONDITION AS DIRECTED BY OWNER.
6. BEFORE THE RELEASE OF FINAL RETAINAGE TO THE CONTRACTOR, THE CONTRACTOR WILL PARTICIPATE IN A WALK-THROUGH WITH THE OWNER AND USFS STAFF TO EVALUATE THE RESTORED AREAS.
7. ALL HEAVY EQUIPMENT OPERATING ON PAVEMENT SHALL USE RUBBER MATS OR SIMILAR TO AVOID IMPACTS TO PAVED SURFACE.
8. ROAD ASPHALT REPAIR/REPLACEMENT WORK SHALL CONFORM TO COUNTY, STATE OR USFS SPECIFICATIONS BASED ON JURISDICTION OF ROAD IF MORE STRINGENT THAN SPECIFICATIONS HEREIN.
9. MATERIALS EXCAVATED FOR DISPOSAL SHALL BE HAULED AND PLACED OUTSIDE OF THE FEMA DELINEATED FLOODPLAIN IN A LEGAL DISPOSAL AREA AND IN COMPLIANCE WITH ANY APPLICABLE REGULATIONS WITH ANY NECESSARY PERMITS OBTAINED BY THE CONTRACTOR.
10. CONTRACTOR SHALL REPAIR/REPLACE CRUSHED GRAVEL ROAD BASE PER WSDOT STANDARD SPECIFICATION 9-03.9(3) CRUSHED SURFACING BASE COURSE. FINISHED GRADE SHALL BE SLOPED PER ROAD JURISDICTIONAL CRITERIA TO PROVIDE POSITIVE DRAINAGE OFF ROAD SURFACE.

MEASUREMENT AND PAYMENT

MOBILIZATION SHALL BE MEASURED AND PAID FOR BY LUMP SUM. PARTIAL PAYMENTS WILL BE MADE IN ACCORDANCE WITH SECTION 2.01 OF THE STANDARD SPECIFICATIONS. WITHHOLDING OF PARTIAL PAYMENT WILL OCCUR IF LIMITS OF DISTURBANCE ARE NOT ADHERED TO. PAYMENT SHALL BE CONSIDERED FULL COMPENSATION FOR ALL EQUIPMENT, LABOR, TOOLS, MATERIALS, AND INCIDENTALS NECESSARY TO COMPLETE THIS WORK AS SPECIFIED.

ITEM 002- TRAFFIC CONTROL

TEMPORARY TRAFFIC CONTROL REQUIREMENTS SHALL INCLUDE BARRICADES AND CONSTRUCTION SIGNAGE AT THE ENTRANCE TO THE PROJECT SITE AND ANY OTHER MEASURES PER STANDARD SPECIFICATIONS SECTION 2-04.3 AND LOCAL REGULATIONS. IT IS THE CONTRACTOR'S RESPONSIBILITY TO OBTAIN APPLICABLE COUNTY PERMITS.

MEASUREMENT AND PAYMENT

TRAFFIC CONTROL SHALL BE MEASURED AND PAID FOR BY LUMP SUM. PARTIAL PAYMENTS WILL BE MADE IN ACCORDANCE WITH SECTION 2.04 OF THE STANDARD SPECIFICATIONS. PAYMENT SHALL BE CONSIDERED FULL COMPENSATION ACQUIRING RIGHT-OF-WAY PERMIT, AS WELL AS ALL EQUIPMENT, LABOR, TOOLS, MATERIALS, AND INCIDENTALS NECESSARY TO COMPLETE THIS WORK AS SPECIFIED.

ITEM 003- TESC, SPCC PLAN AND IMPLEMENTATION

THIS WORK SHALL PROVIDE FOR PREPARATION, IMPLEMENTATION, AND REMOVAL OF A TEMPORARY EROSION SEDIMENT CONTROL (TESC) PLAN AND FOR THE PREPARATION AND IMPLEMENTATION OF A SPILL PREVENTION CONTROL AND COUNTERMEASURE (SPCC) PLAN IN ACCORDANCE WITH SECTION 1-07.15 OF THE STANDARD SPECIFICATIONS, AND AS AMENDED BY THESE SPECIAL PROVISIONS.

1. THE CONTRACTOR SHALL SUBMIT A TESC FOR THE PROJECT TO THE OWNER FOR APPROVAL. THE TESC MUST SATISFY THE REQUIREMENTS OF THE WASHINGTON DEPARTMENT OF ECOLOGY NPDES STORMWATER GENERAL PERMIT FOR CONSTRUCTION ACTIVITY AND ALL OTHER APPLICABLE PERMITS. THE CONTRACTOR SHALL USE MEASURES OF THEIR OWN DESIGN TO ENSURE SATISFACTORY PERFORMANCE AND THAT THE EROSION CONTROL REQUIREMENTS OF ALL APPLICABLE PERMITS ARE MET. THE CONTRACTOR SHALL BE NAMED AS THE PERMIT HOLDER. THE CONTRACTOR SHALL BE RESPONSIBLE FOR IMPLEMENTING, INSPECTING AND FILING REPORTS, MAINTAINING, REPLACING, AND REMOVING TESC AND SPCC MEASURES. THE PLAN SHALL INCLUDE THE NAME, ADDRESS AND 24-HOUR CONTACT NUMBER OF THE PERSON RESPONSIBLE FOR EROSION PREVENTION AND SEDIMENT CONTROL MEASURES.
2. A SPILL CONTAINMENT KIT SHALL BE ON SITE AND CREWS SHALL BE TRAINED IN ITS USE.
3. BIODEGRADABLE HYDRAULIC FLUID SHALL BE INSTALLED INTO EACH PIECE OF HEAVY MACHINERY WORKING WITHIN 50 FEET OF THE RIVER AND SIDE CHANNELS.
4. CONTRACTOR WILL BE REQUIRED TO APPLY FOR AN INDUSTRIAL FIRE PROTECTION LEVEL (IFPL) 3 WAIVER IN THE EVENT THAT DEPARTMENT OF NATURAL RESOURCES DECLARES THE IFPL LEVEL HAS BEEN INCREASED TO LEVEL 3. REGARDLESS OF IFPL LEVELS, A FIRE CONTAINMENT KIT INCLUDING SHOVELS AND FIRE EXTINGUISHERS WILL BE KEPT WHERE ANY CONSTRUCTION ACTIVITIES ARE TAKING PLACE AND AT THE REFUELING LOCATION.

INSPECTION AND MAINTENANCE

THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE AT OWN EXPENSE FOR PROVIDING AND MAINTAINING ALL NECESSARY EROSION CONTROL FACILITIES TO COMPLY WITH APPLICABLE EROSION CONTROL REGULATIONS AND TO MAINTAIN CLEAN ACCESS ROUTES.

ALL TESC FACILITIES SHALL BE INSPECTED, MAINTAINED, AND REPAIRED AS NEEDED TO ASSURE CONTINUED PERFORMANCE OF THEIR INTENDED FUNCTION. ALL TESC FACILITIES SHALL BE INSPECTED DAILY AND WITHIN 24 HOURS AFTER ANY STORM EVENT GREATER THAN 0.5 INCHES OF RAIN PER 24 HOUR PERIOD AND AFTER EVENTS EXCEEDING 2 HOURS DURATION.

CONTRACTOR'S MEETINGS AND TESC RECORDS

THE CONTRACTOR SHALL MEET WITH THE OWNER AND OWNER'S REPRESENTATIVE AT THE BEGINNING OF EACH WORK WEEK TO DISCUSS: WORK COMPLETED DURING THE PRIOR WEEK, WORK ANTICIPATED IN THE NEXT WEEK, CONSTRUCTION SCHEDULE, WORK SITE ORGANIZATION, ACCESS ROUTES, CONSTRUCTION TECHNIQUES, LANDOWNER CONSIDERATIONS, BIOLOGICAL OBJECTIVES, LOGISTICS AND OTHER TOPICS PERTINENT TO IMPLEMENTATION OF THE PROJECT.

THE CONTRACTOR SHALL SUBMIT WEEKLY REPORTS TO THE OWNER. REPORTS SHALL INCLUDE: SCOPE OF INSPECTIONS, THE PERSONNEL CONDUCTING THE INSPECTION, THE DATE(S) OF THE INSPECTION, MAJOR OBSERVATIONS RELATING TO THE IMPLEMENTATION OF THE CONTRACTOR'S EROSION AND SEDIMENT CONTROL PLAN, AND ACTIONS TAKEN AS A RESULT OF THE INSPECTIONS SHALL BE PREPARED AND RETAINED ON SITE BY THE CONTRACTOR. IN ADDITION, A RECORD OF THE FOLLOWING EVENTS SHALL BE INCLUDED IN THE REPORTS:

1. WHEN MAJOR GRADING ACTIVITIES OCCUR,
2. DATES OF RAINFALL EVENTS EITHER EXCEEDING 2 HOURS DURATION OR MORE THAN 0.5 INCHES/24 HOURS,
3. WHEN CONSTRUCTION ACTIVITIES TEMPORARILY OR PERMANENTLY CEASE ON SITE, OR ON A PORTION OF THE SITE,
4. WHEN STABILIZATION MEASURES ARE INITIATED FOR PORTIONS OF THE SITE.

TESC RECORDS SHALL BE MADE AVAILABLE TO THE OWNER AND THE OWNER'S REPRESENTATIVE ON THE REQUEST AND SHALL BE PROVIDED FOR REVIEW AND APPROVAL PRIOR TO APPLICATION FOR PAYMENT.

MEASUREMENT AND PAYMENT

"TESC, SPCC PLAN AND IMPLEMENTATION," INCLUDING THE ABOVE AMENDMENTS TO THE ITEM WILL BE MEASURED AND PAID FOR BY LUMP SUM. PAYMENT SHALL BE CONSIDERED FULL COMPENSATION FOR ALL EQUIPMENT, LABOR, TOOLS, MATERIALS, AND INCIDENTALS NECESSARY TO COMPLETE THIS WORK AS SPECIFIED.

ITEM 004 - CLEARING AND GRUBBING

THIS ITEM CONSISTS OF CLEARING AND GRUBBING FOR CONSTRUCTION AS SHOWN IN THE PLANS INCLUDING THOSE AREAS REQUIRED FOR TEMPORARY ACCESS ROUTES AND IN ACCORDANCE WITH SECTION 3-01 OF THE STANDARD SPECIFICATIONS, AND AS AMENDED BY THESE SPECIAL PROVISIONS.

1. CLEARING AND GRUBBING SHALL BE LIMITED TO APPROVED ACCESS ROUTES, EXCAVATION/FILL AND LWM STRUCTURE CONSTRUCTION AREAS AS SHOWN IN THE PLANS. LIMITS OF DISTURBANCE EXTENTS MAY BE ADJUSTED BY THE OWNER TO REDUCE DAMAGE TO THE ENVIRONMENT. THE FINAL AREAS WILL BE FLAGGED IN THE FIELD BY THE OWNER PRIOR TO CLEARING AND GRUBBING WORK. CLEARING AND GRUBBING SHALL NOT OCCUR OUTSIDE OF THE DESIGNATED LIMITS.
2. BRUSH, SHRUBS AND TREES SHALL BE CLEARED BY CUTTING AT GROUND LEVEL. GRUBBING SHALL ONLY OCCUR TO VEGETATION SPECIFIED BY OWNER.
3. INCLUDED IN THIS ITEM ARE TREES VARYING IN SIZE IDENTIFIED BY THE OWNER FOR REMOVAL AND SALVAGE. TREE SPECIES INCLUDE CONIFEROUS AND DECIDUOUS. REMOVED TREES SHALL BE SALVAGED FOR INSTALLATION AS LARGE WOODY MATERIAL DURING CONSTRUCTION OF THE SIDE CHANNEL AND LOG STRUCTURES. FOR CONIFEROUS TREES, THE CONTRACTOR SHALL EXCAVATE TO LOOSEN SOIL AROUND EACH ROOTWAD AND THEN PUSH OVER TREES IN ORDER TO SALVAGE LOGS WITH INTACT ATTACHED ROOTS. DECIDUOUS TREES MAY BE CUT AT THE STUMP WITH ROOTS LEFT UNGRUBBED. SALVAGED TREES SHALL BE TEMPORARILY STOCKPILED WITHIN PROJECT LIMITS OF DISTURBANCE.
4. TREES AND SHRUBS SMALLER THAN 12" DBH THAT ARE REMOVED DURING CLEARING AND GRUBBING SHALL BE SALVAGED AND USED AS SLASH DURING INSTALLATION OF LWM . UNUSED EXCESS SLASH MAY REMAIN ON SITE AND SHALL BE EVENLY DISTRIBUTED ON DISTURBED AREAS.
5. VEGETATION PROTECTION AND RESTORATION PER SECTION 1-07.16(2) SHALL BE INCIDENTAL TO CLEARING AND GRUBBING.

MEASUREMENT AND PAYMENT

REMOVAL AND SALVAGE OF TREES AND SHRUBS SHALL BE CONSIDERED INCIDENTAL TO CLEARING AND GRUBBING.

INSTALLATION OF THE SALVAGED TREES INTO PROJECT FEATURES SHALL BE AS SHOWN ON THE PLANS AND SHALL BE INCIDENTAL TO THOSE ITEMS. NO ADDITIONAL COMPENSATION WILL BE ALLOWED.

MEASUREMENT AND PAYMENT FOR CLEARING AND GRUBBING SHALL BE BY THE LUMP SUM CONTRACT PRICE FOR "CLEARING AND GRUBBING". PAYMENT SHALL BE CONSIDERED FULL COMPENSATION FOR ALL EQUIPMENT, LABOR, TOOLS, MATERIALS, AND INCIDENTALS NECESSARY TO COMPLETE THIS WORK AS SPECIFIED.

ITEM 005 - COFFERDAM AND DIVERSION

THIS ITEM CONSISTS OF PROVIDING AND INSTALLING, MAINTAINING, AND REMOVING MEASURES TO BYPASS THE SURFACE WATERS OF THE STREAM AROUND IN-CHANNEL WORK AREAS, AND TO PREVENT TURBIDITY FROM ENTERING THE RIVER. COFFERDAM LOCATIONS ARE SHOWN ON THE PLANS.

COFFERDAM SHALL BE VIBRATORY DRIVEN SHEETPILE. DRIVING SHEET PILE BY IMPACT HAMMER IS NOT ACCEPTABLE. REVIEW AND APPROVAL OF THE COFFERDAM PLAN SHALL NOT RELIEVE THE CONTRACTOR FROM FULL RESPONSIBILITY FOR THE ADEQUACY OF COFFERDAM WORK IF THE PROPOSED PLAN IS NOT SUCCESSFUL AT PROPERLY ISOLATING THE WORK AREA. COFFERDAMS SHALL BE SUITABLY OFFSET FROM WORK AREA SO AS TO NOT INTERFERE WITH LOG PLACEMENT OR LIMIT POOL EXCAVATION.

THE WORK INCLUDES COORDINATING WITH THE OWNER FOR FISH SALVAGE AND RELOCATION ACTIVITIES. EXCAVATION, FILL OR LOG PLACEMENT SHALL NOT OCCUR UNTIL THE OWNER COMPLETES FISH SALVAGE. THE CONTRACTOR SHALL PROVIDE MINIMUM 2 DAYS ADVANCE NOTICE TO THE OWNER BEFORE EACH COFFERDAM INSTALLATION DATE. THE CONTRACTOR SHALL PROVIDE OWNER ACCESS TO COFFERDAMS AND SUPPORTING STAFF FOR OWNER'S DEFISHING. THE CONTRACTOR IS ADVISED THAT FISH RESCUE MAY TAKE APPROXIMATELY 4 HOURS PER COFFERDAM.

MATERIALS

THE CONTRACTOR SHALL PROVIDE ALL REQUIRED MATERIALS FOR THE PROJECT.

CONSTRUCTION REQUIREMENTS

THE CONTRACTOR SHALL ISOLATE THE WORK AREA FROM THE RIVER BY INSTALLING COFFERDAM PER THE PLANS. NO TURBIDITY FROM CONSTRUCTION ACTIVITIES SHALL ENTER THE RIVER.

MEASUREMENT AND PAYMENT

"COFFERDAM AND DIVERSION," INCLUDING THE ABOVE AMENDMENTS TO THE ITEM, WILL BE MEASURED BY LUMP SUM. PAYMENT SHALL BE CONSIDERED FULL COMPENSATION FOR ALL EQUIPMENT, LABOR, TOOLS, MATERIALS, AND INCIDENTALS NECESSARY TO COMPLETE THIS WORK AS SPECIFIED FOR THE ENTIRETY OF THE PROJECT. PAYMENT WILL BE MADE IN ACCORDANCE WITH SECTION 1-04.1 FOR THE FOLLOWING BID ITEMS: "COFFERDAM" PER LUMP SUM.

ITEM 006 - PUMPING

THIS ITEM INCLUDES DEWATERING AND CONTROLLING TURBIDITY WITHIN CONSTRUCTION AREAS ISOLATED FROM THE RIVER BY COFFERDAMS. THE WORK CONSISTS OF FURNISHING, MONITORING, OPERATING, MAINTAINING, AND REMOVING PUMPS, COORDINATING WITH THE OWNER FOR FISH SALVAGE RELOCATION ACTIVITIES, AND INSTALLATION OF CONTROL OF WATER BMPS.

MATERIALS

CONTRACTOR SHALL PROVIDE SUFFICIENT SIZE AND NUMBERS OF PUMPS TO DEWATER COFFERDAMS AND CONTROL TURBIDITY FOR THE PROJECT AND ENCOUNTERED FLOWS AND GROUNDWATER CONDITIONS. CONTRACTOR SHALL PROVIDE A MINIMUM OF ONE 6" TRASH PUMP WITH PUMPING CAPACITY GREATER THAN 600 GPM, ASSUMING 12 FEET OF VERTICAL LIFT AND 300 FEET OF DISCHARGE HOSE AND 2" TRASH PUMPS. ADDITIONAL PUMPS SHALL BE PROVIDED BY CONTRACTOR AS NEEDED AT NO ADDITIONAL COST

1. EACH WATER INTAKE SHALL HAVE A FISH SCREEN INSTALLED, OPERATED AND MAINTAINED ACCORDING TO NMFS' FISH SCREEN CRITERIA (NMFS 1997; NMFS 2008). NO PUMPING CAN OCCUR UNTIL FISH SCREEN HAS BEEN APPROVED BY OWNER PRIOR TO INSTALLATION.
2. PUMPS SHALL BE PLACED WITHIN A CONTAINER TO CONTAIN FUEL OR OIL SPILLS. OIL ABSORBENT DIAPERS SHALL BE STORED AT EACH PUMP.
3. THE CONTRACTOR SHALL PROVIDE ENVIRONMENTAL PROTECTION MEASURES SUCH AS STRAW BALES, PERFORATED PIPE FOR DISCHARGE FLOW DISTRIBUTORS, GEOTEXTILES, FILTER BAGS, OR OTHER MEANS OF CONTROLLING DISCHARGE WATER AND TURBIDITY. NO TURBIDITY SHALL BE ALLOWED TO ENTER THE RIVER OR WETLANDS.
4. TO HELP PREVENT TURBIDITY FROM LEAKING THROUGH COFFERDAMS, THE CONTRACTOR SHALL OPERATE 6" TRASH PUMP TO LOWER THE WATER SURFACE WITHIN THE ISOLATED AREA AND DISCHARGE TO AN INFILTRATION AREA.

ENVIRONMENTAL PROTECTION MEASURES

a. IF OBSERVED OR MEASURED TURBIDITY DOWNSTREAM OF COFFERDAM OR PUMP DISCHARGE IS MORE THAN 10% ABOVE THE UPSTREAM BACKGROUND VISUAL OBSERVATION OR MEASUREMENT - OR EXCEEDS APPLICABLE PERMITS AND REGULATIONS - THE ACTIVITY MUST BE MODIFIED TO REDUCE TURBIDITY. CONTINUE TO MONITOR EVERY 2 HOURS AS LONG AS INSTREAM ACTIVITY CONTINUES.

b. IF EXCEEDANCES OCCUR FOR MORE THAN TWO CONSECUTIVE MONITORING INTERVALS (AFTER 4 HOURS), THE ACTIVITY MUST STOP UNTIL THE TURBIDITY LEVEL RETURNS TO BACKGROUND, AND THE EC LEAD MUST BE NOTIFIED WITHIN 48 HOURS.

c. IF AT ANY TIME, MONITORING, INSPECTIONS, OR OBSERVATIONS/SAMPLES SHOW THAT THE TURBIDITY CONTROLS ARE INEFFECTIVE, IMMEDIATELY STOP WORK AND MOBILIZE WORK CREWS TO REPAIR, REPLACE, OR REINFORCE CONTROLS AS NECESSARY. ADDITIONAL AND ALTERNATIVE METHODS, SUCH AS PUMPING INTO STILLING BASINS OR FILTRATION GEOTEXTILE FABRIC SHALL BE REQUIRED AT THE CONTRACTOR'S EXPENSE.

"PUMPING," INCLUDING THE ABOVE AMENDMENTS TO THE ITEM WILL BE MEASURED BY LUMP SUM. PAYMENT SHALL BE CONSIDERED FULL COMPENSATION FOR ALL EQUIPMENT, LABOR, TOOLS, MATERIALS, AND INCIDENTALS NECESSARY TO COMPLETE THIS WORK AS SPECIFIED FOR THE ENTIRETY OF THE PROJECT. PAYMENT WILL BE MADE IN ACCORDANCE WITH SECTION 1-04.8 FOR THE FOLLOWING BID ITEMS: "PUMPING" PER LUMP SUM.

ITEM 007 - TEMPORARY ACCESS BRIDGE

A TEMPORARY BRIDGE SHALL BE REQUIRED TO CROSS FLOW CHANNEL AT LOCATION SHOWN IN THE PLANS. CONTRACTOR SHALL SUBMIT AN ACCESS PLAN INCLUDING DRAWINGS SHOWING DETAILS OF PROPOSED METHODS FOR PROVIDING ACCESS FOR EQUIPMENT, INCLUDING LOADED HAUL TRUCKS, TO THE SITES. REVIEW AND APPROVAL OF THE PLAN SHALL NOT RELIEVE THE CONTRACTOR FROM FULL RESPONSIBILITY FOR THE ADEQUACY AND SAFETY OF THE CROSSING.

TEMPORARY BRIDGE SHALL SPAN FLOWING WATER WITHOUT CREATING A BACKWATER CONDITION AND PROVIDE A MINIMUM OF 1.0-FT OF FREEBOARD FROM LOW CHORD TO MAXIMUM WATER SURFACE ELEVATION FOR DURATION OF BRIDGE INSTALLATION. ABUTMENTS SHALL BE PROVIDED AS NECESSARY FOR THE BRIDGE SYSTEM AND SHALL NOT ENCROACH ON STREAM FLOW. APPROACH RAMPS TO THE BRIDGE SHALL BE CLEAN ALLUVIAL MATERIAL. ABUTMENTS MAY REQUIRE COFFERDAMS. COFFERDAM AND BRIDGE SHALL BE REMOVED AT PROJECT COMPLETION.

THE TEMPORARY BRIDGE SHALL BE REMOVED BEFORE THE END OF THE IN-WATER WORK WINDOW.

MEASUREMENT AND PAYMENT

"TEMPORARY ACCESS BRIDGE" WILL BE MEASURED AND PAID FOR BY ONE LUMP SUM FOR ALL TEMPORARY BRIDGE INSTALLATIONS. INSTALLATION OF THE TEMPORARY BRIDGE, REMOVAL, MAINTENANCE, AND ASSOCIATED ITEMS SUCH AS ABUTMENTS, FOOTINGS, RAMPS, AND SEDIMENT AND WATER CONTROLS SHALL BE INCLUDED IN THIS ITEM.

ITEMS 008 EARTHWORKS

EARTHWORKS SHALL CONSIST OF EXCAVATING, SORTING, LOADING AND HAULING SPOILS AND SALVAGE RIPRAP TO SPECIFIED ON-SITE DISPOSAL AREA TO BE DESIGNATED BY OWNER AND LEGAL OFF-SITE DISPOSAL AREA AND GRADING TO BLEND TO EXISTING CONTOURS, AND PLACING ALLUVIAL FILL IN LOCATIONS DESIGNATED ON PLANS. ROAD MATERIALS INCLUDING ASPHALT SHALL BE HANDLED PER APPLICABLE REGULATIONS FOR HAULING OFF SITE AND DISPOSING OF IN A LEGAL FACILITY. SPECIFIC LOCATION AND GRADING SHALL BE AS INDICATED IN PLANS.

1. CONTRACTOR SHALL PROVIDE SURVEY EQUIPMENT AND CONDUCT STAKEOUT AND SURVEY TO DETERMINE ELEVATIONS. EXISTING ELEVATION CONTROL POINTS ARE LOCATED NEARBY.
2. PORTIONS OF WORK MAY BE IN WATER. THE CONTRACTOR IS ADVISED THAT GROUNDWATER MAY BE ENCOUNTERED THROUGHOUT EXCAVATION AREAS. PUMPING AND TESC SHALL BE IMPLEMENTED AS NECESSARY.
3. THIS ITEM INCLUDES HAULING OF MATERIAL EXCAVATED TO DESIGNATED DISPOSAL AREAS. EXCAVATED MATERIAL MAY BE REQUIRED AS SALVAGED BACKFILL IN STRUCTURES. CONTRACTOR SHALL SELECTIVELY STOCKPILE MATERIALS INTO SEGRAGETED SIZES
4. THIS ITEM INCLUDES DETAIL EXCAVATION, FILL AND GRADING TO SHAPE THE CHANNEL AS SHOWN IN THE PLANS, SCOUR POOLS SHALL BE OVER-EXCAVATED INTO THE STREAM BED AS DESIGNATED IN THE PLANS AND DETAILS.
5. NO WORK SHALL OCCUR OUTSIDE OF THE LIMITS OF DISTURBANCE SHOWN IN THE PLANS UNLESS AUTHORIZED BY THE OWNER.

MEASUREMENT AND PAYMENT

EARTHWORKS WILL BE MEASURED BY CUBIC YARDS OF EXCAVATION AND PLACEMENT. MEASUREMENTS SHALL BE IN PLACE QUANTITY BY COMPARISON OF PRE-PROJECT (EXISTING) TOPOGRAPHY, DESIGN SUBGRADE AND DESIGN FINISHED GRADE TOPOGRAPHIC SURFACES.

QUANTITIES MEASUREMENT BY TRUCK WEIGHT OR TRUCK COUNT SHALL NOT BE ALLOWED.

MEASUREMENT AND PAYMENT.

EXCAVATION, SORTING, HAUL, DISPOSAL, GRADING OF DISPOSED SPOILS, FILL AND GRADING OF CHANNEL FEATURES; PLACEMENT OF SALVAGED SLASH; AND EXCAVATION OF SCOUR POOLS FOR LARGE WOOD STRUCTURES SHALL BE INCIDENTAL TO THIS ITEM. NO ADDITIONAL COMPENSATION WILL BE MADE FOR EXCAVATED MATERIAL THAT IS OVER EXCAVATED OR STOCKPILED, RE-EXCAVATED, AND MOVED AGAIN.

PAYMENT SHALL BE CONSIDERED FULL COMPENSATION FOR ALL EQUIPMENT, LABOR, TOOLS, MATERIALS, AND INCIDENTALS NECESSARY TO COMPLETE THIS WORK AS SPECIFIED.

ITEMS 009-021 - LOG STRUCTURES

"LOG STRUCTURES" INCLUDES ALL WORK ASSOCIATED WITH HAULING, HANDLING AND INSTALLATION OF LWM, SALVAGED TREES AND SLASH. THIS ITEM INCLUDES EXCAVATION AND BACKFILL TO PARTIALLY BURY LWM, AND HAUL AND DISPOSAL OF SURPLUS EXCAVATED MATERIAL. COFFERDAM AND PUMPING ARE REQUIRED AT DESIGNATED "LOG STRUCTURES" SHOWN IN THE PLANS. "LOG STRUCTURES" INCLUDES:

- ITEM 009 - APEX JAMS
- ITEM 010 - BANK BURIED JAM
- ITEM 011 - SMALL BANK BURIED JAM
- ITEM 012 - BANK MARGIN WOOD
- ITEM 013 - BAR ROUGHNESS WOOD
- ITEM 014 - SMALL BANK BURIED AND BAR ROUGHNESS RACKING WOOD
- ITEM 015 - CED3 BANK BARB STRUCTURE
- ITEM 016 - DEFLECTOR JAM
- ITEM 017 - INLET STRUCTURE
- ITEM 018 - LOW FLOW CHANNEL FLOODPLAIN ROUGHNESS LW
- ITEM 019 - LOW FLOW CHANNEL HABITAT COVER LOGS
- ITEM 020 - LOW FLOW CHANNEL FLOODPLAIN ROUGHNESS LOG
- ITEM 021 - TIPPED TREE

MATERIALS

LOG STRUCTURES SHALL BE CONSTRUCTED OF LARGE WOODY MATERIAL (LWM), EXCAVATION AND BACKFILL, SLASH, SALVAGED TREES AND TREE TOPS AND - IF DIRECTED BY OWNER, OPTIONAL ADDITIVE ITEMS: ITEM 022 JAM BALLAST BOULDERS AND/OR ITEM 023 IMPORTED BOULDER BACKFILL.

LWM INCLUDES: LOGS WITH ROOTWADS, LOGS WITHOUT ROOTWADS, AND PILES.

LWM IS SUPPLIED BY THE OWNER AND IS DECKED AT WINTON MILL.

THE CONTRACTOR SHALL LOAD AND HAUL LWM FROM THE OWNER'S STOCKPILE. QUANTITIES TO BE MOVED TO EACH SITE ARE SHOWN IN THE PLANS.

OWNER SUPPLIED LWM WILL HAVE THE FOLLOWING CHARACTERISTICS:

6. LOGS WITH ROOTWADS: 40' LONG AND 18" DBH.
7. LOGS WITHOUT ROOTWADS: 40' LONG AND 18" DBH.
8. PILES: 20' LONG AND 16" DIAMETER AT MIDDLE OF LOG

SLASH: INCLUDES SHRUBS, TREES <6" DBH AND TREE TOPS REMOVED FROM ACCESS ROUTES AND EXCAVATION AREAS. UNITS OF SLASH SHALL BE DENSELY PACKED 4FT DIAMETER BY 12FT LONG BUNDLES.

CONSTRUCTION REQUIREMENTS

LOCATIONS FOR PLACEMENT AND DETAILS OF CONSTRUCTION FOR EACH STRUCTURE TYPE ARE SHOWN IN THE PLANS. FINAL LOCATION AND INSTALLATION WILL DEPEND UPON THE SIZE, SHAPE AND QUANTITY OF MATERIAL DELIVERED OR SALVAGED. INSTALLATION OF LWM SHALL BE UNDERSTOOD TO REQUIRE A "FIT IN THE FIELD" APPROACH AS DIRECTED BY THE OWNER.

PILES: CONSTRUCTION OF PILES SHALL INCLUDE ON-SITE MOVEMENT AND INSTALLATION OF PILES TO DESIGNATED SITES SHOWN IN THE PLANS. PILES SHALL BE PER THE APPROXIMATE NUMBERS AND QUANTITIES INDICATED ON THE PLANS. CONTRACTOR SHALL CUT TO LENGTH AT NO ADDITIONAL COST. SPECIFIC LOCATIONS SHALL BE DETERMINED IN THE FIELD AND DIRECTED BY THE OWNER. THE REQUIRED EMBEDMENT DEPTH IS INDICATED ON THE PLANS. EACH PILE SHALL HAVE A "BROKEN TOP" BY STUMP-GRINDING OR MAKING MULTIPLE PLUNGE CUTS WITH CHAIN SAW TO PROVIDE A ROUGHENED OR RAGGED END. ROUGHENING ENDS SHALL NOT COMPROMISE PILE STRUCTURAL INTEGRITY AT LOG CONNECTIONS. PILES SHALL BE OF VARYING HEIGHTS EXTENDING FROM 2 TO 5 FEET ABOVE FINISHED GRADE. ONE BOLT SHALL BE INSTALLED IN EACH PILE CONNECTING TO TOP LOG AS DETAILED IN THE PLANS.

PILES SHALL BE INSTALLED BY VIBRATORY PILE DRIVER MEETING OR EXCEEDING THE FOLLOWING CHARACTERISTICS:

a. MINIMUM OF 800 KN (80 TONS) OF CENTRIFUGAL FORCE.

b. SIDE GRIP WITH MINIMUM 16” SPACE BETWEEN ENDS OF JAWS SO THAT 16” DIAMETER LOG WILL FIT INTO THE JAWS WITHOUT NEEDING TO SLIDE THE GRIP OVER THE END AND DOWN THE LOG.

c. PRE-APPROVED PILE DRIVERS INCLUDE: MOVAX SP-80, GRIZZLY MG90, OR EQUIVALENT.

TESTING: AT EACH LOG STRUCTURE SITE, A MINIMUM OF ONE PILE SHALL BE TESTED FOR PULLOUT RESISTANCE. EACH TEST WILL REQUIRE UP TO FOUR INDIVIDUAL PULLS, EACH AT A DEEPER DEPTH. SEE DETAILS IN PLANS. THE CONTRACTOR SHALL PROVIDE THE TENSION LINK, METER, AND ASSOCIATED HARDWARE (RATED 12 TON).

SLASH: SLASH SHALL BE INCORPORATED INTO LOG STRUCTURES AS SHOWN IN THE PLANS AND DIRECTED BY THE OWNER. INTERMINGLE, STACK, AND RACK SLASH MATERIAL TO THE INSTALLED LWM AND PILE TO EMULATE NATURAL ACCUMULATIONS OF WOOD MATERIAL. IF INSUFFICIENT SLASH IS SALVAGED ON SITE. CONTRACTOR SHALL IMPORT SLASH AT NO ADDITIONAL COST

WHOLE TREES: TREES CLEARED FOR ACCESS OR ALREADY DOWNED TREES IMMEDIATELY ADJACENT TO CONSTRUCTION SITE AND REQUIRING MOVEMENT FOR SITE ACCESS MAY BE INCORPORATED, AS DIRECTED BY THE OWNER. SALVAGED TREE TOPS MAY BE USED AS SLASH. IF SALVAGE DOES NOT GENERATE SPECIFIED NUMBER OF WHOLE TREES, IMPORT WHOLE TREES AT NO ADDITIONAL COST.

TIPPED TREES SHOWN ON THE PLANS SHALL BE TIPPED BY EXCAVATOR OR CABLE - NO FELLING OR CUTTING OF TREES IS ALLOWED. IF TREE TIPPING IS DESIGNATED BY OWNER TO BE BY OTHERS, CONTRACTOR SHALL COORDINATE WITH TREE TIPPING CONTRACTOR.

EARTHWORK: WHERE PARTIAL BURIAL OF LWM IS REQUIRED, EXCAVATE TO SUBGRADE AND STOCKPILE MATERIAL WITHIN THE DESIGNATED DISTURBANCE AREA. SORT MATERIALS BY GENERAL SIZES, SEPARATING PILES FOR COARSE AND FINE MATERIAL. BACKFILL THE LWM AS EACH LAYER IS INSTALLED. USE COARSE FILL COMPRISED OF GRAVEL/COBBLE ALLUVIUM WITH FINES ALONG EXTERIOR OF FILL ZONE AND ALONG WATERWARD EDGE, AND FINER GRAVEL MATERIALS WITHIN INTERIOR OF FILL ZONE. SILT AND SAND SHALL NOT BE USED FOR BACKFILL AND SHALL BE HAULED FROM THE SITE; CONTRACTOR SHALL SALVAGE OR IMPORT GRAVEL/COBBLE ALLUVIUM FOR BACKFILL AT NO ADDITIONAL COST. WHERE POOL EXCAVATION IS INCLUDED, EXCAVATED MATERIAL SHALL BE SALVAGED AND PLACED AS BACKFILL IN LWM STRUCTURE. BACKFILL ALONG WATERWARD EDGE SHALL BE LAYERED WITH SLASH WITH LIFTS NO THICKER THAN 18INCHES AND BUCKET COMPACTED. SLASH SHALL EXTEND 10FT MINIMUM INTO FILL. BACKFILL THE LOGS AS EACH LAYER IS INSTALLED.

LIVE WILLOW AND DOGWOOD PLANTINGS SHALL BE INSTALLED IN LARGE WOOD STRUCTURES AND AS SHOWN ON PLANS AND DETAILS.

MEASUREMENT AND PAYMENT

MEASUREMENT AND PAYMENT SHALL BE MADE PER EACH STRUCTURE FOR:

- ITEM 009 - APEX JAMS
- ITEM 010 - BANK BURIED JAM
- ITEM 011 - SMALL BANK BURIED JAM
- ITEM 012 - BANK MARGIN WOOD
- ITEM 013 - BAR ROUGHNESS WOOD
- ITEM 014 - SMALL BANK BURIED AND BAR ROUGHNESS RACKING WOOD
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- ITEM 019 - LOW FLOW CHANNEL HABITAT COVER LOGS
- ITEM 020 - LOW FLOW CHANNEL FLOODPLAIN ROUGHNESS LOG
- ITEM 021 - TIPPED TREE

THE CONTRACT PRICE SHALL BE FULL COMPENSATION FOR ALL COSTS INCURRED FOR EQUIPMENT, MATERIALS AND LABOR FOR HANDLING, LOADING AND HAULING LWM FROM STOCKPILE AREAS, EXCAVATING TO SUBGRADE, SELECTIVE HANDLING OF EXCAVATED MATERIALS AND BACKFILL, SALVAGE OR IMPORT OF SUITABLE BACKFILL MATERIAL, INSTALLING AND SECURING LWM, PILES, SLASH AND SALVAGED TREE TOPS AND WHOLE TREES AS OUTLINED IN THE PLANS. EARTHWORK, HAUL AND DISPOSAL OF SPOILS. INSTALLING SLASH AND SALVAGED TREES SHALL BE INCIDENTAL.

LIVE WILLOW AND DOGWOOD CUTTINGS INCLUDED IN LARGE WOOD STRUCTURES SHALL BE INCIDENTAL TO LARGE WOOD STRUCTURES. CUTTINGS STORAGE & WATERING, EXCAVATION, INSTALLATION AND BACKFILL AND ANY OTHER WORK NECESSARY TO INSTALL LIVE WILLOWS SHALL BE INCIDENTAL.

REVEGETATION TO BE DESIGNED BY OTHERS IN FUTURE DESIGN PHASES.

OPTIONAL ADDITIVE ALTERNATE ITEMS

FOLLOWING ARE OPTIONAL ADDITIVE ALTERNATE ITEMS. OWNER SHALL DETERMINE IF ITEMS ARE REQUIRED, QUANTITIES AND LOCATIONS FOR PLACEMENTS. OWNER SHALL PROVIDE WRITTEN AUTHORIZATION TO IMPLEMENT THESE ITEMS PRIOR TO PROCUREMENT, TRANSPORT, HANDLING OR INSTALLATION.

ITEM 022 - JAM BALLAST BOULDERS

OWNER SHALL DETERMINE IF ADDITIONAL JAM BALLAST BOULDERS (BOULDERS) ARE REQUIRED. CONTRACTOR SHALL PROCURE AND IMPORT, HAUL AND PLACE BOULDERS. UNLESS NOTED HEREIN, BOULDERS SHALL MEET WSDOT STANDARD SPECIFICATION 9-13.1. BOULDERS SHALL BE MINIMUM 4FT EQUIVALENT DIAMETER WITH SPECIFIC GRAVITY OF 2.65 OR GREATER AND SHALL WEIGH NO LESS THAN 5,500 POUNDS DRY WEIGHT PER EACH. BOULDERS SHALL BE ROUNDED TO SUBANGULAR.

MEASUREMENT AND PAYMENT

JAM BALLAST BOULDERS SHALL BE MEASURED AND PAID FOR PER EACH BOULDER. PAYMENT WILL BE FULL COMPENSATION FOR ALL COSTS INCURRED FOR SALVAGE OR IMPORT OF BOULDERS, HAULING, STOCKPILING AND PLACING.

ITEM 023 - IMPORTED BOULDER BACKFILL

OWNER SHALL DETERMINE IF IMPORTED BOULDER BACKFILL IS REQUIRED FOR BACKFILL ON BANK BURIED LARGE WOOD STRUCTURES. THIS MATERIAL IS COMPRISED OF COBBLE TO MEDIUM SIZED BOULDERS. SOURCE IS TO BE DETERMINED. CONTRACTOR SHALL PROCURE AND IMPORT, HAUL AND PLACE IMPORTED BOULDER BACKFILL IN LARGE WOOD STRUCTURES AS DIRECTED BY ENGINEER.

MEASUREMENT AND PAYMENT

IMPORTED BOULDER BACKFILL SHALL BE MEASURED AND PAID FOR PER CUBIC YARD PLACED. TRUCK COUNT OR WEIGHT MAY BE ALLOWED WITH WRITTEN PERMISSION. PAYMENT WILL BE FULL COMPENSATION FOR ALL COSTS INCURRED FOR IMPORTED BOULDER BACKFILL, PROCUREMENT, IMPORT, HAULING, STOCKPILING AND PLACING

Nason Creek, Phase 2 RM 3.7-4.6 Floodplain Enhancement

60% Basis of Design Report

SUBMITTED TO
Yakama Nation UCHRP

January 14, 2026

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60% Basis of Design Report

SUBMITTED TO

Confederated Tribes and
Bands of the Yakama Nation
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PREPARED BY

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January 14, 2026

Table of Contents

1. Preface 1

1.1 Name and titles of sponsor, firms and individuals responsible for design 3

1.2 List of project elements that have been designed by a licensed professional engineer 4

1.3 Identification and description of risk to infrastructure or existing resources 5

1.4 Explanation and background on fisheries use (by life stage – period) and limiting factors addressed by the project 7

1.4.1 Steelhead 8

1.4.2 Chinook Salmon 9

1.4.1 Bull trout 9

1.4.2 Limiting factors 10

1.5 List of primary project features including constructed or natural elements 11

1.6 Description of disturbance including timing and areal extent and potential impacts associated with implementation of each element 13

2. Resource inventory and evaluation 14

2.1 Description of past and present impacts on channel, riparian and floodplain conditions 14

2.2 Instream flow management and constraints in the project reach 14

2.3 Description of existing geomorphic conditions and constraints on physical processes 14

2.4 Description of existing riparian condition and historical riparian impacts 18

2.5 Description of lateral connectivity to floodplain and historical floodplain impacts 18

2.6 Tidal influence in project reach and influence of structural controls (dikes or gates) 18

3. Technical data 19

3.1 Incorporation of HIP specific activity conservation measures for all included project elements 19

3.2 Summary of site information and measurements (survey, bed material, etc) used to support assessment and design 19

3.2.1 Elevation data 19

3.2.2 Fish use 19

3.2.3 Geomorphic data 19

3.2.4 Hydrology data 19

3.3 Summary of hydrologic analyses conducted, including data sources and period of record including a list of design discharge (Q) and return interval (RI) for each design element 20

3.3.1 General Hydrology *20*

3.3.2 Peak Flow Hydrology *21*

3.4 Summary of sediment supply and transport analyses conducted, including data sources including sediment size gradation used in streambed design 21

3.5 Summary of hydraulic modeling or analyses conducted and outcomes – implications relative to proposed design 23

3.5.1 Hydraulic Modeling *23*

3.5.2 Model Capabilities and Limitations *23*

3.5.3 Model Extent *23*

3.5.4 Model Terrain *23*

3.5.5 Model Geometry *24*

3.5.6 Model Roughness *25*

3.5.7 Model Boundary Conditions *25*

3.5.8 Model Discharges *26*

3.5.9 Model Output *26*

3.5.10 Model Findings *27*

3.6 Stability analyses and computations for project elements, and comprehensive project plan . 27

3.7 Description of how preceding technical analysis has been incorporated into and integrated with the construction – contract documentation 27

3.8 For projects that address profile discontinuities (grade stabilization, small dam and structure removals): A longitudinal profile of the stream channel thalweg for 20 channel width upstream and downstream of the structure shall be used to determine the potential for channel degradation 27

3.9 For projects that address profile discontinuities (grade stabilization, small dam and structure removals): A minimum of three cross-sections – One downstream of the structure, one through the reservoir area upstream of the structure, and one upstream of the reservoir area outside of the influence of the structure) to characterize the channel morphology and quantify the stored sediment 27

4. Construction – contract documentation 28

4.1 Incorporation of HIP general and construction conservation measures 28

4.2 Design – construction plan set including but not limited to plan, Profile, section and detail sheets that identify all project elements and construction activities of sufficient detail to govern competent execution of project bidding and implementation ... 28

4.3 List of all proposed project materials and quantities ... 28

4.4 Description of best management practices that will be implemented and implementation resource plans including: ... 28

4.5 Calendar schedule for construction/implementation procedures ... 28

4.6 Site or project specific monitoring to support pollution prevention and/or abatement ... 28

5. Monitoring and adaptive management plan ... 28

6. References ... 29

List of Appendices:

Appendix A: RM 3.7-4.6 60% design drawings
Appendix B: Opinion of probable construction quantities
Appendix C: Existing conditions HEC-RAS model
Appendix D: Proposed conditions HEC-RAS model
Appendix E: Large wood stability calculations

1. Preface

The Nason Creek Floodplain Project is located along Nason Creek between RM 3.2 and RM 4.6 in Chelan County, WA, along Highway 207 on land owned by a private landowner, the U.S. Forest Service, Chelan County and a Washington Department of Transportation (WSDOT) right of way (Figure 1). One privately owned parcel is located within the project area at the downstream end, east of Highway 207. Yakama Nation staff are in discussions with a second private landowner near RM 3.2 at the downstream end of the project area about adding large wood structures along approximately 1,000 ft of Nason Creek for habitat enhancements and address concerns with lateral migration.

The valley bottom within the project area is bisected by Highway 207, which was constructed circa 1942. Construction of Highway 207 significantly reduced the size of the river migration corridor, resulting in a reduction in stream length. This compressed migration corridor, and shortened channel appears to have disrupted geomorphic equilibrium at the site, putting Nason Creek in an unbalanced state. Nason Creek has repeatedly damaged the highway embankment in three locations during flood events. An existing side channel near RM 3.3 to 3.75, which was likely the historical main channel, is located east of Highway 207, and is connected to Nason Creek via two culverts approximately 12-feet in diameter under the highway at the inlet and outlet of the side channel.

The project is broken into three phases.

- Phase 1 includes relocating approximately one-half mile of Highway 207 out of the Nason Creek floodplain between RM 3.9 and 4.5. Designs to relocate the road and associated utilities are being prepared by Perteet.
- Phase 2 includes stream habitat enhancements between RM 3.7 and 4.6.
- Phase 3 includes stream habitat enhancements between RM 3.2 and 3.6.

This report summarizes Phase 2 site conditions and 60% designs and plans.

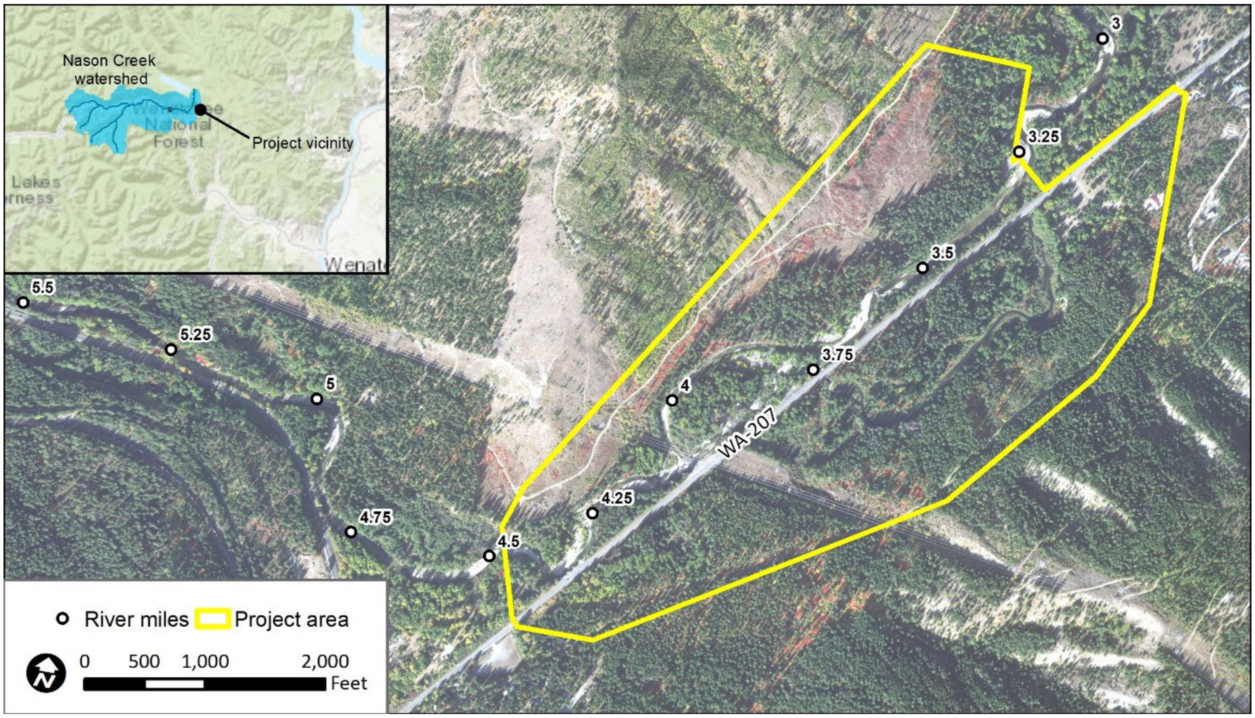

Figure 1. Nason Floodplain project area location.

The goal of the project is to create and enhance instream complexity and off channel aquatic habitats for salmon and steelhead, encourage floodplain connectivity, while also reducing river impacts to the Highway 207 embankment at three locations that have experienced repeated occurrences of erosion.

A number of alternatives for this project area were considered and documented by Inter-Fluve in a 2019 report. This current report documents 60% preliminary design for selected project features that are intended to enhance aquatic habitats while reducing conflicts between Nason Creek and Highway 207 for Phase 2 between RM 3.7 and 4.6 along the main stem, side channel and floodplain along the upstream half of the project area. Project elements for the downstream reach from RM 3.2 and 3.6 are documented in a Phase 3 report (Inter-Fluve, 2024) and will be updated in future design phases.

Currently, Nason Creek is contacting the Highway 207 road prism at three locations within the study area and has historically caused erosion of the road embankment. These locations have been designated as Chronic Environmental Deficiency (CED) sites by WSDOT. CED 1, 2 and 3 sites are located at RM 4.4, 4.1 and 3.7, respectively. CED 1 site is located at a mature meander bend near RM 4.4 (Figure 3b). CED 2 site is at an existing large and historically persistent log structure along the creek near RM 4.1 which directs a portion of Nason Creek flow into the highway embankment (Figure 2). CED 3 site is a riprapped bank along the road that appears stable. Both CED 1 and 2 locations have required emergency placement of rock by WSDOT to stabilize the road embankment. Phase 1 highway relocation will remove the road embankment at these two locations and allow restoration of a more natural geomorphic condition and dynamic stream processes.

Figure 2. Looking downstream at existing log structure, BPA powerlines, and Highway 207 CED 2 site near RM 4.1. Note riprap placed at right to reduce damage to highway embankment.

1.1 NAME AND TITLES OF SPONSOR, FIRMS AND INDIVIDUALS RESPONSIBLE FOR DESIGN

The project is sponsored by the Yakama Nation with Chris Butler as project manager. Inter-Fluve is the engineering design firm with Dan Miller (PE) the licensed engineer of record for this project and the main point of contact for Inter-Fluve.

1.2 LIST OF PROJECT ELEMENTS THAT HAVE BEEN DESIGNED BY A LICENSED PROFESSIONAL ENGINEER

Dan Miller (PE) is the licensed engineer of record for this project. Project elements include the following, with BPA HIP activity and risk category included:

Table 1. Activity categories and risk included in the Nason Floodplain project from RM 3.7 to 4.6.

Description of Proposed Enhancement	Work Element	HIP Category	HIP Risk Level
Relocate existing Highway 207 and remove road embankment, grade to adjacent floodplain elevations including microtopography, and creation of low flow channel and wetland areas. Place floodplain roughness and habitat wood along cut surfaces to reduce avulsion risk. Designs are not intended to prevent channel migration across the valley bottom.	Road relocation outside of floodplain Road embankment (levee) removal. Create wetlands	5b 2b 2a	Low Medium Medium
Place whole trees and large wood (LW) structures of various types in the main stem and side channels to increase hydraulic roughness for floodplain connection, instream habitats and encourage formation of vegetated gravel bars.	Improve floodplain interactions. Install habitat forming instream structures	2a 2d	Medium Medium
Construct low flow/groundwater fed channel and create wetlands along road removal footprint	Improve secondary channel and floodplain interactions. Create wetlands	2a 2a	Medium Medium
Provide separation of Highway 207 riprap-lined embankment from Nason Creek by creation of floodplain terrace with large wood fringe.	Install habitat-forming natural material instream structures	2d	Medium
Revegetation of all disturbed surfaces (designed and installed by others).	Riparian vegetation planting	2e	Low

1.3 IDENTIFICATION AND DESCRIPTION OF RISK TO INFRASTRUCTURE OR EXISTING RESOURCES

Existing infrastructure in the project vicinity includes Highway 207, two 12ft diameter corrugated metal pipe culverts under the road (RM 3.3 [Figure 3.A] and 3.75), miscellaneous existing concrete culverts ranging from 18" to 48" diameter located through the existing road embankment, a BPA powerline corridor which crosses Nason Creek at RM 4.1, miscellaneous overhead and buried utilities along Highway 207 and private residences downstream of the project area. Risk to Highway 207 is high and has historically been high under existing conditions, as evidenced by erosion damage at the three WSDOT CED sites (RM 3.7, 4.1 and 4.4) of the embankment incurred regularly during high-flow events. Relocating Highway 207 from RM 3.7 to 4.4 will move the highway out of harm's way from Nason Creek and eliminate CED 1 (RM 4.4) and CED 2 (RM 4.1) stream-road conflict areas. Risk to BPA powerlines is minimal because the towers are located outside of the present-day active channel and valley bottom. Risk to private residences is minimal because they are located on a higher terrace and well setback from the active channel.

Figure 3. Infrastructure within the project area includes (A) CMP culvert with concrete headwalls (RM 3.75) which provide connectivity to the side channel on the east side of the highway, and (B) Highway 207 (RM 4.4) which has been reinforced with rock in several locations and can be removed with highway relocation and allow hydrologic connection to historic floodplain areas.

1.4 EXPLANATION AND BACKGROUND ON FISHERIES USE (BY LIFE STAGE – PERIOD) AND LIMITING FACTORS ADDRESSED BY THE PROJECT

Current fish known to utilize the project area include ESA-listed spring Chinook (endangered), steelhead (threatened), Bull Trout (*Salvelinus confluentus*, threatened), species-of-concern Pacific Lamprey (*Lampetra tridentate*) and westslope cutthroat trout (*O. clarkii*), and non-listed summer Chinook, Coho Salmon (*O. kisutch*), mountain whitefish (*Prosopium williamsoni*), and non-native brook trout (*Salvelinus fontinalis*). Past redd counts show high Chinook Salmon and steelhead redd densities within the project area (Figure 4). The project reach is a low gradient reach with high quality spawning gravels located throughout.

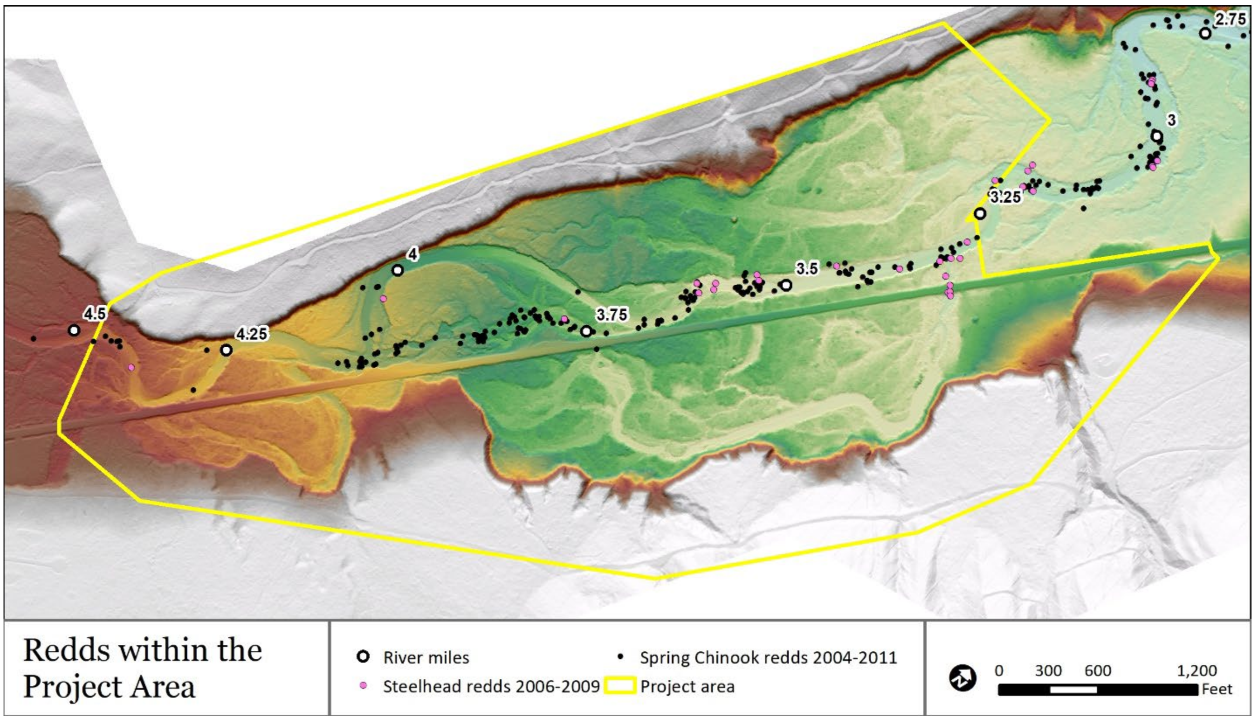

Figure 4. Steelhead and spring Chinook redds recorded in the project area for the specified years, displayed over LiDAR elevation data. The channel network is clearly visible in the LiDAR data. Redd data from Upper Columbia Salmon Recovery Board (2018).

According to the Subbasin Plan (NWPCC 2004), habitat in the project area has high potential to improve populations of aquatic species, including ESA-listed salmonids within the lower Nason Creek. Summary of life-history timing for aquatic species are presented below (Figure 5). Detailed descriptions of habitat requirements by life stage for ESA-listed species are included in the following sections.

Figure 5. Life history timing of target species within the project area.

1.4.1 Steelhead

Adult steelhead enter the Wenatchee basin from August through April, holding in deep pools with overhead cover. Spawning begins in very late March, peaks in mid-April, and lasts through May. Egg survival is highly sensitive to intra-gravel flow and temperature (NWPCC 2004), and is particularly sensitive to siltation earlier in the incubation period (Healy 1991). Fry emerge from the redds 6-10 weeks after spawning (Peven 2003).

Age-0 juveniles spend their first year primarily in shallow riffle habitats, feeding on invertebrates and utilizing overhanging riparian vegetation and undercut banks for cover (Moyle et al. 2002, US Fish and Wildlife Service 1995). Age-0 steelhead use slower, shallower water than Chinook Salmon, preferring small boulder and large cobble substrate (Hillman et al. 1989). Older juveniles prefer faster moving water including deep pools and runs over cobble and boulder substrate (US Fish and Wildlife Service 1995). Juveniles outmigrate between ages one and three, though some hold over and display a resident life history form. Smolts begin migrating downstream from natal areas in March (NWPCC 2004).

1.4.2 Chinook Salmon

Adult spring Chinook enter the Wenatchee in May, holding in deeper pools with overhanging cover until water temperatures are suitable for spawning. Spawning typically begins in very late July, peaks in late August, and ends in late September (NWPCC 2004). Eggs are very sensitive to changes in oxygen levels and percolation, both of which are affected by sediment deposition and siltation in the redd (Healy 1991, Peven 2003). Fry emerge in June and July, which coincides with the rising hydrograph, forcing juveniles to seek out backwater or margin areas with lower velocities, dense cover, and abundant food (Quinn 2005). Fry are extremely vulnerable when they emerge, because their swimming ability is poor and flows are high. Near-shore areas with eddies, large woody debris, undercut tree roots, and other cover are very important for post-emergent fry (Hillman et al. 1989, Healy 1991). The proposed project features are expected to provide low velocity rearing habitat for post-emergent spring Chinook salmon fry because there are high redd densities immediately upstream, and the large woody material (LWM) features are on the outside of a meander bend and create scour pools where the majority of water and fry are expected to be during high flows (Figure 4).

As they increase in size, juveniles begin to select for deeper and faster moving water, particularly areas with overhanging cover (Moyle et al 2002b). These areas provide more holding and feeding habitat area for the larger juveniles to occupy. Upper-Columbia spring Chinook express a stream-type life history, meaning they rear in freshwater for at least one year before outmigrating as yearlings. Smolts begin migrating in March from natal areas (NWPCC 2004).

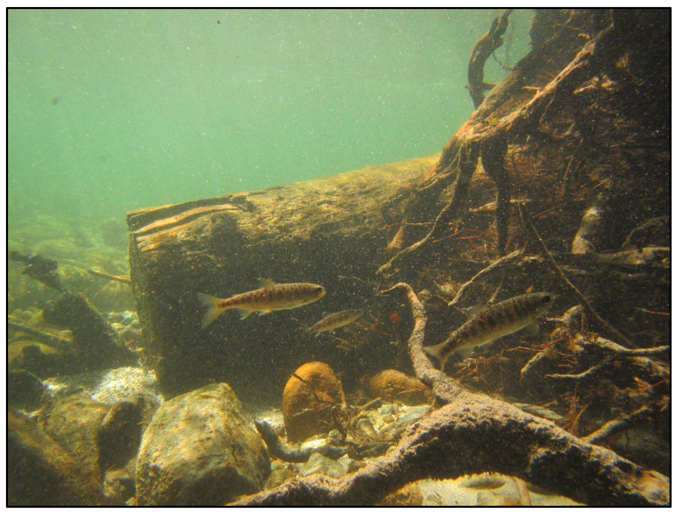

Figure 6. Chinook Salmon parr resting behind a constructed log structure in the Entiat River between feeding forays.

1.4.1 Bull trout

Nason Creek supports a population of resident and fluvial bull trout (NWPCC 2004). The project area is located in a reach of Nason Creek that is mapped as "possible bull trout spawning" in the Wenatchee Subbasin Plan (NWPCC 2004). Bull Trout spawn in the Wenatchee subbasin from August through October. Eggs incubate over the fall, winter, and spring, with fry emerging approximately 220 days after egg deposition. Juveniles select for margin habitat with overhanging cover, feeding primarily on aquatic insects until they grow larger and shift towards feeding on fish. Bull trout juveniles rear in headwater streams for at least two years before migrating downstream as adults or sub-adults to express fluvial life histories, or resident life histories in downstream reaches (McPhail and Baxter 1996). Downstream movement of bull trout in the nearby Chiwawa River has been documented as bimodal, with one pulse in the spring and a second in the fall (NWPCC 2004).

1.4.2 Limiting factors

Regional objectives for salmonid habitat protection and restoration in the Upper Columbia Region have been evaluated and summarized in the document *A Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region* (2017) by the Upper Columbia Salmon Recovery Board (UCSRB) Regional Technical Team (RTT). This Biological Strategy is part of the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (UCSRB 2007) and recommends region-wide biological considerations and approaches for salmonid habitat restoration and protection actions. The RTT guides the development and evaluation of salmonid recovery projects within the Upper Columbia Region.

The Biological Strategy has identified several assessment units within the major watersheds of the Upper Wenatchee River. The Nason Floodplain project area falls within the Nason Creek Assessment Unit. Nason Creek is a Tier 1 watershed of highest priority for both protection and restoration.

All Chinook spawning that occurs in Nason Creek occurs in the lower 15 miles of the main stem, which also contains the poorest quality habitat (UCRTT 2017). The RTT has prioritized a list of restoration actions to address key ecological concerns in the Nason Creek Assessment Unit, and are listed below in priority order (UCRTT 2017):

1. **Peripheral and transitional habitat**: Reconnect side channels and off-channel habitat.
2. **Channel structure and form**: Increase large wood complexes, remove or modify levees and roads where feasible, restore channel structure and form to reduce sediment transport capacity to counteract recent incision and confinement.
3. **Riparian condition:** Improve riparian conditions to improve long term LWM recruitment.
4. **Channel structure and form:** Restore instream habitat diversity by enhancing large wood recruitment, retention, and complexity.
5. **Food**
6. **Sediment conditions:** Decommission roads that are affecting sediment delivery to the stream.
7. **Species interaction (competition)**

1.5 LIST OF PRIMARY PROJECT FEATURES INCLUDING CONSTRUCTED OR NATURAL ELEMENTS

Primary project features along the Phase 2 portion of the project from RM 3.7 to 4.6 consist of the following:

Remove existing Highway 207 and grade embankment to create floodplain and wetland areas: Relocation of Hwy 207 and utilities is included in the Phase 1 portion of the project currently in design by Perteet, Inc. Relocation will allow removal of a portion of the existing road embankment and associated utilities along the abandoned length of highway, reestablishing floodplain elevations and floodplain side channel continuity. Portions of the abandoned road will be excavated to, or below adjacent floodplain to create a low flow/groundwater fed channel and adjacent wetland creation areas for additional complexity. Risk of avulsion along the road removal corridor will be reduced through selective grading and a dense placement of floodplain roughness wood and slash stabilized with log piles and log burial. Structures include: 1) **low flow floodplain roughness large wood structures**, 2) **low flow floodplain roughness large wood logs**, and 3) **low flow habitat wood**. Cut surfaces will be vegetated with appropriate wetland, riparian and upland species. Revegetation designs will be completed by others at future phases of the project.

- **Large wood installation**: A number of large wood structure types are proposed to be constructed in the main stem and side channel of Nason Creek to provide complex salmonid holding and rearing habitat, floodplain inundation, allow channel migration and manage risk of avulsion along the removed road at a range of flow conditions.
    - **Apex jams:** are mid-channel structures intended to split flow, create scour and sediment deposition complexity to provide cover, rearing and spawning habitats. The structures are ballasted by burial in the stream bed with alluvial material, the face of the structures diverting flow energy away from the backfill materials. Log piles are included as supplemental ballast.
    - **Inlet and bank buried log structures:** These are back fill ballasted structures built in the banks. Locations of structures were selected based on flow patterns to encourage scour and sediment deposition complexity, recruit floating debris, and enhance gaps in the riparian fringe. The structures are comprised of logs with rootwads, slash, whole trees and tree tops, which will be restrained by burial in the banks and backfill with alluvial material. Log piles installed with a vibratory pile driver will supplement ballast of racking type wood. Structures are included in the plans as **inlet jams**, **bank buried jams** and **small bank buried jams.**
    - **Margin large wood structure:** These are partially buried and pile ballasted structures built against existing banks. Locations of structures were selected based on flow patterns to encourage flow energy complexity along the stream banks, scour and sediment deposition complexity, recruit floating debris, and enhance gaps in the riparian fringe. The structures are comprised of logs with rootwads, slash, whole trees and tree tops, which will be restrained by log piles installed with a vibratory pile driver and log ends buried into existing banks.

  - **Bar roughness jams:** are smaller structures comprised of partially buried logs with exposed rootwads. Burial will provide ballasting. Piles are included to aid in ballasting and recruiting debris. Slash is pinned under the rootwads. **Deflector jams** are similar structures, minus the partially buried logs. The intent of both structure types is to deflect flow and create lower energy areas downstream of the jam that will encourage deposition of fine sediments and formation of vegetated gravel bars. Racking of floating debris is encouraged to augment the function of these structures.
  - **CED 2 existing jam:** an existing naturally occurring log jam is located under the BPA lines at CED 2 site. If clearance from the power lines allow, log piles will be installed along the edges as equipment reach allows without disturbing the existing jam. LW structures installed downstream of this jam along the side channel will have similar 'log drift' features by placing **racking wood** added to upstream face of individual structures to mimic this existing jam. The structures will provide ballasting of the racking wood.
  - **Whole trees:** Whole trees are incorporated into many structures as shown on the plans as incidental item. Whole trees are anticipated to be sourced in part from on site salvage.
  - **Floodplain roughness logs:** installed large wood restrained by bracing to existing trees will provide floodplain roughness across a meander bend at the upstream end of the project.
  - **Tipped trees:** along an outside bank of a meander bend will provide hydraulic and habitat complexity. Candidate trees will be identified and pulled over using cables to reduce disturbance of bank and adjacent floodplain
- **Bank habitat enhancements at existing riprap bank:** At the CED 3 (RM 3.7) site, bank habitat treatments are proposed to provide fish habitat, channel complexity and greater separation of flow from the highway where exposed riprap is currently armoring the road prism. The existing riprap would remain in-situ under the new bank treatment to serve as a failsafe protection for the highway embankment. Bank treatments include:
  - Creation of floodplain terraces with large wood as shown in the plan set. Bank habitat includes constructing a series of meander bend structures along the length of the riprapped bank. These structures would be constructed of logs with rootwads, logs without rootwads, whole trees, log piles, and slash, and backfilled with large alluvial material and rounded alluvial small boulder material. The results would be to create a floodplain terrace ranging about 25 to 30 feet wide along the existing bank, with about 10 to 15 feet of LWM exposed to active flow. The fill would be revegetated with native live willow, dogwood and cottonwood cuttings, riparian trees and shrubs. Revegetation is planned to be designed by Yakama Nations revegetation consultant.
  - To maintain channel flow conveyance, the opposing gravel bar on river left would be excavated to maintain a similar flow conveyance area and graded to blend to existing topography. The excavated bar material would be salvaged, sorted by size and used as log structure backfill. Nason Creek has dynamic sediment transport conditions with actively shifting gravel bars and is expected to transport material from the gravel bar naturally in response to encroachment into the main stem by the terrace. Excavation anticipates this future condition. Stream riffle and pool conditions are anticipated to be

similar to existing conditions, with habitat improvement by converting river right bank from a riprap condition to riparian margin with large wood condition.

- **Wetland, riparian and upland revegetation**: Native species will be planted in all disturbed areas to promote riparian function and increase food production and habitat complexity for target species. The planting plan will be developed separately in a future phase by Yakama Nation's planting consultant.

1.6 DESCRIPTION OF DISTURBANCE INCLUDING TIMING AND AREAL EXTENT AND POTENTIAL IMPACTS ASSOCIATED WITH IMPLEMENTATION OF EACH ELEMENT

Project disturbance at the site will be from excavation and temporary access routes used to remove portions of the existing road embankment and revetment, install large wood structures, and install plantings. Access to many sites will be along the abandoned road alignment. Trees and vegetation removed during excavation will be salvaged and used to supplement constructed large wood habitat structures. Disturbance during construction to large trees and riparian zones will be minimized, and all disturbed areas will be re-vegetated.

2. Resource inventory and evaluation

2.1 DESCRIPTION OF PAST AND PRESENT IMPACTS ON CHANNEL, RIPARIAN AND FLOODPLAIN CONDITIONS

Riparian and floodplain conditions in the project site and vicinity have been impacted most heavily by the construction of Highway 207 circa 1942 along the Nason Creek floodplain. The circa 1900 plat map indicates that the main stem of Nason Creek used to occupy the southeast side of the floodplain (Figure 7). The 1957 aerial shows Nason Creek in an alignment with planform similar to – though west of – what is seen today, and the BPA power corridor is also visible. Logging in the vicinity, and associated road building, has had impacts on large wood recruitment and sediment delivery to Nason Creek. Construction of the highway has reduced total off channel habitat connectivity, disconnected floodplain areas, and constricted channel migration zones, concentrated more flow into the main stem, and shortened overall channel length by cutting off a historical meander that is depicted in the circa 1900 plat map.

2.2 INSTREAM FLOW MANAGEMENT AND CONSTRAINTS IN THE PROJECT REACH

Not applicable to this project.

2.3 DESCRIPTION OF EXISTING GEOMORPHIC CONDITIONS AND CONSTRAINTS ON PHYSICAL PROCESSES

Figure 7, Figure 8, and Figure 9 show historical aerial imagery of the project area vicinity from 1957, 1963, 1974, 1991, 2006 and 2015. The 1942 Road Relocation plans include an indication of the Nason Creek alignment that appears similar to the 1957 photos. While in general the meandering plan form and bend locations are similar over the photographic history, the channel has migrated eastward closer to the highway. There appears to be a vegetated floodplain approximately 80- and 150-feet wide from the edge of Highway 207 to the right river bank at RM 4.4 and 4.1, respectively, in the 1942 plans (Chelan Co, 2012) and 1957 photos. It appears that Nason Creek encroached on to the road embankment during the time interval between the 1974 and 1991 photos. The side channel along the west side of highway between RM 3.7 to 4.1 is evident in all photos.

The Highway 207 embankment has prevented or limited flow to the east floodplain, leading to fewer off channel and side channel habitats. No pre-development survey is available to determine whether and to what degree incision may have occurred, however it is believed that this unnatural confinement has led to some level of incision (UCRTT 2017).

Nason Creek delivers a dynamic supply of substrate and wood to the project reach. Areas of wood accumulation exhibit defined scour pools and sediment deposit tail spills creating diverse habitats. The numbers and locations of redds mapped (Figure 4) indicate that diversity of LWM and bed forms provide spawning habitats.

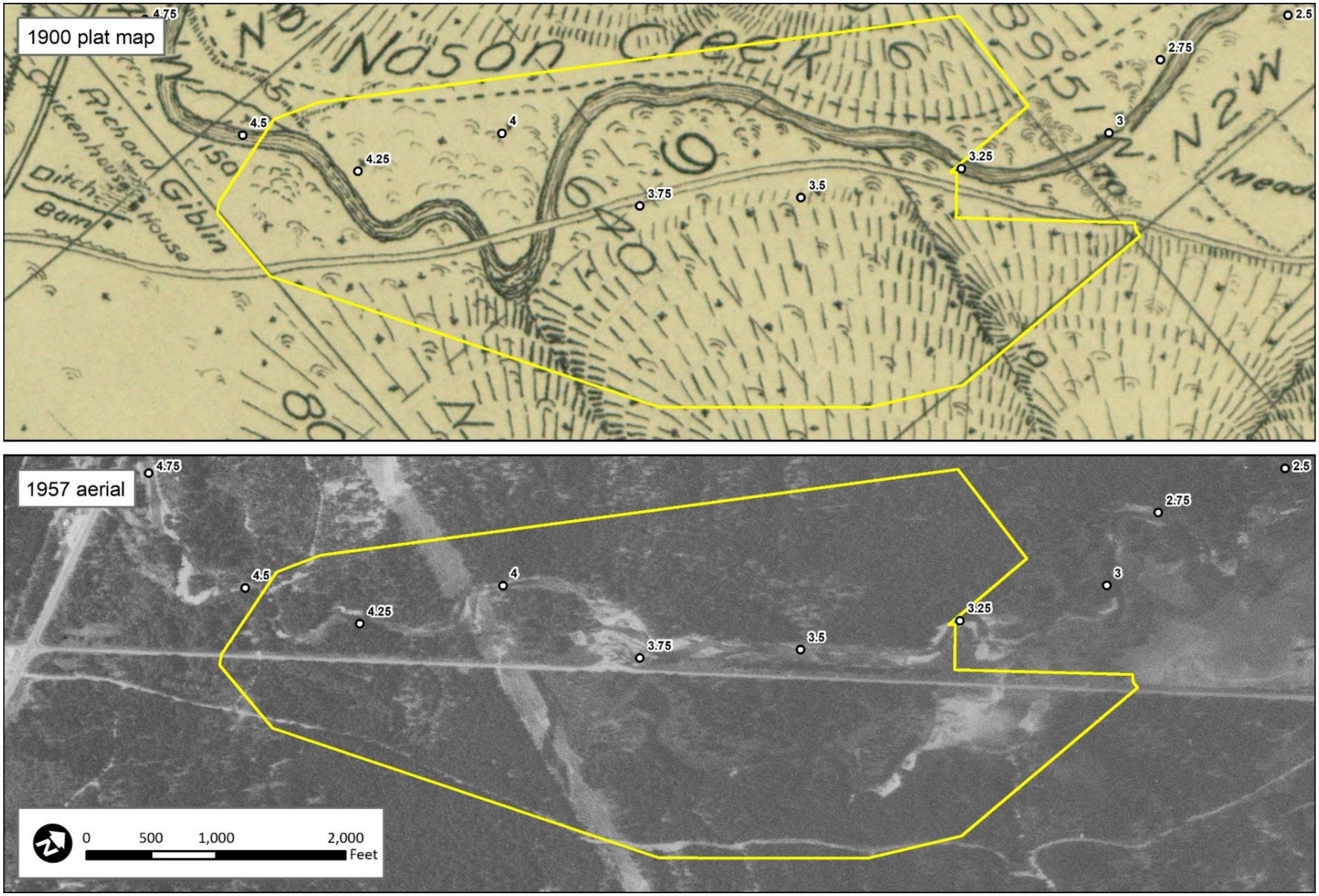

Figure 7. Historical plat map from 1900 and aerial image from 1957, project area boundary shown in yellow.

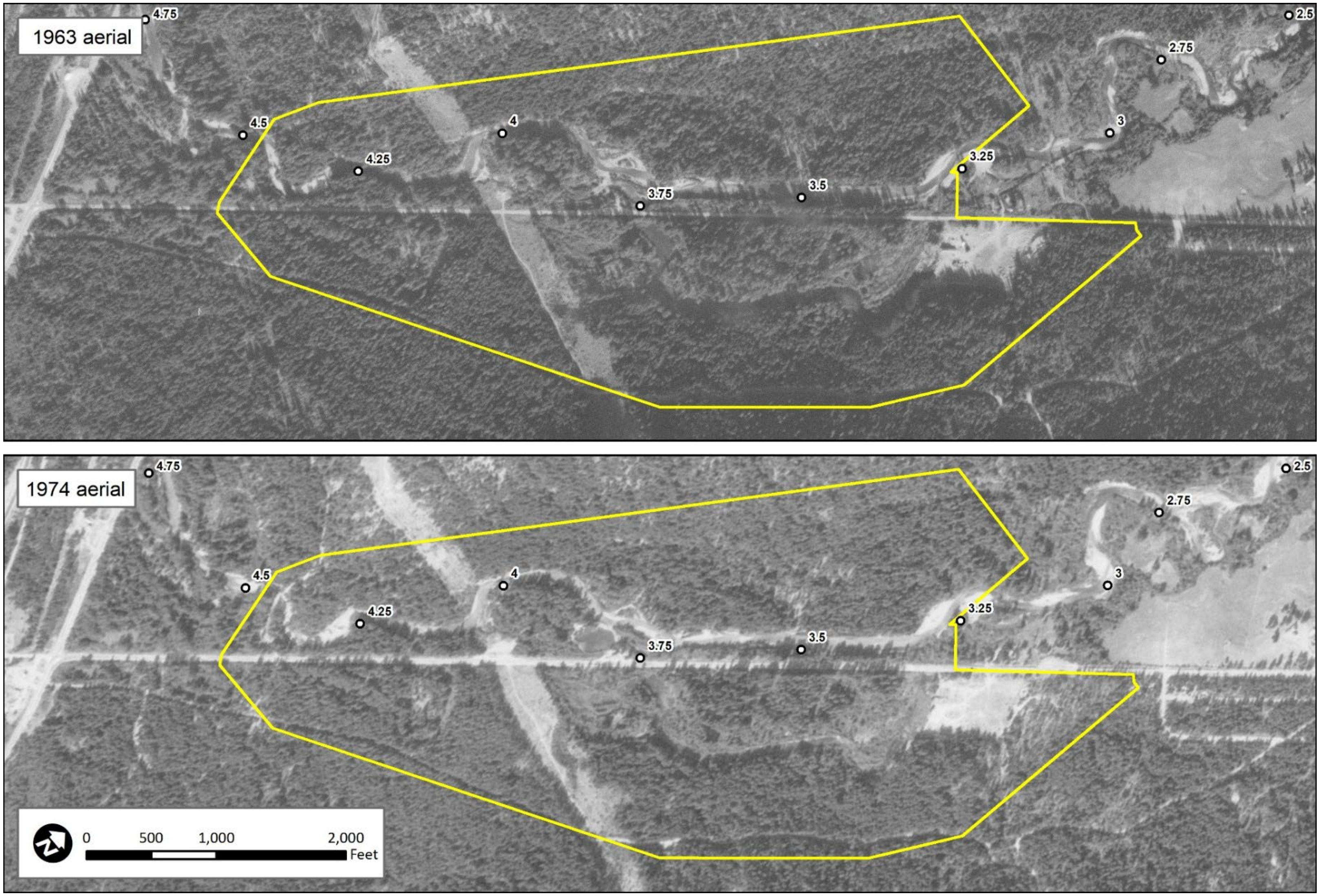

Figure 8. Aerial images from 1963 and 1974, project area boundary shown in yellow.

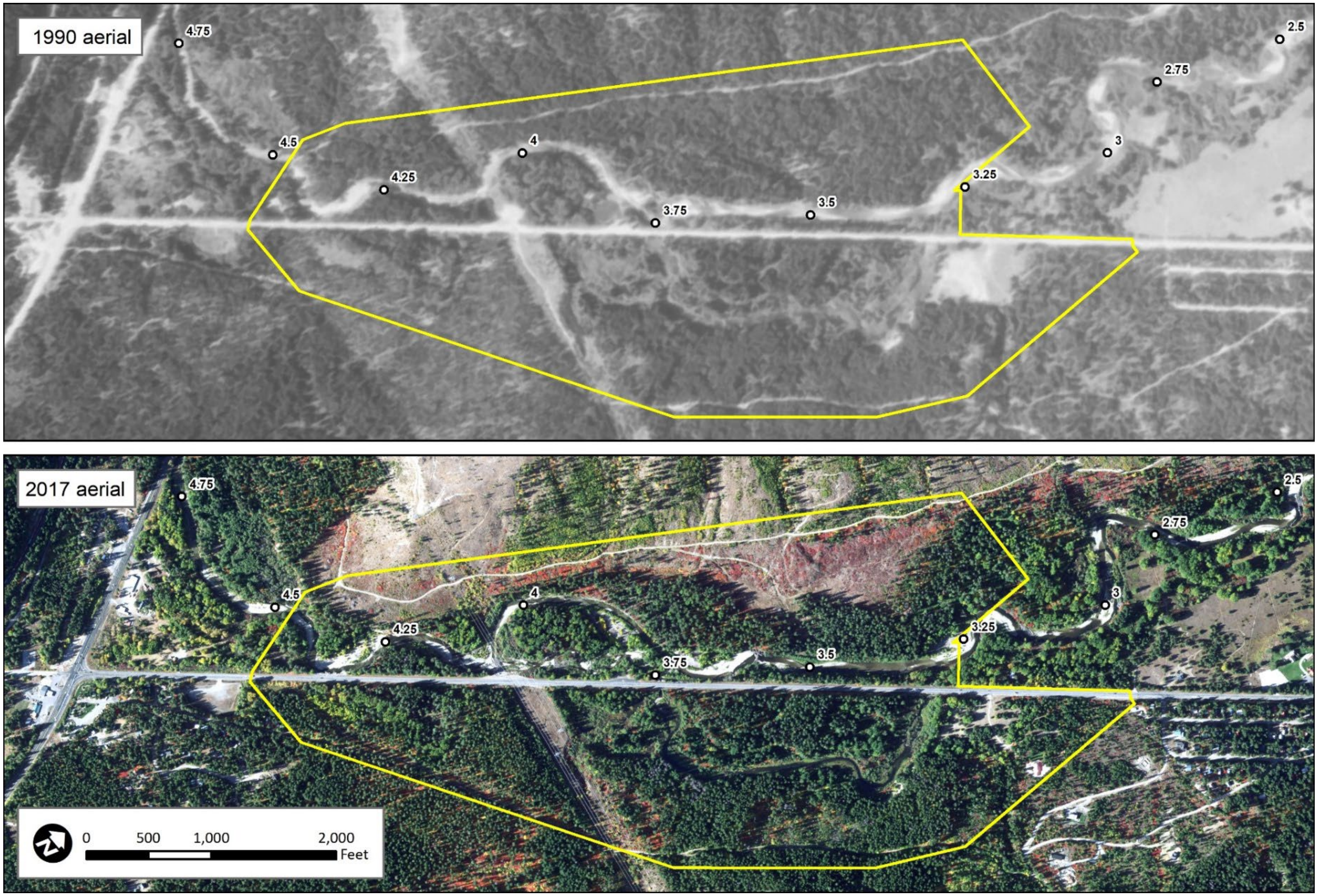

Figure 9. Aerial images from 1990 and 2017, project area boundary shown in yellow.

2.4 DESCRIPTION OF EXISTING RIPARIAN CONDITION AND HISTORICAL RIPARIAN IMPACTS

Riparian conditions in the project area are generally good. The forest is a mixed-age stand of Ponderosa Pine, Douglas fir, willow, dogwood and cottonwood. Typically, conifers occupy higher elevation terraces that have not been disturbed by river activity for a number of decades. Deciduous trees and woody shrubs occupy the riparian zones and areas disturbed by river migration in the recent past. Coniferous trees have been removed along the BPA power line corridor and recently logged at the western edge of the river left floodplain from approximately RM 3.2-3.7. Wetlands were delineated by Hamer Environmental and documented in January 2021 and January 14, 2022 reports.

2.5 DESCRIPTION OF LATERAL CONNECTIVITY TO FLOODPLAIN AND HISTORICAL FLOODPLAIN IMPACTS

Nason Creek historically had high floodplain connectivity with a myriad of off-channel wetlands, alcoves, and channels. This complexity was likely enhanced by large wood accumulations and beaver ponds. The current highway embankment and culvert system have reduced floodplain connectivity and eliminated lateral channel migration to the east of the highway by limiting water movement onto floodplain surfaces to areas east of the highway. Approximately 40.7-acres of active side channel, wetlands and floodplain are located east of the highway RM 3.3-3.9. Approximately 10.9-acres of inactive side channel, wetlands and floodplain are located east of the highway RM 4.15-4.4; which can be available to flow and channel migration with proposed highway relocation. The reduced floodplain width constricted by the highway embankment has reduced the available migration corridor.

2.6 TIDAL INFLUENCE IN PROJECT REACH AND INFLUENCE OF STRUCTURAL CONTROLS (DIKES OR GATES)

Not applicable to this project.

3. Technical data

3.1 INCORPORATION OF HIP SPECIFIC ACTIVITY CONSERVATION MEASURES FOR ALL INCLUDED PROJECT ELEMENTS

HIP conservation measures are included in preliminary project plans. If necessary, requests for variances will be submitted for any conservation measures that cannot be met.

3.2 SUMMARY OF SITE INFORMATION AND MEASUREMENTS (SURVEY, BED MATERIAL, ETC) USED TO SUPPORT ASSESSMENT AND DESIGN

3.2.1 Elevation data

A detailed topographic/bathymetric LiDAR data set collected in 2022 for the river corridor was supplemented with 2015 topographic LiDAR data set for floodplain areas was used to create an existing conditions surface and HEC-RAS model terrain. All data are referenced to the Washington State Plane North coordinate system, the NAVD88 vertical datum and US feet.

3.2.2 Fish use

Fish use data were collected from primary literature, the Wenatchee Subbasin Plan (NWPCC 2004), and the Upper Columbia biological strategy (UCRTT 2017).

3.2.3 Geomorphic data

A pebble count survey was conducted in the project area to evaluate existing substrate conditions. See section 3.4.

3.2.4 Hydrology data

Washington Department of Ecology (WDOE) records flows along Nason Creek at gage 45J070 located near the mouth. The WDOE gage has a period of record from 2002 to the present and is reported to have some inconsistencies – thus was not used solely for estimating flood peak flows. The WDOE gage does provide useful information on seasonal flow variation during the available period of record.

The USGS maintains a stream flow gage on nearby Icicle Creek (USGS Gage #12458000) which has a period of record from 1937 to present. The Icicle Creek watershed has many similarities to the Nason Creek watershed and is viable as a paired watershed to understand Nason Creek hydrology. The Icicle Creek data was used for paired watershed analyses for a number of studies including the U.S. Bureau of Reclamation Nason Creek Tributary Assessment (BOR, 2008).

No field flow measurements were collected for this preliminary analysis.

3.3 SUMMARY OF HYDROLOGIC ANALYSES CONDUCTED, INCLUDING DATA SOURCES AND PERIOD OF RECORD INCLUDING A LIST OF DESIGN DISCHARGE (Q) AND RETURN INTERVAL (RI) FOR EACH DESIGN ELEMENT

3.3.1 General Hydrology

Nason Creek drains high-elevation areas of the Chiwaukum Mountains and has a snowmelt-dominated hydrologic regime. Figure 10 shows typical seasonal median, high, and low exceedance flows for Nason Creek at RM 12.

Although peak flows typically occur due to snowmelt in the late spring or early summer, some of the largest floods have occurred from rain-on-snow events in late fall. Large past flood events occurred in May 1948, November 1990, November 1995, and November 2006. As noted in Chelan County's Feasibility Study (2012), the November 1995 event washed out portions of Highway 207. As of 2011, three repairs to the highway embankment in 10 years at this location led to nomination for the WSDOT Chronic Environmental Deficient (CED) program.

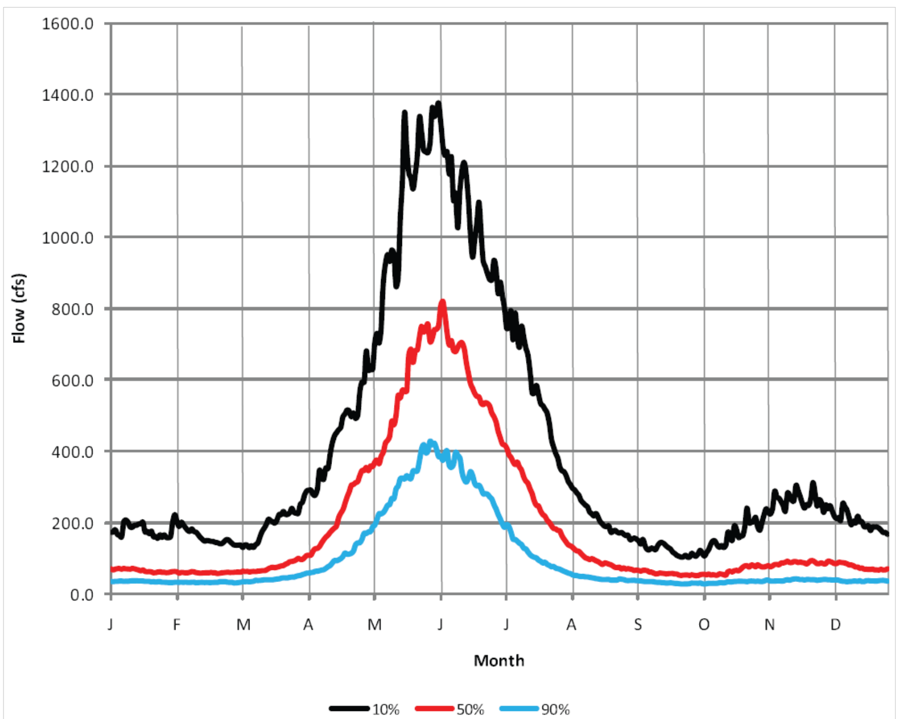

Figure 10. Modeled 10 percent, 50 percent, and 90 percent exceedance flows for RM 12 using data from 7 regional gages. Percentile flows represent the daily flow that is equaled or exceeded for the given percentage of time over the available period of record. Reprinted from Malmon (2010).

3.3.2 Peak Flow Hydrology

As noted in Section 3.2.4, Washington Department of Ecology operates gage 45J070 near the mouth of Nason Creek since 2002, but no long-term stream gage record is available on Nason to reliably estimate peak flows for the project reach. The US Bureau of Reclamation Nason Creek Tributary Assessment (Reclamation, 2008) completed a flood event peak flow analysis using data recorded at the nearby Icicle Creek USGS gage and considers the WDOE peak flow values. The Reclamation estimated flood magnitudes are presented in Table 2. These flows were used in the project hydraulic model.

Table 2. Peak flow estimates for Nason Creek at RM 4.0 (Reclamation, 2008. Appendix D, Table 5)

Recurrence Interval (years)	Estimated flow at RM 4 (cfs)
2	**2,600**
5	**3,900**
10	**4,900**
25	**6,500**
50	**7,900**
100	**9,400**

3.4 SUMMARY OF SEDIMENT SUPPLY AND TRANSPORT ANALYSES CONDUCTED, INCLUDING DATA SOURCES INCLUDING SEDIMENT SIZE GRADATION USED IN STREAMBED DESIGN

There are some bed rock expressions in the stream bed, banks and valley wall along the west edge of the Nason Creek flood plain. Occasional boulders that are not mobile during normal flood flows have been delivered to the valley bottom during much larger glacial outwash flows and delivered to the contemporary channel by being eroded out of the adjacent outwash terraces or exhumed as Nason Creek eroded down through the post glacial outwash. Upstream of the project reach, a number of actively eroding streambanks are seen which supply a significant volume of mobile sized sediments to the project reach. Placed riprap occurs at three locations along the Highway 207 embankment, some of which has moved downstream along the streambed a short distance.

With this understanding, substrate measured by the pebble count is a good approximation of mobile bedload sized sediments transported through the project reach and found in alluvial formed bed, bar and bank deposits. Wolman pebble counts were completed in Nason Creek near RM 4.45 to help estimate sediment particle sizes moving into and through the project reach. Pebble counts were performed at two locations along the river right bar surfaces at the crest (Figure 11.A) of a riffle and along the edge of the same riffle (Figure 11.B) to capture the range of substrates observed.

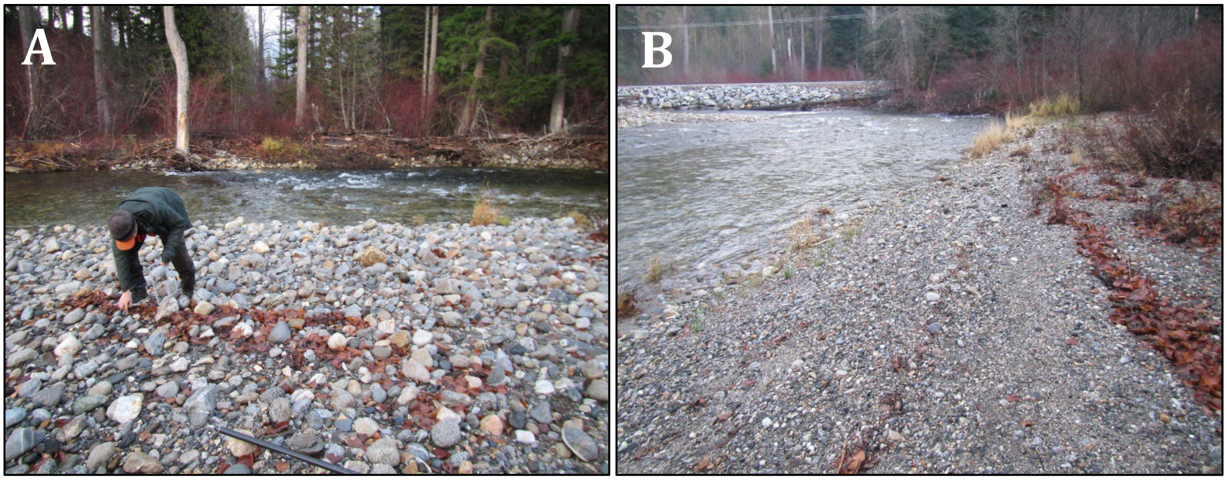

Figure 11. Location of pebble counts performed on Nason Creek. A) GC01 was performed on a gravel bar adjacent to a riffle, on river right of Nason Creek. B) GC02 was performed on a bar adjacent to a riffle on river left.

Results of the pebble count provide a grain size distribution. GC01 contained coarser material compared to GC02, with a d50 best described as very course gravel (Figure 12). Some sand and finer gravels were found within the interstices of larger material. GC02 contained finer material with a d50 best described as medium gravel.

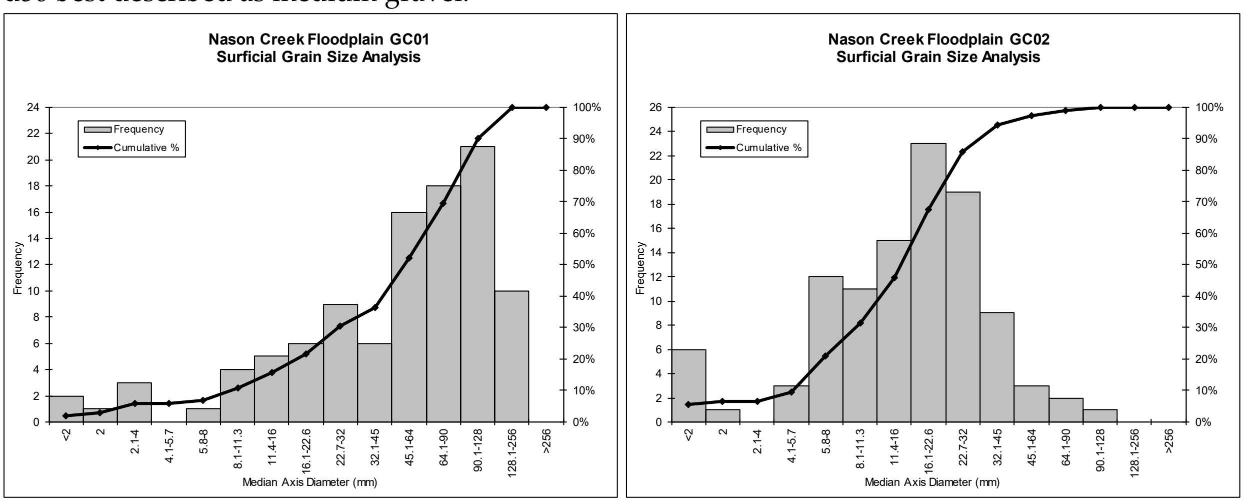

Figure 12. Grain size distribution at GC01 and GC02 based on Wolman pebble counts.

3.5 SUMMARY OF HYDRAULIC MODELING OR ANALYSES CONDUCTED AND OUTCOMES – IMPLICATIONS RELATIVE TO PROPOSED DESIGN

3.5.1 Hydraulic Modeling

The U.S. Army Corps of Engineers HEC-RAS 6.6 (USACE, September 2024) two-dimensional (2D) hydraulic model was used to develop model runs for existing and proposed conditions for the overall Nason Floodplain project reach. Existing conditions model geometry was copied and runs representing design features from RM 3.7-4.6 prepared. HEC-RAS computes hydraulic properties related to the physical processes governing water flow through natural rivers and other channels. Model runs for both existing and proposed conditions were used to assess the current and proposed channel dynamics, as well as assess the overall impacts of a wide range of flows on the existing landscape with and without the proposed design improvements.

The following sections describe the capabilities and limitations of HEC-RAS 6.6 and document the development and output processing of the project existing and proposed conditions models.

3.5.2 Model Capabilities and Limitations

HEC-RAS 6.6 was used in its two-dimensional (2D) unsteady flow simulation mode with the capacity to model the complex flow patterns, on-site water storage, spatial variation of hydraulic roughness and temporally variable boundary conditions. The 2D hydraulic model calculates depth averaged water velocities (including magnitude and direction), water surface elevation, and mesh cell face conveyance throughout the simulation. Other hydraulic parameters such as depth, shear stress, and stream power can be calculated by the model following completion of the simulation.

3.5.3 Model Extent

The downstream extent of the model is near RM 2.9 about 1,750 feet downstream of the lower project boundary. The upstream extent is near RM 4.9 about 3,000 feet upstream of the upper project boundary. Width of the model is valley wide, encompassing channel and floodplain including east of the existing Highway 207. The overall mesh coverage is shown in Appendices C and D.

3.5.4 Model Terrain

The existing conditions model terrain was developed using 2022 bathymetric/topographic LiDAR (USBR 2022) combined with 2015 LiDAR (Quantum Spatial 2016). The LiDAR provided a 1 meter (3.28 feet) horizontal resolution bare earth digital elevation model (DEM) raster for the entire site, including floodplain areas and valley hillslopes. The 2022 LiDAR dataset includes topographic and bathymetric surfaces for the river corridor. The 2015 LiDAR dataset was used to represent the floodplain and hillslopes beyond the limits of the 2022 LiDAR coverage. No transitional buffer between the two LiDAR datasets was used, occasionally resulting in minor surface discontinuities. The proposed condition model terrains were copied from the existing conditions terrain and modified to incorporate the design grading surfaces. Large wood structures were represented in the model as regions of extremely rough Manning's n coefficient values. The model terrains are projected on the Washington State Plane North Zone, North American Datum 1983 (NAD83), coordinate system with US feet distance units. The terrain elevations are in US feet relative to the North American Vertical Datum of 1988 (NAVD88).

3.5.5 Model Geometry

The 2D model geometry used a 40-ft square computational mesh for the entire area of interest with smaller mesh size for greater resolution along the main stem, side channels and road embankment. . A zoomed in view of the mesh shows an example of mesh detail as shown in Figure 13. The overall and example of mesh detail for existing conditions as seen in Appendix C. The modeling capabilities of HEC-RAS 6.6 integrates the sub-grid terrain into the computations and projects the results accordingly. The proposed conditions model domain mesh is seen in Appendix D.

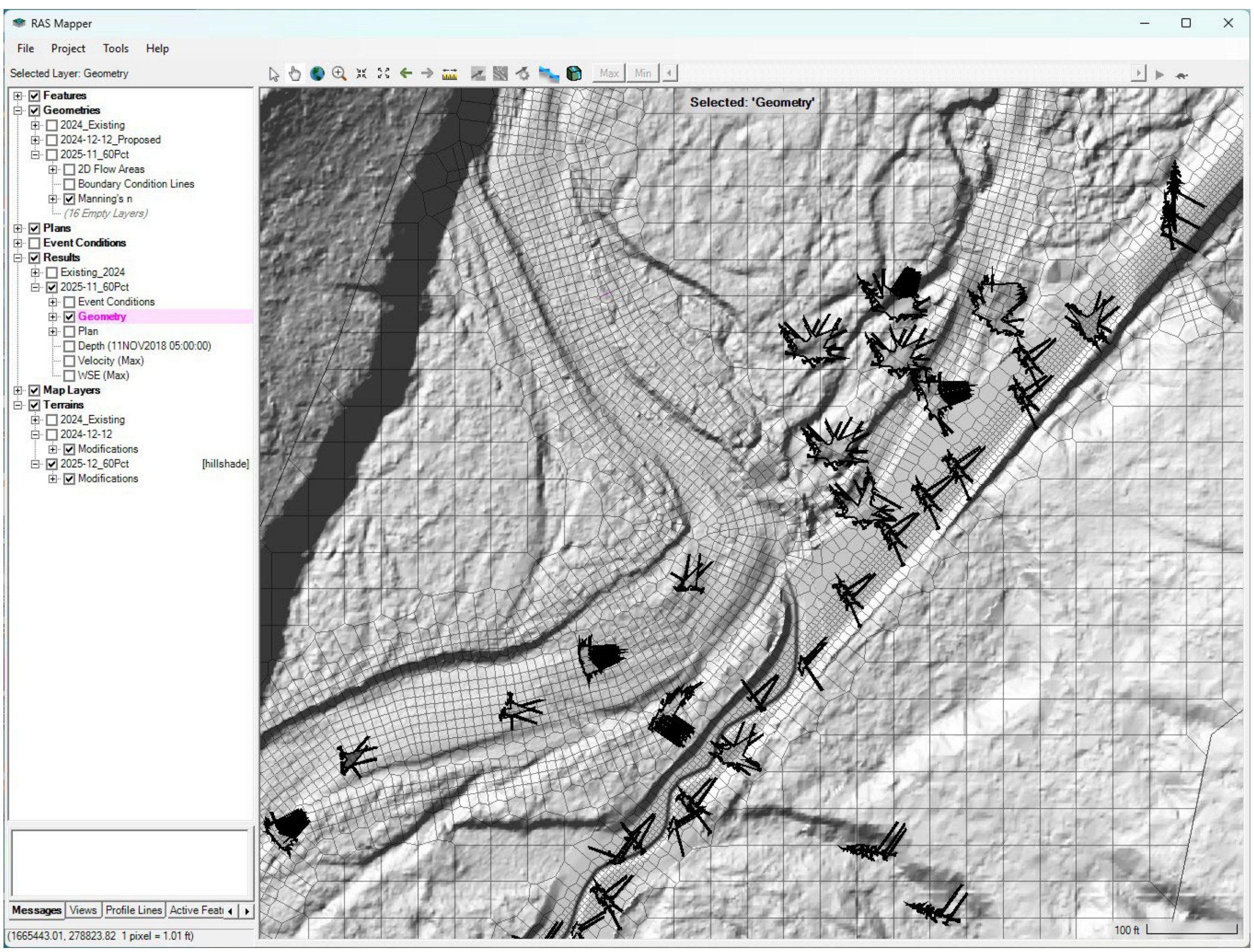

Figure 13. Detailed view of proposed conditions model mesh.

3.5.6 Model Roughness

Roughness coefficients (Manning's n values) are used by the 2D model to calculate flow energy losses, or frictional resistance, caused by channel bed materials, type and density of floodplain vegetation and large wood. Existing conditions roughness coefficients were applied across the model extent to represent the various types and densities of vegetation or surface conditions. Roughness coefficients were modified in the proposed conditions models to represent immediate post construction conditions. In general, roughness regions were delineated based on field observations, aerial photos, and proposed designs. Roughness values for each region were selected using professional judgment and guided by published guidelines (Arcement & Schneider 1989) for channel types and vegetation conditions. Manning's n values were assigned for:

- Main stem and side channel as 0.038-0.043 depending on complexity and amount of LWM.
- Forested bars as 0.055
- Forest and floodplain as 0.080
- LWM structures as 0.15 to 0.2.
- Floodplain roughness as 0.12

3.5.7 Model Boundary Conditions

HEC-RAS 6.6 2D models require boundary conditions at the upstream and downstream ends of the model to control the flow into and out of the model extent. The synthetic hydrograph described in the next section was applied as the upstream boundary condition. The flow was initially distributed along the boundary assuming normal flow depth at a friction slope estimated from topography to be approximately 0.005 feet per foot. The downstream boundary condition assumed normal flow depth at a friction slope estimated from topography to be 0.005 feet per foot. Boundary conditions were set far enough distant from the area of interest that potential uncertainties would be negligible within the project reach.

3.5.8 Model Discharges

The modeled discharges of interest included 2-, 5-, 10-, 25-, 50-, and 100-year recurrence interval peak flows listed in Table 2. Additional low flows of interest included summary low flow through extrapolated annual peak discharges and included: 20-, 50-, 100-, 200-, 300-, 600-, 1000-, and 2000--cfs. These discharges were incorporated into a synthetic hydrograph with periods of steady flow (at the discharges of interest) to create a stair-step like pattern similar to Figure 14. The periods of steady flow allow the model to come to a quasi-steady state condition, improving the interpretation of hydraulics at discharges of interest. It's worth noting that allowing the model to reach a steady state during large flood events may overestimate extents of flooding results, as floodplain storage throughout the model domain must reach capacity to reach steady-state conditions, which in reality may not occur during actual floods, especially short duration events. The receding limb of a typical flood hydrograph is also not represented when using this methodology.

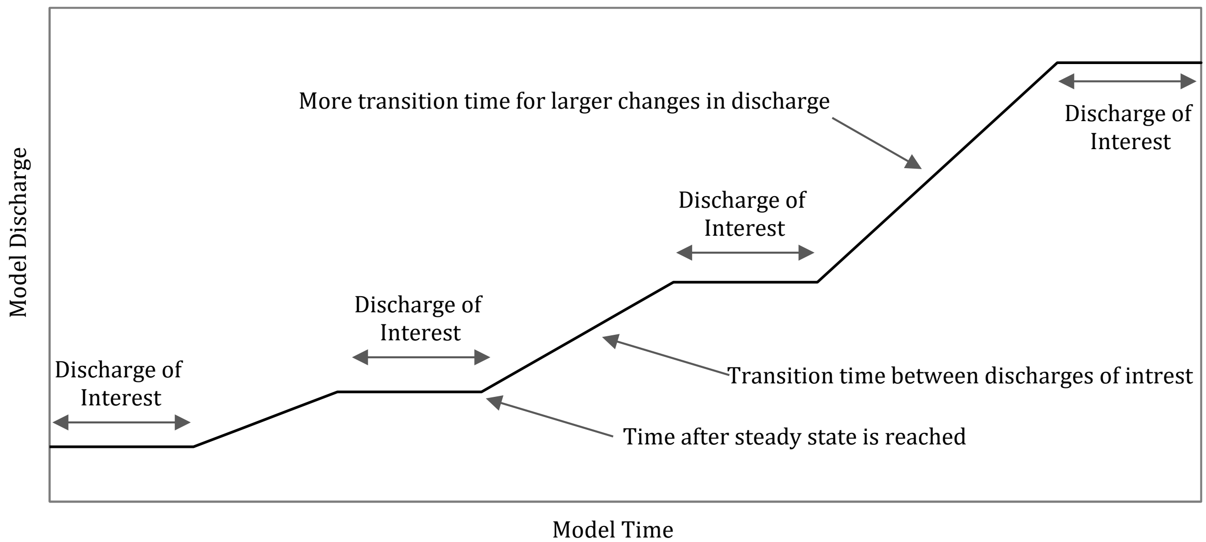

Figure 14. Stepped hydrograph Example

3.5.9 Model Output

To examine the inundation patterns, velocities, and other hydraulic parameters within the model extent for proposed conditions, the RAS Mapper utility of HEC-RAS 6.6 was used to view results in the form of raster data sets at the discharges of interest. Model output graphics for computational mesh, Manning's n coverage, water depths and velocities for the entire project area are included in Appendix C for existing conditions. Appendix D includes similar graphics for proposed conditions.

It should be noted that the 100-year water surface for proposed conditions is higher than existing conditions water surface elevations in several locations. A FEMA CLOMR/LOMR will be completed in a future design phase.

3.5.10 Model Findings

Model findings are preliminary, and the model will continue to be refined as the project progresses. Model results are used for design of LWM structures and evaluation of inundation limits and flow splits.

3.6 STABILITY ANALYSES AND COMPUTATIONS FOR PROJECT ELEMENTS, AND COMPREHENSIVE PROJECT PLAN

LWM structure stability analyses were prepared using guidelines for large wood design (Knutson et. al. 2014 and Reclamation/ERDC 2016). Calculations are included in Appendix E.

3.7 DESCRIPTION OF HOW PRECEDING TECHNICAL ANALYSIS HAS BEEN INCORPORATED INTO AND INTEGRATED WITH THE CONSTRUCTION – CONTRACT DOCUMENTATION

The preceding analysis is the basis for the project features shown in the design drawings. The drawings will be refined as the project progresses to final stamped construction drawing set with sufficient detail to allow contractors to bid and build the project.

3.8 FOR PROJECTS THAT ADDRESS PROFILE DISCONTINUITIES (GRADE STABILIZATION, SMALL DAM AND STRUCTURE REMOVALS): A LONGITUDINAL PROFILE OF THE STREAM CHANNEL THALWEG FOR 20 CHANNEL WIDTH UPSTREAM AND DOWNSTREAM OF THE STRUCTURE SHALL BE USED TO DETERMINE THE POTENTIAL FOR CHANNEL DEGRADATION

Not applicable to this project.

3.9 FOR PROJECTS THAT ADDRESS PROFILE DISCONTINUITIES (GRADE STABILIZATION, SMALL DAM AND STRUCTURE REMOVALS): A MINIMUM OF THREE CROSS-SECTIONS – ONE DOWNSTREAM OF THE STRUCTURE, ONE THROUGH THE RESERVOIR AREA UPSTREAM OF THE STRUCTURE, AND ONE UPSTREAM OF THE RESERVOIR AREA OUTSIDE OF THE INFLUENCE OF THE STRUCTURE) TO CHARACTERIZE THE CHANNEL MORPHOLOGY AND QUANTIFY THE STORED SEDIMENT

Not applicable to this project.

4. Construction – contract documentation

4.1 INCORPORATION OF HIP GENERAL AND CONSTRUCTION CONSERVATION MEASURES

General and construction conservation measures are included in the 60% level plans.

4.2 DESIGN – CONSTRUCTION PLAN SET INCLUDING BUT NOT LIMITED TO PLAN, PROFILE, SECTION AND DETAIL SHEETS THAT IDENTIFY ALL PROJECT ELEMENTS AND CONSTRUCTION ACTIVITIES OF SUFFICIENT DETAIL TO GOVERN COMPETENT EXECUTION OF PROJECT BIDDING AND IMPLEMENTATION

60% level plans are included in Appendix A.

4.3 LIST OF ALL PROPOSED PROJECT MATERIALS AND QUANTITIES

Proposed materials types and quantities are included in the plans and attached opinion of probable construction quantities. Materials include logs, logs with rootwads, slash, whole trees, tree tops, log piles, excavation and backfill of alluvial materials. Additional materials may include boulders and small boulder alluvial backfill if in sufficient sized material for backfill is encountered. The project area will be planted with native riparian plant species to be designed by Yakama Nation's vegetation consultant in a future phase.

4.4 DESCRIPTION OF BEST MANAGEMENT PRACTICES THAT WILL BE IMPLEMENTED AND IMPLEMENTATION RESOURCE PLANS INCLUDING:

HIP conservation measures are included in the preliminary plans including an erosion and sediment control plan using standard BMPs.

4.5 CALENDAR SCHEDULE FOR CONSTRUCTION/IMPLEMENTATION PROCEDURES

A construction timeframe has not been determined at this time.

4.6 SITE OR PROJECT SPECIFIC MONITORING TO SUPPORT POLLUTION PREVENTION AND/OR ABATEMENT

Standard erosion and pollution control measures by the contractor are specified in the construction drawing set.

5. Monitoring and adaptive management plan

The monitoring and adaptive management plan will be determined at the discretion of Yakama Nation Fisheries in subsequent design phases.

6. References

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U.S. Army Corps of Engineers. 2024. Hydrologic Engineering Center River Analysis System HEC-RAS, version 6.6.

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Appendix A – Phase 2 RM 3.7-4.6 60% project drawings

Plans submitted separately.

Appendix B – Opinion of probable construction quantities

Nason Floodplain RM 3.7-4.6 Phase 2 60%: Opinion of Probable Construction Cost

version: 1/14/2026

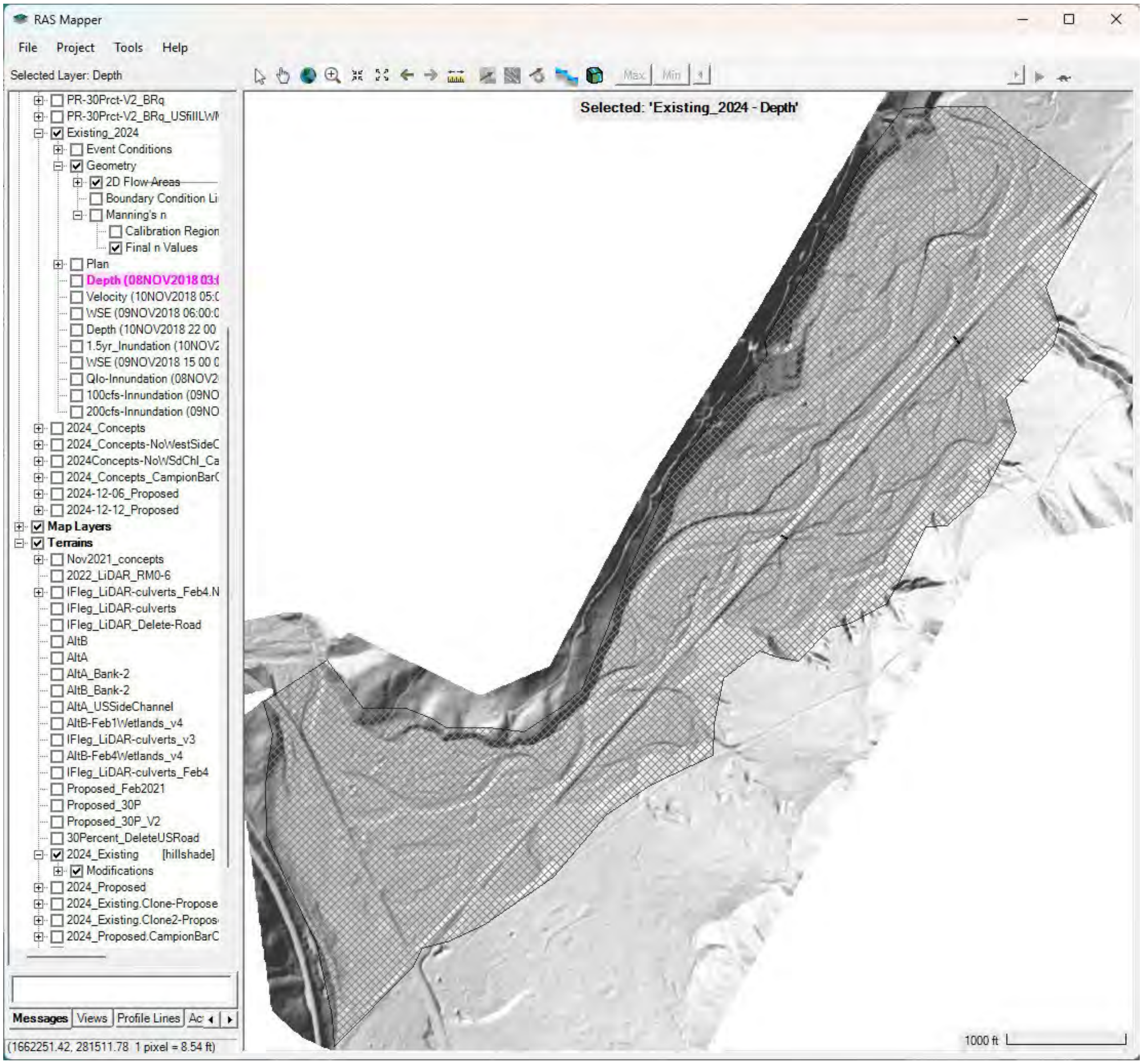
Item	Description	Quantity	Units	Unit Cost	Subtotal	Notes
1	TESC, SPCC Plan and Implementation	1	LS	$ 94,000	$ 94,000	~5% of Items 7-30
2	Mobilization	1	LS	$ 169,000	$ 169,000	~9% of Items 7-30
3	Traffic Control	1	LS	$ 38,000	$ 38,000	~2% of Items 7-30
4	Clearing and Grubbing	1	LS	$ 38,000	$ 38,000	~2% of Items 7-30
5	Cofferdam and Diversion	1	LS	$ 94,000	$ 94,000	~5% of Items 7-30
6	Pumping	1	LS	$ 38,000	$ 38,000	~2% of Items 7-30
7	Temporary bridge	1	LS	$ 100,000	$ 100,000	one bridge, three locations
River Left project components						
8	Apex jams	2	EA	$ 29,000	$ 58,000	Install Owner provided logs and salvaged slash and trees
9	Bar roughness wood structures	5	EA	$ 6,750	$ 33,750	Install Owner provided logs and salvaged slash and trees
10	FP roughness logs	4	EA	$ 500	$ 2,000	Install Owner provided logs and salvaged slash and trees
11	Tipped trees	4	EA	$ 1,000	$ 4,000	
River Right project components						
12	CED-1 & 2 Riprap removal and salvage	700	CY	$ 25	$ 17,500	Approximately 225+250LF x 3ft thick x 12ft high plus barbs
13	CED-1 & 2 Road embankment removal, low flow channel and wetland creation excavation and off site disposal	30700	CY	$ 15	$ 460,500	CADD volume
14	CED-1 Mainstem Meander excavation	2950	CY	$ 15	$ 44,250	CADD volume minus volume of riprap removal
15	CED-1 Mainstem Meander gravel bar alluvial material fill	2330	CY	$ 12	$ 27,960	CADD volume
16	CED-3 Mainstem Meander gravel bar alluvial material excavation	1850	CY	$ 15	$ 27,750	CADD volume
17	CED-2 bank revetment for Phase 1 road	1050	CY	$ 75	$ 78,750	42" thick Class B stone
18	Apex jams	4	EA	$ 29,000	$ 116,000	Install Owner provided logs and salvaged slash and trees
19	Bank buried jam	3	EA	$ 25,000	$ 75,000	Install Owner provided logs and salvaged slash and trees
20	Bank buried jam w/trees	2	EA	$ 31,000	$ 62,000	Install Owner provided logs and salvaged slash and trees
21	Small bank buried jam	9	EA	$ 8,400	$ 75,600	Install Owner provided logs and salvaged slash and trees
22	Bank margin wood	7	EA	$ 20,250	$ 141,750	Install Owner provided logs and salvaged slash and trees
23	Bar roughness wood structures	12	EA	$ 8,470	$ 101,640	Install Owner provided logs and salvaged slash and trees
24	BR and SM-BB racking wood	4	EA	$ 9,970	$ 39,880	Install Owner provided logs and salvaged slash and trees
25	CED3 Bank barb structure	4	EA	$ 39,250	$ 157,000	Install Owner provided logs and salvaged slash and trees
26	Deflector jam	3	EA	$ 9,500	$ 28,500	Install Owner provided logs and salvaged slash and trees
27	Inlet structure	2	EA	$ 32,150	$ 64,300	Install Owner provided logs and salvaged slash and trees
28	low flow channel floodplain roughness LW	11	EA	$ 11,950	$ 131,450	Install Owner provided logs and salvaged slash and trees
29	low flow channel habitat cover logs	11	EA	$ 4,980	$ 54,780	Install Owner provided logs and salvaged slash and trees
30	low flow channel floodplain roughness log	18	EA	$ 3,480	$ 62,640	Install Owner provided logs and salvaged slash and trees
				Subtotal Items 8-28	**$ 1,870,000**	
				Subtotal items 1-7	**$ 571,000**	
				Total	**$ 2,441,000**	

Abbreviations:
CY = Cubic Yards
EA = Each
LS = Lump Sum

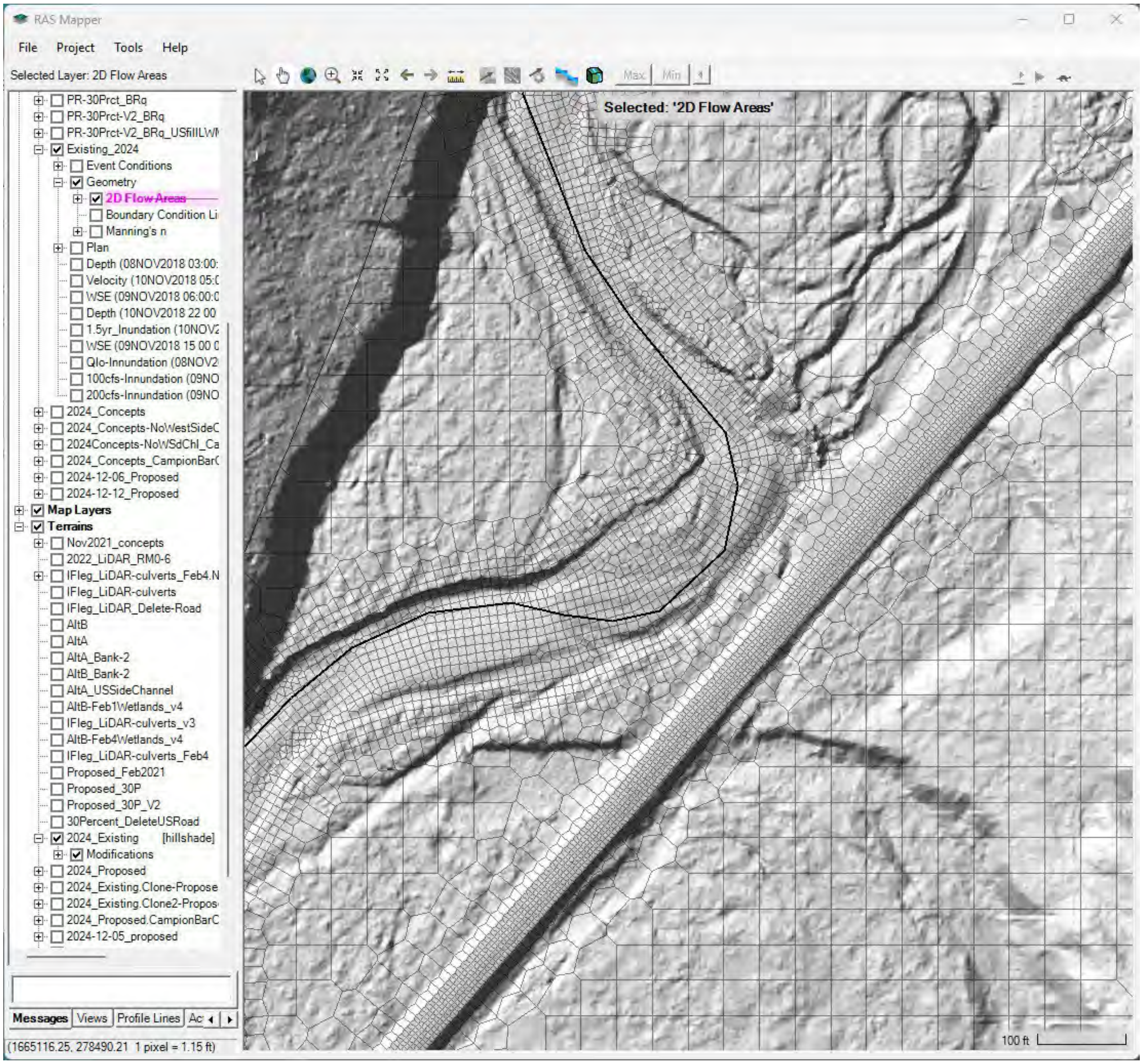
Assumptions:
Large wood is provided by Owner and stockpiled in close proximity to site
Planting plan and revegetation to be designed by others in future phase
Utility removal by others.

Appendix C – Existing conditions HEC-RAS model

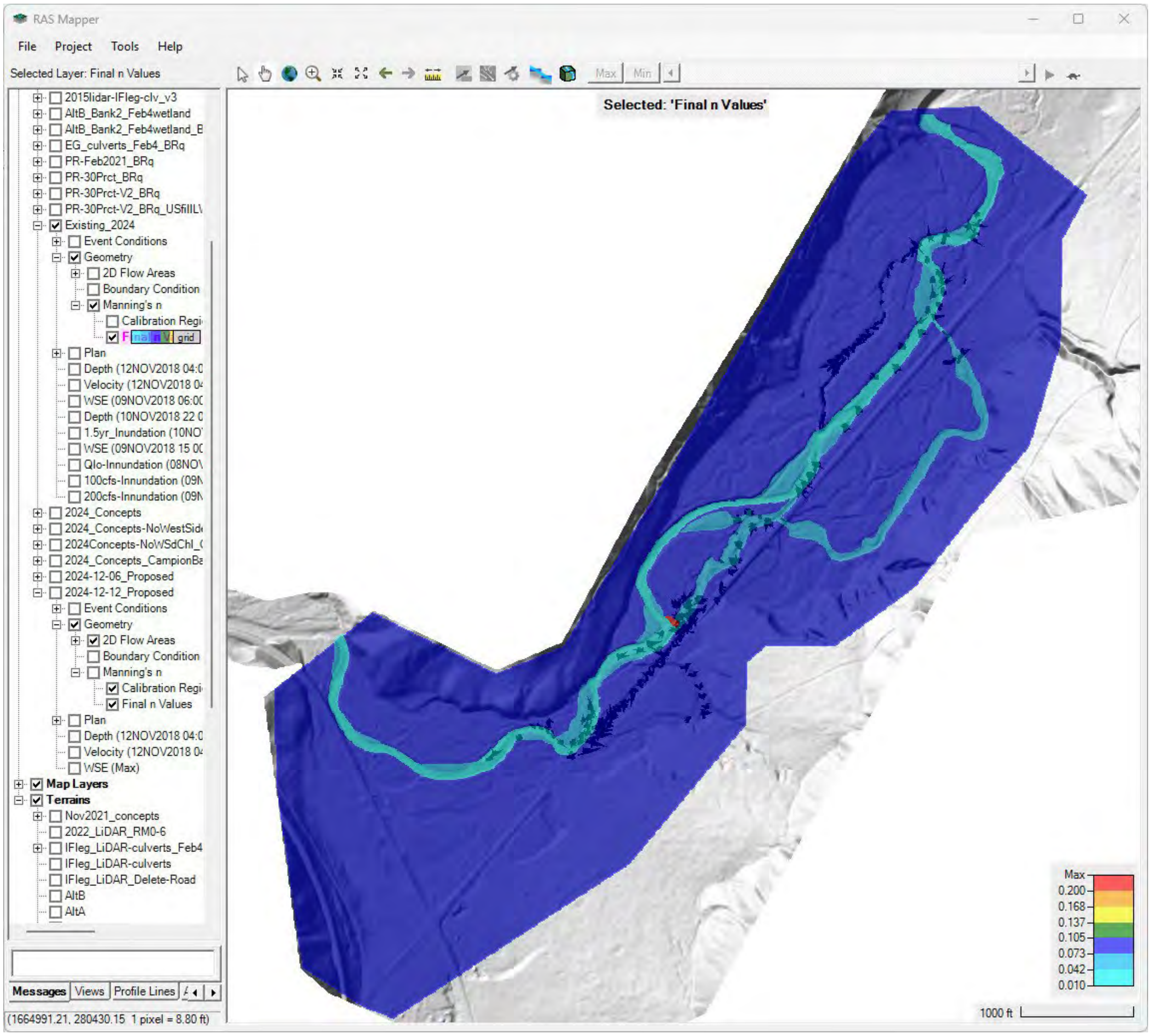
Existing condition model mesh



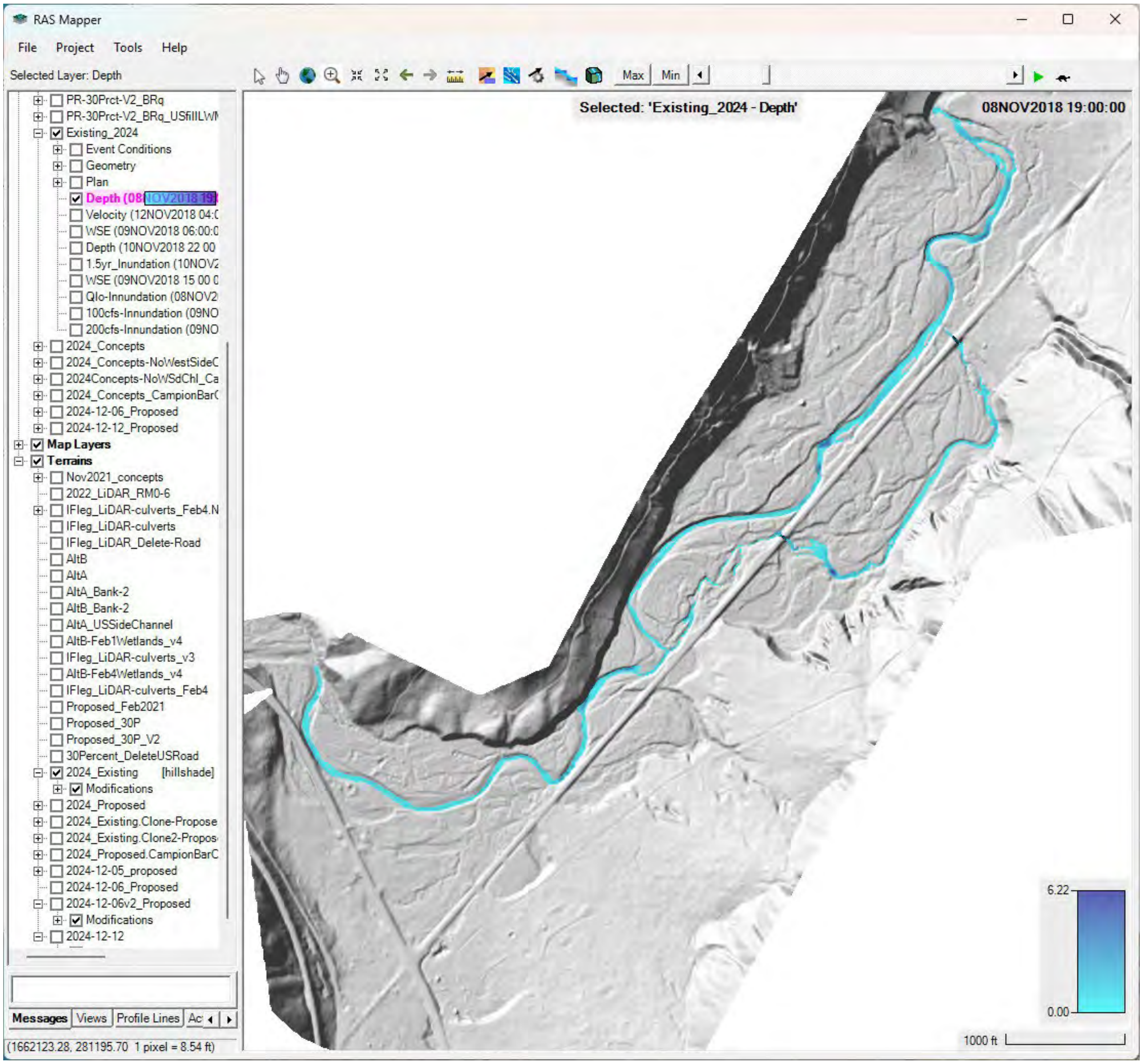
Existing condition model mesh example of detail



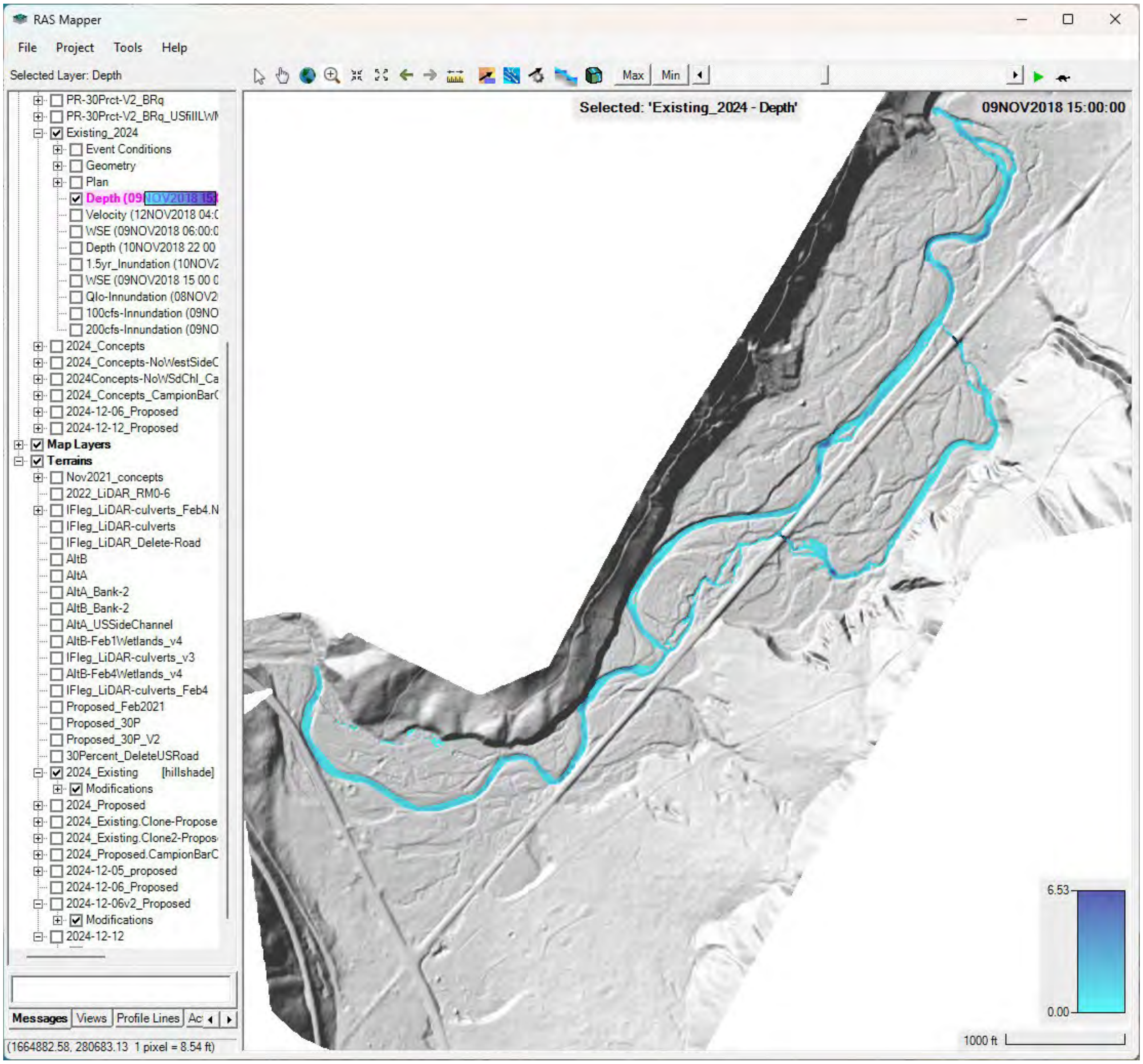
Existing condition Manning's n



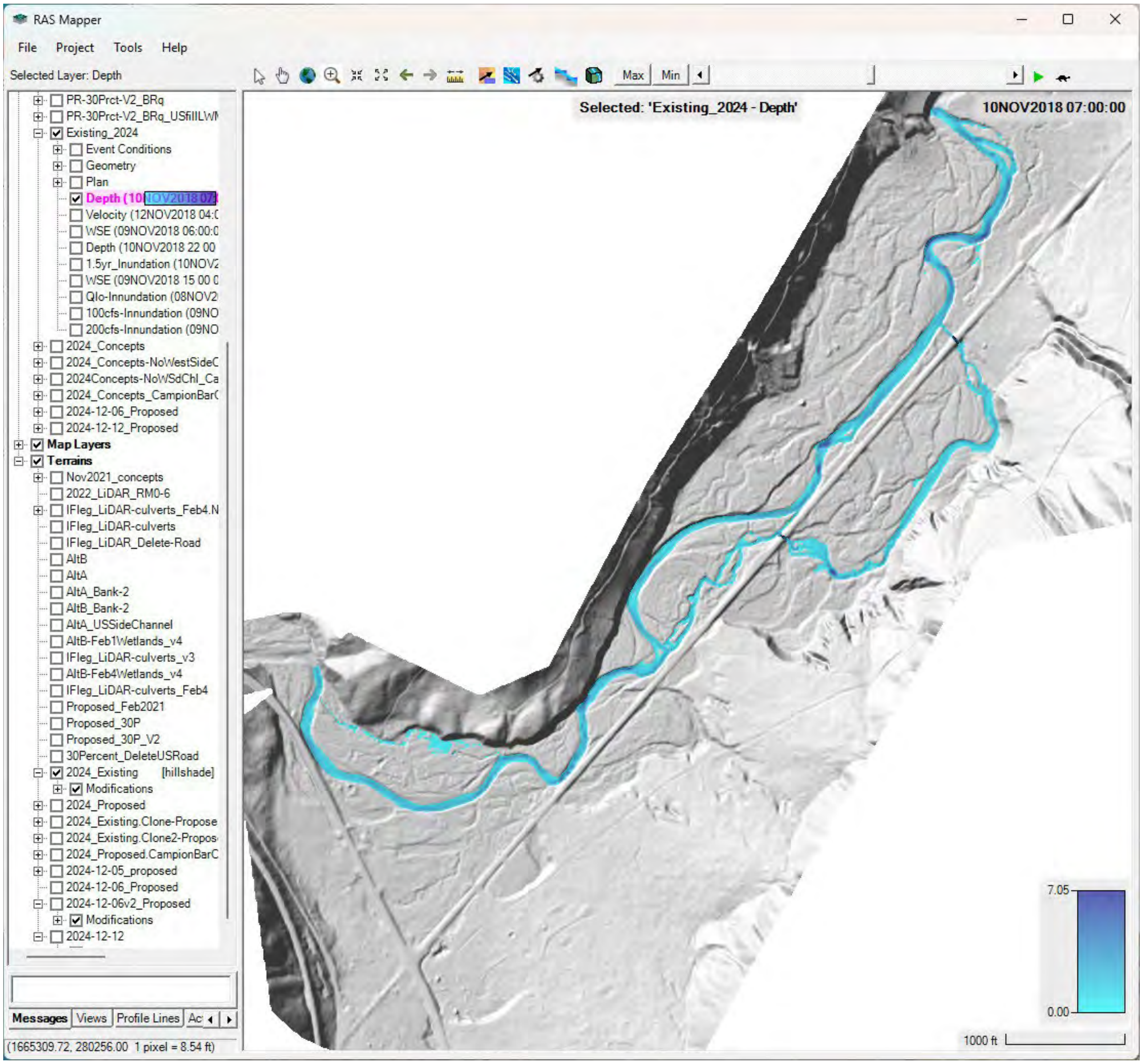
Existing condition: 50-cfs flow depth through project area



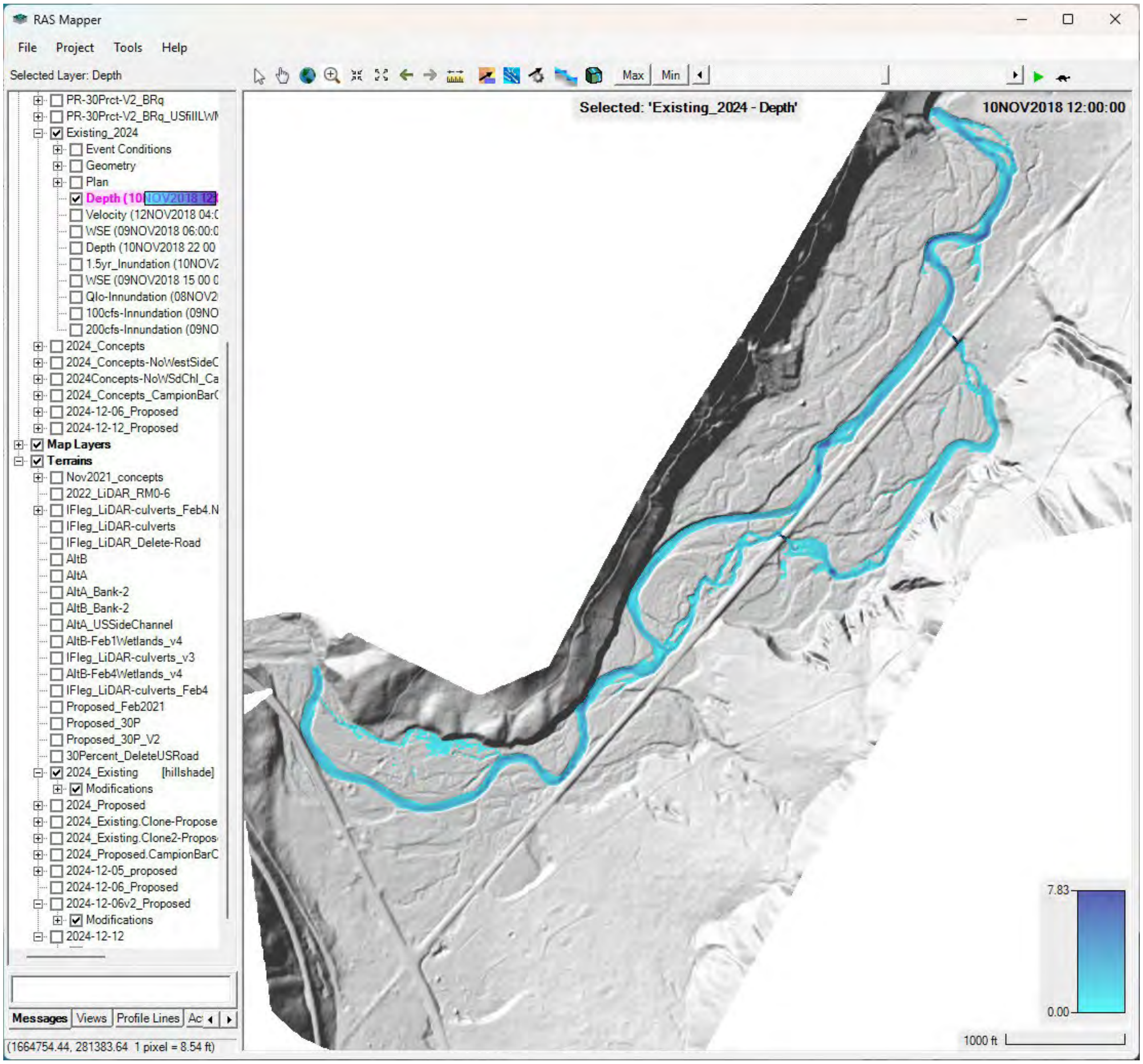
Existing condition: 200-cfs flow depth through project area



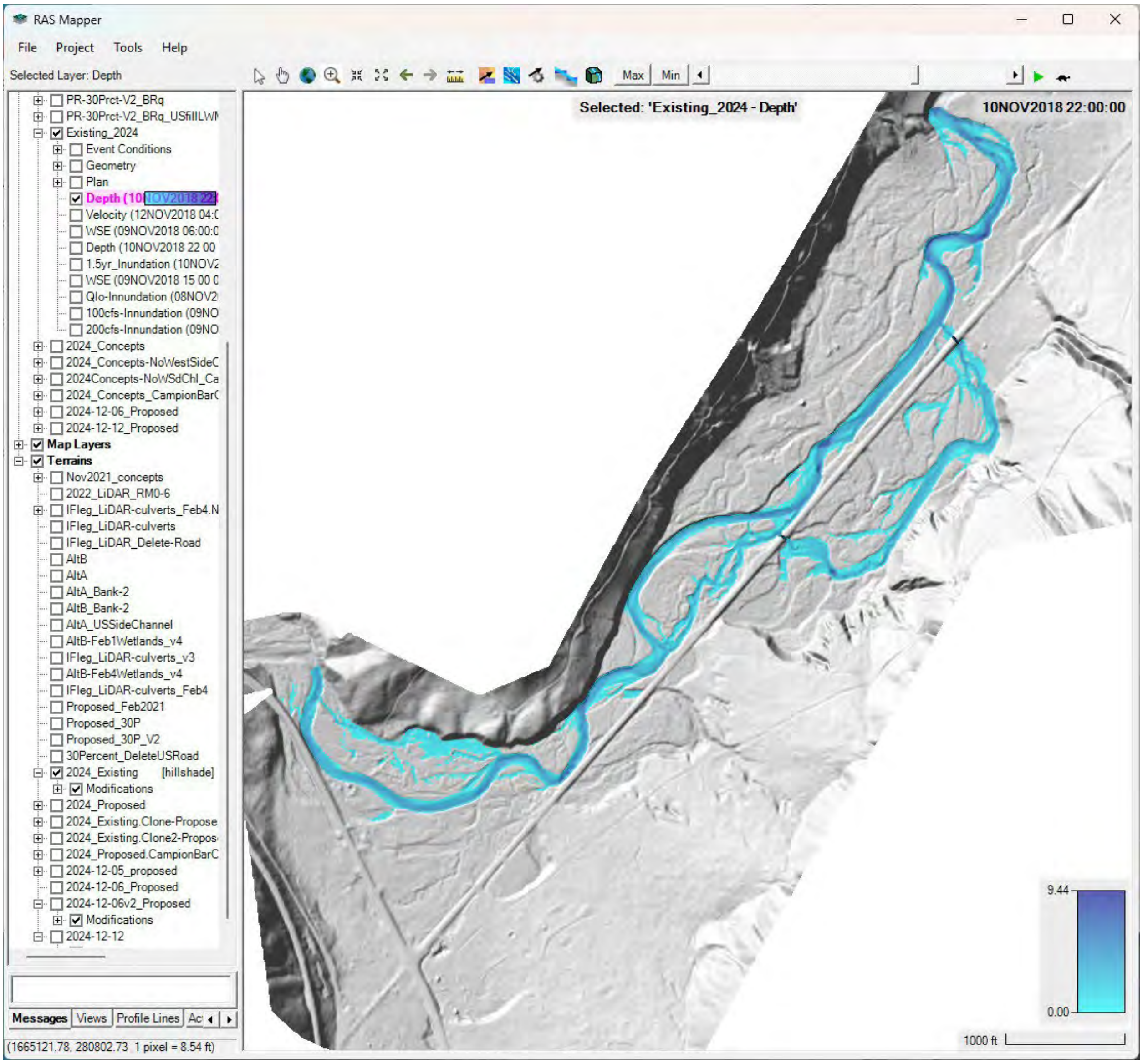
Existing condition: 600-cfs flow depth through project area



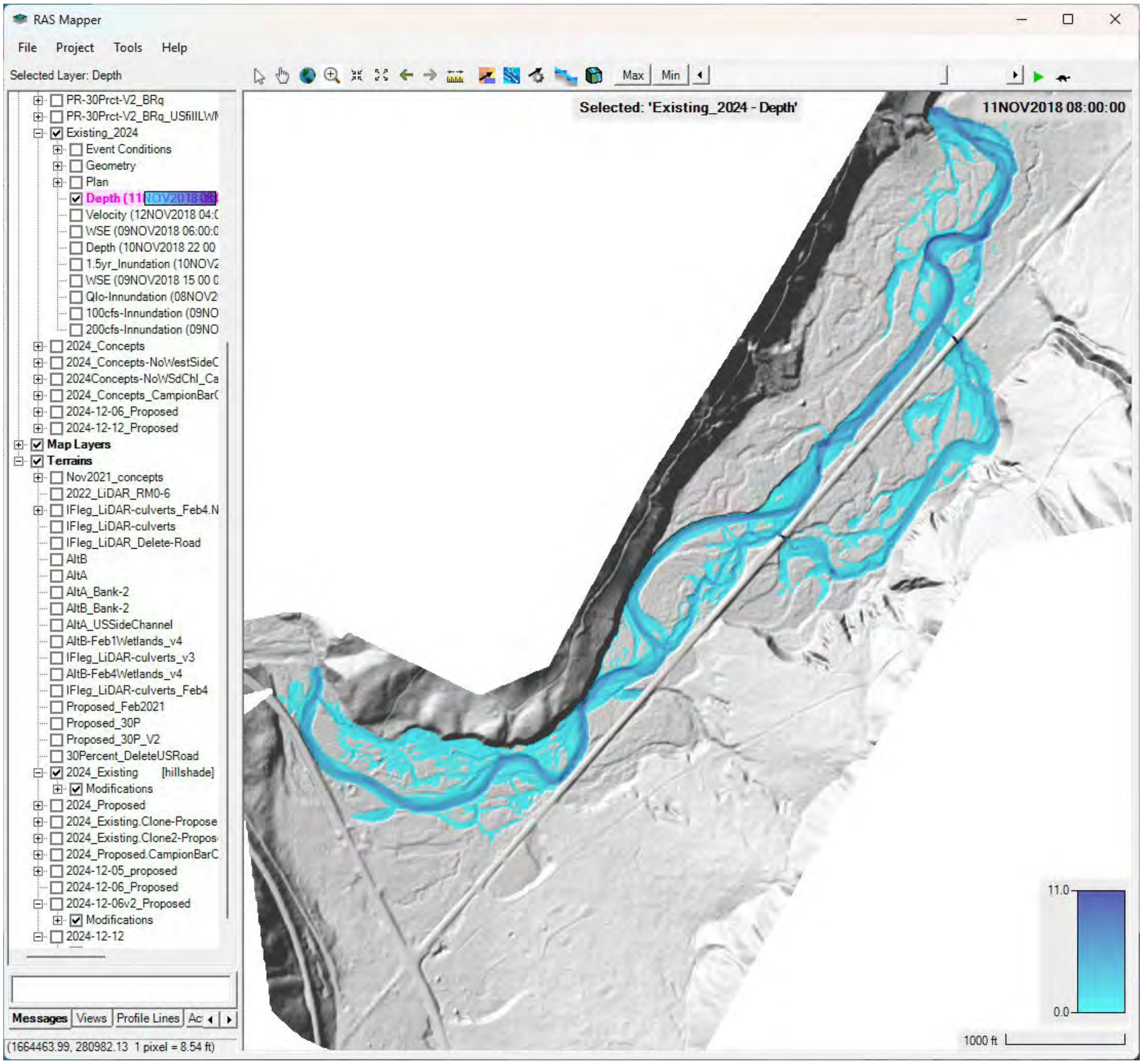
Existing condition: 1,000-cfs flow depth through project area



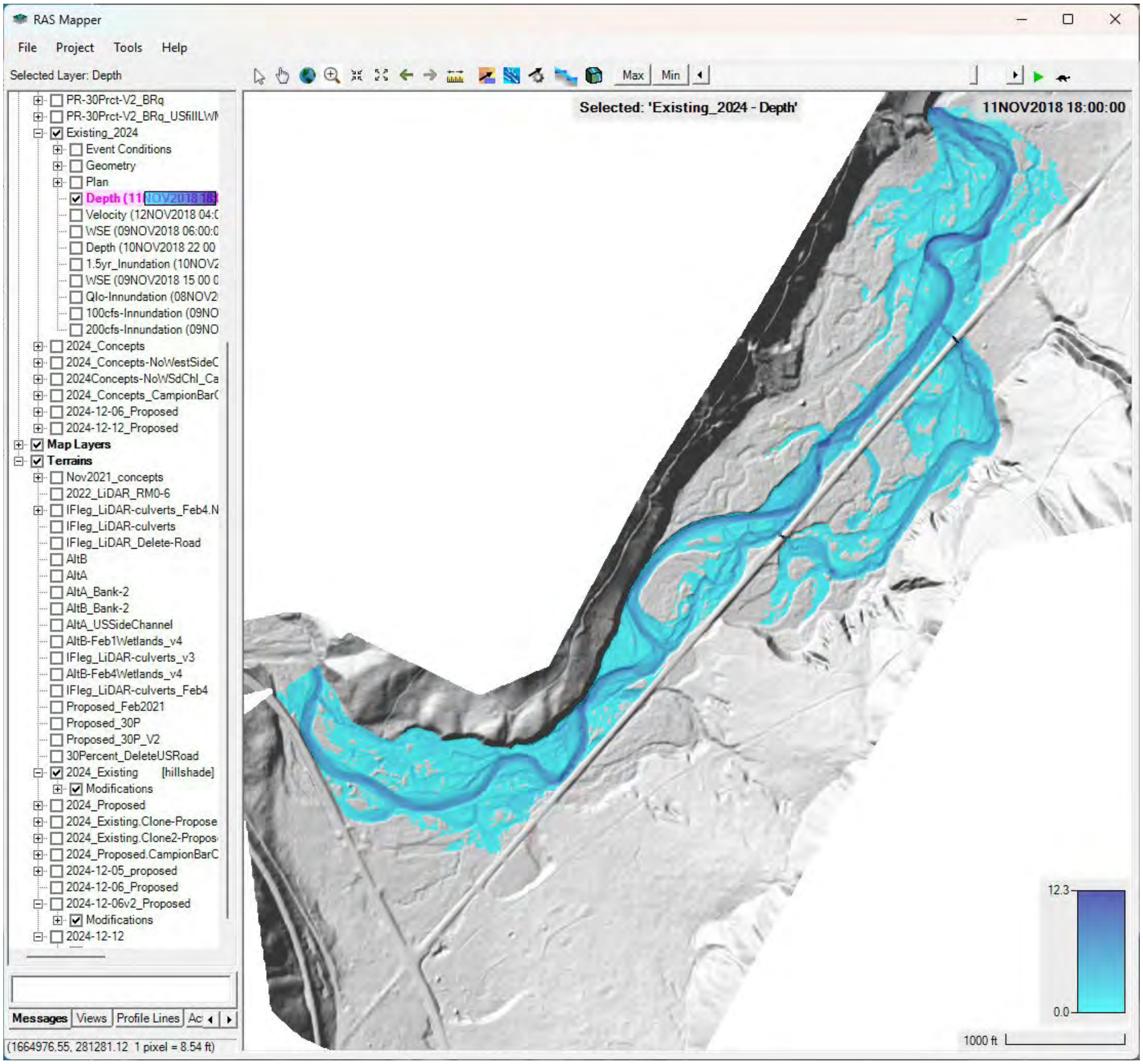
Existing condition: 1.5-year (2,200-cfs) flow depth, entire model domain



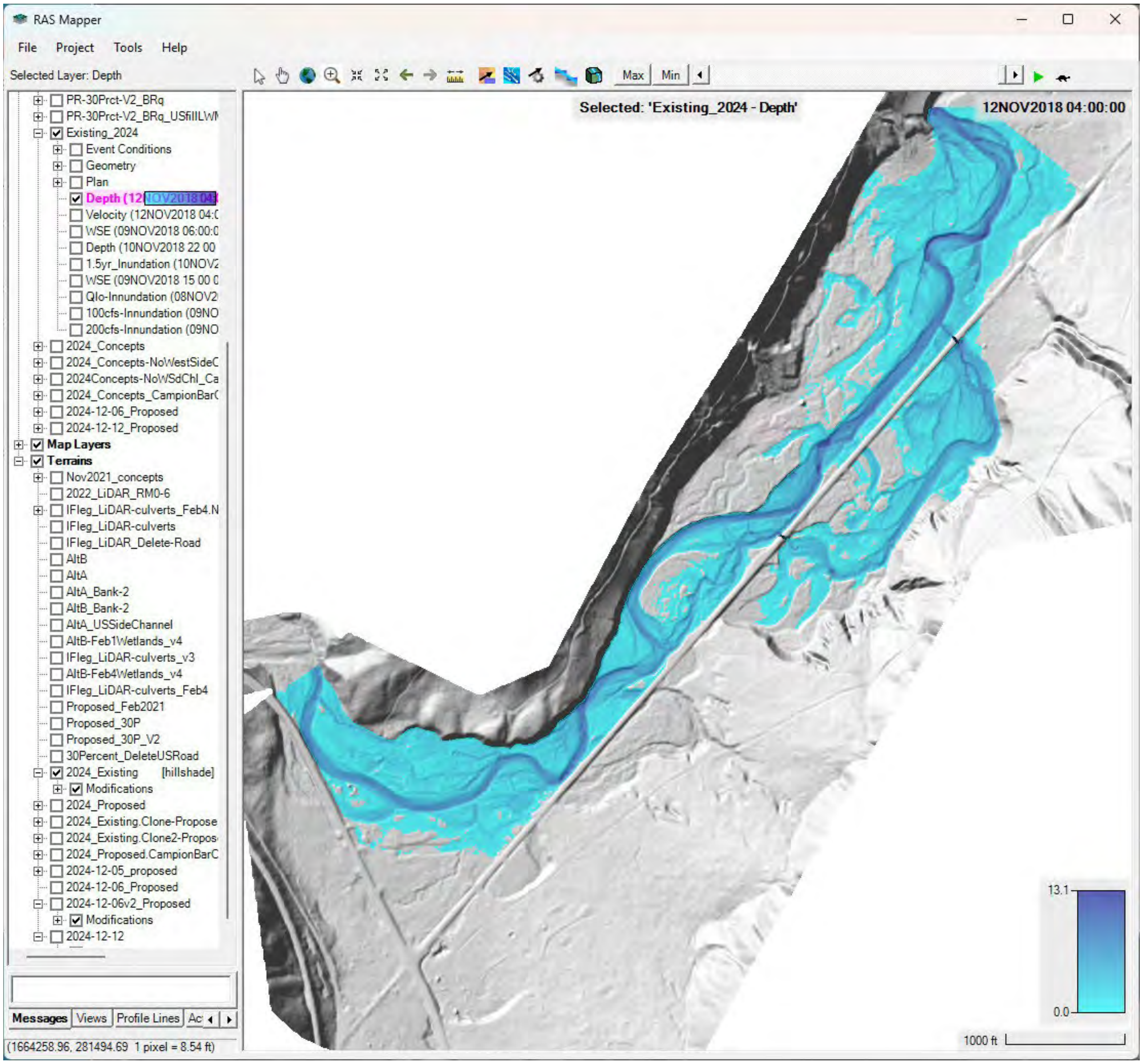
Existing condition: 5-year (3,900-cfs) flow depth, entire model domain



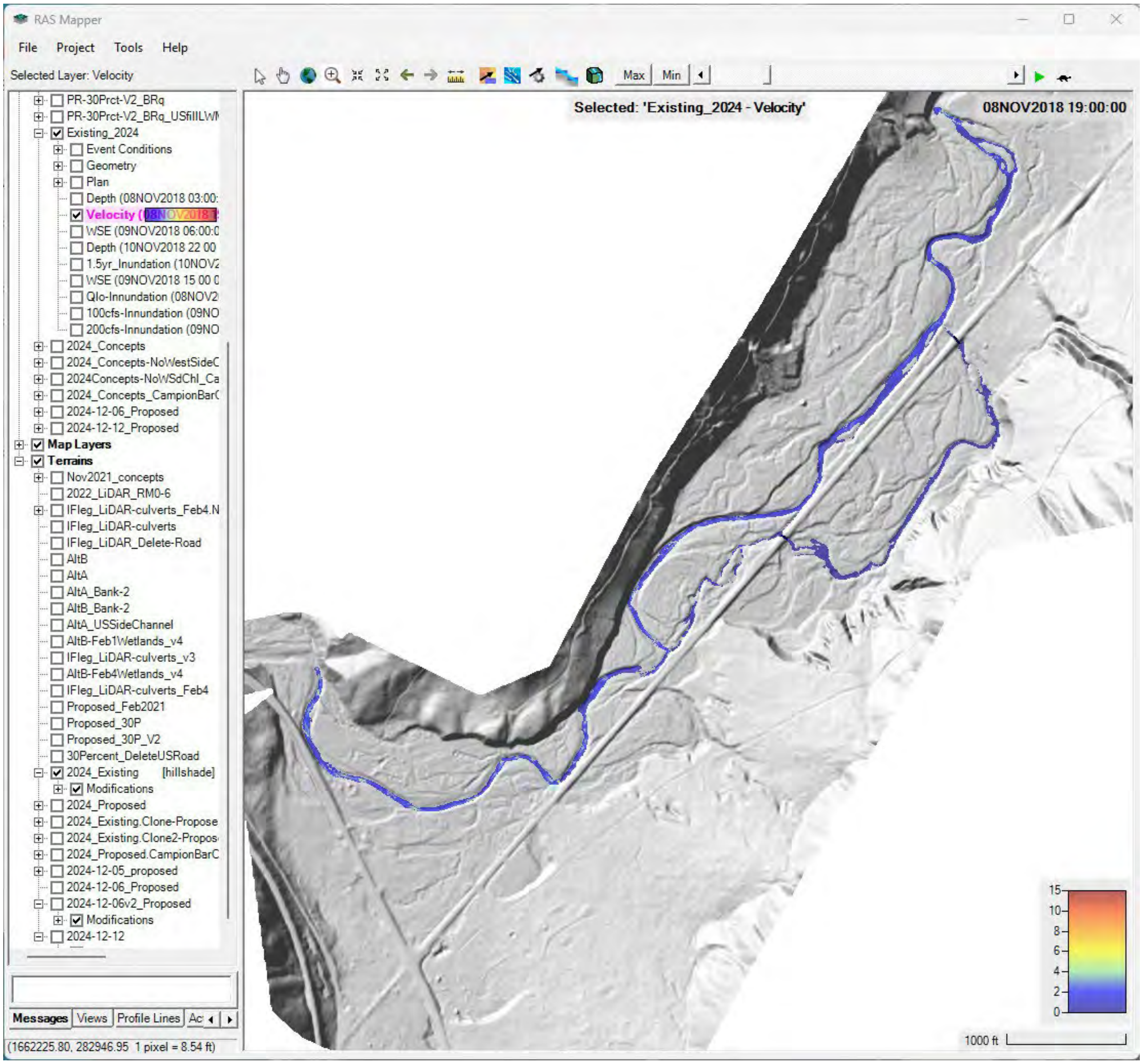
Existing condition: 25-year (6,500-cfs) flow depth, entire model domain



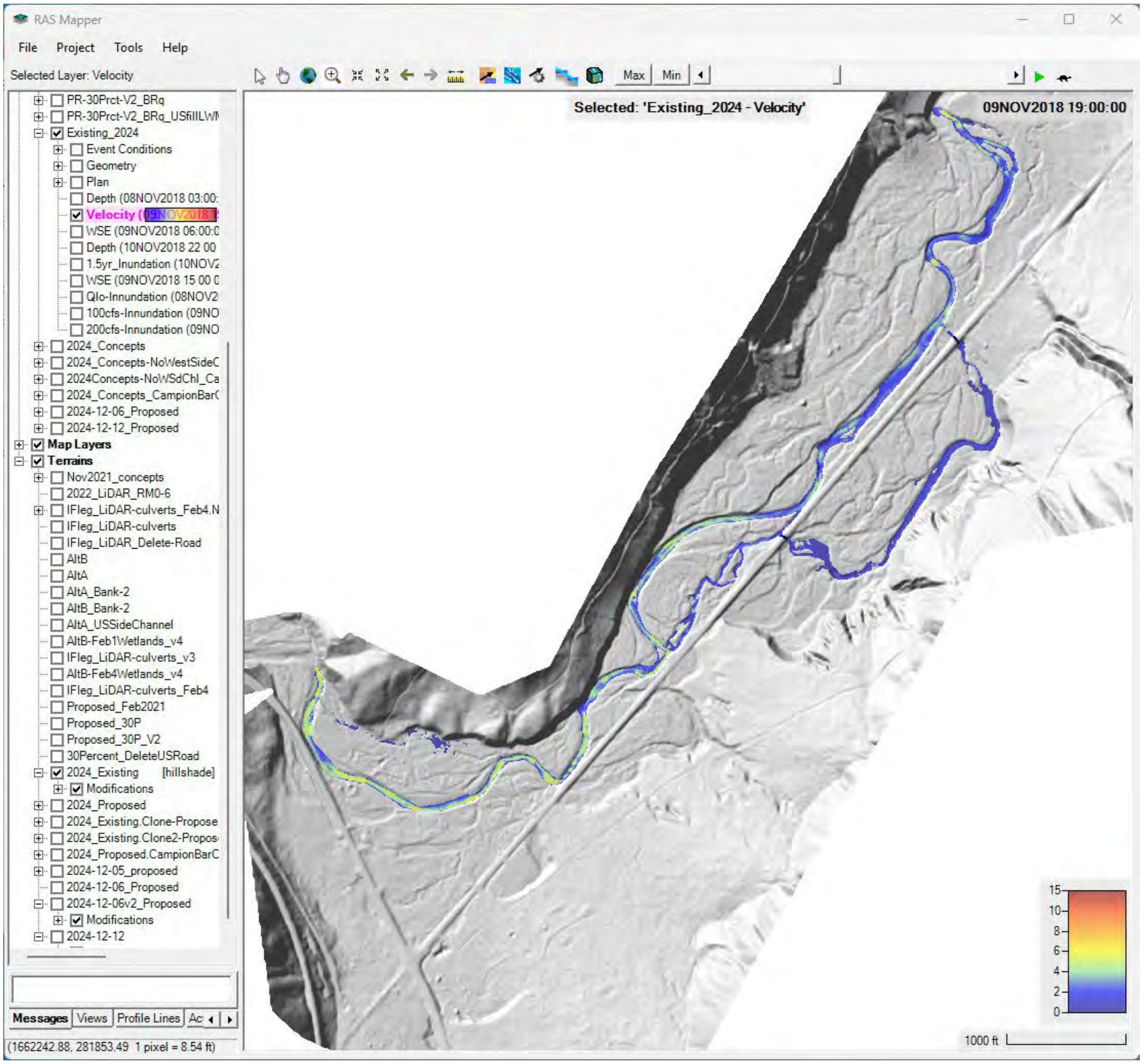
Existing condition: 100-year (9,400-cfs) flow depth, entire model domain



Existing condition: 50-cfs flow velocity through project area



Existing condition: 200-cfs flow velocity through project area



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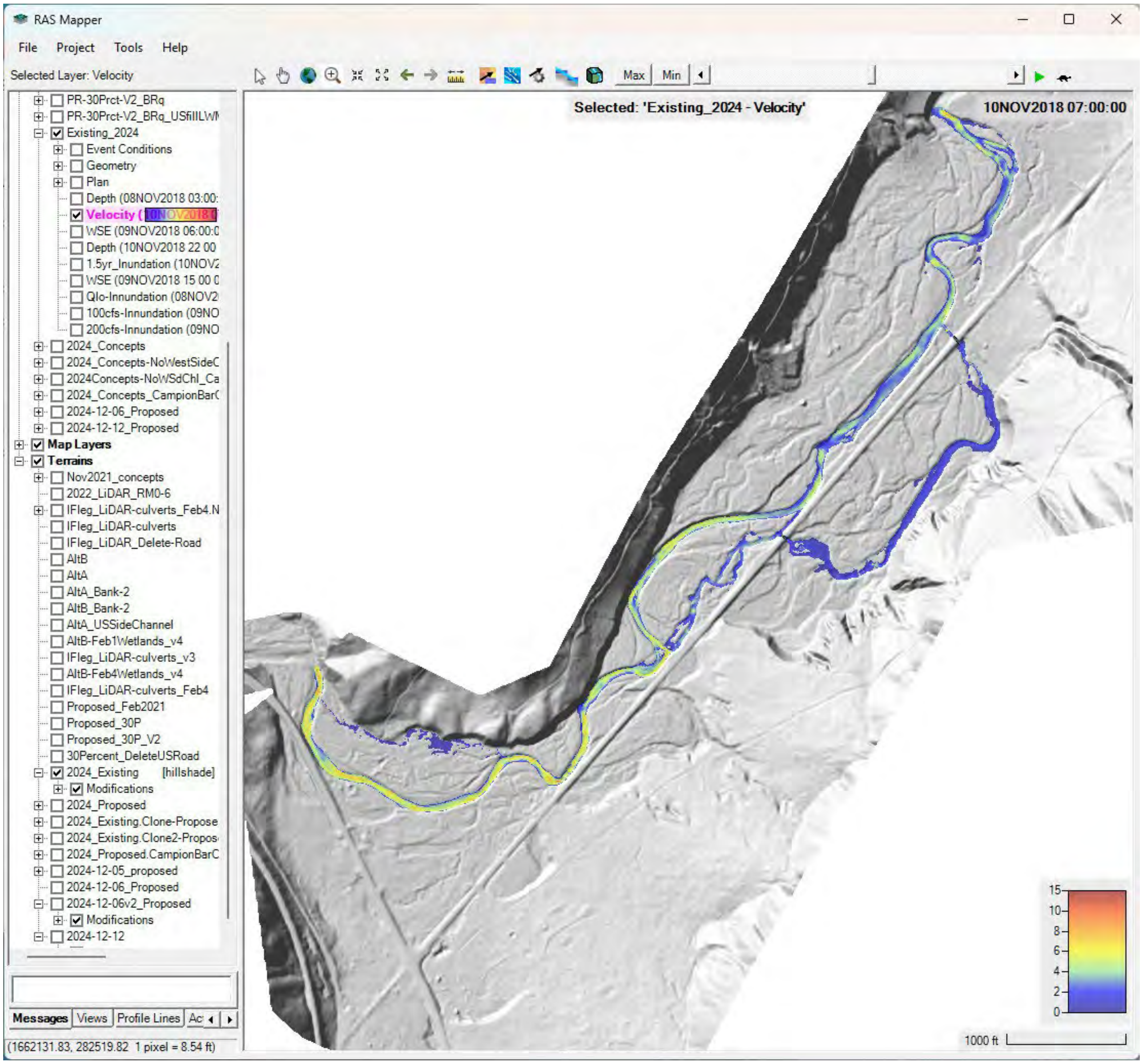
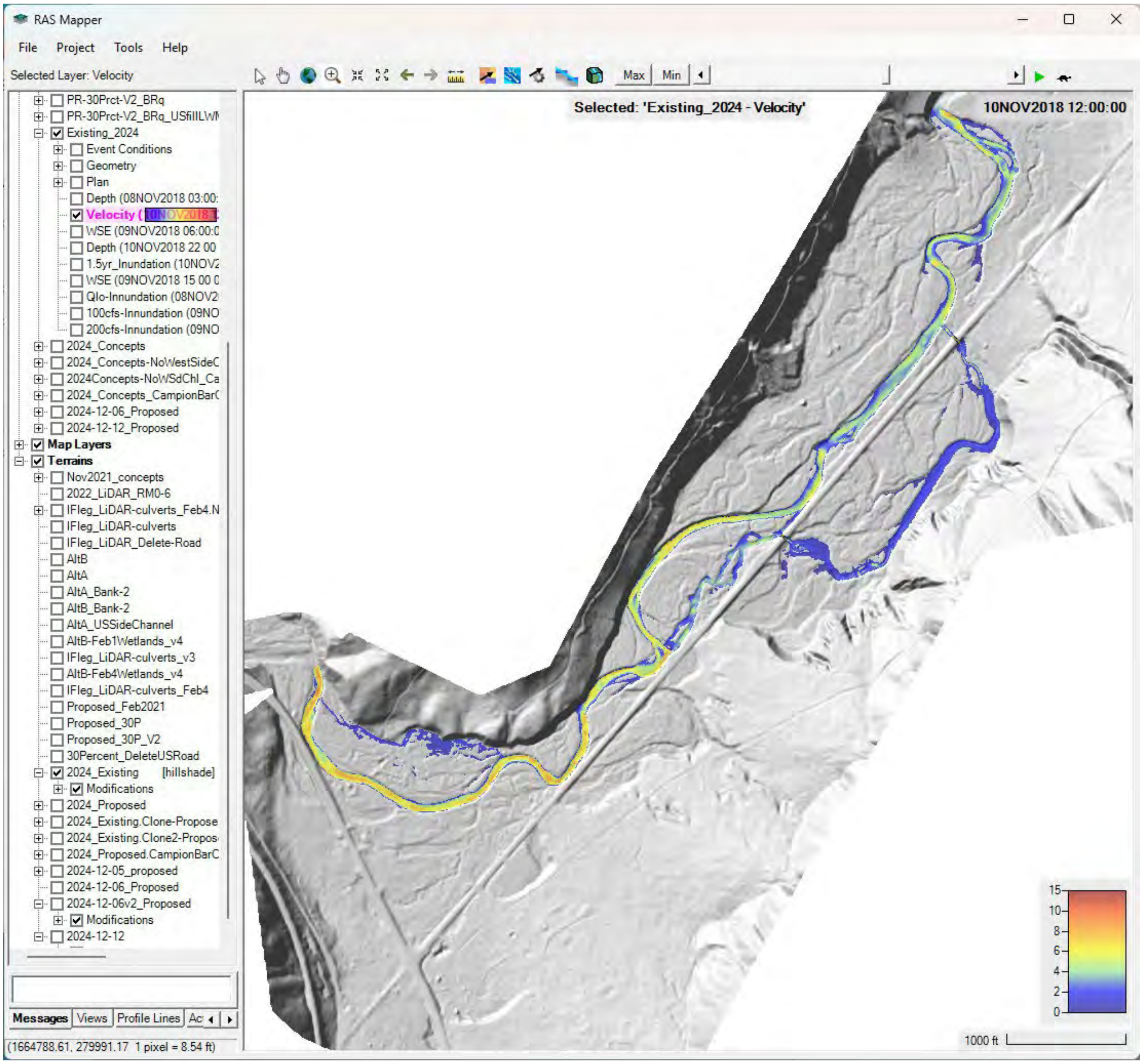
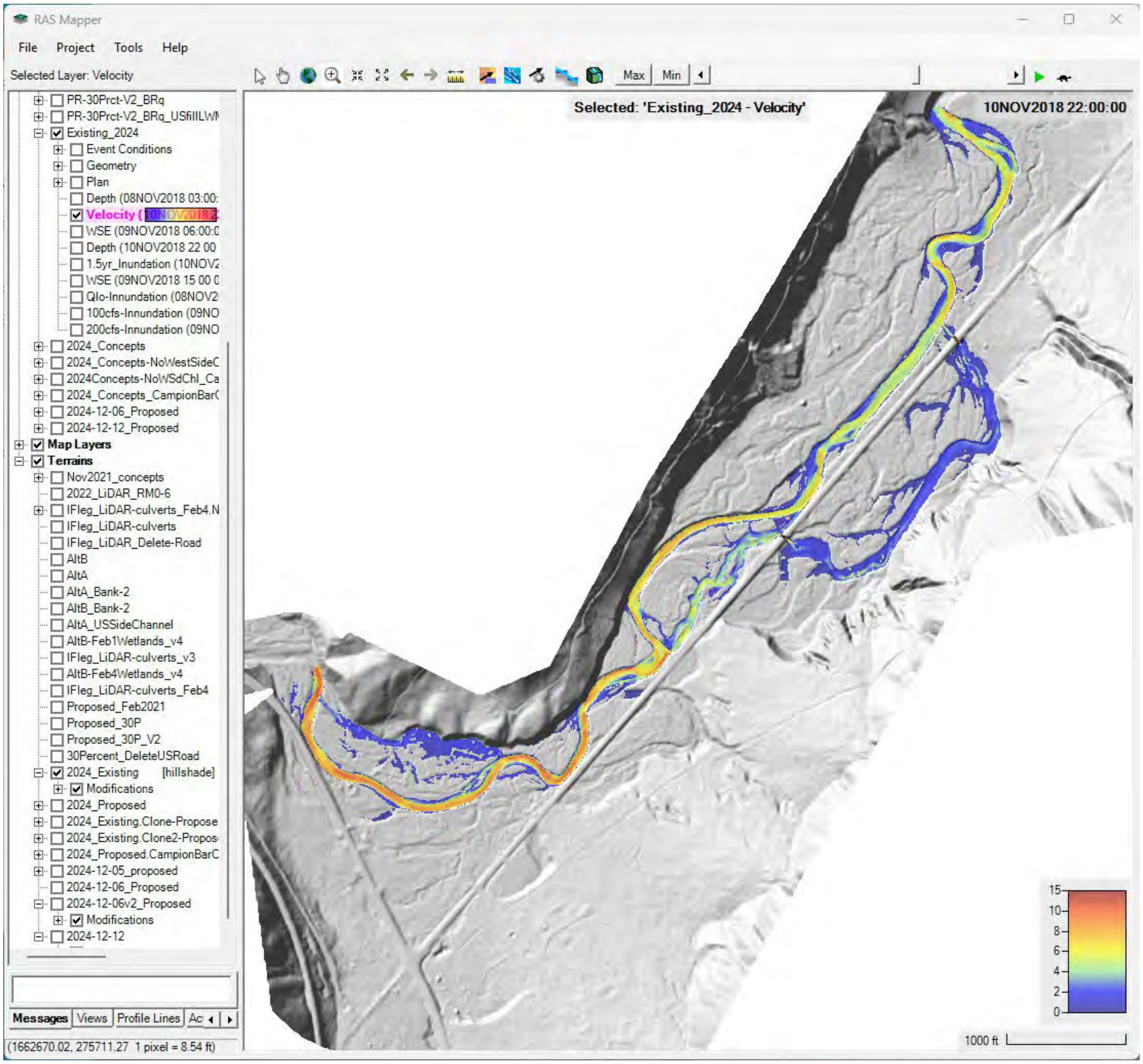


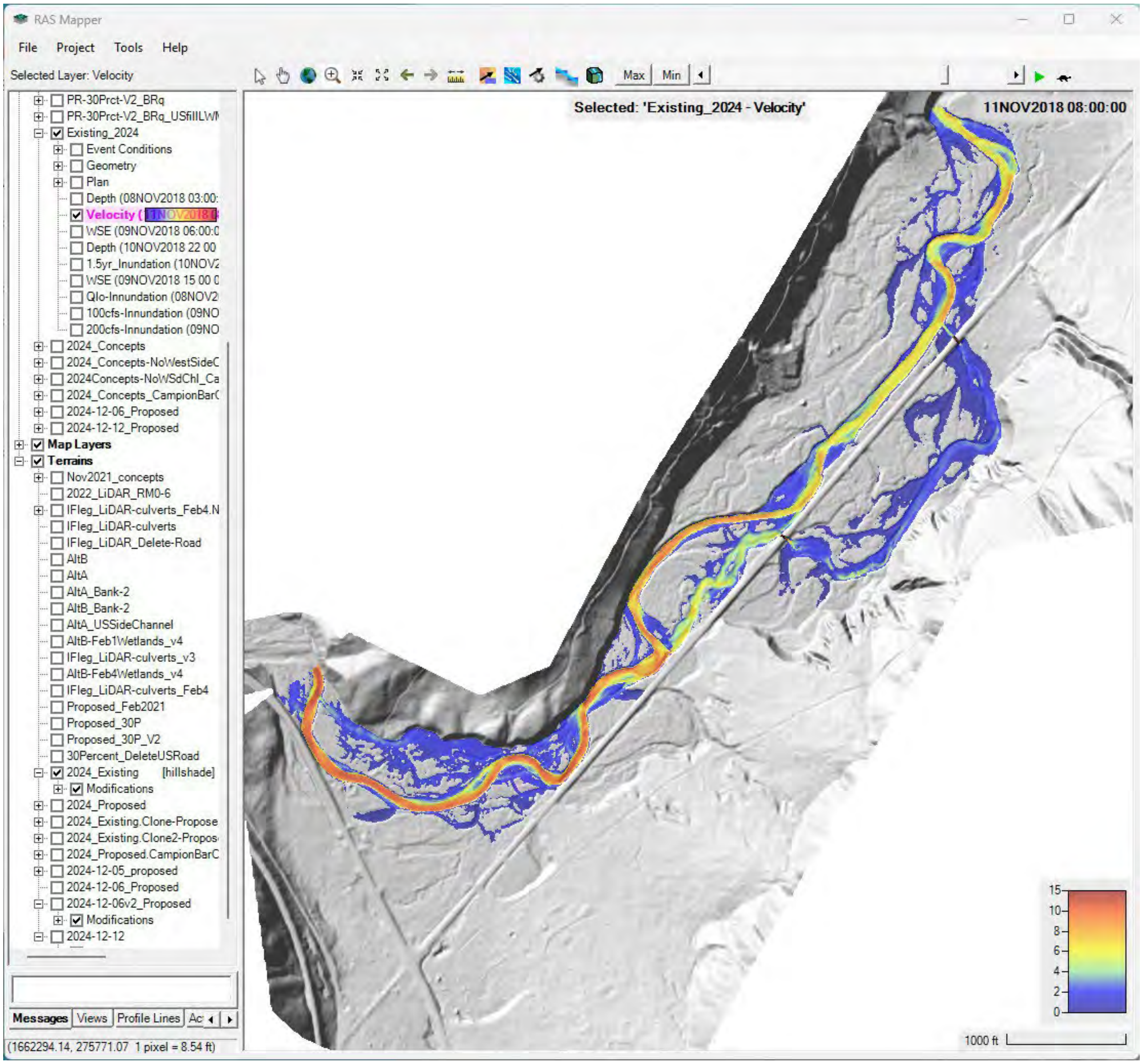
Existing condition: 1,000-cfs flow velocity through project area



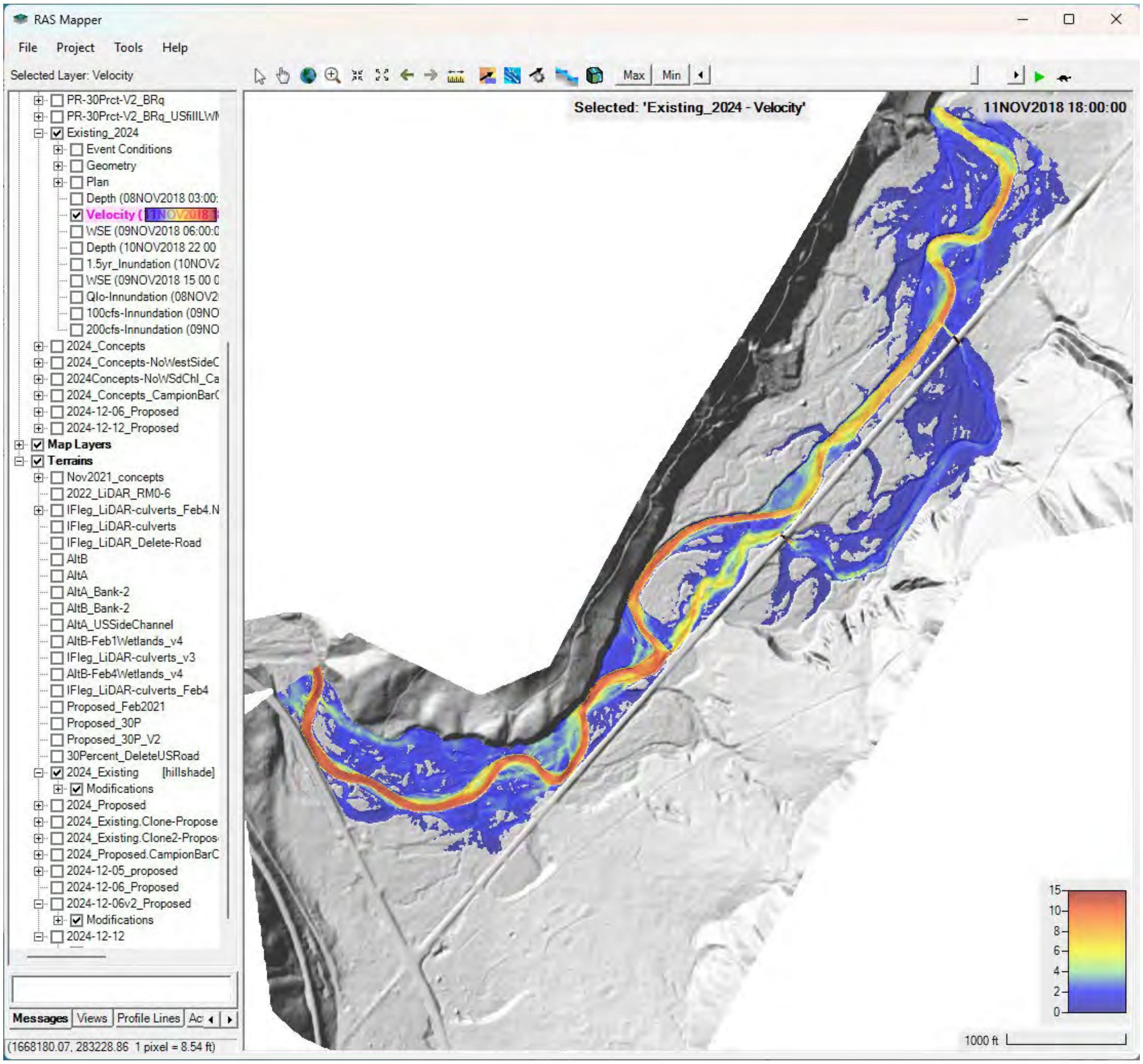
Existing condition: 1.5-year (2,200-cfs) flow velocity through project area



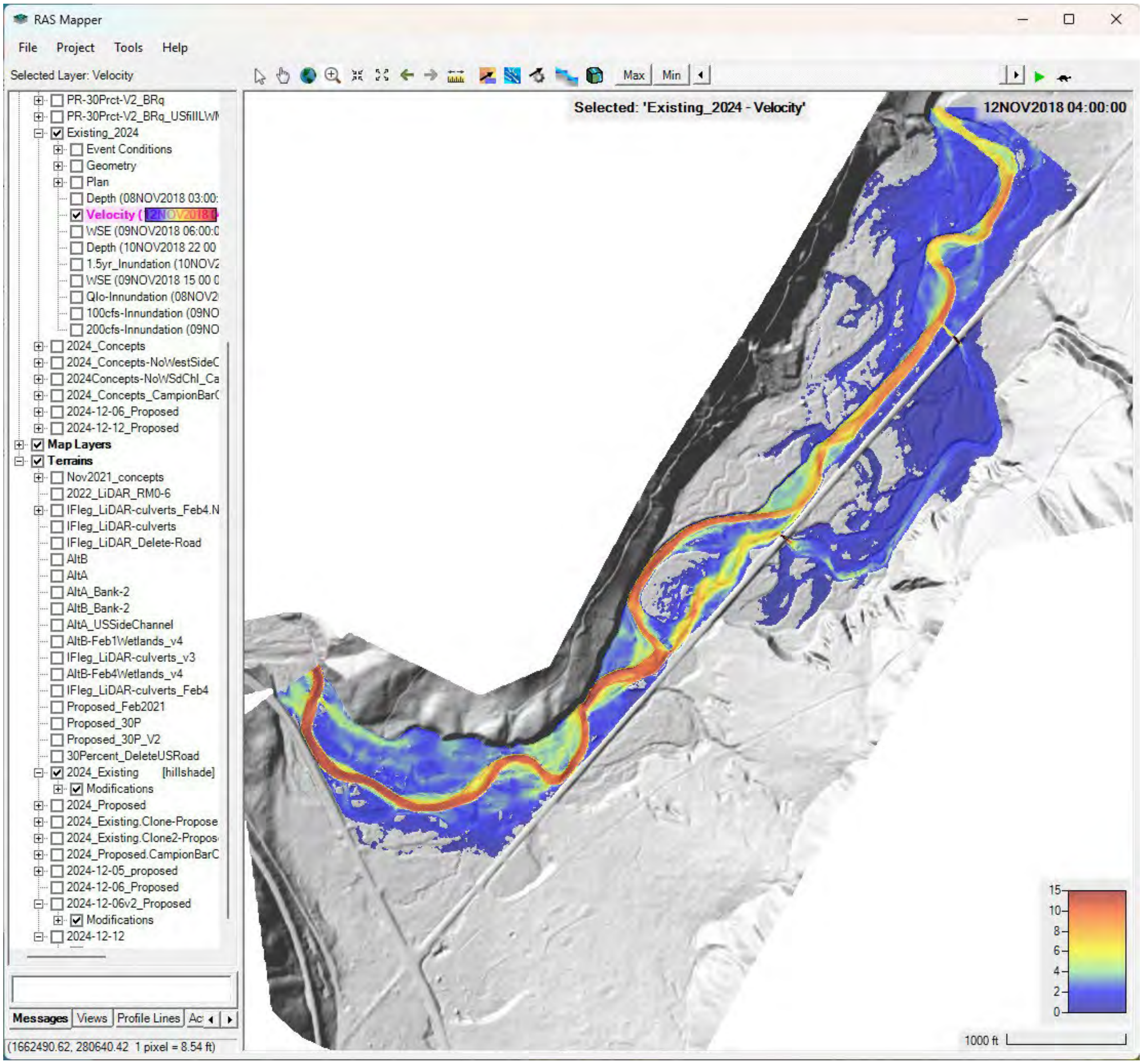
Existing condition: 5-year (3,900-cfs) flow velocity through project area



Existing condition: 25-year (6,500-cfs) flow velocity through project area

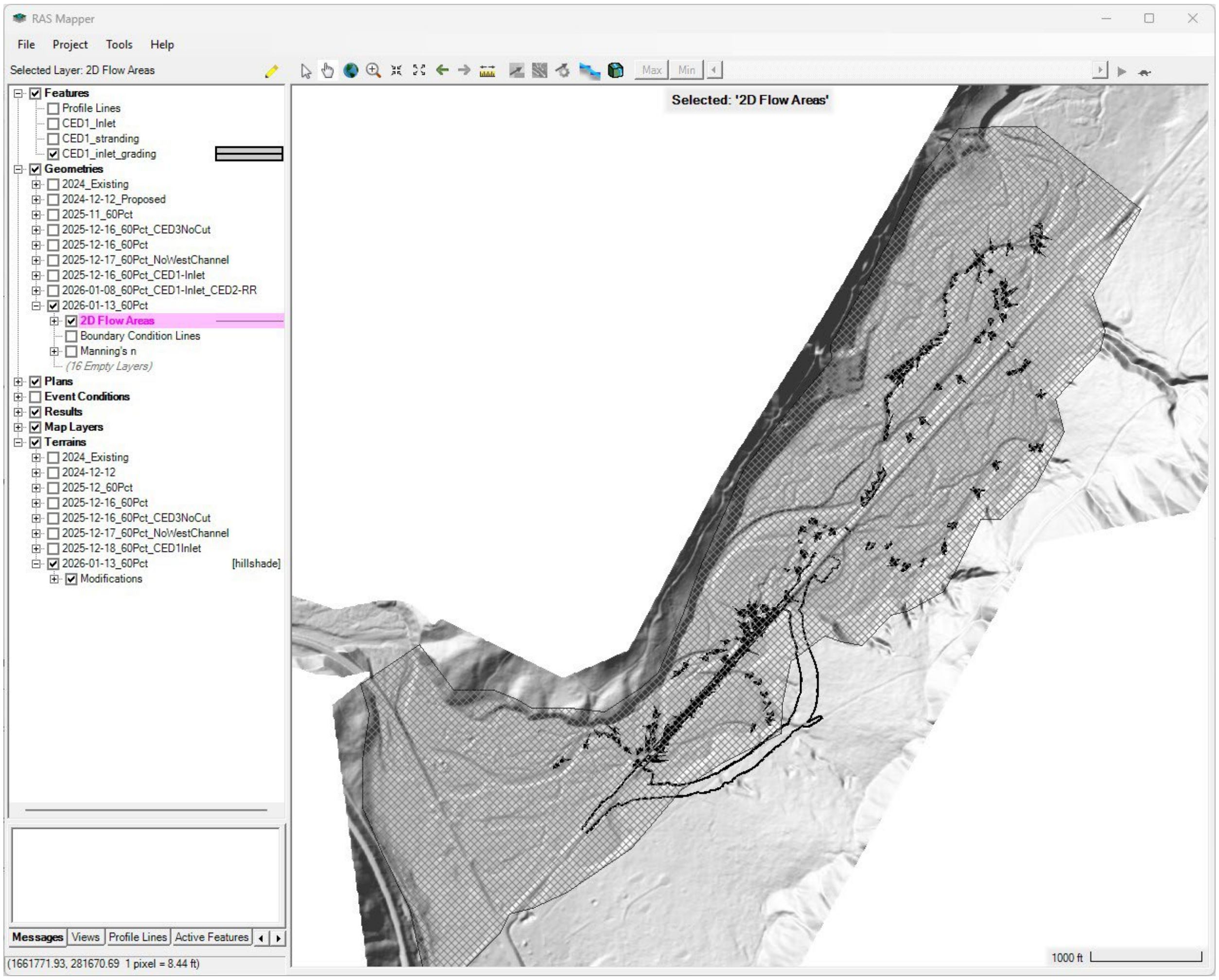


Existing condition: 100-year (9,400-cfs) flow velocity through project area

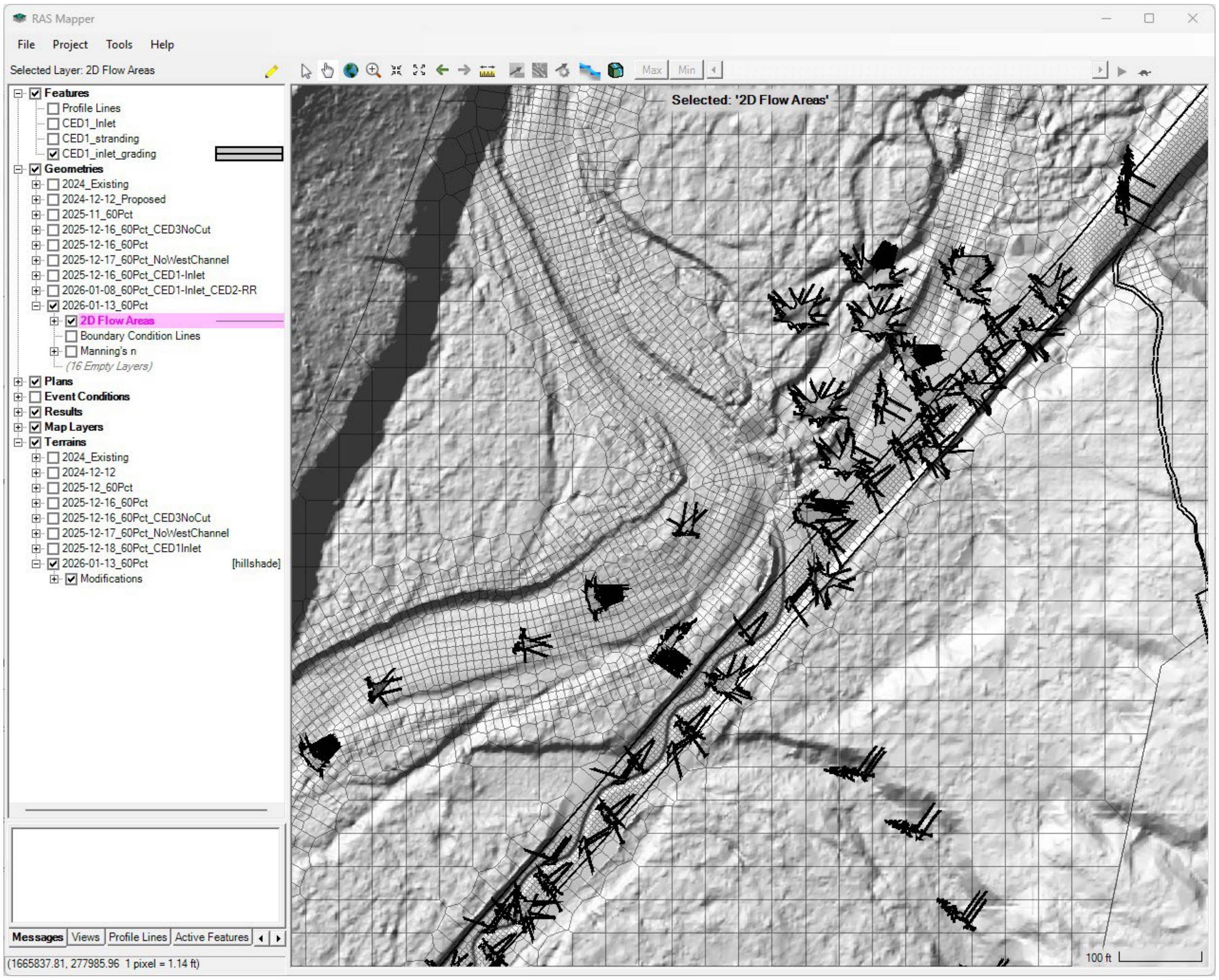


Appendix D – Proposed conditions HEC-RAS model

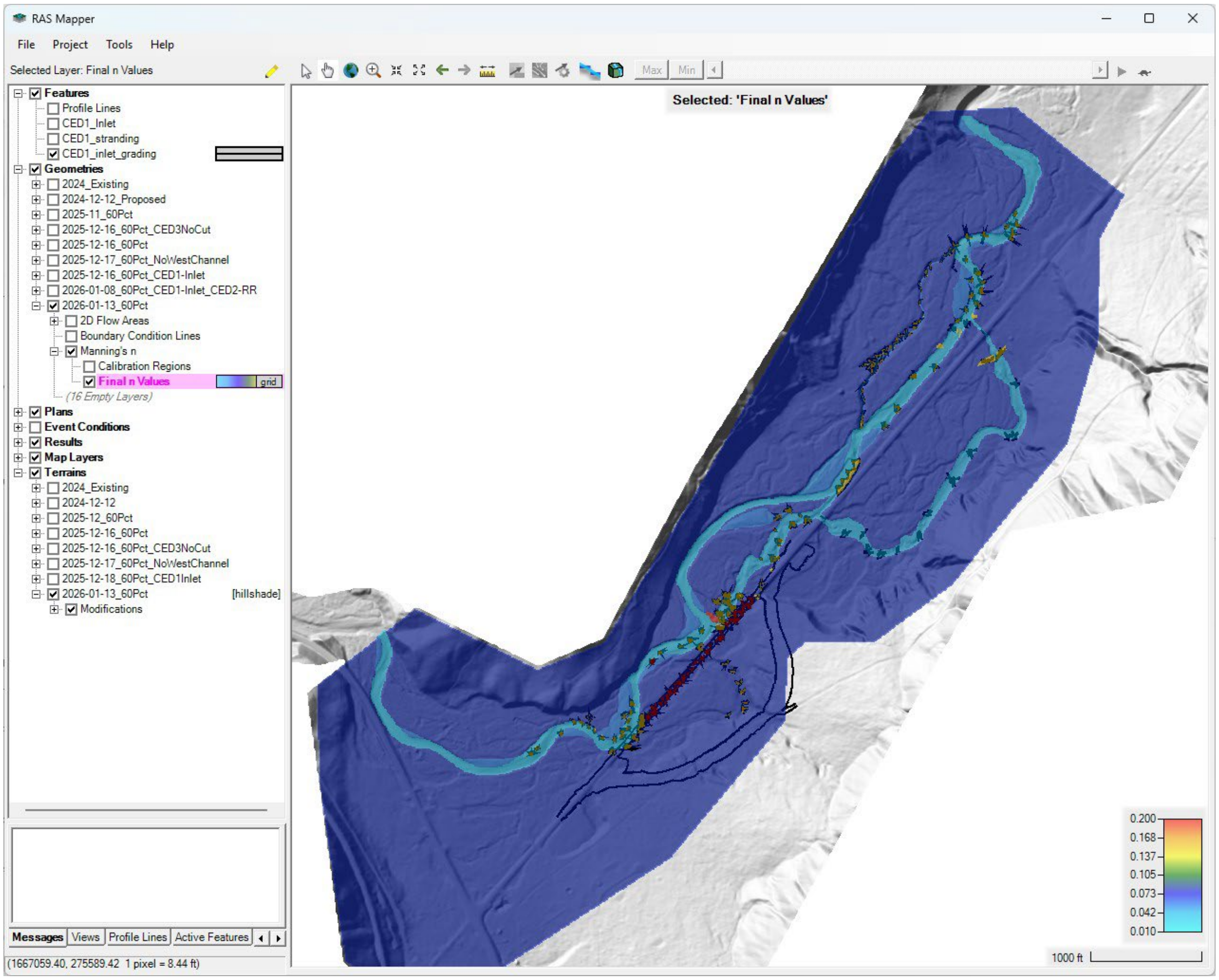
Proposed condition model mesh



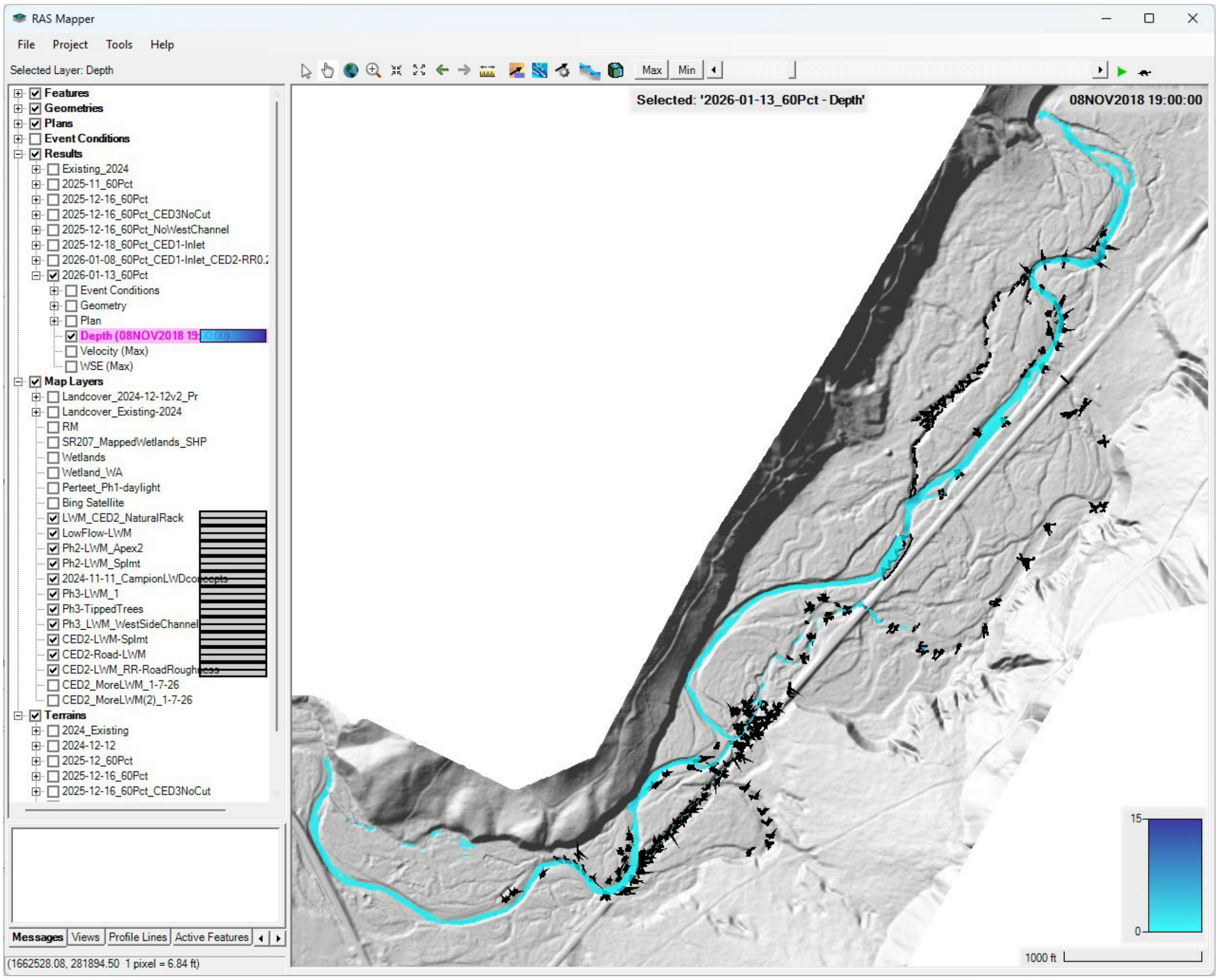
Proposed condition model mesh – example of mesh detail



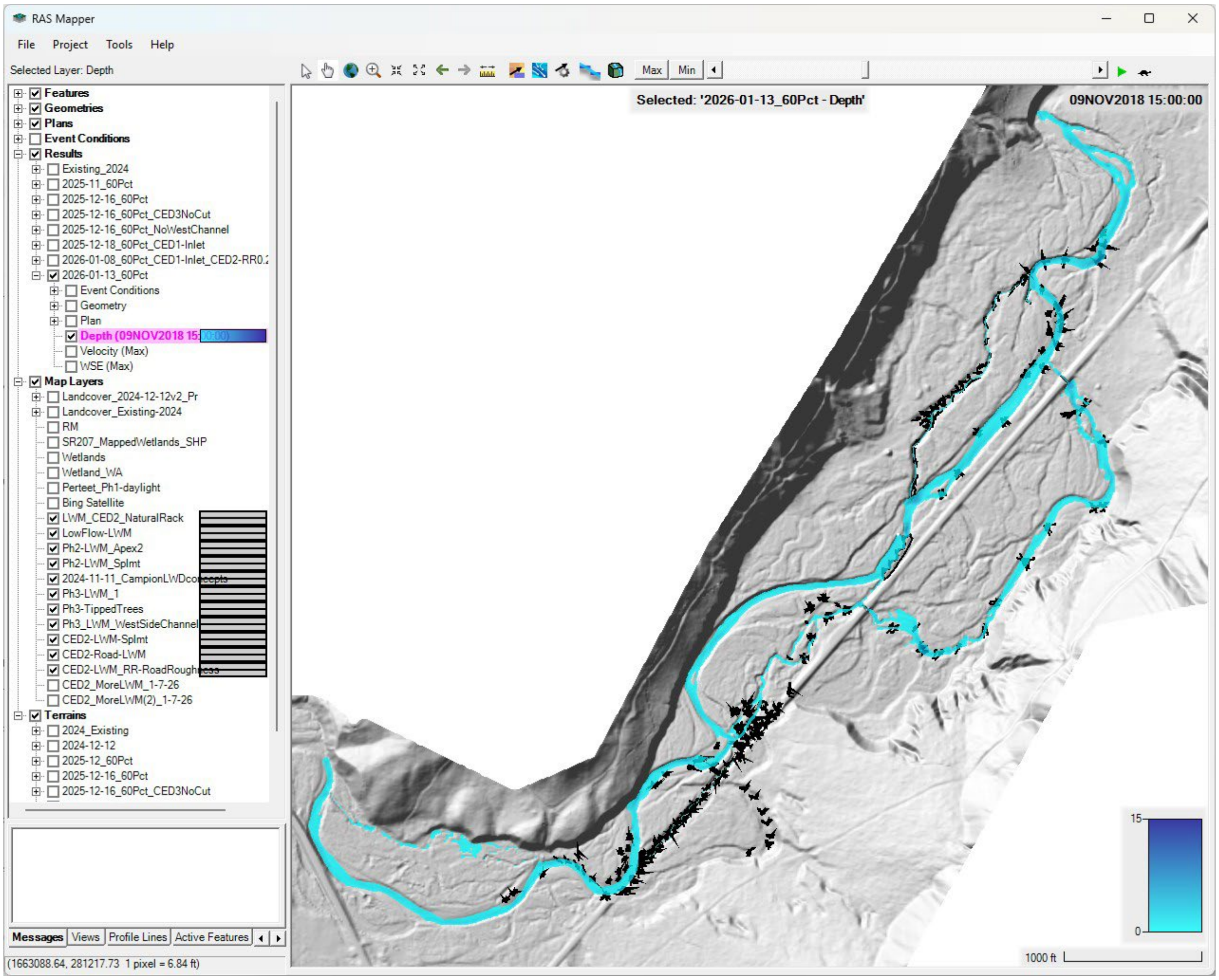
Proposed condition Manning's n



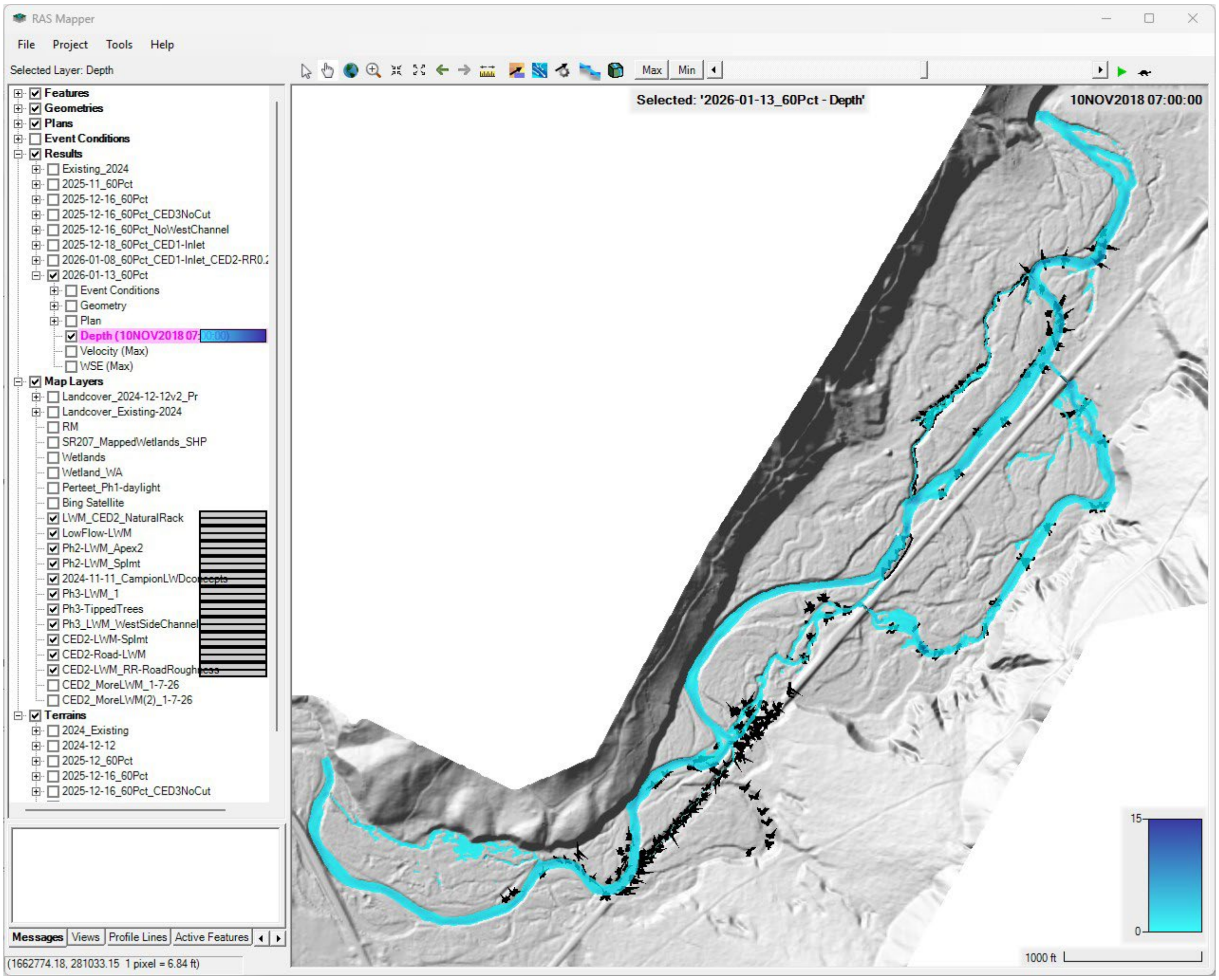
Proposed condition: 50-cfs flow depth through project area



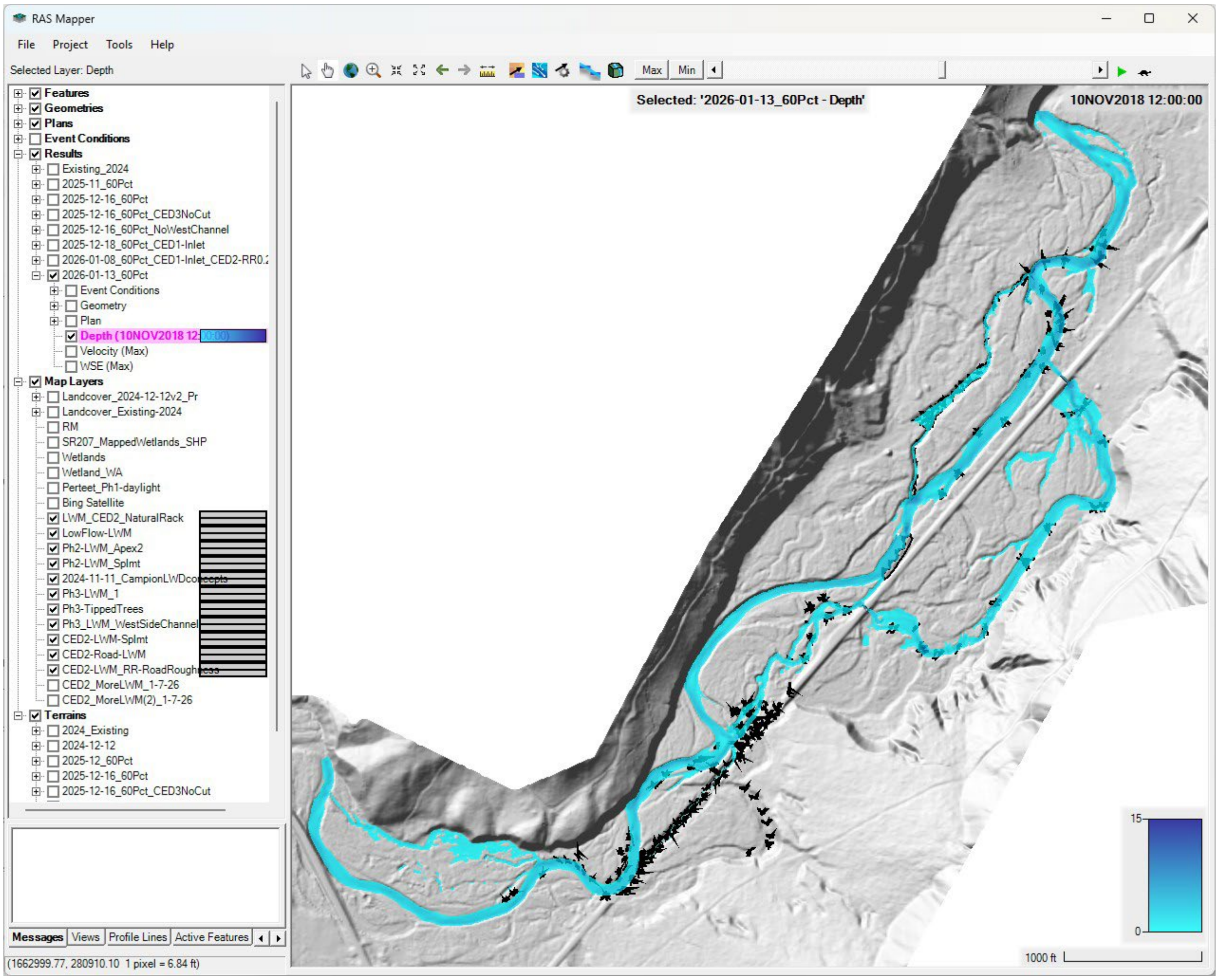
Proposed condition: 200-cfs flow depth through project area



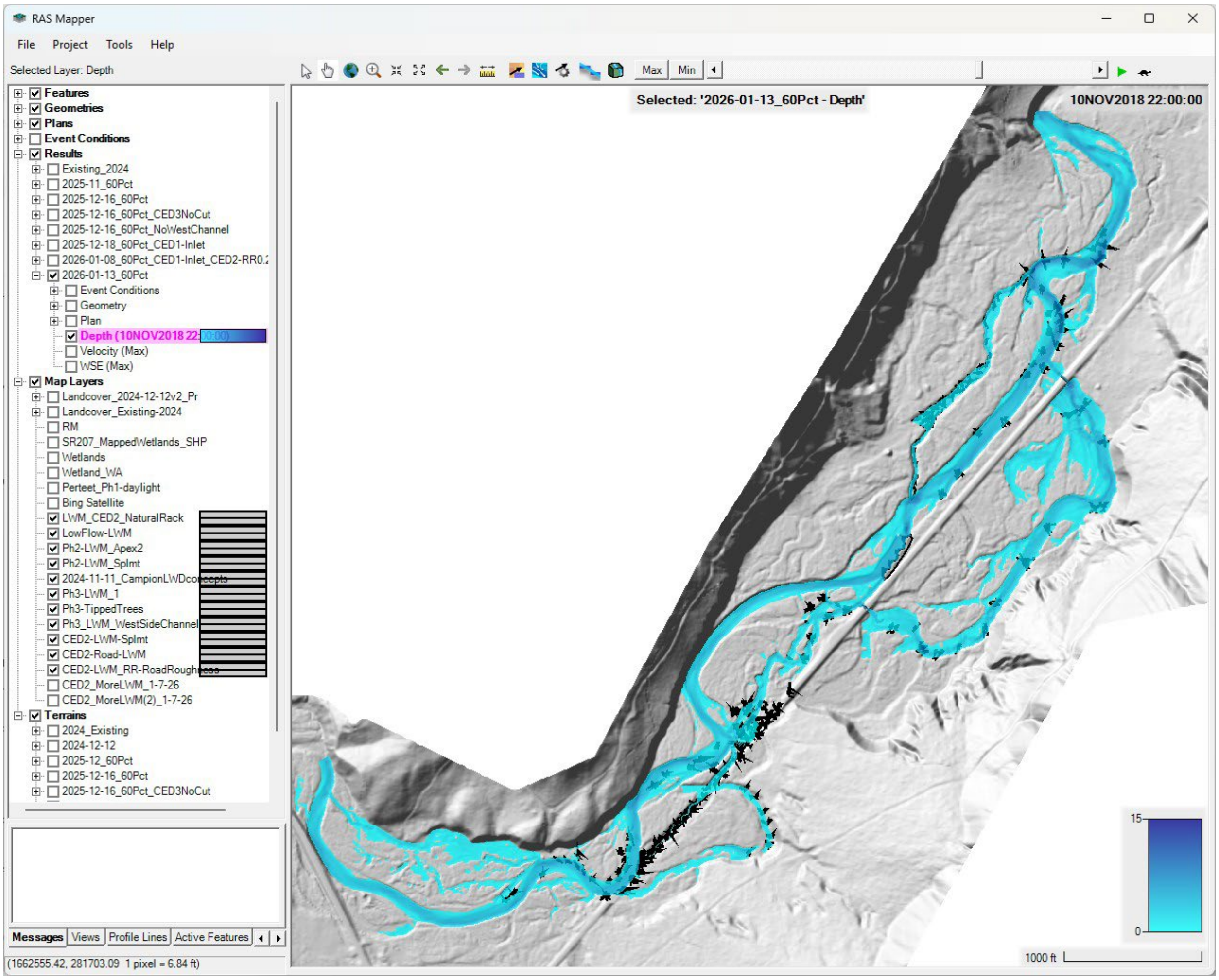
Proposed condition: 600-cfs flow depth through project area



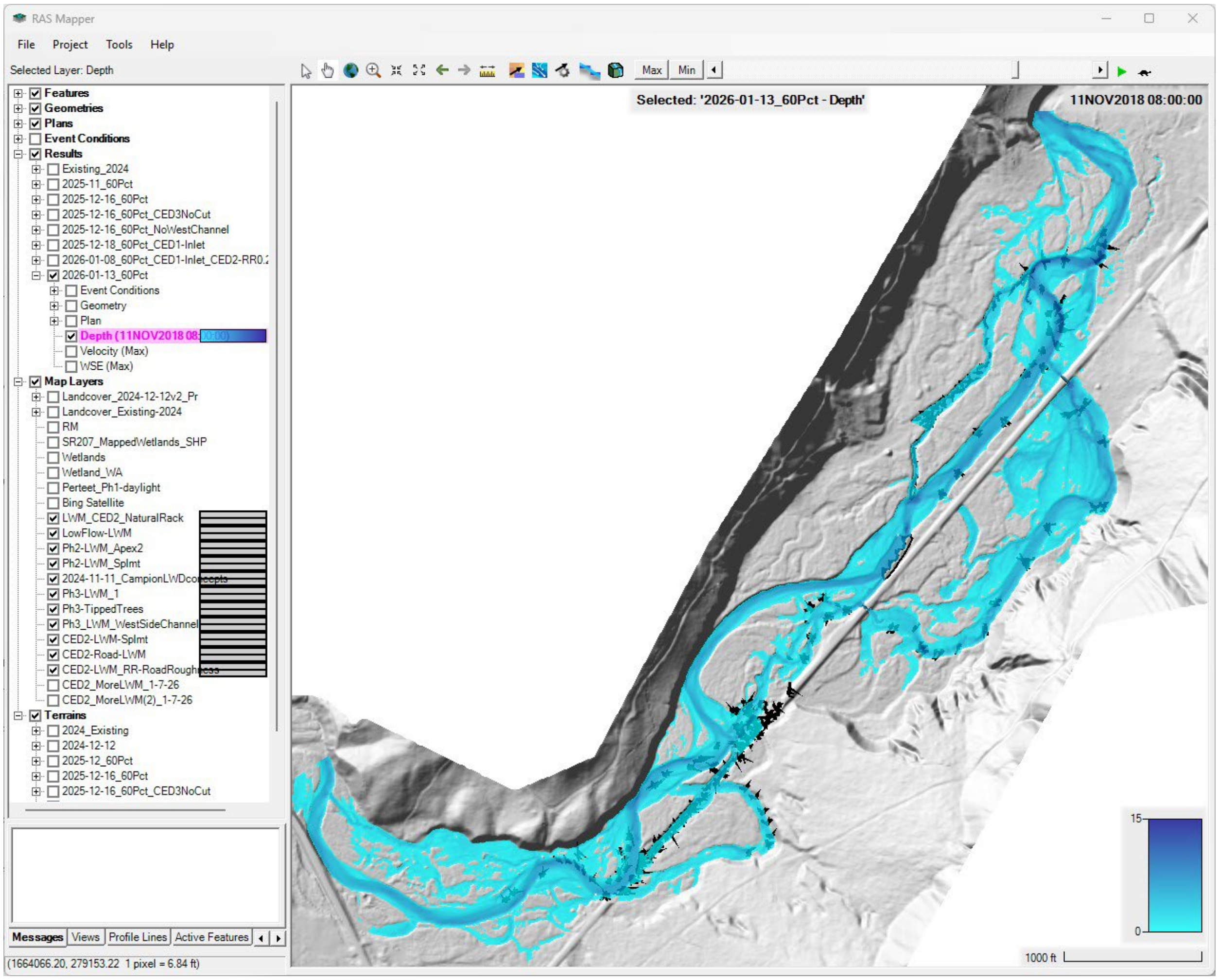
Proposed condition: 1,000-cfs flow depth through project area



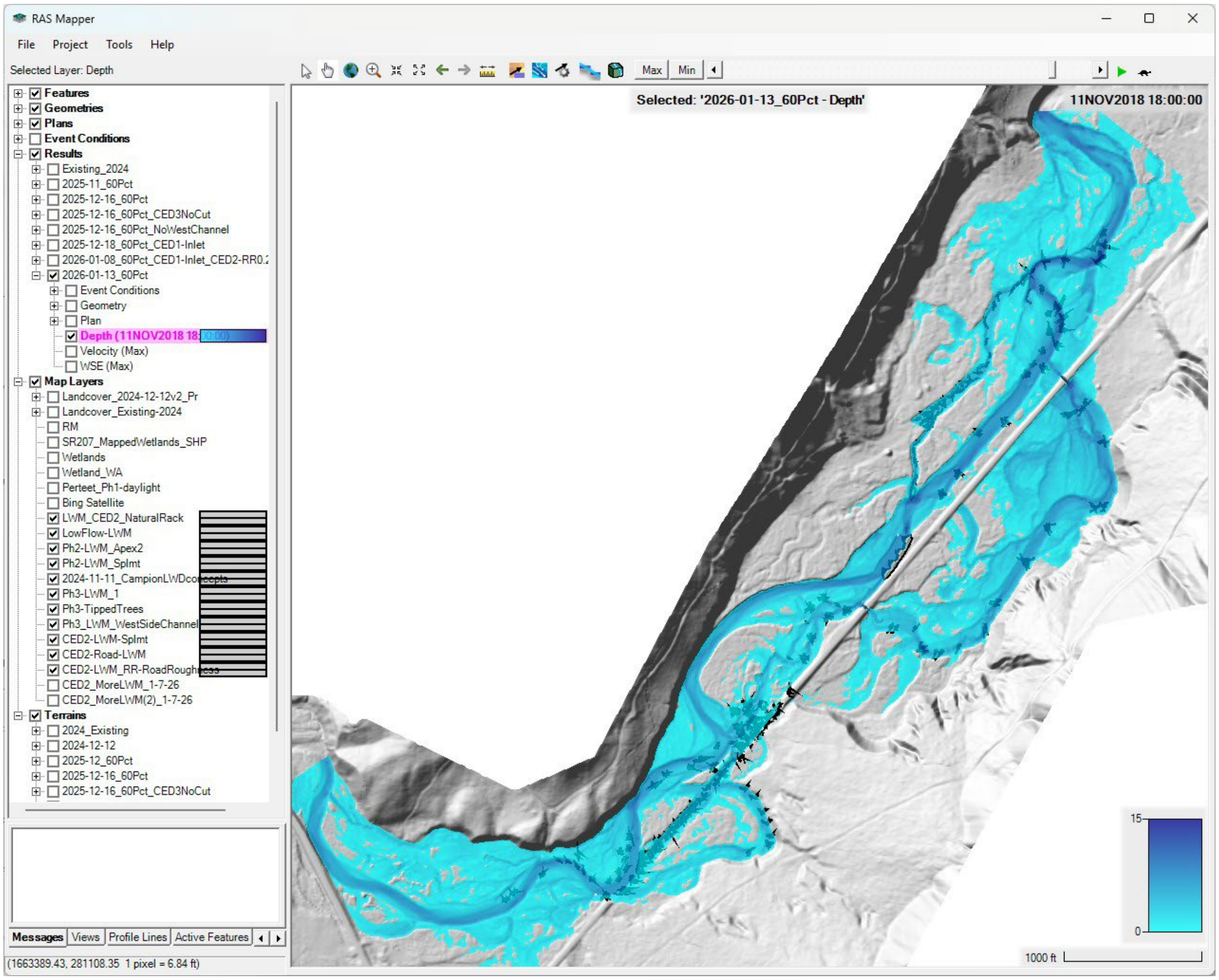
Proposed condition: 1.5-year (2,200-cfs) flow depth, entire model domain



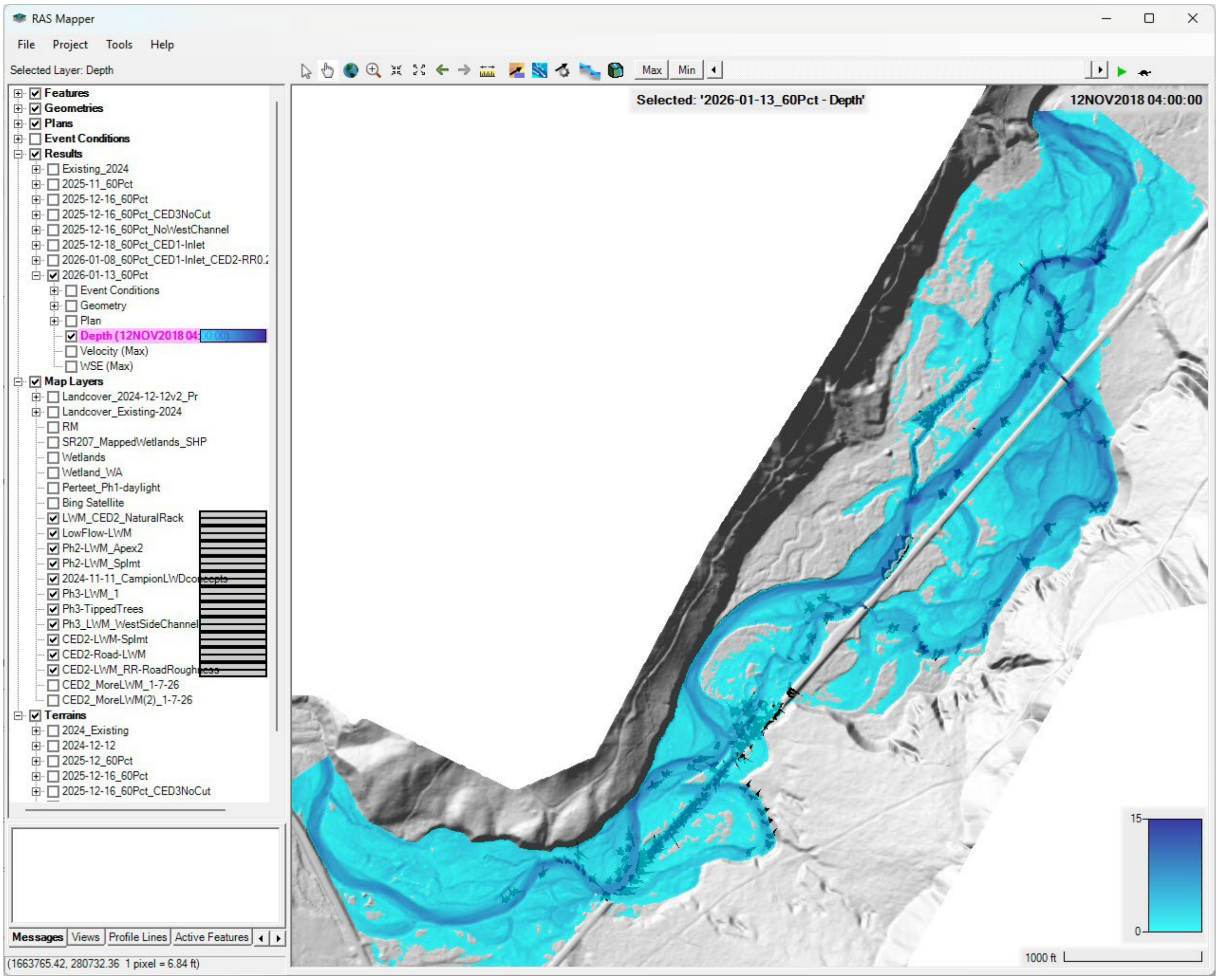
Proposed condition: 5-year (3,900-cfs) flow depth, entire model domain



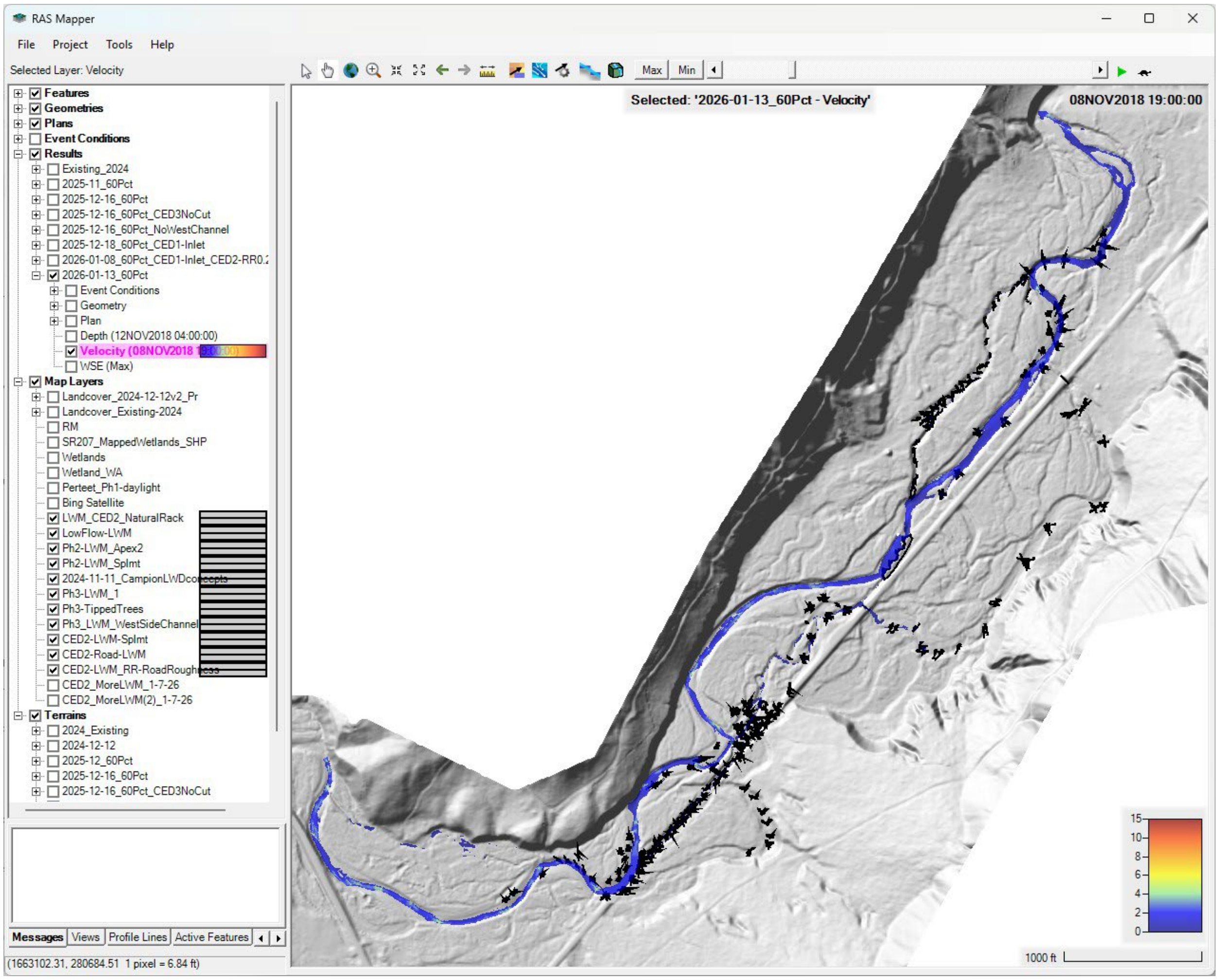
Proposed condition: 25-year (6,500-cfs) flow depth, entire model domain



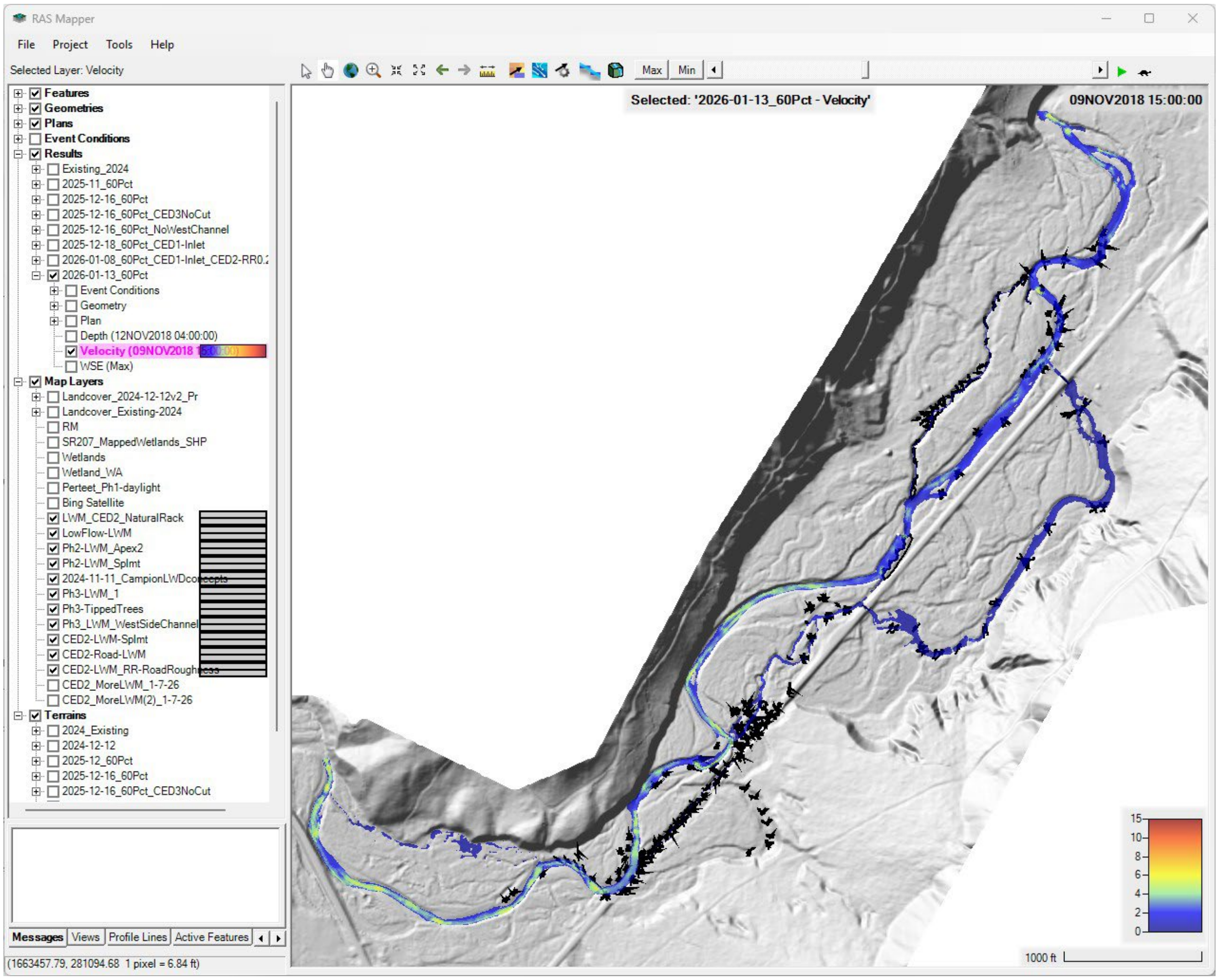
Proposed condition: 100-year (9,400-cfs) flow depth, entire model domain



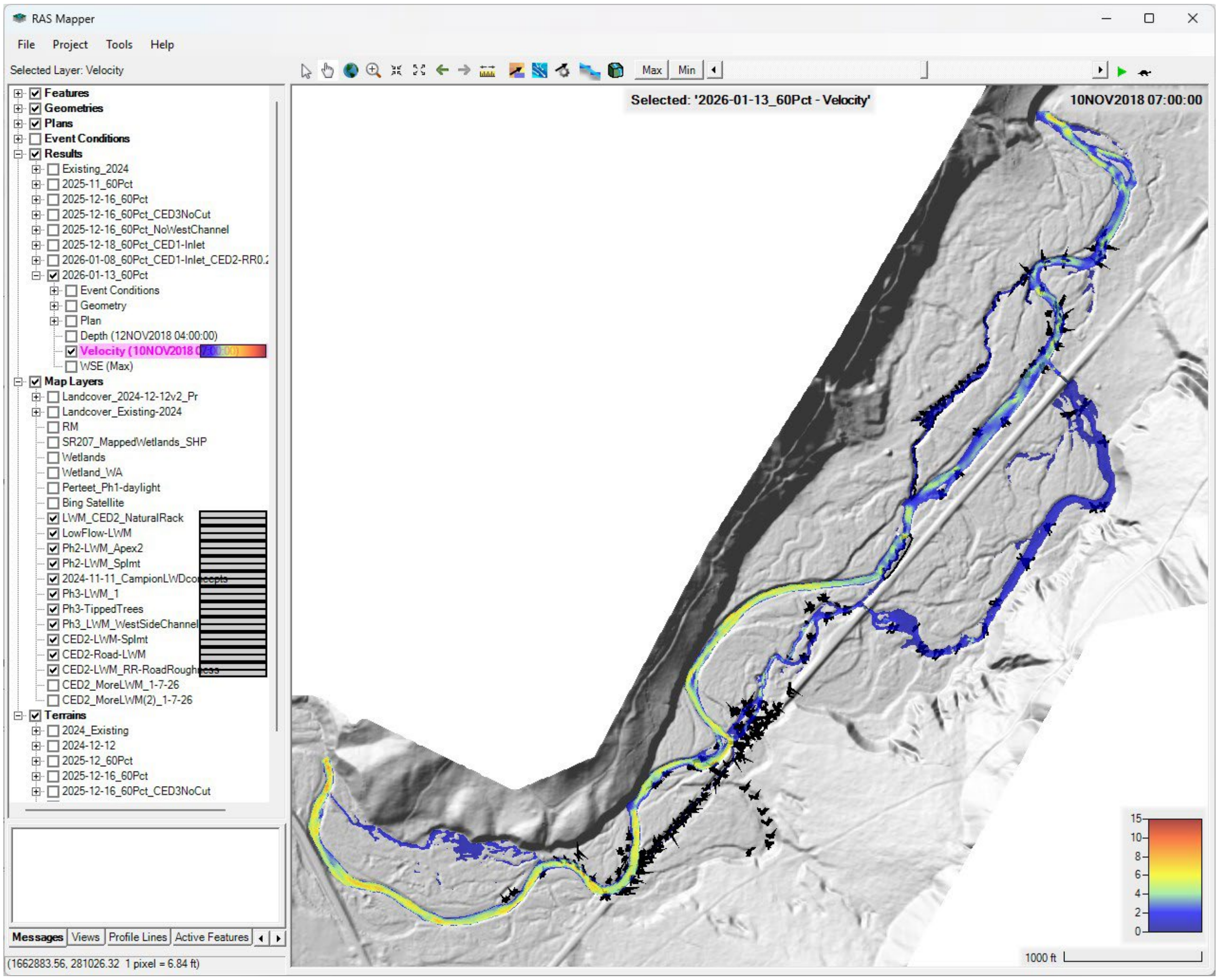
Proposed condition: 50-cfs flow velocity through project area



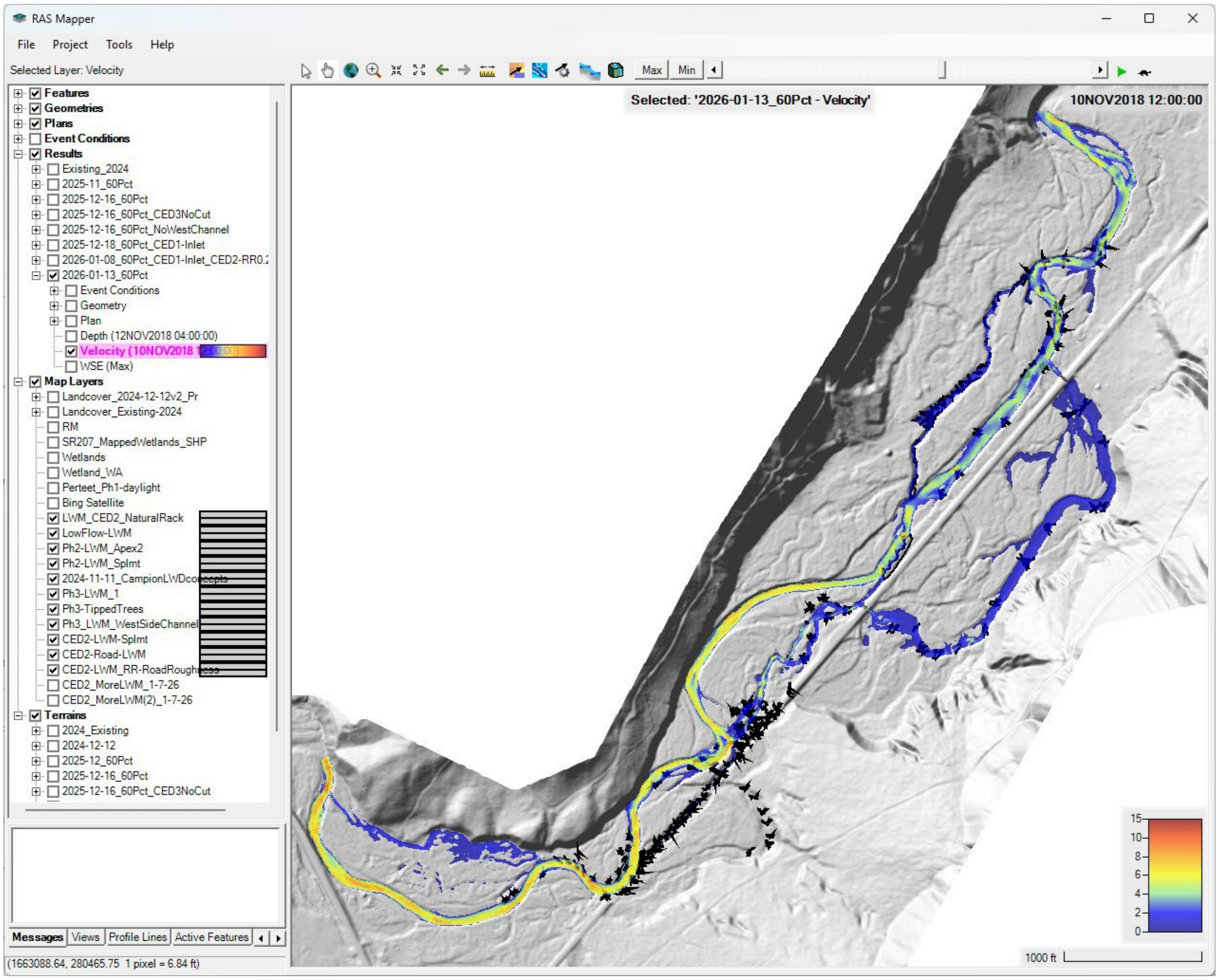
Proposed condition: 200-cfs flow velocity through project area



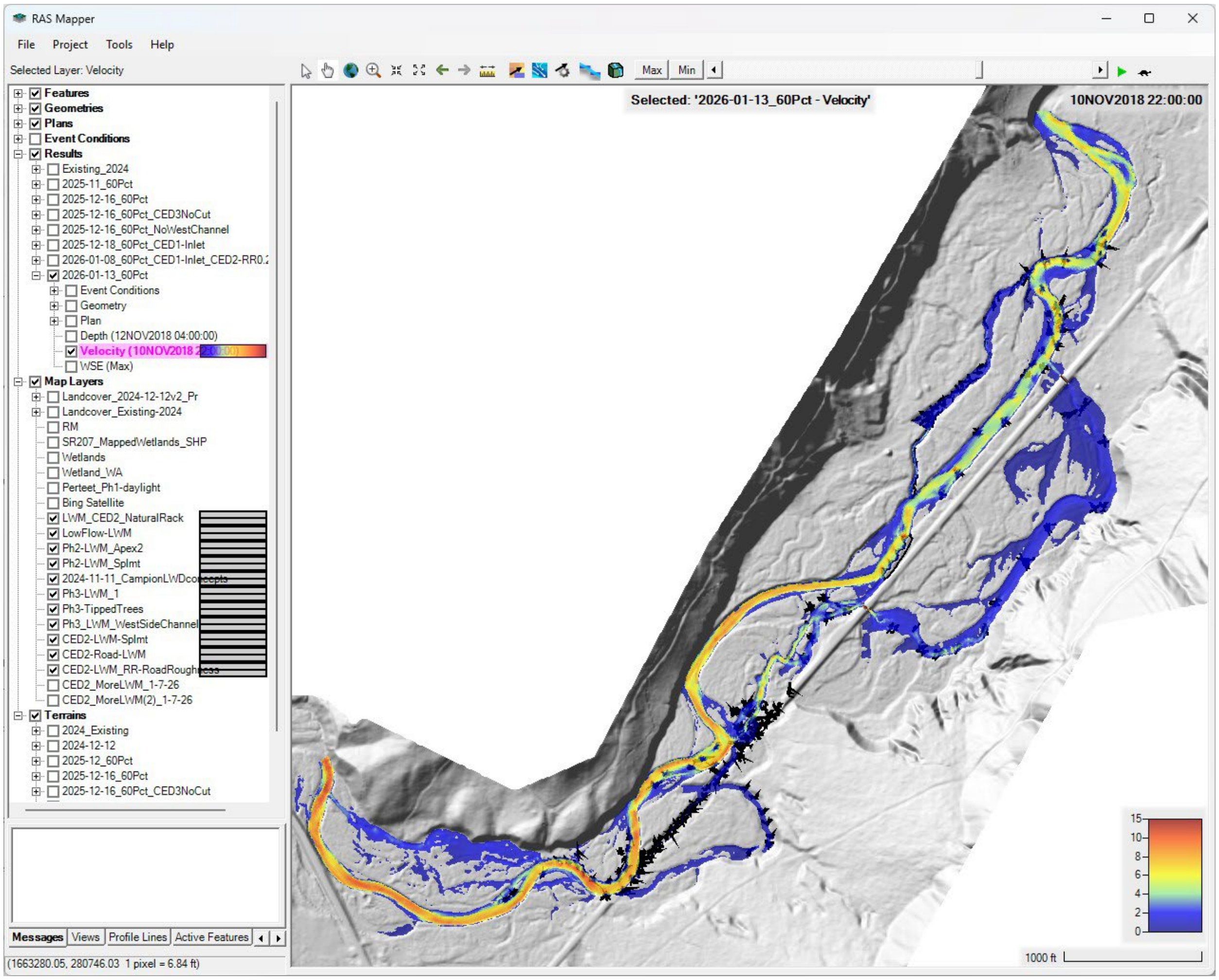
Proposed condition: 600-cfs flow velocity through project area



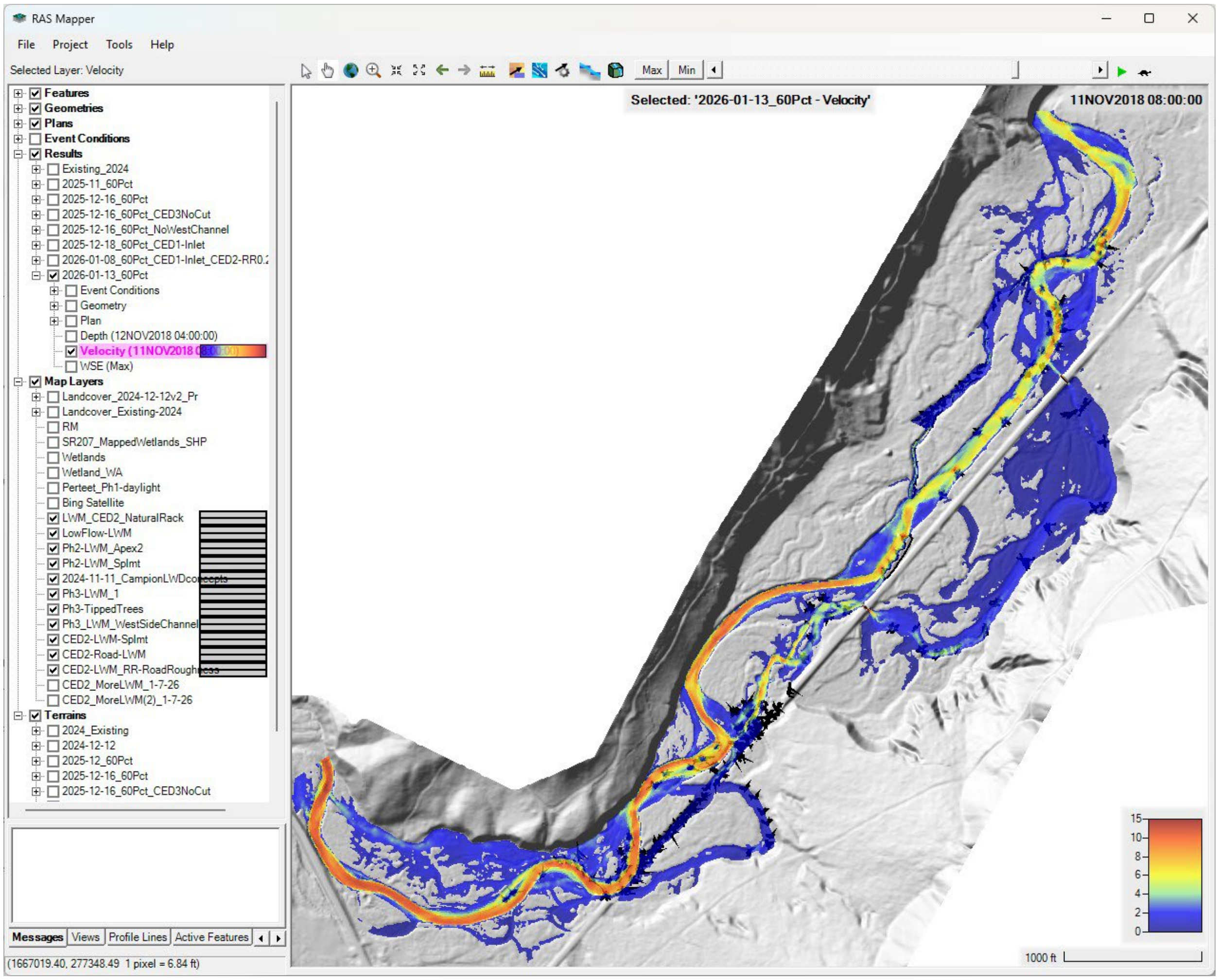
Proposed condition: 1,000-cfs flow velocity through project area



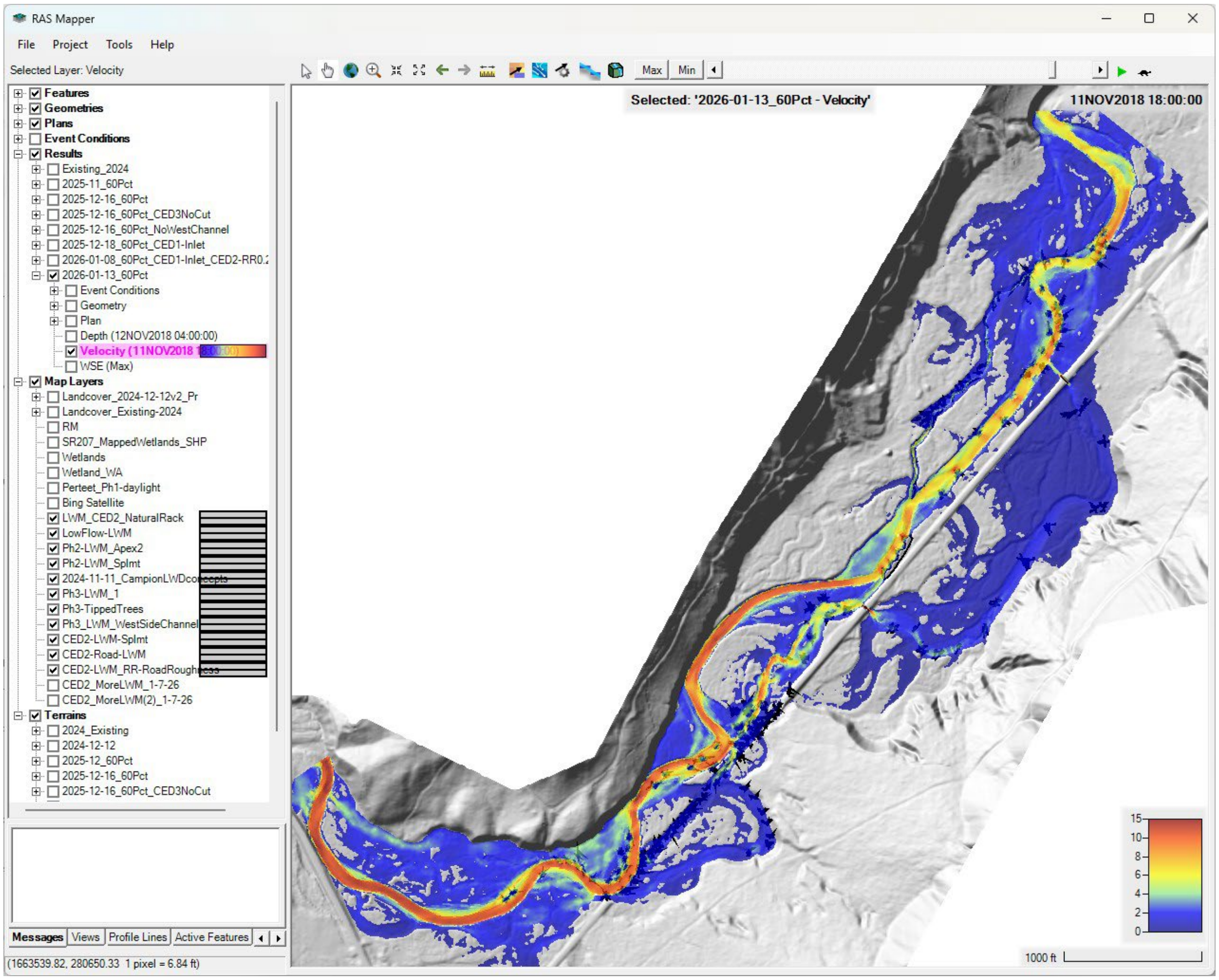
Proposed condition: 1.5-year (2,200-cfs) flow velocity through project area



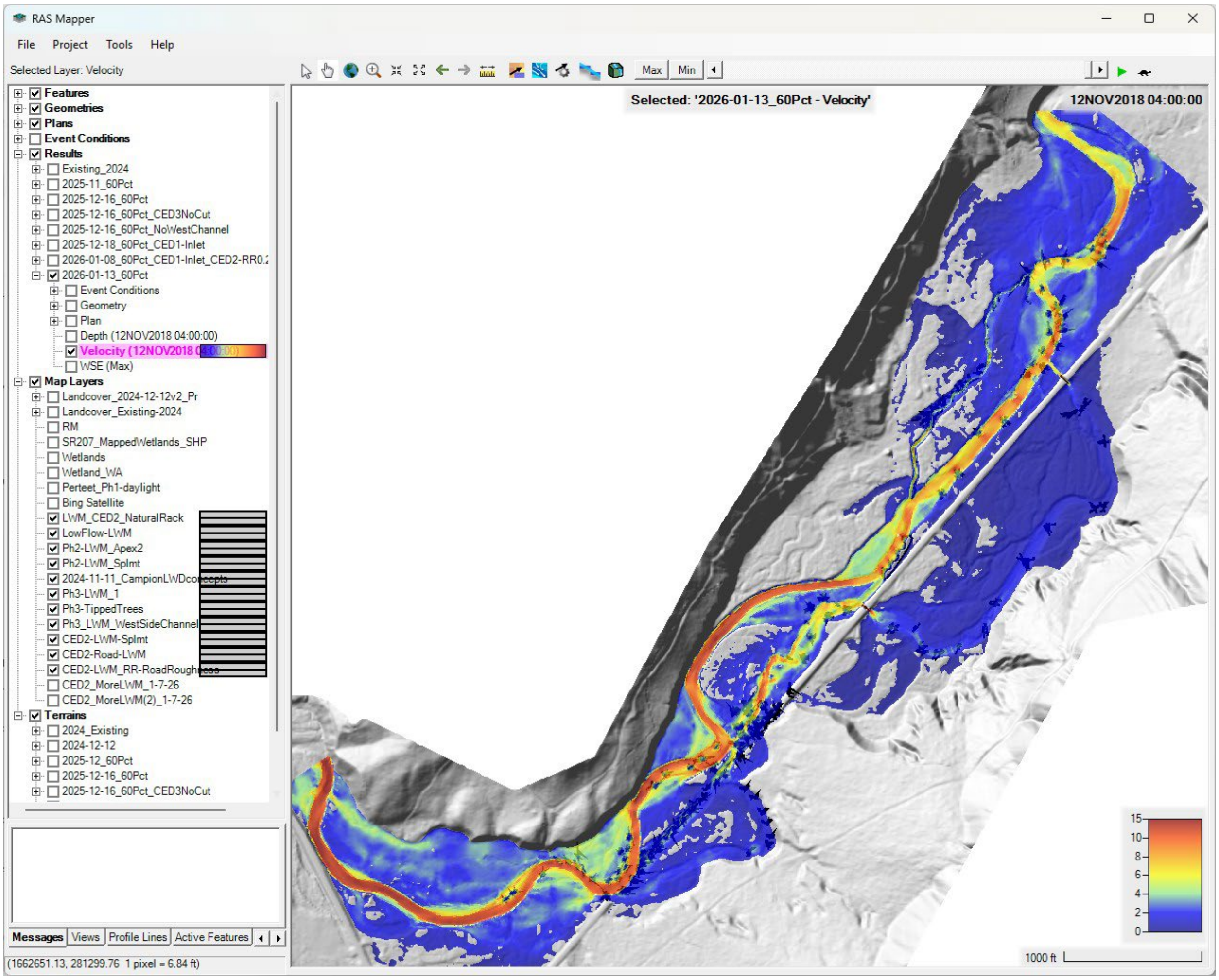
Proposed condition: 5-year (3,900-cfs) flow velocity through project area



Proposed condition: 25-year (6,500-cfs) flow velocity through project area



Proposed condition: 100-year (9,400-cfs) flow velocity through project area



Appendix E – Large Wood Stability Calculations

Nason Floodplain - Large Woody Structure Stability Evaluation

Structural Stability | *6.4*

Structural stability of large woody material placements is evaluated herein using the procedures, formulas, and recommendations provided in the Reclamation's *Large Woody Material - Risk Based Design Guidelines* (Knutson et. al. 2014) along with insight gained from professional experience and general engineering judgment.

Factors of Safety | *6.4.1*

Safety factors for structural stability were selected from *Table 4. Minimum recommended factors of safety* given the site specific public safety and property damage risk levels.

			Criteria:
Public Safety Risk	Moderate	**$FOS_{sliding}$**	1.5
Property Damage Risk	Moderate	**$FOS_{buoyancy}$**	1.75
Stability Design Flow Criteria	50-year	**$FOS_{rotation}$**	1.5

Resistance to Flotation | *6.4.2*

Flotation is typically caused by the buoyant force and the lift force acting on the wood material from water passing over its surface.

Large Wood Material Force

Accounts for the vertical buoyant force of submerged large wood and the vertical weight force of unsubmerged large wood.

$$F_{LWMs} = V_{LWMs} \times (\gamma_{wood} - \gamma_w)$$

$$V_{LWMs} = total\ volume\ of\ submerged\ large\ wood\ material$$

$$V_{LWMs} = \sum N_{LWMi} \times V_{LWMi}$$

Variable	**Design Value**	**Units**
$\gamma_{wood} = unit\ weight\ of\ wood$	38	lb/ft^3
$\gamma_w = unit\ weight\ of\ water$	62.4	lb/ft^3
V_{LWMs}	1129	ft^3

F_{LWMs} (lb)	**27,542**	*Positive values are upward forces.*

Lift Force

Accounts for the lift force of large wood in flowing water. Not applicable to LWS where the bed will deform around the leading edges.

$$F_L = \frac{C_L \times A_{LWM} \times \gamma_w \times U_o^2}{2 \times g}$$

	Design Value	Units / Notes
$C_L = lift\ coefficient$	0.2	typ. LWM value
$A_{LWM} = area\ of\ large\ woody\ material\ perpendicular\ to\ flow$		
$U_u = upstream\ channel\ velocity\ at\ design\ event$	7	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2

$A_{LWM} = See\ Design\ Plan$

A** **LWM** **(ft** ^{2} **)	**152**

For pre-racking condition

F** **L** **(lb)	**N/A**

Boulder Ballast Force

Accounts for the ballasting force of large boulders directly attached to or placed over LWM.

$$F_{bouldersub} = N_{bouldersub} \times {}^{\pi}/_{6} \times d^3_{bouldersub} \times (\gamma_{boulder} - \gamma_w)$$

	Design Value	Units / Notes
$N_{bouldersub} = number\ of\ submerged\ boulders$	0	number
$d_{bouldersub} = effective\ diameter\ of\ submerged\ boulders$	0	ft
$\gamma_{boulder} = unit\ weight\ of\ boulders$	165	lb/ft^3

F** **bouldersub** **(lb)	**N/A**

Backfill Ballast Force

Accounts for the ballasting force of backfill placed directly over LWM members. Volume is based on the fill area over the log(s) and a the effective cover depth shown on the Drawings.

$$F_{backfillsub} = V_{backfillsub} \times (\gamma_s - \gamma_w)$$

	Design Value	Units / Notes
$V_{backfillsub} = volume\ of\ backfill\ over\ LWM\ members$	3,150	ft^3
	See design plans	
$\gamma_s = unit\ weight\ of\ backfill\ material$	110	lb/ft^3

F** **backfillsub** **(lb)	**-149,940**

Pile Skin Friction

Accounts for the vertical resistance provided by piles within the LWM structure. USBR document equation modified by Inter-Fluve to match industry pile design standard formulations.

$$F_{piles-v} = N_{piles} \times \pi \times d_{piles} \times L_{piles} \times \left(k_s \times \tan\tfrac{2}{3}\theta \times \sigma'\right)$$

		Design Values	Units
$N_{piles} = number\ of\ piles$	*Assume three-quarters of piles are effective*	5.25	number
$L_{piles} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		15	ft
$d_{piles} = nominal\ diameter\ of\ the\ piles$		1.30	ft
$\sigma' = \left(L_{piles} \times (\gamma_{sat} - \gamma_w)\right)/2$		357	lb/ft^2
$K_s = coefficient\ of\ lateral\ earth\ pressure\ (0.5\ to\ 1.0)$		1.0	unit less
$\theta = internal\ friction\ angle\ of\ soils$		36	deg.

F** **piles-v** **(lb)	**-51,121**	*Negative values resist upward displacement.*

Piles Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bPiles} = \frac{F_{piles-v}}{F_{LWMs} + F_L}$$

FOS** **b **1.9**

Note this value does not include the backfill assuming it's all lost but the piles are holding.

Backfill Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bBackfill} = \frac{F_{backfillsub}}{F_{LWMs} + F_L}$$

FOS** **b **5.4**

Note this value does not include the piles.

Net Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bNet} = \frac{F_{backfillsub} + F_{piles-v}}{F_{LWMs} + F_L}$$

FOS** **b **7.3**

Note this value includes the piles and backfill.

Resistance to Sliding | *6.4.3*

LWM structures are also susceptible to failure through sliding.

Drag Force

LWM structures are pushed downstream by the fluid drag forces acting upon the wood by the flowing water.

$$F_d = \frac{C_D \times A_{LWM} \times \gamma_w \times U_c^2}{2 \times g}$$

	Design Value	Units / Notes
$C_D = drag\ coefficient$	1	Per Equations 23 and 24
$A_{LWM} = area\ of\ wetted\ wood\ normal\ to\ the\ flow\ direction$		
$U_c = velocity\ adjacent\ to\ the\ LWM\ structure$	7	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2
F_d (lb)	**7,217**	

$A_{LWM} = See\ Design\ Plan$

A_{LWM} (ft^2)	152

Velocity value is conservative for all LWS locations. Value from 100-yr event 2D model results for main channel.

Hydrostatic Force

Hydrostatic forces act on the upstream and downstream faces of a LWM structure. They account for differences in the upstream and downstream water depths against the structure.

$$F_{hu} = \tfrac{1}{2} \times \gamma_w \times Y_u \times A_u \qquad F_{hd} = \tfrac{1}{2} \times \gamma_w \times Y_d \times A_d$$

F_{hu} , F_{hd} = *hydrostatic force on upstream and downstream side of the wood structure*

Y_u , Y_d = *water depth upstream and downstream of the structue*

A_u , A_d = *area projected to flow direction on the upstream and downstream of the structure*

Variable	Design Value
Y_u (ft)	5.5
A_u (ft^2)	152
Post racking area	
Y_d (ft)	5.5
A_d (ft^2)	152
Plan downstream area	

$F_{hu} + F_{hd} = F_h$ (lb)	**N/A**

Impact Force

The impact force associated with debris impacting a large wood structure can be estimated by the impact force equation.

$$F_i = \frac{w_{debris}}{g} \times \frac{V_{channel}{}^{\wedge}2}{2 \times \Delta x} \times C_i \times C_o \times C_d \times C_{b\times} R_{max}$$

$w_{debris} = weight\ of\ debris$

$V_{channel} = channel\ approach\ velocity$

$\Delta x = deceleration\ distance$

Coefficients *(see Table 6 and Figures 11, 12 for values)*
$C_i = importance$, $C_o = orientation = 0.8$, $C_d = depth$, $C_b = blockage$, $R_{max} = impluse\ response\ ratio$

Variable	Design Value
W_{debris} (lb)	3,774
$V_{channel}$ (ft/s)	7
Δx (ft)	5
C_i	0.5
C_o	0.8
C_d	1.0
C_b	1.0
R_{max}	0.8

F_i (lb)	**184**

Friction Force

Accounts for the friction force between the LWM and the channel bed. Restraint force from piles is not included as it does not exert a pressure on the LWS / bed interface.

$$F_f = -\mu_{bed} \times (F_{LWMs} + F_L + F_{bouldersub} + F_{backfillsub})$$

	Design Value	Units / Source
$\mu_{bed} = coefficient\ of\ bed\ friction = \tan(\theta)$	0.78	unit less
$\theta = internal\ friction\ angle\ (degrees)$	38	Table 5, (Knutson et. al. 2014)

F_f (lb)	**-95,628**	*Negative values resist downstream displacement.*

Lateral Resistance From Piles

Accounts for the lateral resistance provided by piles within the LWM structure. Assumes soil resistance is limiting, i.e. the pile pushes over before it breaks.

$$F_{piles-h} = N_{piles} \times \frac{L_{pile}^3 \times \frac{1}{2} \times (\gamma_s - \gamma_w) \times d_{pile} \times K_p}{h_{load} \times L_{pile}}$$

		Design Values	Units
$N_{pile} = number\ of\ piles$	*assume three-quarters of piles are effective*	5.25	number
$L_{pile} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		15	ft
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$h_{load} = applied\ load\ height\ above\ the\ potential\ scour\ depth$		2.5	ft
$K_p = \frac{1 + \sin\theta}{1 - \sin\theta}$		4.2	unit less

$F_{piles-h}$ (lb)	**-61,455**	*Negative values resist downstream displacement.*

Sliding Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{sliding} = \frac{F_f + F_{piles-h}}{F_d + F_{hu} + F_{hd} + F_i}$$

***FOS** sliding* **21.2**

Pile Strength Factor of Safety

The factor of safety for the timber bending stress capacity of the pile. This evaluates the potential for the pile(s) to break under load prior to the pile pushing over in the ground.

		Design Values	Units
$F_b = Timber\ Bending\ Stress\ Capacity$ per Timber Pile Manual Table 3-1 or AWC NDS Supplement Table 4D		1,200 172,800	psi psf
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$I = circular\ cross-sectional\ moment\ of\ inertia$	$I = \frac{\pi B^4}{4}$	2.24	ft^4
$S = circular\ section\ modulus$	$S = \frac{\pi B^3}{32}$	0.216	ft^3
$C_F = strength\ reduction\ size\ factor$ for diameters greater than 12"	$C_F = \frac{1}{B}^{(1/9)}$	0.971	--
$M_p = applied\ moment\ per\ pile$	$M_p = \frac{(F_d + F_i + F_h) \times h_{load}}{N_{piles}}$	3,524	ft-lb
$f_b = applied\ pile\ bending\ stress$	$f_b = \frac{M_p}{S}$	16,338	psf
$F_{bx} = Pile\ bending\ stress\ capacity$	$F_{bx} = F_b \times C_F$	1,166 167,835	psi psf

$$FOS_{pile\ stength} = \frac{F_{bx}}{f_b}$$

***FOS** pile strength* **10.3**

References

Large Woody Material - Risk Based Design Guidelines
M. Knutson, J. Fealko. 2014. *Large Woody Material - Risk Based Design Guidelines.* U.S. Department of the Interior Bureau of Reclamation Pacific Northwest Region & Technical Services. Boise, Idaho. September 2014. Online at: http://www.usbr.gov/pn//fcrps/documents/lwm.pdf

ASTM D25. Allowable Stress Values for Treated Round Timber Piles.

Timber Pile Design and Construction Manual, Timber Piling Council, 2015.

American Wood Council (2018) National Design Specifications for Wood Construction, Design Supplement.

Nason Floodplain - Large Woody Structure Stability Evaluation

Structural Stability | *6.4*

Structural stability of large woody material placements is evaluated herein using the procedures, formulas, and recommendations provided in the Reclamation's *Large Woody Material - Risk Based Design Guidelines* (Knutson et. al. 2014) along with insight gained from professional experience and general engineering judgment.

Factors of Safety | *6.4.1*

Safety factors for structural stability were selected from *Table 4. Minimum recommended factors of safety* given the site specific public safety and property damage risk levels.

			Criteria:
Public Safety Risk	Moderate	**$FOS_{sliding}$**	1.5
Property Damage Risk	Moderate	**$FOS_{buoyancy}$**	1.75
Stability Design Flow Criteria	50-year	**$FOS_{rotation}$**	1.5

Resistance to Flotation | *6.4.2*

Flotation is typically caused by the buoyant force and the lift force acting on the wood material from water passing over its surface.

Large Wood Material Force

Accounts for the vertical buoyant force of submerged large wood and the vertical weight force of unsubmerged large wood.

$$F_{LWMs} = V_{LWMs} \times (\gamma_{wood} - \gamma_w)$$

$$V_{LWMs} = total\ volume\ of\ submerged\ large\ wood\ material$$

$$V_{LWMs} = \sum N_{LWMi} \times V_{LWMi}$$

Variable	Design Value	Units
$\gamma_{wood} = unit\ weight\ of\ wood$	38	lb/ft^3
$\gamma_w = unit\ weight\ of\ water$	62.4	lb/ft^3
V_{LWMs}	800	ft^3

F_{LWMs} (lb)	**19,513**	*Positive values are upward forces.*

Lift Force

Accounts for the lift force of large wood in flowing water. Not applicable to LWS where the bed will deform around the leading edges.

$$F_L = \frac{C_L \times A_{LWM} \times \gamma_w \times U_o^2}{2 \times g}$$

	Design Value	Units / Notes
$C_L = lift\ coefficient$	0.2	typ. LWM value
$A_{LWM} = area\ of\ large\ woody\ material\ perpendicular\ to\ flow$		
$U_u = upstream\ channel\ velocity\ at\ design\ event$	10	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2

$A_{LWM} = See\ Design\ Plan$

A_{LWM} (ft^2)	**40**

For pre-racking condition

F_L (lb)	**N/A**

Boulder Ballast Force

Accounts for the ballasting force of large boulders directly attached to or placed over LWM.

$$F_{bouldersub} = N_{bouldersub} \times {}^{\pi}/_{6} \times d_{bouldersub}^3 \times (\gamma_{boulder} - \gamma_w)$$

	Design Value	Units / Notes
$N_{bouldersub} = number\ of\ submerged\ boulders$	0	number
$d_{bouldersub} = effective\ diameter\ of\ submerged\ boulders$	0	ft
$\gamma_{boulder} = unit\ weight\ of\ boulders$	165	lb/ft^3

$F_{bouldersub}$ (lb)	**N/A**

Backfill Ballast Force

Accounts for the ballasting force of backfill placed directly over LWM members. Volume is based on the fill area over the log(s) and a the effective cover depth shown on the Drawings.

$$F_{backfillsub} = V_{backfillsub} \times (\gamma_s - \gamma_w)$$

	Design Value	Units / Notes
$V_{backfillsub} = volume\ of\ backfill\ over\ LWM\ members$	3,150	ft^3
	See design plans	
$\gamma_s = unit\ weight\ of\ backfill\ material$	110	lb/ft^3

$F_{backfillsub}$ (lb)	**-149,940**

Pile Skin Friction

Accounts for the vertical resistance provided by piles within the LWM structure. USBR document equation modified by Inter-Fluve to match industry pile design standard formulations.

$$F_{piles-v} = N_{piles} \times \pi \times d_{piles} \times L_{piles} \times \left(k_s \times \tan\tfrac{2}{3}\theta \times \sigma'\right)$$

		Design Values	Units
$N_{piles} = number\ of\ piles$	*Assume three-quarters of piles are effective*	0	number
$L_{piles} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		12	ft
$d_{piles} = nominal\ diameter\ of\ the\ piles$		1.30	ft
$\sigma' = \left(L_{piles} \times (\gamma_{sat} - \gamma_w)\right)/2$		285.6	lb/ft^2
$K_s = coefficient\ of\ lateral\ earth\ pressure\ (0.5\ to\ 1.0)$		1.0	unit less
$\theta = internal\ friction\ angle\ of\ soils$		36	deg.

F** $_{piles-v}$ **(lb)	**0**	*Negative values resist upward displacement.*

Piles Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bPiles} = \frac{F_{piles-v}}{F_{LWMs}+F_L}$$

***FOS** $_b$* **0.0**

Note this value does not include the backfill assuming it's all lost but the piles are holding.

Backfill Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bBackfill} = \frac{F_{backfillsub}}{F_{LWMs}+F_L}$$

***FOS** $_b$* **7.7**

Note this value does not include the piles.

Net Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bNet} = \frac{F_{backfillsub}+F_{piles-v}}{F_{LWMs}+F_L}$$

***FOS** $_b$* **7.7**

Note this value includes the piles and backfill.

Resistance to Sliding | *6.4.3*

LWM structures are also susceptible to failure through sliding.

Drag Force

LWM structures are pushed downstream by the fluid drag forces acting upon the wood by the flowing water.

$$F_d = \frac{C_D \times A_{LWM} \times \gamma_w \times U_c^2}{2 \times g}$$

	Design Value	Units / Notes
$C_D = drag\ coefficient$	1	Per Equations 23 and 24
$A_{LWM} = area\ of\ wetted\ wood\ normal\ to\ the\ flow\ direction$		
$U_c = velocity\ adjacent\ to\ the\ LWM\ structure$	10	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2
F*$_d$ *(lb)	**3,876**	

$A_{LWM} = See\ Design\ Plan$

A*$_{LWM}$ *(ft^2)	40

Velocity value is conservative for all LWS locations. Value from 100-yr event 2D model results for main channel.

Hydrostatic Force

Hydrostatic forces act on the upstream and downstream faces of a LWM structure. They account for differences in the upstream and downstream water depths against the structure.

$$F_{hu} = \tfrac{1}{2} \times \gamma_w \times Y_u \times A_u \qquad F_{hd} = \tfrac{1}{2} \times \gamma_w \times Y_d \times A_d$$

F_{hu} , F_{hd} = *hydrostatic force on upstream and downstream side of the wood structure*

Y_u , Y_d = *water depth upstream and downstream of the structue*

A_u , A_d = *area projected to flow direction on the upstream and downstream of the structure*

Variable	Design Value
Y_u (ft)	7
A_u (ft^2)	40
Post racking area	
Y_d (ft)	7
A_d (ft^2)	40
Plan downstream area	

F*$_{hu}$ *+ F*$_{hd}$ *= F*$_h$ *(lb)	**N/A**

Impact Force

The impact force associated with debris impacting a large wood structure can be estimated by the impact force equation.

$$F_i = \frac{w_{debris}}{g} \times \frac{V_{channel}{}^2}{2 \times \Delta x} \times C_i \times C_o \times C_d \times C_{b\times} R_{max}$$

$w_{debris} = weight\ of\ debris$

$V_{channel} = channel\ approach\ velocity$

$\Delta x = deceleration\ distance$

Coefficients *(see Table 6 and Figures 11, 12 for values)*

$C_i = importance\ ,\ C_o = orientation = 0.8\ , C_d = depth\ , C_b = blockage\ , R_{max} = impluse\ response\ ratio$

Variable	Design Value
W_{debris} (lb)	3,774
$V_{channel}$ (ft/s)	10
Δx (ft)	5
C_i	0.5
C_o	0.8
C_d	1.0
C_b	1.0
R_{max}	0.8

F_i (lb)	**375**

Friction Force

Accounts for the friction force between the LWM and the channel bed. Restraint force from piles is not included as it does not exert a pressure on the LWS / bed interface.

$$F_f = -\mu_{bed} \times \left(F_{LWMs} + F_L + F_{bouldersub} + F_{backfillsub}\right)$$

	Design Value	Units / Source
$\mu_{bed} = coefficient\ of\ bed\ friction = \tan(\theta)$	0.78	unit less
$\theta = internal\ friction\ angle\ (degrees)$	38	Table 5, (Knutson et. al. 2014)

F_f (lb)	**-101,901**	*Negative values resist downstream displacement.*

Lateral Resistance From Piles

Accounts for the lateral resistance provided by piles within the LWM structure. Assumes soil resistance is limiting, i.e. the pile pushes over before it breaks.

$$F_{piles-h} = N_{piles} \times \frac{L_{pile}^3 \times \frac{1}{2} \times (\gamma_s - \gamma_w) \times d_{pile} \times K_p}{h_{load} \times L_{pile}}$$

		Design Values	Units
$N_{pile} = number\ of\ piles$	*assume three-quarters of piles are effective*	0	number
$L_{pile} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		12	ft
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$h_{load} = applied\ load\ height\ above\ the\ potential\ scour\ depth$		2.5	ft
$K_p = \frac{1 + \sin\theta}{1 - \sin\theta}$		4.2	unit less

$F_{piles-h}$ (lb)	**0**	*Negative values resist downstream displacement.*

Sliding Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{sliding} = \frac{F_f + F_{piles-h}}{F_d + F_{hu} + F_{hd} + F_i}$$

FOS** **sliding **24.0**

Pile Strength Factor of Safety

The factor of safety for the timber bending stress capacity of the pile. This evaluates the potential for the pile(s) to break under load prior to the pile pushing over in the ground.

		Design Values	Units
$F_b = Timber\ Bending\ Stress\ Capacity$ per Timber Pile Manual Table 3-1 or AWC NDS Supplement Table 4D		1,200 172,800	psi psf
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$I = circular\ cross-sectional\ moment\ of\ inertia$	$I = \frac{\pi B^4}{4}$	2.24	ft^4
$S = circular\ section\ modulus$	$S = \frac{\pi B^3}{32}$	0.216	ft^3
$C_F = strength\ reduction\ size\ factor$ for diameters greater than 12"	$C_F = \frac{1}{B}^{(1/9)}$	0.971	--
$M_p = applied\ moment\ per\ pile$	$M_p = \frac{(F_d + F_i + F_h) \times h_{load}}{N_{piles}}$	#DIV/0!	ft-lb
$f_b = applied\ pile\ bending\ stress$	$f_b = \frac{M_p}{S}$	#DIV/0!	psf
$F_{bx} = Pile\ bending\ stress\ capacity$	$F_{bx} = F_b \times C_F$	1,166 167,835	psi psf

$$FOS_{pile\ stength} = \frac{F_{bx}}{f_b}$$

FOS ***pile strength*** **#DIV/0!**

References

Large Woody Material - Risk Based Design Guidelines
M. Knutson, J. Fealko. 2014. *Large Woody Material - Risk Based Design Guidelines.* U.S. Department of the Interior Bureau of Reclamation Pacific Northwest Region & Technical Services. Boise, Idaho. September 2014. Online at: http://www.usbr.gov/pn//fcrps/documents/lwm.pdf

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Nason Floodplain - Large Woody Structure Stability Evaluation

Structural Stability | *6.4*

Structural stability of large woody material placements is evaluated herein using the procedures, formulas, and recommendations provided in the Reclamation's *Large Woody Material - Risk Based Design Guidelines* (Knutson et. al. 2014) along with insight gained from professional experience and general engineering judgment.

Factors of Safety | *6.4.1*

Safety factors for structural stability were selected from *Table 4. Minimum recommended factors of safety* given the site specific public safety and property damage risk levels.

			Criteria:
Public Safety Risk	Moderate	**$FOS_{sliding}$**	1.5
Property Damage Risk	Moderate	**$FOS_{buoyancy}$**	1.75
Stability Design Flow Criteria	50-year	**$FOS_{rotation}$**	1.5

Resistance to Flotation | *6.4.2*

Flotation is typically caused by the buoyant force and the lift force acting on the wood material from water passing over its surface.

Large Wood Material Force

Accounts for the vertical buoyant force of submerged large wood and the vertical weight force of unsubmerged large wood.

$$F_{LWMs} = V_{LWMs} \times (\gamma_{wood} - \gamma_w)$$

$$V_{LWMs} = total\ volume\ of\ submerged\ large\ wood\ material$$

$$V_{LWMs} = \sum N_{LWMi} \times V_{LWMi}$$

Variable	Design Value	Units
$\gamma_{wood} = unit\ weight\ of\ wood$	38	lb/ft^3
$\gamma_w = unit\ weight\ of\ water$	62.4	lb/ft^3
V_{LWMs}	275	ft^3

F_{LWMs} (lb)	**6,700**	*Positive values are upward forces.*

Lift Force

Accounts for the lift force of large wood in flowing water. Not applicable to LWS where the bed will deform around the leading edges.

$$F_L = \frac{C_L \times A_{LWM} \times \gamma_w \times U_o^2}{2 \times g}$$

	Design Value	Units / Notes
$C_L = lift\ coefficient$	0.2	typ. LWM value
$A_{LWM} = area\ of\ large\ woody\ material\ perpendicular\ to\ flow$		
$U_u = upstream\ channel\ velocity\ at\ design\ event$	4	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2

$A_{LWM} = See\ Design\ Plan$

A_{LWM} (ft^2)	30

For pre-racking condition

F_L (lb)	**N/A**

Boulder Ballast Force

Accounts for the ballasting force of large boulders directly attached to or placed over LWM.

$$F_{bouldersub} = N_{bouldersub} \times {}^{\pi}/_{6} \times d^3_{bouldersub} \times (\gamma_{boulder} - \gamma_w)$$

	Design Value	Units / Notes
$N_{bouldersub} = number\ of\ submerged\ boulders$	0	number
$d_{bouldersub} = effective\ diameter\ of\ submerged\ boulders$	0	ft
$\gamma_{boulder} = unit\ weight\ of\ boulders$	165	lb/ft^3

F_bouldersub (lb)	**N/A**

Backfill Ballast Force

Accounts for the ballasting force of backfill placed directly over LWM members. Volume is based on the fill area over the log(s) and a the effective cover depth shown on the Drawings.

$$F_{backfillsub} = V_{backfillsub} \times (\gamma_s - \gamma_w)$$

	Design Value	Units / Notes
$V_{backfillsub} = volume\ of\ backfill\ over\ LWM\ members$	630	ft^3
	See design plans	
$\gamma_s = unit\ weight\ of\ backfill\ material$	110	lb/ft^3

F_backfillsub (lb)	**-29,988**

Pile Skin Friction

Accounts for the vertical resistance provided by piles within the LWM structure. USBR document equation modified by Inter-Fluve to match industry pile design standard formulations.

$$F_{piles-v} = N_{piles} \times \pi \times d_{piles} \times L_{piles} \times \left(k_s \times \tan\tfrac{2}{3}\theta \times \sigma'\right)$$

		Design Values	Units
$N_{piles} = number\ of\ piles$	*Assume three-quarters of piles are effective*	1.5	number
$L_{piles} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		12	ft
$d_{piles} = nominal\ diameter\ of\ the\ piles$		1.30	ft
$\sigma' = \left(L_{piles} \times (\gamma_{sat} - \gamma_w)\right)/2$		285.6	lb/ft^2
$K_s = coefficient\ of\ lateral\ earth\ pressure\ (0.5\ to\ 1.0)$		1.0	unit less
$\theta = internal\ friction\ angle\ of\ soils$		36	deg.

$F_{piles-v}$ **(lb)**	**-9,348**	*Negative values resist upward displacement.*

Piles Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bPiles} = \frac{F_{piles-v}}{F_{LWMs}+F_L}$$

***FOS** $_b$* **1.4**

Note this value does not include the backfill assuming it's all lost but the piles are holding.

Backfill Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bBackfill} = \frac{F_{backfillsub}}{F_{LWMs}+F_L}$$

***FOS** $_b$* **4.5**

Note this value does not include the piles.

Net Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bNet} = \frac{F_{backfillsub}+F_{piles-v}}{F_{LWMs}+F_L}$$

***FOS** $_b$* **5.9**

Note this value includes the piles and backfill.

Resistance to Sliding | *6.4.3*

LWM structures are also susceptible to failure through sliding.

Drag Force

LWM structures are pushed downstream by the fluid drag forces acting upon the wood by the flowing water.

$$F_d = \frac{C_D \times A_{LWM} \times \gamma_w \times U_c^2}{2 \times g}$$

	Design Value	Units / Notes
$C_D = drag\ coefficient$	1	Per Equations 23 and 24
$A_{LWM} = area\ of\ wetted\ wood\ normal\ to\ the\ flow\ direction$		
$U_c = velocity\ adjacent\ to\ the\ LWM\ structure$	4	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2
F_d (lb)	**465**	

$A_{LWM} = See\ Design\ Plan$

A_{LWM} (ft^2)	30

Velocity value is conservative for all LWS locations. Value from 100-yr event 2D model results for main channel.

Hydrostatic Force

Hydrostatic forces act on the upstream and downstream faces of a LWM structure. They account for differences in the upstream and downstream water depths against the structure.

$$F_{hu} = \tfrac{1}{2} \times \gamma_w \times Y_u \times A_u \qquad F_{hd} = \tfrac{1}{2} \times \gamma_w \times Y_d \times A_d$$

F_{hu} , $F_{hd} = hydrostatic\ force\ on\ upstream\ and\ downstream$ *side of the wood structure*

Y_u , $Y_d = water\ depth\ upstream\ and\ downstream\ of\ the\ structue$

A_u , $A_d = area\ projected\ to\ flow\ direction\ on\ the\ upstream\ and\ downstream\ of\ the\ structure$

Variable	Design Value
Y_u (ft)	5
A_u (ft^2)	30
Post racking area	
Y_d (ft)	5
A_d (ft^2)	30
Plan downstream area	

$F_{hu} + F_{hd} = F_h$ (lb)	**N/A**

Impact Force

The impact force associated with debris impacting a large wood structure can be estimated by the impact force equation.

$$F_i = \frac{w_{debris}}{g} \times \frac{V_{channel}\hat{}2}{2 \times \Delta x} \times C_i \times C_o \times C_d \times C_{b\times} R_{max}$$

$w_{debris} = weight\ of\ debris$

$V_{channel} = channel\ approach\ velocity$

$\Delta x = deceleration\ distance$

Coefficients *(see Table 6 and Figures 11, 12 for values)*
$C_i = importance\ ,\ C_o = orientation = 0.8\ , C_d = depth\ , C_b = blockage\ , R_{max} = impluse\ response\ ratio$

Variable	Design Value
W_{debris} (lb)	3,774
$V_{channel}$ (ft/s)	4
Δx (ft)	5
C_i	0.5
C_o	0.8
C_d	1.0
C_b	1.0
R_{max}	0.8

F_i (lb)	**60**

Friction Force

Accounts for the friction force between the LWM and the channel bed. Restraint force from piles is not included as it does not exert a pressure on the LWS / bed interface.

$$F_f = -\mu_{bed} \times (F_{LWMs} + F_L + F_{bouldersub} + F_{backfillsub})$$

	Design Value	Units / Source
$\mu_{bed} = coefficient\ of\ bed\ friction = \tan(\theta)$	0.78	unit less
$\theta = internal\ friction\ angle\ (degrees)$	38	Table 5, (Knutson et. al. 2014)

F_f (lb)	**-18,194**	*Negative values resist downstream displacement.*

Lateral Resistance From Piles

Accounts for the lateral resistance provided by piles within the LWM structure. Assumes soil resistance is limiting, i.e. the pile pushes over before it breaks.

$$F_{piles-h} = N_{piles} \times \frac{L_{pile}^3 \times \frac{1}{2} \times (\gamma_s - \gamma_w) \times d_{pile} \times K_p}{h_{load} \times L_{pile}}$$

		Design Values	Units
$N_{pile} = number\ of\ piles$	*assume three-quarters of piles are effective*	1.5	number
$L_{pile} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		12	ft
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$h_{load} = applied\ load\ height\ above\ the\ potential\ scour\ depth$		2.5	ft
$K_p = \frac{1 + \sin\theta}{1 - \sin\theta}$		4.2	unit less

$F_{piles-h}$ (lb)	**-11,238**	*Negative values resist downstream displacement.*

Sliding Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{sliding} = \frac{F_f + F_{piles-h}}{F_d + F_{hu} + F_{hd} + F_i}$$

***FOS** sliding* **56.1**

Pile Strength Factor of Safety

The factor of safety for the timber bending stress capacity of the pile. This evaluates the potential for the pile(s) to break under load prior to the pile pushing over in the ground.

		Design Values	Units
$F_b = Timber\ Bending\ Stress\ Capacity$ per Timber Pile Manual Table 3-1 or AWC NDS Supplement Table 4D		1,200 172,800	psi psf
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$I = circular\ cross - sectional\ moment\ of\ inertia$	$I = \frac{\pi B^4}{4}$	2.24	ft^4
$S = circular\ section\ modulus$	$S = \frac{\pi B^3}{32}$	0.216	ft^3
$C_F = strength\ reduction\ size\ factor$ for diameters greater than 12"	$C_F = \frac{1}{B}^{(1/9)}$	0.971	--
$M_p = applied\ moment\ per\ pile$	$M_p = \frac{(F_d + F_i + F_h) \times h_{load}}{N_{piles}}$	875	ft-lb
$f_b = applied\ pile\ bending\ stress$	$f_b = \frac{M_p}{S}$	4,058	psf
$F_{bx} = Pile\ bending\ stress\ capacity$	$F_{bx} = F_b \times C_F$	1,166 167,835	psi psf

$$FOS_{pile\ stength} = \frac{F_{bx}}{f_b}$$

***FOS** pile strength* **41.4**

References

Large Woody Material - Risk Based Design Guidelines
M. Knutson, J. Fealko. 2014. *Large Woody Material - Risk Based Design Guidelines.* U.S. Department of the Interior Bureau of Reclamation Pacific Northwest Region & Technical Services. Boise, Idaho. September 2014. Online at: http://www.usbr.gov/pn//fcrps/documents/lwm.pdf

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Timber Pile Design and Construction Manual, Timber Piling Council, 2015.

American Wood Council (2018) National Design Specifications for Wood Construction, Design Supplement.

Nason Floodplain - Large Woody Structure Stability Evaluation

Structural Stability | *6.4*

Structural stability of large woody material placements is evaluated herein using the procedures, formulas, and recommendations provided in the Reclamation's *Large Woody Material - Risk Based Design Guidelines* (Knutson et. al. 2014) along with insight gained from professional experience and general engineering judgment.

Factors of Safety | *6.4.1*

Safety factors for structural stability were selected from *Table 4. Minimum recommended factors of safety* given the site specific public safety and property damage risk levels.

			Criteria:
Public Safety Risk	Moderate	**FOS**$_{sliding}$	1.5
Property Damage Risk	Moderate	**FOS**$_{buoyancy}$	1.75
Stability Design Flow Criteria	50-year	**FOS**$_{rotation}$	1.5

Resistance to Flotation | *6.4.2*

Flotation is typically caused by the buoyant force and the lift force acting on the wood material from water passing over its surface.

Large Wood Material Force

Accounts for the vertical buoyant force of submerged large wood and the vertical weight force of unsubmerged large wood.

$$F_{LWMs} = V_{LWMs} \times (\gamma_{wood} - \gamma_w)$$

$$V_{LWMs} = total\ volume\ of\ submerged\ large\ wood\ material$$

$$V_{LWMs} = \sum N_{LWMi} \times V_{LWMi}$$

Variable	Design Value	Units
$\gamma_{wood} = unit\ weight\ of\ wood$	38	lb/ft^3
$\gamma_w = unit\ weight\ of\ water$	62.4	lb/ft^3
V_{LWMs}	1005	ft^3

F $_{LWMs}$ ***(lb)***	**24,527**	*Positive values are upward forces.*

Lift Force

Accounts for the lift force of large wood in flowing water. Not applicable to LWS where the bed will deform around the leading edges.

$$F_L = \frac{C_L \times A_{LWM} \times \gamma_w \times U_o^2}{2 \times g}$$

	Design Value	Units / Notes
$C_L = lift\ coefficient$	0.2	typ. LWM value
$A_{LWM} = area\ of\ large\ woody\ material\ perpendicular\ to\ flow$		
$U_u = upstream\ channel\ velocity\ at\ design\ event$	5	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2

$A_{LWM} = See\ Design\ Plan$

A $_{LWM}$ ***(ft^2)***	**80**

For pre-racking condition

F $_L$ ***(lb)***	**N/A**

Boulder Ballast Force

Accounts for the ballasting force of large boulders directly attached to or placed over LWM.

$$F_{bouldersub} = N_{bouldersub} \times {}^{\pi}/_{6} \times d^3_{bouldersub} \times (\gamma_{boulder} - \gamma_w)$$

	Design Value	Units / Notes
$N_{bouldersub} = number\ of\ submerged\ boulders$	0	number
$d_{bouldersub} = effective\ diameter\ of\ submerged\ boulders$	0	ft
$\gamma_{boulder} = unit\ weight\ of\ boulders$	165	lb/ft^3

F $_{bouldersub}$ ***(lb)***	**N/A**

Backfill Ballast Force

Accounts for the ballasting force of backfill placed directly over LWM members. Volume is based on the fill area over the log(s) and a the effective cover depth shown on the Drawings.

$$F_{backfillsub} = V_{backfillsub} \times (\gamma_s - \gamma_w)$$

	Design Value	Units / Notes
$V_{backfillsub} = volume\ of\ backfill\ over\ LWM\ members$	3,150	ft^3
	See design plans	
$\gamma_s = unit\ weight\ of\ backfill\ material$	110	lb/ft^3

F $_{backfillsub}$ ***(lb)***	**-149,940**

Pile Skin Friction

Accounts for the vertical resistance provided by piles within the LWM structure. USBR document equation modified by Inter-Fluve to match industry pile design standard formulations.

$$F_{piles-v} = N_{piles} \times \pi \times d_{piles} \times L_{piles} \times \left(k_s \times \tan\tfrac{2}{3}\theta \times \sigma'\right)$$

		Design Values	Units
$N_{piles} = number\ of\ piles$	*Assume three-quarters of piles are effective*	9	number
$L_{piles} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		12	ft
$d_{piles} = nominal\ diameter\ of\ the\ piles$		1.30	ft
$\sigma' = \left(L_{piles} \times (\gamma_{sat} - \gamma_w)\right)/2$		285.6	lb/ft^2
$K_s = coefficient\ of\ lateral\ earth\ pressure\ (0.5\ to\ 1.0)$		1.0	unit less
$\theta = internal\ friction\ angle\ of\ soils$		36	deg.

$F_{piles-v}$ (lb)	**-56,086**	*Negative values resist upward displacement.*

Piles Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bPiles} = \frac{F_{piles-v}}{F_{LWMs}+F_L}$$

FOS_b **2.3**

Note this value does not include the backfill assuming it's all lost but the piles are holding.

Backfill Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bBackfill} = \frac{F_{backfillsub}}{F_{LWMs}+F_L}$$

FOS_b **6.1**

Note this value does not include the piles.

Net Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bNet} = \frac{F_{backfillsub}+F_{piles-v}}{F_{LWMs}+F_L}$$

FOS_b **8.4**

Note this value includes the piles and backfill.

Resistance to Sliding | *6.4.3*

LWM structures are also susceptible to failure through sliding.

Drag Force

LWM structures are pushed downstream by the fluid drag forces acting upon the wood by the flowing water.

$$F_d = \frac{C_D \times A_{LWM} \times \gamma_w \times U_c^2}{2 \times g}$$

	Design Value	Units / Notes
$C_D = drag\ coefficient$	1	Per Equations 23 and 24
$A_{LWM} = area\ of\ wetted\ wood\ normal\ to\ the\ flow\ direction$		
$U_c = velocity\ adjacent\ to\ the\ LWM\ structure$	5	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s²

$A_{LWM} = See\ Design\ Plan$

A_{LWM} (ft^2)	80

Velocity value is conservative for all LWS locations. Value from 100-yr event 2D model results for main channel.

F $_d$ ***(lb)***	**1,938**

Hydrostatic Force

Hydrostatic forces act on the upstream and downstream faces of a LWM structure. They account for differences in the upstream and downstream water depths against the structure.

$$F_{hu} = \tfrac{1}{2} \times \gamma_w \times Y_u \times A_u \qquad F_{hd} = \tfrac{1}{2} \times \gamma_w \times Y_d \times A_d$$

F_{hu} , F_{hd} = hydrostatic force on upstream and downstream side of the wood structure

Y_u , Y_d = water depth upstream and downstream of the structue

A_u , A_d = area projected to flow direction on the upstream and downstream of the structure

Variable	Design Value
Y_u (ft)	6.5
A_u (ft^2)	80
Post racking area	
Y_d (ft)	6.5
A_d (ft^2)	80
Plan downstream area	

F $_{hu}$ ***+ F*** $_{hd}$ ***= F*** $_h$ ***(lb)***	**N/A**

Impact Force

The impact force associated with debris impacting a large wood structure can be estimated by the impact force equation.

$$F_i = \frac{w_{debris}}{g} \times \frac{V_{channel}\text{^}2}{2 \times \Delta x} \times C_i \times C_o \times C_d \times C_{b\times} R_{max}$$

$w_{debris} = weight\ of\ debris$

$V_{channel} = channel\ approach\ velocity$

$\Delta x = deceleration\ distance$

Coefficients *(see Table 6 and Figures 11, 12 for values)*

$C_i = importance\ ,\ C_o = orientation = 0.8\ , C_d = depth\ , C_b = blockage\ , R_{max} = impluse\ response\ ratio$

Variable	Design Value
W_{debris} (lb)	3,774
$V_{channel}$ (ft/s)	5
Δx (ft)	5
C_i	0.5
C_o	0.8
C_d	1.0
C_b	1.0
R_{max}	0.8

F**$_i$* ***(lb)	**94**

Friction Force

Accounts for the friction force between the LWM and the channel bed. Restraint force from piles is not included as it does not exert a pressure on the LWS / bed interface.

$$F_f = -\mu_{bed} \times \left(F_{LWMs} + F_L + F_{bouldersub} + F_{backfillsub}\right)$$

	Design Value	Units / Source
$\mu_{bed} = coefficient\ of\ bed\ friction = \tan(\theta)$	0.78	unit less
$\theta = internal\ friction\ angle\ (degrees)$	38	Table 5, (Knutson et. al. 2014)

F**$_f$* ***(lb)	**-97,983**	*Negative values resist downstream displacement.*

Lateral Resistance From Piles

Accounts for the lateral resistance provided by piles within the LWM structure. Assumes soil resistance is limiting, i.e. the pile pushes over before it breaks.

$$F_{piles-h} = N_{piles} \times \frac{L_{pile}^3 \times \frac{1}{2} \times (\gamma_s - \gamma_w) \times d_{pile} \times K_p}{h_{load} \times L_{pile}}$$

		Design Values	Units
$N_{pile} = number\ of\ piles$	*assume three-quarters of piles are effective*	9	number
$L_{pile} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		12	ft
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$h_{load} = applied\ load\ height\ above\ the\ potential\ scour\ depth$		2.5	ft
$K_p = \frac{1 + \sin\theta}{1 - \sin\theta}$		4.2	unit less

F**$_{piles-h}$* ***(lb)	**-67,425**	*Negative values resist downstream displacement.*

Sliding Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{sliding} = \frac{F_f + F_{piles-h}}{F_d + F_{hu} + F_{hd} + F_i}$$

***FOS** sliding* **81.4**

Pile Strength Factor of Safety

The factor of safety for the timber bending stress capacity of the pile. This evaluates the potential for the pile(s) to break under load prior to the pile pushing over in the ground.

		Design Values	Units
$F_b = Timber\ Bending\ Stress\ Capacity$ per Timber Pile Manual Table 3-1 or AWC NDS Supplement Table 4D		1,200 172,800	psi psf
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$I = circular\ cross-sectional\ moment\ of\ inertia$	$I = \frac{\pi B^4}{4}$	2.24	ft^4
$S = circular\ section\ modulus$	$S = \frac{\pi B^3}{32}$	0.216	ft^3
$C_F = strength\ reduction\ size\ factor$ for diameters greater than 12"	$C_F = \frac{1}{B}^{(1/9)}$	0.971	--
$M_p = applied\ moment\ per\ pile$	$M_p = \frac{(F_d + F_i + F_h) \times h_{load}}{N_{piles}}$	564	ft-lb
$f_b = applied\ pile\ bending\ stress$	$f_b = \frac{M_p}{S}$	2,616	psf
$F_{bx} = Pile\ bending\ stress\ capacity$	$F_{bx} = F_b \times C_F$	1,166 167,835	psi psf

$$FOS_{pile\ stength} = \frac{F_{bx}}{f_b}$$

***FOS** pile strength* **64.1**

References

Large Woody Material - Risk Based Design Guidelines
M. Knutson, J. Fealko. 2014. *Large Woody Material - Risk Based Design Guidelines.* U.S. Department of the Interior Bureau of Reclamation Pacific Northwest Region & Technical Services. Boise, Idaho. September 2014. Online at: http://www.usbr.gov/pn//fcrps/documents/lwm.pdf

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Nason Floodplain - Large Woody Structure Stability Evaluation

Structural Stability | *6.4*

Structural stability of large woody material placements is evaluated herein using the procedures, formulas, and recommendations provided in the Reclamation's *Large Woody Material - Risk Based Design Guidelines* (Knutson et. al. 2014) along with insight gained from professional experience and general engineering judgment.

Factors of Safety | *6.4.1*

Safety factors for structural stability were selected from *Table 4. Minimum recommended factors of safety* given the site specific public safety and property damage risk levels.

			Criteria:
Public Safety Risk	Moderate	**$FOS_{sliding}$**	1.5
Property Damage Risk	Moderate	**$FOS_{buoyancy}$**	1.75
Stability Design Flow Criteria	50-year	**$FOS_{rotation}$**	1.5

Resistance to Flotation | *6.4.2*

Flotation is typically caused by the buoyant force and the lift force acting on the wood material from water passing over its surface.

Large Wood Material Force

Accounts for the vertical buoyant force of submerged large wood and the vertical weight force of unsubmerged large wood.

$$F_{LWMs} = V_{LWMs} \times (\gamma_{wood} - \gamma_w)$$

$$V_{LWMs} = total\ volume\ of\ submerged\ large\ wood\ material$$

$$V_{LWMs} = \sum N_{LWMi} \times V_{LWMi}$$

Variable	Design Value	Units
$\gamma_{wood} = unit\ weight\ of\ wood$	38	lb/ft^3
$\gamma_w = unit\ weight\ of\ water$	62.4	lb/ft^3
V_{LWMs}	458	ft^3

F_{LWMs} (lb)	**11,165**	*Positive values are upward forces.*

Lift Force

Accounts for the lift force of large wood in flowing water. Not applicable to LWS where the bed will deform around the leading edges.

$$F_L = \frac{C_L \times A_{LWM} \times \gamma_w \times U_o^2}{2 \times g}$$

	Design Value	Units / Notes
$C_L = lift\ coefficient$	0.2	typ. LWM value
$A_{LWM} = area\ of\ large\ woody\ material\ perpendicular\ to\ flow$		
$U_u = upstream\ channel\ velocity\ at\ design\ event$	5	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2

$A_{LWM} = See\ Design\ Plan$

A $_{LWM}$ ***(ft*** ^{2} ***)***	**70**

For pre-racking condition

F $_L$ ***(lb)***	**N/A**

Boulder Ballast Force

Accounts for the ballasting force of large boulders directly attached to or placed over LWM.

$$F_{bouldersub} = N_{bouldersub} \times {}^{\pi}/_{6} \times d^3_{bouldersub} \times (\gamma_{boulder} - \gamma_w)$$

	Design Value	Units / Notes
$N_{bouldersub} = number\ of\ submerged\ boulders$	0	number
$d_{bouldersub} = effective\ diameter\ of\ submerged\ boulders$	0	ft
$\gamma_{boulder} = unit\ weight\ of\ boulders$	165	lb/ft^3

F $_{bouldersub}$ ***(lb)***	**N/A**

Backfill Ballast Force

Accounts for the ballasting force of backfill placed directly over LWM members. Volume is based on the fill area over the log(s) and a the effective cover depth shown on the Drawings.

$$F_{backfillsub} = V_{backfillsub} \times (\gamma_s - \gamma_w)$$

	Design Value	Units / Notes
$V_{backfillsub} = volume\ of\ backfill\ over\ LWM\ members$	1,125	ft^3
	See design plans	
$\gamma_s = unit\ weight\ of\ backfill\ material$	110	lb/ft^3

F $_{backfillsub}$ ***(lb)***	**-53,550**

Pile Skin Friction

Accounts for the vertical resistance provided by piles within the LWM structure. USBR document equation modified by Inter-Fluve to match industry pile design standard formulations.

$$F_{piles-v} = N_{piles} \times \pi \times d_{piles} \times L_{piles} \times \left(k_s \times \tan\tfrac{2}{3}\theta \times \sigma'\right)$$

		Design Values	Units
$N_{piles} = number\ of\ piles$	*Assume three-quarters of piles are effective*	3.75	number
$L_{piles} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		12	ft
$d_{piles} = nominal\ diameter\ of\ the\ piles$		1.30	ft
$\sigma' = \left(L_{piles} \times (\gamma_{sat} - \gamma_w)\right)/2$		285.6	lb/ft^2
$K_s = coefficient\ of\ lateral\ earth\ pressure\ (0.5\ to\ 1.0)$		1.0	unit less
$\theta = internal\ friction\ angle\ of\ soils$		36	deg.

$F_{piles-v}$ (lb)	-23,369	*Negative values resist upward displacement.*

Piles Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bPiles} = \frac{F_{piles-v}}{F_{LWMs}+F_L}$$

FOS_b 2.1

Note this value does not include the backfill assuming it's all lost but the piles are holding.

Backfill Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bBackfill} = \frac{F_{backfillsub}}{F_{LWMs}+F_L}$$

FOS_b 4.8

Note this value does not include the piles.

Net Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bNet} = \frac{F_{backfillsub}+F_{piles-v}}{F_{LWMs}+F_L}$$

FOS_b 6.9

Note this value includes the piles and backfill.

Resistance to Sliding | *6.4.3*

LWM structures are also susceptible to failure through sliding.

Drag Force

LWM structures are pushed downstream by the fluid drag forces acting upon the wood by the flowing water.

$$F_d = \frac{C_D \times A_{LWM} \times \gamma_w \times U_c^2}{2 \times g}$$

	Design Value	Units / Notes
$C_D = drag\ coefficient$	1	Per Equations 23 and 24
$A_{LWM} = area\ of\ wetted\ wood\ normal\ to\ the\ flow\ direction$		
$U_c = velocity\ adjacent\ to\ the\ LWM\ structure$	5	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2
F_d (lb)	**1,696**	

$A_{LWM} = See\ Design\ Plan$

A_{LWM} (ft^2)	70

Velocity value is conservative for all LWS locations. Value from 100-yr event 2D model results for main channel.

Hydrostatic Force

Hydrostatic forces act on the upstream and downstream faces of a LWM structure. They account for differences in the upstream and downstream water depths against the structure.

$$F_{hu} = \tfrac{1}{2} \times \gamma_w \times Y_u \times A_u \qquad F_{hd} = \tfrac{1}{2} \times \gamma_w \times Y_d \times A_d$$

F_{hu} , $F_{hd} =$ *hydrostatic force on upstream and downstream side of the wood structure*

Y_u , $Y_d = water\ depth\ upstream\ and\ downstream\ of\ the\ structue$

A_u , $A_d = area\ projected\ to\ flow\ direction\ on\ the\ upstream\ and\ downstream\ of\ the\ structure$

Variable	Design Value
Y_u (ft)	4
A_u (ft^2)	70
Post racking area	
Y_d (ft)	4
A_d (ft^2)	70
Plan downstream area	

$F_{hu} + F_{hd} = F_h$ (lb)	**N/A**

Impact Force

The impact force associated with debris impacting a large wood structure can be estimated by the impact force equation.

$$F_i = \frac{w_{debris}}{g} \times \frac{V_{channel}{}^\wedge 2}{2 \times \Delta x} \times C_i \times C_o \times C_d \times C_{b\times} R_{max}$$

$w_{debris} = weight\ of\ debris$

$V_{channel} = channel\ approach\ velocity$

$\Delta x = deceleration\ distance$

Coefficients *(see Table 6 and Figures 11, 12 for values)*

$C_i = importance\ ,\ C_o = orientation = 0.8\ , C_d = depth\ , C_b = blockage\ , R_{max} = implu se\ response\ ratio$

Variable	Design Value
W_{debris} (lb)	3,774
$V_{channel}$ (ft/s)	5
Δx (ft)	5
C_i	0.5
C_o	0.8
C_d	1.0
C_b	1.0
R_{max}	0.8

F_i (lb)	94

Friction Force

Accounts for the friction force between the LWM and the channel bed. Restraint force from piles is not included as it does not exert a pressure on the LWS / bed interface.

$$F_f = -\mu_{bed} \times (F_{LWMs} + F_L + F_{bouldersub} + F_{backfillsub})$$

	Design Value	Units / Source
$\mu_{bed} = coefficient\ of\ bed\ friction = \tan(\theta)$	0.78	unit less
$\theta = internal\ friction\ angle\ (degrees)$	38	Table 5, (Knutson et. al. 2014)

F_f (lb)	-33,115	*Negative values resist downstream displacement.*

Lateral Resistance From Piles

Accounts for the lateral resistance provided by piles within the LWM structure. Assumes soil resistance is limiting, i.e. the pile pushes over before it breaks.

$$F_{piles-h} = N_{piles} \times \frac{L_{pile}^3 \times \frac{1}{2} \times (\gamma_s - \gamma_w) \times d_{pile} \times K_p}{h_{load} \times L_{pile}}$$

		Design Values	Units
$N_{pile} = number\ of\ piles$	*assume three-quarters of piles are effective*	3.75	number
$L_{pile} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		12	ft
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$h_{load} = applied\ load\ height\ above\ the\ potential\ scour\ depth$		2.5	ft
$K_p = \frac{1 + \sin\theta}{1 - \sin\theta}$		4.2	unit less

$F_{piles-h}$ (lb)	-28,094	*Negative values resist downstream displacement.*

Sliding Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{sliding} = \frac{F_f + F_{piles-h}}{F_d + F_{hu} + F_{hd} + F_i}$$

FOS ***sliding*** **34.2**

Pile Strength Factor of Safety

The factor of safety for the timber bending stress capacity of the pile. This evaluates the potential for the pile(s) to break under load prior to the pile pushing over in the ground.

		Design Values	Units
$F_b = Timber\ Bending\ Stress\ Capacity$ per Timber Pile Manual Table 3-1 or AWC NDS Supplement Table 4D		1,200 172,800	psi psf
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$I = circular\ cross - sectional\ moment\ of\ inertia$	$I = \frac{\pi B^4}{4}$	2.24	ft^4
$S = circular\ section\ modulus$	$S = \frac{\pi B^3}{32}$	0.216	ft^3
$C_F = strength\ reduction\ size\ factor$ for diameters greater than 12"	$C_F = \frac{1}{B}^{(1/9)}$	0.971	--
$M_p = applied\ moment\ per\ pile$	$M_p = \frac{(F_d + F_i + F_h) \times h_{load}}{N_{piles}}$	1,193	ft-lb
$f_b = applied\ pile\ bending\ stress$	$f_b = \frac{M_p}{S}$	5,531	psf
$F_{bx} = Pile\ bending\ stress\ capacity$	$F_{bx} = F_b \times C_F$	1,166 167,835	psi psf

$$FOS_{pile\ stength} = \frac{F_{bx}}{f_b}$$

FOS ***pile strength*** **30.3**

References

Large Woody Material - Risk Based Design Guidelines
M. Knutson, J. Fealko. 2014. *Large Woody Material - Risk Based Design Guidelines.* U.S. Department of the Interior Bureau of Reclamation Pacific Northwest Region & Technical Services. Boise, Idaho. September 2014. Online at: http://www.usbr.gov/pn//fcrps/documents/lwm.pdf

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Timber Pile Design and Construction Manual, Timber Piling Council, 2015.

American Wood Council (2018) National Design Specifications for Wood Construction, Design Supplement.

Nason Floodplain - Large Woody Structure Stability Evaluation

Structural Stability | *6.4*

Structural stability of large woody material placements is evaluated herein using the procedures, formulas, and recommendations provided in the Reclamation's *Large Woody Material - Risk Based Design Guidelines* (Knutson et. al. 2014) along with insight gained from professional experience and general engineering judgment.

Factors of Safety | *6.4.1*

Safety factors for structural stability were selected from *Table 4. Minimum recommended factors of safety* given the site specific public safety and property damage risk levels.

			Criteria:
Public Safety Risk	Moderate	**$FOS_{sliding}$**	1.5
Property Damage Risk	Moderate	**$FOS_{buoyancy}$**	1.75
Stability Design Flow Criteria	50-year	**$FOS_{rotation}$**	1.5

Resistance to Flotation | *6.4.2*

Flotation is typically caused by the buoyant force and the lift force acting on the wood material from water passing over its surface.

Large Wood Material Force

Accounts for the vertical buoyant force of submerged large wood and the vertical weight force of unsubmerged large wood.

$$F_{LWMs} = V_{LWMs} \times (\gamma_{wood} - \gamma_w)$$

$$V_{LWMs} = total\ volume\ of\ submerged\ large\ wood\ material$$

$$V_{LWMs} = \sum N_{LWMi} \times V_{LWMi}$$

Variable	Design Value	Units
$\gamma_{wood} = unit\ weight\ of\ wood$	38	lb/ft^3
$\gamma_w = unit\ weight\ of\ water$	62.4	lb/ft^3
V_{LWMs}	1525	ft^3

F_{LWMs} (lb)	**37,215**	*Positive values are upward forces.*

Lift Force

Accounts for the lift force of large wood in flowing water. Not applicable to LWS where the bed will deform around the leading edges.

$$F_L = \frac{C_L \times A_{LWM} \times \gamma_w \times U_o^2}{2 \times g}$$

	Design Value	Units / Notes
$C_L = lift\ coefficient$	0.2	typ. LWM value
$A_{LWM} = area\ of\ large\ woody\ material\ perpendicular\ to\ flow$		
$U_u = upstream\ channel\ velocity\ at\ design\ event$	6	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2

$A_{LWM} = See\ Design\ Plan$

A_{LWM} (ft^2)	**75**

For pre-racking condition

F_L (lb)	**N/A**

Boulder Ballast Force

Accounts for the ballasting force of large boulders directly attached to or placed over LWM.

$$F_{bouldersub} = N_{bouldersub} \times {}^{\pi}/_{6} \times d_{bouldersub}^3 \times (\gamma_{boulder} - \gamma_w)$$

	Design Value	Units / Notes
$N_{bouldersub} = number\ of\ submerged\ boulders$	0	number
$d_{bouldersub} = effective\ diameter\ of\ submerged\ boulders$	0	ft
$\gamma_{boulder} = unit\ weight\ of\ boulders$	165	lb/ft^3

$F_{bouldersub}$ (lb)	**N/A**

Backfill Ballast Force

Accounts for the ballasting force of backfill placed directly over LWM members. Volume is based on the fill area over the log(s) and a the effective cover depth shown on the Drawings.

$$F_{backfillsub} = V_{backfillsub} \times (\gamma_s - \gamma_w)$$

	Design Value	Units / Notes
$V_{backfillsub} = volume\ of\ backfill\ over\ LWM\ members$	6,939	ft^3
	See design plans	
$\gamma_s = unit\ weight\ of\ backfill\ material$	110	lb/ft^3

$F_{backfillsub}$ (lb)	**-330,296**

Pile Skin Friction

Accounts for the vertical resistance provided by piles within the LWM structure. USBR document equation modified by Inter-Fluve to match industry pile design standard formulations.

$$F_{piles-v} = N_{piles} \times \pi \times d_{piles} \times L_{piles} \times \left(k_s \times \tan\tfrac{2}{3}\theta \times \sigma'\right)$$

		Design Values	Units
$N_{piles} = number\ of\ piles$	*Assume three-quarters of piles are effective*	10.5	number
$L_{piles} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		15	ft
$d_{piles} = nominal\ diameter\ of\ the\ piles$		1.30	ft
$\sigma' = \left(L_{piles} \times (\gamma_{sat} - \gamma_w)\right)/2$		357	lb/ft^2
$K_s = coefficient\ of\ lateral\ earth\ pressure\ (0.5\ to\ 1.0)$		1.0	unit less
$\theta = internal\ friction\ angle\ of\ soils$		36	deg.

$F_{piles-v}$ (lb)	**-102,241**	*Negative values resist upward displacement.*

Piles Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bPiles} = \frac{F_{piles-v}}{F_{LWMs} + F_L}$$

***FOS_b* 2.7**

Note this value does not include the backfill assuming it's all lost but the piles are holding.

Backfill Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bBackfill} = \frac{F_{backfillsub}}{F_{LWMs} + F_L}$$

***FOS_b* 8.9**

Note this value does not include the piles.

Net Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bNet} = \frac{F_{backfillsub} + F_{piles-v}}{F_{LWMs} + F_L}$$

***FOS_b* 11.6**

Note this value includes the piles and backfill.

Resistance to Sliding | *6.4.3*

LWM structures are also susceptible to failure through sliding.

Drag Force

LWM structures are pushed downstream by the fluid drag forces acting upon the wood by the flowing water.

$$F_d = \frac{C_D \times A_{LWM} \times \gamma_w \times U_c^2}{2 \times g}$$

	Design Value	Units / Notes
$C_D = drag\ coefficient$	1	Per Equations 23 and 24
$A_{LWM} = area\ of\ wetted\ wood\ normal\ to\ the\ flow\ direction$		
$U_c = velocity\ adjacent\ to\ the\ LWM\ structure$	6	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2
F ***d*** ***(lb)***	**2,616**	

$A_{LWM} = See\ Design\ Plan$

A ***LWM*** ***(ft^2)***	75

Velocity value is conservative for all LWS locations. Value from 100-yr event 2D model results for main channel.

Hydrostatic Force

Hydrostatic forces act on the upstream and downstream faces of a LWM structure. They account for differences in the upstream and downstream water depths against the structure.

$$F_{hu} = \tfrac{1}{2} \times \gamma_w \times Y_u \times A_u \qquad F_{hd} = \tfrac{1}{2} \times \gamma_w \times Y_d \times A_d$$

F_{hu} , F_{hd} = *hydrostatic force on upstream and downstream side of the wood structure*

Y_u , Y_d = *water depth upstream and downstream of the structue*

A_u , A_d = *area projected to flow direction on the upstream and downstream of the structure*

Variable	Design Value
Y_u (ft)	9
A_u (ft^2)	75
Post racking area	
Y_d (ft)	9
A_d (ft^2)	75
Plan downstream area	

F ***hu*** ***+ F*** ***hd*** ***= F*** ***h*** ***(lb)***	**N/A**

Impact Force

The impact force associated with debris impacting a large wood structure can be estimated by the impact force equation.

$$F_i = \frac{w_{debris}}{g} \times \frac{V_{channel}^2}{2 \times \Delta x} \times C_i \times C_o \times C_d \times C_{b\times} R_{max}$$

$w_{debris} = weight\ of\ debris$

$V_{channel} = channel\ approach\ velocity$

$\Delta x = deceleration\ distance$

Coefficients *(see Table 6 and Figures 11, 12 for values)*
$C_i = importance\ ,\ C_o = orientation = 0.8\ , C_d = depth\ , C_b = blockage\ , R_{max} = impluse\ response\ ratio$

Variable	Design Value
W_{debris} (lb)	3,774
$V_{channel}$ (ft/s)	6
Δx (ft)	5
C_i	0.5
C_o	0.8
C_d	1.0
C_b	1.0
R_{max}	0.8

F_i (lb)	**135**

Friction Force

Accounts for the friction force between the LWM and the channel bed. Restraint force from piles is not included as it does not exert a pressure on the LWS / bed interface.

$$F_f = -\mu_{bed} \times \left(F_{LWMs} + F_L + F_{bouldersub} + F_{backfillsub}\right)$$

	Design Value	Units / Source
$\mu_{bed} = coefficient\ of\ bed\ friction = \tan(\theta)$	0.78	unit less
$\theta = internal\ friction\ angle\ (degrees)$	38	Table 5, (Knutson et. al. 2014)

F_f (lb)	**-228,981**	*Negative values resist downstream displacement.*

Lateral Resistance From Piles

Accounts for the lateral resistance provided by piles within the LWM structure. Assumes soil resistance is limiting, i.e. the pile pushes over before it breaks.

$$F_{piles-h} = N_{piles} \times \frac{L_{pile}^3 \times \frac{1}{2} \times (\gamma_s - \gamma_w) \times d_{pile} \times K_p}{h_{load} \times L_{pile}}$$

		Design Values	Units
$N_{pile} = number\ of\ piles$	*assume three-quarters of piles are effective*	10.5	number
$L_{pile} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		15	ft
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$h_{load} = applied\ load\ height\ above\ the\ potential\ scour\ depth$		2.5	ft
$K_p = \frac{1 + \sin\theta}{1 - \sin\theta}$		4.2	unit less

$F_{piles-h}$ (lb)	**-122,910**	*Negative values resist downstream displacement.*

Sliding Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{sliding} = \frac{F_f + F_{piles-h}}{F_d + F_{hu} + F_{hd} + F_i}$$

***FOS** sliding*	**127.9**

Pile Strength Factor of Safety

The factor of safety for the timber bending stress capacity of the pile. This evaluates the potential for the pile(s) to break under load prior to the pile pushing over in the ground.

		Design Values	**Units**
$F_b = Timber\ Bending\ Stress\ Capacity$ per Timber Pile Manual Table 3-1 or AWC NDS Supplement Table 4D		1,200 172,800	psi psf
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$I = circular\ cross-sectional\ moment\ of\ inertia$	$I = \frac{\pi B^4}{4}$	2.24	ft^4
$S = circular\ section\ modulus$	$S = \frac{\pi B^3}{32}$	0.216	ft^3
$C_F = strength\ reduction\ size\ factor$ for diameters greater than 12"	$C_F = \frac{1}{B}^{(1/9)}$	0.971	--
$M_p = applied\ moment\ per\ pile$	$M_p = \frac{(F_d + F_i + F_h) \times h_{load}}{N_{piles}}$	655	ft-lb
$f_b = applied\ pile\ bending\ stress$	$f_b = \frac{M_p}{S}$	3,037	psf
$F_{bx} = Pile\ bending\ stress\ capacity$	$F_{bx} = F_b \times C_F$	1,166 167,835	psi psf

$$FOS_{pile\ stength} = \frac{F_{bx}}{f_b}$$

***FOS** pile strength*	**55.3**

References

Large Woody Material - Risk Based Design Guidelines
M. Knutson, J. Fealko. 2014. *Large Woody Material - Risk Based Design Guidelines.* U.S. Department of the Interior Bureau of Reclamation Pacific Northwest Region & Technical Services. Boise, Idaho. September 2014. Online at: http://www.usbr.gov/pn//fcrps/documents/lwm.pdf

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Nason Floodplain - Large Woody Structure Stability Evaluation

Structural Stability | *6.4*

Structural stability of large woody material placements is evaluated herein using the procedures, formulas, and recommendations provided in the Reclamation's *Large Woody Material - Risk Based Design Guidelines* (Knutson et. al. 2014) along with insight gained from professional experience and general engineering judgment.

Factors of Safety | *6.4.1*

Safety factors for structural stability were selected from *Table 4. Minimum recommended factors of safety* given the site specific public safety and property damage risk levels.

			Criteria:
Public Safety Risk	Moderate	**$FOS_{sliding}$**	1.5
Property Damage Risk	Moderate	**$FOS_{buoyancy}$**	1.75
Stability Design Flow Criteria	50-year	**$FOS_{rotation}$**	1.5

Resistance to Flotation | *6.4.2*

Flotation is typically caused by the buoyant force and the lift force acting on the wood material from water passing over its surface.

Large Wood Material Force

Accounts for the vertical buoyant force of submerged large wood and the vertical weight force of unsubmerged large wood.

$$F_{LWMs} = V_{LWMs} \times (\gamma_{wood} - \gamma_w)$$

$$V_{LWMs} = total\ volume\ of\ submerged\ large\ wood\ material$$

$$V_{LWMs} = \sum N_{LWMi} \times V_{LWMi}$$

Variable	Design Value	Units
$\gamma_{wood} = unit\ weight\ of\ wood$	38	lb/ft^3
$\gamma_w = unit\ weight\ of\ water$	62.4	lb/ft^3
V_{LWMs}	348	ft^3

F_{LWMs} (lb)	**8,482**	*Positive values are upward forces.*

Lift Force

Accounts for the lift force of large wood in flowing water. Not applicable to LWS where the bed will deform around the leading edges.

$$F_L = \frac{C_L \times A_{LWM} \times \gamma_w \times U_o^2}{2 \times g}$$

	Design Value	Units / Notes
$C_L = lift\ coefficient$	0.2	typ. LWM value
$A_{LWM} = area\ of\ large\ woody\ material\ perpendicular\ to\ flow$		
$U_u = upstream\ channel\ velocity\ at\ design\ event$	5	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2

$A_{LWM} = See\ Design\ Plan$

A** $_{LWM}$ **(ft^2)	**70**

For pre-racking condition

F** $_L$ **(lb)	**N/A**

Boulder Ballast Force

Accounts for the ballasting force of large boulders directly attached to or placed over LWM.

$$F_{bouldersub} = N_{bouldersub} \times {}^{\pi}/_{6} \times d_{bouldersub}^3 \times (\gamma_{boulder} - \gamma_w)$$

	Design Value	Units / Notes
$N_{bouldersub} = number\ of\ submerged\ boulders$	0	number
$d_{bouldersub} = effective\ diameter\ of\ submerged\ boulders$	0	ft
$\gamma_{boulder} = unit\ weight\ of\ boulders$	165	lb/ft^3

F** $_{bouldersub}$ **(lb)	**N/A**

Backfill Ballast Force

Accounts for the ballasting force of backfill placed directly over LWM members. Volume is based on the fill area over the log(s) and a the effective cover depth shown on the Drawings.

$$F_{backfillsub} = V_{backfillsub} \times (\gamma_s - \gamma_w)$$

	Design Value	Units / Notes
$V_{backfillsub} = volume\ of\ backfill\ over\ LWM\ members$	1,125	ft^3
	See design plans	
$\gamma_s = unit\ weight\ of\ backfill\ material$	110	lb/ft^3

F** $_{backfillsub}$ **(lb)	**-53,550**

Pile Skin Friction

Accounts for the vertical resistance provided by piles within the LWM structure. USBR document equation modified by Inter-Fluve to match industry pile design standard formulations.

$$F_{piles-v} = N_{piles} \times \pi \times d_{piles} \times L_{piles} \times \left(k_s \times \tan\tfrac{2}{3}\theta \times \sigma'\right)$$

	Note	Design Values	Units
$N_{piles} = number\ of\ piles$	*Assume three-quarters of piles are effective*	6.75	number
$L_{piles} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		12	ft
$d_{piles} = nominal\ diameter\ of\ the\ piles$		1.30	ft
$\sigma' = \left(L_{piles} \times (\gamma_{sat} - \gamma_w)\right)/2$		285.6	lb/ft^2
$K_s = coefficient\ of\ lateral\ earth\ pressure\ (0.5\ to\ 1.0)$		1.0	unit less
$\theta = internal\ friction\ angle\ of\ soils$		36	deg.

$F_{piles-v}$ (lb)	**-42,065**	*Negative values resist upward displacement.*

Piles Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bPiles} = \frac{F_{piles-v}}{F_{LWMs}+F_L}$$

FOS $_b$ **5.0**

Note this value does not include the backfill assuming it's all lost but the piles are holding.

Backfill Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bBackfill} = \frac{F_{backfillsub}}{F_{LWMs}+F_L}$$

FOS $_b$ **6.3**

Note this value does not include the piles.

Net Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bNet} = \frac{F_{backfillsub}+F_{piles-v}}{F_{LWMs}+F_L}$$

FOS $_b$ **11.3**

Note this value includes the piles and backfill.

Resistance to Sliding | *6.4.3*

LWM structures are also susceptible to failure through sliding.

Drag Force

LWM structures are pushed downstream by the fluid drag forces acting upon the wood by the flowing water.

$$F_d = \frac{C_D \times A_{LWM} \times \gamma_w \times U_c^2}{2 \times g}$$

	Design Value	Units / Notes
$C_D = drag\ coefficient$	1	Per Equations 23 and 24
$A_{LWM} = area\ of\ wetted\ wood\ normal\ to\ the\ flow\ direction$		
$U_c = velocity\ adjacent\ to\ the\ LWM\ structure$	5	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2
F_d (lb)	**1,696**	

$A_{LWM} = See\ Design\ Plan$

A_{LWM} (ft^2)	70

Velocity value is conservative for all LWS locations. Value from 100-yr event 2D model results for main channel.

Hydrostatic Force

Hydrostatic forces act on the upstream and downstream faces of a LWM structure. They account for differences in the upstream and downstream water depths against the structure.

$$F_{hu} = \tfrac{1}{2} \times \gamma_w \times Y_u \times A_u \qquad F_{hd} = \tfrac{1}{2} \times \gamma_w \times Y_d \times A_d$$

F_{hu} , F_{hd} = hydrostatic force on upstream and downstream side of the wood structure

Y_u , Y_d = water depth upstream and downstream of the structue

A_u , A_d = area projected to flow direction on the upstream and downstream of the structure

Variable	Design Value
Y_u (ft)	4
A_u (ft^2)	70
Post racking area	
Y_d (ft)	4
A_d (ft^2)	70
Plan downstream area	

$F_{hu} + F_{hd} = F_h$ (lb)	**N/A**

Impact Force

The impact force associated with debris impacting a large wood structure can be estimated by the impact force equation.

$$F_i = \frac{w_{debris}}{g} \times \frac{V_{channel}{}^2}{2 \times \Delta x} \times C_i \times C_o \times C_d \times C_{b\times} R_{max}$$

$w_{debris} = weight\ of\ debris$

$V_{channel} = channel\ approach\ velocity$

$\Delta x = deceleration\ distance$

Coefficients *(see Table 6 and Figures 11, 12 for values)*

$C_i = importance,\ C_o = orientation = 0.8,\ C_d = depth,\ C_b = blockage,\ R_{max} = implﾭuse\ response\ ratio$

Variable	Design Value
W_{debris} (lb)	3,774
$V_{channel}$ (ft/s)	5
Δx (ft)	5
C_i	0.5
C_o	0.8
C_d	1.0
C_b	1.0
R_{max}	0.8

F_i (lb)	**94**

Friction Force

Accounts for the friction force between the LWM and the channel bed. Restraint force from piles is not included as it does not exert a pressure on the LWS / bed interface.

$$F_f = -\mu_{bed} \times (F_{LWMs} + F_L + F_{bouldersub} + F_{backfillsub})$$

	Design Value	Units / Source
$\mu_{bed} = coefficient\ of\ bed\ friction = \tan(\theta)$	0.78	unit less
$\theta = internal\ friction\ angle\ (degrees)$	38	Table 5, (Knutson et. al. 2014)

F_f (lb)	**-35,211**	*Negative values resist downstream displacement.*

Lateral Resistance From Piles

Accounts for the lateral resistance provided by piles within the LWM structure. Assumes soil resistance is limiting, i.e. the pile pushes over before it breaks.

$$F_{piles-h} = N_{piles} \times \frac{L_{pile}^3 \times \frac{1}{2} \times (\gamma_s - \gamma_w) \times d_{pile} \times K_p}{h_{load} \times L_{pile}}$$

		Design Values	Units
$N_{pile} = number\ of\ piles$	*assume three-quarters of piles are effective*	6.75	number
$L_{pile} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		12	ft
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$h_{load} = applied\ load\ height\ above\ the\ potential\ scour\ depth$		2.5	ft
$K_p = \frac{1 + \sin\theta}{1 - \sin\theta}$		4.2	unit less

$F_{piles-h}$ (lb)	**-50,569**	*Negative values resist downstream displacement.*

Sliding Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{sliding} = \frac{F_f + F_{piles-h}}{F_d + F_{hu} + F_{hd} + F_i}$$

***FOS** sliding* **47.9**

Pile Strength Factor of Safety

The factor of safety for the timber bending stress capacity of the pile. This evaluates the potential for the pile(s) to break under load prior to the pile pushing over in the ground.

		Design Values	Units
$F_b = Timber\ Bending\ Stress\ Capacity$ per Timber Pile Manual Table 3-1 or AWC NDS Supplement Table 4D		1,200 172,800	psi psf
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$I = circular\ cross-sectional\ moment\ of\ inertia$	$I = \frac{\pi\, B^4}{4}$	2.24	ft^4
$S = circular\ section\ modulus$	$S = \frac{\pi\, B^3}{32}$	0.216	ft^3
$C_F = strength\ reduction\ size\ factor$ for diameters greater than 12"	$C_F = \frac{1}{B}^{(1/9)}$	0.971	--
$M_p = applied\ moment\ per\ pile$	$M_p = \frac{(F_d + F_i + F_h) \times h_{load}}{N_{piles}}$	663	ft-lb
$f_b = applied\ pile\ bending\ stress$	$f_b = \frac{M_p}{S}$	3,073	psf
$F_{bx} = Pile\ bending\ stress\ capacity$	$F_{bx} = F_b \times C_F$	1,166 167,835	psi psf

$$FOS_{pile\ stength} = \frac{F_{bx}}{f_b}$$

***FOS** pile strength* **54.6**

References

Large Woody Material - Risk Based Design Guidelines
M. Knutson, J. Fealko. 2014. *Large Woody Material - Risk Based Design Guidelines.* U.S. Department of the Interior Bureau of Reclamation Pacific Northwest Region & Technical Services. Boise, Idaho. September 2014. Online at: http://www.usbr.gov/pn//fcrps/documents/lwm.pdf

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Timber Pile Design and Construction Manual, Timber Piling Council, 2015.

American Wood Council (2018) National Design Specifications for Wood Construction, Design Supplement.

Nason Floodplain - Large Woody Structure Stability Evaluation

Structural Stability | *6.4*

Structural stability of large woody material placements is evaluated herein using the procedures, formulas, and recommendations provided in the Reclamation's *Large Woody Material - Risk Based Design Guidelines* (Knutson et. al. 2014) along with insight gained from professional experience and general engineering judgment.

Factors of Safety | *6.4.1*

Safety factors for structural stability were selected from *Table 4. Minimum recommended factors of safety* given the site specific public safety and property damage risk levels.

			Criteria:
Public Safety Risk	Moderate	$FOS_{sliding}$	1.5
Property Damage Risk	Moderate	$FOS_{buoyancy}$	1.75
Stability Design Flow Criteria	50-year	$FOS_{rotation}$	1.5

Resistance to Flotation | *6.4.2*

Flotation is typically caused by the buoyant force and the lift force acting on the wood material from water passing over its surface.

Large Wood Material Force

Accounts for the vertical buoyant force of submerged large wood and the vertical weight force of unsubmerged large wood.

$$F_{LWMs} = V_{LWMs} \times (\gamma_{wood} - \gamma_w)$$

$$V_{LWMs} = total\ volume\ of\ submerged\ large\ wood\ material$$

$$V_{LWMs} = \sum N_{LWMi} \times V_{LWMi}$$

Variable	Design Value	Units
$\gamma_{wood} = unit\ weight\ of\ wood$	38	lb/ft^3
$\gamma_w = unit\ weight\ of\ water$	62.4	lb/ft^3
V_{LWMs}	1115	ft^3

F_{LWMs} (lb)	**27,206**	*Positive values are upward forces.*

Lift Force

Accounts for the lift force of large wood in flowing water. Not applicable to LWS where the bed will deform around the leading edges.

$$F_L = \frac{C_L \times A_{LWM} \times \gamma_w \times U_o^2}{2 \times g}$$

	Design Value	Units / Notes
$C_L = lift\ coefficient$	0.2	typ. LWM value
$A_{LWM} = area\ of\ large\ woody\ material\ perpendicular\ to\ flow$		
$U_u = upstream\ channel\ velocity\ at\ design\ event$	8	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2

$A_{LWM} = See\ Design\ Plan$

A_{LWM} (ft^2)	**120**

For pre-racking condition

F_L (lb)	**N/A**

Boulder Ballast Force

Accounts for the ballasting force of large boulders directly attached to or placed over LWM.

$$F_{bouldersub} = N_{bouldersub} \times {}^{\pi}/_{6} \times d_{bouldersub}^3 \times (\gamma_{boulder} - \gamma_w)$$

	Design Value	Units / Notes
$N_{bouldersub} = number\ of\ submerged\ boulders$	0	number
$d_{bouldersub} = effective\ diameter\ of\ submerged\ boulders$	0	ft
$\gamma_{boulder} = unit\ weight\ of\ boulders$	165	lb/ft^3

$F_{bouldersub}$ (lb)	**N/A**

Backfill Ballast Force

Accounts for the ballasting force of backfill placed directly over LWM members. Volume is based on the fill area over the log(s) and a the effective cover depth shown on the Drawings.

$$F_{backfillsub} = V_{backfillsub} \times (\gamma_s - \gamma_w)$$

	Design Value	Units / Notes
$V_{backfillsub} = volume\ of\ backfill\ over\ LWM\ members$	5,910	ft^3
	See design plans	
$\gamma_s = unit\ weight\ of\ backfill\ material$	110	lb/ft^3

$F_{backfillsub}$ (lb)	**-281,316**

Pile Skin Friction

Accounts for the vertical resistance provided by piles within the LWM structure. USBR document equation modified by Inter-Fluve to match industry pile design standard formulations.

$$F_{piles-v} = N_{piles} \times \pi \times d_{piles} \times L_{piles} \times \left(k_s \times \tan\tfrac{2}{3}\theta \times \sigma'\right)$$

		Design Values	Units
$N_{piles} = number\ of\ piles$	*Assume three-quarters of piles are effective*	4.5	number
$L_{piles} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		12	ft
$d_{piles} = nominal\ diameter\ of\ the\ piles$		1.30	ft
$\sigma' = \left(L_{piles} \times (\gamma_{sat} - \gamma_w)\right)/2$		285.6	lb/ft^2
$K_s = coefficient\ of\ lateral\ earth\ pressure\ (0.5\ to\ 1.0)$		1.0	unit less
$\theta = internal\ friction\ angle\ of\ soils$		36	deg.

$F_{piles-v}$ (lb)	**-28,043**

Negative values resist upward displacement.

Piles Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bPiles} = \frac{F_{piles-v}}{F_{LWMs} + F_L}$$

FOS_b **1.0**

Note this value does not include the backfill assuming it's all lost but the piles are holding.

Backfill Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bBackfill} = \frac{F_{backfillsub}}{F_{LWMs} + F_L}$$

FOS_b **10.3**

Note this value does not include the piles.

Net Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bNet} = \frac{F_{backfillsub} + F_{piles-v}}{F_{LWMs} + F_L}$$

FOS_b **11.4**

Note this value includes the piles and backfill.

Resistance to Sliding | *6.4.3*

LWM structures are also susceptible to failure through sliding.

Drag Force

LWM structures are pushed downstream by the fluid drag forces acting upon the wood by the flowing water.

$$F_d = \frac{C_D \times A_{LWM} \times \gamma_w \times U_c^2}{2 \times g}$$

	Design Value	Units / Notes
$C_D = drag\ coefficient$	1	Per Equations 23 and 24
$A_{LWM} = area\ of\ wetted\ wood\ normal\ to\ the\ flow\ direction$		
$U_c = velocity\ adjacent\ to\ the\ LWM\ structure$	8	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2
F_d (lb)	**7,441**	

$A_{LWM} = See\ Design\ Plan$

A_{LWM} (ft^2)	120

Velocity value is conservative for all LWS locations. Value from 100-yr event 2D model results for main channel.

Hydrostatic Force

Hydrostatic forces act on the upstream and downstream faces of a LWM structure. They account for differences in the upstream and downstream water depths against the structure.

$F_{hu} = \frac{1}{2} \times \gamma_w \times Y_u \times A_u$ $\quad$ $F_{hd} = \frac{1}{2} \times \gamma_w \times Y_d \times A_d$

$F_{hu}\ ,\ F_{hd} = hydrostatic\ force\ on\ upstream\ and\ downstream\ side\ of\ the\ wood\ structure$

$Y_u\ ,\ Y_d = water\ depth\ upstream\ and\ downstream\ of\ the\ structue$

$A_u\ ,\ A_d = area\ projected\ to\ flow\ direction\ on\ the\ upstream\ and\ downstream\ of\ the\ structure$

Variable	Design Value
Y_u (ft)	7
A_u (ft^2)	120
Post racking area	
Y_d (ft)	7
A_d (ft^2)	120
Plan downstream area	

$F_{hu} + F_{hd} = F_h$ (lb)	**N/A**

Impact Force

The impact force associated with debris impacting a large wood structure can be estimated by the impact force equation.

$$F_i = \frac{w_{debris}}{g} \times \frac{V_{channel}{}^{\wedge}2}{2 \times \Delta x} \times C_i \times C_o \times C_d \times C_{b\times} R_{max}$$

$w_{debris} = weight\ of\ debris$

$V_{channel} = channel\ approach\ velocity$

$\Delta x = deceleration\ distance$

Coefficients *(see Table 6 and Figures 11, 12 for values)*
$C_i = importance\ ,\ C_o = orientation = 0.8\ , C_d = depth\ , C_b = blockage\ , R_{max} = impluse\ response\ ratio$

Variable	Design Value
W_{debris} (lb)	3,774
$V_{channel}$ (ft/s)	8
Δx (ft)	5
C_i	0.5
C_o	0.8
C_d	1.0
C_b	1.0
R_{max}	0.8

F_i (lb)	**240**

Friction Force

Accounts for the friction force between the LWM and the channel bed. Restraint force from piles is not included as it does not exert a pressure on the LWS / bed interface.

$$F_f = -\mu_{bed} \times (F_{LWMs} + F_L + F_{bouldersub} + F_{backfillsub})$$

	Design Value	Units / Source
$\mu_{bed} = coefficient\ of\ bed\ friction = tan(\theta)$	0.78	unit less
$\theta = internal\ friction\ angle\ (degrees)$	38	Table 5, (Knutson et. al. 2014)

F_f (lb)	**-198,533**	*Negative values resist downstream displacement.*

Lateral Resistance From Piles

Accounts for the lateral resistance provided by piles within the LWM structure. Assumes soil resistance is limiting, i.e. the pile pushes over before it breaks.

$$F_{piles-h} = N_{piles} \times \frac{L_{pile}^3 \times \frac{1}{2} \times (\gamma_s - \gamma_w) \times d_{pile} \times K_p}{h_{load} \times L_{pile}}$$

		Design Values	Units
$N_{pile} = number\ of\ piles$	*assume three-quarters of piles are effective*	4.5	number
$L_{pile} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		12	ft
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$h_{load} = applied\ load\ height\ above\ the\ potential\ scour\ depth$		2.5	ft
$K_p = \frac{1 + \sin\theta}{1 - \sin\theta}$		4.2	unit less

$F_{piles-h}$ (lb)	**-33,713**	*Negative values resist downstream displacement.*

Sliding Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{sliding} = \frac{F_f + F_{piles-h}}{F_d + F_{hu} + F_{hd} + F_i}$$

***FOS** sliding* **30.2**

Pile Strength Factor of Safety

The factor of safety for the timber bending stress capacity of the pile. This evaluates the potential for the pile(s) to break under load prior to the pile pushing over in the ground.

		Design Values	Units
$F_b = Timber\ Bending\ Stress\ Capacity$ per Timber Pile Manual Table 3-1 or AWC NDS Supplement Table 4D		1,200 172,800	psi psf
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$I = circular\ cross - sectional\ moment\ of\ inertia$	$I = \frac{\pi B^4}{4}$	2.24	ft^4
$S = circular\ section\ modulus$	$S = \frac{\pi B^3}{32}$	0.216	ft^3
$C_F = strength\ reduction\ size\ factor$ for diameters greater than 12"	$C_F = \frac{1}{B}^{(1/9)}$	0.971	--
$M_p = applied\ moment\ per\ pile$	$M_p = \frac{(F_d + F_i + F_h) \times h_{load}}{N_{piles}}$	4,268	ft-lb
$f_b = applied\ pile\ bending\ stress$	$f_b = \frac{M_p}{S}$	19,785	psf
$F_{bx} = Pile\ bending\ stress\ capacity$	$F_{bx} = F_b \times C_F$	1,166 167,835	psi psf

$$FOS_{pile\ stength} = \frac{F_{bx}}{f_b}$$

***FOS** pile strength* **8.5**

References

Large Woody Material - Risk Based Design Guidelines
M. Knutson, J. Fealko. 2014. *Large Woody Material - Risk Based Design Guidelines.* U.S. Department of the Interior Bureau of Reclamation Pacific Northwest Region & Technical Services. Boise, Idaho. September 2014. Online at: http://www.usbr.gov/pn//fcrps/documents/lwm.pdf

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American Wood Council (2018) National Design Specifications for Wood Construction, Design Supplement.

Nason Floodplain - Large Woody Structure Stability Evaluation

Structural Stability | *6.4*

Structural stability of large woody material placements is evaluated herein using the procedures, formulas, and recommendations provided in the Reclamation's *Large Woody Material - Risk Based Design Guidelines* (Knutson et. al. 2014) along with insight gained from professional experience and general engineering judgment.

Factors of Safety | *6.4.1*

Safety factors for structural stability were selected from *Table 4. Minimum recommended factors of safety* given the site specific public safety and property damage risk levels.

			Criteria:
Public Safety Risk	Moderate	$\mathbf{FOS}_{sliding}$	1.5
Property Damage Risk	Moderate	$\mathbf{FOS}_{buoyancy}$	1.75
Stability Design Flow Criteria	50-year	$\mathbf{FOS}_{rotation}$	1.5

Resistance to Flotation | *6.4.2*

Flotation is typically caused by the buoyant force and the lift force acting on the wood material from water passing over its surface.

Large Wood Material Force

Accounts for the vertical buoyant force of submerged large wood and the vertical weight force of unsubmerged large wood.

$$F_{LWMs} = V_{LWMs} \times (\gamma_{wood} - \gamma_w)$$

$$V_{LWMs} = total\ volume\ of\ submerged\ large\ wood\ material$$

$$V_{LWMs} = \sum N_{LWMi} \times V_{LWMi}$$

Variable	Design Value	Units
$\gamma_{wood} = unit\ weight\ of\ wood$	38	lb/ft^3
$\gamma_w = unit\ weight\ of\ water$	62.4	lb/ft^3
V_{LWMs}	831	ft^3

F_{LWMs} (lb)	**20,265**	*Positive values are upward forces.*

Lift Force

Accounts for the lift force of large wood in flowing water. Not applicable to LWS where the bed will deform around the leading edges.

$$F_L = \frac{C_L \times A_{LWM} \times \gamma_w \times U_o^2}{2 \times g}$$

	Design Value	Units / Notes
$C_L = lift\ coefficient$	0.2	typ. LWM value
$A_{LWM} = area\ of\ large\ woody\ material\ perpendicular\ to\ flow$		
$U_u = upstream\ channel\ velocity\ at\ design\ event$	3	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2

$A_{LWM} = See\ Design\ Plan$

A $_{LWM}$ (ft^2)	**140**

For pre-racking condition

F $_L$ (lb)	**N/A**

Boulder Ballast Force

Accounts for the ballasting force of large boulders directly attached to or placed over LWM.

$$F_{bouldersub} = N_{bouldersub} \times \pi/6 \times d_{bouldersub}^3 \times (\gamma_{boulder} - \gamma_w)$$

	Design Value	Units / Notes
$N_{bouldersub} = number\ of\ submerged\ boulders$	0	number
$d_{bouldersub} = effective\ diameter\ of\ submerged\ boulders$	0	ft
$\gamma_{boulder} = unit\ weight\ of\ boulders$	165	lb/ft^3

F $_{bouldersub}$ (lb)	**N/A**

Backfill Ballast Force

Accounts for the ballasting force of backfill placed directly over LWM members. Volume is based on the fill area over the log(s) and a the effective cover depth shown on the Drawings.

$$F_{backfillsub} = V_{backfillsub} \times (\gamma_s - \gamma_w)$$

	Design Value	Units / Notes
$V_{backfillsub} = volume\ of\ backfill\ over\ LWM\ members$	1,125	ft^3
	See design plans	
$\gamma_s = unit\ weight\ of\ backfill\ material$	110	lb/ft^3

F $_{backfillsub}$ (lb)	**-53,550**

Pile Skin Friction

Accounts for the vertical resistance provided by piles within the LWM structure. USBR document equation modified by Inter-Fluve to match industry pile design standard formulations.

$$F_{piles-v} = N_{piles} \times \pi \times d_{piles} \times L_{piles} \times \left(k_s \times \tan\tfrac{2}{3}\theta \times \sigma'\right)$$

		Design Values	Units
$N_{piles} = number\ of\ piles$	*Assume three-quarters of piles are effective*	6	number
$L_{piles} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		8	ft
$d_{piles} = nominal\ diameter\ of\ the\ piles$		1.30	ft
$\sigma' = \left(L_{piles} \times (\gamma_{sat} - \gamma_w)\right)/2$		190.4	lb/ft^2
$K_s = coefficient\ of\ lateral\ earth\ pressure\ (0.5\ to\ 1.0)$		1.0	unit less
$\theta = internal\ friction\ angle\ of\ soils$		36	deg.

F** **piles-v** **(lb)	**-16,618**

Negative values resist upward displacement.

Piles Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bPiles} = \frac{F_{piles-v}}{F_{LWMs} + F_L}$$

FOS b **0.8**

Note this value does not include the backfill assuming it's all lost but the piles are holding.

Backfill Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bBackfill} = \frac{F_{backfillsub}}{F_{LWMs} + F_L}$$

FOS b **2.6**

Note this value does not include the piles.

Net Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bNet} = \frac{F_{backfillsub} + F_{piles-v}}{F_{LWMs} + F_L}$$

FOS b **3.5**

Note this value includes the piles and backfill.

Resistance to Sliding | *6.4.3*

LWM structures are also susceptible to failure through sliding.

Drag Force

LWM structures are pushed downstream by the fluid drag forces acting upon the wood by the flowing water.

$$F_d = \frac{C_D \times A_{LWM} \times \gamma_w \times U_c^2}{2 \times g}$$

	Design Value	Units / Notes
$C_D = drag\ coefficient$	1	Per Equations 23 and 24
$A_{LWM} = area\ of\ wetted\ wood\ normal\ to\ the\ flow\ direction$		
$U_c = velocity\ adjacent\ to\ the\ LWM\ structure$	3	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2
F_d (lb)	**1,221**	

$A_{LWM} = See\ Design\ Plan$

A_{LWM} (ft^2)	140

Velocity value is conservative for all LWS locations. Value from 100-yr event 2D model results for main channel.

Hydrostatic Force

Hydrostatic forces act on the upstream and downstream faces of a LWM structure. They account for differences in the upstream and downstream water depths against the structure.

$$F_{hu} = \tfrac{1}{2} \times \gamma_w \times Y_u \times A_u \qquad F_{hd} = \tfrac{1}{2} \times \gamma_w \times Y_d \times A_d$$

F_{hu} , $F_{hd} = hydrostatic\ force\ on\ upstream\ and\ downstream\ side\ of\ the\ wood\ structure$

Y_u , $Y_d = water\ depth\ upstream\ and\ downstream\ of\ the\ structue$

A_u , $A_d = area\ projected\ to\ flow\ direction\ on\ the\ upstream\ and\ downstream\ of\ the\ structure$

Variable	Design Value
Y_u (ft)	4.5
A_u (ft^2)	140
Post racking area	
Y_d (ft)	4.5
A_d (ft^2)	140
Plan downstream area	

$F_{hu} + F_{hd} = F_h$ (lb)	**N/A**

Impact Force

The impact force associated with debris impacting a large wood structure can be estimated by the impact force equation.

$$F_i = \frac{w_{debris}}{g} \times \frac{V_{channel}{}^2}{2 \times \Delta x} \times C_i \times C_o \times C_d \times C_{b\times} R_{max}$$

$w_{debris} = weight\ of\ debris$

$V_{channel} = channel\ approach\ velocity$

$\Delta x = deceleration\ distance$

Coefficients *(see Table 6 and Figures 11, 12 for values)*

$C_i = importance\ ,\ C_o = orientation = 0.8\ , C_d = depth\ , C_b = blockage\ , R_{max} = impluse\ response\ ratio$

Variable	Design Value
W_{debris} (lb)	3,774
$V_{channel}$ (ft/s)	3
Δx (ft)	5
C_i	0.5
C_o	0.8
C_d	1.0
C_b	1.0
R_{max}	0.8

F_i (lb)	**34**

Friction Force

Accounts for the friction force between the LWM and the channel bed. Restraint force from piles is not included as it does not exert a pressure on the LWS / bed interface.

$$F_f = -\mu_{bed} \times (F_{LWMs} + F_L + F_{bouldersub} + F_{backfillsub})$$

	Design Value	Units / Source
$\mu_{bed} = coefficient\ of\ bed\ friction = \tan(\theta)$	0.78	unit less
$\theta = internal\ friction\ angle\ (degrees)$	38	Table 5, (Knutson et. al. 2014)

F_f (lb)	**-26,005**	*Negative values resist downstream displacement.*

Lateral Resistance From Piles

Accounts for the lateral resistance provided by piles within the LWM structure. Assumes soil resistance is limiting, i.e. the pile pushes over before it breaks.

$$F_{piles-h} = N_{piles} \times \frac{L_{pile}^3 \times \frac{1}{2} \times (\gamma_s - \gamma_w) \times d_{pile} \times K_p}{h_{load} \times L_{pile}}$$

		Design Values	Units
$N_{pile} = number\ of\ piles$	*assume three-quarters of piles are effective*	6	number
$L_{pile} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		8	ft
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$h_{load} = applied\ load\ height\ above\ the\ potential\ scour\ depth$		2.5	ft
$K_p = \frac{1 + \sin\theta}{1 - \sin\theta}$		4.2	unit less

$F_{piles-h}$ (lb)	**-19,978**	*Negative values resist downstream displacement.*

Sliding Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{sliding} = \frac{F_f + F_{piles-h}}{F_d + F_{hu} + F_{hd} + F_i}$$

***FOS** sliding* **36.7**

Pile Strength Factor of Safety

The factor of safety for the timber bending stress capacity of the pile. This evaluates the potential for the pile(s) to break under load prior to the pile pushing over in the ground.

		Design Values	Units
$F_b = Timber\ Bending\ Stress\ Capacity$ per Timber Pile Manual Table 3-1 or AWC NDS Supplement Table 4D		1,200 172,800	psi psf
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$I = circular\ cross-sectional\ moment\ of\ inertia$	$I = \frac{\pi B^4}{4}$	2.24	ft^4
$S = circular\ section\ modulus$	$S = \frac{\pi B^3}{32}$	0.216	ft^3
$C_F = strength\ reduction\ size\ factor$ for diameters greater than 12"	$C_F = \frac{1}{B}^{(1/9)}$	0.971	--
$M_p = applied\ moment\ per\ pile$	$M_p = \frac{(F_d + F_i + F_h) \times h_{load}}{N_{piles}}$	523	ft-lb
$f_b = applied\ pile\ bending\ stress$	$f_b = \frac{M_p}{S}$	2,424	psf
$F_{bx} = Pile\ bending\ stress\ capacity$	$F_{bx} = F_b \times C_F$	1,166 167,835	psi psf

$$FOS_{pile\ stength} = \frac{F_{bx}}{f_b}$$

***FOS** pile strength* **69.2**

References

Large Woody Material - Risk Based Design Guidelines
M. Knutson, J. Fealko. 2014. *Large Woody Material - Risk Based Design Guidelines.* U.S. Department of the Interior Bureau of Reclamation Pacific Northwest Region & Technical Services. Boise, Idaho. September 2014. Online at: http://www.usbr.gov/pn//fcrps/documents/lwm.pdf

ASTM D25. Allowable Stress Values for Treated Round Timber Piles.

Timber Pile Design and Construction Manual, Timber Piling Council, 2015.

American Wood Council (2018) National Design Specifications for Wood Construction, Design Supplement.

Nason Floodplain - Large Woody Structure Stability Evaluation

Structural Stability | *6.4*

Structural stability of large woody material placements is evaluated herein using the procedures, formulas, and recommendations provided in the Reclamation's *Large Woody Material - Risk Based Design Guidelines* (Knutson et. al. 2014) along with insight gained from professional experience and general engineering judgment.

Factors of Safety | *6.4.1*

Safety factors for structural stability were selected from *Table 4. Minimum recommended factors of safety* given the site specific public safety and property damage risk levels.

			Criteria:
Public Safety Risk	Moderate	$\mathbf{FOS}_{sliding}$	1.5
Property Damage Risk	Moderate	$\mathbf{FOS}_{buoyancy}$	1.75
Stability Design Flow Criteria	50-year	$\mathbf{FOS}_{rotation}$	1.5

Resistance to Flotation | *6.4.2*

Flotation is typically caused by the buoyant force and the lift force acting on the wood material from water passing over its surface.

Large Wood Material Force

Accounts for the vertical buoyant force of submerged large wood and the vertical weight force of unsubmerged large wood.

$$F_{LWMs} = V_{LWMs} \times (\gamma_{wood} - \gamma_w)$$

$$V_{LWMs} = total\ volume\ of\ submerged\ large\ wood\ material$$

$$V_{LWMs} = \sum N_{LWMi} \times V_{LWMi}$$

Variable	Design Value	Units
$\gamma_{wood} = unit\ weight\ of\ wood$	38	lb/ft^3
$\gamma_w = unit\ weight\ of\ water$	62.4	lb/ft^3
V_{LWMs}	231	ft^3

F** $_{LWMs}$ **(lb)	**5,642**

Positive values are upward forces.

Lift Force

Accounts for the lift force of large wood in flowing water. Not applicable to LWS where the bed will deform around the leading edges.

$$F_L = \frac{C_L \times A_{LWM} \times \gamma_w \times U_o^2}{2 \times g}$$

	Design Value	Units / Notes
$C_L = lift\ coefficient$	0.2	typ. LWM value
$A_{LWM} = area\ of\ large\ woody\ material\ perpendicular\ to\ flow$		
$U_u = upstream\ channel\ velocity\ at\ design\ event$	3	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2

$A_{LWM} = See\ Design\ Plan$

A_{LWM} (ft^2)	**20**

For pre-racking condition

F_L (lb)	**N/A**

Boulder Ballast Force

Accounts for the ballasting force of large boulders directly attached to or placed over LWM.

$$F_{bouldersub} = N_{bouldersub} \times {}^{\pi}/_{6} \times d_{bouldersub}^3 \times (\gamma_{boulder} - \gamma_w)$$

	Design Value	Units / Notes
$N_{bouldersub} = number\ of\ submerged\ boulders$	0	number
$d_{bouldersub} = effective\ diameter\ of\ submerged\ boulders$	0	ft
$\gamma_{boulder} = unit\ weight\ of\ boulders$	165	lb/ft^3

$F_{bouldersub}$ (lb)	**N/A**

Backfill Ballast Force

Accounts for the ballasting force of backfill placed directly over LWM members. Volume is based on the fill area over the log(s) and a the effective cover depth shown on the Drawings.

$$F_{backfillsub} = V_{backfillsub} \times (\gamma_s - \gamma_w)$$

	Design Value	Units / Notes
$V_{backfillsub} = volume\ of\ backfill\ over\ LWM\ members$	450	ft^3
	See design plans	
$\gamma_s = unit\ weight\ of\ backfill\ material$	110	lb/ft^3

$F_{backfillsub}$ (lb)	**-21,420**

Pile Skin Friction

Accounts for the vertical resistance provided by piles within the LWM structure. USBR document equation modified by Inter-Fluve to match industry pile design standard formulations.

$$F_{piles-v} = N_{piles} \times \pi \times d_{piles} \times L_{piles} \times \left(k_s \times \tan\tfrac{2}{3}\theta \times \sigma'\right)$$

		Design Values	Units
$N_{piles} = number\ of\ piles$	*Assume three-quarters of piles are effective*	0.75	number
$L_{piles} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		8	ft
$d_{piles} = nominal\ diameter\ of\ the\ piles$		1.30	ft
$\sigma' = \left(L_{piles} \times (\gamma_{sat} - \gamma_w)\right)/2$		190.4	lb/ft^2
$K_s = coefficient\ of\ lateral\ earth\ pressure\ (0.5\ to\ 1.0)$		1.0	unit less
$\theta = internal\ friction\ angle\ of\ soils$		36	deg.

$F_{piles-v}$ **(lb)**	**-2,077**	*Negative values resist upward displacement.*

Piles Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bPiles} = \frac{F_{piles-v}}{F_{LWMs}+F_L}$$

FOS_b 0.4

Note this value does not include the backfill assuming it's all lost but the piles are holding.

Backfill Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bBackfill} = \frac{F_{backfillsub}}{F_{LWMs}+F_L}$$

FOS_b 3.8

Note this value does not include the piles.

Net Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bNet} = \frac{F_{backfillsub}+F_{piles-v}}{F_{LWMs}+F_L}$$

FOS_b 4.2

Note this value includes the piles and backfill.

Resistance to Sliding | *6.4.3*

LWM structures are also susceptible to failure through sliding.

Drag Force

LWM structures are pushed downstream by the fluid drag forces acting upon the wood by the flowing water.

$$F_d = \frac{C_D \times A_{LWM} \times \gamma_w \times U_c^2}{2 \times g}$$

	Design Value	Units / Notes
$C_D = drag\ coefficient$	1	Per Equations 23 and 24
$A_{LWM} = area\ of\ wetted\ wood\ normal\ to\ the\ flow\ direction$		
$U_c = velocity\ adjacent\ to\ the\ LWM\ structure$	3	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2

$A_{LWM} = See\ Design\ Plan$

A $_{LWM}$ ***(ft*** ^{2} ***)***	20

Velocity value is conservative for all LWS locations. Value from 100-yr event 2D model results for main channel.

F $_d$ ***(lb)***	**174**

Hydrostatic Force

Hydrostatic forces act on the upstream and downstream faces of a LWM structure. They account for differences in the upstream and downstream water depths against the structure.

$$F_{hu} = \tfrac{1}{2} \times \gamma_w \times Y_u \times A_u \qquad F_{hd} = \tfrac{1}{2} \times \gamma_w \times Y_d \times A_d$$

F_{hu} , F_{hd} = *hydrostatic force on upstream and downstream side of the wood structure*

Y_u , Y_d = *water depth upstream and downstream of the structue*

A_u , A_d = *area projected to flow direction on the upstream and downstream of the structure*

Variable	Design Value
Y_u (ft)	4.5
A_u (ft^2)	20
Post racking area	
Y_d (ft)	4.5
A_d (ft^2)	20
Plan downstream area	

F $_{hu}$ ***+ F*** $_{hd}$ ***= F*** $_h$ ***(lb)***	**N/A**

Impact Force

The impact force associated with debris impacting a large wood structure can be estimated by the impact force equation.

$$F_i = \frac{w_{debris}}{g} \times \frac{V_{channel}{}^\wedge 2}{2 \times \Delta x} \times C_i \times C_o \times C_d \times C_{b\times} R_{max}$$

$w_{debris} = weight\ of\ debris$

$V_{channel} = channel\ approach\ velocity$

$\Delta x = deceleration\ distance$

Coefficients *(see Table 6 and Figures 11, 12 for values)*
$C_i = importance\ ,\ C_o = orientation = 0.8\ , C_d = depth\ , C_b = blockage\ , R_{max} = impluse\ response\ ratio$

Variable	Design Value
W_{debris} (lb)	3,774
$V_{channel}$ (ft/s)	3
Δx (ft)	5
C_i	0.5
C_o	0.8
C_d	1.0
C_b	1.0
R_{max}	0.8

F_i (lb)	**34**

Friction Force

Accounts for the friction force between the LWM and the channel bed. Restraint force from piles is not included as it does not exert a pressure on the LWS / bed interface.

$$F_f = -\mu_{bed} \times (F_{LWMs} + F_L + F_{bouldersub} + F_{backfillsub})$$

	Design Value	Units / Source
$\mu_{bed} = coefficient\ of\ bed\ friction = \tan(\theta)$	0.78	unit less
$\theta = internal\ friction\ angle\ (degrees)$	38	Table 5, (Knutson et. al. 2014)

F_f (lb)	**-12,327**	*Negative values resist downstream displacement.*

Lateral Resistance From Piles

Accounts for the lateral resistance provided by piles within the LWM structure. Assumes soil resistance is limiting, i.e. the pile pushes over before it breaks.

$$F_{piles-h} = N_{piles} \times \frac{L_{pile}^3 \times \frac{1}{2} \times (\gamma_s - \gamma_w) \times d_{pile} \times K_p}{h_{load} \times L_{pile}}$$

		Design Values	Units
$N_{pile} = number\ of\ piles$	*assume three-quarters of piles are effective*	0.75	number
$L_{pile} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		8	ft
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$h_{load} = applied\ load\ height\ above\ the\ potential\ scour\ depth$		2.5	ft
$K_p = \frac{1 + \sin\theta}{1 - \sin\theta}$		4.2	unit less

$F_{piles-h}$ (lb)	**-2,497**	*Negative values resist downstream displacement.*

Sliding Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{sliding} = \frac{F_f + F_{piles-h}}{F_d + F_{hu} + F_{hd} + F_i}$$

***FOS** sliding* **71.2**

Pile Strength Factor of Safety

The factor of safety for the timber bending stress capacity of the pile. This evaluates the potential for the pile(s) to break under load prior to the pile pushing over in the ground.

	Formula	Design Values	Units
$F_b = Timber\ Bending\ Stress\ Capacity$ per Timber Pile Manual Table 3-1 or AWC NDS Supplement Table 4D		1,200 172,800	psi psf
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$I = circular\ cross-sectional\ moment\ of\ inertia$	$I = \frac{\pi B^4}{4}$	2.24	ft^4
$S = circular\ section\ modulus$	$S = \frac{\pi B^3}{32}$	0.216	ft^3
$C_F = strength\ reduction\ size\ factor$ for diameters greater than 12"	$C_F = \frac{1}{B}^{(1/9)}$	0.971	--
$M_p = applied\ moment\ per\ pile$	$M_p = \frac{(F_d + F_i + F_h) \times h_{load}}{N_{piles}}$	694	ft-lb
$f_b = applied\ pile\ bending\ stress$	$f_b = \frac{M_p}{S}$	3,217	psf
$F_{bx} = Pile\ bending\ stress\ capacity$	$F_{bx} = F_b \times C_F$	1,166 167,835	psi psf

$$FOS_{pile\ stength} = \frac{F_{bx}}{f_b}$$

***FOS** pile strength* **52.2**

References

Large Woody Material - Risk Based Design Guidelines
M. Knutson, J. Fealko. 2014. *Large Woody Material - Risk Based Design Guidelines.* U.S. Department of the Interior Bureau of Reclamation Pacific Northwest Region & Technical Services. Boise, Idaho. September 2014. Online at: http://www.usbr.gov/pn//fcrps/documents/lwm.pdf

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Timber Pile Design and Construction Manual, Timber Piling Council, 2015.

American Wood Council (2018) National Design Specifications for Wood Construction, Design Supplement.

Nason Floodplain - Large Woody Structure Stability Evaluation

Structural Stability | *6.4*

Structural stability of large woody material placements is evaluated herein using the procedures, formulas, and recommendations provided in the Reclamation's *Large Woody Material - Risk Based Design Guidelines* (Knutson et. al. 2014) along with insight gained from professional experience and general engineering judgment.

Factors of Safety | *6.4.1*

Safety factors for structural stability were selected from *Table 4. Minimum recommended factors of safety* given the site specific public safety and property damage risk levels.

			Criteria:
Public Safety Risk	Moderate	$\mathbf{FOS}_{sliding}$	1.5
Property Damage Risk	Moderate	$\mathbf{FOS}_{buoyancy}$	1.75
Stability Design Flow Criteria	50-year	$\mathbf{FOS}_{rotation}$	1.5

Resistance to Flotation | *6.4.2*

Flotation is typically caused by the buoyant force and the lift force acting on the wood material from water passing over its surface.

Large Wood Material Force

Accounts for the vertical buoyant force of submerged large wood and the vertical weight force of unsubmerged large wood.

$$F_{LWMs} = V_{LWMs} \times (\gamma_{wood} - \gamma_w)$$

$$V_{LWMs} = total\ volume\ of\ submerged\ large\ wood\ material$$

$$V_{LWMs} = \sum N_{LWMi} \times V_{LWMi}$$

Variable	Design Value	Units
$\gamma_{wood} = unit\ weight\ of\ wood$	38	lb/ft^3
$\gamma_w = unit\ weight\ of\ water$	62.4	lb/ft^3
V_{LWMs}	249	ft^3

F $_{LWMs}$ (lb)	**6,085**

Positive values are upward forces.

Lift Force

Accounts for the lift force of large wood in flowing water. Not applicable to LWS where the bed will deform around the leading edges.

$$F_L = \frac{C_L \times A_{LWM} \times \gamma_w \times U_o^2}{2 \times g}$$

	Design Value	Units / Notes
$C_L = lift\ coefficient$	0.2	typ. LWM value
$A_{LWM} = area\ of\ large\ woody\ material\ perpendicular\ to\ flow$		
$U_u = upstream\ channel\ velocity\ at\ design\ event$	3	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2

$A_{LWM} = See\ Design\ Plan$

A_{LWM} (ft^2)	**70**

For pre-racking condition

F_L (lb)	**N/A**

Boulder Ballast Force

Accounts for the ballasting force of large boulders directly attached to or placed over LWM.

$$F_{bouldersub} = N_{bouldersub} \times {}^{\pi}/_{6} \times d_{bouldersub}^3 \times (\gamma_{boulder} - \gamma_w)$$

	Design Value	Units / Notes
$N_{bouldersub} = number\ of\ submerged\ boulders$	0	number
$d_{bouldersub} = effective\ diameter\ of\ submerged\ boulders$	0	ft
$\gamma_{boulder} = unit\ weight\ of\ boulders$	165	lb/ft^3

$F_{bouldersub}$ (lb)	**N/A**

Backfill Ballast Force

Accounts for the ballasting force of backfill placed directly over LWM members. Volume is based on the fill area over the log(s) and a the effective cover depth shown on the Drawings.

$$F_{backfillsub} = V_{backfillsub} \times (\gamma_s - \gamma_w)$$

	Design Value	Units / Notes
$V_{backfillsub} = volume\ of\ backfill\ over\ LWM\ members$	450	ft^3
	See design plans	
$\gamma_s = unit\ weight\ of\ backfill\ material$	110	lb/ft^3

$F_{backfillsub}$ (lb)	**-21,420**

Pile Skin Friction

Accounts for the vertical resistance provided by piles within the LWM structure. USBR document equation modified by Inter-Fluve to match industry pile design standard formulations.

$$F_{piles-v} = N_{piles} \times \pi \times d_{piles} \times L_{piles} \times \left(k_s \times \tan\frac{2}{3}\theta \times \sigma'\right)$$

		Design Values	Units
$N_{piles} = number\ of\ piles$	*Assume three-quarters of piles are effective*	1.5	number
$L_{piles} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		8	ft
$d_{piles} = nominal\ diameter\ of\ the\ piles$		1.30	ft
$\sigma' = \left(L_{piles} \times (\gamma_{sat} - \gamma_w)\right)/2$		190.4	lb/ft^2
$K_s = coefficient\ of\ lateral\ earth\ pressure\ (0.5\ to\ 1.0)$		1.0	unit less
$\theta = internal\ friction\ angle\ of\ soils$		36	deg.

$F_{piles\text{-}v}$ **(lb)**	**-4,155**	*Negative values resist upward displacement.*

Piles Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bPiles} = \frac{F_{piles-v}}{F_{LWMs} + F_L}$$

FOS_b	**0.7**	*Note this value does not include the backfill assuming it's all lost but the piles are holding.*

Backfill Only Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bBackfill} = \frac{F_{backfillsub}}{F_{LWMs} + F_L}$$

FOS_b	**3.5**	*Note this value does not include the piles.*

Net Buoyancy Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{bNet} = \frac{F_{backfillsub} + F_{piles-v}}{F_{LWMs} + F_L}$$

FOS_b	**4.2**	*Note this value includes the piles and backfill.*

Resistance to Sliding | *6.4.3*

LWM structures are also susceptible to failure through sliding.

Drag Force

LWM structures are pushed downstream by the fluid drag forces acting upon the wood by the flowing water.

$$F_d = \frac{C_D \times A_{LWM} \times \gamma_w \times U_c^2}{2 \times g}$$

	Design Value	Units / Notes
$C_D = drag\ coefficient$	1	Per Equations 23 and 24
$A_{LWM} = area\ of\ wetted\ wood\ normal\ to\ the\ flow\ direction$		
$U_c = velocity\ adjacent\ to\ the\ LWM\ structure$	3	ft/s
$g = acceleration\ due\ to\ gravity$	32.2	ft/s^2

$A_{LWM} = See\ Design\ Plan$

A_{LWM} (ft^2)	70

Velocity value is conservative for all LWS locations. Value from 100-yr event 2D model results for main channel.

F_d (lb)	**610**

Hydrostatic Force

Hydrostatic forces act on the upstream and downstream faces of a LWM structure. They account for differences in the upstream and downstream water depths against the structure.

$$F_{hu} = \tfrac{1}{2} \times \gamma_w \times Y_u \times A_u \qquad F_{hd} = \tfrac{1}{2} \times \gamma_w \times Y_d \times A_d$$

F_{hu} , F_{hd} = *hydrostatic force on upstream and downstream side of the wood structure*

Y_u , Y_d = *water depth upstream and downstream of the structue*

A_u , A_d = *area projected to flow direction on the upstream and downstream of the structure*

Variable	Design Value
Y_u (ft)	4.5
A_u (ft^2)	70
Post racking area	
Y_d (ft)	4.5
A_d (ft^2)	70
Plan downstream area	

F_{hu} + F_{hd} = F_h (lb)	**N/A**

Impact Force

The impact force associated with debris impacting a large wood structure can be estimated by the impact force equation.

$$F_i = \frac{w_{debris}}{g} \times \frac{V_{channel}{}^2}{2 \times \Delta x} \times C_i \times C_o \times C_d \times C_{b\times} R_{max}$$

Variable	Design Value
W_{debris} (lb)	3,774
$V_{channel}$ (ft/s)	3
Δx (ft)	5
C_i	0.5
C_o	0.8
C_d	1.0
C_b	1.0
R_{max}	0.8

$w_{debris} = weight\ of\ debris$

$V_{channel} = channel\ approach\ velocity$

$\Delta x = deceleration\ distance$

Coefficients *(see Table 6 and Figures 11, 12 for values)*

$C_i = importance\ ,\ C_o = orientation = 0.8\ , C_d = depth\ , C_b = blockage\ , R_{max} = impluse\ response\ ratio$

***F_i* (lb)**	**34**

Friction Force

Accounts for the friction force between the LWM and the channel bed. Restraint force from piles is not included as it does not exert a pressure on the LWS / bed interface.

$$F_f = -\mu_{bed} \times (F_{LWMs} + F_L + F_{bouldersub} + F_{backfillsub})$$

	Design Value	Units / Source
$\mu_{bed} = coefficient\ of\ bed\ friction = \tan(\theta)$	0.78	unit less
$\theta = internal\ friction\ angle\ (degrees)$	38	Table 5, (Knutson et. al. 2014)

***F_f* (lb)**	**-11,981**	*Negative values resist downstream displacement.*

Lateral Resistance From Piles

Accounts for the lateral resistance provided by piles within the LWM structure. Assumes soil resistance is limiting, i.e. the pile pushes over before it breaks.

$$F_{piles-h} = N_{piles} \times \frac{L_{pile}^3 \times \frac{1}{2} \times (\gamma_s - \gamma_w) \times d_{pile} \times K_p}{h_{load} \times L_{pile}}$$

		Design Values	Units
$N_{pile} = number\ of\ piles$	*assume three-quarters of piles are effective*	1.5	number
$L_{pile} = length\ of\ pile\ embedded\ below\ potential\ scour\ depth$		8	ft
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$h_{load} = applied\ load\ height\ above\ the\ potential\ scour\ depth$		2.5	ft
$K_p = \frac{1 + \sin\theta}{1 - \sin\theta}$		4.2	unit less

***$F_{piles-h}$* (lb)**	**-4,994**	*Negative values resist downstream displacement.*

Sliding Factor of Safety

The factor of safety is the absolute value of the sum of resisting forces divided by the sum of driving forces.

$$FOS_{sliding} = \frac{F_f + F_{piles-h}}{F_d + F_{hu} + F_{hd} + F_i}$$

***FOS** sliding* **26.4**

Pile Strength Factor of Safety

The factor of safety for the timber bending stress capacity of the pile. This evaluates the potential for the pile(s) to break under load prior to the pile pushing over in the ground.

		Design Values	Units
$F_b = Timber\ Bending\ Stress\ Capacity$ per Timber Pile Manual Table 3-1 or AWC NDS Supplement Table 4D		1,200 172,800	psi psf
$d_{pile} = diameter\ of\ the\ pile$		1.30	ft
$I = circular\ cross - sectional\ moment\ of\ inertia$	$I = \frac{\pi B^4}{4}$	2.24	ft^4
$S = circular\ section\ modulus$	$S = \frac{\pi B^3}{32}$	0.216	ft^3
$C_F = strength\ reduction\ size\ factor$ for diameters greater than 12"	$C_F = \frac{1}{B}^{(1/9)}$	0.971	--
$M_p = applied\ moment\ per\ pile$	$M_p = \frac{(F_d + F_i + F_h) \times h_{load}}{N_{piles}}$	1,074	ft-lb
$f_b = applied\ pile\ bending\ stress$	$f_b = \frac{M_p}{S}$	4,978	psf
$F_{bx} = Pile\ bending\ stress\ capacity$	$F_{bx} = F_b \times C_F$	1,166 167,835	psi psf

$$FOS_{pile\ stength} = \frac{F_{bx}}{f_b}$$

***FOS** pile strength* **33.7**

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