30 Percent Basis of Design

Bull Run Creek RM 0.5 Fish Habitat Enhancement
Grant County, Oregon

for

Confederated Tribes of the Umatilla Indian Reservation

March 6, 2026

523 East Second Avenue
Spokane, Washington 99202
509.363.3125

GeoEngineers

Cramer Fish Sciences
An Employee Owned Consulting Company

30 Percent Basis of Design

Bull Run Creek RM 0.5 Fish Habitat Enhancement
Grant County, Oregon

File No. 2698-036-00
March 6, 2026

Prepared for:

Confederated Tribes of the Umatilla Indian Reservation
46411 Timíne Way
Pendleton, Oregon 97801

Attention: John Zakrajsek

Prepared by:

GeoEngineers, Inc.
523 East Second Avenue
Spokane, Washington 99202
509.363.3125

Katrina Hyman-Rabeler, PE
River Engineer

Becca H. Miller, PE
Senior River Engineer

Minda Troost, LG
Senior Fluvial Geomorphologist

Jason R. Scott, FP-C
Principal

KHR:RHM:JRS:mls

Disclaimer: Any electronic form, facsimile, or hard copy of the original document (email, text, table and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

GeoEngineers

Table of Contents

GEOENGINEERS

Appendices

1.0 Project Background/Introduction

GeoEngineers, Inc. (GeoEngineers) has prepared this Basis of Design Report (report) for the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) to describe and illustrate the Bull Run Creek RM 0.5 Fish Habitat Enhancement Project (project). This is also intended for the CTUIR to submit to the Bonneville Power Administration (BPA) Restoration Review Team (RRT) for their review. This report provides a summary of our findings pertaining to the existing conditions within the project reach and processes that shaped the stream. The evaluation and consideration of the site conditions provide the basis for the project design and an explanation of the design process, analyses, and anticipated outcomes for the proposed enhancements. The 30 percent design is included as Appendix A and described below. Additional background, technical data and contract documentation are provided below.

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

Project Sponsor: Confederated Tribes of the Umatilla Indian Reservation

- John Zakrajsek, Fisheries Habitat Biologist, Project Manager
- John Clark, Fisheries Habitat Biologist
- Tamara Payton, Fisheries Habitat Biologist

Design Firm: GeoEngineers, Inc.

- Jason Scott, FP-C CESCL, Principal Fisheries Biologist, Principal in Charge
- Becca Miller, PE, Senior River Engineer, Project Manager/Engineer of Record
- Katrina Hyman-Rabeler, PE, River Engineer
- Minda Troost, Senior Fluvial Geomorphologist

Contributing Authors: Cramer Fish Sciences:

- Tyler Rockhill, PE, CFM, Restoration Engineer
- Nicole Farless, Biologist
- Zack DeLuca, Geomorphologist

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

- Mine Tailing Pile Excavation, Floodplain Grading and Main Channel / Side Channel Grading
- Large Woody Material Structures (LWM)
- Aquatic Organism Passage Structures
- Temporary Erosion and Sediment Control (TESC), Water Management

1.3 EXPLANATION AND BACKGROUND ON FISHERIES USE (BY LIFE STAGE - PERIOD) AND LIMITING FACTORS ADDRESSED BY PROJECT

The John Day River Watershed is the second longest free-flowing river in the continental United States and its spring Chinook Salmon and summer steelhead populations are two of the last remaining intact wild populations of anadromous fish in the Columbia River Basin (NPCC 2005). Additionally, the watershed has been kept relatively free of hatchery influences, which means projects like this will be primarily for the benefit of native wild populations.

The focus species this habitat enhancement project is intended to address include steelhead, spring Chinook Salmon and Bull Trout. This project reach of Bull Run Creek is identified as primary spawning and rearing use for steelhead and spring Chinook Salmon, migration use for Bull Trout and is a restoration priority for these focal fish species (NPCC 2005).

Summer steelhead in Bull Run Creek were listed as threatened under the Endangered Species Act (ESA) in 1999 and are part of the Mid-Columbia River (MCR) steelhead Distinct Population Segment (DPS). The North Fork John Day population is part of the John Day Major Population Group (MPG) and is the only viable population throughout the entire Middle Columbia DPS (NMFS 2009).

Bull Trout were listed as threatened under the ESA in 1999 and are part of the Columbia River Distinct Population Segment (DPS). The John Day Subbasin is a major drainage within the Mid-Columbia Recovery Unit and the North Fork John Day River (NFJDR) is one of 27 Bull Trout core areas in this unit. Seven local populations have been identified in the NFJDR Subbasin and Bull Run Creek falls within the upper Granite Creek population (FWS 2015).

Spring Chinook Salmon are not currently listed under the ESA in the John Day River Watershed; however, their population is significantly depressed, and no sport harvest has been allowed since 1976.

Limiting factors for the focal species in the project area are largely attributable to the impacts of past mining activities. The John Day Watershed Restoration Strategy (CTWSRO 2014), John Day Subbasin Plan (NPCC 2005), and Mid-Columbia Steelhead Recovery Plan (NMFS 2009) identified the primary limiting factors in Bull Run Creek to be degraded riparian areas, disconnected/degraded floodplains, degraded channel conditions and altered sediment routing. Bull Run Creek was also identified as a priority sub-watershed for restoration by the Wallowa-Whitman National Forest (WWNF) under the U.S. Forest Service's Watershed Condition Framework (USFS 2011) resulting in the creation of the Granite Creek Watershed Restoration Action Plan (WRAP) in 2012. Since then, CTUIR has worked in collaboration with WWNF and the North Fork John Day Watershed Council (NFJDWC) to restore sections of Bull Run Creek. Nearby restoration efforts include the recent completion of the approximate 2-mile-long middle Bull Run Creek reach located immediately upstream and the replacement of five Grant County culverts on Granite Hill Road with fish passable structures, constructed in 2025.

Water temperature is a primary limiting factor for aquatic health in Bull Run Creek, particularly due to the thermal sensitivity of the focus species. Elevated water temperatures can result in stress, displacement, or mortality. Elevated stream temperatures also reduce dissolved oxygen concentrations, increase metabolic demand, and contract the extent of suitable habitat, particularly during summer low-flow periods. Recognizing these risks, temperature has been identified as a water quality limited parameter in the Oregon Department of Environmental Quality John Day Basin Temperature Total Maximum Daily Load (TMDL), which establishes thermal targets intended to support cold-water aquatic life and protect designated beneficial uses (ODEQ 2010). In this context, restoration actions that increase floodplain connectivity, enhance hyporheic exchange, and promote riparian shading directly address a key limiting factor affecting long-term ecological resilience in Bull Run Creek.

1.4 PRIMARY PROJECT FEATURES, INCLUDING CONSTRUCTED OR NATURAL ELEMENTS

The 30 percent Design (Appendix A) contains restoration actions designed to achieve the objectives outlined in Table 1. The proposed project elements are described below and detailed technical analysis supporting design development is included in Section 3.0. The project elements include:

1.4.1 Proposed Project Element 1: Floodplain Grading and Mine Tailings Removal

Project Element 1 expands available floodplain through grading and removal of mine tailings along approximately 2.3 miles of Bull Run Creek. While site constraints—including infrastructure and landowner participation limit a full valley-wide restoration—the design prioritizes creation of the largest floodplain practical within these constraints to support natural hydrologic and geomorphic processes. Valley floodplain widths vary between 40 and 400 feet (ft), with widths exceeding 100 ft in many areas. A new main channel will be cut into the valley floodplain at roughly the existing channel thalweg elevation, and the valley floodplain elevation is set approximately 2 feet above the main channel bed elevation. Floodplain grading and tailing pile removal falls under the HIP IV activity category 2a, improving secondary channel and floodplain connectivity and 2f, channel reconstruction.

The grading plan prioritizes the removal of tailings piles that currently impede hydrologic connectivity, particularly where depressional features identified in the Relative Elevation Model (REM; Section 2.2) can be reactivated. Excavation efforts are targeted to minimize unnecessary disturbance and retain existing vegetation within these depressions.

Reconnection of the valley floodplain is also expected to improve stream temperature conditions. Expanding the floodplain area increases surface and subsurface water storage, promotes hyporheic exchange, and lengthens flow paths, all of which can moderate summer water temperatures. Increased floodplain interaction supports riparian vegetation establishment to enhance long-term shading and reduce solar radiation inputs. Over time, these processes are expected to reduce peak summer temperatures and improve thermal resilience within the project reach.

The resulting valley grading will require approximately 204,000 cubic yards (cy) of excavation. Permanent stockpile locations are shown in Appendix A and will continue to be refined based on discussions with project partners during 80 percent Design development.

1.4.2 Proposed Project Element 2: Main Channel Reconstruction

Project Element 2 includes main channel reconstruction within the valley regrade limits. Main channel reconstruction and realignment fall under the HIP IV activity category 2f, channel reconstruction. The channel will be intentionally undersized to allow frequent interaction with the adjacent floodplain and allow for natural channel adjustment and shaping to occur over time. The main channel will be realigned to replicate a high mountain meadow system with numerous high-flow connections and a high degree of sinuosity. The design allows for continued channel migration and adjustment in response to sediment transport and flow variability rather than dictating a rigid planform. Structural elements, such as roughened bed materials in riffle segments, will be incorporated to provide initial stability, backwater side channels and tie into features that must remain fixed within the landscape (e.g. road crossings) while still allowing natural sediment sorting and scour processes to shape habitat features over time. High-functioning sections of the main channel that currently provide functioning habitat, including locations with pools or established riparian cover, will be preserved within the realigned channel. Restoration efforts on Bull Run Creek extend up into the tributary of Corral Creek, which will be reconnected to the Bull Run Creek floodplain.

To further enhance connectivity, side channels will be integrated throughout the project reach, allowing seasonal high flows to disperse across the floodplain and naturally develop a multi-threaded network and floodplain wetlands. Side channel development falls under HIP IV activity category 2a, improving secondary channel and floodplain connectivity. These side channels will activate during seasonally high flows, distributing water across the floodplain and allowing for sediment and wood retention. These features will connect to existing and created floodplain depressions that provide off-channel habitat for fish and wildlife species, including the Columbia spotted frog.

1.4.3 Proposed Project Element 3: Large Woody Material Habitat Structures

Project Element 3 includes LWM habitat structures designed throughout the main channel and side channels. Installation of LWM falls under HIP IV activity category 2d, install habitat-forming instream structures. LWM will be placed throughout the floodplain and side channels to improve off-channel aquatic habitat. These structures are intended to add roughness and hydraulic diversity to the main channel and floodplain surfaces and be embedded within the floodplain throughout the regraded areas to add buried structure within the floodplain. Placement of LWM within the main channel will promote inundation of the adjacent floodplain, encourage sediment sorting, pool formation, support bank structure and hold grade during initial channel adjustments, force sinuosity and add channel complexity. Side channel LWM will function similarly, adding form and structure, forcing sinuosity, and adding complexity. Floodplain roughness in the form of embedded woody material will be incorporated to promote floodplain stability post-construction and support establishment of riparian vegetation. Proposed LWM habitat structures include meander jams, small apex jams, longitudinal logs, step turn logs, bank rootwads, and a variety of single-log structures. Also included under this project element is the installation of smaller woody material structures, including Beaver Dam Analogs (BDA's) which are intended to mimic beaver dam complexes that are currently absent from the site (Section 2.4). The structures will be placed throughout the floodplain, co-located within side channels and will extend up into Corral Creek.

Floodplain grading and tailings removal will generate a large quantity of suitable logs and woody debris through removal of the existing lodgepole pine (*Pinus contorta*) stands that are ubiquitous across the tailings piles. This material will be incorporated to the greatest extent possible within the floodplain and main channel. Wood removal quantities will be developed as the design progresses to better understand the quantity and size of trees within the clearing limits.

1.4.4 Proposed Project Element 4: Riparian Planting

This action includes native revegetation of disturbed areas on the floodplain. The riparian planting falls under HIP IV activity category 2e, riparian and wetland vegetation planting. The project aims to increase the riparian buffer on both sides of the creek with planting of native riparian species. Planting plans will be developed collaboratively with USFS, CTUIR, NFJDWC, CTWSRO, and ODFW as the designs progress. Paramount to vegetation success will be the incorporation of floodplain treatments to promote plant establishment (Section 3.4.6). This includes incorporation of soil amendments, including biochar, compost and fine material to help plant establishment. Plant selection and placement will consider the depth to available groundwater and frequency of inundation. A mix of woody species and sedge mats will be selected to support channel stabilization and revegetation immediately following construction.

Also included under Project Element 4 are proposed channel treatments that incorporate the placement of coir logs and riparian stakes to create an inset vegetated floodplain along the toe of the main channel downstream of the Granite Hill Road crossing. These details will be developed at 80 percent Design.

1.4.5 Proposed Project Element 5: Aquatic Organism Passage Structures

Project Element 5 includes the replacement of three undersized culverts on Bull Run Creek, and one new crossing on Bull Run Creek to facilitate the removal of the driveway and undersized culvert disconnecting Corral Creek with Bull Run Creek. All crossings will be sized to facilitate aquatic organism passage (AOP). Culvert replacement falls under HIP IV activity category 1f Bridge and culvert removal or replacement.

The proposed crossings will provide a minimum hydraulic opening width equal to 1.5 times the design bankfull width (Section 3.4) and will accommodate floodplain benches. Following review of the proposed conditions hydraulic model results, the crossing widths were increased, and the minimum hydraulic opening will continue to be refined as design advances. Final structure selection and foundation design are contingent on geotechnical exploration planned for spring 2026. Boring data from the culvert replacements on Granite Hill Road suggest that subsurface soils at the crossing locations may have low structural capacity and could require deep foundations. For cost estimating and hydraulic modeling purposes, modular rolled girder bridges are currently assumed at all four crossings, in part due to the limited depth of cover over the existing culverts. Structure type and minimum hydraulic opening width will be further evaluated and refined at 80 percent Design.

1.5 PERFORMANCE/SUSTAINABILITY CRITERIA FOR PROJECT ELEMENTS AND ASSESSMENT OF RISK OF FAILURE TO PERFORM, RISK TO INFRASTRUCTURE, POTENTIAL CONSEQUENCES AND COMPENSATING ANALYSIS TO REDUCE UNCERTAINTY

The goal of the project is to address the Primary Limiting Factors identified for the North Fork John Day Watershed in the 2008 Fish Accords, incorporate the primary touchstones described in the 2008 Umatilla River Vision (Jones et al. 2008), and be consistent with the Mid-Columbia Steelhead Recovery Plan (NMFS 2009), Bull Trout Recovery Plan (USFWS 2015), and the John Day Subbasin Plan (NPCC 2005).

CTUIR's River Vision (Jones et al. 2008) is the restoration framework, upon which the designs are based. Design objectives will be consistent with all five of the CTUIR's River Vision Touchstones. Specific project objectives aligned with each of the River Vision Touchstones are shown in Table 1.

TABLE 1. GOALS AND OBJECTIVES

RIVER VISION TOUCHSTONE	GOAL	OBJECTIVE
Water Quality and Quantity	Increase base flow through functional connection with the alluvial aquifer and decrease summer stream temperatures.	Increased instream thermal diversity throughout the year.
Geomorphology	Restore natural form; sinuosity; complexity; geomorphic stability; enhance large wood and boulders to increase channel complexity; and improve sediment routing/dispersal.	Increased channel complexity, with channel morphology closer to historical and natural form. Increased quantity and quality of habitat diversity, especially wood and pools to maintain resting areas for returning salmon. Improved sediment mobilization, deposition, sorting and routing. Increased stream velocity diversity at both low and high flows
Connectivity	Increase lateral connection with the historic floodplain and vertical connection with the alluvial aquifer.	Increased floodplain connectivity and frequency of inundation
Riparian Vegetation	Protect existing riparian vegetation and enhance vegetation to improve geomorphic function and water quality.	Increased riparian function with site-appropriate native vegetation
Aquatic Biota	Increase the quality, quantity and diversity of habitat for resident and anadromous fish of all age classes.	Improved upstream and downstream fish passage Increased area suitable for adult spawning Increased area suitable for juvenile rearing Increased habitat for Columbia spotted frog

Performance of the design in meeting the objectives outlined in Table 1 will be evaluated throughout design development and will include hydraulic modeling of existing and proposed conditions.

1.5.1 Assessment of Risk of Failure to Perform, Risk to Infrastructure, Potential Consequences and Compensating Analysis to Reduce Uncertainty

Within the project reach there are existing infrastructure constraints that need to be maintained. This includes retaining access along Granite Hill Road and the private driveways that provide residential access. Overhead and buried utilities will be considered and either maintained or relocated within the areas impacted by valley grading. Risk to infrastructure will be evaluated as the design progresses through hydraulic modeling to compare proposed water surface elevations to the elevations of adjacent roads and residences. A scour analysis will be performed at each AOP crossing to support foundation design and evaluate risk of channel migration.

Additional risks considered in the design development include flow going subsurface following channel construction if intercepted by a highly permeable lens within the reworked tailings. To reduce this risk, we are maintaining the existing channel elevation to avoid raising the channel above the groundwater table and lowering the valley regrade surface to be within 2 feet of the proposed channel. We will also complete a subsurface analysis to characterize the composition of tailing materials through borings and test pits and will complete a groundwater study, including installation of groundwater monitoring wells to better characterize groundwater levels throughout the project area. The geotechnical analysis and subsurface investigation will help characterize the tailings composition and implementation of additional geotechnical studies, including a hydrogeologic investigation, will help in the evaluation of subsurface flow risks. It is important to note that subsurface investigations will not be comprehensive throughout the entirety of the site and, therefore, will not represent intricacies beyond the sample locations.

The period immediately following construction represents the greatest potential for channel instability, as vegetation will not yet be established to provide root reinforcement and hydraulic roughness. Anticipated short-term channel adjustments were considered in development of the typical main channel cross-section geometry. The channel has been intentionally undersized, and LWM incorporated throughout the graded reaches, to reduce the risk of post-construction widening. Rapid revegetation measures, including installation of sedge mats and other plantings, will also be incorporated to accelerate vegetative establishment and improve bank resistance during the initial stabilization period.

Through discussions with project partners, we have highlighted additional items that are beyond the level of detail to be presented at 30 percent Design but will be considered as the design progresses. This includes:

- Stability of permanent stockpile locations.
- Plant selection and establishment and consideration of soil amendments to promote revegetation.
- Changes in landowner participation in the project.
- Mining claims within the USFS reach.

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

Project construction is anticipated to begin in summer 2027 during an in-water work window established by regulatory agencies and is anticipated to be from July 15 through August 15 (ODFW 2004a). In-water work will include tailings piles removal and floodplain grading, channel creation, installation of LWM structures and installation of AOP structures. In-water work will be isolated to the extent possible to reduce impacts from sediment to ESA-listed and resident fish species. The disturbance and grading limits are shown in Appendix A. CTUIR fisheries staff will provide fish salvage operations in isolated work areas following HIP guidance. A sequencing and work isolation plan and stream diversion plan will be provided at 80 percent Design submittal.

1.7 ALTERNATIVES EVALUATION

1.7.1 Alternative Development

During conceptual design development, we identified multiple alternatives based on project goals, objectives and the anticipated project elements described above. The design team including GeoEngineers, Cramer Fish Sciences, and CTUIR met with Sean Welch of Bonneville Power Administration (BPA) on October 28, 2024, to discuss design concepts and site observations. The conversation included a discussion of the restoration approaches and risks associated with each. The two general design alternatives discussed included:

Alternative 1: Leveling tailings and raising the channel and floodplain: This approach focuses on leveling the tailings to raise the floodplain elevation, similar to a Stage Zero restoration strategy, though the target elevation may not strictly reflect the historical floodplain. Instead, the elevation would be selected to minimize grading disturbances and earthwork volumes and work within the confines of the adjacent properties and stream crossings. While not all tailings will be leveled (with only partial removal or redistribution), the goal is to raise the floodplain surface to restore more natural conditions and enhance the channel's lateral connectivity to the floodplain. The elevation increase would likely be in the range of 2 to 3 feet, though the exact lift will depend on site-specific needs and topography. A key consideration in this approach is the potential risks of losing surface flow to subsurface flow, especially during low-flow conditions.

Alternative 2: Selective tailing removal, routing of the channel towards existing depressions and creation of an inset floodplain: This approach focuses on using the existing depressions in the landscape for routing the channel, while pushing tailing piles to the margins or uphill slopes, selectively removing some but not all material and creating a floodplain inset between tailings.

The draft 15 percent Design considered both Alternative 1 and Alternative 2 and depicted a design similar to Alternative 2. A minimum floodplain width was selected and an inset floodplain defined throughout the valley grading limits, with the channel elevation roughly matching existing channel elevations. GeoEngineers, CTUIR and project partners (NFJDWC, USFS, CTWS) met to discuss the Draft 15 percent Design and other design alternatives on December 17, 2024. Based on the discussion, three alternatives were outlined and discussed including:

Alternative 1—Leveling tailings and raising the channel and floodplain, as described above.

Alternative 2—Selective tailing removal, routing of the channel towards existing depressions and creation of an inset floodplain. This is the design depicted at draft 15 percent Design. The design was then refined to incorporate feedback into the final 15 percent Design.

Alternative 3—Minimal channel grading and placement of LWM through the project reach to increase roughness, encourage overbank flow and provide instream cover and habitat complexity.

Typical sections for Alternative 1, 2 and 3 are shown in Figure 1.

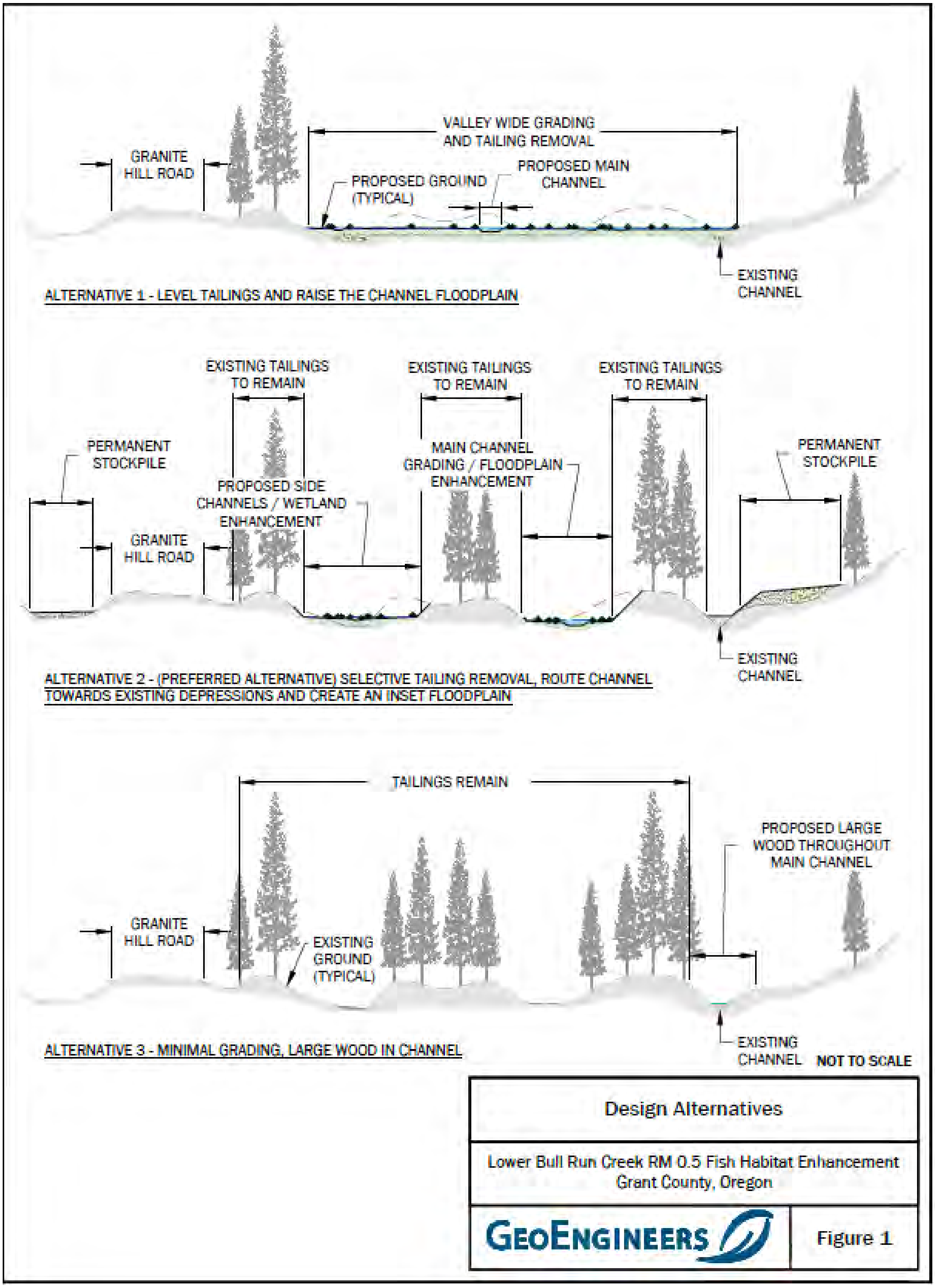

Figure 1. Design Alternatives

1.7.2 Alternatives Evaluation

We compared alternatives based on rough grading quantities and disturbance footprints, summary of risks associated with the design elements and qualitative comparison of the habitat uplift potential for each alternative.

1.7.2.1 ALTERNATIVE 1

A full valley wide reset, including reestablishment of the channel elevation, was considered during the development of the conceptual design to establish a grading that balanced cut and fill volumes and limited export of materials from the site. This full valley reset with a balanced cut/fill approach required the floodplain to be set approximately 5 ft above the existing thalweg elevation and the proposed channel filled to create a new channel approximately 3 ft above the existing. The resulting disturbance footprint is approximately 50 acres and would require approximately 130,000 cy of cut and 130,000 cy of fill.

Following discussions with project partners, it was determined that without extensive subsurface data, there is too great of a risk of summer flows going subsurface if the channel is raised. Additional implementation challenges include high initial disturbance footprint and space constraints and the need to maintain access to existing residences.

1.7.2.2 ALTERANTIVE 2

Alternative 2 includes selective tailing removal, routing of the channel towards existing depressions and creation of an inset floodplain. This approach could achieve similar habitat benefits as Alternative 1, with smaller disturbance footprint and reduced risk of losing surface flow to subsurface flow. Raising the channel and floodplain would be minimal, however, there are still concerns about potential surface flow loss due to tailings' transmissivity. Additionally, the cut and fill volumes will not be balanced, with excavation quantities far exceeding fill volumes during floodplain grading, necessitating permanent stockpile locations to be established as part of the design. The resulting disturbance footprint is approximately 40 acres and would require approximately 150,000 cy of cut.

1.7.2.3 ALTERANTIVE 3

Alternative 3 relies on minimal channel modification and the addition of LWM to increase roughness, promote overbank flow, and enhance instream habitat complexity. While this approach results in significantly less disturbance compared to Alternatives 1 and 2, its footprint remains confined to the existing channel alignment and the topographic constraints on the geomorphic processes in Bull Run Creek remain unaltered (Section 2.3). This alternative does not support natural channel evolution, as it adds wood to replicate a reference channel form without restoring the processes that sustain long-term function. While frequency of inundation may increase, floodplain connectivity will remain constrained by tailings piles.

1.7.3 Alternatives Selection

As part of the project development process, we conducted an alternatives analysis in collaboration with the project partners. Over the course of several meetings between October 2024 and January 2025, we reviewed and discussed a variety of design options, evaluating each, based on factors such as feasibility, environmental impact and risks to long-term success, and alignment with project goals. Through these discussions we reached a consensus on the preferred alternative, Alternative 2. This alternative best meets the project’s objectives while balancing technical, practicable and environmental considerations. The final selection was made with input from the project partners. Alternative 2 was then advanced to 15 percent Design.

1.7.4 30 Percent Design Development

Following the 15 percent Design review, floodplain grading was expanded as much as feasible within existing landowner and infrastructure constraints, maximizing floodplain area and removing tailings that limit connectivity. Grading within floodplain depressions was further limited to position the main channel and side channels near these depressions while minimizing disturbance to established vegetation. Details of the 30 percent Design are further described in Section 3.0. Comments received on 15 percent Design are included in Appendix D.

2.0 Resource Inventory and Evaluation/Site Characterization

Bull Run Creek is a tributary to Granite Creek in the North Fork John Day Watershed in northeast Oregon (Figure 2). Currently, the Bull Run Creek project area consists of a patchwork of private landowners and public parcels with many infrastructure constraints throughout the valley. The project extents are shown in Appendix A and include approximately 2.3 miles of Bull Run Creek and adjacent floodplain.

Bull Run Creek has historically been impacted by placer mining, beaver trapping, livestock grazing and tree clearing (GeoEngineers 2018; Kleinschmidt 2021). Based on the General Land Office (GLO; BLM 2024) map, mining had occurred in Bull Run as early as 1881, which is confirmed by the mining ditches along the riparian zone (Figure 3). Additionally, Blue Mountain Boat company began dredging Bull Run Creek in 1938, and it is estimated that more than 1,000,000 cy of gravel were dredged within a single year (Mining World 1940). Mining throughout Bull Run significantly altered the valley bottom, causing channel straightening, increased channel confinement and incision, reduced channel complexity and limited lateral connection with the floodplain (Figure 4). Based on the 2024 surface data, mining operations resulted in areas that had been dredged as deep as 8.5 ft. The excavation, haul and sediment sorting resulted in a reworking of the entire valley bottom and effectively removed the natural alluvial morphological features that took millennia to develop.

On August 22 and September 12, 2024, we conducted a rapid observational field survey to inventory resources on Bull Run Creek. The results of that survey are discussed throughout Section 2.0. Additionally, channel bathymetry and ortho imagery were collected by RSI in 2024 and blended with 2020 Light Detection and Ranging (LiDAR) to create a combined terrain for the Bull Run Creek project area and the valley bottom (refer to Section 3.0 for more detail). We used the 2024 surface data to develop a flow accumulation model and a relative elevation model (REM) for the Bull Run Creek project site (Figure 5).

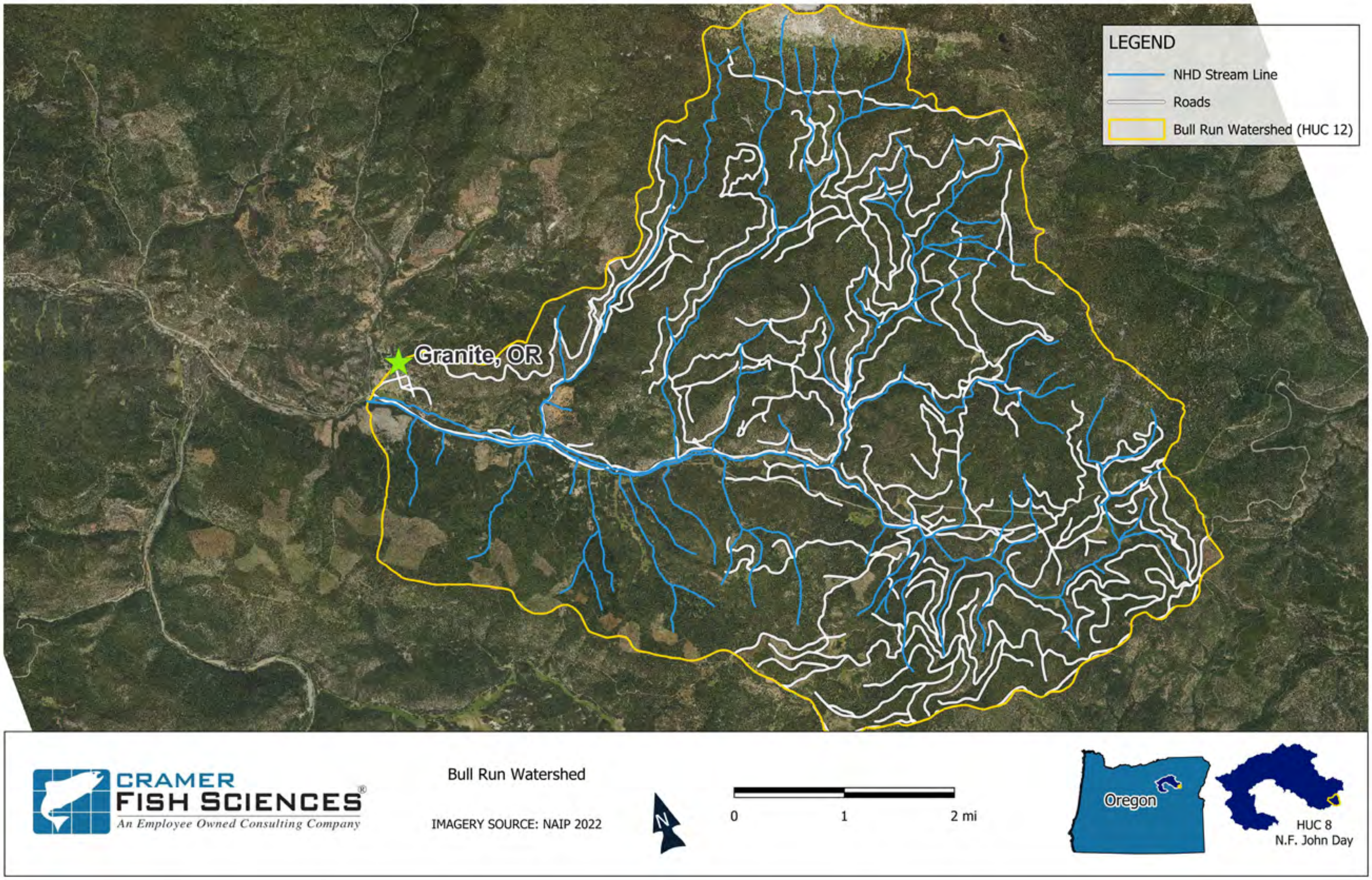

Figure 2. Bull Run project site location and roads and stream flowlines for the watershed.

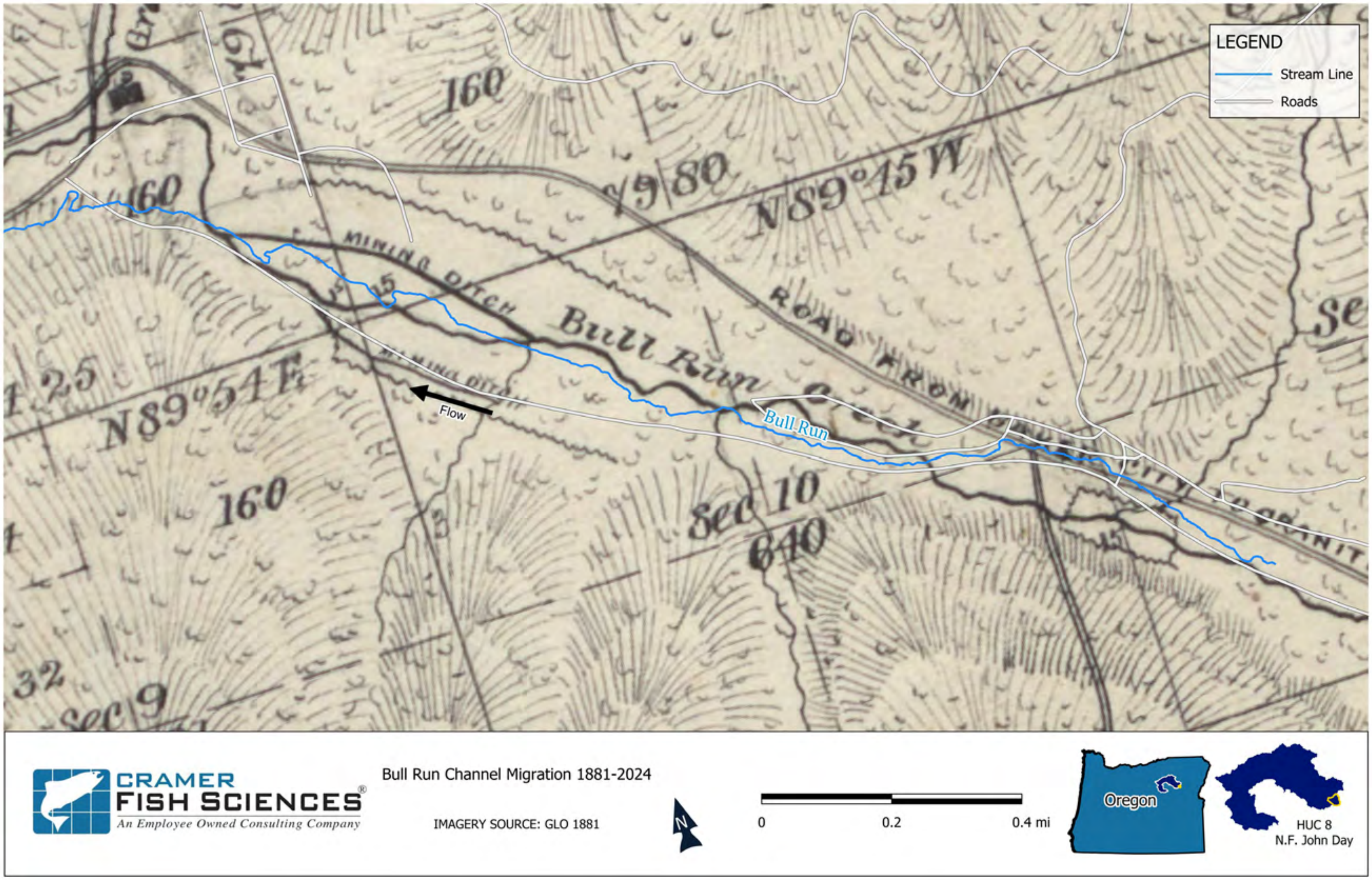

Figure 3. GLO map from 1881 and stream flow line derived from flow accumulation model developed from 2024 LiDAR.

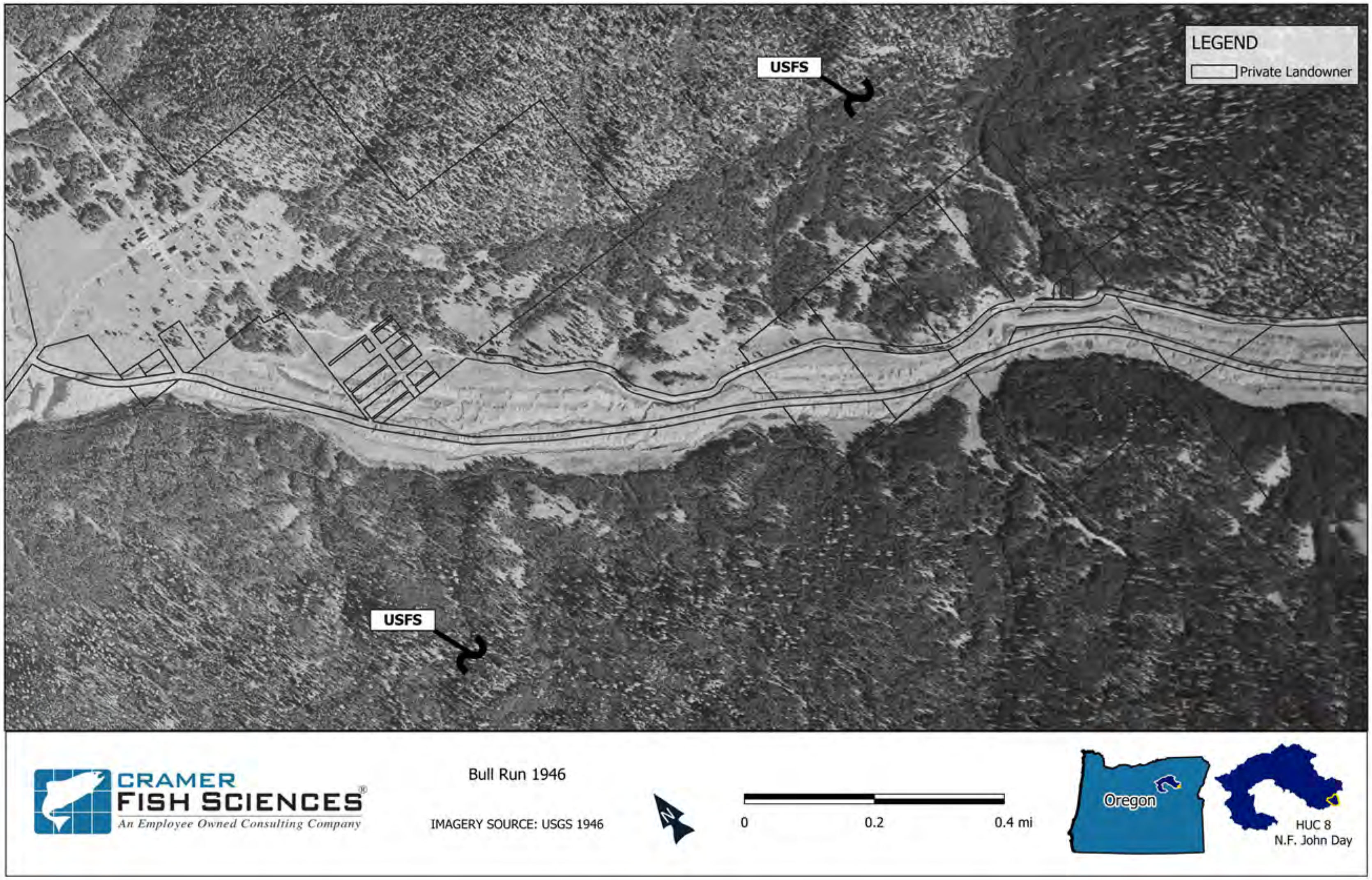

Figure 4. Aerial imagery of Bull Run Creek project site from 1946.

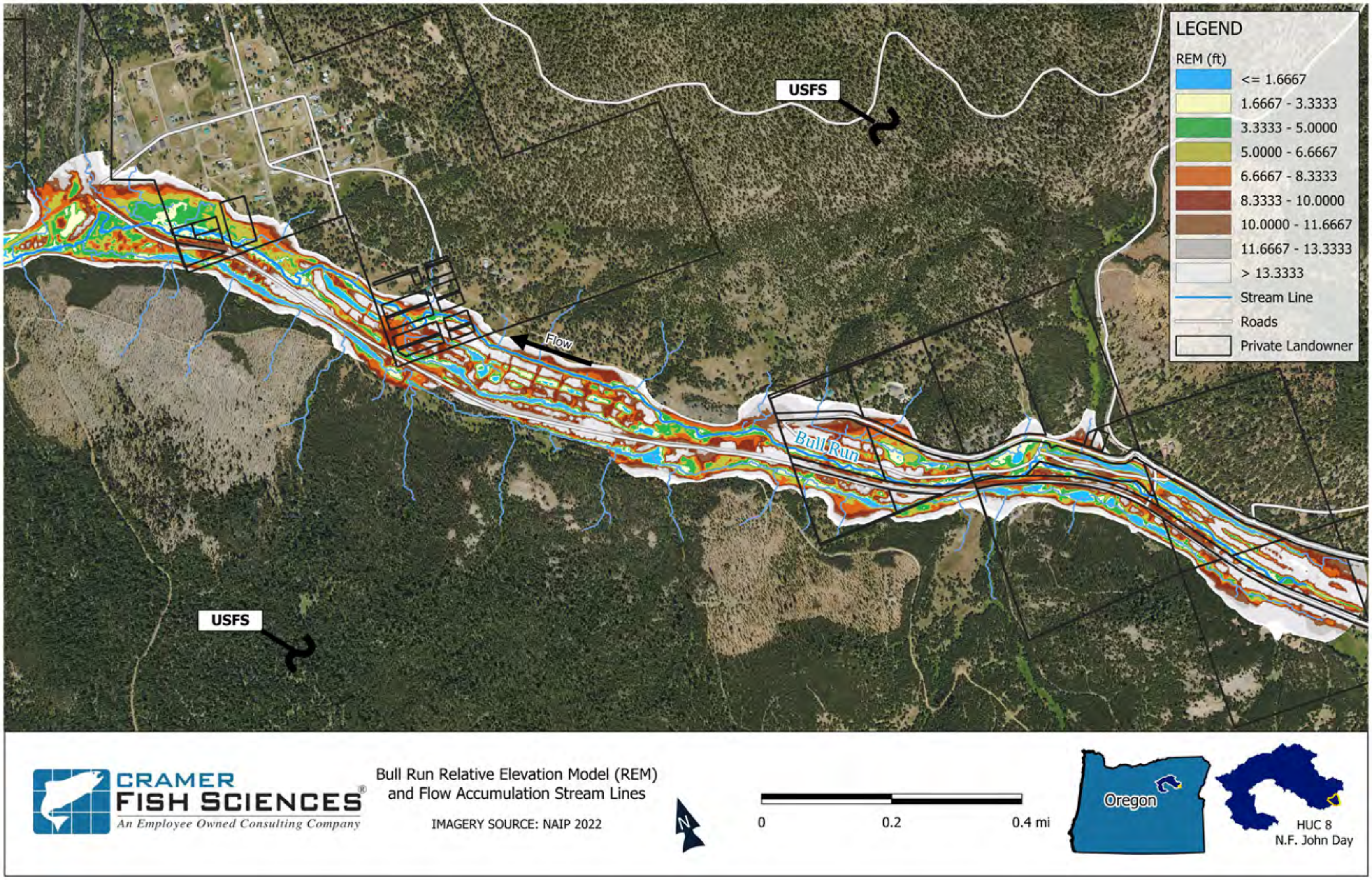

Figure 5. Relative Elevation Model (REM) and stream flowlines derived from flow accumulation model of Bull Run Creek project area.

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

Historic dredge and placer mining in the Bull Run Creek valley has caused extensive degradation to the floodplain and channel. Placer mining involved using a dredge to carve approximately 8 feet into the valley bottom, sorting the alluvial material while on the dredge, separating the gold and leaving the spoils piled up behind the machine. This occurred throughout most of the valley bottom, reorganizing the entirety of Bull Run Creek and leaving the valley bottom covered with mine tailings (Figure 6). By excavating into the floodplain, Bull Run Creek effectively became confined to the path of the dredge and was largely disconnected from the historic floodplain. Throughout the project area, sections of Bull Run Creek have been relocated to the northern side of the valley bottom where it is pinned between tailings piles to the south and the cut banks created by the dredging to the north. Elsewhere it flows among and is constrained by tailings piles and or Granite Hill Rd. In some locations, tailings piles within the dredged area stand more than 18 ft above the banks of Bull Run Creek. Examining the REM shows that the linear nature of the tailings piles creates parallel regions of the valley bottom at relatively low elevations (Figure 5) that are 10 to 15 ft lower in elevation than the corresponding tailings pile. In addition to the impacts associated with mining, Granite Hill Road runs parallel to Bull Run Creek further dissecting the valley bottom and limiting channel migration and floodplain connection.

Infrastructure is present throughout the project site that impacts the natural processes of Bull Run Creek's channel and floodplain. A variety of residential buildings, roads and river crossings occupy the valley bottom, all of which limit the area available for fluvial and riparian processes and habitat for the biota that rely on these environments. Four culverts are located within the approximately 2-mile reach of Bull Run Creek (Figure 7 and Figure 8). According to Oregon Department of Fish and Wildlife (ODFW), culverts 2 and 3 are partial fish passage barriers (ODFW 2024b). There is also a ford crossing located near the middle of the reach and a boulder armored bank protecting a road near the downstream end of the reach (Figure 9 and Figure 10). Fish passage can be impaired due to increased water velocities inside of culverts during high discharge events (Frankiewicz et al., 2021). Additionally, stream habitat downstream of culverts and fords can be impaired, resulting in increased fine sediment and reduced macroinvertebrate indexes. The crossing structures depicted in Figure 7 include:

1. Grant County Road (Granite Hill Rd) Crossing, 120-inch x 84-inch pipe arch corrugated metal pipe (CMP)
2. Residential Crossing, 36-inch, 72-inch, and 30-inch round CMPs
3. Residential Crossing, deformed 84-inch round smooth metal pipe
4. USFS 7366 Rd Crossing, 120-inch x 84-inch pipe arch CMP

The primary cause for riparian degradation within the project area is directly related to past mining activities. Existing riparian vegetation was removed to allow dredges to dig freely. Moreover, turning over the valley bottom to extract gold completely altered the stratification of soils across the alluvial plain. The relict mine tailings piles are higher than the contemporary water table making it impossible for riparian vegetation to establish in many locations. Lodgepole pine has been able to establish on the tailings piles because it is primarily an upland drought tolerant species. Although it is beneficial to have canopy species such as lodgepole pine within the valley bottom, they provide little benefit to the stream channel and aquatic biota because they are rarely near enough to the channel to provide shade or act as a wood recruitment source. Most of the channel has a narrow-inset floodplain with limited floodplain pockets where riparian species can establish. The most common riparian species are willow (*Salix* sp.), alder (*Alnus sp.*), black hawthorn (*Crataegus douglasii*), bull rush (*Typha* sp.), sedges, and various grasses and forbs. Willow and alder commonly overhang the channel, providing erosion protection, shade, and are a source of terrestrial macroinvertebrates for aquatic species.

Figure 6. Images of mine tailing piles along Bull Run Creek. The tailings piles confine Bull Run Creek channel and prevent riparian vegetation establishment throughout the valley bottom, limiting much of the riparian vegetation to grass and forbs species.

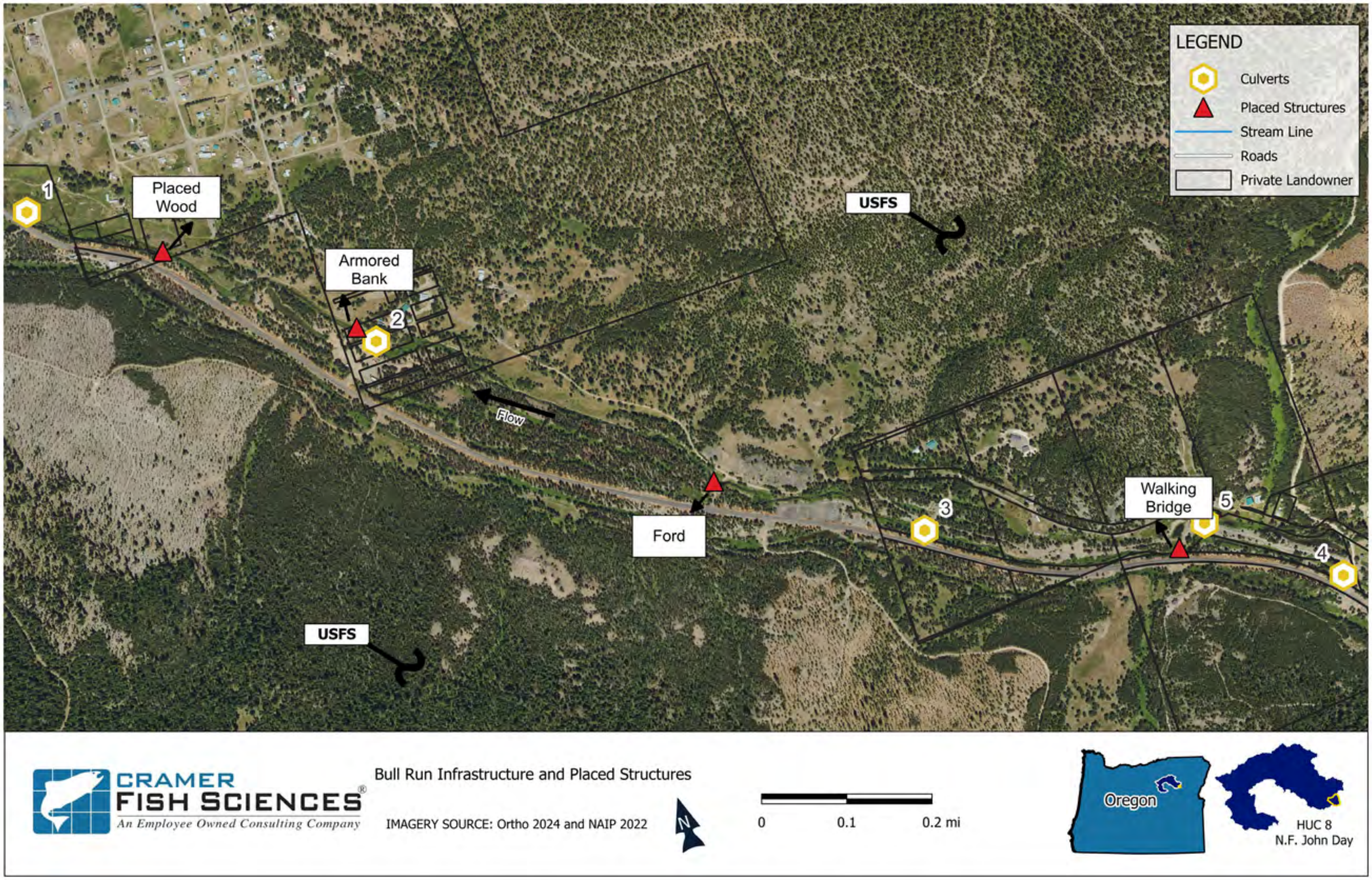

Figure 7. Location of infrastructure and placed structures along Bull Run Creek.

Figure 8. Images of culverts located along Bull Run Creek project area (1 through 4).

Figure 9. Images of placed wood and an armored bank located on Bull Run Creek.

Figure 10. Images of a ford crossing and walking bridge located on Bull Run Creek.

2.2 INSTREAM FLOW MANAGEMENT AND CONSTRAINTS IN THE PROJECT REACH

Bull Run Creek has an existing instream flow requirement per the Oregon Water Resources Department (OWRD) detailed below (Table 2).

TABLE 2. INSTREAM FLOW REQUIREMENTS ON BULL RUN CREEK

MONTH	INSTREAM FLOW REQUIREMENT (CFS)
Oct	2.95
Nov	4.09
Dec	6.00
Jan	7.10
Feb	8.90
Mar	11.40
Apr	22.00
May	22.00
June	6.00
July	4.00
Aug	2.31
Sep	2.04

Note:

cfs = cubic feet per second

2.3 EXISTING GEOMORPHIC CONDITIONS AND CONSTRAINTS ON PHYSICAL PROCESSES

The geology of Bull Run Creek consists primarily of Pennsylvanian to Triassic Elkhorn Ridge Argillite on ridgelines and upper elevations of valley walls. Elkhorn Ridge Argillite is overlain by Tertiary silicic lava flows consisting of porphyritic dacite, silicic dacite and rhyodacite flows and Tertiary basalt (Ferns et al. 1982). Basaltic and silicic lava flows occurred contemporaneously and may alternately overlap. Within the valley bottom, the bedrock geology is generally concealed by Quaternary alluvium, except for a few localized bedrock exposures within the channel.

The stream channel through the project reach primarily consists of a confined, low sinuosity, and plane-bed channel with an average gradient of 0.8 percent and predominantly gravel/cobble substrate. Physical processes in Bull Run Creek are constrained by mine tailings piles, roads, roadway crossings and other artificial structures. Mining operations effectively limit the space available for geomorphic processes in two ways. First, is the result of the dredge excavation. By excavating the valley bottom, the base level for the Bull Run Creek's bed elevation is reduced and the creek is cut off from the surrounding floodplain and valley bottom area that typically defines the transition from the active channel zone to the valley margins. Second, the extensive tailings piles that are present within the dredged area further restrict physical processes. Given the duration of time after dredging, the existing channel morphology and stream power demonstrate limited indicators of being able to erode, transport and/or sort the deposited tailings materials, which is evident from comparing historic imagery. The historic floodplain to the south has been lowered and then filled with tailings piles, the Granite Hill Road prism and other built infrastructure.

In addition to topographic constraints, there is a lack of LWM throughout Bull Run Creek. The LWM survey conducted on approximately 2 miles of Bull Run Creek showed that there were only 11 pieces of wood in the TFW (Timber, Fish, and Wildlife; Schuett-Hames et al., 1999) size classes and 15 pieces that were in the fine size class (Table 3; Figure 11 and Figure 12). According to regional recommendations for wood densities by Fox and Bolton (2007), a median number of 26 woody pieces are predicted to occur within the small to large size classes per 328 ft (100 meters). These results indicate that Bull Run Creek is very limited in LWM, especially for the larger size classes. Although LWM is limited in Bull Run Creek, due to the frequent mine tailings in the floodplain confining the channel, adding LWM without addressing the mine tailings will not increase floodplain connectivity. The frequent mine tailings in the floodplain prevent Bull Run Creek from eroding out of the channel and migrating into the floodplain. However, increasing LWM density would lead to greater morphological diversity within the channel to improve spawning and rearing habitat for salmonids (Fox and Bolton 2007).

TABLE 3. LARGE WOODY DEBRIS (LWM) SIZE CLASSIFICATION AND ASSOCIATED DIAMETER (INCHES) AND LENGTH (FT)

LWM SIZE	LARGE	MEDIUM	SMALL SIZE CLASS	TIMBER FISH AND WILDLIFE (TFW) SIZE CLASS	FINE CLASS
Diameter (in)	> 36	> 24	> 12	> 4	> 1
Length (ft)	> 50	> 50	> 25	> 6.5	>1.5

The simplified-straightened channel of Bull Run Creek has evident effects on the in-channel habitat (Figure 13 and Figure 14). Most of Bull Run Creek consists of shallow riffle-pool complexes comprised of gravel and cobble substrate. There are a few meander bends throughout the reach where the stream was able to create deeper scour pools with simplified morphologies and limited fish cover. Although there were a few small backchannels, gravel bars and vegetated islands that created quality habitat, they were rare due to the channel’s confinement by the mine tailings.

There are various levels of horizontal erosion occurring along Bull Run Creek in the project area (Figure 12 through Figure 16). Some sections have cutbanks that were less than 1 ft in height occurring along the meadow habitats and along low-lying floodplain habitat. There were sections of the creek that were eroding into mine tailings piles that were between 1 and 3 ft in height. There were also sections where the creek was eroding into terraces creating cutbanks in excess of 4 ft in height.

Figure 11. Example of Fine (A and B) and TFW (C and D) along Bull Run Creek.

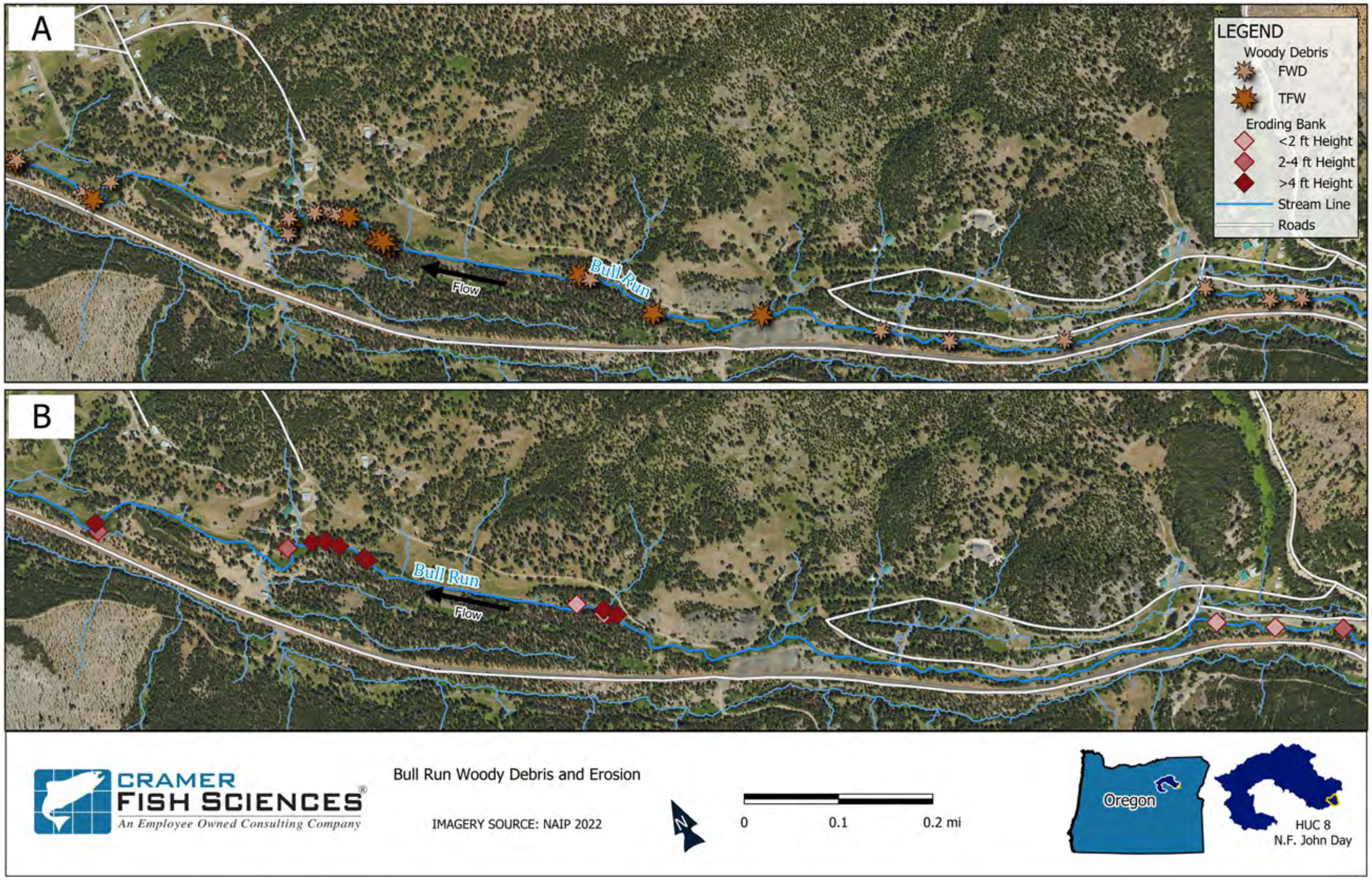

Figure 12. Location of woody debris (A) and eroding banks (B) along Bull Run Creek.

Figure 13. Photos showing available habitat along Bull Run Creek project area, including riffle-pool complexes (A), deeper pools along meander bends (B), small backchannels (C), and small gravel bars (D).

Figure 14. Example of vegetated gravel bars that create split flow channels on Bull Run Creek.

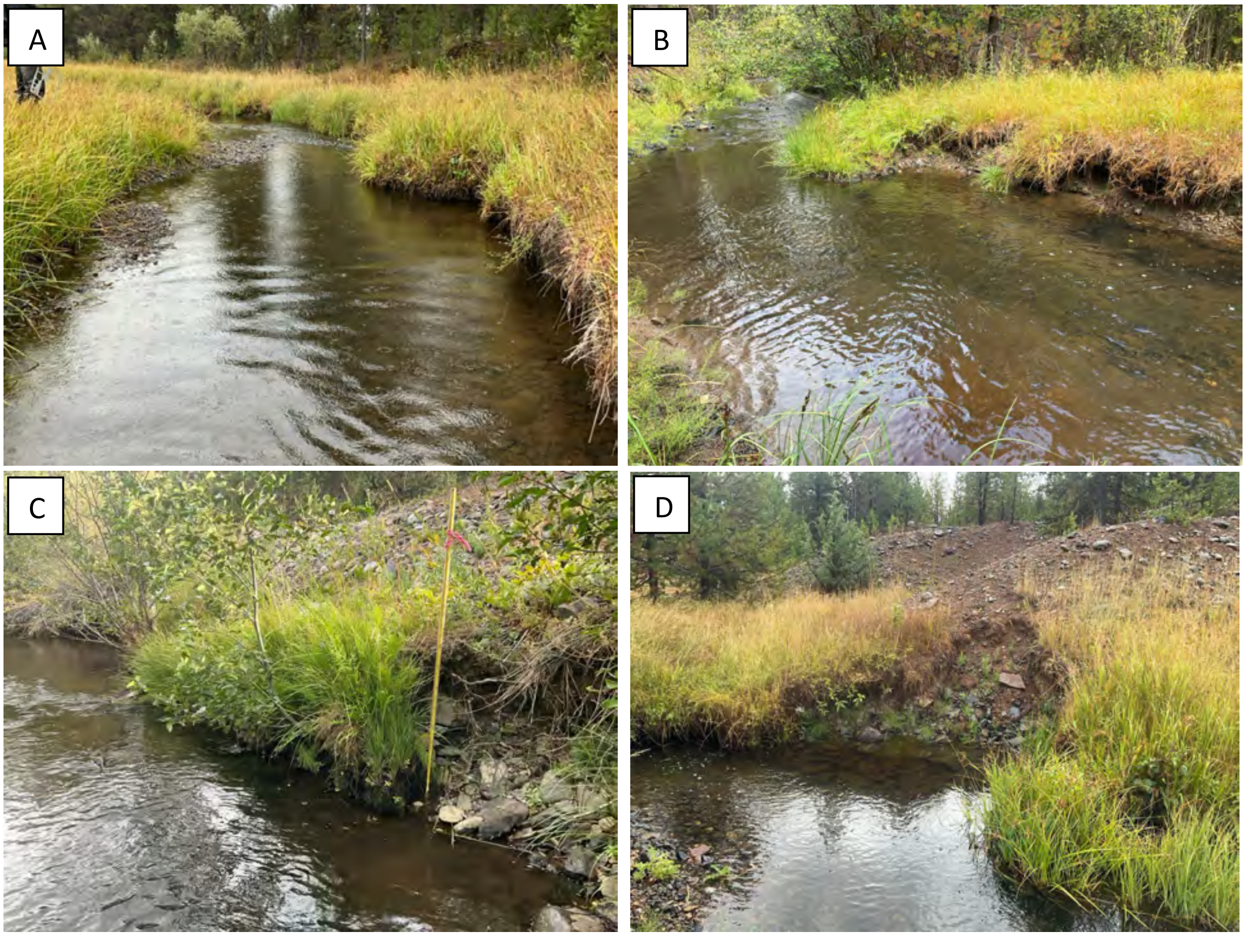

Figure 15. Example of eroding banks leading into inset floodplain (A and B) and leading into mine tailings (C and D) on Bull Run Creek.

Figure 16. Example of eroding banks leading into relict floodplain deposits and ancient terraces on Bull Run Creek that are greater than 4 ft in height.

2.4 EXISTING RIPARIAN CONDITION AND HISTORICAL RIPARIAN IMPACTS

Extensive dredge mining removed all riparian vegetation in the project area and left mine tailings across the entire valley bottom. Currently, the riparian area of Bull Run Creek consists of a narrow ribbon along the channel margin and small floodplain pockets where riparian species can establish. The riparian area consists of small patches of willows and alders interspersed with low growing emergent grasses, rushes, sedges and other forbs. This results in patches of canopy cover, shade and structure along the channel margin, but the center of the channel is mostly open and fully exposed to solar radiation (Figure 17). Additionally, there are very few mature trees within the riparian area which will continue to limit the recruitment of LWM to the system. Some conifers growing on the tailings piles may reach the channel, but it is unlikely they will be naturally recruited through fluvial processes without intervention. In several locations there are areas of low elevation between the tailings piles that act as depressions that trap rainwater. Although these areas are disconnected from the channel, there are riparian species present. These areas support riparian and wetland species and are possibly connected to the water table during flood events. A subsurface investigation will occur at later stages of the design and may be used to better describe the hydrogeologic connection between these features and the main channel.

There is limited information on the historic beaver population of Bull Run Creek, however prior to trapping and mining, beavers were likely prevalent throughout the area. In low-gradient streams, similar to Bull Run, beavers would have built stable dams that created wetland habitat that evolved into meadows (Fouty 2018). Additionally, the riparian vegetation would have been diverse and dominated by water-dependent species instead of drought-tolerant species such as lodgepole pine. Although there does not appear to be an active beaver population, signs of beaver chews, bank lodges, and food caches were present during our survey, but they appeared to be at least 5 years old (Figure 18). Relic beaver dams would have resulted in increased ponded water habitat within Bull Run Creek and increased channel-floodplain connection (Fouty 2018). These channel-floodplain connections would have been limited to areas not confined by mine tailings piles. After beavers abandoned the area or were extirpated, the base level of Bull Run Creek was probably lowered due to the failing beaver dams flushing the trapped fine sediment downstream (Fouty 2018).

Figure 17. Example of stream structure, cover and shading along Bull Run Creek.

Figure 18. Example of floodplain pocket with beaver runs (A) and cache (B). Example of breached beaver dam with gravel deposition from relic dam (C). Example of backwater maintained by beavers that was originally created due to mining bucket scoop (D).

2.5 LATERAL CONNECTIVITY TO FLOODPLAIN AND HISTORICAL FLOODPLAIN IMPACTS

Past mining activity and culvert construction on Bull Run Creek has diminished the total area available for floodplain processes and connectivity throughout the project site (Figure 19 and Figure 20). Prior to anthropogenic impacts, some of which date as far back as 1881 (Figure 2), the floodplain likely extended from valley wall to valley wall. Extensive mining throughout the region obfuscates the pre-impact condition of the valley. Based on topographic analysis of 10 valley bottom transects within the project area and within the downstream meadow area, the historic floodplain width likely ranged from 300 to 800 ft with an average width of 500 ft. The historic area of the valley bottom was 134 acres, and the current valley bottom is 72 acres, which is a 46 percent reduction in available floodplain connectivity. The overall reduction in floodplain area is the result of tailings piles with sufficient height to stand above existing inset terraces in the valley bottom, and other confining features associated with the built environment.

Historic imagery and channel scars within the meadow south of Granite, Oregon suggest that this area was less impacted by mining activity and provides insight into the pre-disturbance floodplain character (Figure 21). Based on this small area of preserved (unexcavated) valley-bottom, it appears that Bull Run Creek was a low gradient system consisting of multiple channels that saturated the meadow, possibly from valley-wall to valley-wall, during periods of high flow. Unfortunately, without a larger area of intact stream, it is difficult to determine additional details that could be used to produce stream design metrics. In addition, the valley bottom space required to fully restore the stream and floodplain does not currently exist, yet it is a valuable glimpse into the pre-disturbance conditions Bull Run Creek may have flowed through.

Figure 19. Examples of meadow habitat (A), confined reach (B), small floodplain pocket (C) and confining infrastructure (D) along Bull Run Creek project area.

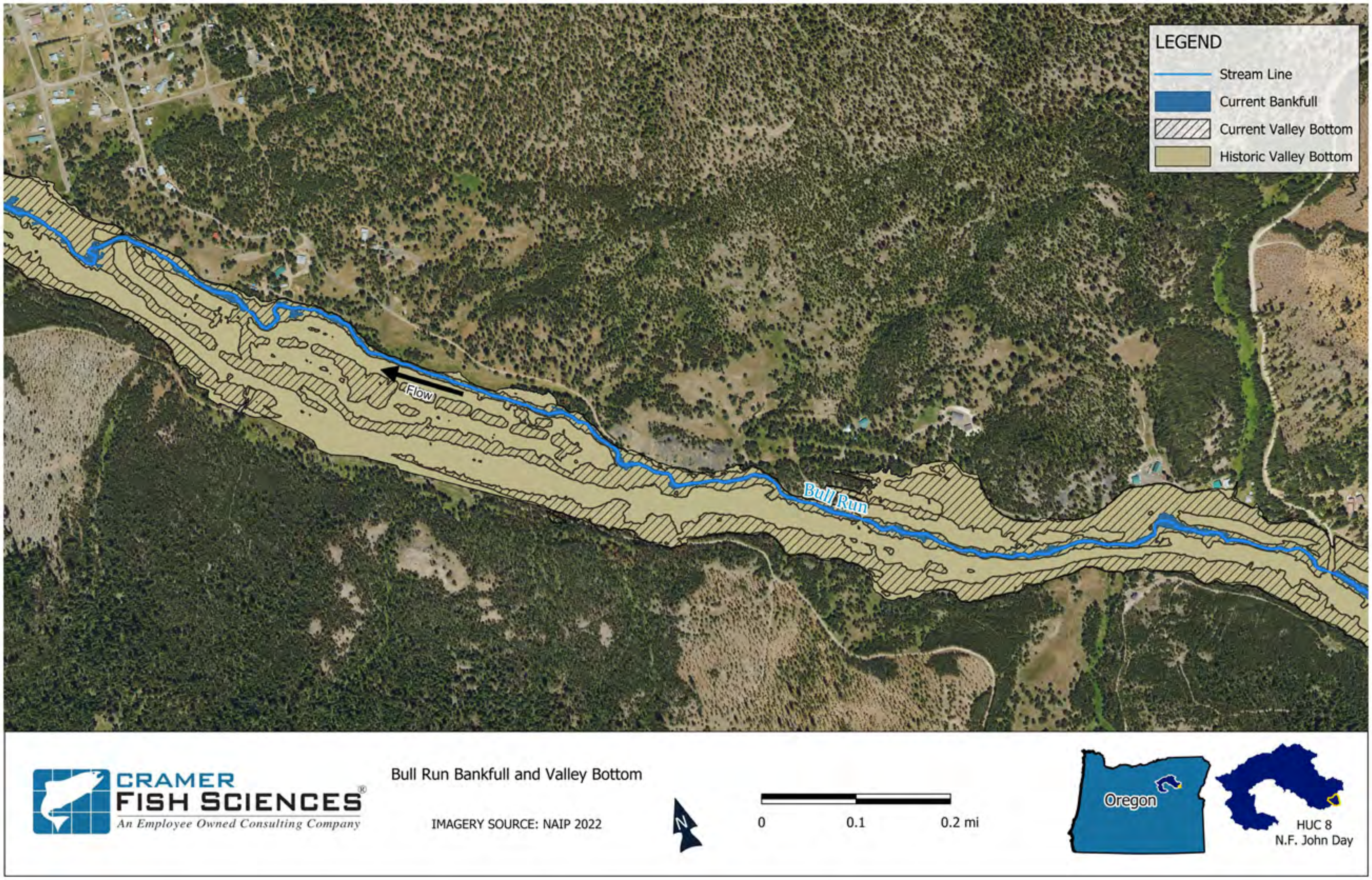

Figure 20. The current bankfull, current valley bottom and estimated historic valley bottom of Bull Run Creek determined by the relative elevation model.

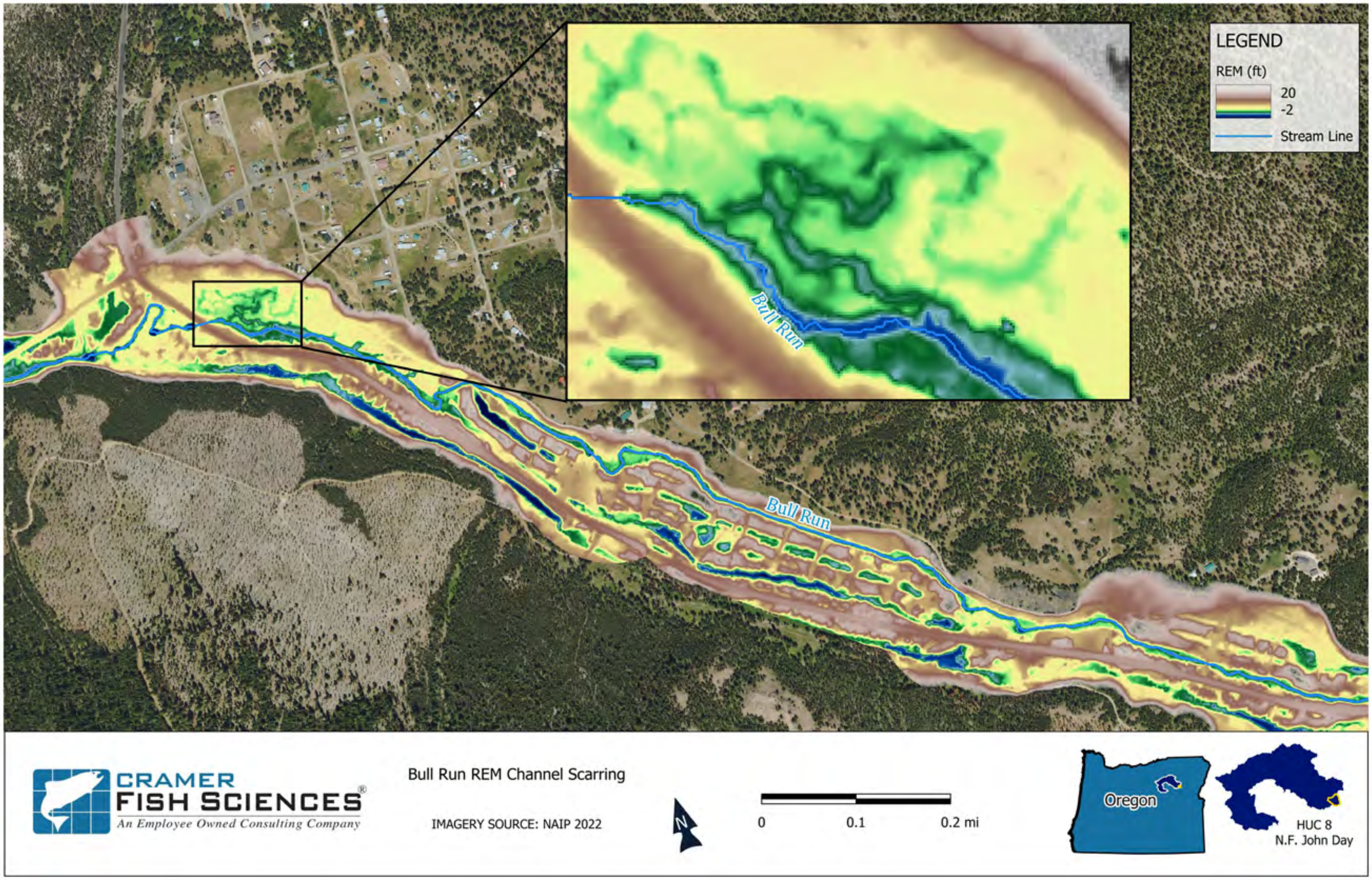

Figure 21. Relative elevation model of Bull Run Creek project area showing area without mining impact and channel scarring.

Although there is limited floodplain available within the project site, there are waterbodies and wetlands located throughout the valley. There are three types of wetlands identified by the National Wetland Inventory (NWI) occurring within the Bull Run Creek project area (USFWS 2024; Figure 22). Additionally, many ponds were delineated by the National Hydrography Dataset (USGS 2018; NHD). However, based on recent aerial imagery, it appears some of the ponds and wetlands do not currently exist with perennial surface water. Additionally, there were some waterbodies that appear on the aerial imagery that were not detected by NHD or NWI. Based on this information, we used more recent data from the ortho imagery to determine what waterbodies were present within the project site (Figure 23). Many of the waterbodies in the project sites are dredge ponds due to past mining (Kleinschmidt 2021). Additionally, there are several long ponds north of Bull Run Creek within the upstream half of the project area. Corral Creek enters one of these ponds, but Corral Creek does not have a direct connection to the mainstem of Bull Run Creek. These basins and areas surrounding the ponds provide opportunities to connect and expand the riparian area for Bull Run Creek with minimal mine tailing excavation and sediment removal.

Current infrastructure places additional confinement on the channel that limits lateral connectivity. However, the parallel roads run along the tops of relict tailings piles and the bridge and culvert crossings are located between tailings piles. Therefore, the tailings piles remain the primary constraint on lateral connectivity. Consolidating road and stream crossings where feasible will provide more opportunities for restoration of the channel and floodplain, but any improvements will need to coincide with modifications or removal of the tailings piles.

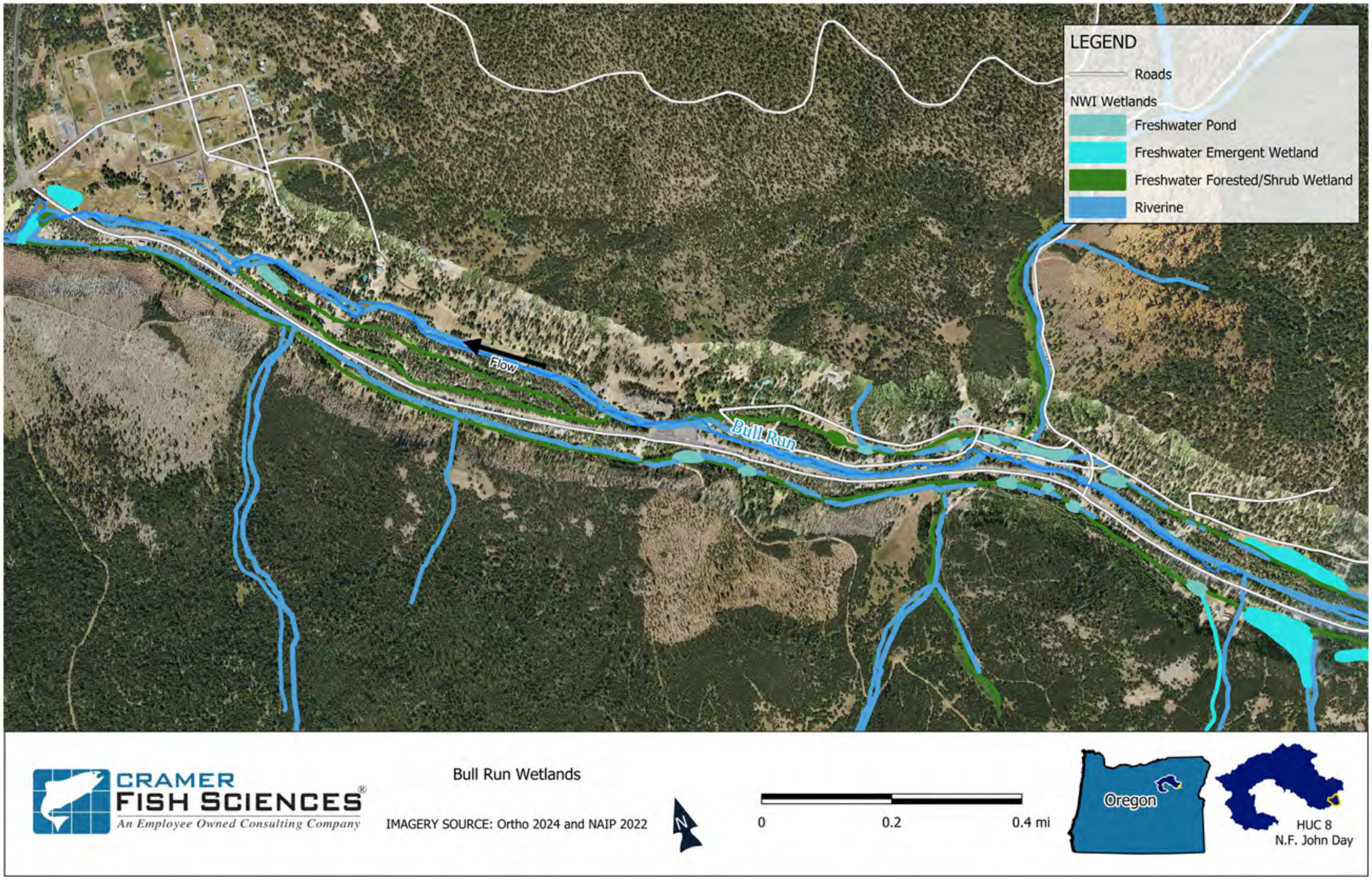

Figure 22. National wetland inventory (NWI) of wetlands throughout Bull Run Creek project site.

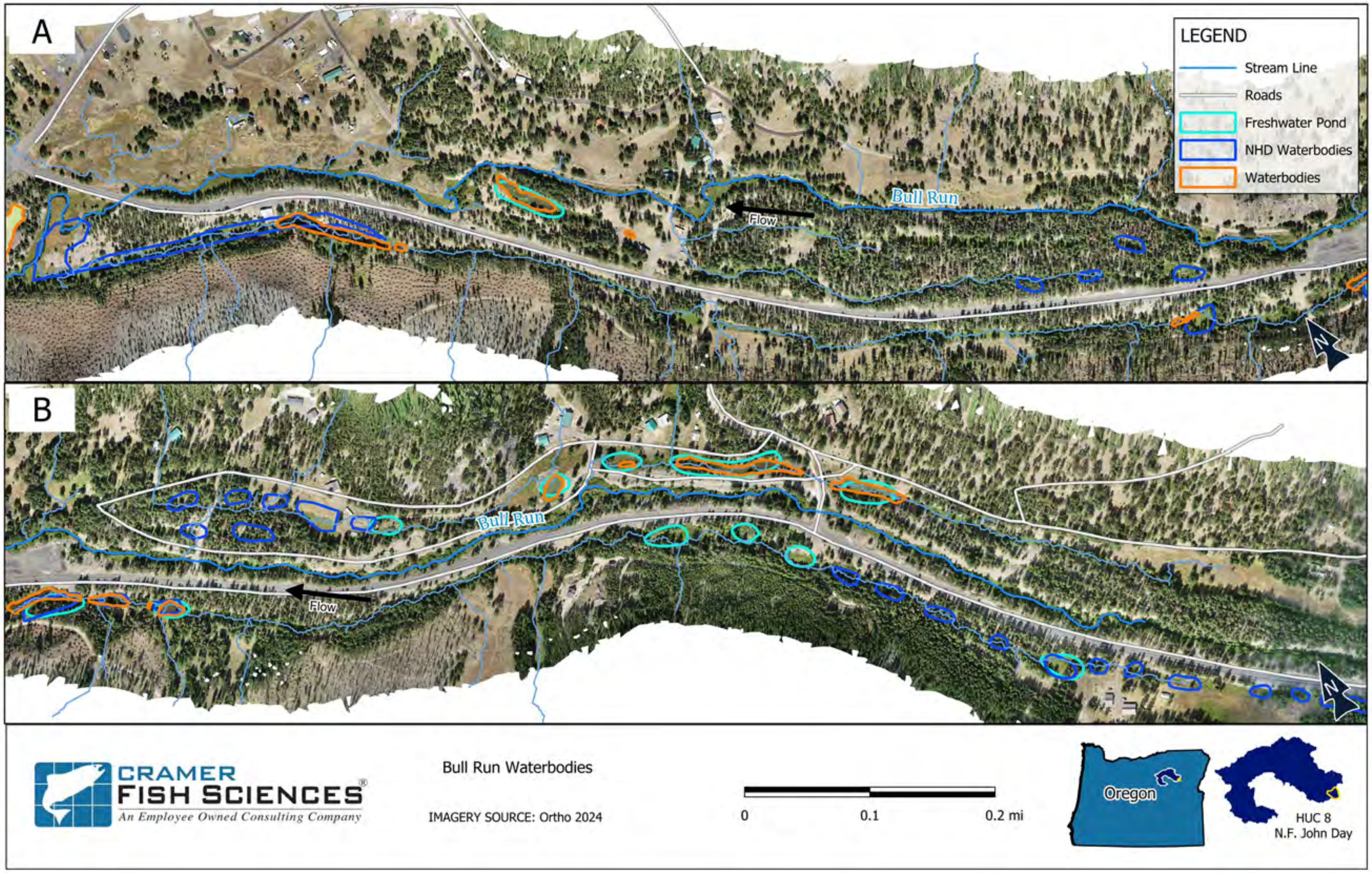

Figure 23. Waterbodies and freshwater ponds located near Bull Run project site identified via NWI, NHD and ortho imagery.

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

The project is not located within a tidally influenced setting.

3.0 Technical Data/Design Considerations and Analyses

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

The Bull Run Creek project includes HIP IV specific activity conservation measures associated with:

- Action Category 1: Fish Passage Restoration
  - 1F – Bridge and Culvert Removal or Replacement
- Action Category 2: River, Stream, Floodplain and Wetland Restoration, including:
  - 2A – Improve Secondary Channel and Floodplain Connectivity
  - 2D – Install Habitat-Forming Instream Structures
  - 2E – Riparian and Wetland Vegetation Planting
  - 2F – Channel Reconstruction

HIP Conservation measures are included in Appendix A, Design Drawings (Drawing 1.2 to 1.4). The plans include separate sheets outlining HIP conservation measures, which cover general conservation measures, fish protection and water quality protection measures. Additional sheets that detail project-specific measures for temporary erosion and sediment control, and access and staging requirements are included in Drawing 2.1 and 2.2. A sequencing and water management plan will be provided at 80 percent Design.

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

GeoEngineers and Cramer Fish Sciences completed a site reconnaissance on August 22 and September 12, 2024, to document existing geomorphic and riparian conditions and identify areas for floodplain reconnection and habitat uplift. Field observations are included within Section 2.0. The sections below describe the site information and measurements informing design.

3.2.1 Topographic Data

The site was surveyed by Resource Specialists, Inc. (RSI) in August 2024. RSI created an existing conditions surface of the project area by blending a detailed RTK GPS topo/bathymetric survey of the creek with orthorectified point data collected via unmanned aerial system (UAS), along with 2020 LiDAR data available from the Oregon Department of Geology and Mineral Industries (DOGAMI). The resulting existing conditions surface provides a basis for planform and geometric measurements and existing terrain for use in grading and hydraulic modeling. The longitudinal profile is shown in Figure 24.

Figure 24. Longitudinal profile of Bull Run Creek

3.2.2 Bed Material

During the site reconnaissance, we collected streambed gradation data at six locations using Wolman pebble-count sampling methods (Table 4, Figure 25, Figure 26 and Figure 29). Other examples of bed composition, including alluvial material and bedrock within the channel are shown in Figure 27 and Figure 28.

TABLE 4. SUBSTRATE GRAIN-SIZE SUMMARY STATISTICS

GRAIN-SIZE STATISTIC	PEBBLE COUNT 1 (INCHES)	PEBBLE COUNT 2 (INCHES)	PEBBLE COUNT 3 (INCHES)	PEBBLE COUNT 4 (INCHES)	PEBBLE COUNT 5 (INCHES)	PEBBLE COUNT 6 (INCHES)
D_{16}	0.1	0.3	0.3	0.4	0.6	0.4
D_{50}	0.7	0.6	0.9	1.7	1.9	0.8
D_{84}	1.1	1.0	2.3	4.4	4.2	1.4
D_{95}	1.2	1.1	3.0	5.0	4.7	1.6
D_{100}	7.1	3.5	7.1	10.1	7.1	3.5

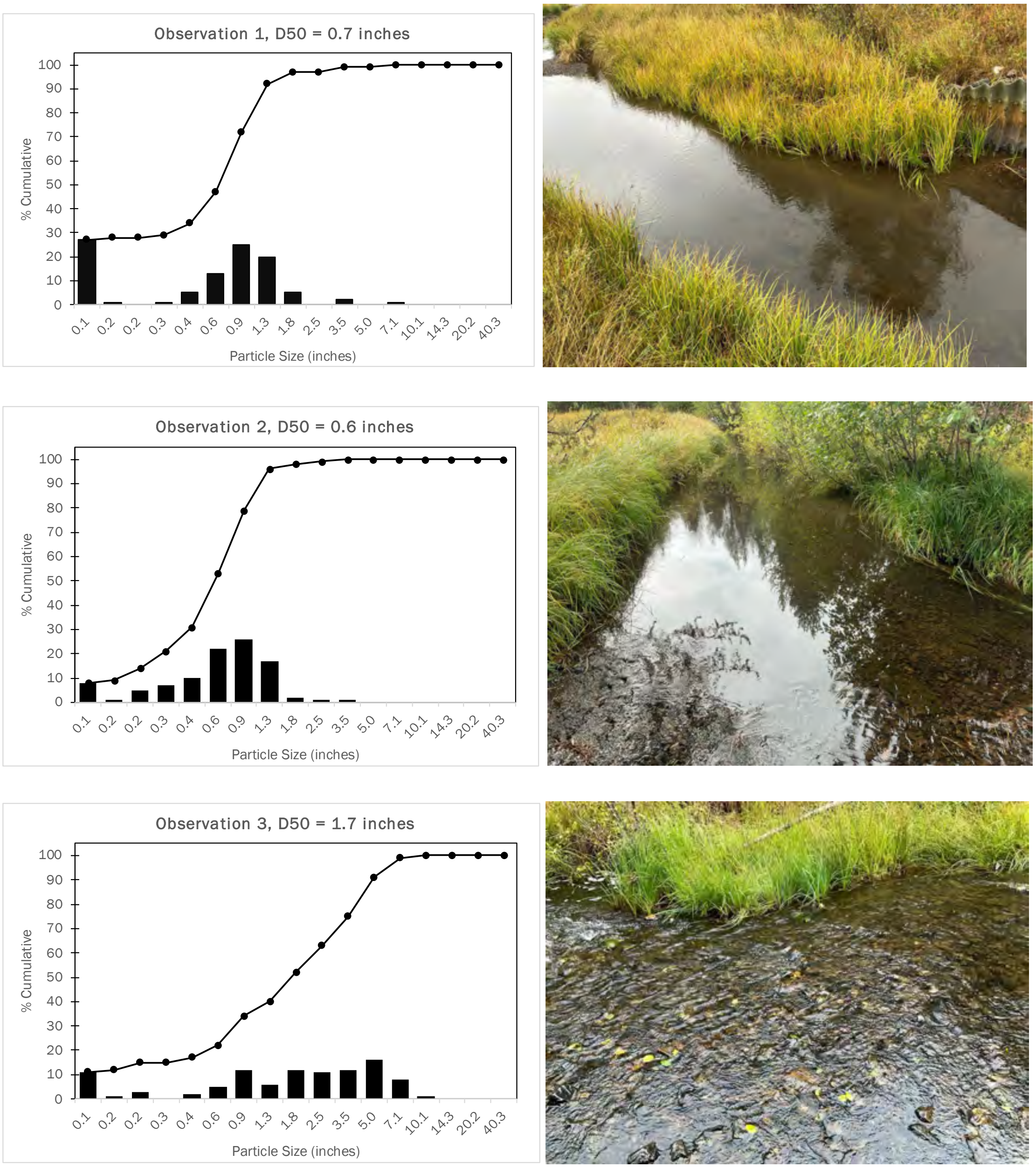

Figure 25. Cumulative particle size distribution and habitat image of the Wolman pebble count surveys 1 through 3 conducted on Bull Run Creek.

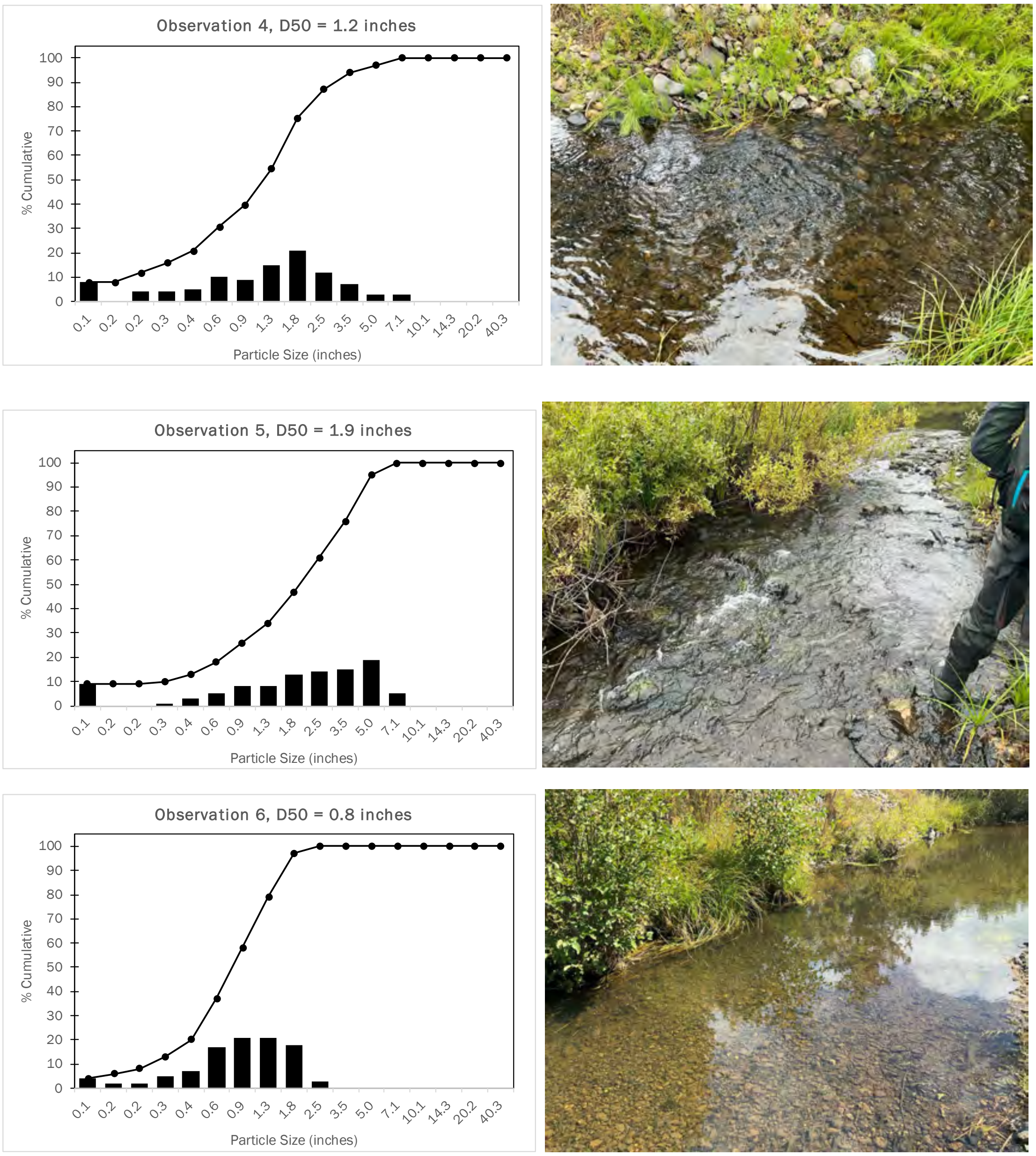

Figure 26. Cumulative particle size distribution and habitat image of the Wolman pebble count surveys 4 – 6 conducted on Bull Run Creek.

Figure 27. Exposed alluvial base on Bull Run Creek.

Figure 28. Bedrock dominated reach of Bull Run Creek.

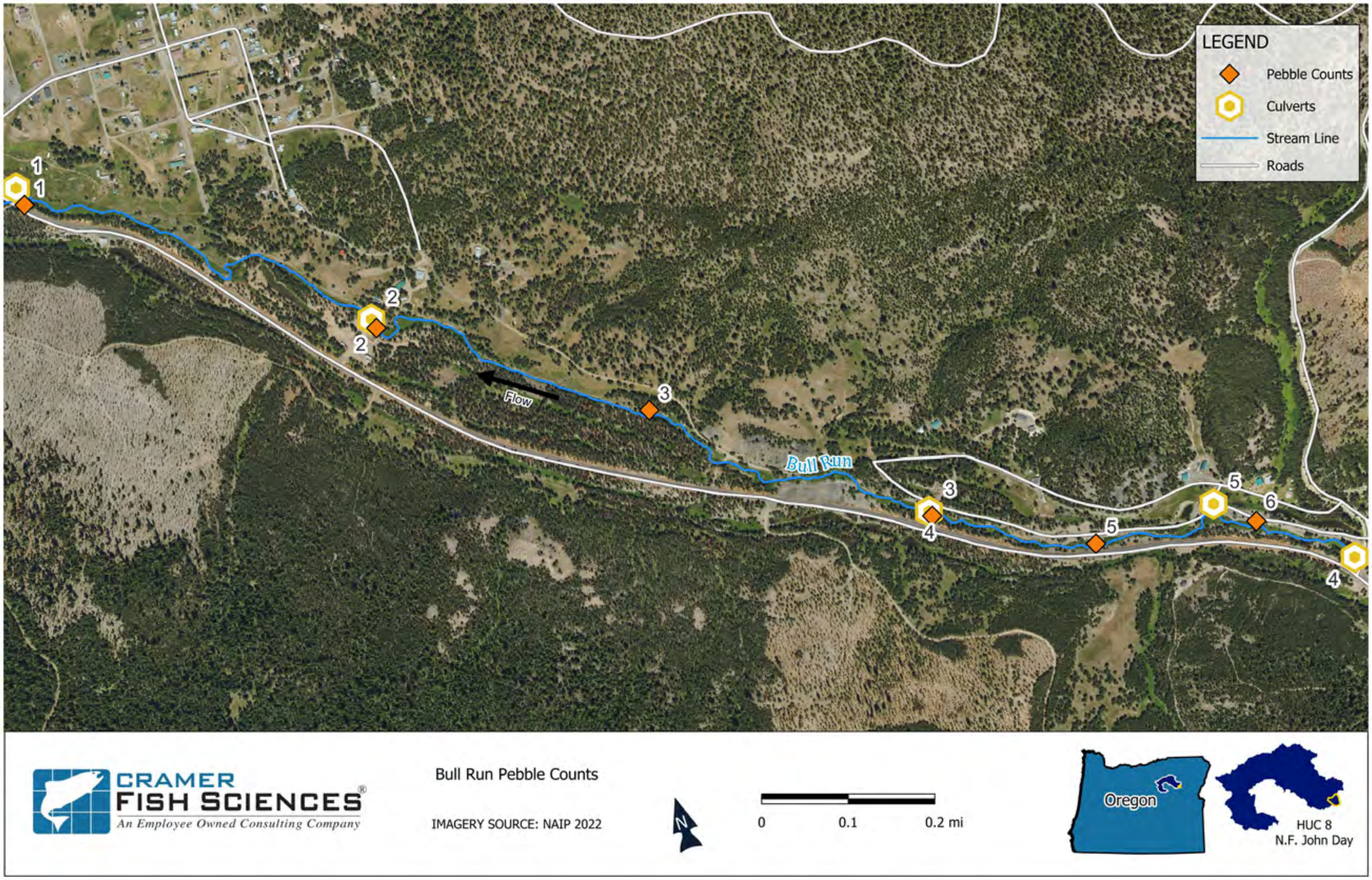

Figure 29. Location of Wolman pebble count surveys and culverts along Bull Run Creek.

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

Bull Run Creek is a predominantly snowmelt-driven, high-elevation stream characterized by a heavily forested watershed with wet climate class and low/moderate permeability (Leibowitz et al. 2014). The approximately 25 square mile watershed extends from 5,540 ft to 8,300 ft in elevation (North American Vertical Datum of 1988 [NAVD88]) and is nearly 80 percent conifer forest. There is no existing stream gage on Bull Run Creek; therefore, we completed a hydrologic assessment of Bull Run Creek primarily relying on regression analyses, remote sensing, and best available scientific literature. The methodology from Risley et al. (2009) was used to determine flow duration and low flows. Bull Run Creek hydrology generally peaks in May as a result of upper basin snowmelt, declining throughout June and July and reaching the low flow period between August and Ocober. Winter rain and snow and rain storms typically result in elevated flows from November to March, with the potential for rain on snow events. The 7-day, 2-year and the 7-day, 10-year low flows are 3.6 and 2.6 cfs, respectively.

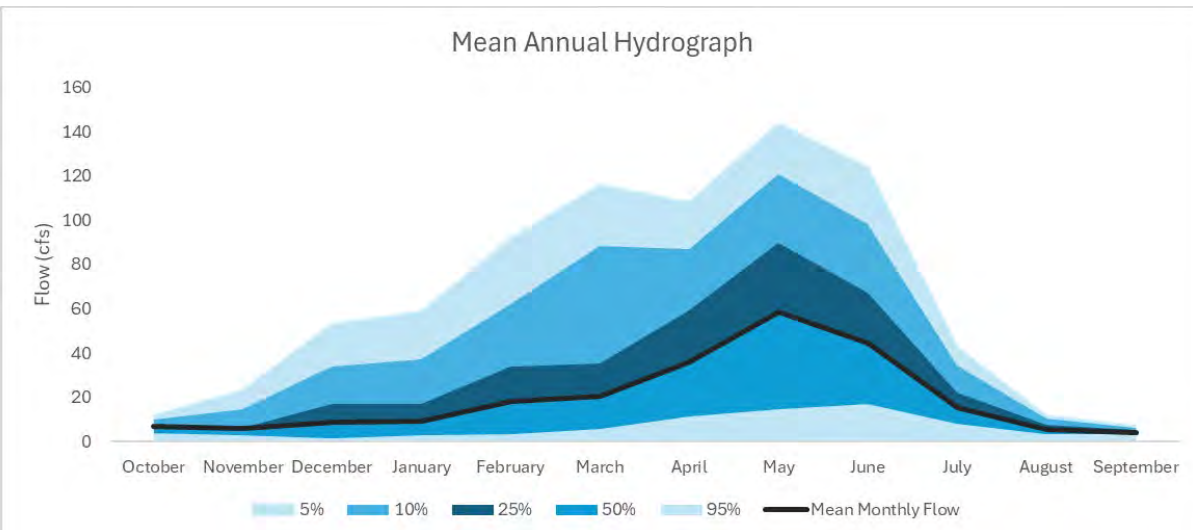

Figure 30. Mean annual monthly hydrograph of Bull Run Creek at the study area.

Flood frequency analysis for Bull Run Creek was conducted using regression analysis from the Cooper *et al*. 2006 *Estimation of Peak Discharges for Rural, Unregulated Stream in Eastern Oregon* methodology. Flood frequency results were accessed at https://apps.wrd.state.or.us/apps/sw/peak_discharge_map/ on October 2, 2024 and are presented in Table 5. It should be noted that confidence interval flows for Bull Run Creek present a wide range of potential flood flows and that accuracy of regression equations will be considered during the design process. In order to validate flood frequency analysis, the OWRD regression for Bull Run Creek was adjusted based on comparison of OWRD gage 13317850 (Upper Grande Ronde River), Bulletin 17C flood frequency analysis (England et al. 2019) and OWRD regression (Cooper 2006). Comparisons to a similar basin with a gage record of sufficient duration for flood frequency statistical assessment resulted in an average adjustment factor of 0.81 (recurrence interval adjustment factors shown in Table 5), which was applied to the OWRD (Cooper 2006) regression for Bull Run Creek. Comparison to prior hydrologic analysis completed (Kleinschmidt 2021) indicates that results are approximately consistent with prior findings, when adjusted for basin area.

TABLE 5. FLOOD FREQUENCY ANALYSIS RESULTS FOR BULL RUN CREEK AT THE STUDY AREA. VALUES IN BOLD WERE USED IN THIS STUDY

RECURRENCE INTERVAL	PEAK FLOW (CFS)	ADJUSTED PEAK FLOW (CFS)	ADJUSTMENT FACTOR	95% CONFIDENCE LOWER LIMIT (CFS)	95% CONFIDENCE UPPER LIMIT (CFS)
2-year	152	**131.6**	0.866	58.6	394
5-year	229	**185.9**	0.812	98.7	529
10-year	282	**223.9**	0.794	125	638
25-year	354	**278.7**	0.787	157	794
50-year	408	**321.6**	0.788	180	926
100-year	464	**366.3**	0.789	201	1070
500-year	601	**486.4**	0.809	245	1470

The Bull Run Creek watershed hydrology is likely to experience a shift due to the impacts of climate change. It is anticipated that winter snowpack will decrease with generally warmer winters, resulting in higher winter peak flows from rain on snow events and lower summer base flows (Halofsky et al. 2018; Clifton et al. 2018). Wegner et al. (2010) results from downscaling global climate projections for the end-of-century conditions indicate a 126 percent increase in winter streamflow and an 8.3 percent reduction in summer streamflow. These projected changes will also occur coincidentally with higher summer temperatures, increasing thermal stress on salmonids and other aquatic organisms during low flow conditions. The reduction in winter snowpack is also linked to earlier snowmelt onset and earlier and longer base flow conditions (Halofsky et al. 2018; Clifton et al. 2018). The transition to a more rainfall dominated climate is also projected to increase the number and frequency of winter storms (+81 percent) and the amplitude of peak runoff (+14.2 percent for the 25-year event). Climate change predictions for the watershed indicate that riparian areas, wetlands and other groundwater features will be at an elevated level of risk for ecological disturbance and shift to more drought tolerant conifer and shrubs (Dwire et al. 2017). These ecosystems play a critical role in providing habitat and cold-water refuge for salmonids and other aquatic organisms. Protecting, restoring and/or enhancing these areas is a high priority for this project.

3.4 VALLEY FLOODPLAIN RESTORATION

The greatest opportunity for restoration within Bull Run Creek is restoring space for fluvial processes to occur through removal of tailings piles and creation of a reconnected valley bottom floodplain. Restoration of the historic Bull Run Creek floodplain width, which likely ranged from 300 to 800 ft, is not feasible due to site constraints that include existing infrastructure and landowner participation.

3.4.1 Grading Extent

We developed a recommendation for minimum floodplain width based on Nelson et al. (2024) and Fryirs et al. (2016), who describe the minimum valley space necessary to sustain the processes governing channel and floodplain formation. Channels classified as laterally unconfined are characterized by a valley confinement ratio of approximately 4.6 times the bankfull width (Nelson et al. 2024; Fryirs et al. 2016). Applying this ratio to the average adjusted bankfull width of 21.8 feet (Section 3.5.2) results in a minimum floodplain width of approximately 100 feet. This value served as the initial target for valley grading design.

Where landownership and infrastructure constraints allowed, floodplain widths were expanded beyond the 100-ft minimum to provide additional space for lateral channel processes and floodplain interaction. The table below summarizes contiguous grading segments, organized by ownership, and presents the resulting floodplain widths within each segment, approximated using the proposed 2-year inundation extents. In areas under private ownership or constrained by existing infrastructure, achieving the 100-ft target was not always feasible. Conversely, following discussions with the design team and project partners, and incorporating feedback received from RRT on the 15 percent Design, floodplain limits were expanded to the maximum practicable extent within publicly owned segments (Table 6). Additional discussion of changes in floodplain inundation across a range of flows under existing and proposed conditions is provided in Section 3.7.3, with further detail included in Appendix A.

TABLE 6. VALLEY FLOODPLAIN WIDTHS

CONTIGUOUS VALLEY REGRADING SEGMENT	LAND OWNERSHIP	START / STOP STATION ALONG THE PROPOSED BULL RUN CREEK ALIGNMENT[1]	RANGE IN VALLEY FLOODPLAIN WIDTH[2]	AVERAGE VALLEY FLOODPLAIN WIDTH[2]
1	Public – USFS	0+00 to 17+00	20 to 250 ft	173 ft
2	Public – USFS	50+00 to 66+25	40 to 210 ft	142 ft
3	Private	68+40 to 77+00	30 to 150 ft	81 ft
4	Public – USFS	77+00 to 116+50	50 to 420 ft	239 ft
5	Private	116+50 to 156+50	40 ft to 150 ft	117 ft
6	Private	172+00 to 175+25	50 to 60 ft	52 ft

Notes:

1. See Appendix A, Drawings 3.0 to 3.8 for main channel stationing along the proposed Bull Run Creek alignment.
2. Floodplain widths are approximated based on the proposed 2-year inundation extent.

Although the proposed regrading restores substantial connected floodplain within the valley bottom, the reconstructed valley remains smaller than the historic valley footprint described in Section 2.5, reinforcing the importance of designing for frequent inundation and active lateral engagement within the available footprint. The valley floodplain surface is set to approximately two feet above the existing main channel bed elevation to promote frequent inundation while maintaining a defined low-flow channel. Within the floodplain, variability will be added through excavation of floodplain depressions and side channels and retention of existing vegetated depressions.

3.4.2 Floodplain Materials

The scale of proposed grading disturbance will initially create a wide, unvegetated floodplain surface that may be susceptible to erosion and channel over-widening immediately following construction. To reduce this risk, incorporation of LWM and rapid revegetation will be critical to provide roughness, promote sediment retention and deposition, encourage flow dispersion, and stabilize developing channel margins while vegetation establishes.

Additional detail will be provided at 80 percent Design regarding excavation sequencing, sorting and placement of existing and imported floodplain materials. We anticipate biochar, wood straw and/or additional soil amendments will be required to support vegetation establishment.

3.4.3 Permanent Stockpiles

The resulting valley grading will require approximately 204,000 cubic yards (cy) of excavation. Permanent stockpile locations are shown in Appendix A and will be refined based on discussions with project partners during the 80 percent Design development.

3.5 CHANNEL RESTORATION

The channel restoration design for Bull Run Creek focuses on reestablishing a dynamic, multi-threaded system that interacts frequently with its floodplain. Historic logging, mining, and dredging have erased much of the original valley morphology, making a single reference condition unlikely to define the restored channel. While prior work in the downstream Granite Creek reach and upstream middle Bull Run reach suggests the creek may have historically expressed a single-thread meandering planform with side channels and wetland features (GeoEngineers 2018; Kleinschmidt 2021), valley-scale characteristics and downstream evidence of multi-threading indicate that a wet meadow system with dynamic channel splitting and rejoining was also plausible. Rather than prescribing a fixed geometry, the design evaluates a range of morphologic forms using regional hydraulic geometry, process-based methods (NRCS 2007; Ciotti et al. 2021), and observations from adjacent reference reaches. An undersized channel geometry was intentionally selected to promote frequent floodplain activation and allow the system to evolve naturally, with LWM, side channels, and depressional floodplain features supporting long-term habitat complexity and ecological function.

3.5.1 Channel Morphology

The existing channel morphology summarized in the long profile (Figure 24) represents a baseline for channel gradient and sinuosity. Historic valley bottom dredging is expected to have significantly straightened the channel, thereby increasing the gradient. The area available for existing channel planform adjustments is severely confined by tailings piles yet there are sections of Bull Run Creek that display tendencies towards single thread wandering (Figure 16) and braiding or anastomosing (Figure 14). The project location within the watershed, in an area of local valley bottom width increase and gradient decrease, suggests that the project area was a response reach (Montgomery and Buffington 1997). Response reaches represent a local transition to a transport limited condition from a transport or supply limited condition resulting in channel aggradation. If channel geometry reflects the near threshold condition between single thread wandering and braided planform, the balance between sediment supply and transport capacity will likely determine which side of the threshold natural processes will push the channel towards (Buffington and Montgomery 2013). There is the distinct possibility that the upper end of the reach tended towards braided with a slightly higher slope closer to the upstream sediment supply while the lower end of the reach tended towards a multi-thread wandering or meandering wet meadow system. It is likely that there would have been ample in-stream wood, a variety of riparian vegetation, and a significant beaver influence based on a small area of preserved floodplain with numerous high-sinuosity channel scars due to decreasing channel gradient (Figure 21).

Historic beaver activity would have resulted in a valley bottom with a frequently inundated floodplain, a diverse riparian and wetland vegetation community, and a reduction in available channel capacity. With the decreased channel capacity the sediment transport capacity would decrease, promoting aggradation. Aggradation of coarse sediment would occur at the upstream end of the meadow complex and fine sediment would be captured in ponds. This aggradation may be responsible, in part, for the presence of the fine grained alluvial base present throughout the project reach and even the accumulation of alluvium that was the subject of mining efforts. Evidence of beaver presence in the area is visible in beaver caches and relict runs observed in site reconnaissance (Figure 18) even in Bull Run Creek's heavily altered state. A glimpse at the influence of beaver on the valley bottom and channel planform is present one drainage to the south in Beaver Creek. Beaver Creek was not dredged thereby preserving the floodplain character. The floodplain and channel planform can be described as a high mountain meadow with an anastomosing multi-thread channel with numerous channel scars and a high degree of sinuosity. This is consistent with the expectation that prior to European settlement in the area beavers would have been present on the landscape and would have shaped Bull Run Creek.

3.5.2 Channel Width and Depth

We evaluated several regional hydraulic geometry relationships to establish an initial bankfull width and depth based on site hydrology and grain size data (Castro and Jackson 2001, NRCS 2007, Parker et. al 2007). These methods produced a range of potential bankfull widths that vary between 16 and 30 ft and bankfull depths that vary between 1.3 and 1.6 ft (Table 6). Rather than using these values as rigid design targets, they serve as a baseline to inform design. A bankfull width narrower than reference bankfull geometry was used as a starting point in the design to facilitate more frequent floodplain inundation at lower recurrence interval events, with the expectation that the channel may widen in certain locations over time. We selected a value of 11 ft for channel top width, 5 ft for channel bottom width and 1.8 ft for channel depth. We evaluated normal depth hydraulics for this starting cross section to determine the approximate expected frequency of floodplain activation. The channel begins to overtop its banks at approximately 44 cubic feet per second (cfs) based on normal depth hydraulics. This corresponds to a flow that is exceeded between 10 and 25 percent of the time on an annual basis, with anticipated overbank flow occurring frequently (more than 50 percent of the time) in May and June, and semi-frequently (between 10 and 50 percent of the time) between February through March. Additional analysis and discussion of floodplain inundation using a two-dimensional hydraulic model and the proposed conditions terrain is provided in Section3.7.3.

By incorporating this approach, the design aims to restore a dynamic, multi-threaded channel form that interacts with the floodplain at a range of flow conditions. The expectation is that seasonal winter and spring flows will fully inundate the floodplain, redistributing sediment and organic material, supporting riparian vegetation, and enhancing aquatic habitat complexity. This approach aligns with historical conditions in the watershed, where beaver activity, in-stream wood, and sediment deposition likely maintained a complex valley bottom containing a single to multi-threaded channel with wandering planform. Evidence from the adjacent Beaver Creek drainage suggests that prior to European settlement, Bull Run Creek likely exhibited a similar floodplain structure.

Extensive discussions were had with the project partners regarding the risks of designing an undersized channel. Importantly, we discussed the increased potential for channel avulsion and realignment throughout the project area due to natural processes. The project partners agreed that the long-term ecological benefits outweighed the risk of potential channel adjustment. Therefore, natural adjustments to the channels and floodplains should be expected over time.

TABLE 7. MAIN CHANNEL BANKFULL WIDTH AND DEPTH ESTIMATES BASED ON HYDRAULIC GEOMETRY RELATIONSHIPS

GEOMETRY (METHOD)	GEOMETRY PREDICTED USING 2-YEAR ADJUSTED PEAK FLOW, REDUCED BY 15% (111.9 CFS)
Bankfull Width (NRCS 2007)	21.5
Bankfull Width (Castro and Jackson 2001)	16.3
Bankfull Width (Parker 2007)	27.6
Average	**21.8**
Bankfull Depth (Castro and Jackson 2001)	1.6
Bankfull Depth (Parker 2007)	1.3
Design Channel Top Width (ft)	**11 ft**
Design Channel Depth (ft)	**1.8 ft**

3.5.3 Main Channel Plan and Profile

We developed a proposed channel alignment within the valley regrade limits to increase sinuosity and slightly reduce overall slope relative to existing conditions. Within the contiguous valley regrade area, the approximate valley length is 7,704 ft and the existing channel length is 8,672 ft (sinuosity = 1.1). The proposed channel length is 10,471 ft, representing a net increase of 1,799 ft and an increase in sinuosity to 1.4. The average slope of the proposed channel is 0.7 percent, a reduction from the existing reach-average slope of 0.8 percent. Reach-scale slopes vary from approximately 0.5 to 1.0 percent, with steeper segments generally corresponding to retained sections of the existing channel and flatter segments occurring where the regraded valley footprint is widest.

Several high-functioning sections of the existing main channel that currently provide pools or dense riparian cover were retained within the proposed channel alignment and profile. Maintaining these segments reduces disturbance in areas that would otherwise experience extensive floodplain grading and preserves pockets of established vegetation to support ecological function while newly graded areas revegetate. The alignment was further refined to integrate the four proposed aquatic organism passage crossings within the project reach.

Channel riffles will be strategically incorporated into the channel profile to provide grade control, increase hydraulic roughness, and promote vertical and lateral complexity as the system adjusts. Riffle segments will be constructed with coarser bed materials screened from native excavated material. Riffles are intended to provide initial structural stability, create localized backwater effects, and support the development of depressional floodplain features and side channels. Wood will serve a similar role in helping maintain channel grade and maintain side channels connectivity. Pools will be constructed in association with large wood structures and at key locations along the alignment to provide immediate habitat diversity.

Additional details on existing and proposed channel profiles are provided in Appendix A.

3.5.4 Channel Materials

Streambed materials within the proposed channel will prioritize the use of native substrate encountered during excavation. Native streambed material exposed during main channel grading will remain in place where suitable to preserve existing sediment characteristics and minimize unnecessary disturbance. Areas underlain by sand or other unsuitable material will be over-excavated and replaced with streambed material. Riffle segments will also be over-excavated and replaced with screened native material. Final gradation requirements for both streambed and riffle materials will be developed during the 80 percent Design.

LWM structures will help shape channel morphology by forcing and maintaining sinuosity, deflecting flow, and promoting targeted scour to create and sustain pool habitat. These structures will also increase hydraulic roughness and promote sediment sorting and retention. To the greatest extent practicable, LWM will be sourced from on-site, including logs and slash from USFS fuels treatments or thinning operations. LWM sizes will reflect the dimensions of available trees and material. Future coordination between the CTUIR and the USFS will evaluate stand density and determine the quantity and size of trees available for use in LWM structures.

3.5.5 Side Channels, Alcoves and Floodplain Depressions

In addition to main channel grading, the design includes construction of approximately 80 side channel segments to establish a complex network of high-flow pathways across the restored floodplain. Three side channel types are incorporated to provide a range of activation frequencies and hydraulic functions.

- **Type 1 side channels** activate most frequently and branch directly from the main channel to connect with existing relic pond features. These channels are set approximately 0.8 feet above the main channel thalweg and are intended to introduce fresh flow into ponds that are currently stagnant. As part of this work, the ponds will be partially filled—retaining their deepest points within a smaller pond footprint, while converting the rest of the pond from a large open-water features to seasonally inundated wetlands—allowing for tailings disposal and enhancement of amphibian habitat.
- **Type 2 side channels** are the most common and branch from the main channel onto the floodplain. These side channels are set approximately 1.2 feet above the main channel thalweg.
- **Type 3 side channels** branch from Type 2 channels and are smaller, typically set approximately 0.2 feet above the Type 2 thalweg elevation to promote progressive flow distribution across the valley surface.

Side channels are designed to be relatively small and sinuous, with planform geometry informed by sinuosity observed in nearby meadow systems. They are sized to convey seasonal high flows to other portions of the floodplain while still allowing widespread floodplain inundation. Typical dimensions include a bottom width of approximately 2 feet and top widths ranging from 3 to 8 feet, dependent on depth.

At inlets and outlets, side channels will be over-excavated for approximately 20 horizontal feet and backfilled with streambed material to provide stability and resist headcutting (material gradation requirements will be developed at the 80 percent Design). Outside of these connection zones, native material encountered during excavation will remain in place unless unsuitable (e.g., sand-dominated), in which case it will be replaced with streambed material. Woody material will be embedded within side channel beds and floodplain grades to help maintain alignment, force sinuosity, and promote sediment retention and local scour as the channels adjust over time.

Alcoves are incorporated along both the main channel and side channels to provide low-velocity habitat and potential cold-water refugia. Main channel alcoves occur where LWM reorients flow toward the bank and are set approximately 0.8 feet above the main channel thalweg. Side channel alcoves are located at side channel confluences and are typically set approximately 0.5 feet above the main channel thalweg. In several locations, alcoves are co-located where the main channel has been rerouted, allowing shaping of the bank to form an alcove while retaining existing vegetation to the extent practicable. Alcoves are also positioned at the downstream end of side channels, particularly where riffles elevate the main channel thalweg to backwater the side channel, increasing residence time and promoting hyporheic exchange. Collectively, these features are intended to enhance hydraulic diversity, thermal refuge potential, and long-term floodplain connectivity as the restored valley evolves.

Depressions will be excavated on the floodplain approximately 1 ft below the valley regrade surface and will vary longitudinally in width with the intent to mimic abandoned meander scrolls and relic channels. These depressions are intended to store seasonal floodwaters, promote hyporheic exchange, and increase habitat heterogeneity for amphibians.

Typical side channel, alcove and floodplain details are provided in Appendix A, Drawing 5.1 and 5.2.

3.5.6 Corral Creek

Additional grading is proposed along Corral Creek to follow an existing high flow pathway and integrate it with the restored Bull Run Creek valley. Plan and profile details for Corral Creek are provided in Appendix A, Drawing 3.9.

We developed the Corral Creek alignment in coordination with the affected landowners and project partners. Under existing conditions, Corral Creek passes beneath a private driveway through an undersized and partially obstructed culvert before entering Bull Run Creek. During high flows, this restriction causes water to back up and discharge into a series of depressions located north of Bull Run Creek. Landowners and project partners expressed a preference to maintain this general routing through the series of depressional features. Because the driveway separating Corral Creek from Bull Run Creek will be removed as part of the broader restoration effort, grading is required to preserve this flow path. Field observations of Corral Creek indicate an existing bankfull width of approximately 4.5 feet. The proposed channel geometry includes a 2-ft bottom width and approximately 4-ft top width. Outside of the valley regrade limits, a pilot channel is excavated to connect Corral Creek to the series of depressions using a 2-ft bottom width grading up to catch the existing grade at a 2 horizontal to 1 vertical side slope.

At present, Corral Creek descends relatively steeply from the hillslope before transitioning abruptly into a ponded area. Under natural conditions, this slope break would likely promote sediment deposition and development of an alluvial fan. To replicate this depositional transition and maintain the desired flow direction, the design incorporates a constructed sediment wedge, referred to herein as a floodplain berm, at the grade break. This feature is intended to mimic natural fan deposition, encourage overbank spreading, and guide flow toward the existing depressions rather than directly toward Bull Run Creek. Additional floodplain berms are proposed downstream to distinguish the Corral Creek and Bull Run Creek floodplain surfaces and to promote routing of Corral Creek flows into the wetlands while impeding Bull Run Creek waters from flowing into the wetlands.

The graded reach extends approximately 1,300 ft from the valley tie-in, including a new culvert at the private driveway crossing (to be designed at 80 percent Design), and continues to the existing depressional features. Proposed slopes range from approximately 0.6 percent near the downstream limits of Corral Creek to 2.0 percent near the valley transition at its confluence with the restored floodplain. Corral Creek will be routed through these depressions limiting grading within these areas to the extent practicable. Where grading intersects existing tailings berms, a 3-ft-wide floodplain bench will be maintained on both sides of Corral Creek channel to provide lateral stability and promote floodplain where the channel cuts through tailings to rejoin Bull Run Creek.

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

Material gradations and transport analysis for streambed materials will be provided at 80 percent Design. It is anticipated that all streambed materials will be sourced from excavated native alluvium.

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

3.7.1 Hydraulic Model Development

The project team developed a two-dimensional (2D) hydraulic model of the project reach using the U.S. Army Corps of Engineers' Hydraulic Engineering Center River Analysis System (HEC-RAS) Version 6.6 computer program, a two-dimensional (2D) hydraulic numerical model (United States Army Corps of Engineers 2024).

Development of a two-dimensional hydraulic model requires the modeler to:

- Define the model domain (Section 3.7.1.1)
- Create or obtain a surface that is an accurate representation of the river system's topography including bathymetry (Section 3.7.1.2)
- Generate a mesh that accurately defines the surface for input into the model (Section 3.7.1.3)
- Generate a layer that defines the Manning's n roughness parameter (Section 3.7.1.4)
- Define the boundary conditions which describe how flow enters and exits the model's mesh (Section 3.7.1.5)
- Define model controls including simulation time and time step (Section 3.7.1.6)
- Define hydraulic structures, if applicable (Section 3.7.1.7)

The existing conditions model for the site is described in Section 3.7.2 and the proposed conditions model for the site is described in Section 3.7.3. The model development steps listed above are described in the sections below for both the existing and proposed conditions models.

3.7.1.1 MODEL DOMAIN

The model encompasses an approximately 2.5-mile reach of Bull Run Creek and floodplain through the project site. Laterally, the model spans roughly 1,000 ft. Figure B-1 shows the model domain.

3.7.1.2 MODEL ELEVATION SURFACE

HEC-RAS requires a topographic surface to represent bathymetric and overbank areas in the model. We obtained overbank and bathymetric survey data in the vicinity of the project from RSI that was collected in August 2024 and from Light Detection and Ranging (LiDAR) collected in 2016. GeoEngineers developed the proposed conditions model elevation surface by modifying the existing 2D model elevation surface to reflect conditions described as the proposed project elements (Section 3.4 and 3.5).

3.7.1.3 MESH DEVELOPMENT

The mesh is the geometry input into the 2D model and is made up of elements with varying shapes. The edges of elements define key elevation information for the model. These elevations are extracted from the model surface. Development of the mesh requires creation of breaklines to align element edges with hydraulically relevant features such as the channel banks, side channels, and elevated features. Breaklines created during the development of the model surface were used to define these key features. Both the existing conditions and the proposed conditions model meshes cover approximately 200 acres and include more than 100,000 elements. Elements are spaced approximately 1 to 3 ft apart in the channel and increase to up to 9 ft in the floodplain areas.

3.7.1.4 HYDRAULIC ROUGHNESS

Manning's n is a parameter used in the model to represent roughness of surfaces and are defined within HEC-RAS using coverages that define Manning's n value regions with polygons. Manning's n regions throughout the existing model domain include the main channel, floodplain (e.g. forest, wetland, and grass areas), and roads (Table 8). RSI downloaded land cover data from the U.S Geological Survey (USGE) National Land Cover Database (NLCD) tool in October 2024 (USGS 2024). CFS added a refinement area to the model to represent the existing active channel as an open water surface, and GeoEngineers added refinement areas to the proposed conditions model to represent the proposed main channel, proposed Corral Creek, proposed side channels, and the proposed inset floodplain (Figure B-2). Table 8 shows the land cover types and their associated Manning's n value delineated by NLCD and based on values from the US Army Corp of Engineers (USACE 2024). Existing and proposed conditions main channel Manning's n values are composite values based on combining tabular and quantitative guidance (Yochum 2018). We estimated proposed floodplain Manning's n values using V.T. Chow's Open Channel Hydraulics Manning's reference table (Chow 1959). Manning's n regions throughout the proposed model domain include the same categories as the existing conditions but with increased roughness to account for the placement of LWM throughout the main channel, side channels, and floodplain (Addy and Wilkenson 2019, Yochum 2018).

TABLE 8. MANNING'S N FOR THE MODEL AREA, AS DEFINED BY NLCD LANDCOVER CATEGORIZATION

ID	LANDCOVER TYPE	MANNING'S N
71	Grassland-Herbaceous	0.04
42	Evergreen Forest	0.11
52	Shrub-Scrub	0.05
21	Developed, Open Space	0.035
22	Developed, Low Intensity	0.08
23	Developed, Medium Intensity	0.12
95	Emergent Herbaceous Wetland	0.045
90	Woody Wetland	0.07
N/A	Existing Main Channel	0.035
N/A	Proposed Main Channel	0.045
N/A	Proposed Floodplain	0.09

3.7.1.5 BOUNDARY CONDITIONS

HEC-RAS utilizes user-defined boundary conditions to define flow that enters and exits the model. Inflows are defined at the upstream boundary conditions and normal depth water surface elevations are defined at the downstream boundary conditions. We used two inflow boundary conditions in the model: one for the main channel Bull Run Creek above Corral Creek and one for Corral Creek. Inflow values include the flows identified from the hydrologic analysis (Section 3.3, Table 5), and flow values were apportioned to each sub-watershed in proportion to contributing drainage area (Table 9). The Corral Creek watershed (4.6 square miles) accounts for approximately 18 percent of the Bull Run Creek watershed (25.6 square miles).

We calculated the normal depth water surface elevation for each simulated flow at the downstream boundary condition using the downstream average slope (0.01 ft/ft) and the composite Manning's n value from the HEC-RAS roughness coverage.

TABLE 9. UPSTREAM BOUNDARY CONDITIONS

SCENARIO	DISCHARGE (CFS)	EXISTING CONDITIONS MODEL		PROPOSED CONDITIONS MODEL	
		BULL RUN CK US BC 1 (CFS)	CORRAL CK US BC 1 (CFS)	BULL RUN CK US BC (CFS)	CORRAL CK US BC (CFS)
95%	4.0	4.0	N/A	3.4	0.6
50%	11.1	11.1	N/A	9.4	1.7
25%	24.5	24.5	N/A	20.5	4.0
10%	60.1	60.1	N/A	50.7	9.4
5%	89.6	89.6	N/A	75.9	13.7
2-year	131.6	131.6	N/A	108.2	22.4
5-year	185.9	152.8	33.1	152.8	33.1
10-year	223.9	184.0	38.9	184.0	38.9
25-year	278.7	229	49.7	229	49.7
50-year	321.6	264.3	57.3	264.3	57.3
100-year	366.3	301.2	65.3	301.2	65.3

[1] Note: The existing conditions model does not include a Corral Creek inflow boundary condition for flows below the 5-year event because the existing low areas near the Corral Creek confluence resulted in model instabilities and exceptionally long run times. In these instances, all flow was added at the main channel Bull Run Creek upstream boundary condition.

3.7.1.6 MODEL RUN CONTROLS

We ran all models using the HEC-RAS full momentum equation: Shallow Water Equations, Eulerian-Lagrangian Method (SWE-ELM), with the initial condition for all simulations set to dry. The simulation time ranged from 8 to 16 hours to achieve steady state flows throughout the model. The time step was 1 second.

3.7.1.7 HYDRAULIC STRUCTURES

3.7.1.7.1 Existing Conditions Hydraulic Structures

We modeled hydraulic structures in the existing conditions model using HEC-RAS SA/2D Area Connections. We modeled four main-channel culverts (1-4) (Figure 31 and Figure 8) and an additional minor culvert (5) under an existing driveway and connects Corral Creek with Bull Run Creek (Table 10).

Culverts 1 and 4 are mapped by the ODFW map of fish habitat distribution and barriers. Culvert 1 is mapped as not passable for all species and life stages and Culvert 4 is mapped but listed as unknown regarding fish passage.

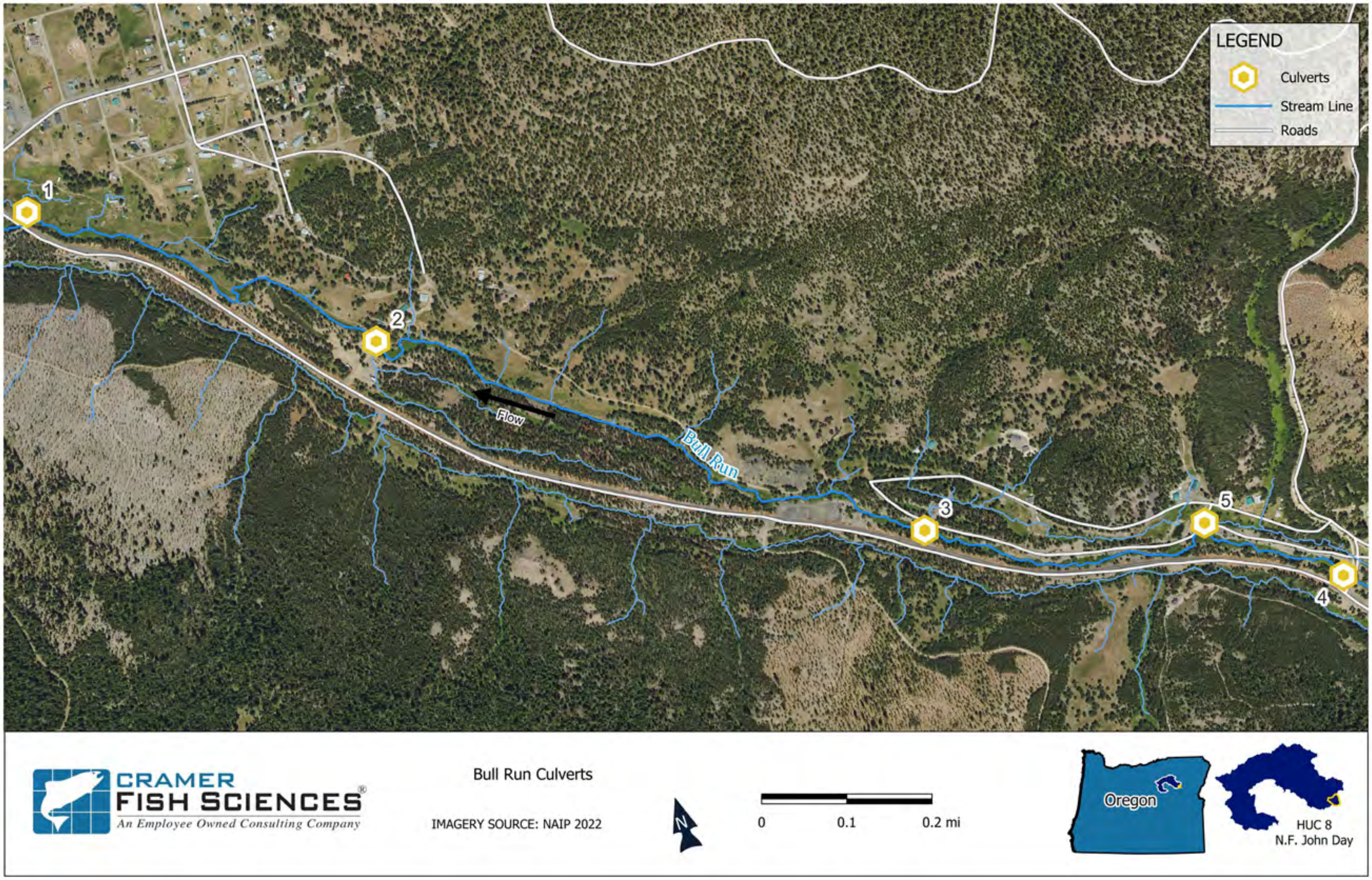

Figure 31. Location of Modeled Culverts along Bull Run Creek.

TABLE 10. EXISTING CONDITIONS CULVERT ATTRIBUTES AS MODELED FOR HYDRAULIC ASSESSMENT

CULVERT #	CULVERT NAME	DIAMETER (FT)	LENGTH (FT)	INLET ELEVATION	OUTLET ELEVATION	MATERIAL	STREAM
1	Culvert 1	7	71.7	4566.45	4565.92	Corrugated Metal	Bull Run
2	Culvert 2a	3	20.8	4584.74	4584.38	Corrugated Metal	Bull Run
	Culvert 2b	6	20.6	4582.98	4582.50	Corrugated Metal	
	Culvert 2c	2.5	20.9	4585.68	4585.42	Corrugated Metal	
3	Culvert 3	7.5	28.8	4614.05	4614.22	Corrugated Metal	Bull Run
4	Culvert 4	10 span 7 rise (Arch)	49.1	4639.43	4639.33	Corrugated Metal	Bull Run
5	Culvert 5	0.5	46.6	4635.21	4636.10	Corrugated Metal	Corral Creek

3.7.1.7.2 *Proposed Conditions Hydraulic Structures*

We modeled hydraulic structures in the proposed conditions model using modifications to the proposed surface (Appendix A). We modeled five main-channel structures in HEC-RAS for the proposed conditions model, including four proposed AOP structures (Table 11), three of which replace undersized culverts described above (AOP Crossing Structures 1, 2, and 4) and one of which is a new crossing structure (AOP Crossing Structure 3). Structure locations are shown in Appendix A, Drawings 6.0 to 6.3. We also modified the proposed model surface to account for the new bridge across Granite Hill Road that was replaced by Grant County in summer 2025 as part of a separate project near the downstream project limits on Bull Run Creek.

TABLE 11. PROPOSED CONDITIONS CULVERT ATTRIBUTES AS MODELED FOR HYDRAULIC ASSESSMENT

STRUCTURE NAME	PROPOSED OPENING WIDTH (FT)	PROPOSED STRUCTURE TYPE	STREAM/ROAD
AOP Crossing Structure 1	40	Prefabricated bridge	Bull Run
AOP Crossing Structure 2	40	Prefabricated bridge	Bull Run
AOP Crossing Structure 3	50	Prefabricated bridge	Bull Run
AOP Crossing Structure 4	40	Prefabricated bridge	Bull Run

3.7.2 *Existing Conditions Model Results*

Using the existing conditions HEC-RAS 2D model, we simulated low and high flow events to better understand: (1) flow patterns within the main channel, (2) interactions between Bull Run Creek, the floodplain, and existing side channels, and (3) how existing culverts impact the main channel and floodplain connectivity.

Under existing conditions, flow is generally confined to the main channel through the 10 percent flow duration, with velocities ranging between 1 to 4 feet per second (ft/s) and depths below 2 ft (Table 12). Above the 5 percent flow duration, floodplain activation increases but remains largely confined until the 5-year recurrence interval, above which wetted width and flow area increase more rapidly. Spatial results for select simulated discharges are included in Appendix B.

TABLE 12. SUMMARY OF EXISTING CONDITIONS HYDRAULIC RESULTS

DESIGN FLOW	DISCHARGE (CFS)	AVERAGE DEPTH[1] (FT)	AVERAGE VELOCITY[1] (FT/S)	INUNDATED AREA (ACRES)
Annual 95 percent exceedance	4.0	0.6	1.1	3.2
Annual 50 percent exceedance	11.1	0.8	1.8	3.8
Annual 25 percent exceedance	24.5	1.1	2.6	4.6
Annual 10 percent exceedance	60.1	1.6	3.7	6.5
Annual 5 percent exceedance	89.6	2.0	4.2	8.4
2-year	131.6	2.3	4.8	11.1
10-year	223.9	2.9	5.5	22.9

Notes:

[1] Calculations performed along river thalweg

3.7.3 Proposed Conditions Model Results

The proposed conditions model simulates the 30 percent design. We completed proposed conditions hydraulic model simulations at the same design flows we modeled for existing conditions.

In general, the proposed design decreases main channel depths across all flow events, significantly decreases main channel velocity at most flow events, and significantly increases inundation extents for all flow events (Table 13). The narrower proposed main channel and lower and wider floodplain under proposed conditions resulted in shallower main channel depths (0.3 to 0.7 ft lower) and lower velocities (up to 2.9 ft/s lower) at higher flows since water is able to spread out onto the floodplain. Average shear stress observed along the proposed main channel thalweg ranged from approximately 0.02 lb/ft^2 at the 95 percent exceedance flow to 0.4 lb/ft^2 at the 100-year flood event, with higher values observed along channel banks but typically not exceeding 2 lb/ft^2, aside from areas without a wide floodplain such as at AOP crossing structure locations.

The proposed main channel banks are exceeded between the annual 25 percent and 10 percent exceedance (between 24.5 cfs and 60.1 cfs), with the proposed 12.5-ft-wide 2-percent slope floodplain benches fully inundated by the 10 percent exceedance. In many locations, the 10 percent exceedance flow inundates the entire regraded valley width, and in most locations, the 5 percent exceedance flow inundates the entire regraded valley width. The proposed design resulted in a dramatic increase in inundated area from existing, ranging from an approximately 28 percent increase at low flow events to more than a 300 percent increase at the 5 and 10 percent exceedances (Table 12).

Most proposed side channels activate between the 50 percent exceedance and 25 percent exceedance flows. Since Type 1 side channels are wider and deeper, they often activate earlier than Type 2 side channels and have higher discharge, although some Type 2 side channels located closer to the main channel activate earlier (Table 13, Appendix B).

Maximum velocity in side channels ranges from approximately 0.3 ft/s at the 10 percent exceedance to approximately 2 ft/s at the 100-year flood event. Maximum shear stress in side channels ranges from approximately 0.05 lb/ft^2 at the 10 percent exceedance to approximately 0.8 lb/ft^2 at the 100-year event. Velocity and shear stress on the floodplain are similarly low. Average velocity on the proposed regraded floodplain is less than 0.8 ft/s at the 10 percent exceedance and less than 2.0 ft/s at the 100-year event. Floodplain velocities are lower in areas where the floodplain is wider and higher in narrower areas. Shear stress in the floodplain is typically less than 0.05 lb/ft^2 at the 10 percent exceedance and less than 1 lb/ft^2 at the 100-year event.

TABLE 13. SUMMARY OF PROPOSED CONDITIONS HYDRAULIC RESULTS

DESIGN FLOW	DISCHARGE (CFS)	AVERAGE DEPTH[1] (FT)	AVERAGE VELOCITY[1] (FT/S)	INUNDATED AREA (ACRES)	INCREASE IN INUNDATED AREA (%) FROM EXISTING
Annual 95 percent exceedance	4.0	0.7	1.3	4.1	28.5
Annual 50 percent exceedance	11.1	1.0	1.9	5.6	46.1
Annual 25 percent exceedance	24.5	1.4	2.4	11.2	144.9
Annual 10 percent exceedance	60.1	2.0	3.0	27.3	318.2
Annual 5 percent exceedance	89.6	2.2	3.1	34.1	307.8
2-year	131.6	2.4	3.2	36.9	231.3
10-year	223.9	2.7	3.2	45.7	81.9
100-year	366.3	3.1	3.2	45.7	44.9%

Notes:

[1] Calculations performed along river thalweg

TABLE 14. CHANNEL ACTIVATION RESULTS

DESIGN FLOW	DISCHARGE (CFS)	AVERAGE MAIN CHANNEL DISCHARGE[1]		AVERAGE TYPE 1 SIDE CHANNEL DISCHARGE		AVERAGE TYPE 2 SIDE CHANNEL DISCHARGE		AVERAGE FLOODPLAIN DISCHARGE	
		CFS	%	CFS	%	CFS	%	CFS	%
Annual 95 percent exceedance	4.0	3.7	100%	0.0	0%	0.0	0%	0.0	0%
Annual 50 percent exceedance	11.1	10.0	98%	0.0	0%	0.0	0%	0.2	2%
Annual 25 percent exceedance	24.5	20.9	94%	1.2	4%	0.5	2%	0.5	2%
Annual 10 percent exceedance	60.1	44.5	81%	4.1	6%	2.6	4%	5.6	10%
Annual 5 percent exceedance	89.6	53.8	66%	5.4	6%	3.8	4%	20.5	25%
2-year	131.6	60.6	51%	8.3	7%	5.6	4%	46.8	39%
10-year	223.9	71.3	35%	12.5	7%	8.6	4%	113.2	55%
100-year	366.3	84.2	25%	19.1	6%	13.3	4%	219.1	66%

Notes:

[1] Discharge data were collected at four representative locations along the project reach, two of which are above the Corral Creek confluence. Percentages account for Corral Creek while simple discharge totals do not, explaining discrepancies between totals and percentages.

3.7.4 Assumptions and Limitations

Modeling hydraulic systems comes with inherent assumptions. A single model is only able to provide results for a single channel morphology based on available survey and LiDAR. The LiDAR used for this model was collected in 2016 which means changes to the channel since then are unable to be accounted for without further survey. The survey conducted by RSI provided important location data for the existing main channel and hydraulic structures, but surface data outside of the channel relies heavily on the 2016 LiDAR. Modeling also assumes that the stream system is static for the duration of a simulated flow. Real streams respond to flooding by adapting dynamically to the flow, but a model is unable to capture this behavior and the associated sediment transport and fluvial morphology changes that come with it. Discrete flow events of constant discharge are also unlikely to be representative of natural events. With the model limitations in mind, the level of detail in the model is representative of best practices for a project of this scope.

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

Project elements that require stability analysis include the LWM structures, streambed materials and scour countermeasure materials. All multi-log structures will be designed to be stable against buoyancy and drag with a factor of safety equal to or greater than 1.5 at the 100-year event. Stability calculations and additional detail on LWM design will be included in the 80 percent Design submittal.

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

GeoEngineers has used the preceding technical analysis to inform the locations of proposed project elements depicted in the design drawings (Appendix A). The approach has been iterative, starting with a resource inventory and evaluation/site characterization informing design concepts and channel grading, followed by a refinement of main channel, side channel, and AOP crossing structure locations and geometry informed by hydraulic modeling (Appendix B). A LWM stability analysis will be completed at the next design phase and used to inform LWM layout and burial depths shown in the design details. Additionally, a streambed mobility analysis and scour analysis will be completed at the next design phase and used to inform channel design and AOP crossing structure design.

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

This project does not address a profile discontinuity.

3.11 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

This project does not address a profile discontinuity.

4.0 Construction – Contract Documentation

4.1 INCORPORATION OF HIP GENERAL AND CONSTRUCTION CONSERVATION MEASURES

The Bull Run Creek RM 0.5 Fish Habitat Enhancement project includes HIP IV specific activity conservation measures associated with:

- Work area isolation and fish salvage
- Action Category 1: Fish Passage Restoration
  - 1F – Bridge and Culvert Removal or Replacement
- Action Category 2: River, Stream, Floodplain and Wetland Restoration, including:
  - 2A – Improve Secondary Channel and Floodplain Connectivity
  - 2D – Install Habitat-Forming Instream Structures
  - 2E – Riparian and Wetland Vegetation Planting
  - 2F – Channel Reconstruction

The conservation measures are included in Appendix A in the 1-series drawings.

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

See attached, Appendix A, for project design drawings.

4.3 LIST OF ALL PROPOSED PROJECT MATERIALS AND QUANTITIES/COST ESTIMATE

Table 15 includes the proposed project bid items, including materials and quantities to be imported to the site.

TABLE 15. PROJECT BID ITEMS

ITEM #	ITEM DESCRIPTION	UNITS	NO. OF UNITS
1	Mobilization and Demobilization	LS	1
2	Environmental Controls - Permit Compliance-Best Management Practices	LS	1
3	Temporary Access Bridge	EA	2
4	Temporary Access Road	LF	8,800
5	Temporary Stream Diversion and Work Isolation	LS	1
6	Clearing, Grubbing, Stockpile and Disposal	AC	39
7	Stockpile and Sort Cleared Logs for LWM structures	AC	39
8	Excavation - Valley Grading	CY	204,230
9	Place Excavated Material - Dispose on Site	CY	205,660
10	Sort and Stockpile Excavated Material	CY	5,530
11	Finish Grade - Main Channel	CY	6,640
12	Finish Grade - Side Channels, Alcoves, Depressions	CY	2,490
13	Place Excavated Material - Fill Existing Channel	CY	9,440
14	Place Excavated Material - 2-inch Minus Gravel	CY	2,470
15	Place Excavated Material - Streambed Material	CY	2,000
16	Place Excavated Material - Riffles	CY	1,060
17	Import logs for LWM Structures	EA	220
18	Place LWM with Rootwad	EA	849
19	Place LWM no Rootwad	EA	1,769
20	AOP Crossing Structure #1 - 40-foot driveway bridge	LS	1
21	AOP Crossing Structure #2 40-foot driveway bridge	LS	1
22	AOP Crossing Structure #3 - 50-foot driveway bridge	LS	1
23	AOP Crossing Structure #4 - 40-foot USFS bridge	LS	1
24	Resurface Gravel Road	LF	830
25	Driveway Culvert	EA	4
26	Walking Bridge - 40-foot modular bridge	LS	1
27	Floodplain Preparation - Biochar	AC	30
28	Floodplain Preparation - Compost	AC	30
29	Seeding and Mulching	AC	36
30	Planting	AC	30
31	Contingency Grading	HR	40

GeoEngineers calculated construction quantities and applied unit costs based on recent project experiences, engineering judgment and published documentation. We included a summary of the anticipated construction costs in Appendix D. The total anticipated construction cost is $10,214,000 in 2026 dollars, including a 25 percent contingency.

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

4.4.1 Site Access Staging and Sequencing Plan

See attached, Appendix A, for site access and staging plan. Construction sequencing plan to be developed at 80 percent Design.

4.4.2 Work Area Isolation and Dewatering Plan

Work area isolation and construction sequencing plan to be developed at 80 percent Design. See attached, Appendix A, for work isolation structures.

4.4.3 Erosion and Pollution Control Plan

See attached, Appendix A, for erosion and pollution control plan and details.

4.4.4 Site Reclamation and Restoration Plan

Site reclamation and restoration plan, including revegetation to be developed at 80 percent Design. Riparian planting will be conducted following construction and will include all grading areas and temporary access and staging areas. BMPs will be used to ensure no invasive species, including noxious weeds and aquatic invasives, are brought to the project site. Temporary access roads and paths will be decommissioned, involving decompacting the surface, pulling the fill material, and reshaping the original contour.

4.4.5 List Proposed Equipment and Fuels Management Plan

Proposed equipment may include low ground-pressure machinery to minimize soil compaction and disturbance. Heavy equipment anticipated for the project may include:

- Tracked excavators with grapples or thumbs for floodplain excavation, side-channel grading, and large wood placement
- Bulldozers and skid steers for rough grading, shaping floodplain surfaces, and short-distance material movement
- Articulated dump trucks or haul trucks for hauling excavated material, gravel, rock, and logs
- Wheel loaders for material handling and loading trucks

Modifications to this equipment configuration may be suggested by the contractor selected to implement the project.

Fuel storage and refueling activities will be carefully managed, with fuel tanks and equipment staged a minimum of 150 feet away from the stream and refueling of all equipment occurring within the staging areas. See attached, Appendix A, for HIP conservation measures related to fuel management.

4.5 CALENDAR SCHEDULE FOR CONSTRUCTION/IMPLEMENTATION PROCEDURES

The calendar schedule for construction/implementation procedures will be developed at 80 percent design. The in-water work window established by regulatory agencies is anticipated to be from July 15 through August 15 (ODFW 2004a).

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

The project will follow the BPA Conservation Methods for pollution prevention and abatement as put forth in the two biological opinions issued by the United States Fish and Wildlife Service and the National Marine Fisheries Service on the effects of BPA's Habitat Improvement Program (National Marine Fisheries Service 2020, U.S. Fish and Wildlife Service 2020).

5.0 Monitoring And Adaptive Management Plan

This section will be completed during 80 percent Design.

5.1 INTRODUCTION

5.2 EXISTING MONITORING PROTOCOLS

5.3 PROJECT EFFECTIVENESS MONITORING PLAN

5.4 PROJECT REVIEW TEAM TRIGGERS

5.5 MONITORING FREQUENCY, TIMING, AND DURATION

5.6 MONITORING TECHNIQUE PROTOCOLS

5.7 DATA STORAGE AND ANALYSIS

5.8 MONITORING QUALITY ASSURANCE PLAN

6.0 Limitations

We have prepared this report for CTUIR for the Bull Run Creek RM 0.5 Fish Habitat Enhancement project located near Granite, Oregon. CTUIR may distribute copies of this report to their agents and regulatory agencies as may be required for the project.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of stream and river habitat enhancement, stabilization and restoration design engineering in this area at the time this report was prepared. The conclusions, recommendations and opinions presented in this report are based on our professional knowledge, judgment and experience. No warranty, express or implied, applies to our services and this report.

Any electronic form, facsimile or hard copy of the original document (email, text, table and/or figure), if provided, and any attachments should be considered a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

Please refer to Report Limitations and Guidelines for Use, Appendix E, for additional information pertaining to the use of this report.

7.0 References

Bonneville Power Administration (BPA). 2025. Habitat Improvement Program (HIP) Handbook. Guidance of Programmatic Requirements and Process. Portland, Oregon.

Buffington, J.M., and D.R. Montgomery. 2013. Geomorphic classification of rivers. Pages 730-767 in J. Shroder and E. Wohl, editors. Treatise on Geomorphology; Fluvial Geomorphology. Vol 9. Academic Press. San Diego, California.

Bureau of Land Management (BLM). General Land Office Records. Available online. Accessed October 3 2024. https://glorecords.blm.gov/search/default.aspx.

Castro, J. M., and P. L. Jackson. 2001. Bankfull Discharge Recurrence Intervals and Regional Hydraulic Geometry Relationships: Patterns in the Pacific Northwest, USA. Journal of the American Water Resources Association.

Caty F. Clifton, Kate T. Day, Charles H. Luce, Gordon E. Grant, Mohammad Safeeq, Jessica E. Halofsky, Brian P. Staab, Effects of climate change on hydrology and water resources in the Blue Mountains, Oregon, USA, Climate Services, Volume 10, 2018, Pages 9-19, ISSN 2405-8807, https://doi.org/10.1016/j.cliser.2018.03.001.

Ciotti, Damion C., J. M. McKee, K. L. Pope, G. M. Kndolf, and M. M. Pollock. 2021. "Design Criteria for Process-Based Restoration of Fluvial Systems." *BioScience* 71; 831-845.

Clifton, C. F., K. T. Day, C. H. Luce, G. E. Grant, M. Safeeq, J. E. Halofsky, B. P. Staab. 2018 Effects of climate change on hydrology and water resources in the Blue Mountains, Oregon, USA. Climate Services 10.

Cooper, R.M., 2006. Estimation of peak discharges for rural, unregulated streams in eastern Oregon: Oregon Water Resources Department Open File Report SW 06-00, 150 p.

Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO). 2014. John Day River Watershed Restoration Strategy. John Day, Oregon.

Dwire, K. A. and S. Mellmann-Brown. 2017. Climate change and special habitats in the Blue Mountains: Riparian areas, wetlands, and groundwater-dependent ecosystems. U.S. Forest Service General Technical Report. Available at: https://research.fs.usda.gov/treesearch/54020

England, J.F., Jr., Cohn, T.A., Faber, B.A., Stedinger, J.R., Thomas, W.O., Jr., Veilleux, A.G., Kiang, J.E., and Mason, R.R., Jr., 2018, Guidelines for determining flood flow frequency — Bulletin 17C (ver. 1.1, May 2019): U.S. Geological Survey Techniques and Methods, book 4, chap. B5, 148 p., https://doi.org/10.3133/tm4B5.

Ferns, M.L., H. C. Brooks, and J. Ducette. 1982. Geology and Mineral Resources Map of the Mt. Ireland Quadrangle, Baker and Grant Counties, Oregon: Oregon Department of Geology and Mineral Industries Geologic Map Series, Map GMS-22, scale 1:24,000.

Fouty, S.C. 2018. Euro-American beaver trapping and its long-term impact on drainage network form and function, water abundance, delivery, and system stability. Riparian Research and Management: Past, Present, Future.

Fox, M., and S. Bolton. 2007. A Regional and Geomorphic Reference for Quantities and Volumes of Instream Wood in Unmanaged Forested Basins of Washington State. North American Journal of Fisheries Management 27: 342–359.

Frankiewicz, P., A. Radecki-Pawlik, A.W.M. Lapinska, and A. Wojital-Frankiewicz. 2021. Small hydraulic structures, big environmental problems: is it possible to mitigate the negative impacts of culverts on stream biota? Environmental Reviews 29: 510–528.

Fryirs, K. A., J. M. Wheaton, and G. J. Brierley. 2016. An approach for measuring confinement and assessing the influence of valley setting on river forms and processes: Measuring confinement along fluvial corridors. Earth Surface Processes and Landforms 701-710. https://doi.org/10.1002/esp.3893.

GeoEngineers, Inc. 2018. Granite Creek Restoration Basis of Design Report. Prepared for Confederated Tribes of Umatilla Indian Reservation.

Halofsky, J.E., K. Hoglund-Wyatt, K. Dello, D.L. Peterson, and J. Stevenson. 2018. Assessing and adapting to climate change in the Blue Mountains, Oregon (USA): Overview, biogeography, and climate. Climate Services, 10, pp.1-8.

Jones, K., Poole, G., Quaempts, E., O'Daniel, S., & Beechie, T. (2008). Umatilla River Vision. Confederated Tribes of the Umatilla Indian Reservation (CTUIR) Department of Natural Resources (DNR).

Kathleen A. Dwire, Sabine Mellmann-Brown, Joseph T. Gurrieri. Potential effects of climate change on riparian areas, wetlands, and groundwater-dependent ecosystems in the Blue Mountains, Oregon, USA, Climate Services, Volume 10, 2018, Pages 44-52, ISSN 2405-8807, https://doi.org/10.1016/j.cliser.2017.10.002.

Kleinschmidt. 2021. Stream and Floodplain Restoration Bull Run Creek Basis of Design Report 100% Design. Confederated Tribes of the Umatilla Indian Reservation.

Leibowitz, S.G., R.L. Comeleo, P.J. Wigington Jr., C.P. Weaver, P.E. Morefield, E.A. Sproles, and J.L. Ebersole. 2014. Hydrologic landscape classification evaluates streamflow vulnerability to climate change in Oregon, USA. Hydrology and Earth System Sciences, 18(9), pp. 3367-3392.

Mining World. 1940. Blue Mountains Dredging. Magazine Article.

Montgomery, D.R, and J.M. Buffington. 1997. Channel reach morphology in mountain drainage basins. Geological Society of America Bulletin. 109(5), pp. 596-611.

Nelson, A. D., V. D. Collins, J. S. Payne, and T. B. Abbes. 2024. Proactive River Corridor Definition: Recommendations for a Process-Based Width Optimization Approach Illustrated in the Context of the Coastal Pacific Northwest. WIREs Water 1-22. https://doi.org/10.1002/wat2.1711.

National Marine Fisheries Service (NMFS). 2009. Middle Columbia Steelhead Distinct Population Segment ESA Recovery Plan. MFS. Northwest Region. Portland, Oregon.

Northwest Power and Conservation Council (NPCC). 2005. John Day Subbasin Plan. Portland, Oregon.

Natural Resources Conservation Service (NRCS). 2007. Stream Restoration Design. National Engineering Handbook Part 654.

Oregon Department of Fish and Wildlife (ODFW). 2004a. Oregon Guidelines for Timing of In-Water Work to Protect Fish and Wildlife Resources. https://www.dfw.state.or.us/lands/inwater/2024%20Oregon%20In-Water%20Work%20Guidelines.pdf.

Oregon Department of Fish and Wildlife (ODFW). 2024b. Natural Resources Information Management Program Fish Barrier Data. https://nrimp.dfw.state.or.us/nrimp/default.aspx?pn=fishbarrierdata.

Oregon Department of Environmental Quality. (2010). *John Day River Basin Total Maximum Daily Load (TMDL) and Water Quality Management Plan* (DEQ 10-WQ-025). Oregon Department of Environmental Quality. https://www.oregon.gov/deq/FilterDocs/jdTMDLwqmp.pdf

Parker, G. P., P. R. Wilcock, C. Paola, W. E. Dietrich, and J. Pitlick. 2007. Physical Basis for Quasi-Universal Relations Describing Bankfull Hydraulic Geometry of Single-Thread Gravel Bed Rivers. Journal of Fluid Mechanics 76; 457-480.

Risley, John, Stonewall, Adam, and Haluska, Tana, 2008, Estimating flow-duration and low-flow frequency statistics for unregulated streams in Oregon: U.S. Geological Survey Scientific Investigations Report 2008-5126, 22 p.

Schuett-Hames, D., A.E. Pleus, J. ward, M. Fox, and J. Light. 1999. Method Manual for the Large Woody Debris Survey. TFW Monitoring program TFW-AM9-99-004.

U.S. Army Corps of Engineers (USACE). 2024. HEC-RAS river analysis system version 6.6 [Computer Program]. U.S. Army Corps of Engineers, Institute for Water Resources, Hydrologic Engineering Center (HEC), Davis, California. October 2024.

U.S. Fish and Wildlife Service (USFWS). 2015. Recovery Plan for the Coterminous United States Population of Bull Trout (Salvelinus confluentus). Portland, Oregon.

U.S. Fish and Wildlife Service (USFWS). 2024. Wetlands Data. https://www.fws.gov/program/national-wetlands-inventory/data-download.

U.S. Geological Survey (USGS). 2018. TNM Download (v2.0) USGS National Hydrography Dataset. https://apps.nationalmap.gov/downloader/.

U.S. Geological Survey (USGS), 2024, Annual NLCD Collection 1 Science Products: U.S. Geological Survey data release, https://doi.org/10.5066/P94UXNTS.

US Forest Service (USFS). 2011. Watershed Condition Framework: A Framework for Assessing and Tracking Changes to Watershed Condition. Baker City, Oregon.

Wenger, S.J., C.H. Luce, A.F. Hamlet, D.J. Isaak, and H.M Neville. 2010. Macroscale hydrologic modeling of ecologically relevant flow metrics. Water Resources Research. 46: W09513. doi:10.1029/2009WR008839.

Appendices

Appendix A
Bull Run Creek RM 0.5 Fish Enhancement Project
30 Percent Design Drawings

Appendix B
Hydraulic Model Results

Appendix C
Cost Estimate

Appendix D
HIP4 Project Review Comment Tracking

HIP4 Project Review
Kuckucéepe téekin (Bull Run Creek RM 0.5) Comment Tracking

Project Information: Kuckucéepe téekin (Bull Run Creek RM 0.5)

Project Name:	Kuckucéepe téekin (Bull Run Creek RM 0.5)
Proposed Implementation:	July 2027
BPA Project #:	2000-31-00
Contract #:	73982 REL 223
Sponsor/PM:	CTUIR/John Zakrasjek
Designer:	GeoEngineers
Area Lead:	Jesse Wilson, EWL, Lower Mainstem and John Day Lead
COR:	Chad Baumler, EWL

HIP Review Team:

HIP Program Lead:	Daniel A. Gambetta, ECF-4
BPA EC Lead:	John M Vlastelicia - ECF-4
BPA Technical Lead:	Sean P. Welch, P.E., EWL
NMFS Branch Chief:	TBD, Columbia Basin Branch Chief
NMFS Biologist:	Rebecca Viray
NMFS Engineer:	Dropdown Menu
USFWS Field Office:	Randi Riggs, La Grande Field Office
USFWS Reviewer:	Graham Shaw

Documents Reviewed:

BRC Rm 0.5 15% BOD Rpt Final	March 2025
BRC Rm 0.5 15% Appendix A Final	March 2025
BRC Rm 0.5 15% Appendix B Final	March 2025
Document 2	
Document 3	

Activity Categories:	**Risk Level:**
1f - Bridge and Culvert Removal or Replacement	Medium
2a - Improve Secondary Channel and Floodplain Connectivity	High
2d - Install Habitat-Forming Instream Structures	Medium
2e - Riparian and Wetland Vegetation Planting	Low
2f - Channel Reconstruction	High
Overall Project Risk	**High**

Review Timeline: 2025-03-10	**Date Completed**
• Conceptual Review (typically 15%)	
o Site visit, if needed	Not Started
o Sponsor to submit conceptual design to EC Lead and COR	3/6/2025
o EC Lead to submit concept to HIP Review Team to initiate review	3/10/2025
o EC Lead to send design package to appropriate HIP Review members	3/10/2025
o EC Lead to compile comments and forward to Sponsor	12/17/2025
o Sponsor to provide responses to EC Lead	12/18/2025
o HIP Review Team and Sponsor to resolve "open" comments	12/19/2025
o EC Lead to notify Sponsor to proceed to preliminary design	12/19/2025
• Preliminary Design or Alternatives Analysis Review (typically 30%)	
o Sponsor to submit preliminary design to EC Lead and COR	Not Started
o EC Lead to submit design package to HIP Review Team	Not Started
o EC Lead to submit design to NMFS Engineer if applicable	Not Started
o NMFS Engineer approves project, if applicable	Not Started
o EC Lead to compile comments and forward to Sponsor	Not Started
o Sponsor to provide responses to EC Lead	Not Started
o HIP Review Team and Sponsor to resolve "open" comments	Not Started
o EC Lead to notify Sponsor to proceed with design	Not Started
• Permit Level Design Review (typically 60% to 80%)	
o Sponsor to submit design package to EC lead and COR	Not Started
o EC Lead to submit design package to HIP Review Team	Not Started
o EC Lead to compile comments and forward to Sponsor	Not Started
o Sponsor to provide responses to EC Lead	Not Started
o HIP Review Team and Sponsor to resolve "open" comments	Not Started
o EC Lead to notify Sponsor to proceed to final design	Not Started
• Final Design Package (100%)	
o Sponsor to submit final designs to EC Lead and COR	Not Started
o EC Lead and BPA Technical Lead to verify no critical changes	Not Started

Comments:

#	Reviewer (Org.)	Date	Document	Page/ Section	Comment		Response by (Org.)	Date	Response to Comment	Status (BPA to Update)
1	BPA	4/18/25	15% Design Drawings	General	Please include the HIP conservation measures in the 30% plan set. Those can be found on the BPA external webpage at this link: habitat-improvement-program - Bonneville Power Administration (bpa.gov)		CTUIR	17 Dec25	Noted	To be Addressed at Next Review
2	BPA	4/18/25	15% Design Drawings	General	Please add the statement "This project was designed in accordance with the BPA Habitat Improvement Program, Programmatic Biological Opinion (HIP4)" to the Cover Sheet of the 30% plans.		CTUIR	17 Dec 25	Noted	To be Addressed at Next Review
3	BPA	4/18/25	15% Design Drawings	General	Please note the in-water work window on the Cover Sheet of the 30% plans.		CTUIR	17 Dec 25	Noted	To be Addressed at Next Review
4	BPA	4/18/25	15 Design Drawings	General	For the 30% submittal, please add a legend to each plan view sheet of the design drawings. The 15% plan set has a legend only on Sheet 1.1.		CTUIR	17 Dec 25	Noted	To be Addressed at Next Review
5	BPA	4/18/25	15% BOD Report	Appendix B	Please list the flow rate corresponding to each recurrence interval noted in the titles of the hydraulic modeling maps.		CTIR	17 Dec 25	Noted	To be Addressed at Next Review
6	BPA	10/1/25	15% BOD and Design Drawings		The design approach identified in Section 3.4.2 of the basis of design report provides an informative and supported objective statement for the project. Maximizing floodplain process space with a combination of tailings removal, a raising of the vertical profile, and strategic and targeted tailings removal is supported as a key component of the design. This could be accomplished by incorporating aspects of alternative 1 into the alternative 2 design approach. "By incorporating this approach, the		CTUIR	17 Dec 25	Noted. CTUIR has been pushing for a smaller main channel with multiple side channels and much of spring runoff distributed across the floodplain. While valley slope isn't overly steep, it is still steep enough that surface erosion may occur and mechanisms to limit, if not avoid, are being considered. If BPA has examples of treatments that minimize/avoid short term erosion please pass them on for consideration. This is a consideration we'll be running into often in the Granite Creek basin as	Open (Recommendation)

#	Reviewer (Org.)	Date	Document	Page/ Section	Comment		Response by (Org.)	Date	Response to Comment	Status (BPA to Update)
					design aims to restore a dynamic, multi-threaded channel form that interacts with the floodplain at a range of flow conditions. The expectation is that seasonal winter and spring flows will fully inundate the floodplain, redistributing sediment and organic material, supporting riparian vegetation, and enhancing aquatic habitat complexity. This approach aligns with historical conditions in the watershed, where beaver activity, in-stream wood, and sediment deposition likely maintained a complex valley bottom containing a single to multi-threaded channel with wandering planform.”				many of the stringer meadows seem to have a slope around 2%.	
7	BPA	10/1/25	15% Design Drawings		How was the nominal and maximal process space identified and how is that laid in to optimize the grading plan for alternative 2? Bonneville recommends an iterative grading alternative approach to maximize floodplain width. Color shaded cut fill maps would be helpful in assessing alternatives that maximize floodplain width.		CTUIR	17 Dec 25	Noted. We also need to consider where materials are wasted as 150,000cy3 may be difficult and could be compounded in working through issues associated with mining claims.	Open (Recommendation)
8	BPA	10/1/25	15% Design Drawings and BOD Report	Drawing 5.0	The channel design dimensions seem exorbitant, a 13-foot base width appears to be almost twice the size of the channel in the upstream project area. Bonneville noted the channel form was arrived at through an analytical approach using a number of different regional curves, but did not see if and how these were referenced in existing channel form. Bonneville suggests the channel form be refined		CTUIR	17 Dec 25	Noted. Narrowing channel width has been pushed multiple times by CTUIR. The 30% design will contain a narrower channel.	Open (Recommendation)

#	Reviewer (Org.)	Date	Document	Page/ Section	Comment		Response by (Org.)	Date	Response to Comment	Status (BPA to Update)
					based on ground measurements and a narrow deep channel be considered.					
9	BPA	10/1/25	15% BOD and Design Drawings	BOD 1.4.2	Raising the vertical profile of the thalweg should be considered and informed by the geotechnical investigation as well as the establishment of the groundwater elevations within the project reach. Bonneville believes it is appropriate to raise the channel thalweg and associated graded floodplain as high as possible versus constructing new channels at the existing thalweg elevation. Raising the thalweg would help limit the excavation required, result in a larger floodplain area, and increased groundwater storage. A narrow deeper channel could be considered to offset concerns associated with subsurface flow.		CTUIR	17 Dec 25	Noted. Piezometers were placed with data recorded during 2025. While flows remained within Bull Run Creek throughout 2025 and most floodplain depressions lost surface water they were still damp to mucky in late summer suggesting near proximity to groundwater though this may be disguising dissimilar groundwater elevations. Mostly agree with this, though feel the system could benefit from channel reconstruction where appropriate to maximize floodplain area and manage flow velocities, keeping in mind the importance of preserving quality in-and-off-channel habitats.	Open (Recommendation)
10	BPA	10/1/25	15% Design Drawings		Please provide references for the images included on the design sheets and locations of these reference conditions.		CTUIR	17 Dec 25	Noted	To be Addressed at Next Review
11	BPA	10/1/25	15% Design Drawings		Bonneville evaluated reference reaches of some beaver dominated alluvial wetland complexes and identified two discerning types of Beaver Dam complex morphologies including unconstrained valley bottom stranded valleys, and distributed floodplain complexes. We believe site is a good candidate for the latter with the meandering wandering channel balanced within an alluvial wetland complex dominating the available process.		CTUIR	17 Dec 25	Noted. Please provide pictorial examples of the latter. CTUIR has provided comment related to buried and surface placed wood within the stream channel and floodplain. A distributed floodplain beaver dam complex can be found upstream in the Bull Run Creek RM 3 project area. The beavers in this area continue to expand and, in time, could populate RM 0.5. Design elements that support beaver inhabitation are encouraged.	Open (Recommendation)

#	Reviewer (Org.)	Date	Document	Page/ Section	Comment		Response by (Org.)	Date	Response to Comment	Status (BPA to Update)
					Suggest floodplain and in channel wood be incorporated to the maximum extent practicable.					
12	BPA	10/1/25	15% Design Drawings		Retaining tailings piles within the available process space may limit channel evolution or result in abandoned floodplains areas as main and side channels evolve over time. Consideration should be given to maximizing uninterrupted process space. 10/		CTUIR	17 Dec 25	Noted although a case can be made for irregularities within a floodplain surface. 15% Design Draw Agree with this comment. Tailings removal should maximize floodplain area and support channel evolution to the extent possible.	Open (Recommendation)
13										

Appendix E
Report Limitations and Guidelines for Use

APPENDIX E
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

READ THESE PROVISIONS CLOSELY

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 misunderstanding can create unrealistic expectations, sometimes leading to disappointments, claims and disputes. GeoEngineers includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or site.

STREAM AND RIVER DESIGN ENGINEERING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This report has been prepared for the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) and their authorized agents and regulatory agencies for use on the Bull Run Creek RM 0.5 Fish Habitat Enhancement project located near Granite, Oregon. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than CTUIR 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(s), and its (their) schedule and budget, our services have been executed in accordance with our Agreement with the CTUIR signed June 18, 2024 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.

A STREAM OR RIVER DESIGN ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

This report has been prepared for the Basis of Design for the Bull Run Creek RM 0.5 Fish Habitat Enhancement project. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers 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

[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

- 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, orientation or weight of the proposed structures;
- Composition of the design team; or
- Project ownership.

If changes occur after the date of this report, GeoEngineers 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.

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 GeoEngineers 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.

REPORT RECOMMENDATIONS AND DESIGNS ARE NOT FINAL

The recommendations included in this report are preliminary and should not be considered final. The designs depicted herein are approximate and are intended to express the overall design intent of the Project and need to be adjusted in the field during construction in order to meet the specific-site conditions and intended function. GeoEngineers' recommendations can be finalized only by observing actual site-specific conditions revealed during construction.

We recommend that you allow sufficient monitoring and consultation by GeoEngineers 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. GeoEngineers cannot assume responsibility for the recommendations in this report if we do not perform construction observation.

REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and pre-construction 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 for Use." When providing the report, 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 GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer.

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 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.

GeoEngineers 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.

INCREASED FLOOD ELEVATIONS AND WETLAND EXPANSION ARE POSSIBLE

The proposed stream enhancements may result in increased flood elevations and expansion of wetlands. These impacts are generally considered advantageous for aquatic and riparian habitat in the project locations of these stream systems, but the analysis, consideration and quantification of these impacts is beyond the scope of this report, unless expressly included within GeoEngineers' scope of services.

CHANNEL EROSION AND MIGRATION ARE POSSIBLE

In general, river and stream enhancements result in more stable streambeds, banks and floodplains. In some cases, stream enhancement and channel stability includes reestablishing the natural balance of sediment erosion, distribution and deposition, which in some cases may induce channel meandering and migration. Therefore, channel erosion, channel migration and/or avulsions can occur over time.

IMPORTANCE OF MONITORING AND MAINTENANCE

In some instances, GeoEngineers may have purposely excluded piles, anchors, chains, cables, reinforcing bars, bolts and similar fasteners from structures with the intent of mimicking naturally occurring instream structures. In other instances, GeoEngineers may have purposely included such fasteners, if considered appropriate. While GeoEngineers 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, such as at downstream road, bridge and/or culvert crossings, including replacing, adjusting and removing damaged, malfunctioning or deteriorated components of Structures, particularly after a major storm event.

CONTRACTORS ARE RESPONSIBLE FOR SITE SAFETY ON THEIR OWN CONSTRUCTION PROJECTS

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