Chesnimnus Creek – Williams Restoration Design
Basis of Design Report (80% Design)

For the Nez Perce Tribe
July 30, 2025

Prepared by Rio ASE
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ACKNOWLEDGEMENTS

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2D – two-dimensional

BPA – Bonneville Power Administration

cfs – cubic feet per second

DPS – distinct population segment

Drawings – Design Drawings

DW – diffusion wave

ESA – Endangered Species Act

FM – full momentum

GPDSR – General Project and Data Summary Requirements

GRMW- Grande Ronde Model Watershed

HEC-RAS – Hydrologic Engineering Center's River Analysis System

HIP – Habitat Improvement Program

LWD – large woody debris

MOVE.1 – Maintenance of Variance Extension type 1

NOAA – National Oceanic and Atmospheric Administration

NPT – Nez Perce Tribe

NRCS – National Resources Conservation Service

NWI – National Wetlands Inventory

Rio ASE – Rio Applied Science & Engineering

RM – river mile

SWE – shallow water equation

USACE – U.S. Army Corps of Engineers

USFS – U.S. Forest Service

USFWS – U.S. Fish and Wildlife Service

USGS – U.S. Geological Survey

1 INTRODUCTION

Rio Applied Science & Engineering (Rio ASE) has prepared this 80 Percent Basis of Design report (report) for the Nez Perce Tribe (NPT). This report provides a summary of our findings pertaining to the existing conditions of the Williams reach on Chesnimnus Creek and an explanation of the design process, analyses, and outcomes for the proposed enhancement design.

This report is organized according to the General Project and Data Summary Requirements (GPDSR) required by the Bonneville Power Administration (BPA) for regulatory compliance coverage under the Habitat Improvement Program (HIP). These requirements developed by BPA ensure effective communication of appropriate planning, analysis, design, and resulting construction documentation. The project reach is described in terms of processes that shaped the stream and associated ecosystem, including discussions on hydrology, hydraulics, habitat, and geomorphology. The evaluation and consideration of site conditions provide the basis for project design.

1.1 Project Responsible Parties

- The project sponsor is the Nez Perce Tribe, and the project manager is Kate Frenyea, 541-432-2506.
- The design consultant is Rio ASE and the engineer of record is Jeff Fealko, PE, 208-866-8753.

1.2 Site Location

The Chesnimnus Creek Williams project reach is located on private land along Chesnimnus Creek in Wallowa County, Oregon and extends from approximately river mile (RM) 9.2 at the upstream boundary to RM 4.3 at the downstream property boundary (Figure 1-1). The upstream neighboring parcels are federally owned and managed by the U.S. Forest Service (USFS) while the downstream parcels are private. Additional mapping is provided in the Design Drawings (Drawings) in Appendix A.

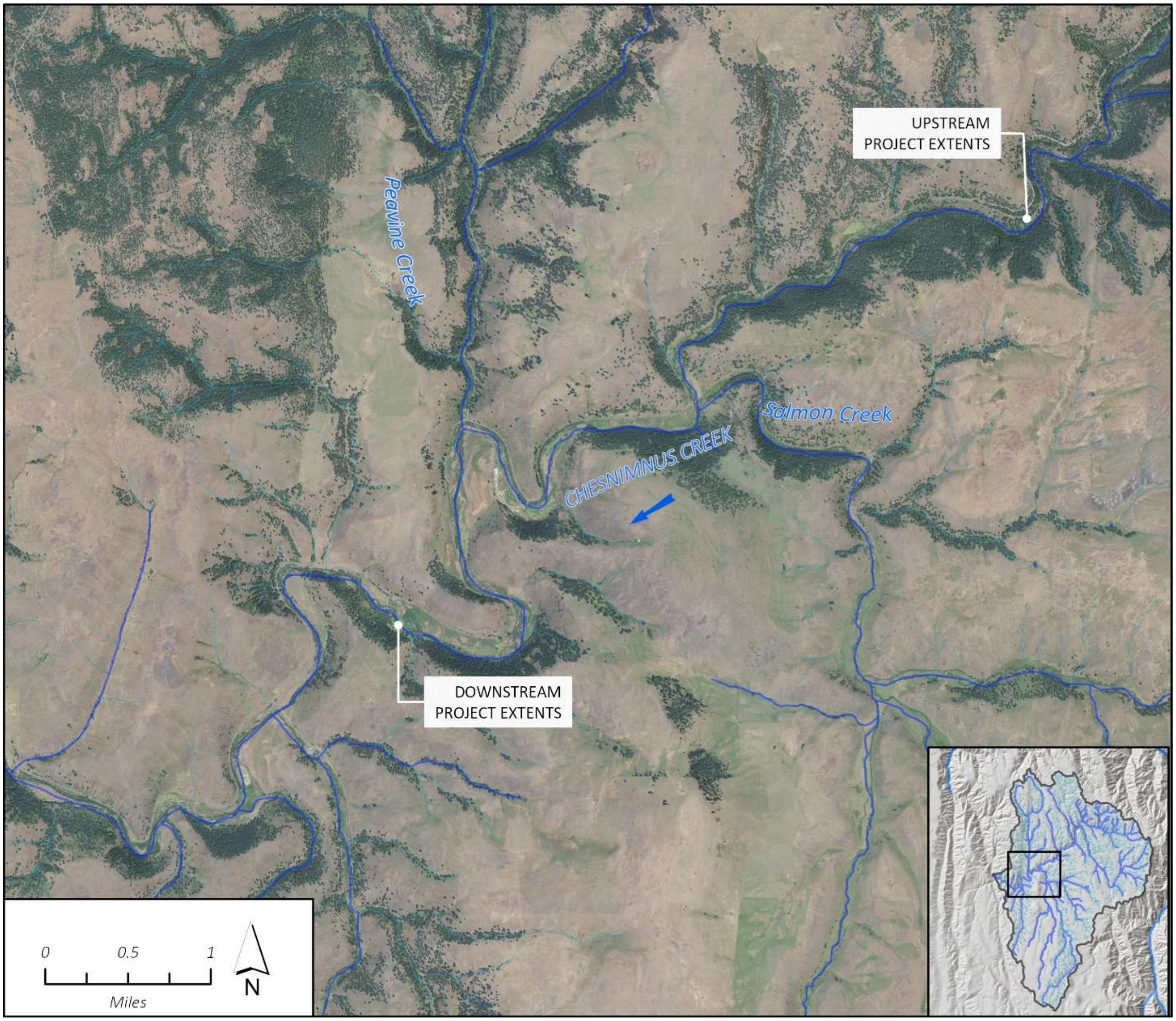

Figure 1-1. Project location map.

2 PROJECT BACKGROUND

The project reach is located on a combination of privately owned land (one landowner) and USFS land. Approximately 85% of the project is on the single private landowner's property. There is a USFS road that runs adjacent to Chesnimnus Creek throughout the length of the project area. Project partners and the landowner share a vision involving the restoration of fisheries habitat, including the encouragement and/or mimicry of beaver activity, to the benefit of Endangered Species Act (ESA)-listed steelhead and Pacific lamprey.

2.1 Environmental Setting

Chesnimnus Creek is a tributary of Joseph Creek in northern Wallowa County, Oregon. The project area is roughly in the middle of the watershed and lies within the Canyons and Dissected Highlands level IV ecoregion, within the larger Blue Mountains Level III Ecoregion. This area is defined by uplifted Columbia Plateau basalts that have been eroded into steep canyons largely characterized by loess and ash soils supporting Douglas fir, larch, and grand fir vegetation (Thorson et al., 2003). Chesnimnus Creek is significantly degraded from historical conditions. After decades of livestock grazing, channel manipulation, levee construction, vegetation clearing, infrastructure placement, and other anthropogenic interventions, the stream channel and floodplain have been simplified and disconnected. These land-use practices, combined with a substantial reduction in beaver populations within the watershed, have resulted in a loss of off-channel habitat and floodplain connectivity, which are the largest factors affecting steelhead incubation and juvenile rearing life stages (National Oceanic and Atmospheric Administration [NOAA], 2017). Increased water velocity due to the straightening and simplification of the channel has especially degraded water quality during spring runoff by increasing bank erosion, which contributes to fine sediment deposition in the stream. The lack of deep pool habitat, riparian vegetation, and cold-water connection within the floodplain have also increased instream water temperatures.

The NPT is seeking to reconnect the channel to its historical floodplain and improve instream habitat and vegetation to benefit limiting life states of ESA-listed salmonids between RM 4.3 and 9.2 of Chesnimnus Creek. This project, located on a private ranch and downstream of USFS land, will be Phase I of a multi-phased effort to restore fisheries habitat, including the encouragement and/or mimicry of beaver activity, to the benefit of ESA-listed steelhead and Pacific lamprey. The NPT has worked closely with landowners to identify approved restoration actions, infrastructure in need of protection or modification, and livestock use areas and travel routes; these items will be used to inform design development.

2.2 Project Goals and Objectives

This project is focused on improving limiting habitat factors that are critical to multiple life stages of ESA-listed steelhead and Pacific lamprey, with a central goal of increasing the survival and productivity of early life stages of steelhead, lamprey and other aquatic species. To achieve this outcome, project objectives are based on established ecologic, geomorphic, and hydrologic process-based mechanisms. Coordination with landowners is essential to attain habitat restoration goals that are both sustainable and compatible with cattle operations.

Goals

- To enhance aquatic habitat diversity and restore natural stream function, including the encouragement and/or mimicry of beaver activity, for all freshwater life stages of threatened and sensitive species within the project reach.

Objectives

- Increase the spatial heterogeneity and complexity of high-quality habitat and distribute stream flow and energy through a range of hydrologic conditions. Reconnect or create new secondary channels and off-channel connections and improve channel geometry to include a generally low width-to-depth ratio with increased hydraulic diversity and sediment sorting that is favorable for spawning (width, depth, and velocity with ample structure and cover).

- Increase seasonal floodplain connection and function to dissipate flood energy while improving flood water storage, hyporheic exchange, floodplain fine sediment storage, in-channel sediment reduction, high-flow juvenile refugia, nutrient exchange, and riparian vegetation.
- Establish, protect, and maintain a robust native riparian plant community along channel banks and floodplains, increasing shade, improving bank structure and habitat, and providing a buffer from upland and floodplain sediment sources.
- Maintain and enhance existing beaver activity where possible and create habitat features that can be utilized by beaver to expand their area of use and influence.
- Protect and/or modify infrastructure (roads, bridges, structures, and other constraints) while maximizing fish habitat uplift throughout their project area.

3 EXISTING CONDITIONS

The current condition of the project reach and much of lower Chesnimnus Creek is significantly degraded from historic conditions. This degradation is due to decades of anthropogenic interventions and the substantial reduction in beaver, which has left both the stream and floodplain extremely simplified and disconnected. The following sections describe the current conditions of geomorphology, hydrology, wetlands and riparian conditions, and fish use.

3.1 Geomorphology

The project area geology is composed of 14- to 17-million-year-old Grand Ronde basalts, part of the larger Columbia River Basalt Group (Reidel & Tolan, 2013). Fractures within the basalt bedrock provided preferential flow paths for streams that have slowly eroded steep-walled, often narrow valleys. Where steep tributaries enter wider trunk streams with a floodplain, like Chesnimnus Creek, debris flows have deposited sediment, periodically spanning the floodplain where the valley is narrow (primarily upstream of the project area) or partially spanning the floodplain and creating an alluvial fan, as observed within the project area (Figure 3-1). These alluvial fans provide topography on the floodplain, creating periodic floodplain constrictions while forcing the active channel toward the opposite valley margin. Additionally, sediment delivered from uplands and tributaries periodically becomes entrained in the stream and overbank flows, contributing to floodplain formation over the past several thousand years. Deposition occurs when sediment volumes overwhelm the streams' capacity to transport the load, building the floodplain up. In subsequent years, when the sediment volume is less, the system becomes supply limited and incises through prior deposition leaving behind terraces.

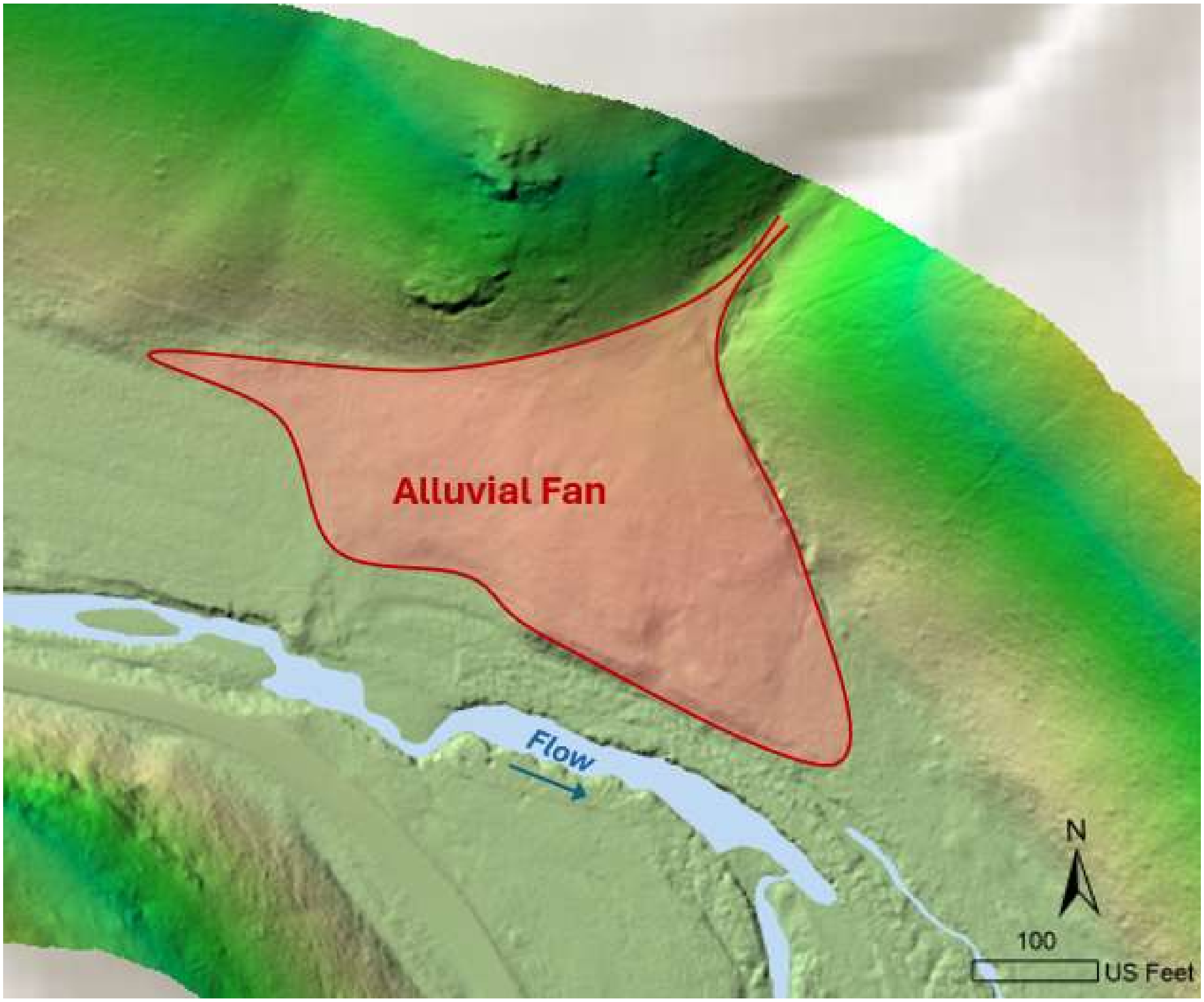

Figure 3-1. The alluvial fan visible in LiDAR topography spans approximately half of the valley width in the lower project reach.

Beaver dams have also contributed to the formation of the project area floodplain. As discussed below in section 3.2, discharge in the upper project reach is approximately half of that in the lower reach, which effectively reduces stream power by about the same amount. Therefore, despite the relatively narrow valley confining and concentrating flows, large boulders and woody debris recruited directly from the valley margin provided roughness and structure to further dissipate flow energy, thus enabling beaver dams to persist over time. Where the valley widens in the lower project reach, flow energy was dissipated across the relatively broad floodplain, enabling beaver dams to persist despite a doubling of the flow volume and stream power. Backwater conditions upstream of beaver dams created low-energy environments that promoted the deposition of sand and silt and further aggraded the floodplain. Cut bank exposures within the project reach reveal debris flow deposits consisting of poorly sorted angular sediment overtopped by fine-grained floodplain and beaver dam deposits (Figure 3-2).

Figure 3-2. Poorly sorted mix of subangular with rounded alluvium overlain by silt and sand-sized floodplain material suggest debris flow deposition (coarse) followed by periodic floodplain deposits (fine), likely influenced by beaver.

The likely outcome of this geologic setting, hydrology, sediment regime, and beaver influence would have been a complex and diverse fluvial system, commonly multi-threaded (anastomosing) with a mosaic of open water, emergent wetland, floodplain, and upland. The riparian community would have mirrored this diversity with areas of wetland meadow (rushes and sedges), floodplain shrubs (willow, dogwood, and cottonwood) and upland vegetation (evergreen trees and grass). The sinuous and multi-threaded channels likely exhibited a mix of pool-riffle to forced step-pool morphology (based on Montgomery & Buffington, 1998) depending on sediment volume and the amount of structure provided by riparian vegetation (especially tree roots) and in-stream woody material (including beaver dams).

Human influence over the past 100+ years has resulted in the loss of beaver, channel confinement, and greater hydraulic efficiency within the channel. These factors combined to increase sediment transport capacity and forcing incision, which was only abated by erosion-resistant bedrock exposed periodically in the bed (Figure 3-3). The modern geomorphology is now defined by a primarily single-thread, relatively straight channel and poorly connected floodplain often lacking dense riparian vegetation. The narrower valley/floodplain in upstream reaches is dominated by angular, cobble-sized sediment, while the broader valley/floodplain in downstream reaches is characterized by a mix of coarse and fine sediment based on local and changing hydraulic conditions associated with in-stream structure including occasional beaver dams and woody debris. Beavers are recolonizing the area, with most beaver dams observed in relict side channels (Figure 3-4), although several beaver dams have attempted to span the main channel, resulting in at least partial dam failure (Figure 3-5). Additional instream structure and removal of confining features (such as push-up levees) is necessary to reduce flow energy, reactivate the floodplain, and improve sediment, riparian, and in-stream habitat conditions.

Figure 3-3. Example of basalt bedrock exposure in the streambed within the project reach. Note the well-rounded rock faces, suggesting many years of exposure.

Figure 3-4. Off-channel beaver dam in the lower project reach.

Figure 3-5. The mainstem beaver dam in the lower reach has partially failed.

3.2 Hydrology

Chesnimnus Creek is an ungaged tributary of Joseph Creek, which is also ungaged and is a tributary of the Grande Ronde River. Approximately halfway through the project reach, Salmon Creek (referred to by the locals as Pine Creek) nearly doubles the drainage area. At the upstream end of the project site, Chesnimnus Creek drains 79.2 square miles. Elevations in the watershed occur in a tight band, ranging from 3,560 to 5,460 feet with an average of 4,710 feet. As a consequence of the relatively flat watershed and close proximity to bedrock (resulting in little groundwater storage), Chesnimnus Creek is believed to be more dramatically influenced by rain or rain-on-snow events than similarly sized streams with greater elevation relief, resulting in a flashier hydrograph with higher peak flows.

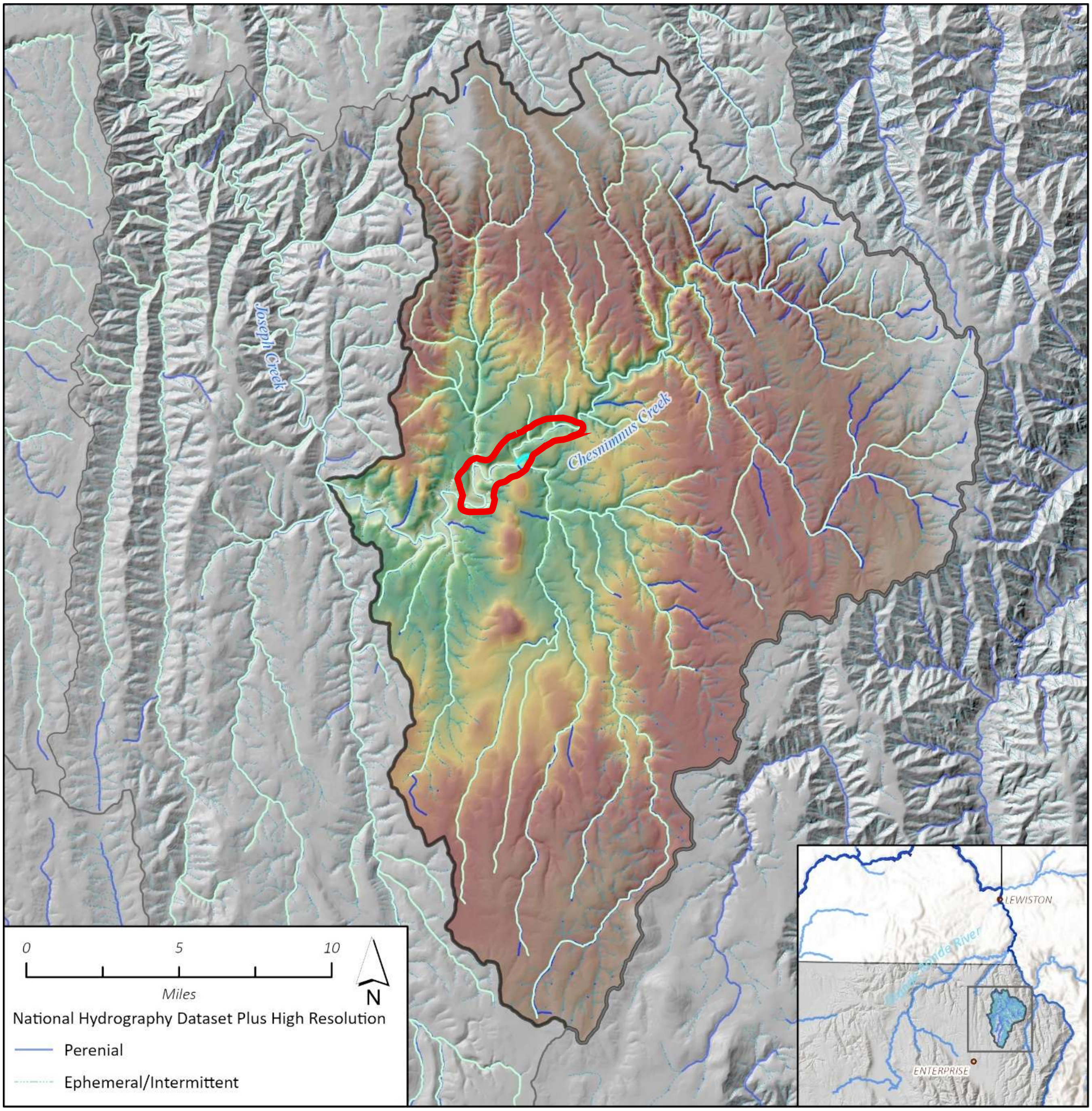

Figure 3-6. Overview of Chesnimnus Creek watershed with the project area outlined in red.

To estimate peak flows within the project area, several nearby gages on similar streams were used to create drainage area regression equations. Gages used were U.S. Geological Survey (USGS) 13333100 Doe Creek near Imnaha, OR; USGS 13291400 Deer Creek near Imnaha, OR; and USGS 13292000 Imnaha River at Imnaha, OR. These gages were selected from geographically similar gaged streams to provide a range of drainage areas that allowed for interpolation for the project reach. Gages were also selected based on their geographic proximity to each other, to better quantify the influence of drainage area while minimizing confounding factors.

To further refine the hydrologic analysis for the Chesnimnus Creek project reach, streamflow data has been collected at several locations and two of those sites were selected to collect streamflow measurements and record flow depth variations using Hobo Data Loggers (Figure 3-7).

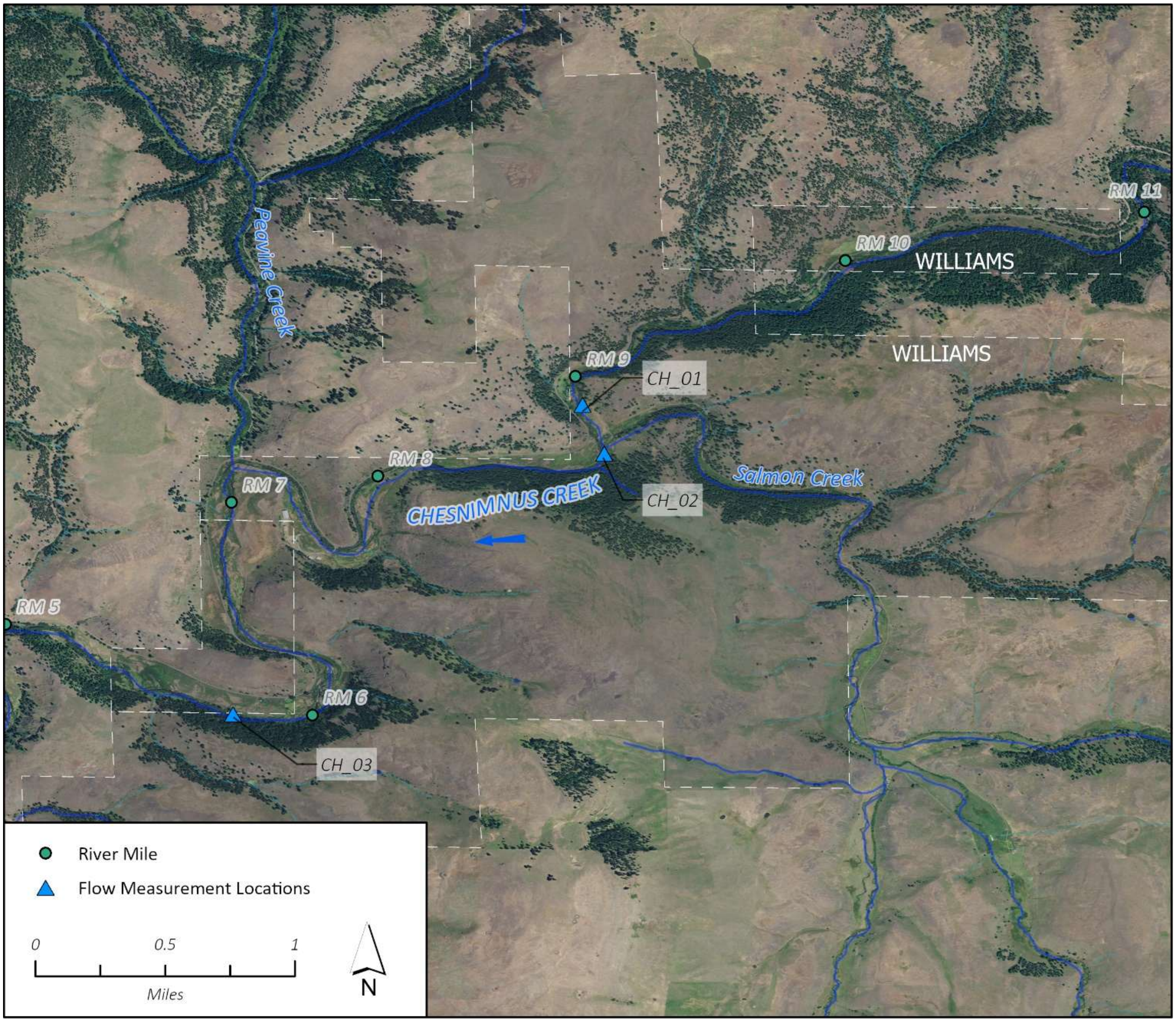

Figure 3-7. Streamflow measurement sites with HOBO dataloggers installed (February 2024) to collect flow depth and temperature data.

3.2.1 Annual Peak Flows

Peak flows were estimated using the gages described above. To provide sufficient data for a gage extension using the Maintenance of Variance Extension type 1 (MOVE.1), the Deer Creek gage was linearly extended using the Imnaha gage. Doe Creek and Deer Creek were then extended using the MOVE.1 methodology using the Imnaha River at Imnaha gage to provide a 95-year period of record for analysis (Figure 3-8 and Figure 3-9, respectively). Peak flows at each gage were then calculated using the 17C Expected Moments Algorithm and are summarized in Table 3-1 (England et al., 2019). The resulting peak flows were then used to create a linear regression equation (Figure 3-10) to interpolate peak flows at the project site based on drainage areas, both upstream and downstream of Salmon Creek and at the downstream extent of the project. Drainage areas are shown in Table 3-2. Peak flows for the project site are summarized in Table 3-3.

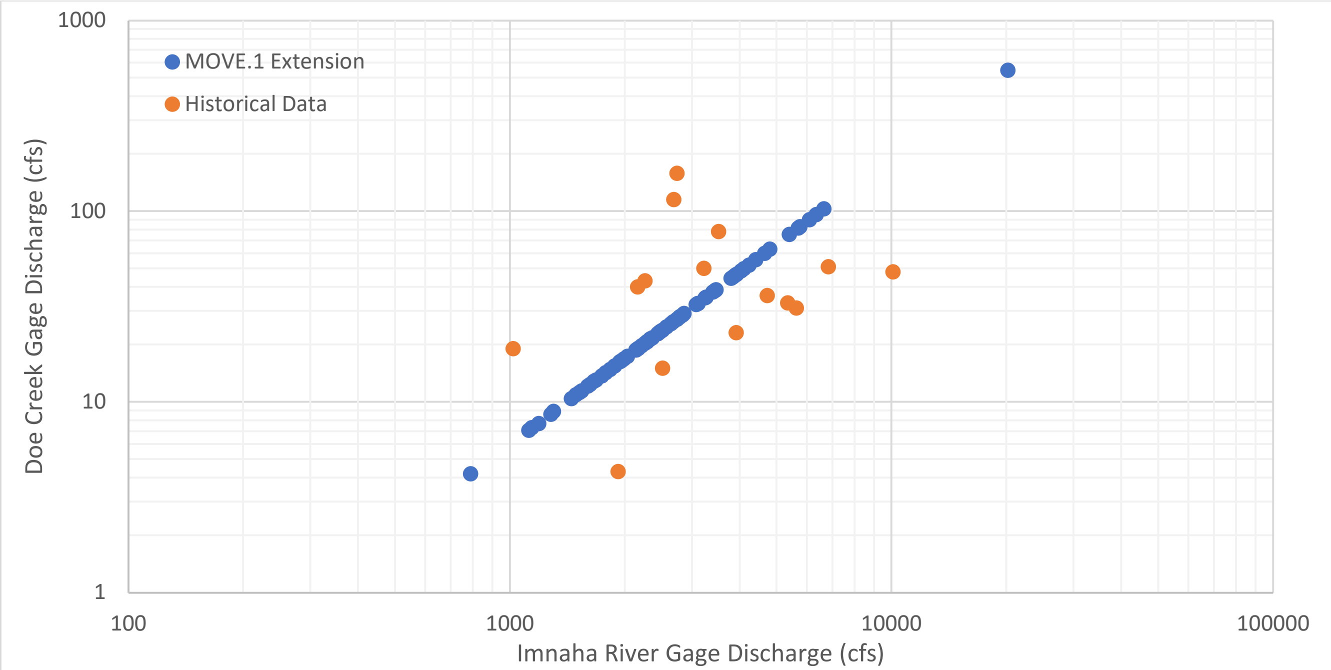

Figure 3-8. MOVE.1 correlation between the Imnaha gage's historic peak flow record and the Doe Creek's historic peak flow record.

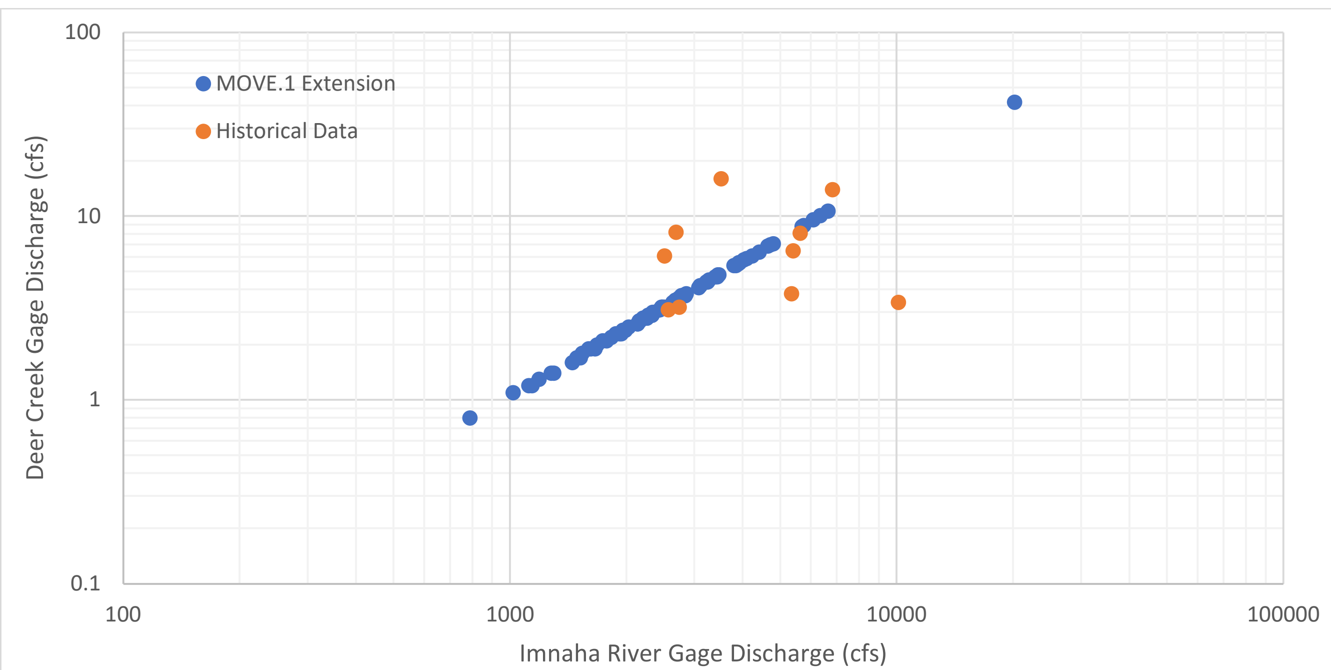

Figure 3-9. MOVE.1 correlation between the Imnaha gage's historic peak flow record and the Deer Creek's historic peak flow record.

Table 3-1. Peak Flood Flow Recurrence Intervals for USGS Gage Locations

Recurrence Interval (yrs)	Percent Chance Exceedance	Imnaha River Gage (cfs)	Deer Creek (cfs)	Doe Creek (cfs)
1.01	99	1077	1	6
1.5	66.7	2104	3	14
2	50	2582	3	25
5	20	4090	6	50
10	10	5380	8	75
25	4	7401	12	106
50	2	9231	16	160
100	1	11377	21	215
200	0.5	13893	27	283
500	0.2	17898	37	401

cfs = cubic feet per second

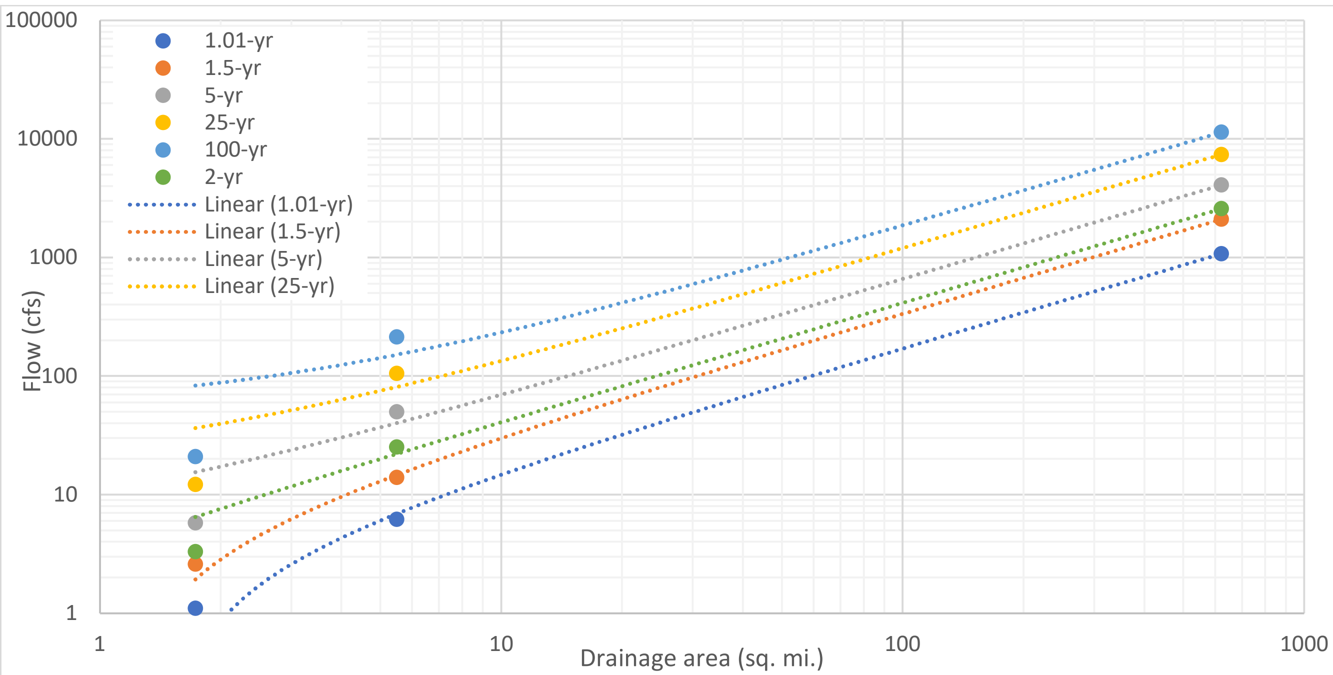

Figure 3-10. Regression equations based on drainage area from USGS gage locations utilized for extrapolation to Chesnimnus project area.

Table 3-2. Drainage Areas for USGS Gage Locations and Project Site Locations

Location	(sq. mi.)
Imnaha River Gage	622
Deer Creek Gage	1.73
Doe Creek Gage	5.49
Upstream of Salmon Creek	79.2
Salmon Creek at Mouth	65.6
Downstream Project Boundary	172

Table 3-3: Peak Flows in Project Area

Flow at a Given Recurrence Interval (cfs)			
Location	**Upstream of Salmon Creek**	**Salmon Creek at Mouth**	**Downstream end of project**
1.01-yr	135	111	296
1.5-yr	264	218	579
5-yr	524	435	1134
25-yr	956	795	2058
100-yr	1494	1246	3184

3.2.2 Seasonal Flows

Without a stream gage on Chesnimnus Creek it is difficult to quantify seasonal flows. It has been documented that some sections of this project run dry in a typical summer. Lack of late summer flows can cause short-term stranding of salmonids in pools, create increased thermal loading of standing water with limited hyporheic exchange, and reduce overall access and ability to evade predators. To better quantify seasonal flows, Hobo Data Loggers were placed at two sites within the project area (Figure 3-7) on February 24, 2024. These water level loggers will record river stage at 30-minute intervals. Stage-discharge curves have begun to be created using the Federal Highway Administration Hydraulic Toolbox, surveyed cross sections, and corresponding discharge measurements. When the data loggers are downloaded and additional discharge measurements are gathered, the stage-discharge curves can be developed and used to estimate the flows throughout the recorded 30-minute increments. In the long term, this data can be used to provide daily exceedance values for the period of record. There are no documented irrigation diversions within the project reach.

Discharges were measured during field work on February 24, 2024. Discharge measurements were taken a short distance upstream of Salmon Creek, downstream of Salmon Creek, and at the downstream limits of the project area. These measurements are summarized in Table 3-4.

Table 3-4. Discharge Measurements Through the Project Site on February 22, 2024

Location	Measured Discharge (cfs)
Upstream of Salmon Creek	16
Downstream of Salmon Creek	44
Downstream Project Extent	47

3.3 Fish Use and Habitat Availability

Steelhead and Pacific lamprey are present at various times within the project reach. This reach holds both juvenile and adult life stages of steelhead as well as adult and adult migration and spawning for lamprey.

Summer steelhead in the Grande Ronde River basin fall within the Snake River Distinct Population Segment (DPS) and are listed as threatened under the ESA. Steelhead that migrate to Chesnimnus Creek are part of the Snake River Steelhead DPS and are generally classified as summer A-run, based on their adult run-timing patterns (NOAA, 2011a). Steelhead redd surveys were conducted in Chesnimnus Creek between March 31 and June 4, 2014 (Banks et al., 2015). Most redds in the Upper Grande Ronde basin, including Chesnimnus Creek, were first observed during the descending hydrographs of early May to late June. Decreasing summer water temperatures and minimizing sediment input are listed as some of the main factors in lower Chesnimnus Creek to improve steelhead incubation and juvenile rearing.

3.4 Riparian Conditions and Wetlands

Residual geomorphic and vegetative indicators within the floodplain provide evidence of wetter and more hydrologically connected pre-disturbance conditions. Features such as relict side channels, low-lying floodplain benches, incised flow paths, and topographic depressions suggest a historically complex stream corridor with frequent overbank inundation. Soil and vegetation patterns also reflect legacy fluvial processes, including fine sediment deposition zones and vegetation assemblages consistent with periodically saturated conditions.

A wetlands assessment report, attached as Appendix C, evaluates actual field-verified wetlands compared to those identified by the U.S. Fish and Wildlife Service (USFWS) in their National Wetlands Inventory (NWI), as seen in Figure 3-11 (More detailed NWI mapping is available in Appendix C).

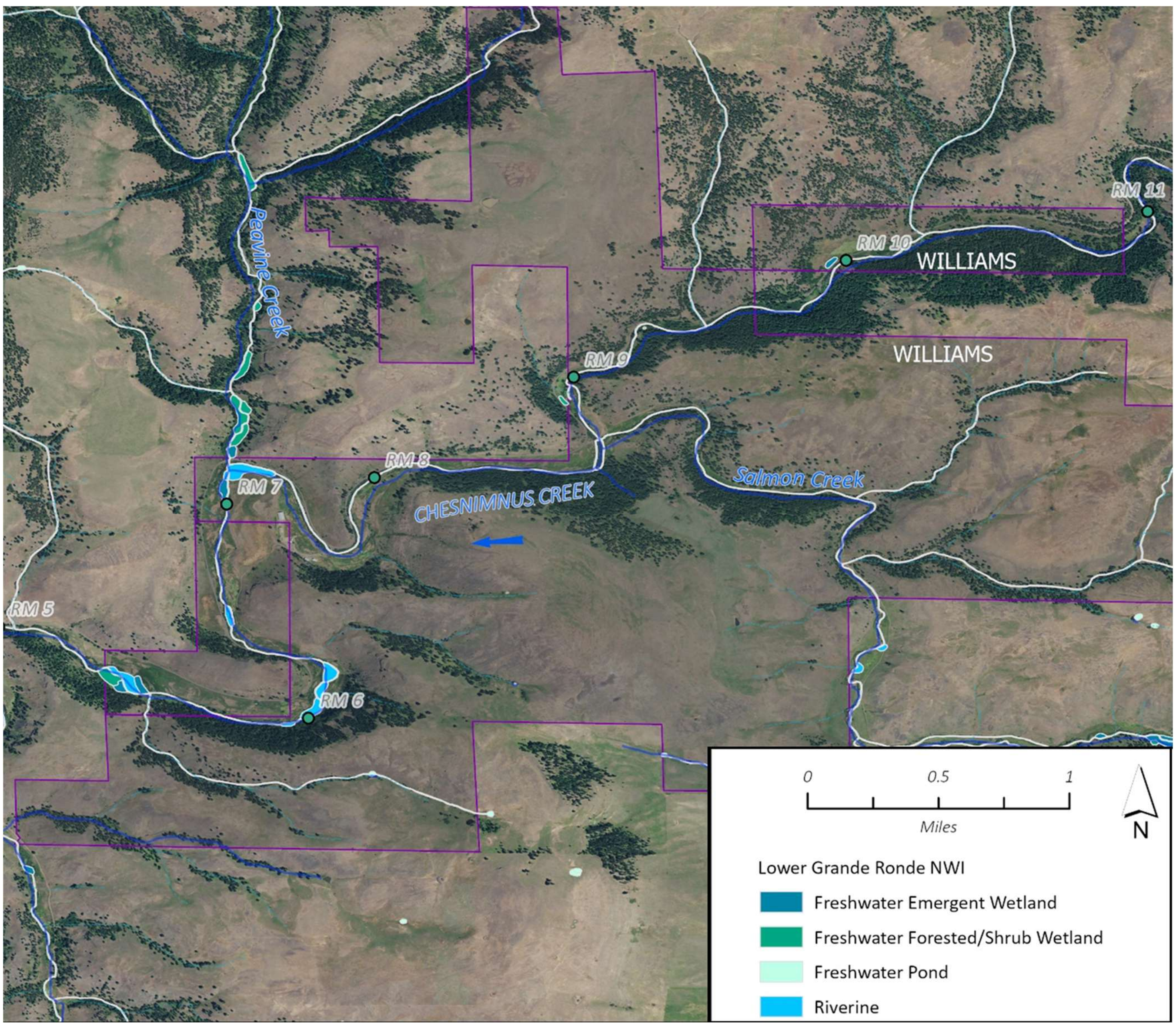

Figure 3-11. Existing wetlands within the project reach (USFWS, n.d., accessed March 2024).

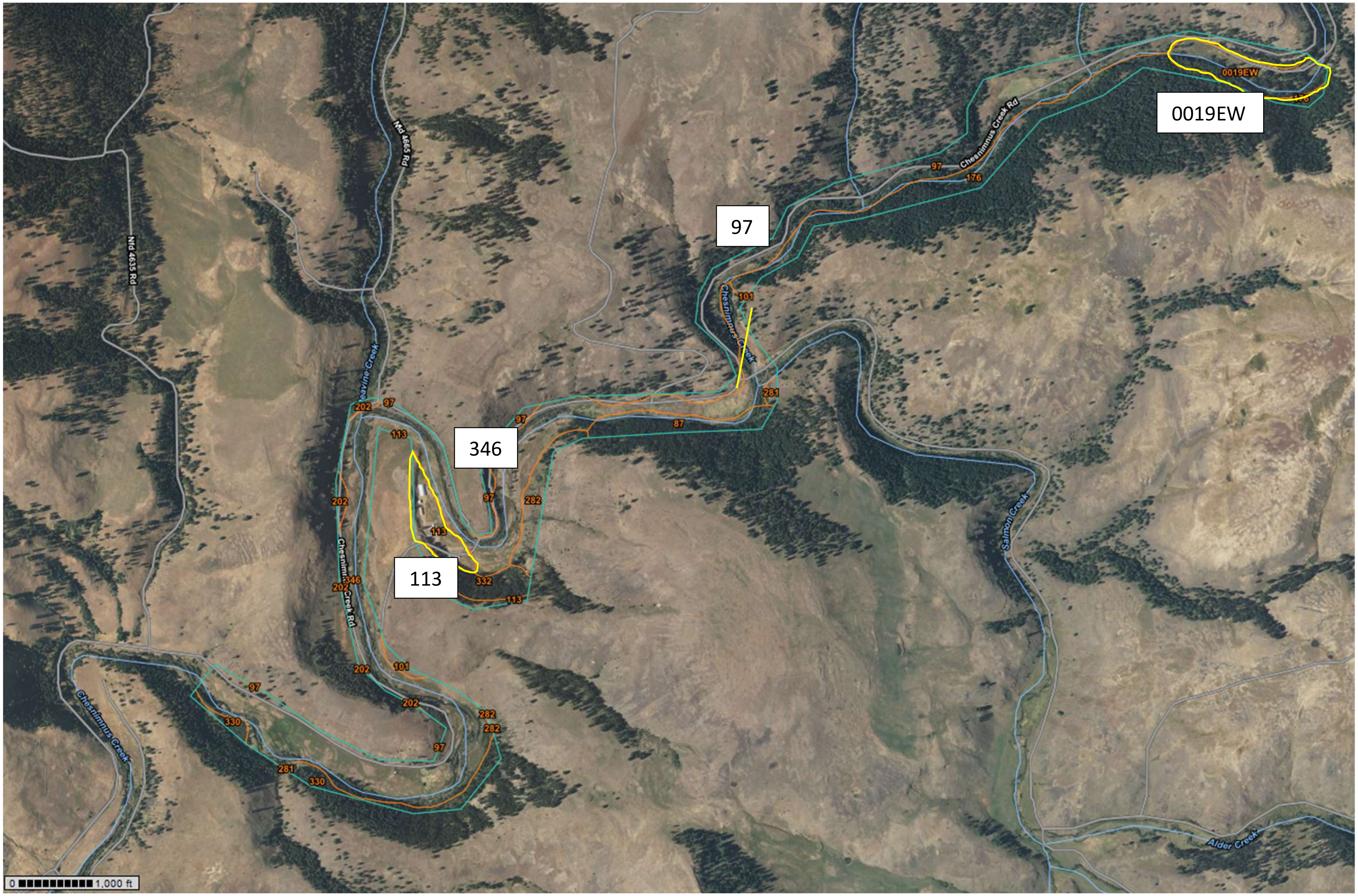

Figure 3-12. National Resources Conservation Service (NRCS) soil survey data for the project area shows the majority of the floodplain valley as Voats-Veazie complex downstream of Salmon Creek and Gwinly-Kettenbach rock outcrop upstream of Salmon Creek.

There is a small section of Terrod-Melloe-Gulliford complex at the far upstream extent of the project area that consists of moderately well-drained, silty loam that extends into a very stony, sandy clay loam from ~2-4 feet deep and an extremely stony, loamy sand underlying that 4-foot depth. Otherwise, the reach upstream of Salmon Creek is predominately classified as Gwinly-Kettenbach rock outcrop and consists of shallow, cobbly, silty loams (~1-foot thick) over a thin layer extremely cobbly clay (~0.5 feet thick) that is underlain by unweathered bedrock. Bedrock is often anticipated at shallow depths. Where this feature extends across the valley bottom, it is anticipated that the loam thickness will likely increase and as does the typical depth to bedrock. Downstream of Salmon Creek, the floodplain is made up primarily of the Voats-Veazie complex of soils that consist of fine, sandy loam in the top ~1.5 feet underlain by stratified, very cobbly sand to very gravelly, loamy sand. This layer describes a strongly contrasting stratification at this 1.5-foot depth interface that can be a restrictive feature. There is also a small pocket of Harlow-Becker complex in the vicinity of the ranch house and outbuildings. This soil complex ranges from a stony loam (~1-foot thick) to an extremely cobbly clay (~0.5-feet thick), all underlain by unweather bedrock at depth ranging from 1.5 to 2.5 feet.

Table 3-5. Soil Unit Identification and Description (NRCS, n.d., accessed 2025)

Soil Map ID	Soil Unit Name
0019EW	Terrodd-Melloe-Gulliford Complex, 0 to 5 percent slopes
97	Gwinly-Kettenbach Rock Outcrop Complex, 60 to 90 percent south slopes
113	Harlow-Bocker Complex, 2 to 15 percent slopes
346	Voats-Veazie Complex, 0 to 3 percent slopes

4 DESIGN DEVELOPMENT

The restoration plan for the project reach integrates elements of limiting disturbance to existing sensitive resource areas, restoring processes for improved river-floodplain function, establishing key wood structures for beavers to create more permanent main channel structures, and rehabilitation and enhancement of fish habitats and riparian vegetation. Applying this strategy is intended to improve habitat complexity while restoring the river to a more complex mainstem channel with active secondary channels, pools, riffles, appropriate width-to-depth ratios where currently straightened, and increased riparian shrub-dominated habitat to provide long-term structure and cover. The following restoration concepts have been considered within the project reach:

- Restore process and habitat by distributing flow and energy laterally and/or reconstructing appropriate primary and secondary channel planforms within the range of recommended target conditions. Preferably, relocate and/or create new channels directly adjacent to existing mature vegetation.
- Restore hydraulic processes, floodplain reconnection, and habitat by providing a greater diversity of channel forms. Channel geometry and planform restoration should focus on reducing channel confinement, increasing sinuosity, and increasing geomorphic complexity. Secondary channels should be incorporated where possible. Restoration efforts should focus on recruitment of natural beaver dams and addition of structural wood members to increase longevity of beaver-created dams in the mainstem to promote deposition, channel aggradation, floodplain connectivity, and hydraulic diversity.
- Protect and enhance existing areas of dense woody riparian vegetation where hydraulic complexity and habitat conditions are already favorable.
- Restore riparian processes by planting woody vegetation with greater plant density along the outside of bends and in floodplain areas susceptible to channel migration and/or avulsion to ensure future channel evolution results in favorable conditions.
- Restore process and habitat by increasing the abundance of instream structure, creating hydraulic diversity and habitat complexity while promoting more floodplain inundation and side channel development.
- Restore localized hydraulic processes and habitat by modifying primary channels to result in diverse habitat units, including pool-riffle sequences with a range of geometry and spatial distribution.

4.1 Proposed Project Elements

Design team and stakeholder collaborations and interpretations of the current environmental setting have helped identify specific restoration actions for the project reach. The actions listed below and depicted in Appendix A are being proposed at this conceptual design phase and may be changed or modified as the design progresses:

- Treatments that redirect and distribute flow and energy laterally across a broader surface, thereby creating and maintaining increased floodplain connectivity, channel complexity, and a more robust riparian corridor. Channel structure (vegetation, large woody debris [LWD], and variable sediment sizes) is severely limited within the project reach; incorporating hard points with wood structures (bank jams, apex jams, beaver dam analog structures), constructed riffles, and levee removals are recommended to obstruct downstream flow and redirect flow and energy laterally.
- Redirecting flow into adjacent existing riparian vegetation where feasible will provide immediate bank structure and habitat. Similarly, utilizing existing low-lying, relict topography to capture and redistribute flows across the floodplain will facilitate side channel formation while reducing construction and excavation, enabling a lighter touch during project implementation.
- Realigning the channel (where possible and necessary) will reduce channel slope, reduce velocities, and increase water surface elevations, which will improve floodplain connectivity and result in more bank

length. Combined with the addition of adequate structure, new channel segments will provide increased hydraulic variability, resulting in gravel retention and sorting, scour pools, and slower-moving water microhabitats.
- Removing levees and incorporating floodplain excavation, beaver complexes, and side channels to promote hyporheic and cold-water storage and exchange, off-channel habitat, and wet meadow development.
- Addressing landowner expectations to include riparian fence removal/relocation, off-channel livestock watering, preserving or improving existing crossings and access points, and improving access to private property.
- Utilizing cattle exclusion fencing, incorporating topographic complexity, and planting and seeding using a variety of methods to ensure revegetation efforts result in robust and diverse vegetative communities and habitats.

It is expected that implementation of any/all restoration actions will need to comply with the GPDSR required by BPA for regulatory compliance coverage under the HIP. Therefore, Rio ASE organized the risk evaluation of restoration concepts according to the Performance and Sustainability criteria prescribed in the HIP GPDSR (Table 4-1).

Table 4-1. Performance and Sustainability Criteria for Each HIP Action

Work Element	HIP IV Category	Performance/Sustainability Criteria
Headcut and Grade Stabilization	1c	**Performance:** Develop appropriate riffle/streambed material gradation based on estimated hydraulics from the two-dimensional (2D) hydraulic model to be stable during effective discharges (2- to 5-year peak flows). At critical grade control locations, ensure material is stable at a 100-year flow event without substantially degrading the riffle. **Sustainability:** Utilize native material for riffle construction. The reduced channel slope will reduce shear stresses throughout the project area, lessening potential for incipient motion of materials. The long-term plan allows for some movement of the channel plan forms; attempting to utilize existing gravels as riffle matrix should maintain riffle performance over time. At critical locations riffle matrix shall be developed from onsite boulders and/or imported material to sufficient size to be stable at the 100-year flow event. **Risk:** The riffles become unstable and hydraulic forces lower riffle elevations, causing a reduction in floodplain activation. The risk will be mitigated by designing riffles to an appropriate high-flow discharge and providing redundancy in design through use of wood structures in the same vicinity as critical riffle locations to aid in maintenance of riffle grades.
Bridge Replacement	1f	**Performance:** Modify, relocate, or replace existing infrastructure that does not convey the 100-year discharge

Table 4-1. Performance and Sustainability Criteria for Each HIP Action

Work Element	HIP IV Category	Performance/Sustainability Criteria
		without over topping or pressure flowing. Structures will be modified to increase the elevation of the low chord to prevent flanking, pressure flow, or over topping. If structures cannot be modified to meet that criteria replacement or additional structures will be utilized to convey the 100-year flow under the bridges. If replacement or additional structures are required, they will meet HIP conservation measures regarding clear span widths, etc. If bridges are modified by replacing abutments, they may not meet HIP requirements on span, but will convey the 100-year discharge. **Sustainability:** Abutments and grade controls through the structure will be designed to be stable at the 100-year discharge. **Risk:** Risk is channel incision through openings that are not expanded to convey 1.5 times the bankfull width. Modified structures will require a grade control structure under them and shall fall under Category 1c.
Installation of Fords	1h	**Performance:** Fords that are not abandoned will be replaced or relocated to a suitable location to be stable at channel-forming flows, limit flood flow routing down congregating access trails, and limit introduction of fine sediment into the channel. **Sustainability:** Fords will be a maximum of 15 feet wide and founded on bedrock or on constructed riffles consisting of native rounded gravels/cobbles that are stable at a 5-year flow event. Banks will be laid back to limit erosion and new fencing will be installed. **Risk:** Risk to fords is debris on fencing, erosion of banks, and introduction of fines into the channel. Riffle stability, fencing, and upstream wood structure placement will aid in mitigating these risks.
Improve Floodplain Connectivity	2a	**Performance:** Develop vertical profile to activate the floodplain at a more frequent (1- to 2-year discharge) interval. Correct channel width-to-depth ratio (over-widening) to a more natural ratio to improve floodplain connectivity. Reconnect complex floodplain features (oxbows, high-flow swales, topographic variability) to diversify floodplain conditions at all active flows and

Table 4-1. Performance and Sustainability Criteria for Each HIP Action

Work Element	HIP IV Category	Performance/Sustainability Criteria
		increase floodplain connectivity. Constructed beaver dams and riffles will also increase floodplain connectivity. **Sustainability:** Initial floodplain roughness features need to survive and grow to prevent overbank erosion. Early stability of bank roughness and large woody material structures will maintain initial channel configuration to provide stability in floodplain features. Riffle stability and beaver dam structures will maintain active improved floodplain connectivity. **Risk:** There is a risk of channel incision or channel avulsion/straightening that increases channel capacity and reduces floodplain connectivity. This risk is being reduced by strategic placement of floodplain roughness, riffle stability, and large woody material in-channel to promote short-term stability and robust beaver dams.
Set-back or Removal of Existing Berms, Dikes, and Levees	2b	**Performance:** Small push up levees will be removed to the greatest extent possible while still maintaining some of the mature vegetation on or immediately adjacent to the levees. Removal will promote floodplain connectivity. Levees will be setback where they are adjacent to existing infrastructure to increase floodplain connectivity while maintaining flood protection to structures. **Sustainability:** Removal of levees increases floodplain connectivity. Setbacks will require levees to be constructed to limit flows up to the 100-year flood elevation. **Risk:** Levees in this environment can trap water on the opposite side of the active floodplain. To mitigate this risk, levees will be tied into the valley walls to prevent any low spot flanking. No risk to levee removal areas.
Protect Streambanks Using Bioengineering Methods	2c	**Performance:** Provide short-term stability (5 years) at strategic locations by roughening banks using large woody debris, willow clumps, or other natural materials by limiting bank erosion to less than 20% of the total bank length of the project. **Sustainability:** The near-bank revegetation plan should provide rapid development of an early willow complex that will increase bank stability in the long term (+5 years). **Risk:** Risks include increased erosion and channel widening that reduces floodplain connectivity. This risk is being

Table 4-1. Performance and Sustainability Criteria for Each HIP Action

Work Element	HIP IV Category	Performance/Sustainability Criteria
		mitigated by redundancy in structures and revegetation treatments, which will provide bank structure. Cattle exclusion fencing and revegetation enclosure fencing will reduce bank disturbance.
Install Habitat-Forming Natural Material Instream Structures	2d	**Performance:** Willow rootball and large woody debris structures will be designed to withstand estimated hydraulic conditions associated with a minimum 10-year flow event. Structures will be strategically located to prevent channel recapture through filled portions of the main channel. The density of structures will be sufficient to meet NOAA's large wood requirements in the region (20 large pieces per mile). **Sustainability:** The volume of wood structures installed will mitigate the short-term lack of natural large woody recruitment through the project reach. Revegetation strategy should provide future large wood recruitment once the system matures (+20 years). **Risk:** The loss of structures could reduce wood loading metrics below NOAA standards. This is mitigated through volume of wood initially placed.
Riparian Vegetation Planting	2e	**Performance:** Revegetation designs will utilize local native species and a range of stock types including live stakes, plugs, and containerized plants. The objective is to generate 80% land cover within the grading area by year four. **Sustainability:** There are cottonwood trees and willows in and around the project area, including seed sources further upstream. The proposed grading plan takes into consideration native recruitment and it is expected that native cottonwood, willow, and other plants will naturally recruit within the project area, further bolstering the plant cover. The riparian community should be naturally sustainable over time following project completion. **Risk:** Plants not surviving or performing poorly increases the potential for encroachment by weeds and reduced stability of graded surfaces over time (due to reduced root mass and associated soil binding). This risk may be mitigated by requiring a specialized contractor to acquire and install plant materials, and by requiring a warranty on potted plants. Revegetation may also be scheduled for spring to maximize the probability of success.

Table 4-1. Performance and Sustainability Criteria for Each HIP Action

Work Element	HIP IV Category	Performance/Sustainability Criteria
Channel Reconstruction	2f	**Performance:** Increase sinuosity, reduce slope, add multi-threaded channel segments, narrow over-widened areas, and add instream structure to diversify instream hydraulics, improve fish habitat, and increase floodplain connectivity. The floodplain will be activated at a more frequent (1- to 2-year) interval. Channel profile and cross sections should have less than a 10% adjustment within the first five years to promote short-term stability as vegetation becomes established. **Sustainability:** Long-term goals for the project are to allow natural migration and deformability of the reconstructed channel; maintaining habitat complexity will be based upon floodplain vegetation becoming the dominating hydraulic control for the project risk. **Risk:** In early years, prior to establishment of a robust riparian corridor that will provide dominant hydraulic control, there is risk of increased deformation. This risk is being mitigated by placement of bank roughness, large woody material structures, and constructed riffles to maintain plan form and profile in the short term.

Given the small quantity of water and the project goal of distributing flow across the whole floodplain during higher flow events, the current design still simplifies the floodplain to a largely single thread channel during low-flow periods. Activation of side channels tends to begin when channel flows begin exceeding low-flow discharge. It is anticipated that this type of design treatment will allow the greatest increase in flow distribution while reducing channel energy during higher flows and still maintain passage to match existing conditions.

Based on feedback from conceptual and preliminary levels of design, the landowner encouraged the restoration effort to include more channel realignment and plugging of larger sections of the existing channel in an attempt to get the channel to occupy more of the available floodplain width. This resulted in additional plugs in the main channel and larger constructed channels within the 80% design.

The project plans for revegetation include the development of three different revegetation zones based on water availability moving from near-bank to a transitional and finally into an upland zone. Seed mixes near water include a mixture of sedges and rushes and transition into grasses and yarrow moving toward drier zones away from the active channel. These seeding zones are shown in Table 4-2 and Table 4-3.

Table 4-2. Seeding Plan for Bank/Overbank Zone.

Bank/ Overbank		
COMMON NAME	**SCIENTIFIC NAME**	**PLS* lbs./AC**
dagger-leaf rush	*Juncus ensifolius*	4
smallwing sedge	*Carex microptera*	4
Geyer's sedge	*Carex geyeri*	2

Table 4-2. Seeding Plan for Bank/Overbank Zone.

Bank/ Overbank		
COMMON NAME	**SCIENTIFIC NAME**	**PLS* lbs./AC**
panicled bulrush	*Scirpus microcarpus*	2
bigleaf sedge	*Carex amplifolia*	2
woolly sedge	*Carex pellita*	2

Table 4-3. Seeding Plan for Transitional and Upland Areas.

Transitional and Upland		
COMMON NAME	**SCIENTIFIC NAME**	**PLS* lbs./AC**
bluebunch wheatgrass	*Pseudoroegneria spicata*	16
Idaho fescue	*Festuca idahoensis*	8
Sandberg's bluegrass	*Poa secunda*	4
common yarrow	*Achillea millefolium*	1

Similarly for potted plants, wetter species (willows, alder, water birch, etc.) in the near-bank zone will transition into drier species (rose, snowberry, hawthorn, etc.) in the transitional zone and into ponderosa pine in the upland zones (Table 4-4 through Table 4-6.)

Table 4-4. Summary of Bank/Overbank Live Plants Schedule.

Bank/ Overbank				
COMMON NAME	**SCIENTIFIC NAME**	**TYPE**	**SIZE**	**SPACING (FT) (OC)**
red osier dogwood	*Cornus sericea ssp. sericea*	Potted	1 gal	4
thinleaf alder	*Alnus incana ssp. tenuifolia*	Potted	1 gal	4
water birch	*Betula occidentalis*	Potted	1 gal	4
coyote willow	*Salix exigua*	Live stake	1/2 to 1-1/2" dia	4
peachleaf willow	Salix amygdaloides	Live stake	1/2 to 1-1/2" dia	4
Scouler willow	*Salix scouleriana*	Live stake	1/2 to 1-1/2" dia	4
Bebb's willow	Salix bebbiana	Live stake	1/2 to 1-1/2" dia	4

Table 4-5. Summary of Transitional Live Plants Schedule.

Transitional				
COMMON NAME	**SCIENTIFIC NAME**	**TYPE**	**SIZE**	**SPACING (FT) (OC)**
Woods' rose	*Rosa woodsii*	Potted	1 gal	6
common snowberry	*Symphoricarpos albus*	Potted	1 gal	6
black hawthorn	*Crataegus douglasii*	Potted	1 gal	6
Scouler willow	*Salix scouleriana*	Potted	1 gal	6

Table 4-6. Summary of Upland Live Plants Schedule.

Upland				
COMMON NAME	**SCIENTIFIC NAME**	**TYPE**	**SIZE**	**SPACING (FT) (OC)**
ponderosa pine	*Pinus ponderosa*	Potted	1 gal	18

4.2 Cost Estimates

A construction cost estimate has been developed based on the 80% design drawings and is in Appendix E. Based on discussions with NPT and landowner, the project is likely to be broken into multiple phases to account for available funding and what can be constructed within a given timeframe. To accommodate this, the project quantities were broken down into four zones (upstream to downstream) and two preliminary phases of construction. Phase 1 would be the downstream half of the project from Pine Creek (also known as Salmon Creek) downstream to the property boundary. Phase 2 would extend from the upstream property (project) boundary downstream to Pine Creek. It is anticipated that construction of Phase 1 will occur in 2026 followed by Phase 2 in 2027.

5 HYDRAULIC MODELING AND ANALYSIS

The purpose of the existing conditions hydraulic model is to determine current hydraulic conditions (depth, velocity, shear stress, and water surface elevation), evaluate existing floodplain connectivity and in-channel and floodplain habitat conditions (at high and low flows), and provide the basis for comparison with future proposed conditions hydraulic modeling (to ensure project objectives are being met).

5.1 Data Used

Data used to develop the 2D hydraulic model include topography and bathymetry, aerial imagery, and hydrology.

5.1.1 Topography and Bathymetry

Topographic and bathymetric information used to create existing ground surfaces (terrain) for use in the hydraulic model (and for design) includes the following data sources:

1. **2024 Rio Topographic and Bathymetric Survey**. In February 2024, Rio ASE collected edge-of-water surface elevations to be utilized for model calibration. Additional survey was obtained in October 2024 that included bathymetric survey checks, cross sections across the floodplain to validate LiDAR elevations.
2. **2024 Chesnimnus LiDAR** (NV5, 2024). The project reach was flown by NV5 as part of the 2024 Grande Ronde Model Watershed (GRMW) LiDAR dataset. This LiDAR was collected using a red and green wavelength, which improves the ability of the LiDAR to capture bathymetric elevations. This product was provided by the GRMW in a digital elevation model format and was unaltered by Rio ASE. This dataset was validated with Rio ASE's on-the-ground survey and was ultimately used unaltered to represent the existing site conditions.

Rio ASE created an existing terrain surface using Auto CAD Civil 3D utilizing the 2024 red and green LiDAR. The terrain surface was exported to the U.S. Army Corps of Engineer's (USACE) Hydrologic Engineering Center's River Analysis System (HEC-RAS) as an existing conditions terrain with cell size of 1-foot. The surface has a coordinate system of NAD 83 OR-SP-N, NAVD 88, international feet.

5.1.2 Aerial Imagery

- 2024 Chesnimnus Orthophotography (NV5, 2024). The project reach was flown by NV5 as part of the 202 LiDAR dataset. Georeferenced orthophotography was collected and was provided as part of this dataset.

5.2 Model Development

Development of a HEC-RAS 2D hydraulic model requires a terrain surface, delineation of the model domain, designation of hydraulic roughness (Manning's n values), creation of the model mesh, and designation of boundary conditions specifying the inflow(s) hydrology and conditions for outflow(s). Each of these major components of the hydraulic model are discussed in greater detail in subsequent sections.

The existing conditions 2D hydraulic model begins three quarters of a mile upstream of the project limits and extends approximately on- half-mile downstream of the project limits. The project also includes approximately 2,000 feet of Salmon Creek where it ties into Chesnimnus Creek. The intent is to have the model domain extend sufficiently upstream and downstream of the project reach to model flow and inundation conditions at the start and end of the project reach accurately. The length on each end is to dissipate errors associated with model boundary condition assumptions.

5.2.1 Terrain

Rio ASE created an existing conditions terrain surface using HEC-RAS v6.6 by importing the existing grade surface, which is consists of the 2024 red and green LiDAR. The cell size of this terrain was set to 1 foot by 1 foot.

Proposed grading of the finish grade surface was developed in AutoCAD Civil 3D using complex graded channels (e.g., pools, riffles, point bars, etc.) that followed generalized reach slopes (riffle to riffle) provided in previous design iterations. These proposed channel surfaces were compiled into a composite finish grade surface, which was then pasted on top of the existing grade surface. The proposed conditions terrain was created using HEC-RAS v6.6 by importing the composite of the finish grade surface pasted on top of the existing grade surface. The cell size of this terrain was set to 1 foot by 1 foot.

5.2.2 Hydraulic Roughness

Rio ASE used the aerial imagery, to estimate hydraulic roughness mapping for the entire model domain. Using the aerial imagery as a reference, polygons were digitized based on the identifiable features listed in Table 5-1. Manning's n values were assigned to each vegetation/feature type based on a combination of values used in previous modeling efforts for projects on the Lemhi River (which were selected based on calibration data) and based on the Arcement & Schneider (1989) method. The selected Manning's n values in Table 5-1 are consistent with published values in Chow (1959).

Table 5-1. Hydraulic Model Manning's n Values

Description	≥ 1.25-year Flow Manning's n	Low Flow (75 cfs) Manning's n
Channel	0.044	0.087
Dense Forest	0.12	0.12
Road – Gravel	0.023	.023
Road – Dirt	0.018	.018
Wetlands	0.075	.075
Buildings	0.16	0.16
Grass	0.03	0.03
Moderate Forest	0.1	0.1
Moderate Riparian	0.1	0.1
Log Jam	0.15	0.15

For flows equal to or greater than the 1.25-year flow, the channel Manning's n value was determined using model calibration results. There was one water surface elevation dataset available to calibrate the model, which consists of surveyed water surface elevations associated with the February 2024 Rio ASE site visit.

The 2024 Rio topographic and bathymetric survey collected in February 2024 included one flow measurement upstream of Salmon Creek, one downstream of Salmon Creek, and one at the downstream extent of the project site. These flows were modeled using the existing conditions terrain and the resulting modeled water surface elevations were compared to the measured water surface elevations. These results confirmed that the assumed Manning's roughness value of 0.044 was valid for this site for flows at or greater than the 1.25-year recurrence interval flow.

5.2.3 Computational Mesh

The USACE's HEC-RAS 2D program uses a finite-volume solution scheme, which allows for use of a structured or unstructured computational mesh. This means that the computational mesh can be a mixture of 3- to 8-sided cells. The existing and proposed conditions hydraulic model uses a structured and unstructured mesh that contains variable mesh cell sizes ranging from 30-ft spacing to 2-ft spacing. Generally, the model mesh within floodplain areas that have a low topographic complexity use a nominal grid mesh (square cells) with a resolution of 10 feet by 10 feet. Channels or areas with high topographic complexity use a much finer mesh with variable-sided computational cells. Areas on the fringe or believed to be above the flood water surfaces has a gird with a resolution of 30 feet by 30 feet. For all perennially active channels, the mesh was sized to achieve on average six cells across the channel bottom. To improve model accuracy and efficiency, breaklines were included to enforce cell size and to align the edges of mesh cells at locations of topographic change. These locations include top of existing and proposed banks, toe of slopes, centerline or thalweg of channels, top of roads, riffle crests, and any other areas requiring a more detailed mesh or where more complex hydraulic conditions are expected to occur.

5.2.4 Boundary Conditions

Boundary conditions designated within the model specify the flow rate(s) for flow entering the model (inflow) and conditions or flow rates leaving the model (outflow). Table 5-2 lists boundary conditions defined in the existing and proposed conditions hydraulic models.

Table 5-2. 2D HEC-RAS Model Boundary Condition Flows

Flow	Upstream Inflow Boundary (cfs)	Salmon Creek Inflow (cfs)	Peavine Creek Inflow (cfs)
Low Flow (Summer 95% Exceedance)	3	6	3
Calibration/Winter Flow	16	28	3
1.5-year	264	218	97
5-year	524	435	175
100-year	1494	1246	444

Note: negative values indicate outflow

The upstream inflow boundary flow rate is different for each model run. Development of flows used for the upstream inflow boundary condition is presented in Table 3-3.

The downstream outflow boundary is set to normal depth and therefore uses the Manning's equation to compute normal depth at each computational mesh cell along the boundary, assuming an energy slope of 0.0059 ft/ft which is equal to the reach slope within 200 feet upstream of the model extent.

5.2.5 Structures

There are two private access bridges located within the project reach. The upstream bridge is a railcar bridge set on timber abutments located upstream of Salmon Creek. The downstream bridge is located to access the main ranch house and other infrastructure. This bridge is timber bridge set on concrete/timber abutments. These structures are defined in the existing and proposed conditions 2D hydraulic models.

Figure 5-1. Railcar bridge located upstream of Salmon Creek (looking downstream).

Figure 5-2. The lower timber bridge (looking downstream) is narrower than the channel width upstream and downstream of the crossing and shows signs of being flanked during high flows.

5.2.6 Computational Method and Options

The existing and proposed conditions 2D hydraulic models were run using both the diffusion wave (DW) and shallow water equation (SWE) computational engines. The SWE set uses full Saint-Venant momentum equations. For all model runs, separate DW and SWE plans are created and are named with a “DW” for diffusion wave or “FM” for full momentum in the plan file. Each DW model run saves a restart file at the end of the model simulation, which is then used as the initial condition for the SWE model simulation. All model runs are performed using unsteady state boundary conditions and use a fixed time step; the computational interval (time step) for DW model runs was 1 second and the time step for SWE model runs was 0.5 seconds. All other computation options and tolerances utilize HEC-RAS default settings.

5.3 Existing Conditions Model Results

The hydraulic model results in Appendix B include a link to an online viewer of the 2D hydraulic model results (depth and velocity) for existing conditions during various recurrence interval flows. Interpretations of the results are summarized as follows:

1. Depth and velocity results indicate a substantial lack of hydraulic variability throughout the project reach.
2. Leveed sections and entrenched/incised sections show limited floodplain connectivity throughout the subreaches. Typically flow activates at the upstream end and has disconnected connections at the downstream end.
3. Both bridges are undersized for extreme flow events.
4. High energy in main channel results in seasonal loss of beaver dams.
5. Areas showing some lateral connection near the 1.5-year water surface elevation typically align with more consistent beaver presence and activity.

The project reach is straightened, incised, and confined, resulting in a lack of floodplain connectivity. Combined with a homogenous channel bed, the project reach provides little quantity and quality habitat value to juvenile and adult salmonids.

5.4 Proposed Conditions Model Results

A proposed conditions model was developed for the 80% design that includes all proposed channel excavation and channel fill grading. These proposed conditions were embedded into the existing conditions terrain model and the hydraulic model was run. A website has been provided to the Tribe and project partners for review of hydraulic model results.

6 STABILITY ANALYSIS

6.1 Large Woody Material Risk Assessment and Design Factors of Safety

Large woody material structures are proposed in the main channel, side channels, and floodplain to provide roughness and habitat throughout the project area. There are numerous types of proposed structures; each will consist of key log members that act as the frame of the structure. The structure will then be completed with the addition of racking logs and slash material. These structures are intended to emulate natural log jams. Loose, unanchored wood pieces/structures will also be incorporated into the design.

Rio ASE analyzed perceived risk associated with large woody material using the Large Woody Materials–Risk Based Design Guidelines (Knutson & Fealko, 2014). The risk analysis for the project area estimates a low risk to public safety and a low risk to property damage. There are no residential houses, outbuildings, irrigation diversions, or public bridges within or in the near downstream vicinity of the project reach. The risk matrix scorings in Figure 6-1 are intended to be representative of all structures proposed within the project reach.

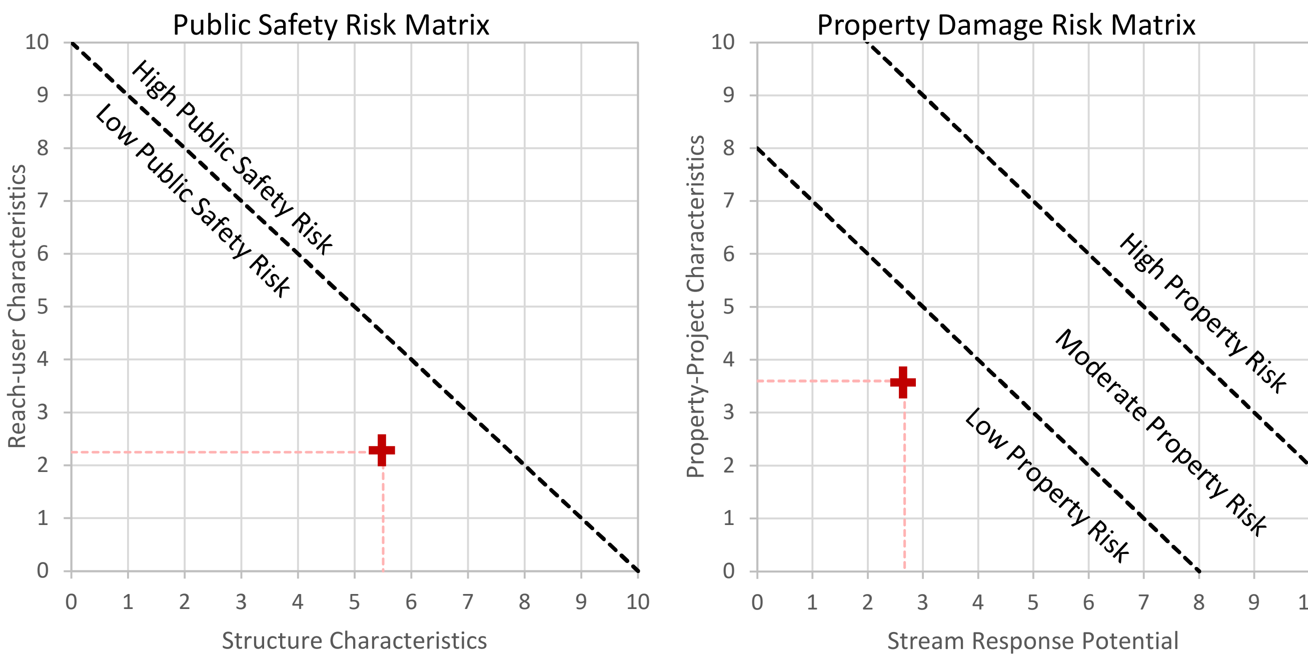

Figure 6-1. Risk evaluations for public safety and property damage.

These guidelines recommend a design flow event equal to or greater than the 10-year peak flood and factors of safety of 1.5 for buoyancy and 1.3 for sliding and rotation.

7 CONSTRUCTION

Rio ASE considered HIP General Aquatic Conservation Measures when completing the project design. We included HIP Conservation Measures, with more detail, as notes in the Drawings attached in Appendix A for ease of reference by the construction contractor. The following is a summary of the project's compliance with the general conservation measures.

7.1 General Aquatic and Construction Conservation Measures

- **Climate change**: Climate change was considered in the design. Primary features that address climate change scenarios (runoff timing, lower flows, increased temperature) include side channels, wetlands, and shallow groundwater storage. In addition to these features, there will be increased floodplain connectivity and wetland habitat, which should also enhance shallow groundwater storage and subsequent surface water/groundwater connectivity in warmer months and low-flow conditions.
- **Timing of in-water work**: The approved in-water work window for Chesnimnus Creek is currently July 15 – February 15 (ODFW, 2023).
- **Site layout and flagging**: The construction contractor will be required to stake all major project elements for approval by the contracting officer or engineer prior to construction and adhere to vertical and horizontal tolerances in accordance with the Specifications (to be developed in a future design phase).
- **Temporary access roads and paths**: Temporary access routes are shown in the Drawings (Appendix A). The construction contractor will not be allowed to deviate from the designated routes unless approved by the contracting officer or engineer.
- **Temporary stream crossings**: Temporary stream crossings are shown in the Drawings (Appendix A). The construction contractor will not be allowed to deviate from the crossing locations unless approved by the contracting officer or engineer.
- **Staging, storage, and stockpile areas**: Proposed staging and stockpile areas throughout the project area are shown in the Drawings (Appendix A). The construction contractor will not be allowed to deviate from these areas unless approved by the contracting officer or engineer.
- **Equipment**: Equipment necessary to complete the project likely will include dozers, excavators, loaders, and a variety of service vehicles. We included HIP General Conservation and Implementation Measures as notes in the Drawings (Appendix A), and those notes indicate biodegradable lubricants are required for work below the OHWM.
- **Erosion control**: HIP General Aquatic Conservation Measures in the Drawings (Appendix A). Those include erosion control measures for temporary erosion controls, sediment barriers restricting loads to the stream, soil stabilization measures and emergency erosion controls. Our scope does not include preparation of a project specific storm water pollution prevention plan (SWPPP).
- **Dust abatement**: General Conservation and Implementation Measures in the Drawings (Appendix A). Those include recommendations regarding work scheduling, dust stabilization measures (water only), spill containment, and a restriction on petroleum-based stabilization products.
- **Spill prevention, control, and counter measures**: HIP General Conservation and Implementation Measures are included in the Drawings (Appendix A). Those include directing the contractor to keep a list of hazardous materials, written procedures for notification of environmental response, spill containment kits, worker training, and storage of waste liquids. Our scope does not include preparation of a project specific SWPPP.
- **Invasive species control**: HIP General Conservation and Implementation Measures are included in the Drawings (Appendix A). Those include directing the contractor to power wash all vehicles, inspecting in-water equipment and a restriction on felt-soled wading boots. Our scope does not include preparation of a project-specific invasive species control plan.

8 LIMITATIONS

Some clients, design professionals, and contractors may not recognize that stream and river engineering analysis and design practices are less exact than other engineering and natural science disciplines. Such misunderstandings can create unrealistic expectations, sometimes leading to disappointments, claims, and disputes. Rio ASE includes these explanatory “limitations” provisions in our reports to help reduce such risks. Please confer with Rio ASE if you are unclear how these “Report Limitations and Guidelines” apply to your project or site.

8.1 Design Purposes, Persons, and Projects

This report has been prepared for the Client and their authorized agents and regulatory agencies for use on the Project(s) specifically designed in the report. The information contained herein is not applicable to other sites or projects.

Rio ASE structures its services to meet the specific needs of its clients. No party other than the Client may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Project and its schedule and budget, our services have been executed in accordance with our Agreement and generally accepted practices in this area at the time this report was prepared. We do not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

8.2 Design Factors

This report has been prepared solely for this Project and Client. Rio ASE considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless Rio ASE specifically indicates otherwise, it is important not to rely on this report if it was:

- Not prepared for you,
- Not prepared for your project,
- Not prepared for the specific site, or
- Completed before project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- The function of the proposed design and/or structure
- Elevation, configuration, location, or orientation of the proposed structures
- Composition of the design team, or
- Project ownership.

If changes occur after the date of this report, Rio ASE cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations in the context of such changes. Based on that review, we can provide written modifications or confirmation, as appropriate.

8.3 Conditions Can Change

This report is based on conditions that existed at the time the study/design was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability, stream flow fluctuations or stream channel fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact Rio ASE before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

Any designs associated with this report may need to be adjusted in the field during construction in order to meet the specific-site conditions and intended function. Rio ASE cannot assume responsibility for the recommendations in this report if unexpected conditions are encountered during construction. We recommend that you allow sufficient monitoring and consultation by Rio ASE during construction to confirm that the conditions encountered are consistent with those indicated in the report, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether construction activities are completed in accordance with our recommendations.

8.4 Report Misinterpretation

Misinterpretation of this report can result in costly problems. Rio ASE can help reduce the risks of misinterpretation by conferring with appropriate stakeholders after submitting the report, participating in pre-bid and preconstruction conferences, and providing construction observation.

To help reduce the risk of problems, we recommend giving contractors the complete report, including these "Report Limitations and Guidelines." When providing the report, we recommend that you preface it with a clearly written letter of transmittal that:

- Advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited, and
- Encourages contractors to confer with Rio ASE and/or to conduct additional study to obtain the specific types of information they need or prefer.

8.5 Hazards of Instream Habitat Structures

Instream habitat structures ("Structures") create potential hazards, including, but not limited to:

- Persons falling from the Structures and associated injury or death,
- Collisions of recreational users and their watercraft with the Structures, and associated risk of injury, and damage of the watercraft,
- Mobilization of a portion or all of the Structures during high water flow conditions and related damage to downstream persons and property,
- Flooding,
- Erosion, and
- Channel avulsion.

In some cases, instream habitat structures are only intended to be temporary, providing temporary stabilization while riparian vegetation becomes established or while stream/river processes stabilize. This gradual deterioration with age and vulnerability to major flood events make the risks with temporary Structures inherently greater with their increasing age.

Rio ASE strongly recommends that the Client appropriately address safety concerns, including but not limited to warning construction workers of hazards associated with working in or near deep and fast-moving water and on steep, slippery, and unstable slopes. In addition, signs should be placed along the enhanced stream reaches in prominent locations to warn third parties, such as nearby residents and recreational users, of the potential hazards noted above.

8.6 Channel Response is Unpredictable

In general, rivers and streams are dynamic and unpredictable. Any predictions regarding future channel evolution and/or response either stated or implied in this report or associated design(s) shall be considered an estimate based on professional judgment given the data available and conditions that existed at the time the study/design was performed. Channel evolution and/or response may include but is not limited to erosion, deposition, channel migration, avulsion, flooding, and sediment and debris transport. Channel evolution and/or response is inevitable, and it should not be assumed that any condition whether natural or constructed will persist unchanged indefinitely in a riverine environment.

8.7 Monitoring and Maintenance

In some designs, Rio ASE may have excluded piles, anchors, chains, cables, reinforcing bars, bolts and similar fasteners from woody habitat structures with the intent of mimicking naturally occurring instream wood structures. In other designs Rio ASE may have included such fasteners in woody habitat structures, if considered appropriate. While Rio ASE designs structures to be relatively stable during flood events, some movement of these structures is expected. We recommend that the Client implement appropriate monitoring and maintenance procedures to minimize potential adverse impacts at or near areas of concern, and consider replacing, adjusting and/or removing damaged, malfunctioning, or deteriorated components of structures.

8.8 Construction Site Safety

Our recommendations are not intended to direct the construction contractor's procedures, means, methods, schedule, or management of the work site during construction of any project associated with this report. The construction contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

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APPENDIX A DESIGN DRAWINGS

APPENDIX B HYDRAULIC MODEL RESULTS

Results can be viewed at the following website:

https://experience.arcgis.com/experience/53ca9816243d4e97925ecfeb85eb5fd7/.

APPENDIX C WETLANDS DELINEATION REPORT

APPENDIX D ADAPTIVE MANAGEMENT PLAN

APPENDIX E CONSTRUCTION QUANTITIES AND COST ESTIMATE

APPENDIX F DESIGN REVIEW COMMENT TRACKING