Basis of Design Report: Draft Final (95%)

Bird Track Springs Habitat Improvement Project

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Document Information

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Acronyms

°F	degrees Fahrenheit
1D	one-dimensional
2D	two-dimensional
3D	three-dimensional
BDR	basis of design
BiOp	Biological Opinion
BPA	Bonneville Power Administration
BTS	Bird Track Springs
cfs	cubic feet per second
DBH	Diameter at Breast Height
DEM	digital elevation model
ESA	Endangered Species Act
FCRPS	Federal Columbia River Power System
FLIR	forward-looking infrared
GIS	geographic information system
GPS	global positioning system
GRR	Grande Ronde River
GRMW	Grande Ronde Model Watershed
HIP III	BPA’s Habitat Improvement Program
HSC	Habitat Suitability Curves
HSI	habitat suitability index
LiDAR	light detection and ranging
LWD	large woody debris
LWM	large woody material
mi^2	square miles
mm	millimeter
NMFS	National Marine Fisheries Service
NOAA Fisheries Service	NOAA’s National Marine Fisheries Service
NPCC	Northwest Power and Conservation Council
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
OWEB	Oregon Watershed Enhancement Board

RCI	River Complexity Index
Reclamation	U.S. Bureau of Reclamation
RM	river mile
RPA	Reasonable and Prudent Alternative
RRT	Restoration Review Team
SP	soil profile
SOW	Statement of Work
TIR	thermal infrared
UGR	Upper Grande Ronde
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WUA	weighted usable area

1 Introduction

The U.S. Bureau of Reclamation (Reclamation) and Bonneville Power Administration (BPA) contribute to the implementation of salmonid habitat improvement projects in the Grande Ronde subbasin to help meet commitments contained in the 2008 Federal Columbia River Power System (FCRPS) Biological Opinion (BiOp) (National Oceanic and Atmospheric Administration [NOAA] Fisheries 2008) and the 2010 and 2014 Supplemental BiOps (NOAA Fisheries 2010, 2014). This BiOp includes a Reasonable and Prudent Alternative (RPA), or a suite of actions to protect salmon and steelhead listed under the Endangered Species Act (ESA) across their life cycle. Habitat improvement projects in various Columbia River tributaries are one aspect of this RPA. Reclamation's contributions to habitat improvement are all meant to be within the framework of the FCRPS RPA or related commitments and follow the requirements of the NOAA and U.S. Fish and Wildlife Service [USFWS] BiOp as outlined under BPA's Habitat Improvement Program (HIP III).

The Bird Track Springs (BTS) Habitat Improvement Project is Phase I of the larger Bird Track Reach Project, which includes the BTS, Longley Meadows, and Bear Creek Ranch projects. The "basis of design" (BDR) set forth in this document provides scientific information on geomorphology and physical processes used to help identify, prioritize, and implement sustainable fish habitat improvement projects focused on addressing key limiting factors to protect and improve survival of listed salmonids, as well as engineering analyses directly reflected in the design. Much of the background on existing conditions presented herein is applicable across the all phases of the Bird Track Reach Project. However, the design description and associated analysis discussion is specific to BTS.

1.1 Purpose and Use of 80% Document

This iteration of the project's BDR reflects the planning process and design development that occurred between 30% and 80%. As the design progresses, additional technical information supporting design guidance and decisions will be incorporated in updated versions of the BDR and its appendices (i.e., at the final design milestone). The focus of this report is to present information that has been developed since the 30% design. For additional project background and early design support see the 15% and 30% BDR. This Draft 95% BDR mostly presents new information and is not intended to encompass the entirety of the background information included in the 15% and 30% BDR.

1.2 Project Vision and Goals

The project vision, as defined in the 15% and 30% BDR, is to improve physical and ecological processes by rehabilitating and restoring the project area to achieve immediate and long-term benefits to Chinook, steelhead, and bull trout at all life stages. Restoration and rehabilitation of the whole floodplain system, targeting specific limiting factors such as temperature which will achieve immediate benefits to salmon. Long-term benefits will be realized through a focus on restoring fluvial and habitat-forming processes, floodplain, groundwater, and hyporheic connectivity, riparian and wetland plant communities, and instream complexity and diversity commensurate with the reach's intrinsic potential.

An inclusive approach to project implementation that accounts for the interests and needs of stakeholders and the broader community is essential for project success. Similarly, achieving the necessary biologic and ecologic outcomes must, at the same time, incorporate approaches and measures to minimize adverse impacts to public infrastructure, local land use, and natural and culturally significant resources.

The life-stage-related goals expressed for the Grande Ronde River in the Model Watershed/Atlas Process were applied to the project as the core biological objectives where were developed to address all the desired physical conditions and habitat attributes and the biologic goals for the project. At the 15% level of design, specific goals and objectives were established to emphasize the potential project benefits and are discussed in detail within the 15% BDR. To meet project goals, specific objectives were developed that were differentiated into two categories – physical habitat conditions and biologic function uplift, which are presented in Table 1-1.

Table 1-1 Project Goals and Objectives

Objective Title	Description
Physical Habitat Conditions and Attributes	
Enhance Large Pool Habitat	Increase the number and quality of 'large' pools (>) in the main and/or side channels.
Mitigate Ice Jam Processes	Decrease the potential for ice formation and reduce the likelihood of damage from ice jams that do form.
Expand Peripheral Habitats	Create and enhance channel margin slow water areas in the main and/or side channels.
Increase Hyporheic Connectivity	Add lateral and vertical complexity to the channel planform and bed morphology to increase hyporheic exchange
Improve Riparian & Wetland Condition	Re-invigorate self-sustaining native plant communities with diverse compositions and structures along channel margins and across the floodplain, including patches associated with beaver colony activity.
Moderate Water Temperature	Provide the physical, geomorphic, and ecologic conditions that buffer diurnal and seasonal water temperature fluctuations within the project area and target accessing cold water spring sources.
Evolve Channel Plan Form	Foster channel plan form evolution towards a stable multi-thread pattern with relatively narrow, deep channel(s) between vegetated islands.
Diversify Channel Bed	Create self-sustaining in-channel hydraulics that support varied bed forms including deep pools, and a range of particle sizes with a smaller median particle size.
Strengthen Bed Sediment Sorting	Support diverse geomorphic processes, features, and patterns of sediment movement, sorting and deposition within the active channel(s), including flushing of fine sediment.
Biologic Function Uplift	
Juvenile Winter Rearing	Increase the quantity of suitable habitat for juvenile Chinook winter rearing, based on the depth and velocity HSI curves per Favrot and Jonasson, 2014
Juvenile Emigration	Increase the quantity of suitable habitat for juvenile Chinook emigration.
Juvenile Summer Rearing	Increase the quantity of suitable habitat for juvenile Chinook summer rearing, based on the depth and velocity HSI curves per Maret et al., 2006
Adult Fish Use Potential	Increase the quantity of suitable habitat for adult salmonid holding.

HSI = habitat suitability index

1.2.1 Geomorphology

During the earlier planning and design steps, the geomorphology of the channel and floodplain system was evaluated within the context of the watershed and valley reach geologic and topographic controls, hydrology and historical uses, disturbances and legacy impacts on conditions and processes. Specific characterization and geomorphic mapping within the reach was conducted to support the proposed planform alignment, channel dimensions and flow partitioning, and identify opportunities and constraints related to soils and sediment supply, riparian vegetation, and ice processes. Those data and analyses were reported in the 15% and 30% BDR packages.

The focus of geomorphic analyses during subsequent design development (reported herein) have been on optimizing and increasing: channel planform complexity; interactions between channel and off-channel features; sustainability of channel bed materials and morphologic features; ice processes adaptation; bank stability; and, deformability/dynamics in support of riparian vegetation establishment.

1.2.2 Water Quality/Temperature

A key objective of the project will be to address inadequate water temperature conditions for ESA-listed salmonids (Snake River spring-summer Chinook salmon [*O. tshawytscha*] and summer steelhead [*O. mykiss*]). The project reach often exceeds maximum temperatures for salmonid fishes in the summer. Similarly, temperatures are often too cold in the winter.

In the upper Grande Ronde River, habitat for cold water fish has been steadily degraded since the mid-1800s due to a long list of alterations to the landscape, with water temperature being arguably one of the most impaired and influential factors for ESA-listed fish in the basin (Justice et.al., 2016). In the early 1990s, Bohle completed a modeling study of water temperatures within the Upper Grande Ronde Basin and concluded that overall poor water temperature conditions were a result of alterations to the river's width/depth relationship along with degradation to its riparian vegetation community and that improvements could be made if the wetted width were reduced and riparian stream shading increased in altered reaches (Bohle, 1994). Hence, a key goal of the project is to address inadequate water temperature conditions for ESA-listed salmonids.

Recent research shows a strong relationship between geomorphic complexity and increased and more variable hyporheic exchange. Variations in hyporheic flow path length produce a complex and nested pattern of floodplain water temperature variation that dampens diel and annual temperature variations. This upwelling hyporheic water contributes to cool water refugia in the summer and warm water refugia in the winter for both rearing juvenile and holding adult salmonids.

Evidence of potential hyporheic exchange during low flows exists for the Upper Grande Ronde River including the BTS project area. Project-related temperature monitoring shows that while much of the reach exhibits relatively uniform behavior in terms of water surface temperature, there are several areas of cold water input. These findings highlight the current feeble state of hyporheic exchange, but also show the potential for enhancing hyporheic exchange if geomorphic complexity in the reach is increased (Appendix E).

Vegetated and complex floodplain features exist throughout the BTS project area, but they are disconnected from the over-widened, single-thread river. Thus, the proposed project will maximize these existing floodplain features that includes relic channels, swales, and ponds which when combined with proposed channel realignment and restoration features will rapidly maximize the extant physical complexity of the reach. Along with the well-documented benefits riparian canopy recovery, increased hyporheic exchange and concomitant water temperature heterogeneity, the project should realize improved temperature conditions for ESA-listed salmonids.

1.2.3 Vegetation Community

Direct anthropogenic disturbances of the plant community and geomorphic processes in response to historic human activities have degraded the vegetation across the site, along channel margins and on floodplains and terrace surfaces. The existing vegetation on the site is a mixture of coniferous and deciduous tree species, scattered patches of woody shrubs, immature trees and mesic forbs. Much of the area has been specifically disturbed by previous recreational uses (e.g., dispersed/group camping, off-road motorized vehicles) as well as agricultural practices on private lands (USFS 2017). However, there are numerous areas with dense stands and/or isolated mature to decadent specimens of shrub and tree species, particularly along remnant channel segments. The beneficial effects of the channel network modifications, enhanced floodplain interaction, diverse sediment transport and deposition processes are expected to improve woody vegetation establishment. Dissipation of hydraulic shear during high flows and ice build-up conditions would improve plant survival while supporting plant community diversity, wildlife habitat and aquatic habitat benefits over time.

To minimize disturbance and impacts to vegetation and habitat, as well as provide soil/streambank cohesion in areas of forced pools and channel splits, the planform alignment of the main and side channels have been optimized through iterative modeling and field review. In this manner, the design preserves and integrates key exiting vegetation elements, particularly large specimen trees. They provide immediate and continuing riparian habitat, shading of the aquatic habitat, and bank stabilization. Over the long-term, they will become standing snags, floodplain wood, and/or a source of LWM accessible to the active channel.

Large areas of the site, despite preservation of existing vegetation in key locations, will require earthwork to implement the design via cut and fill and installation of features, as well as disturbance for staging and storage of materials, and providing access. Topsoil, herbaceous, shrubs and trees that require removal will be salvaged and reused in various components of channel and floodplain treatments, particularly LWM structures and bank treatments. The design includes extensive revegetation elements, planning for active and adaptive revegetation within all areas subject to earthwork and/or surface disturbance.

The materials and methods during construction and through monitoring and adaptive management will include measures to address existing weed infestation and prevent new or expanded occurrences.

1.2.4 Channel Hydraulics and Ice

The Grande Ronde river system experiences ice buildup, jams, and can produce breakout ice floes and flooding in some winters. Various portions have experienced major ice jams over the last few years that have been directly observed, photographed and by ODOT, Reclamation, and CTUIR staff, including time-lapse photos within the BTS project site. Ice jam related flooding along the highway and ice scour effects on channel morphology, bed features, and redds, and to riparian vegetation are likely exacerbated by the wide, shallow channel geometry of the existing degraded channel. The 30% BDR presented observations, mapping elevation estimates of ice scour damage scars on riparian trees, providing an estimate of ice scour extent and elevation (exceeding the 100-year WSEL) under existing conditions. During development of the 80% design, additional empirical observations of processes on site and in similar systems have been reviewed to design beneficial reduction in accumulation potential near the highway, increased floodplain access for ice storage, adequate ice flow paths, and flood water release opportunities through the side channel network. Consideration of ice processes and potential stresses has influenced the siting and design details of proposed structures and bank treatments and proposed revegetation plans and approach. While it is not feasible to predict with surety, the proposed condition is expected to offer an improved setting that limits the potential for ice jams and flooding that would have adverse impacts to existing infrastructure, the channel and floodplain soils and vegetation, or the aquatic habitat conditions.

1.2.5 Salmonid Habitat and Fish Use

The Project seeks to restore fish habitat and floodplain process and function to benefit fishery resources on the Grande Ronde River within the project area. Targeted fish populations include ESA listed Snake River spring-summer Chinook salmon and summer steelhead. The project area rearing habitat for juvenile fish is currently in poor condition with high summer water temperatures, poor habitat complexity and diversity, lack of low velocity habitat in wetlands and side channels, actively eroding streambanks and limited riparian cover. Project objectives focus on increasing the suitable habitat for winter and summer rearing by juvenile Chinook, expanding availability of habitat for emigrating juveniles, and providing improvements in habitat that would support adult salmonid holding. The project will diversify the existing homogenous, plane bed aquatic and riverine habitat, creating a varied plan form with appropriate dimension, pattern, profile, and floodplain connectivity naturally exhibited in unconfined alluvial floodplains through channel realignment, floodplain grading, side channel re-activation and alcove habitat creation, installation of large wood habitat and off-channel habitat complexity, and riparian vegetation restoration. These measures will modify the hydrologic interactions between the channel and floodplain, raising and modify groundwater levels and path, enhancing hyporheic functions, and producing buffered and lagged surface water temperature conditions during summer and winter periods.

Targeted life requisites for rearing habitat include: summer water temperature/cold water refuge, depth, velocity, cover, sediment, and riparian/wetland. Habitat and geomorphic features and processes enhanced to improve spawning and rearing suitability include: decreased channel slope, velocity and width to depth ratio, increased pool, riffle, run habitat types, habitat complexity and diversity, large pools, and improved diversity of sediment size and storage/sorting of suitable spawning gravel.

Focal species for the project are Chinook salmon and steelhead; however, bull trout and other aquatic species are also expected to benefit from the proposed habitat actions. Additional information for each of the ESA-listed species and their current use of the project reach, including life stage utilization, periodicity, and seasonal passage requirements is provided in the 30% BDR.

1.2.6 Sediment Transport and Storage

Geomorphic and hydraulic conditions related to sediment sources, transport, erosion and deposition and net storage were introduced in the earlier versions of the BDR. Additional modeling by the TSC since the 30% design (Appendix C) has addressed three iterations of the proposed condition topography, channel configurations, and generated estimates of flow competence affecting bed mobility and morphology. Consideration of the mapped geomorphic surfaces, bedrock and terrace outcrop locations was applied iteratively with the hydraulic modeling and grading to adjust the design to attain as-built conditions and sustainable processes that improve the diversity of local sediment supply, sorting of bed material within varied physical aquatic habitat units, and facilitate frequent overbanking with floodplain deposition. The project will create long-term access a mixture of local side slope and streambank materials, convey throughput sediment from the watershed into multiple channels and to more depositional settings within the site, and the mosaic of hydraulic conditions within the channels will provide improved bed mobility, sorting, and create more low velocity areas under a wide range of flows.

1.2.7 Large Woody Debris

While it is expected that the channel will eventually adjust its horizontal position over time, large woody material (LWM) structures are designed at specific locations throughout the mainstem river corridor to maintain the channel while riparian vegetation establishes in the near term (approximately 15 to 20 years). Over this time, the LWM feature elements will deteriorate but the initial LWM loading is intended to provide stability and habitat benefits. Over the longer term, it is expected that natural channel migration rates will prevail throughout much of the proposed project with the exception of those locations identified as critical to break-up ice flows, establish split flows, and protect existing infrastructure, such as the highway.

LWM is proposed throughout the project to serve two functions: to provide initial bank stability (horizontal stability); and, to create immediate habitat improvements. Beyond these particular needs, LWM is added to re-supply this reach of the UGR River to loading levels that mimic natural recruitment prior to anthropogenic disturbance of the area. LWM has been designed through Reclamation's Risk Based Design Process (Reclamation, 2014). LWM is located based upon split flow locations, direct bank attack, and from bank shear stresses identified in the 2D hydraulic model. Several typical LWM features are designed to be applied at various locations throughout the project, while a few locations required unique LWM design features and targeted performance, such breaking up ice-flows or highway protection.

1.2.8 Beaver

A design goal of the project is to enhance habitat and physical processes that attract and maintain beaver, restoring the ecosystem benefits of beaver as a keystone species in shaping habitat for fish and wildlife. Historically beaver occurred through the Grand Ronde River drainage including the BTS project site. Past management activities degraded habitat and the hydraulics of the entrenched systems make dams vulnerable to failure within a season. Mountain lion predation and hunting may both depress the beaver population (USFS 2017). At present there are no active beaver colonies, although recent, transient beaver activity is evident in several wetland and backwater areas of the site. Project enhancements will reactivate side and backwater channels and wetlands to create complex floodplain areas where perennial water is present in channels and depressions. In addition, direct planting and long-term riparian vegetation recovery aims to increase food and material source support for beaver occupation via a wide range and large quantity of aquatic herbaceous to woody plant species. In addition to habitat changes that would support continued beaver presence, several design elements are specifically designed to mimic the effects of beaver activity, for instance, enhancing backwater areas with known beaver activity to maintain perennial water, provide off-channel habitat, and support seasonal base flows.

1.2.9 Physical Complexity

The single thread channel in the project area under existing conditions is wide and shallow and lacks the depth and width variation characteristic of productive salmon streams in the Pacific Northwest. In addition, bed surface texture is uniform and coarse, with armoring. The proposed project would directly increase physical complexity within the project reach by increasing floodplain connectivity and introducing a multi-threaded channel. Over time, natural processes would add further complexity of the system as the project interacts with the relic channel and vegetation.

1.3 Report Outline and Content Relative to BPA BDR Template Guidance

Table 1-2 provide a cross reference for those reviewers familiar with the specific report template guidance provided by BPA in the HIP III General Project & Data Summary Requirements (GPDSR), Basis of Design Report Template. The relevant sections of this Draft 95% BDR or the 15% and 30% BDR (Cardno 2016) that contain the requested information are provided to facilitate review for HIP III compliance.

Table 1-2 Analogous Sections Summary

Basis of Design Report BPA Template		Cardno Draft 95% Design Report[1]	
Section Number	**Section Header**	**Section Number**	**Section Header**
1.1	Name and titles of sponsor, firms and individuals responsible for design	1	Introduction
1.2	List of project elements that have been designed by a licensed Professional Engineer	3.3	Design Elements and Rational
1.3	Identification and description of risk to infrastructure or existing resources	4 Appendix G	Risk Assessment LWM Risk-Based Design
1.4	Explanation and background on fisheries use (by life stage - period) and limiting	1.2.5	Salmonid Habitat and Fish Use

Table 1-2 Analogous Sections Summary

Basis of Design Report BPA Template		Cardno Draft 95% Design Report[1]	
Section Number	**Section Header**	**Section Number**	**Section Header**
	factors addressed by project	30% BDR 3.7	Fish Biology
1.5	List of primary project features including constructed or natural elements	3.3 Appendix A	Design Elements and Rational 80% Design Plans
1.6	Description of performance / sustainability criteria for project elements and assessment of risk of failure to perform, potential consequences and compensating analysis to reduce uncertainty	4 Appendix G	Risk Assessment LWM Risk-Based Design
1.7	Description of disturbance including timing and areal extent and potential impacts associated with implementation of each element	Appendix A	80% Design Plans
2.1	Description of past and present impacts on channel, riparian and floodplain conditions	30% BDR 3	Existing Conditions
2.2	Instream flow management and constraints in the project reach	30% BDR 3.3	Surface Hydrology
2.3	Description of existing geomorphic conditions and constraints on physical processes	1.2.1 30% BDR 3.2	Geomorphology Fluvial Geomorphology
2.4	Description of existing riparian condition and historical riparian impacts	1.2.3 30% BDR 3.2.1	Vegetation Community Historical Conditions
2.5	Description of lateral connectivity to floodplain and historical floodplain impacts	1.2.1 30% BDR 3.2.2	Geomorphology Geomorphic Characterization and Mapping
2.6	Tidal influence in project reach and influence of structural controls (dikes or gates)	N/A	
3.1	Incorporation of HIPIII specific Activity Conservation Measures for all included project elements	Appendix A Sheets 2-3	80% Design Plans
3.2	Summary of site information and measurements (survey, bed material, etc.) used to support assessment and design	3 Appendix E 30% BDR 3	Design Development BTS Water Temperature Background – Existing Conditions
3.3	Summary of hydrologic analyses conducted, including data sources and period of record including a list of design	3.3.3	Hydraulic Modeling 80% Design Hydrologic Model

Table 1-2 Analogous Sections Summary

Basis of Design Report BPA Template		Cardno Draft 95% Design Report[1]	
Section Number	**Section Header**	**Section Number**	**Section Header**
	discharge (Q) and return interval (RI) for each design element	Appendix C Appendix C 30%	Report Hydrologic Analysis for Bird Track Restoration Project
3.4	Summary of sediment supply and transport analyses conducted, including data sources including sediment size gradation used in streambed design	3.3.3 Appendix C	Hydraulic Modeling 80% Design Hydrologic Model Report
3.5	Summary of hydraulic modeling or analyses conducted and outcomes – implications relative to proposed design	3.3.3 Appendix C	Hydraulic Modeling 80% Design Hydrologic Model Report
3.7	Stability analyses and computations for project elements, and comprehensive project plan	3.3.6 Appendix G	Large Wood Material Structures LWM Risk Design
3.8	Description of how preceding technical analysis has been incorporated into and integrated with the construction – contract documentation	To be provided at later design phase	
3.9	Description of how preceding technical analysis has been incorporated into and integrated with the construction – contract documentation	To be provided at later design phase	
3.10	Description of how preceding technical analysis has been incorporated into and integrated with the construction – contract documentation	To be provided at later design phase	
3.11	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	N/A	
3.12	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	N/A	
4.1	Incorporation of HIPIII General and Construction Conservation Measures	Appendix A Sheets 2-3	80% Design Plans

Table 1-2 Analogous Sections Summary

Basis of Design Report BPA Template		Cardno Draft 95% Design Report[1]	
Section Number	**Section Header**	**Section Number**	**Section Header**
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	Plan set development for bidding and implementation to be provided at 100% design phase, but current (80%) plan set provided in Appendix A	80% Design Plans
4.3	List of all proposed project materials and quantities	5.1 Appendix B	Quantities Engineer's Bid Sheet
4.4	Description of best management practices that will be implemented and implementation resource plans including: Site Access Staging and Sequencing Plan Work Area Isolation and Dewatering Plan Erosion and Pollution Control Plan Site Reclamation and Restoration Plan List proposed equipment and fuels management plan	Appendix A	80% Design Plans
4.5	Calendar schedule for construction/implementation procedures	To be provided at later design phase	
4.6	Site or project specific monitoring to support pollution prevention and/or abatement	9 Appendix H	Monitoring, Maintenance and Adaptive Management Draft Monitoring, Maintenance and Adaptive Management Plan
5.1	Introduction	Appendix H	Draft Monitoring, Maintenance and Adaptive Management Plan
5.2	Existing monitoring protocols	Appendix H	Draft Monitoring, Maintenance and Adaptive Management Plan
5.3	Project Effectiveness Monitoring Plan Objective 1 Objective 2	Appendix H	Draft Monitoring, Maintenance and Adaptive Management Plan
5.4	Project review team triggers	Appendix H	Draft Monitoring, Maintenance and Adaptive Management Plan
5.5	Monitoring frequency, timing, and duration Baseline survey As-Built survey Monitoring site layout Post-bankfull event survey Future survey (related to flow event)	Appendix H	Draft Monitoring, Maintenance and Adaptive Management Plan

Table 1-2 Analogous Sections Summary

Basis of Design Report BPA Template		Cardno Draft 95% Design Report[1]	
Section Number	**Section Header**	**Section Number**	**Section Header**
5.6	Monitoring technique protocols Photo documentation and visual inspection Longitudinal profile Habitat survey Survival plots Channel and floodplain cross-sections Fish passage	Appendix H	Draft Monitoring, Maintenance and Adaptive Management Plan
5.7	Data storage and analysis	Appendix H	Draft Monitoring, Maintenance and Adaptive Management Plan
5.8	Monitoring Quality Assurance Plan	Appendix H	Draft Monitoring, Maintenance and Adaptive Management Plan
6	References	11	References Cited

[1] If section is in a previous version of BDR the appropriate version is identified with the section number.

2 30% Design RRT Comment Response

BPA's RRT participated in an 30% RRT meeting on February 1, 2017 to discuss the 30% design submittal. As part of the meeting the project design team gave a presentation on project components and the RRT provided feedback on advancement of the design to 80%. Formal RRT comments were provided to the design team on February 21, 2017, and are included in Appendix J, 30% RRT Comment and Response. Technical comments were received by BPA and ODFW, USFWS and NMFS did not provide comments on the 30% design. RRT comments and design team response from the 30% design phase are provided below.

2.1 BPA – Sean Welch

a. HSI Uplift Ratios – Is a higher response possible than that shown between existing and proposed?

The issues of HSI uplift ratios has been addressed in two ways, physically and mathematically. Physically, more off-channel habitat with low velocity has been added – see next response. Mathematically, our methods have been adjusted to better depict how the proposed project not only adds more overall suitable habitat, but significantly increases optimal or "preferred" habitat, that is habitat with high HSI combined depth and velocity scores.

We have evaluated our methods for developing the HSI results and made some adjustments to these to better account for "preferred habitat". During evaluation of our 30% methods to tabulate HSI results, we also noticed a discrepancy between the tabulated results and the existing versus proposed condition HSI figures. Upon further investigation, we found that through the process of averaging (weighting) usable area, we were lumping all available habitat and not discerning optimal or "preferred" habitat. Habitat that may minimally meet velocity and/or depth criteria (i.e., low depths and higher velocities) was lumped and tabulated with high quality habitat (i.e., deep pools with ideal velocity conditions). When these values are separated, we see distinct differences in the tabulated results with large improvements to high quality (preferred) habitat conditions, which better matches what is shown in figures of HSI results (Appendix K).

Essentially, the existing over-widened and shallow channel mathematically contains a large quantity of acceptable, but marginal habitat at lower flows, which we believe misrepresents actual rearing habitat availability. While the proposed condition shows a major increase in optimal or preferred habitat, whereas under existing conditions there is minimal to no preferred habitat during any flow condition. While the definition of preferred habitat is subjective, after testing we determined that the upper third of HSI values best meets optimal criteria (combined depth and velocity HSI result of 0.67 or greater). When compared to existing, proposed conditions indicate a substantial increase in preferred habitat across all flows and seasons as depicted in HSI figures (Appendix K). In fact, for all discharges, a large percent increase in preferred habitat (i.e., deep pools with ideal velocities) is realized. For example, during summer low flow conditions, the proposed project improves potential preferred rearing habitat from approximately zero to upwards of 4-acres, resulting in several thousand percent increase in preferred habitat. Further details and results of HSI can be found in Appendix K, Target Habitat Suitability Indices.

b. Incorporation and design of more low-velocity off-channel habitats as described in the British Columbia Fish Habitat Rehabilitation Manual, Chapter 7; including rearing ponds, hyporheic off channel habitats, alcoves and other low velocity, bio-energetically favorable habitats to support summer and winter rearing for salmonids. Several examples of fish growth response, improved water quality effects (temperature) and increased valley bottom water storage were discussed.

We had planned to further develop additional floodplain features after the 30% review to include more off-channel habitat elements. As a result of this comment we have added and modified some additional features. Significant additional floodplain features that were added and/or modified between the 30% and 80% design are shown in Figure 2-1 and described below. Additional detail for each of these features can be found in the design plans.

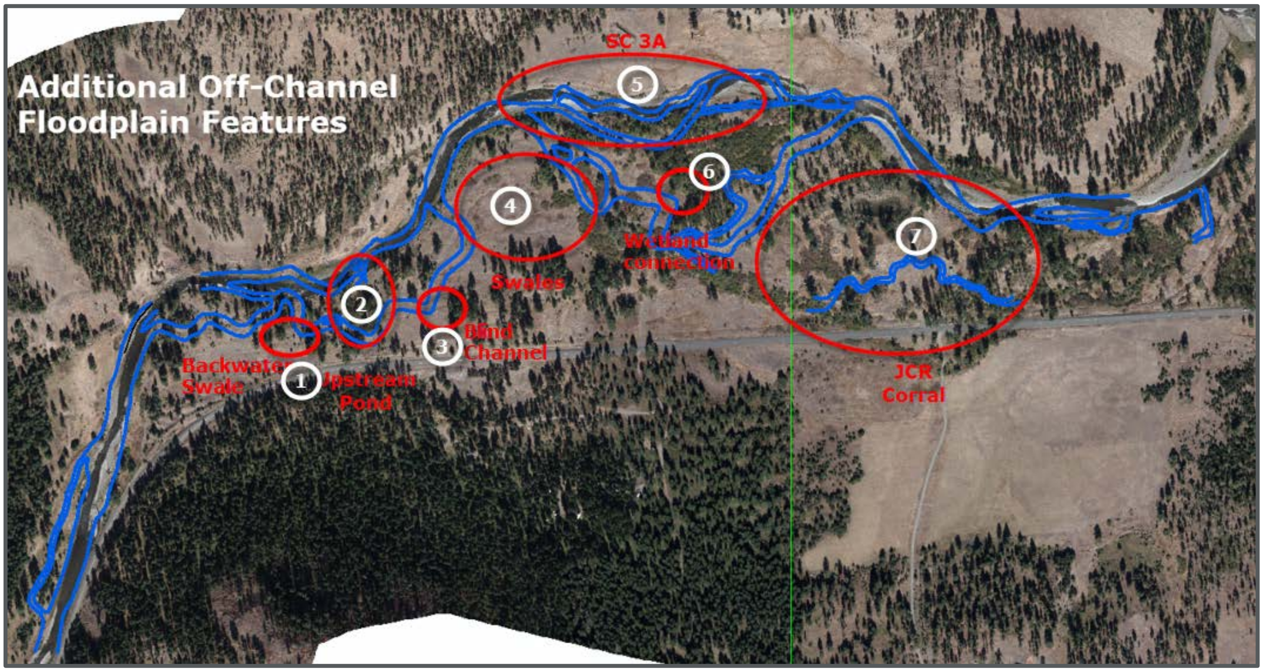

Figure 2-1. Modified floodplain features.

1. Main Channel (MC) Station 28+00 – Backwater swale – A flood swale was graded in the floodplain as additional flood flows will inundate this area due to removal of the upstream railroad spur along the river near MC stations 12+00 to 15+00. The outlet of this swale near MC 28+00 was graded to exit in a channel backwater alcove feature that will serve two purposes, to provide low velocity habitat and high flow refugia for salmonids and to provide energy dissipation for re-entry of flood flows back to the main channel.

2. MC Station 31+00 – Upstream pond (Beaver Pond 1) – An existing depression from a former channel meander scar will be connected to high flows and through hyporheic inputs between MC Station 31+00 and Side Channel (SC) 2 Station 16+00. Backwater will be provided through placement of a reinforced habitat structure located near the outlet into SC 2. To provide additional depth and cold-water inputs during low flow conditions, the depression will be partially excavated as shown in grading plans.

3. MC Station 37+00 – Blind channel – Connections to an existing swale network that follows the southern edge of the project between approximately MC Station 37+00 and MC Station 63+00 were further developed to include surface water connection at the March median discharge (400 cubic feet per second [cfs]) and above and hyporheic connection through construction of a "blind channel" consisting of an excavated trench that is back-filled with coarse alluvium for preferential hyporheic exchange.

4. MC Station 42+00 – Swales – An existing channel network consisting of three distinct swales in an open field will be further graded and enhanced. During construction, this area is planned to be used as a large staging and sorting area that will experience significant construction impacts. Once construction is nearly complete, the floodplain and swale network will be re-graded and reconnected. Additional grading in this area includes a wide over-flow from MC station 42+00 that gets routed into individual swale all leading to perennial pond features that are graded and

connected to SC 4. Pond features are backwatered with reinforced habitat structures that are then connected to SC 4 through perennial alcoves. Each pond will provide excellent depth and velocity conditions for juvenile salmonids with cover. Ponds receive surface flows through the graded floodplain at flows at and exceeding the winter high flow (900 cfs). Hyporheic inputs are expected at low water conditions.

5. Side Channel 3A – This side channel feature is designed to receive high flow discharges (900 cfs and above) and is designed to mimic a former channel meander scar that has been re-occupied by beaver with a series of pool features separated by high riffles and low reinforced habitat structures. This channel was intentionally designed within the existing channel footprint (to be filled) for three reasons: First, this area is to be filled and may take several years to re-vegetate if filled with alluvium significantly above low water; second, the project design team recognizes the need to mine the existing channel for larger clean cobble material to use in construction of riffle features; and third, the resulting ponds will provide excellent rearing habitat and will likely receive cool hyporheic inputs as they are located within the preferred alluvial flow path of the existing river channel with a large perennial channel pool located immediately upstream. Over time, it is envisioned that this side channel feature will re-vegetate and eventually become a significant wetland.

6. MC Station 60+00 – Existing wetland connection – A large wetland feature currently exists on the floodplain south of the existing channel and was formerly occupied by a beaver colony. It is currently unknown if beaver still reside within this wetland feature or are transient. The proposed project will provide increased connectivity to this large floodplain feature by virtually surrounding it at higher discharges. Access for juvenile fish to this feature will be much improved as side channels 3 and 5 are located adjacent to its boundaries. To improve surface connectivity, a small channel was graded into an existing swale feature near MC station 60+00. This graded channel will provide upstream surface connection at the winter high flow discharge (900 cfs) and above.

7. Side Channel 10 – Jordan Creek Ranch Corral Area – At 30% design, the private landowners of Jordan Creek Ranch had agreed to move their corral and confined animal operation away from the floodplain to their land south of Highway 244 and allow for floodplain restoration of this area through an easement with CTUIR. This area has been designed with several additional floodplain features to include channel construction (SC 10) through the existing corral to reconnect an existing channel swale network. The resulting SC 10 is approximately 3,000-feet long and will activate upstream at discharges above 250-cfs near MC station 64+50. It is anticipated that this side channel network will contain many deep pools that are both constructed in the corral area and that will develop within the existing swale network as flood flows interact with existing large wood features. In addition to this side channel, the corral area was re-graded to provide a large floodplain that interacts with SC 10. Additionally, the existing man-made pond north of the corral will be deepened and restored as a perennial feature for off-channel rearing habitat to include cover. Existing swale features that connect with this pond were strategically connected to main channel features near stations 70+00 and 84+00. A reinforced habitat structure will be constructed near the pond outlet to provide a perennial pond. Surface water inputs are expected at high flows annually. From temperature monitoring of existing pond features (Appendix E), buffered-cool-water conditions are expected through hyporheic inputs during low water conditions within this pond and likely within deeper pools associated with SC 10.

c. Considerations and impacts to dispersive low-flow partitioning between the main channel and side-channel network

Design criteria for development of proposed conditions included development of an initial preferred channel path during low flow conditions. The preferred low flow channel path has been optimized for initial conditions such that surface water during low water will primarily flow down one major flow path (main channel). However, it should be recognized that the project is meant to be dynamic and to allow for natural processes, which will include an increase in variability with anticipated channel swapping from natural forcing through ice, debris, and sediment deposition. It is anticipated, and desired, to have bedload deposition within the project area as this natural process is currently believed to be out-of-balance within this river corridor. It is anticipated and model results suggest that bedload will deposit within the project at multiple locations, which will provide dynamic conditions over time.

d. Design criteria and structure objectives for proposed LWD – LWM elements with linkage to processes and function identified with the Lostine River reference analogs. An example criteria table is provided addendum.

Design criteria identifying both habitat and hydraulic benefits for proposed LWM structures is provided in Table 3-2. Reference reaches in the Lostine River and Imnaha River basins were used to reflect natural wood loading and processes. Many of the larger proposed structures will require upwards of approximately 15 to 20 logs to replicate what 5 to 7 logs would have been able to do in an undisturbed system. In specific areas of side channels, wood loading has been drastically increased to replicate some of the more unique features identified in the Lostine River reference reaches. Large whole trees will be placed spanning the channel and will interact with a wide range of flows. Increasing both cover and habitat complexity for juvenile salmonids.

2.2 ODFW - Scott Favrot

e. Provided existing examples and suggestion to create more sustainable pools that mimic natural features with upstream high velocity zones that abruptly change channel direction (i.e., 90-degree bends) and re-partition energy into channel bed for sustainability. Suggest this should be added to the “quiver” of options and use both placed wood features and directed at existing large trees.

The project team agrees with ODFW regarding this design philosophy. The design team had planned to further incorporate these grading details for locations where major pools are expected after 30% design. Additional design has included the development of 90 degree bends through channel grading in combination with specific constructed large wood features and existing features (trees and rock) that have been designed to force the bulk of high flow discharges into these structures for pool development and maintenance. Deep pools have been designed using both constructed large wood features and existing trees at multiple locations. Additionally, upstream energy has been purposely maintained to provide maximum pool development. Larger pools that will be created under proposed conditions, using this design philosophy, are identified Figure 2-2.

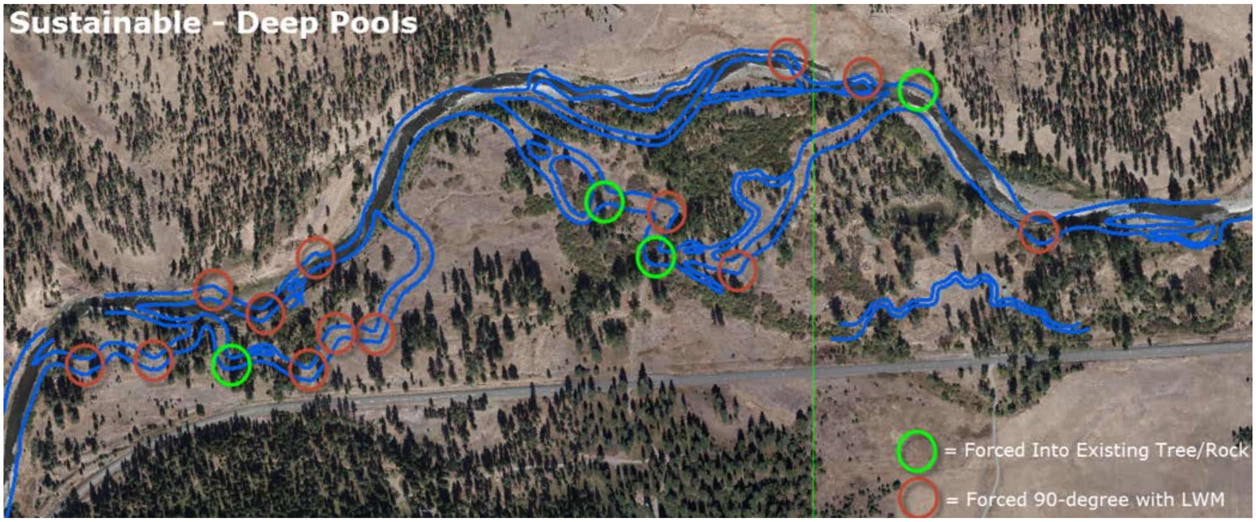

Figure 2-2. Proposed sustainable deep pools.

2.3 Next Steps

This document and the 80% project drawings are provided to BPA for review and technical comments. The 80% design and BDR demonstrates incorporation of technical comments and recommendations received during the 30% Project Review phase. The 80% design submittals include near final drawings and specifications including specific site locations, site plans, profiles, cross sections, details, construction quantities, implementation resource plans and design technical analysis as summarized in this BDR. Outcomes from the 80% Project Review process will consist of 1) comments to be addressed and re-submittal, 2) comments and approval, 3) approval. Upon approval, BPA will notify the Sponsor of acceptance of the project design and construction documentation for the project.

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3 Design Development

3.1 Overview

During the 80% design development step, the project design team conducted supplemental field observations, reviewed additional data, iteratively updated the proposed topographic surface and hydraulic model, integrated recommendations arising from the RRT review and the NEPA environmental compliance process, and leveraged understanding gained via lessons learned on other similar projects (e.g., Meacham Creek, Catherine Creek, the Salmon River). The following section summarizes the expected performance of the BTS design relative to specific quantitative metrics, followed by a description of key design elements and rationale, organized by major topic.

3.2 Proposed Condition Metrics

Tangible metrics were originally developed by the project team to rate alternative concepts' ability to meet project objectives in selecting the preferred alternative (see 15% BDR). The metrics chosen to represent each criterion emphasize parameters from appropriate published sources that can be reliably quantified using the available empirical inventory data, conceptual design features, and 2D numerical modeling outputs. These are metrics that can be applied to the existing condition as well as the proposed condition with relatively consistent, sensible assumptions. The original project metrics include parameters concerning in-channel hydraulics, out-of-bank inundation, and aquatic habitat quality and quantity.

Each of the selected criterion are linked to at least one of the project objectives. Some criteria have an influence on various objectives, and some objectives are assessed by a combination of multiple criteria. These relationships and the relative importance of each criterion as an indicator for alternatives' performance on individual objectives was expressed by weighting the influence of each metric on specific objectives (see Table 5-2 in the 15% BDR).

In addition to metrics that were used to select the preferred alternative as described in the 15% BDR, new metrics were developed during design to further represent important project objectives that were not fully accounted for at 15% design level. Additional metrics presented herein include: sinuosity; high flow refuge area; number of pools; and, preferred usable area for both summer and winter juvenile Chinook rearing. Each of the new project metrics addresses at least one primary project objective as described below:

- Sinuosity –was developed at 15% design to inform the River Complexity Index (RCI), but was not reported. This metric is now reported and represents an additional evaluation of channel complexity.
- High Flow Refuge Area – specifically addresses the quantity of suitable habitat for juvenile Chinook refuge during emigration by accounting for marginal floodplain or fringe habitat with low velocities expected during the spring freshet at a high flow condition.
- Deep Pools per Mile – addresses several project objectives to include bed diversity, juvenile rearing, and adult fish use potential for holding habitat.
- Preferred Usable Area (PUA) for Summer and Winter Juvenile Rearing – represents the results of HSI modeling as an area of "preferred" habitat suitability for juvenile rearing. Preferred habitat is the unique combinations of depth and velocity that result in high HSI scores (0.67 or above) and provides a better representation of actual area available to juvenile fish for rearing.

3.2.1 Proposed Conditions Criteria

The proposed conditions criteria and metrics used at this step in design fulfill the following:

> Include all important driving processes, including:
  - Change the geomorphic planform from single-thread to 'island-braided'
  - Wet the alluvial valley fill at greater frequency and for longer durations
  - Increase the connectivity and availability of active side channels
  - Develop thermal refuge locations
  - Increase the complexity and dynamics of the channel system
  - Manage ice processes and effects
> Are firmly linked to all key goals and objectives
> Can be adapted for use in the other Phases of the Bird Track Springs Reach Project (e.g., Longley Meadows)

The metrics chosen to represent each criterion (Table 3-1) emphasize parameters that can be reliably quantified using the available empirical inventory data, conceptual design features, and 1D and 2D numerical modeling outputs. These are metrics that can be applied to the existing condition and both action alternatives with relatively consistent, sensible assumptions. The metrics include parameters concerning in-channel hydraulics, out-of-bank inundation, and aquatic habitat quality and quantity.

Table 3-1 Project Metrics

Primary Objective	Project Metric	Definition	Units
Floodplain Connectivity	Flood Prone Area	Area inundated under the 10-year peak flow minus area of March median flow	acres
Floodplain Connectivity	Active Floodplain	Area inundated under the 2-year peak flow minus area of March median flow	acres
Floodplain Connectivity	Channel Margin Inundation	Incremental Wetted Area (Spring High flow > March median flow)	acres
Channel Complexity	Sinuosity at low flow	Sinuosity = channel length at low flow/valley length	n
Thermal Complexity	Channel and Hyporheic Complexity	Channel Complexity Index = sinuosity for the active winter channel * (1+ intersection nodes at march median flow)	n
Bedload Retention	Critical Streambed d50 Particle Size	Average of critical d50 within the March median channel and flow	mm
Channel Complexity	Critical Streambed d50 Particle Diversity	Coefficient of Variation of critical d50 within the March median flow channel and flow	n
Winter – Juvenile Chinook Rearing	Winter Juvenile Chinook WUA	HSI of the 2D model output for the Low Flow using Favrot and Jonassan 2014 curves for depth and velocity	acres

Table 3-1 Project Metrics

Primary Objective	Project Metric	Definition	Units
Summer – Juvenile Chinook Rearing	Summer Juvenile Chinook WUA	HSI of the 2D model output for the Low Flow using Maret 2006 curves for depth and velocity	acres
Winter – Juvenile Chinook Rearing	Winter Juvenile Chinook PUA	Total area of habitat available with combined depth and velocity Winter HSI of 0.67 or greater during low flow conditions	acres
Summer – Juvenile Chinook Rearing	Summer Juvenile Chinook PUA	Total area of habitat available with combined depth and velocity Summer HSI of 0.67 or greater during low flow conditions	acres
Juvenile Chinook Emigration	High Flow Refuge Area	Area of connected habitat available with a velocity less than or equal to 1-fps at $Q_{1.25}$ – year event	acres
Adult Chinook Holding	Deep Pools per Mile	# of residual pools with depth of 4-feet or greater per river mile during low flow conditions	n

3.2.2 Criteria Discussion

The methods that were used to calculate each of the project metrics listed in Table 3-1 are described below.

3.2.2.1 Flood Prone Area

Flood inundation areas were developed using the SRH2D model of the 80% design surface (November 2017). The March median flow (50% exceedance flow in March = 400 cfs), which approximately represents main channel area, was subtracted from the 10-year inundation area to obtain the “Flood Prone Area.”

3.2.2.2 Active Floodplain Area

Flood inundation areas were developed using the SRH2D model of the 80% design surface (November 2017). The March median flow (50% exceedance flow in March = 400 cfs), which approximately represents main channel area, was subtracted from the 2-year inundation area to obtain the “Active Floodplain Area.”

3.2.2.3 Channel Margin Inundation

Channel inundation areas were developed using the SRH2D model of the 80% design surface (November 2017). The March median flow (50% exceedance flow in March = 400 cfs), which approximately represents main channel area, was subtracted from the winter high flow (5% exceedance flow between October through March = 900 cfs) inundation area to obtain the “Channel Margin Inundation Area.”

3.2.2.4 Channel and Hyporheic Complexity

Channel and hyporheic complexity was originally developed by Brown (2002). Methods used to calculate RCI values for this project were from Thatcher and Boyd (2007) utilizing mainstem and side channels lengths and percent increase between proposed and existing planforms for the 80% design of the BTS project on the Grande Ronde River.

SRH-2D model inundation results of five geomorphic and/or biologically significant flows were analyzed in a geographic information system (GIS) platform. The flows analyzed (in cfs) were:

> Bankfull 1.25-year recurrence interval (1,368 cfs)

> Winter High Flow (900 cfs)

> March Median Flow (400 cfs)

> Winter Median Flow (82 cfs)

> Low Flow (18 cfs)

Analysis included approximate main channel and side channel lengths of proposed versus existing channel planforms. In addition, points (nodes) of flow convergence and divergence for both proposed vs existing conditions were digitized and totaled for each flow of interest. The number of nodes for a given existing and proposed flow were then plugged into the following formula to calculate project area RCI:

$$RCI = Sinuosity * (1 + Nodes)$$

The RCI per foot value was calculated with the following formula:

$$RCI/ft = \frac{Sinuosity * (1 + Nodes)}{Valley\ Distance}$$

Proposed vs existing results for each flow were compared to calculate the percent increase of main channel length, side channel length, sinuosity, total nodes, RCI per foot and project area RCI with the following formula.

$$\%\ Increase\ = \frac{value\ of\ the\ proposed\ condition - value\ of\ the\ existing\ condition}{value\ of\ the\ existing\ condition}$$

3.2.2.5 Critical Streambed d_{50} Particle Size and Critical Streambed d_{50} Particle Diversity

SRH-2D model critical diameter results from the 80% design (November 2017) were analyzed in a GIS platform. Main channel data points were isolated from the side channel data points. Once isolated, the mean, standard deviation and coefficient of variation of the isolated values were calculated using GIS and Excel programs. Pebble count data collected at four sites within the BTS project area were similarly statistically analyzed to obtain the mean, standard deviation, and coefficient of variation.

3.2.2.6 High Flow Refuge Area

High flow refuge area was calculated using velocity results from a TIN of velocity output from the SRH2D model of the 80% design surface (November 2017). High flow refuge area was calculated for the 1.25-year discharge condition (1,368 cfs) as areas within the modeled inundation zone with velocity at or less than 1-foot/second.

3.2.2.7 Deep Pools per Mile

Pools located within active channels at low flow conditions with residual depths (pool depth below point of zero flow on the downstream control riffle crest) of 4-feet or more were tallied from the existing and design channels and compared after dividing by the valley length of the project reach (1.875-miles).

3.2.2.8 High Flow Refuge Area

High flow refuge area was developed using output results for velocity magnitude from the November 2017 (80% design) SRH2D model. Point-based 2D hydraulic modeling results of depth-average velocity were interpolated to ArcGIS rasters in a grid size of 2 ft by 2 ft utilizing the Inverse Distance Weighted (IDW) geostatistical method for comparison between proposed (channel reconstruction conditions) and existing conditions for the 1.25-year discharge. The resulting rasters were then evaluated to determine the extent of wetted area available with a depth-averaged velocity of 1 foot/second for less under the existing and proposed conditions, respectively. Grid cells that met the velocity criteria were counted and the total area calculated by the number of qualifying grid cells times the area of each grid cell.

3.2.2.9 Habitat Suitability Indices

3.2.2.9.1 Juvenile Chinook Weighted Usable Area

Winter and Summer weighted usable area (WUA) has been developed for low flow conditions (18 cfs) from the 80% design surface (November 2017). Methods for developing Winter WUA are described in Appendix K.

3.2.2.9.2 Juvenile Chinook Preferred Usable Area (PUA)

Rearing habitat suitability, within the BTS project area, was assessed for juvenile Chinook salmon using the Habitat Suitability Index (HSI) methodology. Both summer and winter conditions were evaluated in the BTS project area upstream of Bear Creek under four flow conditions (Low – 18 cfs, Median - 82 cfs, Median March – 400 cfs, and High – 900 cfs).

3.2.3 Criteria Evaluation

A summary of the metric status for both existing and proposed conditions (Table 3-2), including the relative change, documents the large magnitude of beneficial change in all metric categories. Large absolute and proportional increases in desired conditions are evident, and the decrease in critical streambed particle size is the desired direction of change. A focused presentation of the physical habitat uplift and biological metrics follows the table, and additional discussion of design elements, methods and rational are providing in subsequent sections.

Table 3-2 Project Metrics Summary

Primary Objective	Metric	Units	Existing Conditions	Proposed Conditions	Percent Change
Floodplain Connectivity	Flood Prone Area	acres	47	87	85%
Floodplain Connectivity	Active Floodplain	acres	17	44	159%
Channel Margin Habitat	Channel Margin Inundation	acres	2.9	10.4	259%
Channel Complexity	Sinuosity at low flow	n	1.2	1.5	25%
Thermal Complexity	Channel and Hyporheic Complexity	n	5.9	42.0	612%
Bedload Retention	Critical Streambed d50 Particle Size	mm	22	17	-23%
Channel Complexity	Critical Streambed d50 Particle Diversity	n	63	92	46%
Winter - Juvenile Chinook Rearing	Winter Juvenile Chinook WUA	acres	0.2	1.1	450%
Summer - Juvenile Chinook	Summer Juvenile Chinook WUA	acres	3.4	6.2	82%

Table 3-2 Project Metrics Summary

Primary Objective	Metric	Units	Existing Conditions	Proposed Conditions	Percent Change
Rearing					
Winter - Juvenile Chinook Rearing	Winter Juvenile Chinook Preferred UA	acres	0	1.0	1,000%
Summer - Juvenile Chinook Rearing	Summer Juvenile Chinook Preferred UA	acres	0.2	3.8	1,800%
Juvenile Chinook Emigration	High Flow Refuge Area	acres	2.5	18.5	640%
Adult Chinook Holding	Deep Pools per Mile (>4-feet)	n	0	12.8	12,800%

3.2.3.1 Physical Habitat Uplift

Comparison of physical habitat metrics between the existing and proposed conditions shows substantial improvements for each, which translates to meeting original project objectives. The proposed river network will interact with its floodplain at a much higher frequency and to a much greater extent. The active floodplain is nearly three times larger than the existing and the flood prone area is approximately twice that of the existing. In terms of channel margin habitat potential, the proposed condition contains approximately 3 to 4 times the channel margin habitat currently available. In addition to river-floodplain connectivity, the proposed condition will be much more complex with a river complexity index that is seven times that of the current condition at the March median discharge. The channel bedform will be transformed to a pool-riffle from the plane bed that currently exists. Currently, deep pools are non-existent, but will be common with approximately thirteen per mile at low flow and will increase in size and number with increasing discharge in the proposed condition. As indicated by modeled sediment results, the existing plane-bed channel will be transformed into a multi-threaded channel network. Channels will likely contain numerous depositional bar features with varied gravel sized particles that will respond dynamically to flood events that will re-work them through the proposed channel network.

3.2.3.2 Habitat Suitability Index

3.2.3.2.1 Preferred Usable Uplift Analysis and Results

Rearing habitat suitability, within the BTS project area, was assessed for juvenile Chinook salmon using the HSI methodology. Both summer and winter conditions were evaluated in the BTS project area upstream of Bear Creek under four flow conditions (Low – 18 cfs, Median - 82 cfs, Median March – 400 cfs, and High – 900 cfs).

In order to evaluate HSI and associated WUA, point-based 2D hydraulic modeling results of flow depth and depth-average velocity were converted to ArcGIS raster’s in a grid size of 2ft by 2ft for comparison between proposed (channel reconstruction conditions) and existing conditions. Spatial distributions of flow depth and depth-average velocity were then imported into the North Arrow Research Habitat Model, where HSI analyses were performed utilizing Maret et al. (2006) curves for the summer season and Favrot and Horn (2016) curves for the winter season.

The resulting, HSI rasters can then be aggregated to evaluate WUA and assess relative uplift due to project implementation. However, one of the downfalls of the standard methods associated with HSI are that a wide and shallow reach might have a reasonable WUA value, but fail to have what could be termed “Preferential Habitat.” “Preferential Habitat” being areas of the river where utilization should be high relative to other areas, because optimal conditions exist to support a specific life stage (i.e., favorable depth, velocity).

The point of this analysis is to try and account for relative uplift of these more suitable habitat areas provided by design. Unfortunately, this type of analysis suffers from the need to set a threshold value and lends itself to some subjectivity. In an attempt to avoid subjectivity “Preferential Habitat” is simply defined as the upper 1/3rd of available suitable habitat (i.e., raster’s cells with HSI value of 0.67 or greater). Further, this method of comparison avoids weighting unit area. As a result, “Preferential Habitat” is the aggregate wetted area in acres that has conditions that would meet habitat suitability criteria that would produce HSI values of 0.67 or better.

Thus, the numbers presented in this analysis are not WUA values, but rather the planform wetted area that provides preferred conditions of depth and depth-averaged velocity based on suitability criteria for a specific life stage. Rearing conditions within the project reach during summer low flow are currently limited by available high quality habitat to include deep pools and cover, but more importantly are limited by temperature conditions which are often lethal during this period. Several project metrics are inter-related to describe the potential benefits to juvenile fish within the reach during this period. Based on HSI analysis of depth and velocity, physical habitat is expected to be much improved with approximately two times the WUA during low flow conditions and more importantly, adding 3.6-acres out of 10-acres total of preferred physical habitat, which is nearly non-existent now.

Table 3-3 Comparison of Preferred Summer Rearing Habitat for Chinook Salmon

Preferred Summer Habitat Comparison (≥ 0.67)					
Scenario	**Season**	**Flow**	**Preferred Habitat (acre)**	**% Change**	**Portion of Wetted Area**
Existing	Summer	Low	0.15	2,346%	2%
Proposed	Summer	Low	3.78		37%
Existing	Summer	WinMed	0.0	15,354%	0%
Proposed	Summer	WinMed	3.9		29%
Existing	Summer	WinMar	0.0	11,141%	0%
Proposed	Summer	WinMar	2.8		13%
Existing	Summer	WinHi	0.1	3,553%	1%
Proposed	Summer	WinHi	4.1		13%

Based on Maret et al. (2006)

Rearing conditions within the project reach during summer low flow are currently limited by available high quality habitat to include deep pools and cover, but more importantly are limited by temperature conditions which are often lethal during this period. Several project metrics are inter-related to describe the potential benefits to juvenile fish within the reach during this period. Based on HSI analysis of depth and velocity, physical habitat is expected to be much improved with approximately two times the WUA during low-flow conditions and more importantly, adding 3.6-acres out of 10-acres total of preferred physical habitat, which is nearly non-existent now.

Table 3-4 Comparison of Preferred Winter Rearing Habitat for Chinook Salmon

Preferred Winter Habitat Comparison (≥ 0.67)					
Scenario	**Season**	**Flow**	**Preferred Habitat (acre)**	**% Change**	**Portion of Wetted Area**
Existing	Winter	Low	0.02	4,038%	0%
Proposed	Winter	Low	0.97		9%
Existing	Winter	WinMed	0.0	4,844%	0%
Proposed	Winter	WinMed	1.7		13%
Existing	Winter	WinMar	0.0	21,652%	0%
Proposed	Winter	WinMar	0.7		3%
Existing	Winter	WinHi	0.0	20,703%	0%
Proposed	Winter	WinHi	1.4		4%

Table based on Favrot and Horn (2016).

Considering depth and velocity criteria only and during low flow conditions, the proposed project provides additional winter rearing habitat of approximately 1-acre from that which is currently nearly non-existent. When considering the total wetted area of the project is only approximately 10-acres at low flow, this represents a substantial uplift. Further, additional benefits of cover were not considered or modeled, which will provide additional low velocity zones and the added benefits of cover to what is reported by the WUA. Additionally, the added rearing habitat of 1-acre is nearly all "preferred" habitat (combined score of 0.67 or greater), where currently preferred habitat does not exist.

A visual comparison of winter juvenile Chinook rearing Habitat Suitability for all 80% modeled flow discharges between existing and proposed conditions using Preferred Usable Habitat is presented in Appendix K. A significant gain in habitat suitability is observed from the existing to the proposed conditions.

3.3 Design Elements and Rationale

The following discussions present design issues and features not fully developed at the 30% design, and presents updates on the status of other design elements, with methods, rationale and/or justifications associated with the 80% design.

3.3.1 Project Footprint

Based on feedback received during the NEPA EA public review, the BTS project area has been reduced to exclude activities on and immediately adjacent to the most downstream private parcels (i.e., Bear Creek Ranch) included at earlier phases of design. Similarly, the public parcel ("State Parks" ODOT) east of the old railroad grade remnant is also excluded at this time. Based on an opportunity with Jordan Creek Ranch (i.e., Lowe Family Ranch parcels), the project incorporates actions on those private lands, adjacent to the upstream USFS lands (Figure 3-1).

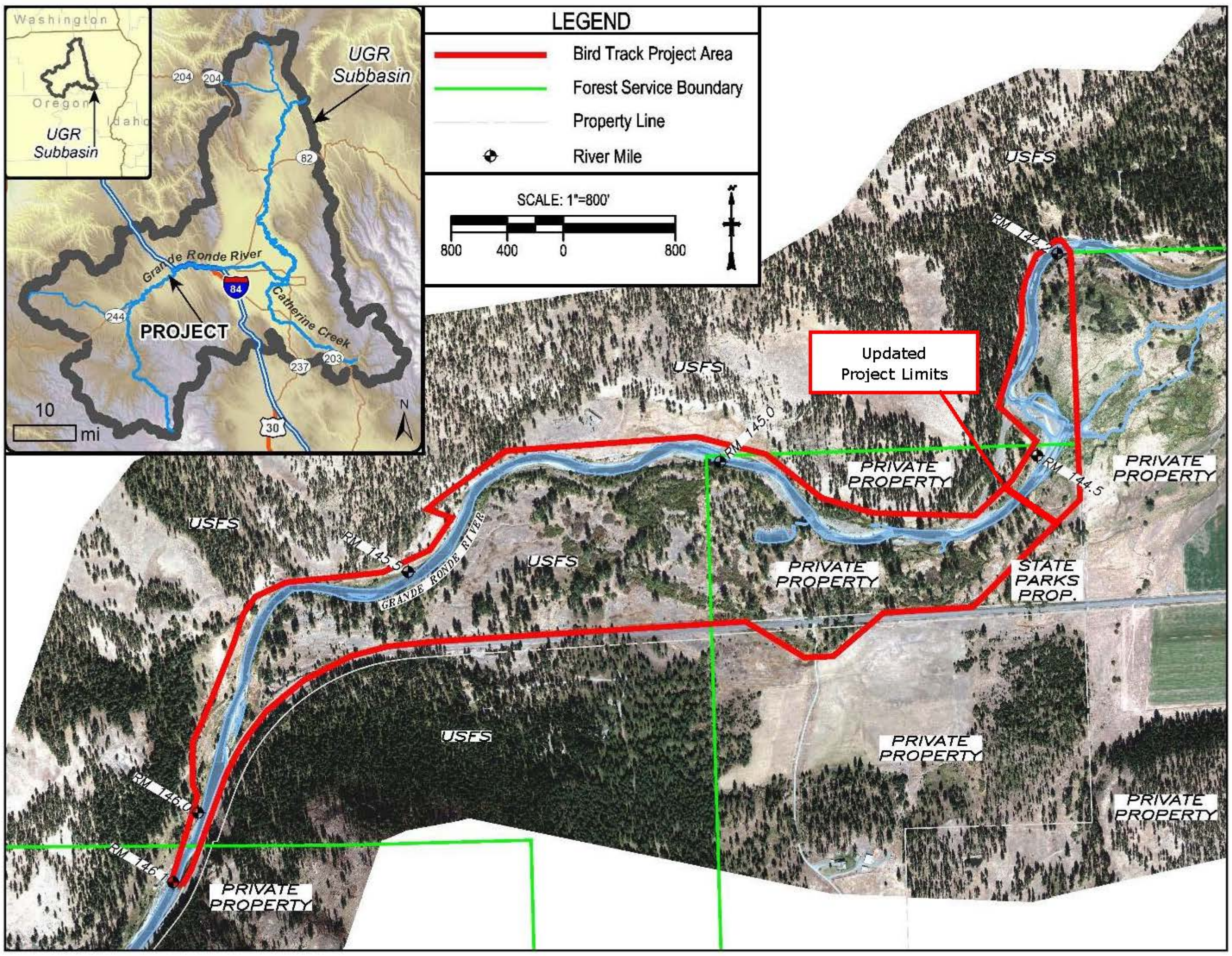

Figure 3-1. BTS project area.

3.3.2 <u>30% to 80% Surface/Grading</u>

Channel development at the 30% design level was primarily focused on creating the appropriate geometry of the channel bed (vertical) and banks (horizontal) to achieve the desired hydraulic conditions for side channel activation and floodplain inundation at specific design flows. Advancing from 30% to 80% further refined hydraulic objectives and focused on developing off-channel rearing habitat. This was accomplished by refining the proposed surface (DEM) and conducting 2D hydraulic modeling. Three iterations were performed in developing the 80% surface that was used for HSI modeling, LWM design and risk analysis, material quantity calculations, sediment transport analysis, and bank stability design.

Iteration one, 80% Surface 1, focused on adjusting the channel planform to address the comments at 30% for sharper bends and pool creation by making abrupt forcing conditions to encourage pool scour. This required adjusting alignments in the main channel and side channels. Side Channel 10 and floodplain grading was created in the corral area on Jordan Creek Ranch. In addition, off-channel habitat features were created in the surface including swale networks to further activate floodplain habitat. Side Channel 3A was created to function as relic beaver ponds in the portion of the existing channel that was filled bank to bank in the 30% design. Hydraulic modeling 80% Run 1 was performed with this surface.

Iteration two, 80% Surface 2, made further adjustments to off-channel grading and floodplain habitat design using the modeling results of 80% Run 1. At this iteration there were no major changes to the channel alignments horizontally and only slight adjustments vertically at key riffle locations to achieve side channel activation and flow partitioning objectives. Several off-channel fill pads were created at the confluence of side channels to maintain channel geometry and in areas where flow overtopping the banks had the potential for severe erosion based on hydraulic model outputs at the 10-year flow. Hydraulic modeling 80% Run 2 was performed with these changes to the surface. Initial 80% HSI modeling was conducted during Run 2 to determine the uplift from changing channel geometry and adding off-channel complexity compared with existing conditions and the 30% HSI modeling.

Iteration three, 80% Surface 3, further refined floodplain grading specifically focusing on adding off-channel rearing ponds, simulated reinforced debris structures, and refining floodplain swale features. In addition several fill pads were added in the vicinity of Highway 244 to route flood flows away from the highway.

Development of the surface will continue from 80% through final design. The next steps are to incorporate LWM into the surface, further enhance off-channel habitat features, and make finer scale adjustments to channel grading to address areas of high shear stress.

3.3.3 Hydraulic Modeling

Hydraulic modeling by TSC since the 30% design represented three iterations of proposed topography (Appendix C). The main change between the 30% and the current design is the addition of side channels to the floodplain network.

3.3.4 Channel Complexity and Floodplain Connectivity

The design increases channel and floodplain interactions through a combination of means: additional linear and lateral access via side channels and increased vertical overbanking extent, frequency and duration. Under the 30% design an increase in shallow floodplain channels and flow access to swales was proposed; under the 80% design an additional increase in floodplain channel density and flow access to variable floodplain surfaces and off-channel habitat support is proposed.

3.3.4.1 River Complexity Index

The RCI for the channel in its existing condition under all flows is very low. The design would substantially increase channel complexity via the addition of multiple channels active at various discharges, as well as an overall increase in channel sinuosity (Table 3-5).

Table 3-5 Channel Length, Sinuosity, and RCI Comparisons

Q	Total channel Length (ft)	Sinuosity	RCI Project Area
Existing 1.25; BF @ 1368 cfs	8141.7	1.2	3.00
Proposed 1.25; BF @ 1368 cfs	34988.5	1.4	177.4
Increase	26846.9	0.3	174.4
% Increase	329.7%	22.6%	5814.7%
Existing Winter Hi @900 cfs	7924.4	1.2	3.5
Proposed Winter Hi @900 cfs	28415.0	1.43	98.8
Increase	20490.6	0.3	95.3
% Increase	258.6%	22.2%	2711.3%
Existing March Median @400 cfs	8181.9	1.2	5.9
Proposed March Median @400 cfs	21371.8	1.4	42.0
Increase	13189.9	0.3	36.1
% Increase	161.2%	23.7%	617.3%
Existing Winter Median @82 cfs	8242.5	1.2	11.8
Proposed Winter Median @82 cfs	14414.8	1.46	24.8
Increase	6172.3	0.3	13.1
% Increase	74.9%	24.3%	111.4%
Existing Low Flow @ 18 cfs	8429.4	1.2	8.3
Proposed Low Flow @ 18 cfs	12712.1	1.5	16.1
Increase	4282.7	0.3	7.8
% Increase	50.8%	23.8%	94.6%

The increase in complexity at bankfull flow (Figure 3-2) provides an important indicator of the anticipated improvement in potential hyporheic flow path diversity and the project (through iterative design of flow splits and channel capacities) also increases complexity for lower seasonal flows, including a measureable change at low flow (Figure 3-3).

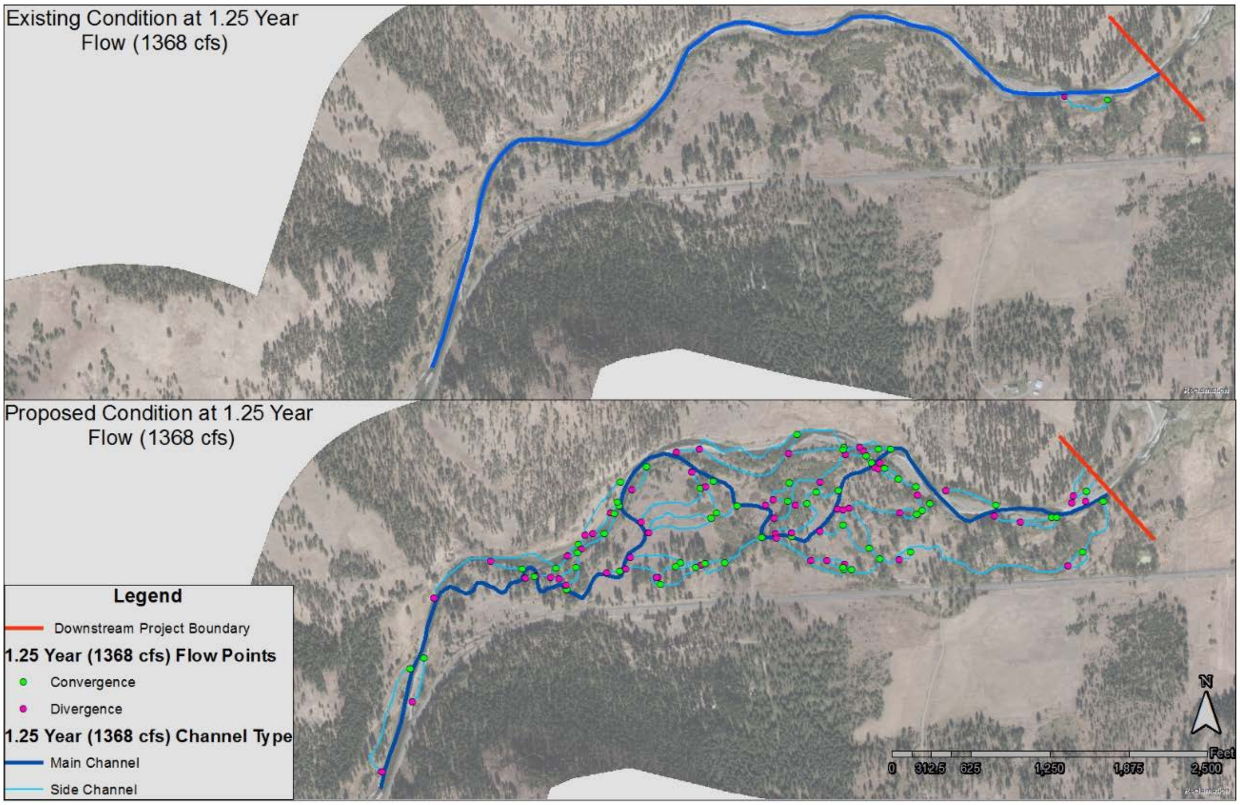

Figure 3-2. Existing versus proposed RCI nodes – bankfull flow.

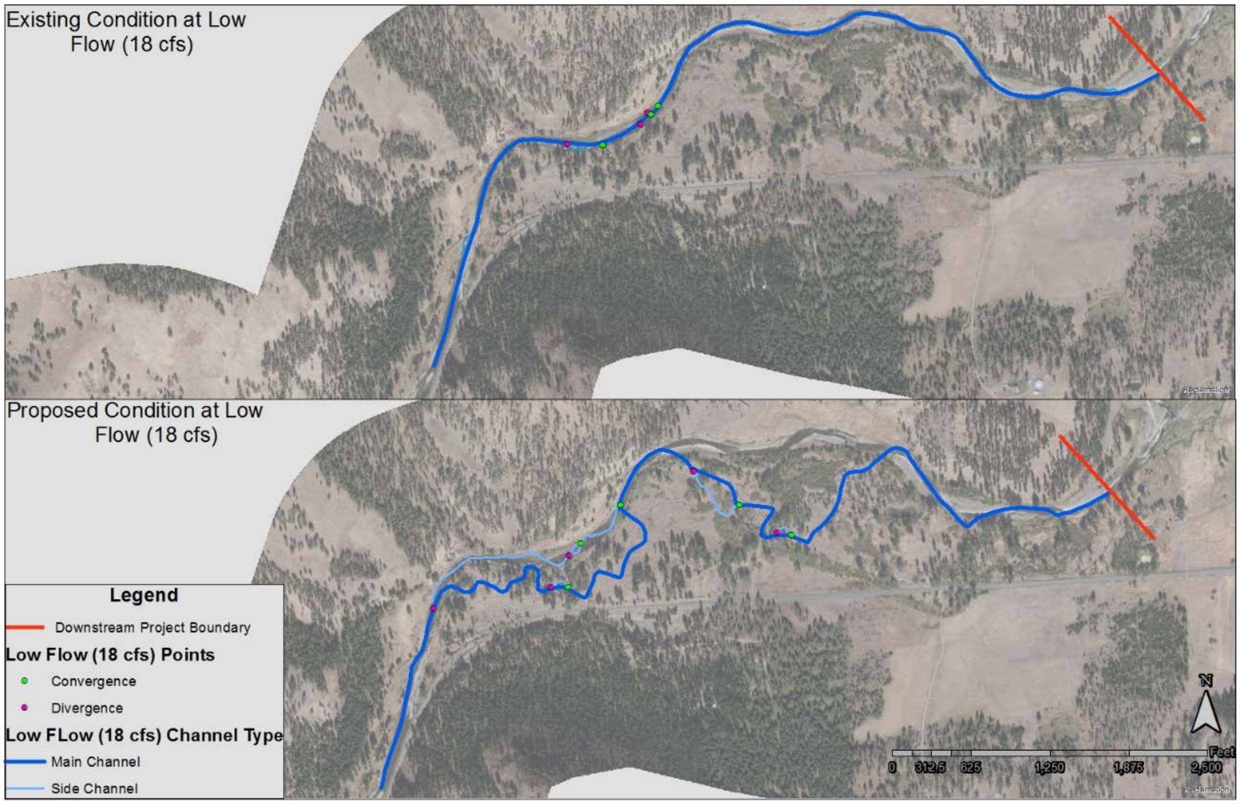

Figure 3-3. Existing versus proposed RCI nodes – low flow.

In addition to an increase in complexity resulting from initial design features, the project is envisioned to gain in complexity over time as physical processes allow the channel to interact with relict swales and extant riparian vegetation that is being preserved. Over time, dynamic processes will recruit local LWM from stock on site, locally adding varied numbers and sizes of LWM interacting with the channel as forcing agents on the bed and banks and directly providing habitat.

3.3.4.2 Floodplain Inundation

The design planform alignments, channel dimensions, and activation elevations all interact to realize the project intent of maximizing flood inundation extent and duration for all non-damaging flow levels, without increasing hazardous flooding. A graphic comparison between existing and proposed floodplain extent beyond the channel (i.e., area of the March median flow) shows the substantial increases in area activated over geomorphically and ecologically significant ranges (e.g., 2-year, 5-year, 10-year) (Figure 3-4). It also demonstrates a diminishing increase for the large to major flood discharges (Figure 3-4). Modeled inundation limits for the high flows representing small to moderate overbanking events (Figure 3-5) demonstrates the desired multi thread pattern and distributed wet areas across the valley bottom, activating the constructed and reactivated remnant floodplain features and ponds. Modeled inundation limits comparison of the 100-year event under existing and proposed conditions (Figure 3-6) indicates that while the area inundated increases slightly from about 112 to 116 acres (Figure 3-4), expanded boundaries are primarily in the interior of the site and or adjacent to side slopes rather than the highway.

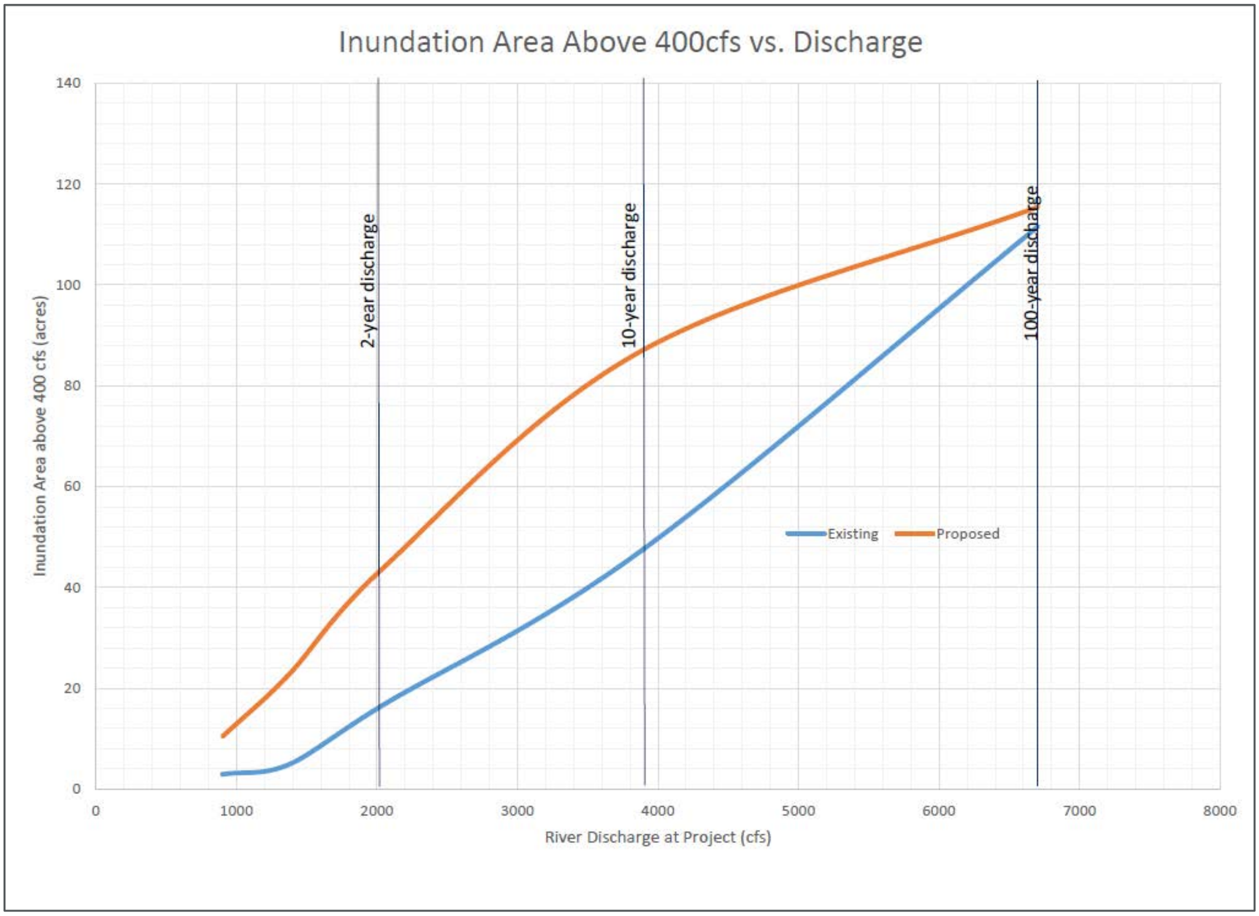

Figure 3-4. Floodplain inundation area comparison for existing and proposed conditions.

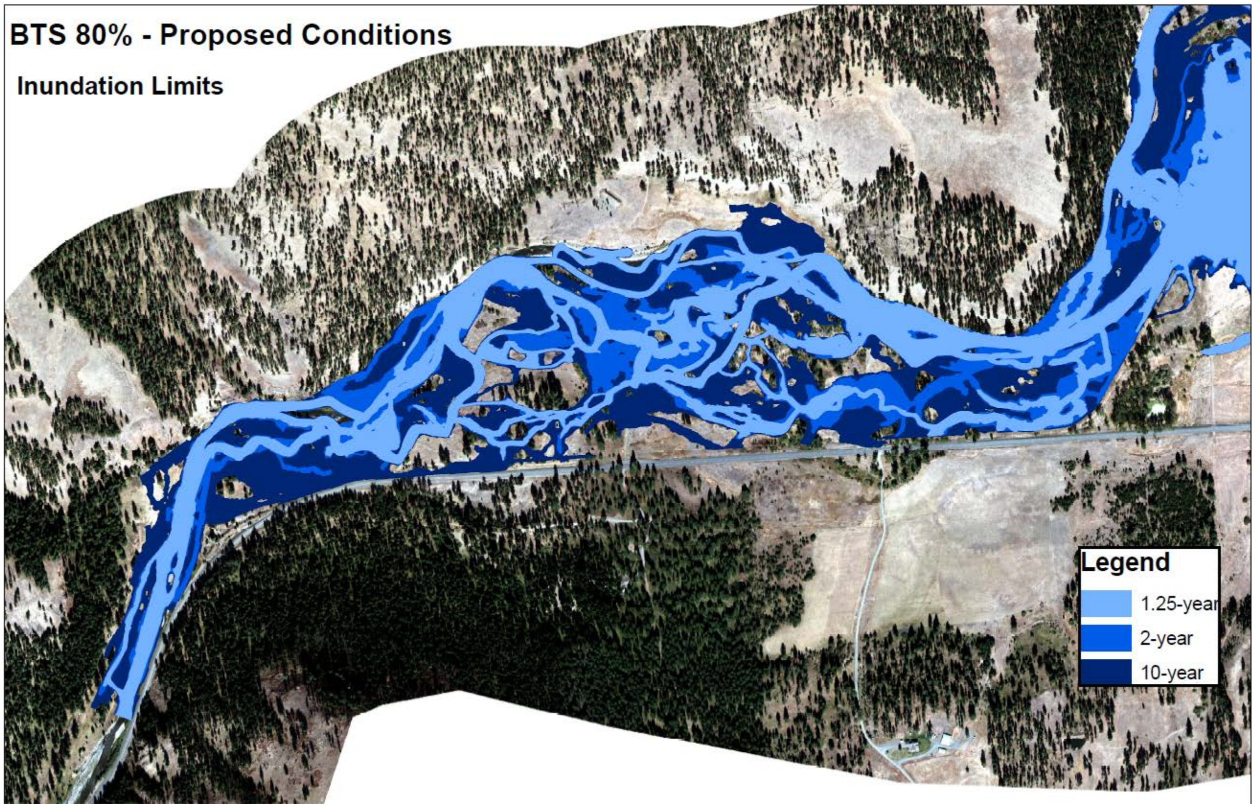

Figure 3-5. Floodplain inundation limits for proposed conditions under high flows.

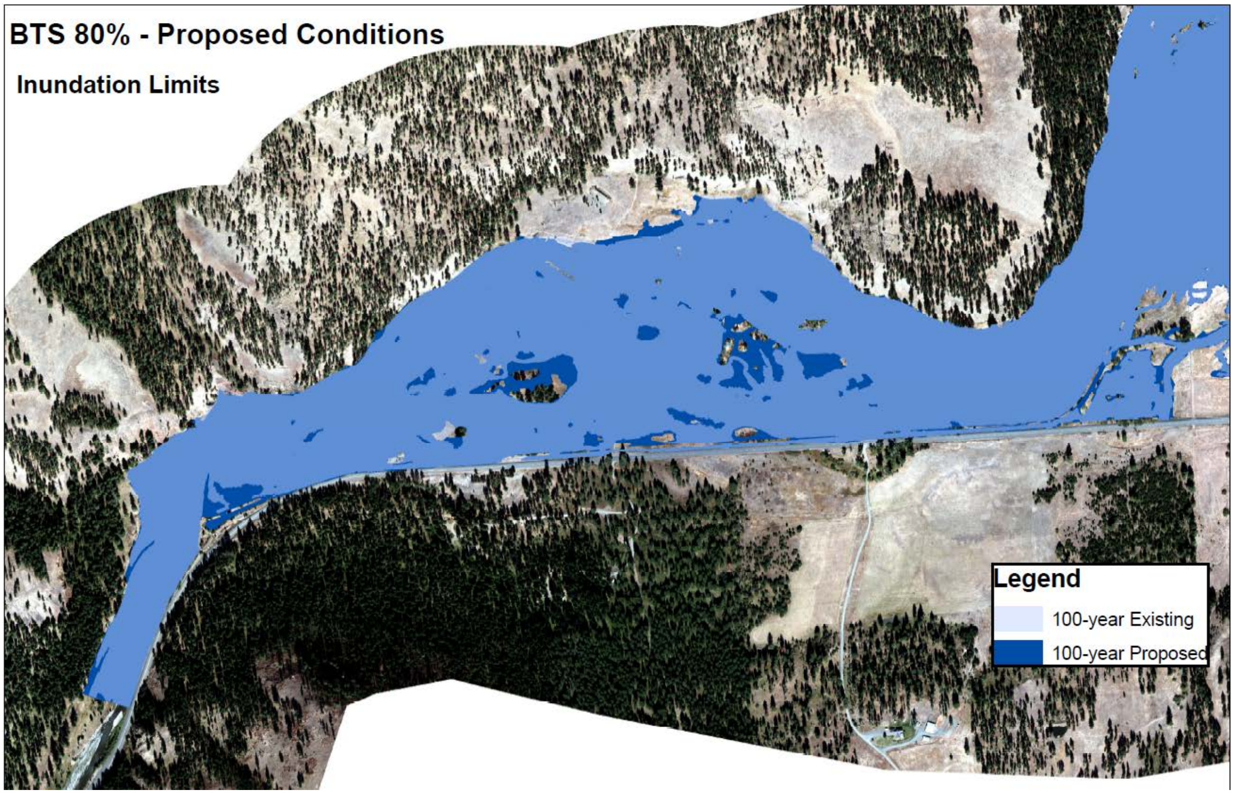

Figure 3-6. Floodplain inundation limits for existing and proposed conditions at the 100-year event.

3.3.5 Large Wood Material Structures

Siting and design of LWM for the BTS project has been informed by the experience of the design team on similar projects throughout the West, many of which have gone through the HIP III process and Reclamations Risk Based Design Guidelines (Section 4). Design principles that apply to all of the LWM structures for this project are described below:

> All visible ends of logs will be cut or broken off to create a natural appearance.

> Racking logs will have irregular and natural appearance and not be stacked.

> Different sizes and lengths of trees will harvested with rootwads and branches intact to the best extents possible. Log size categories are:

- Key: greater than 18-inch diameter at breast height (DBH)
- Medium: 12- to 18-inch DBH
- Racking: 6- to 12-inch DBH
- Pinning: 12-inch DBH
- Tree tops and branches: 1- to 6-inch average diameter

> Larger logs and whole trees may also be available and will be placed at the discretion of the Contracting Officer and Engineer during construction.

> Native coarse alluvium and selected boulders will be used for ballast. Depending on the size of native alluvium encountered during construction, addition boulders may need to be imported.

Due to ice loading and the stability requirements at certain key structures, bolted connections will be used in key locations. Where used, each key log shall be connected in at least two places with threaded rod to adjacent logs and/or piles, or as approved by the engineer. Rods shall be 1-inch diameter minimum fully threaded steel rods, with steel nuts, and 4-inch washers on each end. Visible portions of hardware shall be grey or other neutral color. Rods shall be flush cut at the nuts and sharp edges ground flush.

The onsite construction Contracting Officer, with prior verification from the Engineer of Record, will direct necessary field modifications of structures to ensure optimal fit at each site.

3.3.5.1 Large Woody Material Structure Benefits

Large woody material structures integrate multiple design benefits, including both hydraulic and habitat elements as described in Table 3-6. As part of the design each structure was evaluated for the project and site specific benefits being provided to the project.

Table 3-6 Large Woody Material Structure Type Benefits

Structure Description	Hydraulic Benefits	Habitat Benefits
Type A – Apex Narrow	> Create split flow, and protect or create vegetated island or gravel bar. > Create scour pool and sort sediment.	> Accumulate debris over time. > Enhance fish habitat complexity and diversity.
Type B1 – Meander Upstream	> Limits channel migration in the short term to restore aquatic and riparian habitat. > Increases velocities in channel leading to downstream component of meander jam to force larger scour hole.	> Enhances fish habitat by creating large bankside pools for fish holding and sediment sorting.
Type B2 – Meander Middle	> Limits channel migration in the short term to restore aquatic and riparian habitat. > Angles stream power into bed creating sustainable scour hole.	> Enhances fish habitat by creating large bankside pools for fish holding and sediment sorting. > Accumulates debris over time. Provides cover.
Type B3 – Meander Downstream	> Limits channel migration in the short term to restore aquatic and riparian habitat. > Angles stream power into bed creating sustainable scour hole.	> Enhances fish habitat by creating large bankside pools for fish holding and sediment sorting. > Accumulates debris over time. Provides cover
Type B4 – Meander Deflector	> Limits channel migration in the short term to restore aquatic and riparian habitat. > Angles stream power into bed creating sustainable scour hole.	> Enhances fish habitat by creating large bankside pools for fish holding and sediment sorting. > Accumulates debris over time. Provides cover.
Type C1 – Longitudinal Channel Margin	> Temporarily stabilize new banks in the short term to restore aquatic and riparian habitats. > Divert high flows into side channels and floodplain. > Sort and retain gravel.	> Create diverse fish habitat on river margin. > Provide cover
Type C2 - Angled Channel Margin	> Temporarily stabilize new banks in the short term to restore aquatic and riparian habitats. > Maintain scour holes by flow convergence.	> Create diverse fish habitat along channel margin. > Provide cover.

Table 3-6 Large Woody Material Structure Type Benefits

Structure Description	Hydraulic Benefits	Habitat Benefits
	Divert high flows into side channels and floodplain. > Sort and retain gravel.	
Type D1 – Deflector Small	> Redirect high flows. > Create scour pools.	> Enhance fish habitat complexity and diversity. > Provide cover.
Type D2 – Deflector Large	> Redirect high flows. > Create scour pools.	> Enhance fish habitat complexity and diversity. > Provide cover.
Type E – Sweeper	> Redirect flow.	> Encourage gravel deposition.
Type F – Floodplain Roughness	> Increase hydraulic roughness of floodplain.	> Encourage sediment deposition. > Create protected pockets for riparian vegetation growth
Type G1 – Side Channel Single	> Create scour holes.	> Mimic trees falling into the channel. > Provide cover
Type G2 – Side Channel Double	> Create scour holes.	> Mimic trees falling into the channel. > Provide cover
Type G3 – Side Channel Triple	> Create scour holes.	> Mimic trees falling into the channel. > Provide cover
Type G4 – Side Channel Sill Log Complex	> Drop grade into pond complex. > Maintain grade control. > Create scour holes.	> Mimic trees falling into the channel. > Provide cover
Type H – Cover Logs	> Increase hydraulic roughness of floodplain.	> Encourage sediment deposition. > Provide cover.
Type I1 – Ice Crib Jam (Small)	> Break-up and deflect ice. > Withstand impact from heavy ice flow. > Create scour pool	> Create split flow, and protect or create vegetated island or gravel bar
Type I2 – Ice Crib Jam (Large)	> Break-up and deflect ice. > Withstand impact from heavy ice flow. > Create scour pool	> Create split flow, and protect or create vegetated island or gravel bar
Type J – Reinforced Debris Structure	> Raise water table and bed elevation > Reduce flow velocities in side channels and floodplain > Retain sediment in side channels and floodplain.	> Create habitat complexity > Create off channel rearing habitat

3.3.6 Bank Treatments

The approach for bank stability structures that are not strictly designed as LWM structures was to consider the geomorphic position and relative degree of potential inundation of the bank in the context of risk for failure of the bank in both the near- and the long-term within a context of an acceptable level of channel dynamics characteristic of natural channels. The basic objective was to provide near-term stability immediately after construction via incorporation of LWM and dead brushy material, while at the same time protecting and incorporating living vegetation to promote long-term stability as vegetation recovers and becomes well established at the toe, face and/or top of bank.

Acceptable levels of channel dynamics for both the main channel and side channels considered the following infrastructure and design elements in choosing a bank treatment at a given site:

> Resistance of local bedrock outcrops or colluvial side slopes

> Opportunities provided by existing mature vegetation

> Adjacent/internal areas with constraints (i.e., highway margins, access points, infrastructure);

> Risks to downstream land uses, conditions, or infrastructure

> Life span desired for channel habitat features

> Desire for deformability, sediment sources, and natural plant bed deposition

> In-situ soil and sediment characteristics (cut areas)

> Vulnerability to erosion (fill areas)

> Floodplain return flow pathways

> Exposure to damaging ice processes

> Predicted near-bank hydraulics

Decision making for treatment options and locations gathered insight from the following resources: geomorphic, vegetation and ice scour mapping; bank sediment and soil profiles; hydraulic modeling; bank stability principles and lessons learned on similar projects. This iterative process lead to the development the design details for three typical bank treatments and one special treatment area along the SR 244 right-of-way (see Appendix A, sheets 108–111). The summary of bank treatment characteristics in Table 3-7 also notes that the design includes areas with no constructed bank treatment. These are in locations where the anticipated conditions (hydraulics, geomorphic processes, and vegetation) would provide an appropriate level of stability and habitat value without intervention.

Table 3-7 Summary of Bank Treatment Types

ID	Name	Target Stability	Toe	Face	Top	Width (buried into bank)
0	N/A	Varied Low to High	Native (existing or cut) Material	Native (existing or cut) Material	Existing vegetation	N/A
1	Brush Bank	Low-Mod (~5-yr)	Placed Bed Material and/or Native Material	Live staking and Brush bundles	Salvaged plantings/ plantings	6–8 ft
2	Roughened Edge	Mod (~5-10 yr)	Toe logs	Brush Layer, Riffle Material, Racking; plant through	Salvaged plantings/ plantings	10–20 ft
3	Riffle Material	High (~10-yr)	Riffle Material	Riffle Material (w cobble/boulder)	Existing vegetation or plantings	~ 2 ft
4	Special ODOT Treatment Area	Very High (> 20-yr)	Mixed native and spec rock	Mixed riffle and native materials, planted (flexible stems)	Planted … deep rooted flexible stem)	Without disturbance to existing road prism

3.3.7 Channel Bed

The design for the channel bed continues to leverage opportunities on the site such swales, relic channel features and existing backwaters and ponds; to anticipate the incorporation of in-situ materials in areas that will be reactivated by flow only and to design and construct appropriate features in excavated channels and/or required control points. Vertical stability of channels within the proposed project will be provided by hardened riffles constructed in the channel bed. Riffles will be constructed in the new channel segments by over-excavation of the native materials by 2-feet (approximately 2-times the D100 material) and replacement with native rock of specific gradation and methods to form a well-graded mixture of compacted alluvium similar to what is found in natural riffles within the upper Grande Ronde River.

An alluvial design process was utilized for this project such that constructed riffles would behave similarly to those found naturally near the project site. This process required evaluation of computed critical shear stresses at proposed riffles along with allowable shear stress of existing material gradations found within and near the project site. Newly constructed riffles are intended to be at least as stable as those found upstream of the project to allow the channel to mature gradually. However, riffles are expected to move and transform at higher discharge frequencies. The channel will be stable vertically for varying discharge values dependent upon location. In general, constructed riffles crests will be stable for discharges at and below the 10-year return interval flood, and most riffle faces will be stable through the 2-year return interval. At discharges exceeding the 2-year peak, it is expected that channel substrate at riffle locations may adjust within the project area, similar to natural stream reaches in this setting.

3.3.7.1.1 Riffle Locations and Design

As mentioned, riffles are located throughout the proposed project to control the vertical profile of the overall channel (bankfull) water surface slope. Riffles were located at predicted thalweg cross-over locations, split flow locations, and where channel slope breaks occur. The proposed project will have seven slope breaks within the main channel and many others within side channels. In all newly constructed channels, riffles are to be constructed by over-excavation of the existing materials and replacement with a well-graded and compacted mixture of alluvial material of a specific gradation. At existing channel riffle tie-in locations, existing riffles will be inspected for vertical grade and competency and will be altered if necessary to meet both requirements.

The proposed project has been designed to be a naturally functioning stream channel using stream simulation design techniques (USFS 2008). The majority of riffles within natural streams are a component of the stream's channel alignment morphology. They are either natural valley hard points (bedrock, colluvium, or other) or they are depositional features that are related to upstream and downstream channel meanders. The hydraulics of stream meandering create a depositional feature at the stream's cross-over location. Riffles associated with stream meandering are not static, they adjust and move as the stream meander adjusts and moves or as physical materials and hydraulics change, such as after alteration to sediment supply. In designing the vertical profile, one must ask "at what point are the riffles allowed to move?" For this project, we have used stream simulation design techniques as outlined in the USFS's Stream Simulation Design Guidelines (USFS 2008) to answer that question. The following is a discussion of methods and assumption used in this design process.

Riffle Framework Design

Riffles are constructed of well-graded (poorly sorted) alluvial sediments that all act together as a single structure. Riffle mobilization occurs when the "framework" material is mobilized. This framework material is often defined as the D84 size class and larger. For this project, we have analyzed potential entrainment of the D84 particle sizes within proposed riffles based upon 2D numerical modeling results of shear stress values. To analyze our proposed riffle framework material, we utilized the modified critical shear stress equation (Andrews 1983; Bathurst 1987; Komar 1987, 1996; Komar and Carling 1991) which allows designers to determine the particle size of interest based upon the D50 particle. This equation is applicable for plane-bed type channels (gradually varied) with bed gradients of 5 percent or less, and D84 ranging between 10 to 250mm, both of which fit with our proposed riffles.

$$\tau_{ci} = 102.6\, \tau^*_{D50}\, D_i^{\,0.3}\, D_{50}^{\,0.7}$$

Where,

τ_{ci} = the critical shear stress at which the sediment particle of interest (D_{84}) begins to move.

τ_{D50} = the dimensionless Shield's parameter for D50 particle size

D_{50} = diameter of the median particle size of riffle gradation

D_i = diameter of the particle size of interest (D_{84})

When utilizing the modified critical shear stress equation for design purposes, the dimensionless Shield's parameter for the D50 particle becomes critical. Table 3-8 lists the dimensionless Shields parameter for various alluvial particle sizes. Based on the site pebble count data the D50 particle size for riffles is assumed to lie within the small cobble (64 to 128mm) size class; accordingly, a value of 0.052 was used for the design dimensionless Shield's parameter.

Table 3-8 Dimensionless Shield's Parameter for Different Particle Sizes

Particle size classification	*Particle size, D (mm)*	*Angle of repose, ϕ (degrees)*	*Shield's parameter, τ^**	*Critical shear stress, τ_c (lb/ft^2)*
very large boulders	*> 2,048*	*42*	*0.054*	*37.37*
large boulders	*1,024-2,048*	*42*	*0.054*	*18.68*
medium boulders	*512-1,024*	*42*	*0.054*	*9.34*
small boulders	*256-512*	*42*	*0.054*	*4.67*
large cobbles	*128-256*	*42*	*0.054*	*2.34*
small cobbles	*64-128*	*41*	*0.052*	*1.13*
very coarse gravels	*32-64*	*40*	*0.050*	*0.54*
coarse gravels	*16-32*	*38*	*0.047*	*0.25*
medium gravels	*8-16*	*36*	*0.044*	*0.12*
fine gravels	*4-8*	*35*	*0.042*	*0.057*
very fine gravels	*2-4*	*33*	*0.039*	*0.026*

Source: (USFS 2008).

Riffle Framework Design

At 80% design, shear stresses at riffles are generally similar for proposed conditions throughout the proposed project. A couple riffles show outlier results of shear that we believe are a result of the proposed conditions grading surface and will be adjusted through altering point bar encroachment and/or fixing surface triangulation anomalies. All proposed newly constructed riffles and existing riffles that will remain in the proposed project were evaluated for computed maximum bed shear stresses, which show narrow ranges of expected shear stress during the 1.25-year, 2-year, and 10-year discharge conditions. Therefore, rather than tabulating shear results at each riffle, a range of shear stress conditions to be expected at riffle crests and along downstream faces of each riffle have been tabulated for each flow condition (Table 3-9). The highest predicted shear stresses were compared to the allowable shear stress based upon a proposed D50 and D84 particle size. Values of D50 and D84 were iterated upon until proposed riffles would remain stable throughout the Project up to the 2-year discharge; the riffle faces become mobile within some of the riffles while other riffles remain stable to higher levels of discharge.

Table 3-9 Allowable Shear Stress Versus Modeled Shear Stress (SRH2D) at Riffles

Proposed Riffles	From SRH2-D Model				Design Gradation			
	Bankfull Max Shear	2-Year Max Shear	10-year Max Shear	Channel D50	Channel D84	Dimensionless Shields	Calculated Allowable Shear Stress	Discharge at which mobile
Riffle Crests	1.1 lbs/sqft	1.2 lbs/sqft	1.6 lbs/sqft	3.0 in	8.0 in	0.052	1.8 lbs/sqft	10-year
Riffle Faces	1.7 lbs/sqft	2.0 lbs/sqft	1.9 lbs/sqft	3.0 in	8.0 in	0.052	1.8 lbs/sqft	2-year

Proposed riffles were designed to mimic existing conditions in terms of similar existing D50 particle sizing. Existing D50 particle sizes were identified using pebble count data obtained throughout the project reach. Nineteen pebble counts were performed throughout the project reach at various channel units along within exposed banks (Figure 3-7). The sediments generally display a two groupings of particle size distributions: mobile materials with a smaller median and finer overall particle size range, such as eroding banks, overbank splays, or high flow areas; and, armored layers at riffle and transverse bar features. We theorize that the smaller particle size distribution can be related to active bedload, while the larger size range resembles the armor layer and can be better related to expected riffle framework particle sizes. For the existing riffle and transverse bar particle size distributions, the existing D50 ranges between 2.5- and 4-inches.

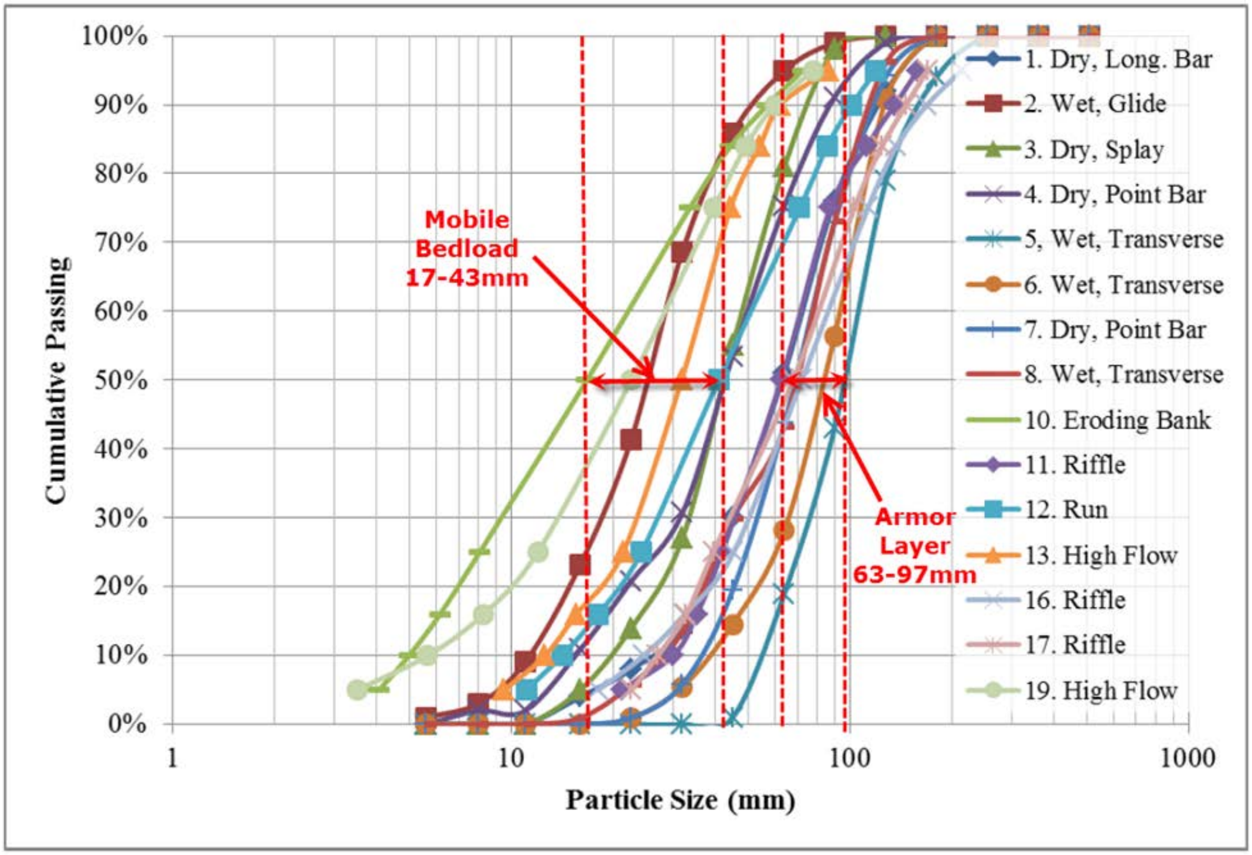

Figure 3-7. Particle size gradation curves for 19 pebble counts within the BTS project reach.

Utilizing 3-inches for D50 for our proposed riffles, we iterated to achieve an acceptable D84 particle size to maintain stability of riffles at and below the 2-year flood event, which results in a D84 particle size of 8-inches. Our calculated D84 particle size is larger than that found from pebble count data, which is approximately in the 4-inch to 6-inch range. However, pebble count data is from surface deposits only and we believe that the D84 particle may be higher in the existing channel than shown from these results. As a result, the proposed particle framework gradation appears to be similar to what is currently found at the project site.

Riffle Matrix Gradation

Once the framework design defined the larger size particles including the D50 particle size, the lower range of particles were developed. It is very important to have a full range of particle sizes in the riffle gradation as the smaller particle sizes fill void spaces and create an impermeable barrier, which prevents low flows from going subsurface through constructed riffles. To design the full range of particle sizes required to develop this well-graded mixture for riffles, the Fuller-Thompson equation (1907) was used. The Fuller-Thompson equation is:

$$P/100 = \left[\frac{d}{D_{max}} \right]^n$$

Where, P is the percent of the mixture smaller than d, Dmax is the largest size material in the mix, and n is a parameter that determines how fine or coarse the resulting mix is. An “n” value of 0.5 produces a maximum density mixture when particles are round and was used for design of riffles for this project. The Fuller-Thompson equation was re-arranged to base particle sizes on D50 rather than Dmax, which results in the following equations used to calculate D30, D10 and D5:

$$D_{30} = 0.6^{1/n}\ D_{50}$$

$$D_{10} = 0.2^{1/n}\ D_{50}$$

$$D_5 = 0.1^{1/n}\ D_{50}$$

Based on the design riffle framework gradation of:

D50 = 3.0-inches

The following lower curve values were calculated:

D30 = 1.0 inches

D10 = 0.12 inches

D5 = 0.03 inches

These calculations result in the design riffle matrix material (Figure 3-8). The proposed riffle matrix design matches the BTS project pebble count data fairly well with the exception that the proposed material finer than D50 will be smaller than that found on the existing, armored surfaces. This is an intentional shift from existing conditions, to better fit with the bedload pebble count data distribution (Figure 3-7).

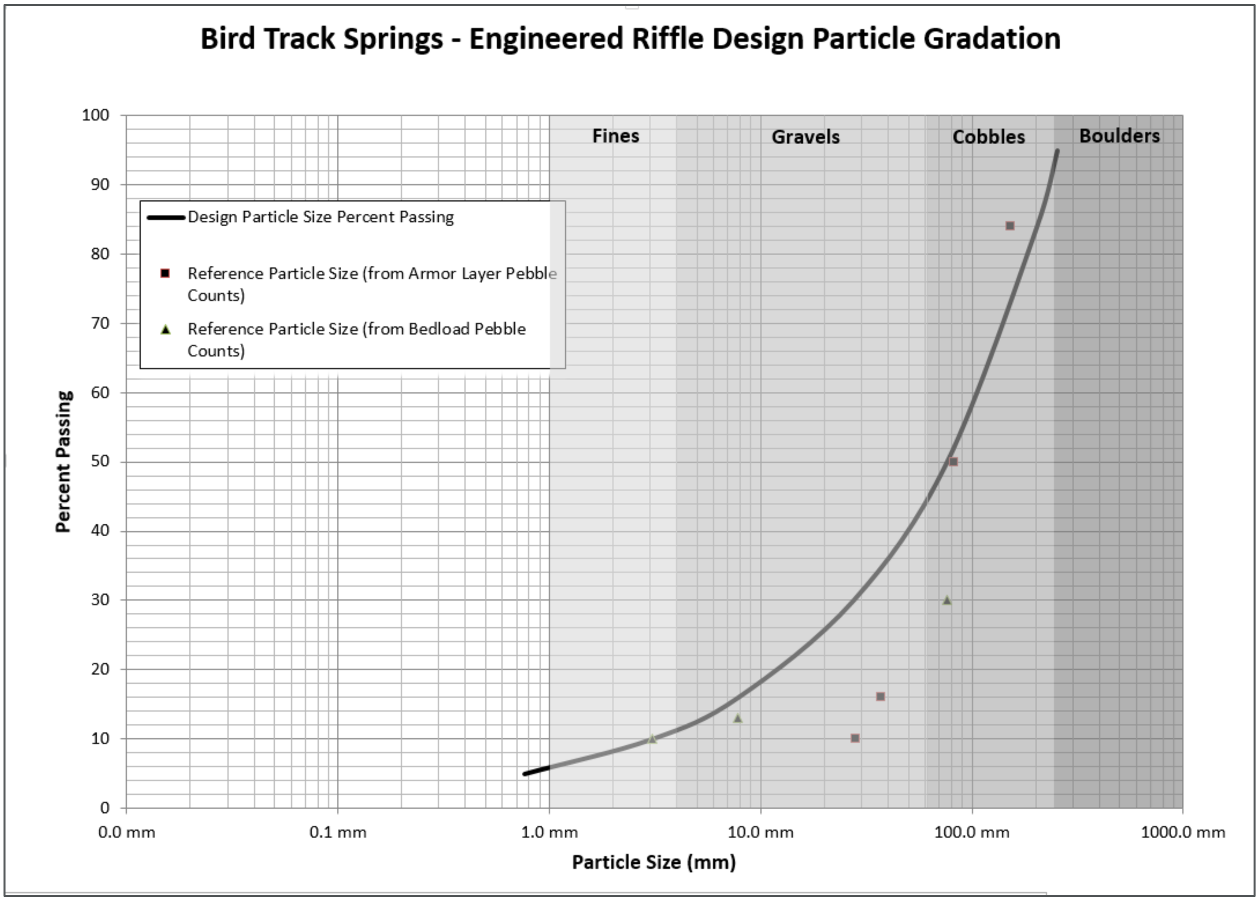

Figure 3-8. Proposed riffle matrix particle size gradation and site reference pebble count data.

Riffle Source Material and Sorting

Materials for riffles will be sorted from excavated materials on-site. Seven size class sorting piles (from small boulders through fines were chosen to ensure the materials meet objectives of the design gradation curve. Some simplification of the sorting process may be deemed possible during construction (fewer sorting units), if materials meet gradation requirements upon inspection. Table 3-10 shows the seven size classes of materials required along with each proportion to construct the proposed riffle matrix.

Table 3-10 Riffle Matrix Material Size Classes and Mixing Proportions

Description	Size Class	Mix Percentage (by volume)	Percent Finer	Mix Ratio (by volume)
Large boulders	Greater than 12 inches	NA	NA	See notes
Small boulders	8–12 inch	20%	80%	2 parts
Very large cobble	6–8 inch	10%	70%	1 part
Large cobble	4–6 inch	10%	60%	1 part
Small cobble	3–4 inch	10%	50%	1 part
Large gravel	1.0–3 inch	20%	30%	2 parts
Small gravel	0.125–1.0 inch	20%	10%	2 parts
Fines	Less than 0.0025 inch	10%	0%	1 part

3.3.7.1.2 Point Bars and Glide Materials

Sorting for channel bed materials will be limited to the riffle matrix sorting and mixing described above. However, the sorting process may result in excess materials that may be used to form point bars and glides. Point bars and glides will be formed from excavated (un-sorted) alluvium along with excess sorted material that meet material specifications for Point Bars (Table 3-11) and Glides (Table 3-12).

Table 3-11 Point Bar Materials Specifications

Material Gradation	Percent Range Permissible
Small Cobble (3-inch to 4-inch)	20%–50%
Large Gravel (1-inch to 3-inch)	30%–70%
Small Gravel (less than 1-inch)	10%–20%
Fines (less than 0.0025-inch)	10%–20%

Table 3-12 Glide Materials Specifications

Material Gradation	Percent Range Permissible
Small Cobble (3-inch to 4-inch)	10%–20%
Large Gravel (1-inch to 3-inch)	50%–70%
Small Gravel (less than 1-inch)	10%–20%
Fines (less than 0.0025-inch)	0%–10%

3.3.8 <u>Sediment Transport and Deposition</u>

Under the 80% design channel configuration and dimensions, hydraulic energy distributions are dramatically diversified and geomorphic processes of sediment transport and deposition will occur over a larger and more patching area of the site. While there are several variables affecting the processes, hydraulic modeling of the proposed versus existing conditions (SRH2D, Appendix E) offers proxy representation of eventual patterns and stable size categories of materials.

Under existing conditions the distribution of critical D50 at the 2-year event within and downstream of the BTS project (Figure 3-9) indicates that the main channel has relatively uniform very coarse gravel to small boulder D50 throughout the reach. Only extremely narrow and discontinuous channel margins sustain finer gravel D50s within the USFS lands. The side channels and bars near the downstream end of the project and on the BCR are the only areas with substantial variation in D50 particle sizes. This simulation matches observed conditions.

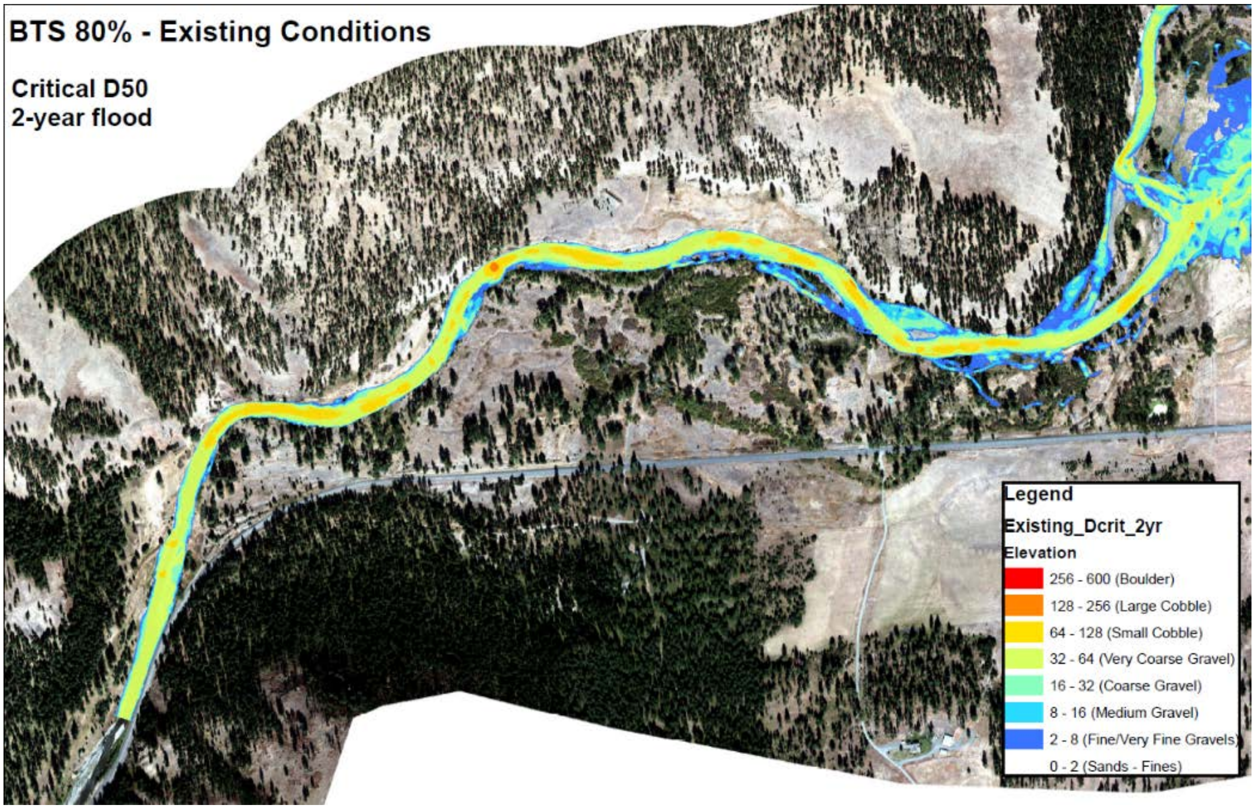

Figure 3-9. Modeled critical D50 at the 2-year event – existing conditions.

For the proposed 80% design (Figure 3-10), the low flow channel threads include segments with D50 in the very large gravel to cobble sizes in several areas with deep runs and higher gradient riffles; importantly, the main channel and numerous side channels and off channel wetted areas will experience hydraulics facilitating a large range in D50 size classes. These will occur in a complex pattern that reflects diverse and adjacent physical habitats. These hydraulic conditions will favor the sorting, mobilization and redistribution of active and mobile materials on a regular basis and limit future stagnation of the bed materials or armoring. Downstream of the active project area, the critical D50 sizes and spatial pattern is simulated to remain quite similar to present conditions, which displays some of the most favorable bed diversity and serves as an analog for design of project sections. Initial adjustments following construction may include scour within relic swales as accumulated mineral and organic sediment is mobilized and/or net deposition of smaller bedload materials within the project channels.

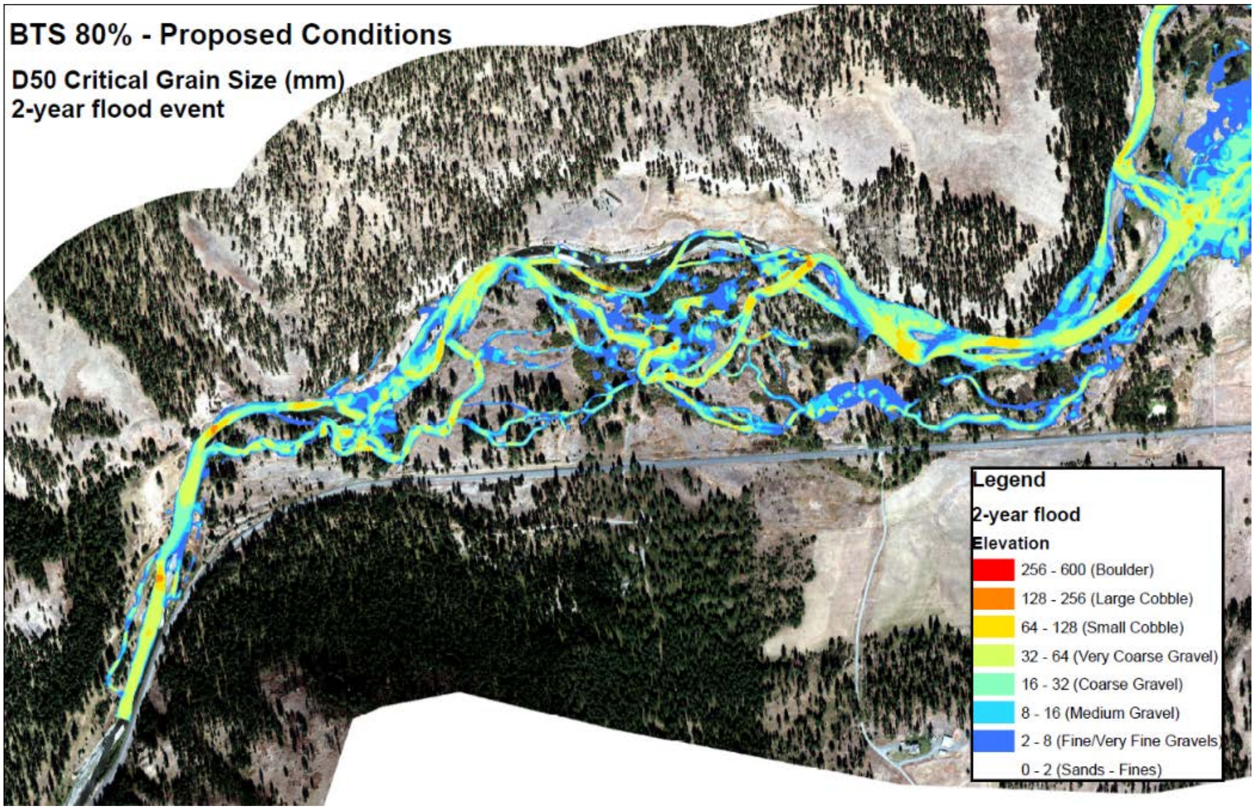

Figure 3-10. Modeled critical D50 at the 2-year event – proposed conditions.

3.3.9 Ice Processes Management

Consideration of ice process management has been prominent in the 80% design development. Additional empirical observations of processes on-site and in similar systems have been reviewed to design beneficial reduction in accumulation potential near the highway, increased floodplain access for ice storage, adequate ice flow paths, and flood water release opportunities through the side channel network. Time lapse photography at multiple stations within the project area facilitated mapping of a major ice jam in February 2017 (Figure 3-11) and understanding of the flood pattern, ice rafting upon its collapse. These perspectives were applied as part of optimizing the design of side channels, bank treatments and LWM structures; using iterative hydraulic modeling and geomorphic and engineering principles. We know that in the recent past, large jams and flooding has occurred near the upstream end of BTS and affected the highway, and our 2017 data documents a major jam in the middle of the reach. We cannot predict the exact location or extent of future jams, but our expansion of the channel network, decrease of channel width/depth ratio, and improved floodplain connectivity will all contribute to improved ice process management. We estimate that multiple areas will provide suitable ice storage areas, allow for ice movement, and offer water relief conveyance (Figures 3-12 and 3-13).

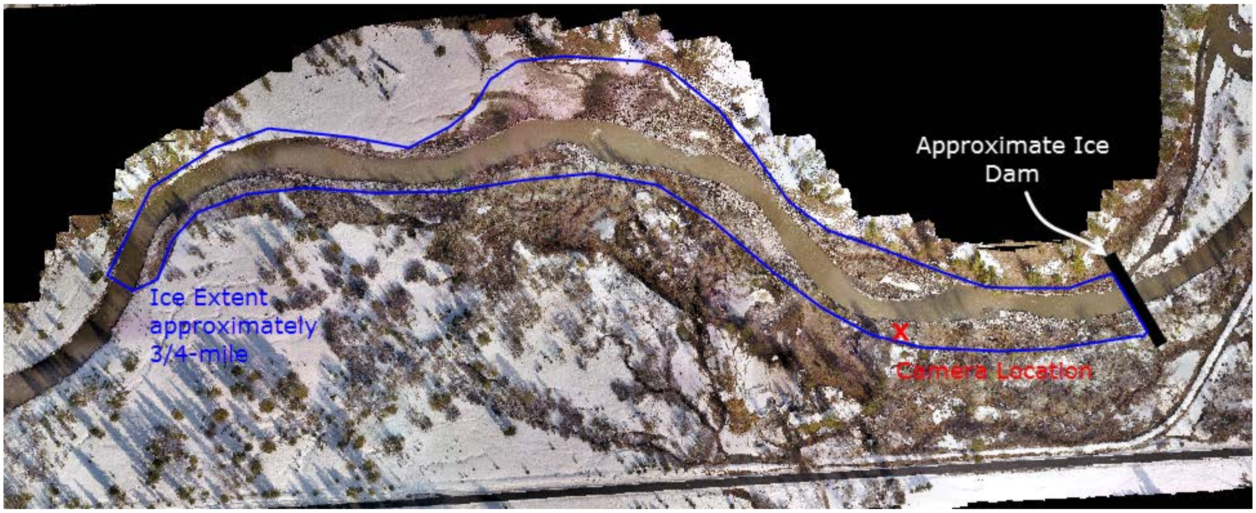

Figure 3-11. Location of the February 2017 ice jam within BTS.

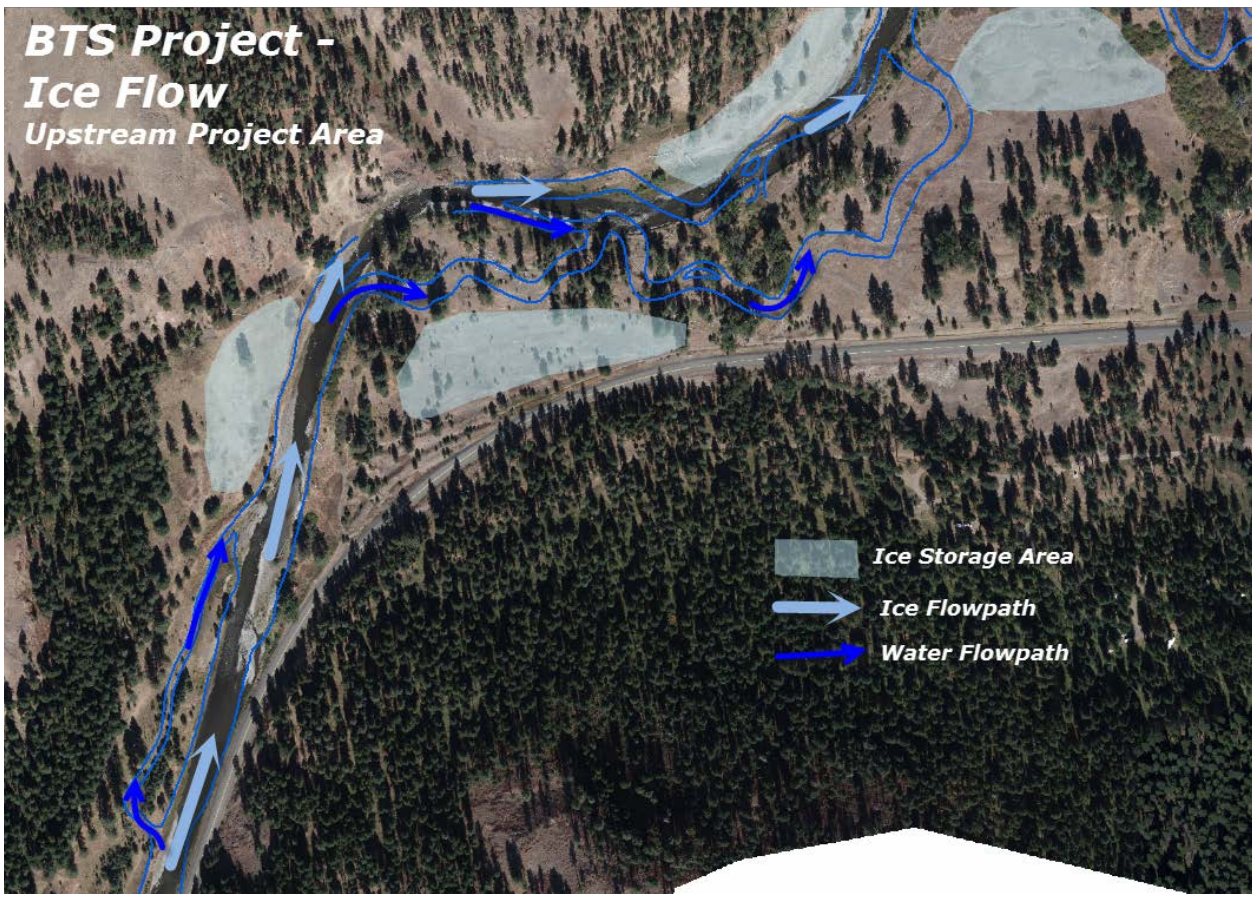

Figure 3-12. Ice process management under proposed conditions – upstream portion of BTS.

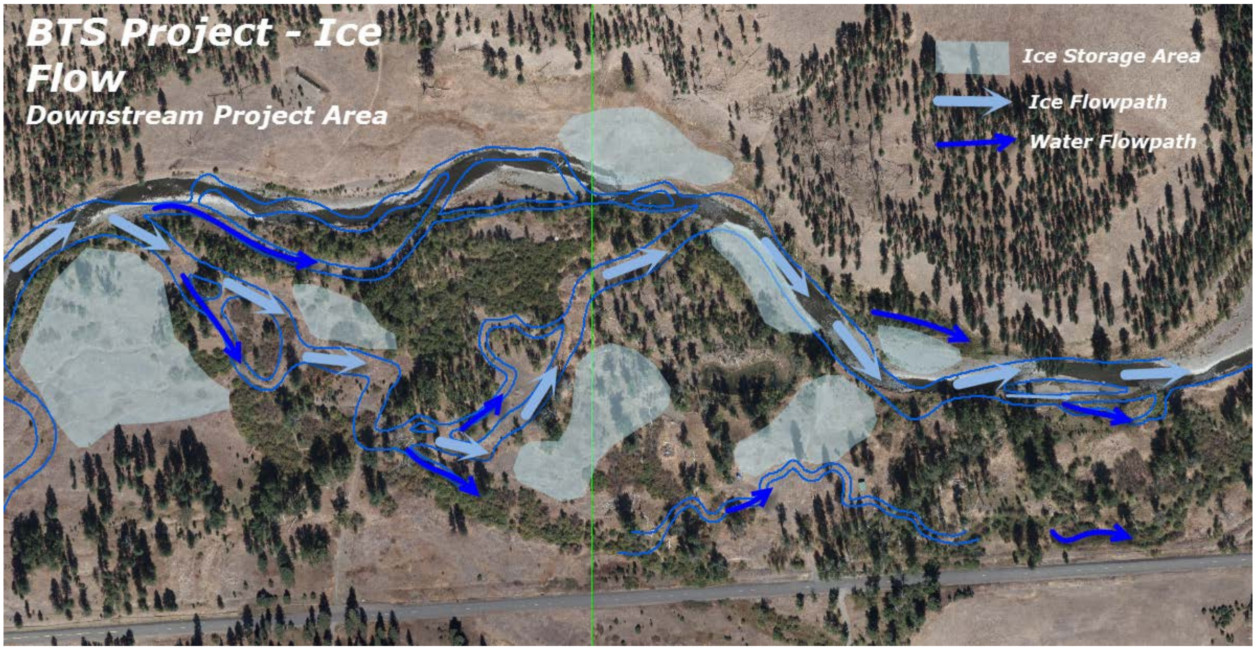

Figure 3-13. Ice process management under proposed conditions – downstream portion of BTS.

3.3.10 Revegetation

The revegetation plan has been developed in conjunction with Reclamation, CTUIR and USFS. Successful revegetation of the reconstructed floodplain will prioritize stability of newly constructed waterways and floodplain surfaces, maximize the benefits to salmonid habitat, and maintain and improve the aesthetic value of the site. Revegetation within the project area will be planned and implemented with an emphasis on protection of existing native vegetation, particularly specimen trees, the salvage and reuse of existing native vegetation, and successful plantings and natural regeneration of regionally specific woody and herbaceous riparian species along the channels, in microhabitats of the reactivated floodplain, as well as on the terrace and disturbed upland fringe. Based on monitoring of similar projects implemented in this region, initial recovery of the project area is expected to happen rapidly with extensive vegetation filling-in within 5- to 10-years. Mature trees will understandably take longer, but greatly improved hydrology and sediment sorting would create improved conditions for riparian and wetland vegetation.

Plant community enhancement is integrated within several design elements, particularly the living elements within the LWM structures and bank treatments. The revegetation efforts also specifically address the constructed and modified floodplain surfaces as well as all other disturbed areas. While immediate and short-term stabilization are guiding requirements, long-term improvements in plant community structure, diversity, vigor, and self-sustainability are key considerations. This will be accomplished through implementing a revegetation plan that details: pre-construction planning to maximize salvage and preservation of desirable vegetative species, immediate harvest and redistribution of desirable woody and herbaceous vegetative species; live cutting and/or propagation of cuttings for future planting; purchase and planting, and reseeding.

Salvage of existing woody vegetation will be completed during the active construction phase. Harvest and redistribution of native species into adjacent areas will take place immediately following initial disturbance. Locations where salvaged, rooted plants are a priority for replanting will be identified on the planting plan. Live cuttings and seeds will be collected from native species within the Grand Ronde or adjacent drainages and stored, propagated, and/or container grown in a nursery to maximize rates of survival.

Nursery activities for the project were initiated by CTUIR and the USFS in 2017 to produce one gallon container stock for a range of the desired native shrub and tree species. Plantings of live cuts, propagated plants, containerized or purchased woody vegetation will be planted after ground disturbing activities are completed or planted in phases as construction activities dictate. Live cuts, propagated or containerized plants and seedlings will be planted in early spring before breaking dormancy, or in fall between September 15 and before November 1.

The 80% design includes an overall restoration and revegetation plan and related summary of the planting zones treatment types, methods and target plant communities (Appendix A, sheets 139–140). Revegetation that is integrated in the large wood structures and bank treatments is specified in the details and plan view on the habitat sheets, along with special areas of floodplain areas.

3.3.10.1 Revegetation Approach

The approach for revegetation of the BTS project includes an overarching priority to maximize protection of existing mature riparian forest stands and individual large trees, as well as some other areas of young mature riparian vegetation that can readily be preserved within the desired topographic and geomorphic pattern. This approach minimizes disturbance and impacts to wildlife habitat while maximizing initial and long-term benefits in terms of plant community structural diversity and providing intact vegetation along channels and off channel aquatic habitat. It is believed that young black cottonwood, willow, and alder in particular will be prolific in this project reach and will recruit naturally on exposed bar features; particularly given the improved sediment sorting and overbanking processes.

The revegetation plan specifies treatment associated with all areas altered by construction activities. A range of vegetation management actions will be taken, including:

> avoid and protect (i.e., active channel bars; sensitive wetlands; specimen trees),

> active revegetation (i.e., soil modifications and/or planting methods),

> adaptive revegetation (i.e., soil modifications, monitoring and as-needed plantings),

> plantings protection (from ungulate and beaver browse),

> undesirables/weed control actions, and

> monitoring and adaptive management.

3.3.10.2 Revegetation Design

Each area was delineated based on its anticipated geomorphic surface/inundation frequency, target plant community, and type and severity of construction disturbance to existing soils and vegetation. Revegetation design has been prepared using iterative review of the design data in GIS/CAD formats by the geomorphologists and riparian ecologists to identify zones within the project area expected to have similar surface hydrology inundation regimes and geomorphic characteristics upon completion of the project. These comprise the anticipated treatment zones (Table 3-13) that will support the natural plant communities.

Table 3-13 Revegetation Treatment Zones

ID	Treatment Zone	Description
1	Channel and off-channel open water	Perennial or seasonal water, within channel or in deeper isolated off-channel ponds.
2	Main and Side Channel Banks	Channel margins along toe of banks, and channel bank faces up to top-of-bank.
3	Active Floodplain	Area inundated between the Bankfull flow and the 2-year peak; including some areas of floodplain swales that may

Table 3-13 Revegetation Treatment Zones

ID	Treatment Zone	Description
		be inundated more often.
4	High Floodplain	Area inundated between the 2-year and 10-year peaks; including some inclusions that may be week more or less often.
5	Upland	Area outside of the 100-year floodplain and some isolated areas of existing terraces that are between the 10-year and 100-year inundation boundaries.

The type and magnitude of construction disturbance (e.g., clearing, grading, compaction, excavation of in-situ soils, placed fill) along with the proposed topographic configuration, expected soils/sediment composition, and level of geomorphic dynamics produce variation in area types that dictate various revegetation actions necessary within each zone (Table 3-14).

Table 3-14 Soil and Vegetation Conditions and Construction Disturbance Types

ID	Area Type	Description
A	Barren	Existing un-vegetated locations: including alluvium within the active channel or alluvial/colluvial soils and sediments on the floodplain, terraces or side slopes.
B	Existing soil with intact vegetation	Existing vegetated locations that would not experience clearing or grubbing; could be subject to minor grading (<0.5 ft cut or <1.0 ft fill).
C	Existing soil with vegetation removal	Existing vegetated locations that would be cleared and/or grubbed out; could be subject to minor grading (<0.5 ft cut or <1.0 ft fill).
D	Cut surface with intact soils	Existing vegetated locations that would be cleared, grubbed, and subject to excavation > 0.5 ft of cut.
E	Constructed surface of fill	Proposed surface that would be constructed of placed fill material > 1 ft thick, at a gentle overall surface slope of < ~2 %.
F	Constructed slope/fan of fill	Proposed surface that would be constructed of placed fill material > 1 ft thick, at a moderate overall surface slope > 2 %.

The anticipated conditions by zone (Table 3-13) and the soil and vegetation conditions/disturbances (Table 3-14) are assessed together in assigning the target plant communities (Table 3-15). Additional considerations include anticipated ice processes, roadside buffer restrictions and/or preferential public access or restrictions. Specifics of the necessary soils preparations (if any), level of action, and planting methods and materials will be provided on large scale sheets in the 95% design.

Table 3-15 Target Plant Communities

ID	Target Plant Communities[1]
i	Barren (active channel and bars)
ii	Wet Graminoid Herbaceous (with standing water)
iii	Moist Graminoid Herbaceous (without standing water)
iv	Wet-Moist Graminoid Meadow Complex
v	Open Tall Willow
vi	Willow Gravel Bar Shrubland
vii	Alder Floodplain Shrubland
viii	Black Cottonwood/Willow Floodplain
ix	Open Black Cottonwood Forest
x	Black Hawthorne Shrubland
xi	Ponderosa Pine Forest/Woodland
xii	Dry Graminoid Meadow
xiii	Unvegetated (open water or developed surfaces)

[1] Target plant communities consistent with Wells et al (2015)

4 Risk Assessment

A preliminary LWD risk analysis following Reclamation's Risk-Based Design Guidelines (RBDG; Knutson and Fealko 2014) was prepared at the 30% design phase. This preliminary risk assessment was used by the design team to identify design, engineering, and stability requirements for proposed LWM structures. As part of the 80% design, the risk assessment was updated to include additional user groups, as described under Public Safety Risks. The risk analysis focuses on overall risk classification of the project and structure types, which helps set stability targets and safety factors for the design. Risk matrix outcomes (Chapter 5, Table 1) dictate design requirements. The below sections discuss public safety and property damage risks associated with the proposed design, as well as recommendations to mitigate the identified hazards.

4.1 Public Safety Risks

4.1.1 User Groups

American Whitewater currently rates the Red Bridge to Hilgard Reach as a class II whitewater reach, which indicates some potential usage and some degree of difficulty. Their website contains a note of concern for potential floaters within this reach regarding the downstream La Grande Rifle Club stating: "HAZARDS: Rifle range 4.2 miles below put-in (make your presence known!!)" The international scale of difficulty definition for class II whitewater is as follows:

> *Straightforward rapids with wide, clear channels which are evident without scouting. Occasional maneuvering may be required, but rocks and medium-sized waves are easily avoided by trained paddlers. Swimmers are seldom injured and group assistance, while helpful, is seldom needed. Rapids that are at the upper end of this difficulty range are designated Class II+.*

During project formulation and design, several tools were utilized to determine recreational use within the project reach. A recreation survey was conducted in August 2016 (see 30% BDR). Several game cameras were installed throughout the project reach in December 2015. Cameras were positioned at vantage points to view large areas and set to record every 15-minutes. Cameras recorded for 2-years between 2015 and 2017 and include peak recreational use periods during the summers of 2016 and 2017. Photos were downloaded and stitched together for ease of viewing. Review of photographs led to greater insight into recreational use and varied user types. In addition to the survey and cameras, the project team has been collecting field data while developing the project over this same period (2015–2017), including numerous field trips by the project team to the site. Throughout these field trips, patterns of recreation have been observed by project team members. The most common type of recreational usage observed in the project area has been hiking and bird-watching. Other infrequent uses include fishing from banks and floating in inner tubes. The major access points were observed to:

- BTS Interpretive Trail/Campground
- North Side USFS Lands – unimproved roads and non-designated camping
- Red-Bridge State Park

Based on the data described above three user types were identified (Table 4-1) for rating public safety for recreational use, within the project area. User groups include; Dispersed Campers/Tubers, Boaters/Paddlers, and Adventurous River Users. Each user group utilizes the river at differing times, differing flows, with differing frequency of use, and has varying skill sets and preparedness.

Table 4-1 User Group Comparison

Criteria	User Group 1	User Group 2	User Group 3
Group Descriptor	Dispersed Campers/Tubers	Boaters/Paddlers	Adventurous River Users
Frequency of Use	Often	Occasional	Rare
Time of Year	Summer, Warm/Hot Weather	Spring-Summer	Spring
Children	Probable	Possible	Unlikely
Skill Level	Minimal	Beginner/Intermediate	Intermediate/High
Information Sources	None/Visual/ Conversational	Trained Observation/Online Data Review	Trained Observation/Online Data Review
PFD	None	Likely	Assumed
Flow Range	10–40 cfs	40–400 cfs	400–1,368 cfs
Design Flow for Analysis	Low Flow (18 cfs)	Median March Flow (400 cfs)	Bankfull Flow (1,368 cfs)
Alcohol	Assumed	Possible	Unlikely
Data Source	Observation/Interviews/ Game Cameras	Observation/Interviews/ Game Cameras	Interviews/Project Sponsor

4.2 Property Damage

4.2.1 Impacts to Downstream Land Owners

Landowner comments received on the 30% design indicated that “There is no discussion of the probability of severe impacts to downstream land owners as a direct result of this project which will be highly likely to occur during Spring conditions when the rivers and streams more often than not flood the lower flood plains already.”

A detailed response to the NEPA assessment is provided in Appendix J In brief, in its current state the river exhibits static, simplified conditions in the proposed upstream project area and dynamic unstable conditions immediately downstream of the proposed project near and within Bear Creek Ranch (BCR). Sediments, trees, and ice are transported through the entrenched, high conveyance and armored Grande Ronde River channel through the proposed project area under existing conditions. Changes to the channel network, smaller channels and routing of flows, sediment and ice onto various areas of the floodplain within the project reach will minimize the potential for net worsening of natural processes on delivery of materials downstream. Modeling results show that this complex system would alter current conditions and provide numerous opportunities for deposition and capture of sediments, mobile wood, and ice upstream of BCR. It is anticipated that initially, the project area could capture the majority of bedload sediments and large mobile wood entering upstream until an equilibrium is reached which would take several years dependent upon hydrology. Conversely, elements of the constructed features add new local wood and sediment materials that may become available for transport downstream.

The proposed project is designed to have immediate and short term stability (i.e., approximately 10–15 years) utilizing numerous engineered large woody material structures and bank treatment features to provide initial horizontal channel and bank stability. Additionally, the constructed riffles of specific gradation using local river rock sources will provide vertical channel stability for normal flows. These initial stabilizing elements are important to project success and are planned to be constructed of local, natural materials, and will be engineered to have stability similar to the existing and natural channel during flood events.

4.2.2 Property/Project Characteristics

During a major ice event in 2017, a large ice blockage was observed in the project area. The next day, the same ice had traveled to the nearest downstream bridge, 6 miles below the project area, at the interchange of the Hilgard Highway and I-84. Based on observations the 2017 event, the project design team chose to review and update the Property/Project Characteristics Ratings to reflect the likelihood of wood placed as part of this project, traveling downstream having an impact on in-channel structures. Table 4-2 shows the updated Property/Project Characteristics Ratings.

Table 4-2 Property/Project Characteristics Ratings

Factor	Rating
In-Channel Structures	3
Floodplain Structures	5
Land Use	4
Average Score	4.0

4.3 Overall Risk Summary and Recommendations

4.3.1 LWM Risk Summary

The BTS project received both a “Low” and a “High” Public Safety Risk Rating and a “Moderate” Property Damage Risk Rating. Using the Low:Moderate and High:Moderate ratings, LWM structures for this project will be designed for 25-year or 50-year flow event. In addition, with the High:Moderate ranking a 2D hydraulic model is required. The design team has met or exceeded the requirements for both the Low:Moderate and High:Moderate ratings.

4.3.2 Discussion of Proposed Conditions and Changes to Hazards

The proposed project will dramatically change the existing river corridor within the 1.9-mile project reach.

Floating this section of the Grande Ronde River during moderate to high flows would not be recommended due to hazards posed by improvements to the river’s natural dynamic behavior. The proposed project intends to alter the river corridor from a relatively static condition to a more dynamic condition. It is anticipated that this will create uncertain conditions from season to season that may include fluctuations in main channel location, bar formation, trees falling in the river from within the project site, log capture from upstream sources, and channel-spanning log-jams. For these reasons, this reach of the Grande Ronde will likely present new hazards to floaters within this reach that they are not currently accustomed to, as the river corridor within this area had been in a degraded, simplified state for so many decades.

The proposed project will present new hazards and may also present conditions that attract increased recreational swimming during low flows. Log jams will be numerous and likely dynamic through processes previously described. Log jams can be an attractive feature for children to explore. Improvements to pools to include number and size are intended, which may attract increased swimming possibilities within the project site. Most pools within the proposed project will be formed by channel forcing through large wood features and will therefore likely include hazards of wood. During the very low flow period in the summer months (highest use period), recreational floating and swimming is likely to occur, the proposed project will contain new hazards for this user group.

4.3.3 Recommendations

The proposed project intends to dramatically alter the existing Grande Ronde River landscape within the 1.9-mile project reach. The Grande Ronde River has been dramatically altered from historic conditions for as long as current inhabitants of this region can likely remember. The river corridor has been simplified, such that it is a single thread that is wide and shallow. Hazards to recreational floating exist, but are not as prevalent or dynamic as what was likely a historically dynamic river with multiple channels and logjams. The proposed project intends to restore historic conditions to the project reach, which will be a dramatic change to the river corridor. Local residents and potential recreationalists may not be accustomed to this and need information to make informed decisions on recreation within this area. It is therefore recommended that the project sponsor and the land manager (USFS) develop a recreational communication plan with stakeholders and potential recreational groups. Communication tools to consider may include signage at known access points, multi-media postings, newspaper postings, and public meetings or outreach.

5 Cost Estimate

5.1 Quantities

Below are updated quantities based on the 80% design.

5.1.1 Large Woody Material

The installation of LWM is proposed as a key element of the design. The design proposes 20 different LWM structure types, located as shown in the 80% design. Each structure type calls for a specific number of logs meeting certain length and diameter criteria. LWM can be found in the plan set on sheets 82-107, located in appendix A. The total number of each type of LWM structure was summed (Table 5-1), and the individual wood piece numbers and sizes for each respective structure type were calculated to arrive at the total number of each size of wood piece (Table 5-2). Boulder quantities required for LWM structure construction have also been included in Table 5-2.

Table 5-1 LWM Structure Quantities

Structure Type	Number of Structures
Type A1 - Apex Jam	24
Type B1 - Meander Jam - Upstream Component	7
Type B2 - Meander Jam - Middle Bend Component	5
Type B3 - Meander Jam - Downstream Component	16
Type B4 - Meander Jam - Mallet Jam	8
Type C1 - Longitudinal Channel Margin Jam	33
Type C2 - Angled Channel Margin Jam	49
Type D1 - Deflector Jam (Small)	14
Type D2 - Deflector Jam (Large)	3
Type E - Single Log Sweeper Jam	37
Type E - Double Log Sweeper Jam	21
Type F - Floodplain Roughness	279
Type G1 - SC Habitat - Single Log	22
Type G2 - SC Habitat - Double Log	17
Type G3 - SC Habitat - Triple Log	28
Type G4 - SC Sill Log Complex	1
Type H - Cover Logs	89
Type I1 - Ice Crib Jam (Small)	3
Type I2 - Ice Crib Jam (Large)	1
Type J - Reinforced Habitat Structure	14

Table 5-2 Wood Quantities

Wood Size Class	Key Member	Medium Log	Racking Logs	Pinning Logs	Tree Tops & Branches	Large Boulders
Diameter (in)	**(18”+)**	**(12”–18”)**	**(6”-12”)**	**(12”)**	**(1”-6”)**	**(>24”)**
Quantity	742	697	2015	1931	3600	308

5.1.2 Earthwork Volumes

Rough earthwork volumes have been calculated using a comparison between the existing and proposed 3D-surface model generated as part of the 80% design (Table 5-3). This provides an estimate of cut and fill in cubic yards, as well as the net remainder of soil, but does not include any quantity associated with over excavation for channel design features, or effects of shrink/swell. It is useful in developing cost as well as general project effort. Year 1 and Year 2 Cut and Fill are shown on pages 76 and 77 of the plan set with “cut” represented in red, whereas “fill” is represented in green.

Table 5-3 Earthwork Volumes

Earthwork Category	Cut	Fill	Net
Units	**Cubic Yards**	**Cubic Yards**	**Cubic Yards**
Design Volumes	85,146	68,385	16,761 (excess Cut)

5.1.3 Riprap Quantities

Table 5-4 Earthwork Volumes

ODOT Rip Rap Class	Cubic Yards
Class 200 Rip Rap	1,865
Class 700 Rip Rap	425

5.2 Bid Sheet Development

A Bid Item List based on the 80% design is included as Appendix B of this report.

6 Environmental Compliance and Permitting

A review of ongoing environmental compliance and permitting efforts associated with the BTS project is provided below. At this stage in the design process tasks are not yet complete, the next iteration on the BDR will provide additional information and concurrences, where applicable.

6.1 National Environmental Policy Act (NEPA) Compliance

USFS prepared an Environmental Assessment (EA) for the BTS Project, including the non-commercial wood source areas. The Draft EA[1] was published September 2017. Comments were received and responses published October 2017. The objection period closed in early-December and assuming no objections are received USFS will issue a Record of Decision (ROD). BPA is preparing a tiered ROD to cover the proposed action under the Fish and Wildlife Implementation Plan Final Environmental Impact Statement (FWIP EIS). Additional consultation and compliances that will be required prior to issuance of USFS and BPA's decision include:

> Cultural Resources, Section 106

> Endangered Species Act, Section 7

6.2 Cultural Resources, Section 106 Consultation

The Bureau of Reclamation and BPA initiated consultation in compliance with section 106 of the National Historic Preservation Act with the Oregon State Historic Preservation Office (SHPO) in July 2015. The Bonneville Power Administration updated the area of potential effects for the project in August 2016. Oregon SHPO agreed with the delineation of the area of potential effects in September 2016. This project will be reviewed and approved by SHPO. Concurrence is expected to be received Spring 2018.

6.3 Endangered Species Act, Section 7 Consultation

Consultation with National Marine Fisheries Service (NMFS) and US Fish and Wildlife Service (USFWS) for threatened and endangered species will be completed for this project through the BPA HIP III programmatic agreement.

The BPA initiated programmatic consultation with the United States National Marine Fisheries Service (NOAA Fisheries), and the USFWS to comply with the requirements of the ESA and the Magnuson-Stevens Fishery Conservation Act. The original consultation resulted in a BiOp from NOAA Fisheries (reference number 2003/00750) on August 1, 2003. After the relisting of critical habitat for ESA-listed salmon and steelhead, consultation was initiated anew and concluded on (reference number 2007/03996) January 10, 2008. This consultation was initiated due to the expiration of the 2008 BiOp at the end of calendar year 2012.

This consultation now includes green sturgeon, eulachon, bull trout, Oregon chub, and their critical habitats. The action area for this consultation is the Columbia River Basin within the contiguous United States that is also within the range of ESA-listed fish and their designated critical habitats, as well as within the range of essential fish habitat (EFH) for many species. BPA funds habitat improvement activities to fulfill its obligations under the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Public Law 96-501), and in response to the requirements of various BiOps, including the 2008 BiOp on the Operation of the FCRPS (NOAA Fisheries 2008). Although the FCRPS 2008 BiOp is

[1] https://www.fs.usda.gov/project/?project=47283.

currently in litigation and on remand to the U.S. District Court of Oregon, BPA and the other Action Agencies, United States Army Corps of Engineers and Reclamation are continuing to implement the habitat improvement actions described in that BiOp.

It is BPA's determination that the HIP III proposed action is likely to adversely affect anadromous salmon and steelhead, and freshwater fish. Based on BPA's determinations under the HIP III biological assessment, the BTS Project is likely to adversely affect the following that are present in the Grande Ronde watershed:

> Spring Chinook (*O. tshawytscha)* and Critical Habitat

> Steelhead (*O. mykiss*) and Critical Habitat

> Bull trout (*Salvelinus confluentus*) and Critical Habitat

This project will have short-term construction related effects but will greatly benefit the listed species in the long-term.

The BTS Project under this HIP III biological assessment and opinion is considered a high risk activity in the River, Stream, Floodplain and Wetland Restoration category, and more specifically the Channel Reconstruction subcategory. High risk projects in the Channel Reconstruction activity subcategory will require a review by the Restoration Review Team (RRT), and a NOAA Fisheries Hydro Division review. The review process will follow the Channel Reconstruction activity Guidelines for Review contained in the HIP III biological assessment and opinion.

6.4 State and Federal Permits

With the completion of the 80% design drawings a BTS permit applications will be prepared for the USACE CWA Section 404, Oregon Department of State Lands (DSL) Removal-Fill, and Oregon Department of Transportation (ODOT) permits will be prepared. For CWA Section 404, it is assumed that the project will be covered under Nationwide Permit #27, Aquatic Habitat Restoration, and the CWA Section 401 Water Quality Certification will be issued as part of the 404 permit package. A wetland delineation has been prepared conversations are ongoing between the project proponent, DSL, and USFS to determine the appropriate permit pathway.

7 Construction Approach

Developed at 80%, refer to plan set pages 113 to 138.

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8 Implementation Schedule

To be included at Final 95%.

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9 Monitoring, Maintenance, and Adaptive Management

9.1 Time-Bound Objectives

The following project objectives will be monitored continuously for up to 10 years to determine if the project goals and objectives have been met (Section 1.2).

> Improve channel-floodplain connectivity (Groundwater Wells)

> Improve altered thermal regime

> Maintain Fish Passage (Annually and at high and low flows)

Monitoring techniques, metrics, and acceptable ranges can be found in Appendix H, Monitoring and Adaptive Management Plan.

9.2 Implementation (Compliance) Monitoring

Implementation monitoring will be the responsibility of the Sponsor or their representative. An observer should be present during construction to ensure that all BPA conservation measures are in effect, that construction activities comply with environmental permit(s), and that the project is constructed per specification requirements.

The Sponsor will be responsible for completing a “HIP III Programmatic – Consultation Project Completion Form” within 60 days of completing a project covered under the HIP III programmatic biological opinion. BPA staff will review and submit the completed form with the following information to the project sponsor and to NOAA Fisheries at hip.nwr@noaa.gov.

The Sponsor will be responsible for reporting fish capture information to BPA since this project involves work area isolation with associated fish capture and relocation. The report should provide a tally by species for each species impacted, if available. Refer to BPAs 2012 Habitat Improvement Program Biological Assessment (BPA 2012) for additional information.

9.3 Effectiveness Monitoring

Effective monitoring tests whether management actions have been effective in creating the management action at the project scale and validates that the management action or cumulative management actions resulted in the intended outcome. This monitoring maintains accountability for management decisions and provides the basis for adaptive management decisions and actions (NOAA Fisheries 2011b).

To test whether the management actions were effective in creating the “target conditions” that address ecological concerns for salmon at the channel segment-scale, an “as-built” drawing should be completed and submitted in the close-out report. “Threats due to curtailment or destruction of habitat or range” are listing factors for the ESA-listed fish in the Grande Ronde River watershed. These listing factors are considered a high priority for monitoring by NOAA Fisheries that are applicable to determining the viability of the ESA-listed species (NOAA Fisheries 2011b). Multiple key habitat attributes and metrics should be collected or evaluated to establish a “baseline condition” so that the status/trend of habitat conditions can be quantified. Measurable metrics that should be considered include, but are not limited to the following:

> Length of reconnected channel and area of wetted channel at baseflow

> Acres of reconnected active floodplain

> Static or intermittent disturbance regime

> Channel patterns and bedforms
> Number of instream wood placements and number of pieces used for floodplain loading
> Acres planted with riparian and/or upland vegetation
> Number or percent of species planted as riparian, upland or mixed vegetation

9.4 Status and Trend Monitoring

There is no status and trend monitoring sited within the BTS project boundary. However, this area represents a prime research opportunity, particularly as there are CHaMP sites within the vicinity of the project area.

CHaMP is a habitat status and trend monitoring program designed for implementation across the Columbia River Basin's salmon and steelhead populations. The program's primary objective is to assess the quantity and quality of stream habitat for salmonids in wadeable, perennial streams below natural impassible barriers within Technical Recovery Team population boundaries (Bouwes et al. 2011). There are currently no CHaMP sites within the BTS project area, however, there are two sites that occur nearby, one upstream, one downstream, that could serve as control sites for the BTS Project. Provided adequate funding and support, regional fisheries managers could implement CHaMP monitoring sites, or protocols adapted from CHaMP, to determine status and trends associated with restoration activities.

The monitoring protocols used by CHaMP were developed by the Integrated Status and Effectiveness Monitoring Program (ISEMP) funded by BPA that was specifically tasked with assessing and developing standardized monitoring protocols for fish and fish habitat in the Columbia River Basin (Bouwes et al. 2011). CHaMP monitoring protocols are fish-centric and measure the quantity and quality of, and changes in, stream habitat for salmonids of interest under the FCRPS BiOp.

CHaMP was also designed to help measure habitat responses to land management and stream restoration actions by evaluating the effectiveness of restoration, rehabilitation, and conservation actions across the basin (CHaMP 2013). The goal is to use stream habitat data generated by CHaMP which will be used in conjunction with salmonid growth, survival, abundance, and productivity to estimate fish-habitat relationships across the Columbia River Basin (Bouwes et al. 2011).

10 Implementation Funding

The funding sources for Project implementation will primarily come from CTUIR, BPA, and OWEB, which are briefly described in the following sections. Other implementation services for the Project are anticipated to be provided by Reclamation and the Wallowa-Whitman National Forest.

10.1 CTUIR

Several aspects of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), Department of Natural Resources, Fisheries Program, Grande Ronde Subbasin Restoration Project (Project 199608300) are funded through the CTUIR-BPA Accord with an annual average budget of approximately $790,000. Funding through this annual BPA contract provides: project administration; operations and maintenance; planning and design support; and, limited construction and monitoring / evaluation funding. BPA program funding is set annually through Pisces Statement of Work (SOW) and Budget. Budget and SOW planning is flexible and is tailored to annual needs. Funding can be applied to a variety of project-related activities including planning, design, development of subcontracting documents, construction contract solicitations, construction observation and inspection, planting, seeding, fencing, maintenance, and limited monitoring and evaluation.t

Additionally, CTUIR developed a limited term funding agreement with Reclamation that provides annual funding of approximately $170,000 per year. Funding is program for core staffing and allocated to project identification, development, and planning and design. Construction related activities are not funded through this source. This funding source and agreement expires in 2019.

10.2 BPA

CTUIR has secured two BPA funding agreements for construction of the BTS project through the Grande Ronde Model Watershed (GRMW). Funding is programmed for materials acquisition and project construction. Funding proposals were developed based on 30% designs. BPA provides versatility with project construction funds to meet project construction needs.

The BPA-CTUIR Construction Funding contracts include:

> Contract #73314, Project #199202601, Expires 8/31/2018, in the amount of $1,083,105.00. Includes plant and large wood material purchase/delivery to project site.

> Contract #73982, Project #199202601, Expires 12/31/2019, in the amount of $2,011,291.00. Includes plant and large wood material purchase/delivery to project site.

The USFS, Wallowa-Whitman National Forest, La Grande Ranger District has secured a BPA funding contract through the GRMW for purposes of purchasing and installing plant materials within the project area. Funds were also secured for obtaining and hauling LWM to the project site for construction. Funding agreement totals $272,591.

10.3 OWEB

CTUIR and GRMW have been awarded an Oregon Watershed Enhancement Board (OWEB) grant to provide construction funds in the amount of $507,752. The funding has been awarded to the Grande Ronde Foundation (a non-profit arm of the GRMW). A funding contract between CTUIR and the Grande Ronde Foundation will be required prior to CTUIR obligating a construction contract.

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