Túuši Wána Design Project

Touchet River - Mile 14 – 17

90% Level Basis of Design Report

November 2024

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90% Level Basis of Design Report

SUBMITTED TO

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1. Preface

The Túuši Wána Design Project (Project) area is located along the Touchet River in Walla Walla County, Washington (Figure 1). The project is located between approximately River Mile (RM) 14 to 17. The project is entirely on privately owned land. It is currently unknown if the Washington Department of Natural Resources (WADNR) will assert that the Touchet River, within the project extent, is part of the State-Owned Aquatic Lands (SOAL). Habitat conditions for juvenile and adult salmonids and the riparian processes which support the formation of aquatic habitats have been impaired within the project area by riparian clearing, channelization, and degraded watershed conditions. This report describes the 90% design package and is formatted to meet the Bonneville Power Administration (BPA) Habitat Improvement Program (HIP) General Project Data Summary Requirements (GPDSR) Basis of Design Report guidelines for the project.

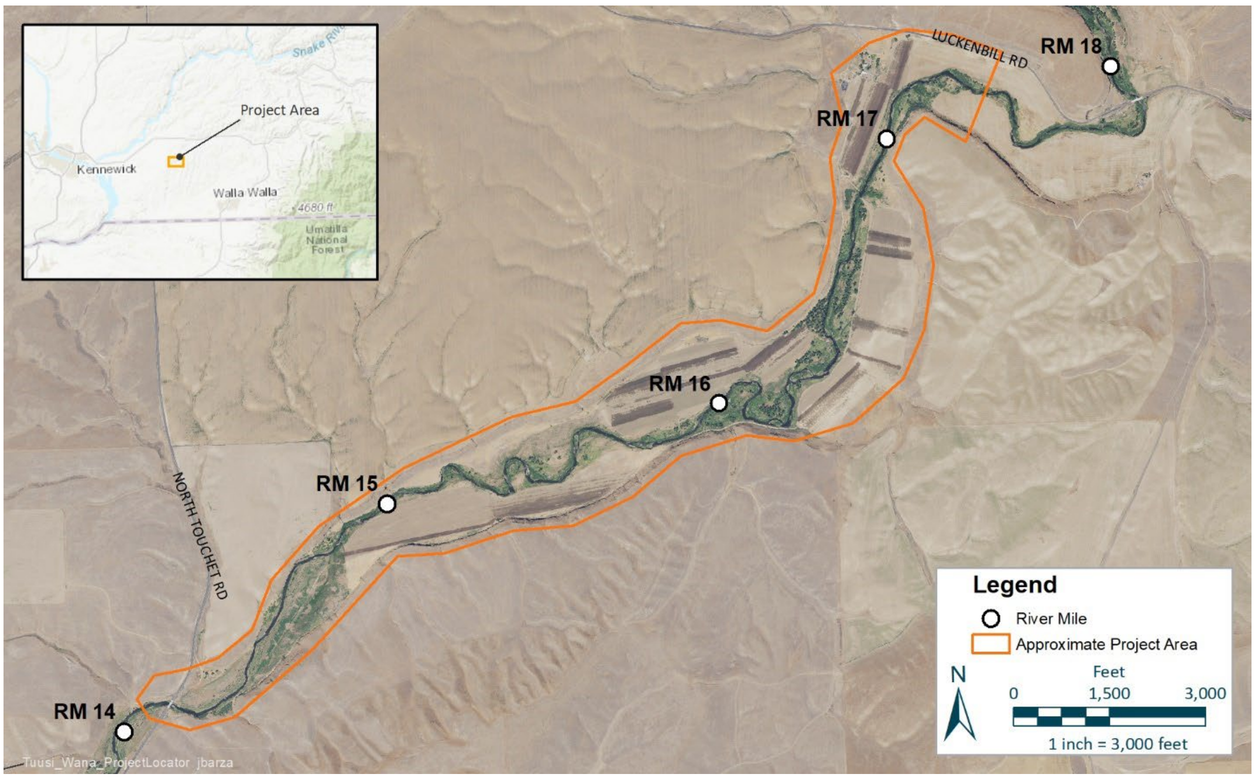


Figure 1: Túuši Wána Design project area.

This project is intended to improve aquatic habitat conditions of the project area so that the reach more closely resembles target conditions outlined in the Confederated Tribes of the Umatilla Indian Reservation's (CTUIR) River Vision (Jones et al. 2008). In line with CTUIR's River Vision, the project elements described here are intended to enhance and restore the processes needed to support aquatic First Foods. These processes include the following items: improving degraded hydrology, reclaiming geomorphic function, providing habitat connectivity, supporting a diverse riverine biotic community, and restoring riparian vegetation diversity and density (Jones et al. 2008). It is acknowledged that the restoration of watershed-scale processes that may influence reach-scale processes are outside the scope of this effort.

Driven by the River Vision, the goals of this project are focused on improving habitat for two key salmonid species. Additionally, the project aims to recover the biophysical processes and ecosystem services associated with a functioning river and riparian corridor. The initial project goals include the following items:

- Improve holding, overwintering, and migration refugia habitat throughout reach to support upstream migrating adult salmonids.
- Improve high flow refugia and rearing habitat for juvenile salmonids using lower reaches of Touchet River for rearing and/or outmigration.
- Recovery of more natural river valley geomorphic processes through the installation of a large quantity of large wood structures (LWS) intended to initiate and maintain hydraulic variability leading to a more complex channel planform (e.g., split flows) and depth variations (e.g., pools and bars) for mid-term timescales.
- Recovery of more natural riparian processes through the installation of a large quantity of live cuttings and other plantings intended to initiate and maintain an extensive and diverse forested valley bottom for long-term timescales.

Building from these initial goals, quantifiable project area specific goals, objectives, treatments details, and expected project performance/recovery timescales have been established by CTUIR as part of the project development and review process. Section 1.6 describes how the initial project goals stated above were evaluated and have evolved into new, quantifiable criteria upon which the project was designed, and how project design elements link to these criteria. Table 3 summarizes the connections between habitat limiting factors, quantifiable projects goals, and timeframes and actions for achieving those goals at the project site. Furthermore, additional details regarding the evolution of the project goals and design approach are included as Appendix 7.6 which describes the findings of an external expert technical review of the project. Figure 2 shows one of the many times over the course of the project that the project development team visited the site to discuss designs.

Figure 2: Photo looking down river near RM 16.1. | February 2024
Photo shows the tall right bank composed of fine sediments over a consistent layer of gravels.

Following the review of updated concepts for the Túuši Wána Design project, preliminary design and accompanying documentation was completed for the entire Tussi Wana project site (Inter-Fluve 2024a). These preliminary designs were advanced to the 60% design level (Inter-Fluve 2024b), and design updates between the preliminary and 60% design levels focused on maximizing habitat uplift associated with proposed restoration treatments, while incorporating multiple restoration treatment approaches and recognizing funding limitations for implementation. The restoration designs have been further developed to the 90% design level, and the primary difference between the 60% and 90% design plans is the expansion of wood loading throughout the entire project reach. The 90% design plans are included as Appendix 7.1, and the following report provides site context and details about the project planning process which informed these designs.

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

Restoration designs developed for this project are sponsored by The Confederated Tribes of the Umatilla Indian Reservation (CTUIR). Inter-Fluve has been hired as the engineering design firm. Jerry Middel (Rainwater Wildlife Area Project Lead and Upper Touchet Habitat Specialist, CTUIR), Emily Alcott, CE, PWS (Fluvial Geomorphologist/Ecologist; Inter-Fluve) and John Gaffney, PE (Water Resources Engineer; Inter-Fluve) are responsible for the design. Mike Brunfelt, LG (Fluvial Geomorphologist; Inter-Fluve), Mackenzie Butler, CE, FP-C (Fisheries Biologist; Inter-Fluve), and Christoph Suhr, GIT (Fluvial Geomorphologist; Inter-Fluve) have supported design development throughout the design process.

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

John Gaffney (PE, Washington State No. 51075) is the licensed engineer of record for this project. Table 1 summarizes project elements and includes the following with BPA HIP (BPA 2023) activity and risk categories.

Table 1: HIP Work Elements and activity Categories included in the project.

ID	**Work Element Name** *Project Action Summary* Category Name	Category	Risk Level
29	Increase Aquatic and/or Floodplain Complexity		
	Floodplain reveal excavations. Improve Secondary Channel and Floodplain Connectivity	2a	High
	Install large wood structures in the channel and across the revealed floodplain. Install Habitat-Forming Instream Structures (Large Wood, Small Wood, and Boulders)	2d	Med
30	Realign, Connect, and/or Create Channel		
	Channel signatures/scribes within the revealed floodplain. Improve Secondary Channel and Floodplain Connectivity	2a	High
33	Decommission Road/Relocate Road		
	Removal of farm access routes and fords within floodplain reveal extents. Road Decommissioning	5b	Low
47	Plant Vegetation		
	Planting of native riparian and emergent vegetation across the project area. Riparian vegetation planting	2e	Low
180	Enhance Floodplain/Remove, Modify, Breach Dike		
	Removal of fills, berms, and bridge approach fills. Set-back or Removal of Existing Berms, Dikes, and Levees	2b	High
181	Create, Restore, and/or Enhance Wetland		
	Lower channel signatures/scribes within the revealed floodplain are expected to become wetlands and will be planted accordingly. Riparian and Wetland Vegetation Planting	2e	Low
199	Remove Vegetation		
	Removal of non-native and invasive plants throughout the project reach, including via. floodplain reveal excavations. Manage Vegetation Using Physical Control	3a	Low

1.3 IDENTIFICATION AND DESCRIPTION OF RISK TO INFRASTRUCTURE OR EXISTING RESOURCES.

Existing infrastructure in the vicinity of the project area includes the Luckenbill Road Bridge 0.8 miles upstream of the project easement, the Touchet North Road Bridge 0.7 miles downstream of the project area, and overhead powerlines & utility poles in the floodplain. The most prominent infrastructure constraint within the project area are the large transmission lines which cross the valley in the center of the project area (near River Mile (RM.) 16.5). This feature includes transmission line towers on the valley bottom surface. No restoration actions are proposed in the vicinity of where the transmission lines cross the valley. Additionally, there are residential and agricultural buildings present within the project site, tilled and untilled agricultural fields on the floodplain, irrigation pump stations along the channel, and several rudimentary dirt roads used for farm operation and site access across the project area. Luckenbill Road crosses the valley at a relatively wide section of valley, the road prism does not extend substantially above the valley bottom surface, and field observations suggest the road has been overtopped in places (including during 2020 flooding which is estimated at 12,000 cfs at the site, approximately a 50-year flood, Figure 1) based on field observations of the site. The Touchet North Road valley crossing is well above the valley bottom surface. Valley bottom grading avoids the locations of the existing local powerline poles and pump stations so that existing pumps can be used for irrigation of the site during the plant establishment window as allowed by the Washington Department of Ecology (up to 5 years post project), and it is anticipated that the pumps and local powerline infrastructure may be removed once irrigation is no longer needed at the site. Site access via dirt roads will be modified to relocate access roads to the valley margins, and any stream crossings and/or roads in the center of the valley will be removed. Analysis of how design components may create a risk to infrastructure, or existing resources, includes comparisons of changes to water surface elevations and velocities between existing and proposed conditions. This analysis has included use of a two-dimensional hydraulic modeling to evaluate potential risks to these resources. Potential risk to infrastructure and the stability of LWS was evaluated relative to these risks (see Section 3.6 for additional discussion).

Figure 3: Photos of 2020 Flooding

Note inundation of large areas of the valley bottom (A), appearance of sediment laden water (B), and fine sediment deposition on the order of inches (C) visible as the flood water receded.

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

The Touchet River in the vicinity of the project area is used by threatened Mid-Columbia Steelhead Trout (*Oncorhynchus mykiss)* and Mid- Columbia Spring Chinook Salmon (*O. tshawytscha*). Columbia River Bull Trout (*Salvelinus confluentus*) are present in the headwaters of the basin, and are known to overwinter in mainstream reaches, but Bull Trout are not anticipated to regularly inhabit the project area. Little empirical data is available on fish use of the Touchet River within the project area; it is assumed to be primarily a migration corridor for adults migrating upstream to spawning areas and for juveniles migrating downstream to the ocean. Resident fish, including native Redband and Rainbow trout, as well as non-native Smallmouth and Largemouth bass, are also assumed to use the project area throughout the entire year. Timing of life stage use by species for the larger Touchet River basin is discussed in subsequent subsections and an overview of Touchet basin life stage use timing for species of interest is presented in Figure 4. Of note, for discussions below, emergence timing refers to fry emergence from gravel and not alevin hatching (Quinn 2005, Moyle et al. 2002, Moyle et al. 2002b). Additionally, the limited data pertaining to salmonid presence and use by life stage within the project area and associated discussion is included in subsection 4.1.3 and salmonid habitat limiting factors are presented in subsection 4.1.4. The timing and type of use by each of these species informs both the type of project elements proposed and dictates the frequency and duration of project element connectivity.

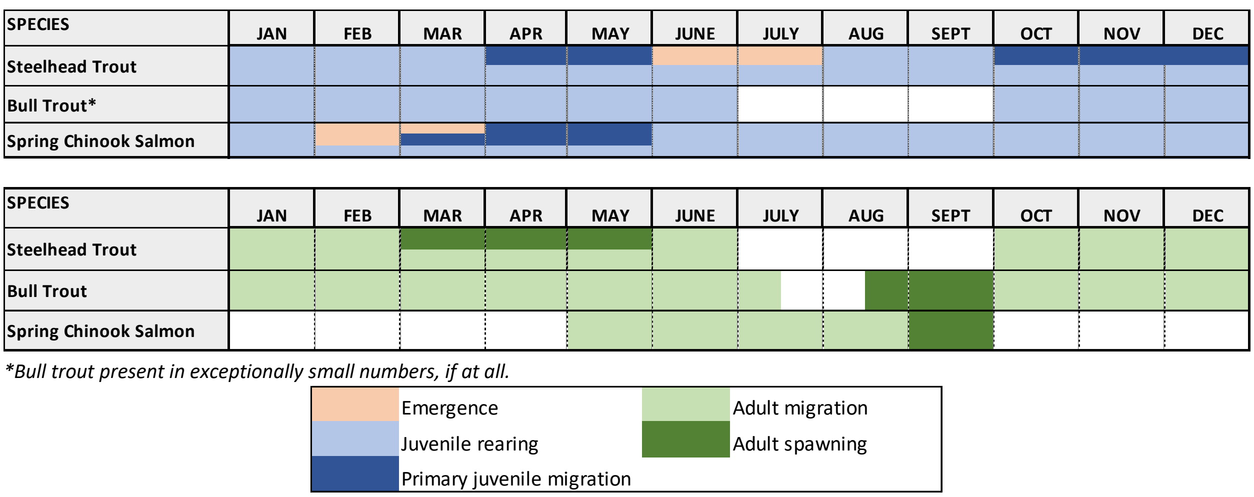


Figure 4: ESA listed fish use timing in the project area. From CTUIR 2014 and Steve Martin, personal communication.

1.4.1 Touchet Basin Steelhead

Adult Steelhead may start to move into the Touchet watershed as early as September if flows and water temperatures are sufficient and migration typically continues through June. Adult Steelhead may also hold in the Columbia and lower Walla Walla Rivers in the fall, migrating up into the tributaries near spawning areas in January. Peak upriver migration, when Steelhead would be passing through the project area, typically occurs in March and April right before spawning (Figure 5). Spawning and juvenile rearing occur mostly in the upper portions of the watershed above the project area. Upstream of the project area, the majority of Steelhead fry emerge between June and July, right as the hydrograph typically drops to near base flow and water temperatures rise (Moyle et al. 2002, Quinn 2005). Age-0 juveniles spend their first year primarily in shallow riffle habitats, feeding on invertebrates and using overhanging riparian vegetation and undercut banks for cover (Moyle et al. 2002, USFWS 1995). Older juveniles prefer faster moving water including deep pools and runs (USFWS 1995). Juvenile outmigration is bimodal, with fall outmigration of small (likely Age-0) juveniles in October – December and spring outmigration of transitional and smolt-sized fish in April and May (CTUIR 2014). Juveniles out-migrating in the fall may be leaving the drainage or looking for rearing/overwintering areas in the lower Touchet or Walla Walla Rivers. Juveniles out-migrate between ages zero and three, though some may hold over and display a resident life history form in reaches upstream of the project area (Mendel et al. 2014).

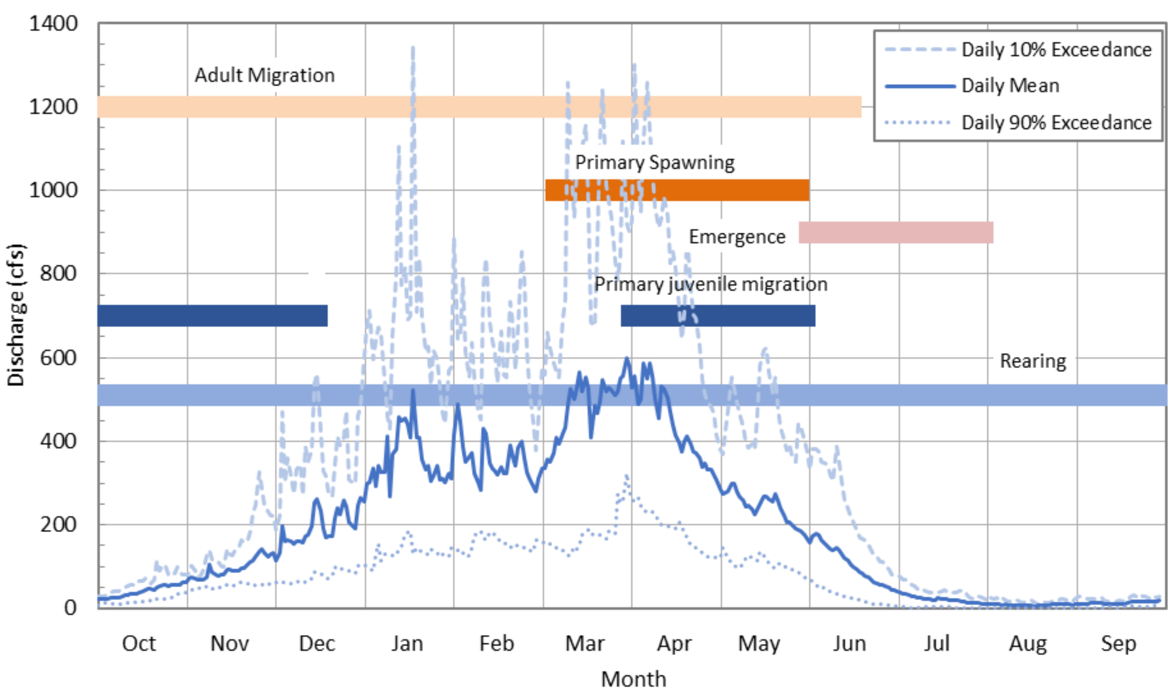


Figure 5: Steelhead (Oncorhynchus mykiss) life history timing in the Touchet River and Walla Walla River watersheds overlaid on discharge in the Túuši Wána project area.

Discharge data is adjusted from the WADOE Cummins Rd gage (~RM 3, period of record Water Year 2003-2021) using a direct basin area correction. Fish use timing is approximate and reflects typical life history stages (WDFW 2014, Steve Martin 2016) for fish using the Touchet River. Upstream adult and downstream juvenile migration are the primary life history stages assumed to be present in the Túuši Wána project area.

1.4.2 Touchet Basin Spring Chinook

Native spring Chinook were considered extirpated from the greater Walla Walla River subbasin in the mid-20th century, but recent reintroduction efforts have re-established a naturally spawning population (CTUIR 2014). Spring Chinook return to the Touchet River between April and July, with peak migration likely occurring through the project area between Marh and May, though some late-returning fish may be delayed due to high water temperatures and finish their final upstream migration through the Touchet in September as temperatures drop (Figure 6). Peak return coincides with a strong decline in the hydrograph and a simultaneous increase in water temperatures, forcing Chinook to migrate further upstream to avoid stranding and/or potentially lethal temperatures, particularly in drought years (Mendel et al. 2014). Most of the spawning occurs in September upstream of the project area, with fry emerging in February and March. Emergence coincides with the rising hydrograph, forcing juveniles to seek out backwater or margin areas with lower velocities, dense cover, and abundant food (Quinn 2005). As they increase in size, juveniles begin to select for deeper and faster moving water, particularly areas with overhanging cover (Moyle et al 2002b). These areas provide more holding and feeding habitat areas for the larger juveniles to occupy. Mid-Columbia spring Chinook express a stream-type life history, meaning they rear in freshwater for at least one year before out-migrating in the spring as yearlings.

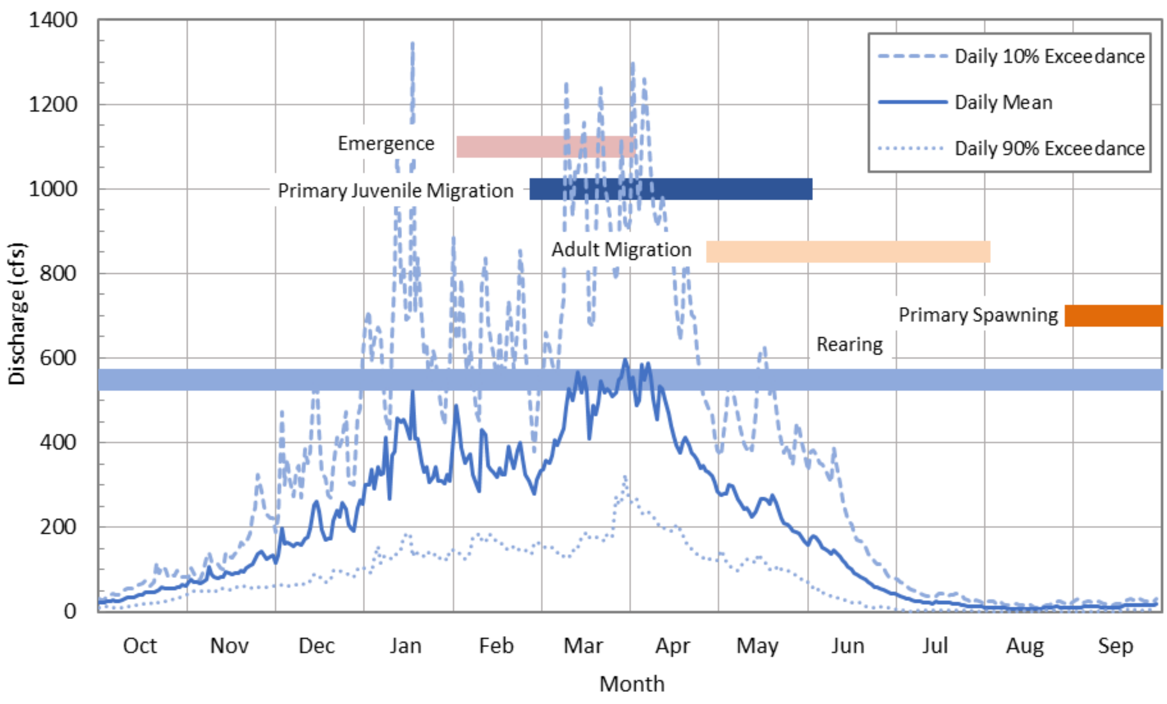


Figure 6: Chinook (Oncorhynchus tshawytscha life history timing in the Touchet River and Walla Walla River watersheds overlaid on discharge in the Túuši Wána project area.

Discharge data is adjusted from the WADOE Cummins Rd gage (~RM 3, period of record Water Year 2003-2021) using a direct basin area correction. Fish use timing is approximate and reflects typical life history stages (WDFW 2014, Steve Martin 2016) for fish using the Touchet River. Upstream adult and downstream juvenile migration are the primary life history stages assumed to be present in the Túuši Wána project area.

1.4.3 Project Area Salmonid Use

No salmonid spawning has been documented in the project area, and studies focusing on other portions of the Touchet basin note that Steelhead spawning generally occurs upstream of Prescott, WA, located about 15 miles upstream of the project area, and Chinook spawning occurring primarily in the headwaters (CCD 2020). While a lack of spawning data in the vicinity of the project area does not necessarily indicate that spawning does or cannot occur, high summertime water temperatures (Figure 7) and low flows in the project area point to the area being unsuitable for Chinook spawning. Steelhead spawning is the project area may be possible due to more suitable water temperatures during the spawning period (March – May), though frequent high flows during the spawning period may create hydraulic conditions at the site that are not conducive to spawning under current conditions. The project area is not anticipated to be suitable for juvenile rearing due to high summer water temperatures and a lack of temperature refugia under current conditions; in the Touchet basin Steelhead rearing is considered marginal or inhospitable below Waitsburg and Chinook rearing is considered marginal or inhospitable below Dayton. Upstream adult and downstream juvenile migration are the primary life history stages assumed to be present in the Túuši Wána project area, and these times generally coincide with more suitable water temperature and water availability at the project site.

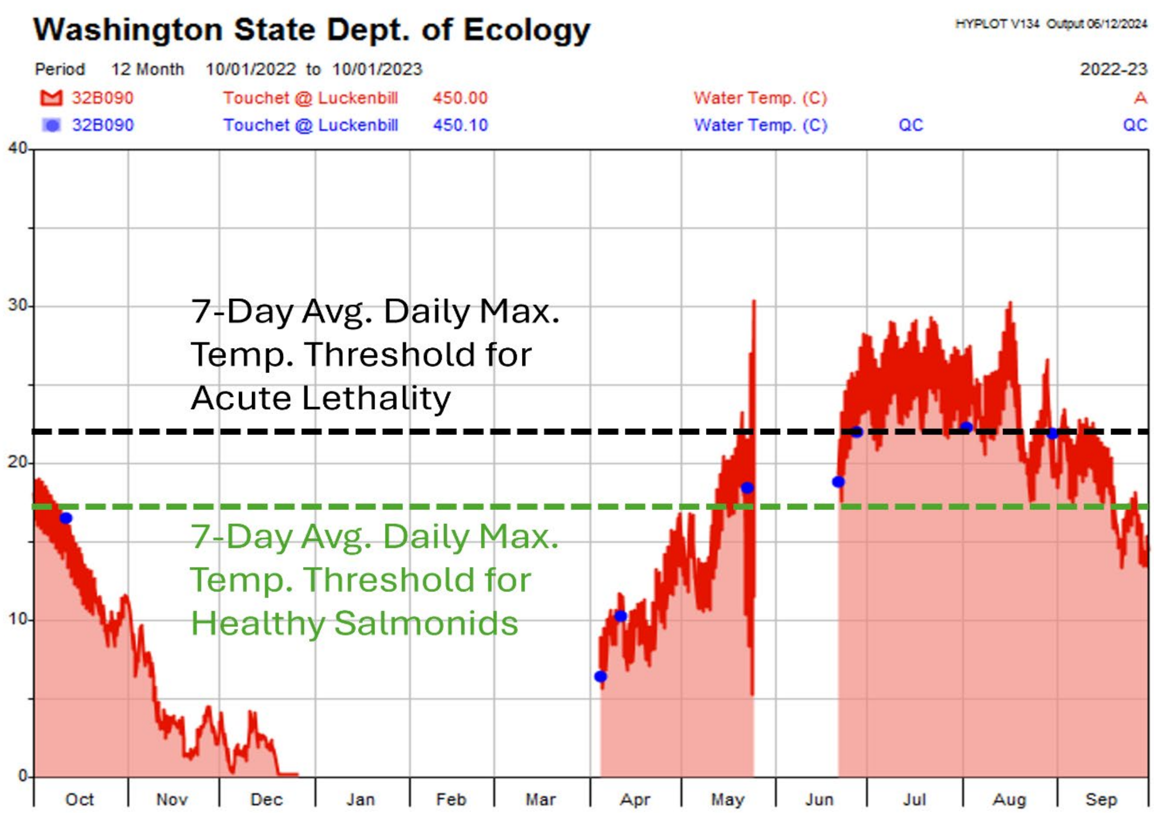


Figure 7: Plot of water temperatures recorded immediately upstream of the project area with salmonid water temperature threshold overlay.

Temperature values are in degrees Celsius from the WADOE gage 32B090.

1.4.4 Habitat Limiting Factors and Water Quality

This project is designed to address several limiting factors, as identified by CTUIR, for target species in the project area, including a lack of in-channel characteristics, limited passage/entrainment, and reclaiming riparian and floodplain function and connectivity. Project objectives, listed here and with quantifiable objectives found in supporting Table 3, are intended to improve these primary limiting factors and are presented in Table 2. In addition to these limiting factors, the Touchet River currently has a category 4A water quality listing for temperature (Washington Department of Ecology Listing #23779) and is part of the Walla Walla River Subbasin TMDL for pH, dissolved oxygen, and temperature.

Table 2: Limiting factors and project objectives.

Primary Limiting Factors	Project Objectives
In-channel characteristics	Increase channel complexity, with morphology closer to historical function and form
	Increase stream velocity diversity at a range of flows
	Improve sediment sorting and routing
	Improve in-stream thermal diversity
	Increase quantity and quality of habitat diversity, especially large wood and pools
Passage/entrainment	Increase area suitable for juvenile rearing
Riparian/floodplain	Increase floodplain connectivity and frequency of inundation
	Increase riparian function with site-appropriate native vegetation

1.5 LIST OF PRIMARY PROJECT FEATURES INCLUDING CONSTRUCTED OR NATURAL ELEMENTS.

1.5.1 Proposed Project Actions

Based upon site analysis, project goals and objectives, identified habitat limiting factors, site review (design team (CTUIR, Inter-Fluve), stakeholders, funder technical review (Bonneville Power Administration [BPA], Salmon Recovery Funding Board [SRFB]), external technical review (Appendix 7.6)), and anticipated available funding ranges, two complementary restoration treatment approaches are proposed for the project area. These two treatment approaches were initially described in the June 2024 Preliminary Designs (Inter-Fluve 2024a). At preliminary design, the two restoration approaches were described in the report and shown on the Plans in two treatment reaches, 1) **Floodplain Reveal Treatment Reach**, and 2) the **Large Wood Treatment Reach** (Inter-Fluve 2024a). These two approaches were intended to balance both the desire for more immediate benefit response time (Table 3) as well as 'lighter' touch approaches that are expected to provide longer term benefits. These two proposed approaches were provided in an attempt to balance potential risks presented by both approaches as well as provide comparative lessons learned for future restoration efforts in the lower Walla Walla Basin. To note, the 60% design level plans (Inter-Fluve 2024b) only show the "Floodplain Reveal" restoration treatment approach, though the 90% designs reincorporate the large wood structure (LWS) treatment approach proposed throughout the project area, similar to the treatment approaches shown on the preliminary design plans (Inter-Fluve 2024a).

The first approach, prescribed for the **Floodplain Reveal Treatment Reach**, (River Mile 16.5 to 17.1) intends to accelerate extensive, frequent, and sustained floodplain engagement. This more direct approach is expected to realize project benefits on the more immediate (immediately post construction) and near-term (1 to 3 year) benefits. These benefits will be achieved through excavation ("floodplain reveals") by exposing a floodplain surface compatible with and just above the established long profile of the Touchet River's gravel bed channel that has been found to sustain the river's base-level elevation profile. The floodplain reveals also target elevations that will encourage and sustain passive revegetation. This approach will be paired with channel and floodplain structural elements (e.g., LWS) which will be placed along the channel margins and across the floodplain. The placement of these LWS is intended to promote moderate to long-term (60 to 150 years (Beechie et al. 2008)) channel aggradation and enhanced floodplain-forming and riparian processes. The second approach, prescribed for the **Large Wood Treatment Reach** (RM 14.9 to 16.5), will use aggressively positioned[1] main channel LWS to initiate lateral channel migration and drive moderate- to long-term (60 to 150 years (Beechie et al. 2008)) channel aggradation. This downstream treatment approach is proposed to be paired with active vegetation stewardship, such as a regenerative agriculture or permaculture approach, targeted to successively rebuild soil

[1] LWS are considered aggressively positioned when they block more than 1/3 of the channel width and are engaged with low flow for at least 1/3 of their perimeter. Although not initially channel spanning, aggressively positioned LWS still have the capability of blocking and redirecting flow to accelerate channel dynamics. They may also capture mobile wood creating a channel spanning condition until the fine sediment bank(s) deform creating a new flow path(s).

structure and ultimately support the return of active agricultural areas towards more naturalized floodplain forest and uplands.

Throughout the treatment reach, process barriers such as riprap shall be removed. A more detailed description of the treatment reach and associated project feature types is provided below.

Floodplain Reveal Treatment Reach (River Mile 16.5 to 17.1)

From River Mile 16.5 to 17.1, a more direct excavation approach, paired with LWS additions inset within these excavations, will be taken. This treatment reach is intended to achieve the goals and objectives within the timeframes (e.g., immediate to 20 years) desired by CTUIR in the project objectives (Table 3). A more detailed description of each project feature type is provided below.

Floodplain reveals. Floodplain excavation areas are proposed to increase the valley bottom's hydrogeomorphic connectivity and support the growth and natural regeneration of desirable riparian plant species (e.g., willow, cottonwood). These excavations are intended to provide achievement of the project objectives in the immediate to 20-year target timeframes (Table 3). Given that aggradation is expected following construction, these excavations will be paired with the addition of structural elements (e.g., large wood) and riparian revegetation to accelerate the recovery timescale of the project area.

Informed by the analyses described in this report, floodplain reveal excavations will target elevations bands where alluvium composition matches the hydraulics (in the absence roughness from mature floodplain vegetation) (Sections 4.1.17 and 4.1.30), suitable for independent vegetation establishment (Section 2.3), and spring high flow juvenile salmon rearing habitat development (Section 4.1.19). This target is near the 400 cfs water surface elevation (Section 4.1.22) and the gravel/cobble alluvium across the valley bottom (Section 3.4).

Landscape complexity features within the floodplain ("Proposed Scribes") have been designed to mimic relict channel scars with similar channel geometry and sinuosity as those observed in upstream analogous reaches. These features will be excavated inset to the revealed floodplain surface to provide depth and velocity heterogeneity at a variety of flow conditions. Three "Proposed Scribe" elevations are set at 0.5, 1.0 and 1.5 feet below the target reveal elevation. The planforms were developed based the progressive down valley meandering and meander cut-off patterns often found in mature dynamic equilibrium settings, as well as comparison to relative height differences from the low water surface to existing vegetation communities (see section 2.3 for additional details).

As currently proposed, it is expected that these excavations will connect nearly 20 acres of floodplain at the 2-year peak flow (Table 3) across the 330-acre valley bottom within the project's conservation easement. The proposed floodplain excavation reach is intended to provide more immediate habitat benefits on the desired timescales described by CTUIR. Primary considerations related to this are:

1) The desired response and recovery for this timescale for many project objectives are immediate, 5, 10, and 20 years (Table 3). This approach, while more direct and aggressive, provides more immediate recovery when compared to aggradation recovery estimates provided in Beechie et al. 2008.
2) Because the valley bottom and channel margins lack mature vegetation, when exposed to velocities of moderate to high flows (1 to 5 years), the gravel alluvium layer present at the target elevation has a sufficiently coarse grainsize distribution to help self-maintain a channel elevation needed for floodplain connection and riparian revegetation.
3) The project area is known to have chronically impaired baseflow, often dropping to less than 10 cfs in July, August, and September and becoming unmeasurable during peak irrigation withdrawal times of the day. It has been noted by residents along the river that this low flow results in no surface flow over riffle crests and the isolation of pools in August and September. Lowering the surrounding landscape to near the current persistent low water table alleviates some uncertainty related to dewatering the reach, particularly in light of climate change projections the suggest base flow could be reduced by up to another 90% by 2080 (Yoder 2022).
4) Proposed floodplain elevations target the ground height above river (HAR) (Bair et al. 2021) needed to encourage the natural regeneration of willow and cottonwoods. Here, site analysis suggests the HAR estimated to support natural regeneration of emergent vegetation 0.5 to 1.5 feet, while willows at an average of near 6 feet HAR, and cottonwood regeneration is more variable depending upon flood-specific conditions (i.e., Mahoney & Rood 1998). This proposed floodplain reveals will place the surrounding landscape an elevation that can more readily support the natural regeneration of desirable plant species on a the timescale identified for project performance (see Table 3).

Given the high annual sediment yields in the basin and the expectation for aggradation to occur post-project, the intent of these floodplain reveals is to allow the regeneration and growth of floodplain vegetation to outpace aggradation rates. While annual sediment yield rates are estimated at 1,519,000 m^3 (Beechie et al. 2008), it is expected that sediment loads are delivered at least in part episodically. Large-scale flood events within the first three to five years after the project may present a risk to project success and replanting may be needed if sedimentation rates exceed plant growth tolerances. Target surfaces have been designed to be near the low end of plant communities HAR in an effort to provide some mitigation for this risk. Floodplain grading is proposed to terminate at the valley-spanning transmission line corridor, which is a current immovable project constraint.

Valley margin terraces and hummocks. To add additional complexity to the revealed floodplain and reduce the earthwork costs, hummocks will be left within the reveal extent and terraces will be left or constructed along the valley margins. The hummocks will be inundated as water levels rise, providing newly accessible suitable juvenile salmon habitats as other areas become less preferential with increasing depth. The terraces edges will be graded to mimic the appearance of fluvial terraces left behind as a river base level lowers or the watershed hydrology and sediment regime changes. To increase the valley bottom area available for floodplain reveals the terrace fills will be located along the existing valley margin where the ground is already higher relative to the river. The terrace fills were set in areas with no or limited connectivity at the 100-year flood event and will occupy around 27 acres of the 330-acre valley bottom within the project's conservation easement. The thickness of the terrace fill will be no more than 15 feet, tapering down in thickness at the valley margin and bottom of the hillslope so as to blended into surrounding topography and graded to route hilltop drainage pathways away from floodplain reveals. The riverward side of the terraces will be contoured to gradually transition to the current valley bottom, with a flat buffer between the floodplain reveals that will also provide a maintenance access route and room for potential future expansion of floodplain reveals. Given the proposed relatively high elevation of these terrace fills, revegetation is expected to be a significant challenge and will require maintenance and monitoring to establish the desired upland vegetation community.

In-channel LWS. The in-channel LWS, including the apex and bank-buried LWS, will be used as a proxy to mimic the structure provided by historical mature cottonwood trees. The intent of these is to drive lateral migration and act as deflection points for the channel to migrate around and respond to. This is intended to jump start the development of riparian vegetation "nursery sites" that will aggrade atop and within the floodplain reveals, primarily downstream point and mid-channel bars. These will be paired with live cuttings extending below the low water level.

The collective action of the in-channel LWS will also somewhat raise the water surface elevations over a range of moderate to high flows and increase the hydraulic connectivity of around 30 acres over both the floodplain reveal excavations and adjacent areas. This increase in hydraulic connectivity will help support the growth of riparian vegetation and provide refuge hydraulic/cover conditions for out-migrating juvenile salmon in the spring.

The in-channel LWS are not intended to immediately or directly increase the low flow (base flow) water surface profile through the project reach[2]. However, based on modeled sediment loads (Beechie et al. 2008), they will likely lead to aggradation over the moderate to longer term which may increase the base flow water surface profile.

[2] In-channel LWS may support the aggradation of the riverbed in the moderate to long-term, and coupled with an increase in base flow rates may increase the low flow water surface profile.

Floodplain wood structures. The floodplain LWS with accompanying live plantings, will be constructed throughout the floodplain reveals. These will act as deflection points for flows to move around and generate hydraulic and terrain complexity. Plantings will occur in the downstream velocity shadow of these structures to simulate island shapes. These will be done with live cuttings and salvaged whole willows/cottonwoods extending below the low water level and interspersed between the large wood materials.

Off-channel post-assisted log structures. The off-channel post-assisted log structures (PALS), with accompanying live plantings, will be placed in floodplain reveal areas and areas where higher flows will more routinely route down the floodplain. These will act as deflection points for the channel to migrate around and respond to. These will simulate the shape of a small apex log structure or the structural function of a beaver dam, with live cuttings and willow bundles extending below the low water level interwoven with the large wood materials and in the downstream velocity shadow.

Removal of riprap and derelict items. Existing riprap, other types of bank armoring, a farm bridge deck and abutments (Figure 8), and other derelict agricultural items (pipes, fences, poles, equipment, etc.) will be removed throughout the project area. Removal of the riprap and bank armoring will allow for natural bank erosion rates and remobilization of floodplain sediments with the project reach. The overhead electric powerlines serving the irrigation pumps with the project area will remain in-place until they are no longer needed to provide irrigation water to help establish the riparian plantings. This plant establishment period is expected to take around five years. The larger power transmission lines that cross the valley near River Mile 16.5 will remain, including the two sets of poles in the valley bottom. There will be a 300-foot buffer on each side of the transmission lines with no excavation, fills, or LWS within it.

Figure 8: Photo of derelict bridge and abutments to be removed near River Mile 16.5.

Revegetation. The long-term goal is to reestablish native riparian shrubs and a mature cottonwood gallery forest within the active channel migration zone and along the channel margins that can moderate channel migration rates. To achieve this goal, strategic revegetation efforts will be implemented in a variety of styles and will be key to the project's future success. Given the scope and scale of propsed earthwork and the significant presence of noxious weeds in the watershed, revegetation effort will require a long-term commitment from the Project Sponsor. It is anticipated that the revegetation effort will be intensive in the first three to five years as the floodplain reveal excavation or wood structure is completed, followed by multiple years of monitoring, maintenance and adaptive management to realize the benefits provided by installed LWS (e.g., invasive species management, planting/re-planting a deposit after it forms downstream following a high flow event).

Revegetation design was informed by the analyses described in subsequent sections, along with information garnered from a site visit with Chris Hoag, Hoag Riparian & Wetland Restoration LLC (September 2022) and Mike Denny, a Walla Walla area naturalist (May 2024). It is anticipated that *Willow and Cottonwood Scroll Clusters* and *LWS Revegetation* would happen concurrently with in-water work to capitalize on equipment able to dig to the low water table, while the other revegetation treatments should be completed during appropriate planting windows. The following revegetation treatments are included in the project designs:

1) *Willow and Cottonwood Scroll Clusters:* Revegetation within the floodplain reveals will focus on installation of live willow and cottonwood cuttings in scroll and island shapes. These planting areas are mostly associated with LWS, and are targeted in the downstream velocity shadow of those proposed structures. Cuttings will be installed in trenches at angles that will also provide flow deflection and accumulate smaller large wood and sediments that are being transported by flood events. To further support the growth of live cuttings in willow trenches a log will be placed at the bottom of the trench against the cuttings. This is intended to slowly release water and feed microbial communities in the soil.

2) *LWS Revegetation:* Similar to the willow and cottonwood Live cuttings installed to extend below the low water table within the footprint, and in then downstream velocity shadow, of all LWS to jump start the native revegetation process. Floodplain and off-channel LWS will incorporate live cuttings and willow bundles extending below the low water level and interwoven with the large wood material.

3) *Valley Margin Terrace Revegetation*: Revegetation on valley margin terraces will focus on seeding of native upland bunch grasses and sagebrush. Because these areas will be composed of fill generated from onsite cut, careful surface. Hydroseeded and hydromulch are recommended here, including a tackifier, to reduce initial erosivity.

4) *Open Riparian Revegetation:* These areas will serve as the primary foundational bench for the floodplain reveals. These areas are approximately 2 feet above the low water table, which is commensurate with relative elevations were similarly observed in field work, and are expected to support the establishment of native riparian shrubs.

5) *Emergent and Riparian Shrub Revegetation:* These areas along the floodplain reveals will be lower inset features within the *Open Riparian Revegetation* areas. These features are on average 0.5 to 0.8 feet above the low water table and are expected to support a mix of native riparian shrubs as well as a mix of riparian and emergent herbaceous plants.

6) *Transitional Revegetation:* These areas are located along the slopes from the *Open Riparian Revegetation Zones* upwards to the unexcavated areas. This transitional zone is not expected to be exposed to higher velocities and less frequent inundation, and focuses on riparian shrubs that that are capable of adapting to variations in wet and dry conditions.

7) *Riparian Vegetation Management:* These areas are currently wooded and/or do not have floodplain reveal excavations shown. These areas have been identified as areas where aggressive, non-desirable plant species exist and are recommended for targeted invasive species management and removal. Continued ongoing collaboration with the landowner and lease holder will be required to plan and appropriately manage and phase this effort.

8) *Agricultural Conversion Zone:* Given that the width extents and associated proposed excavation is narrower than the conservation easement, agricultural conversion zones are intended to restore soil structure in areas that have been actively used for agricultural. It is expected that these areas will require multiple phases of management to ultimately achieve the desired plant community. These phases are expected to include holistic management that includes site preparation (e.g., burning, invasives removal), cover crop planting[3] as part of an active agriculture approach to rebuild soil structure, followed by successional management of native revegetation and continued invasive species management. This approach would leverage existing irrigation and agricultural infrastructure (e.g., access routes) to transition areas currently in agriculture to riparian forest or uplands that fit the Tribe's River Vision. The proposed as part of this design package is planting of an annual cover crop. This crop is composed of species that are intended to increase organic matter, suppress undesirable weeds, increase available soil nitrogen, and decrease soil compaction. Continued ongoing collaboration with the landowner and lease holder will be required to appropriately manage and phase this effort.

[3] Cover crop plant common names may include Lacy Phacelia, Austrian field peas, Buckwheat, Groundhog Daikon Radish, Yellow blossom sweet clover, Fridge Triticale.

<u>Large Wood Treatment Reach (</u><u>RM 14.9 to 16.5</u>**<u>)</u>**

From River Mile 14.9 to 16.5, a more indirect approach of LWS additions will be taken. This approach is intended to initiate lateral channel migration and aggradation. It is acknowledged that the lateral extents and timescale of this approach lags behind the desired response time listed in Table 3. However, when implemented along with the Floodplain Reveal Treatment Reach it provides a paired approach that will provide longer term benefits, as well as a chance to compare treatment approaches that may inform future watershed restoration efforts.

<u>In-channel LWS</u>. The in-channel LWS, including the apex and bank-buried LWS, will be used as a proxy to mimic the structure provided by historical mature cottonwood trees. The intent of these is to promote lateral migration and act as deflection points for the channel to migrate around and respond to. This is intended to jump start the development of riparian vegetation "nursery sites," primarily downstream point and mid-channel bars. These will be paired with live cuttings that will be installed to extend below the low water level.

The collective action of the in-channel LWS will also somewhat raise the water surface elevations over a range of moderate to high flows and increase the hydraulic connectivity of around 30 acres of existing ground along the current channel and adjacent to the floodplain reveal excavations. This increase in hydraulic connectivity will help support the growth of riparian vegetation and provide refuge hydraulic/cover conditions for out-migrating juvenile salmon in the spring.

The in-channel LWS are not intended to immediately or directly increase the low flow (base flow) water surface profile through the project reach[4]. However, based on modeled sediment loads (Beechie et al. 2008), they will likely lead to aggradation over the moderate to longer term which may increase the base flow water surface profile.

It is expected that the lateral extent of treatment benefits of this approach will be more limited than the Floodplain Reveals approach. Review of channel traces from the aerial photographic record and channel signatures from LiDAR provide a good proxy for anticipated lateral channel migration extents (Section 4.1.14). A notable risk associated with this approach is that the contemporary channel migration zone lacks mature riparian vegetation in many locations. This is expected to lead to more rapid channel migration than those which historically were moderated by the root structure of mature riparian shrubs and trees.

[4] In-channel LWS may support the aggradation of the riverbed in the moderate to long-term, and coupled with an increase in base flow rates may increase the low flow water surface profile.

Revegetation. Intentional revegetation efforts are key to the project design and will be implemented in a variety of styles. Revegetation design was informed by the analyses described in subsequent sections, along with information garnered from a site visit with Chris Hoag, Hoag Riparian & Wetland Restoration LLC (September 2022) and Mike Denny, a Walla Walla area naturalist (May 2024). Generally, revegetation will focus on the removal of non-native plants and subsequent application of a variety of plating treatments based on specified zones within the treatment reach. It is anticipated that the revegetation effort will require a long-term commitment from the Project Sponsor and be phased over multiple years, in part due to the scale and cost of this effort, but also particularly in the **Large Wood Treatment Reach** also because of the moderate to long-term migration and aggradation response times. The following revegetation treatments are included as part of the Large Wood Treatment Reach:

1) *Willow Scroll and Cottonwood Clusters:* Revegetation within the Large Wood Treatment Reach will focus on installation of live willow and cottonwood cuttings in scroll and island shapes. These planting areas are mostly associated with LWS, and are targeted in the downstream velocity shadow of those proposed structures. Cuttings will be installed in trenches at angles that will also provide flow deflection and accumulate smaller large wood and sediments that are being transported by flood events. To further support the growth of live cuttings in willow trenches a log will be placed at the bottom of the trench against the cuttings. This is intended to slowly release water and feed microbial communities in the soil. It is anticipated that the revegetation effort will be intensive in the year that the floodplain reveal excavation or wood structure is completed, followed by multiple years of monitoring, maintenance and adaptive management to realize the benefits provided by installed LWS (e.g., planting/re-planting a deposit after it forms downstream following a high flow event). The long-term goal is to reestablish a mature cottonwood gallery forest within the active channel migration zone and along the channel margins that can moderate channel migration rates.

2) *Agricultural Conversion Management:* Given that the width extents and associated response of the Large Wood Treatment reach is narrower, it is proposed that areas currently in actively agriculture being converted to desirable vegetation over multiple phases and years. These phases are expected to include holistic management that includes site preparation (e.g., burning, invasives removal), cover crop planting[5], active regenerative agriculture or permaculture to rebuild soil structure, followed by successional management of native revegetation and continued invasive species management. This approach would leverage existing irrigation and agricultural infrastructure (e.g., access routes) to transition areas currently in agriculture to riparian forest or uplands that fit the Tribe's River Vision. It is expected that these areas will require multiple phases of management to ultimately achieve the desired plant community. The effort proposed as part of this design package is planting of an annual cover crop. This crop is composed of species that are intended to increase organic matter, suppress undesirable weeds, increase available soil nitrogen, and decrease soil compaction. Continued ongoing collaboration

[5] Cover crop plant common names may include Lacy Phacelia, Austrian field peas, Buckwheat, Groundhog Daikon Radish, Yellow blossom sweet clover, Fridge Triticale.

with the landowner and lease holder will be required to appropriately manage and phase this effort.

1.5.2 Actions Considered but Not Proposed

Based upon site analysis and project goals, several actions were considered but not proposed for floodplain reconnection. These actions, along with justification for why they are not proposed, are described in more detail below.

Valley bottom reconnection through channel filling. Based on the project area's unconfined, depositional setting[6] connecting the contemporary valley bottom through channel filling was considered but is not proposed. This approach would involve filling the channel with soil, gravel, and large wood with "the aim to construct a valley surface that is connected at base flow" (Powers et al. 2018). A key component of this methodology is (1) "identifying geomorphic controls" and (2) "key relic/historic features and their elevations" that "provide strong indicators of the pre-disturbance valley" (Powers et al. 2018). These two factors, discussed in more detail below, were the main limitations and reasons for not proposing this approach.

1) *Lack of sufficient geomorphic controls.* Ground-based and desktop assessment of the project area (LiDAR, geomorphic and geologic maps), indicated that there are no valley-spanning geomorphic controls to serve as the downstream boundary condition for this approach within the project extent bounded by the currently negotiated conservation easement. A geomorphic grade control would be necessary to maintain the elevated profile (achieved from filling the channel) and transition into the downstream reach outside the valley wide conservation easement. Given the relative height difference of eight to ten feet between the low water table and the surrounding ground surface, much of which is fine silts (Section 4.1.15), and documented low summer base flows (often less than 10 cfs with flows becoming unmeasurable for periods), transitioning the slope from a filled condition back to the existing condition (downstream of the project boundary) would also be challenging, requiring much of the project length and a series of immobile and impermeable valley spanning geologic grade controls to be constructed. Additionally, given the low summer base flows, the risk of dewatering the channel if incision occurred was deemed significant.
2) *Lack of relic features that are resilient to proposed stream power.* Investigation of relic features for a potential target reconnection elevation included test pits (Figure 28 & Inter-Fluve 2022). As described in the prior Preliminary Design Report for the smaller easement project area (Inter-Fluve 2022), test pits revealed approximately eight to ten feet of fine silts overlying gravel/cobble alluvium. While the Valley Bottom Reconnection Through Channel Filling approach would aim to distribute stream power across the valley bottom, the silt content of the floodplain is of insufficient grain size to maintain the proposed filled channel invert elevation without roughness evenly distributed across the valley bottom (large wood and/or vegetation).

[6] Project area valley profile slope is 0.23%.

Channel aggradation through wood structure placement, BDAs. Based on the significant annual sediment yields of the watershed (1,519,000 m^3 (Beechie at al. 2008)), floodplain reconnection solely via aggradation processes was considered but is not proposed. This approach would include placement of hydraulic roughness elements (LWS, BDAs) across the valley bottom to increase roughness and accelerate aggradation. While Beechie et al. (2008) estimated potential recovery through aggradation associated with the placement of Beaver Dam Analogues (BDAs) to occur on the timescale of 60 to 150 years. The paper also notes that "allowing or encouraging recolonization by beaver can reduce recovery time by up to 33%" (Beechie et al. 2008). While aggradation through structural placement (LWS) is proposed as part of this project, the recovery time scale of 60 to 150 years for a wood only based approach was longer than that timescale desired by the landowner and project funders. Further, based on modeled stream velocities and a "Low" Beaver Intrinsic Potential (Dittbrenner 2018) rating for the site, it is expected that BDAs have a low likelihood of being taken over by natural beaver colonies and that they would need to be regularly maintained and reinstalled if selected as the sole restoration approach.

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.

Initial design criteria provide the overall guideposts for the project and are developed so that project components address key constraints and objectives and remain consistent with CTUIR's River Vision. The initial design criteria were divided into four categories: habitat, geomorphology / hydrology / ecology, engineering and risk, and construction impacts. During the external technical review process, a key data gap at the project team level regarding quantifiable design goals and expected response times was identified and agreed on. In response to this data gap, the CTUIR team developed a list of more quantified project design goals, which are grouped into three categories based on how they relate to the habitat limiting factors of the site: aquatic habitat availability; channel characteristics; and floodplain/riparian characteristics. Table 3 and Table 4 summarize the connections between habitat limiting factors, quantifiable projects goals, and timeframes and actions for achieving those goals at the project site. Additionally, the following points summarize the key findings from the expert technical review, and informed the description of the updated goals and objectives table:

- There is lingering curiosity and uncertainty as to the origin of thick deposits of fine sediment in the valley bottom (i.e., Missoula Floods, upslope agricultural erosion, wind deposits, overbank deposits, combinations, or other sources). It was noted by Tim Beechie that in the Northwest there are three competing hypothesis for how these valley bottom deposits developed, but at the time of this study there was not an efficient or effective way to resolve those differences.
- If the channel is raised up by filling, it is likely to laterally migrate over and cut back down through floodplain areas. Generally, reviewers agreed this would not be a reliable or sustainable approach to achieving project goals.
- There was interest expressed by Dr. Kondolf to place LWS in an early phase to initiate lateral channel migration. It was expected that as the channel laterally migrated, it would build floodplain surfaces that would be connected to contemporary hydrology, but at a narrower flood prone width. It was discussed that the response to this would be flow event dependent. This raised the question of how quickly a response was desired, and in discussion, CTUIR expressed that they desired a faster response time.
- There was general agreement that setting the site up for long-term vegetation success and juvenile rearing are the primary drivers of design, and that existing cottonwood trees near the end of their lifespan that are outside target riparian tree spacing (>18 feet on center) could be removed to encourage the develop surfaces that would regenerate native species.
- There was general consensus that targeting floodplain reveal depths to expose the buried gravel layer would be beneficial. It was also suggested that variability in floodplain reveal depths, both slightly above and below the gravel layer, would provide initial habitat and plant community complexity.
- For revegetation of disturbed areas, it was agreed that an intensive multi-year approach would be needed to improve plant establishment and begin early successional processes. This could include approaches such as initial high-density willow and cottonwood plantings with subsequent interplanting for increasing species diversity. Funding and

operational strategies and how they correlate with easement-related restrictions for this remain in conversation.

- Project phasing could include both spatially phased sperate work areas (e.g., Site A, B, C, etc.) and time phased activities in the same work area over multiple years (e.g., large wood, earthwork, plantings, more large wood, more plantings, etc.). The intention would be to reduce the need for multiple entries to a work area, but it is understood that the project scale, geomorphic response timeline, and vegetation succession, may warrant a multiple entry approach to reinforce the restoration trajectory.
- Flood events that mobilize substantial amounts of fine sediment pose an acknowledged risk to revegetation of the site and excavation-related work. This is primarily if fine sediment is deposited then buries or outpaces the growth of revegetation.

The performance criteria, risk of failure, and analyses to reduce associated uncertainties are described by category for the three categories of updated goals and objectives, and for the engineering and risk, and construction impact categories previously established for the project in the following subsections. The consequences associated with failure to perform in the criteria categories vary depending on the severity of failure and the specific criteria. A discussion of these consequences follows each category.

Table 3: Floodplain Reveal Treatment Reach. Updated quantifiable project goals, performance criteria, linked restoration actions, and timelines. Placeholders will continue to be refined during subsequent project phases and via. project monitoring.

Primary Limiting Factors	Touchstones Addressed	Goals	Timeframe (years)	Existing Conditions	90% Design	Expected Trajectory (0 to 5 years)	Expected Trajectory (5 to 10 years)
Channel Migration Zone Characteristics	*Geomorphology*	Increase channel complexity (RCI)	5	2.23	*Not quantified*	**+** | Expected increase with lateral migration	**+** | Expected increase with lateral migration
	Geomorphology	Increase sinuosity	0	1.1	1.1	**+** | Expected increase with lateral migration	**+** | Expected increase with lateral migration
	Geomorphology	Increase connected wetlands and backwater areas at 2-year recurrence interval flow. Measured as area with Velocity Less and 0.5 feet per second at the Q2.	0	0.6 acres	2.8 acres	**+** | Expected increase with lateral migration	**+** | Expected increase with lateral migration
	Geomorphology	Decrease stream power and increase velocity diversity. Stream power calculated along longitudinal stream centerline (kg*m2/s3).	5	3.3	2.6	**-** | Likely to decrease with active stewardship	**+** | Expected increase with lateral migration
	Geomorphology	Increase quantity and quality of habitat diversity, esp. large wood material and pools.	5	Essentially none	On par with reference restoration targets *(C)*	**~** | Expected to remain similar	**~** | Expected to remain similar
	Water Quality and Quantity	Increase Flow	5	20	24	**-** | Likely to decrease with climate change	**-** | Likely to decrease with climate change
	Aquatic Biota	Increase locations suitable for juvenile rearing at 2-year recurrence interval flow (1-4 ft depth, 0-1.75 fps)	5	1 acre *(D)*	15 to 16 acres *(D)*	**+** | Expected increase with lateral migration	**+** | Expected increase with lateral migration
Passage Entrainment	*Aquatic Biota*	Increase locations suitable for juvenile rearing at 750 cfs flow (1-4 ft depth, 0-1.75 fps)	5	1 acre *(D)*	15 to 18 acres *(D)*	**+** | Expected increase with lateral migration	**+** | Expected increase with lateral migration
Riparian/Floodplain	*Riparian Vegetation*	Decrease prevalence of false indigo	0	TBD	TBD	**-** | Likely to decrease with active stewardship	**-** | Likely to decrease with active stewardship
	Riparian Vegetation	Increase riparian cover (shade)	5-20 (20)	TBD	TBD	**+** | Likely to increase with active stewardship	**+** | Likely to increase with active stewardship
	Riparian Vegetation	Increase vegetation structure and diversity (heights, patch size and distribution)	10	TBD	TBD	**+** | Likely to increase with active stewardship	**+** | Likely to increase with active stewardship
	Riparian Vegetation	Increase area suitable for cottonwood seedling recruitment (Last week of May flow)	0	TBD	TBD	**-** | Likely to decrease with active stewardship	**-** | Likely to decrease with active stewardship
	Riparian Vegetation	Increase available potential recruitment band area - 0.6 to 2 m above base flow	0	7.0 acres	7.7 acres	**+** | Expected increase with lateral migration	**+** | Expected increase with lateral migration
	Connectivity	Inundation extent at 2-year	0	7.6 acres	26.6 acres	**~** | Expected to remain similar	**~** | Expected to remain similar
	Biogeomorphic connectivity	Significantly increase the evenness and richness (Simpson's Diversity Index) of canopy height classes within within the active (Q2) fluvial corridor 10 years after project completion.	10	TBD	TBD		
	Hydrogeomorphic Connectivity	Decrease the average depth to water table to <1.5 feet, the elevation assumed to support desirable riparian vegetation, over >50% of the percentage of the project area	5	6.1 acres	22.6 acres	**+** | Expected increase with lateral migration	**+** | Expected increase with lateral migration
	Connectivity	Increase floodplain connectivity (2,000 cfs (2 year event))	5	7.6 acres	26.6 acres	**~** | Expected to remain similar	**~** | Expected to remain similar

Notes

(A) Slideshow Chinook & Steelhead habitat requirements- Pess, Beechi and Hillman, "Seasonal Microhabitat Use by Juvenile Spring Chinook Salmon in the Yakima River Basin, Washington" Mark A. Allen 2000

(B) Current channel width +/- ~ 30 feet

(C) Fox and Bolton 2007, Table 4, DF-PP Zone, 75th percentile is 1 piece per 10-feet of channel.

(D) Suitable habitat area ranges are for Juvenile Chinook and Steelhead

Table 4: Large Wood Treatment Reach. Updated quantifiable project goals, performance criteria, linked restoration actions, and timelines. Placeholders will continue to be refined during subsequent project phases and via. project monitoring.

Primary Limiting Factors	Touchstones Addressed	Goals	Timeframe (years)	Existing Conditions	90% Design	Expected Trajectory (0 to 5 years)	Expected Trajectory (5 to 10 years)
Channel Migration Zone Characteristics	*Geomorphology*	Increase channel complexity (RCI)	5	2.23	*Not quantified*	+ | Expected increase with lateral migration	+ | Expected increase with lateral migration
	Geomorphology	Increase sinuosity	0	1.1	1.1	+ | Expected increase with lateral migration	+ | Expected increase with lateral migration
	Geomorphology	Increase connected wetlands and backwater areas at 2-year recurrence interval flow. Measured as area with Velocity Less and 0.5 feet per second at the Q2.	0	1.7 acres	2.6 acres	+ | Expected increase with lateral migration	+ | Expected increase with lateral migration
	Geomorphology	Decrease stream power and increase velocity diversity. Stream power calculated along longitudinal stream centerline (kg*m2/s3).	5	2.5	3.2	- | Likely to decrease with active stewardship	+ | Expected increase with lateral migration
	Geomorphology	Increase quantity and quality of habitat diversity, esp. large wood material and pools.	5	Essentially none	On par with reference restoration targets *(C)*	~ | Expected to remain similar	~ | Expected to remain similar
	Water Quality and Quantity	Increase Flow	5	20	24	- | Likely to decrease with climate change	- | Likely to decrease with climate change
	Aquatic Biota	Increase locations suitable for juvenile rearing at 2-year recurrence interval flow (1-4 ft depth, 0-1.75 fps)	5	6 to 7 acres *(D)*	7 to 9 acres *(D)*	+ | Expected increase with lateral migration	+ | Expected increase with lateral migration
Passage Entrainment	*Aquatic Biota*	Increase locations suitable for juvenile rearing at 750 cfs flow (1-4 ft depth, 0-1.75 fps)	5	7 to 9 acres *(D)*	10 to 12 acres *(D)*	+ | Expected increase with lateral migration	+ | Expected increase with lateral migration
Riparian/Floodplain	*Riparian Vegetation*	Decrease prevalence of false indigo	0	TBD	TBD	- | Likely to decrease with active stewardship	- | Likely to decrease with active stewardship
	Riparian Vegetation	Increase riparian cover (shade)	5-20 (20)	TBD	TBD	+ | Likely to increase with active stewardship	+ | Likely to increase with active stewardship
	Riparian Vegetation	Increase vegetation structure and diversity (heights, patch size and distribution)	10	TBD	TBD	+ | Likely to increase with active stewardship	+ | Likely to increase with active stewardship
	Riparian Vegetation	Increase area suitable for cottonwood seedling recruitment (Last week of May flow)	0	TBD	TBD	- | Likely to decrease with active stewardship	- | Likely to decrease with active stewardship
	Riparian Vegetation	Increase available potential recruitment band area - 0.6 to 2 m above base flow	0	7.0 acres	7.0 acres	+ | Expected increase with lateral migration	+ | Expected increase with lateral migration
	Connectivity	Inundation extent at 2-year	0	24.3 acres	26.3 acres	~ | Expected to remain similar	~ | Expected to remain similar
	Biogeomorphic connectivity	Significantly increase the evenness and richness (Simpson's Diversity Index) of canopy height classes within within the active (Q2) fluvial corridor 10 years after project completion.	10	TBD	TBD		
	Hydrogeomorphic Connectivity	Decrease the average depth to water table to <1.5 feet, the elevation assumed to support desirable riparian vegetation, over >50% of the percentage of the project area	5	6.1 acres	6.1 acres	+ | Expected increase with lateral migration	+ | Expected increase with lateral migration
	Connectivity	Increase floodplain connectivity (2,000 cfs (2 year event))	5	7.6 acres	9.6 acres	~ | Expected to remain similar	~ | Expected to remain similar

Notes

(A) Slideshow Chinook & Steelhead habitat requirements- Pess, Beechi and Hillman, "Seasonal Microhabitat Use by Juvenile Spring Chinook Salmon in the Yakima River Basin, Washington" Mark A. Allen 2000

(B) Current channel width +/- ~ 30 feet

(C) Fox and Bolton 2007, Table 4, DF-PP Zone, 75th percentile is 1 piece per 10-feet of channel.

(D) Suitable habitat area ranges are for Juvenile Chinook and Steelhead

1.6.1 Aquatic Habitat Availability

Design goals and performance criteria which pertain to aquatic habitat availability limiting factors at the project site include the following:

- Initiating floodplain connectivity at 400 cfs flow and above. 400 cfs is the March mode and is exceeded at least 14 continuous days in most years (Figure 30), a desirable target from a fish growth perspective (Jeffres et al. 2008)
- Increase locations suitable for juvenile salmonid rearing at 750 cfs flow, the median March discharge representative of a typical high flow event which occurs at least once annually (Table 6). Increase area by >=100-200% of existing.
- Increase locations suitable for juvenile salmonid rearing at the 2-year recurrence interval flow (Table 5). Increase area by >200% of existing.

Increasing suitable salmonid rearing habitat at a variety of selected design discharges (see section 3.3 for additional details) is an outcome which is linked to all proposed project elements. Both treatment approaches are anticipated to increase aquatic habitat availability on different timescales.

<u>Floodplain reveals</u> will deliver a large area of seasonally connected floodplain immediately flowing construction. The elevation of floodplain reveals is tied to design discharge values so that channel-floodplain connection initiates at the 14-day exceedance flow (400 cfs), and that the floodplain can offer suitable habitat area, velocity refugia, and hydraulic heterogeneity across the floodplain by the peak fish flow (750 cfs). This approach for selecting design discharge magnitudes and relating these discharges to floodplain functions is based on the work of Jeffres et al. (2008) which found that ephemerally connected and variable floodplain habitats provide the best growth conditions for juvenile salmonids. How this relates to proposed design features can be visualized on Habitat Suitability Maps presented in Appendix 7.8.

<u>LWS</u> immediately provide habitat complexity, cover, and hydraulic heterogeneity in the channel and on the floodplain, when the floodplain reveals are inundated. Additionally, in-channel LWS are anticipated to encourage fluvial processes in the channel including sediment sorting, mobile wood retention, and lateral channel migration, which are anticipated to create and maintain high quality in-channel aquatic habitat and contribute to the maintenance of channel-floodplain connectivity as the site evolved.

<u>Revegetation</u> efforts will create hydraulic roughness, and, as plantings mature, cover and shade on the floodplain reveals and to the channel, and a source of woody material for the channel to entrain and create wood accumulations.

<u>Removal of anthropogenic features</u> will increase the frequency of floodplain inundation and allow for channel migration and evolution, increasing the availability and quality of aquatic habitats.

Risk of Failure to Perform

Failure to perform on the habitat availability criteria would result from a decrease in connected floodplain for a given discharge and/or an increase in the minimum discharge required to produce floodplain-channel connectivity. These outcomes could be produced by either mainstem channel incision or aggradation on the floodplain reveals, or a combination of these two mechanisms. Since proposed conditions will substantially increase channel hydraulic roughness and lower the threshold for overbank flow channel transport capacity is anticipated to decrease following the implementation of project elements, and channel incision is not viewed as a serious risk to project performance. Gradual aggradation of fine sediment on floodplain reveal surfaces via overbank deposition is anticipated due to high suspended sediment loads in the Touchet basin, but hydraulic heterogeneity produced by topographic and roughness variability on these surfaces is anticipated to produce zones of deposition and scour, thereby retaining improved levels of floodplain-channel connection and habitat complexity relative to pre-project conditions as the project evolves. Gradual fine sediment aggradation on the floodplain reveals may result in a minor to moderate decrease in available habitat area for lower design discharges, but the project is anticipated to function as designed and deliver habitat uplift. However, rapid, large-scale fine sediment aggradation within the first three to five years following project implementation (likely caused by large-scale flood event(s)) presents a risk to project function by potentially burying floodplain plantings (particularly if it outpaces plant growth) and roughness elements, and by creating a less frequently inundated floodplain surface.

1.6.2 Channel Characteristics

Design goals and performance criteria which pertain to channel characteristics limiting factors at the project site include the following:

- Increase channel complexity (increase River Complexity Index (RCI)[7] from 2.23 to >12 at 750 cfs)
- Increase channel sinuosity (increase sinuosity by >20%)
- Decrease stream power and increase velocity diversity (reduce excess transport capacity <0)
- Increase quality and quantity of habitat diversity, especially the presence of large wood debris and pools (target: 2 key pieces per channel width, place whole trees in channel)

Improving channel characteristics at the project site is primarily driven by <u>in-channel wood structure</u> installation, though other proposed design elements provide complimentary benefits which support the performance criteria in this category. In-channel LWS are designed to interact with near all flows, but the lowest flows when surface flow is not present in the vicinity of the LWS. The Apex LWS are placed out into the main channel with at least 1/3 of their length to be engaged with low flows. The position of each LWS will be field fit to optimize low flow engagement and

[7] The River Complexity Index (RCI) is a method used to measure the complexity of a river at bankfull flow. It involves taking the product of the reach's sinuosity and node density, which is a measure of channel connections in a reach. This method was proposed by Brown in 2002 and further detailed by Buelow et al. in 2017.

function for conditions at the time of construction. These structures mimic the structure and function of cottonwood stands, provide cover, and by incorporating wood that is stable at these structures will facilitate geomorphic processes key to the formation and maintenance of in-channel aquatic habitat features and the development and maintenance of naturally formed connected floodplain surfaces. Apex-style in-channel LWS will drive lateral channel adjustment, which is anticipated to result in increased channel sinuosity. All wood structure types will add hydraulic roughness to the site, which will decrease stream velocities and increase inundation across the site. In the Floodplain Reveal Treatment Reach, wood structure operating in conjunction with decreased bank height due to floodplain reveal excavation will reduce stage-discharge relationships at the site. By decreasing flow velocity and accommodating high flows across the floodplain, sediment transport capacity is anticipated to decrease substantially at the site, and potentially lead to bed aggradation. In the Large Wood Treatment Reach the installation of LWS will drive increased hydraulic heterogeneity throughout the channel, which is anticipated to facilitate the physical channel processes (channel migration, sediment sorting, mobile wood retention) which will promote channel complexity over time.

Risk of Failure to Perform

Failure to perform on the channel characteristics criteria would result from project elements not producing the geomorphic response and habitat formation to the degree specified in the listed goals. The installation of LWS in the channel will immediately deliver wood loading targets, and it is anticipated that these targets will be met until flows exceed the design stability threshold for LWS or the wood degrades. Similarly, LWS will provide immediate complexity and hydraulic roughness to the channel and continue to deliver these benefits over the design lifespan of the wood structures. Channel complexity, sinuosity, and decreased channel complexity are anticipated to result as the site evolves following the implementation of large wood elements in the channel. Channel treatment elements are anticipated to enhance lateral channel processes, and floodplain benching may increase the likelihood of channel avulsion, but both outcomes are not anticipated to be detrimental to project performance, as long as major channel changes do not occur before vegetation has established on the floodplain reveal surfaces or other area adjacent to the LWS.

1.6.3 Floodplain and Riparian Conditions

Design goals and performance criteria which pertain to floodplain and riparian condition limiting factors at the project site include the following:

- Remove invasive false indigo at the project site
- Increase riparian cover and shade (by 50-75%)
- Increase vegetation structure and diversity (heights, patch size, and distribution)
- Increase area suitable for cottonwood seeding recruitment
- Increase inundation at biogeomorphically significant flows
- Significantly increase the evenness and richness (Simpson's diversity index) of canopy height classes within the active channel corridor

- Decrease the average depth of the water table to <1.5 feet, the elevation assumed to support desirable riparian vegetation for a large position of the project area
- Increase connected wetland and backwater areas at 2-year recurrence interval flow (channel-floodplain connectivity for 25-50% of available valley bottom at 2-year flow)

Improving floodplain and riparian conditions at the project site is primarily linked to floodplain reveal excavation, and revegetation and vegetation management elements. Given the large scale of this project area, the history of agricultural management, and the prevalence of invasive species in the watershed, restoring desirable vegetation communities will be incredibly challenging. It is anticipated that the highest likelihood of success is in Floodplain Reveal Treatment reach, where the relative height above river (HAR) will be reduced, allowing for natural recruitment of cottonwood (expected between approximately 2 feet (0.6 meters) and 6.6 feet (2.0 meters) above the low water table (Mahoney & Rood 1998)) and shrub-type willows (expected to be at a similar elevation to current False Indigo communities (see Figure 25). Floodplain reveals will also facilitate increased floodplain inundation and wetland and backwater connections to the channel at target design discharges. Floodplain and off-channel LWS will pair with targeted willow and cottonwood plantings at the site to deliver hydraulic diversity across the excavated floodplain surfaces. Removal of anthropogenic barriers and bank stabilization measures will be part of the floodplain excavation efforts. False indigo removal will be implemented across the project site; however, it is acknowledged that a prior False indigo removal effort was completed and following a large-scale flood, false indigo immediately re-established. In the Large Wood Treatment Reach the addition of in-channel LWS in the channel is anticipated to decrease channel conveyance, which should decrease the magnitude and increase the frequency of floodplain inundation and channel-floodplain connectivity. Additionally, sediment sorting and channel dynamism associated with increased hydraulic heterogeneity may deliver the substrates and surfaces required for cottonwood seedling recruitment.

Risk of Failure to Perform

Failure to perform on the floodplain and riparian criteria would result from decreased floodplain connectivity and/or failures relating to revegetation efforts. The risk of failure of floodplain connectivity may occur if a large volume of fine sediment is rapidly deposited on the floodplain reveal surfaces (likely by one or multiple large floods) shortly after project implementation. If sediment aggradation outpaces vegetation growth, there is significant risk.

1.6.4 Engineering and Risk

- Do not increase flood inundation extents or depth surrounding public/private infrastructure or in areas other identified by landowners, unless compensating/mitigation measures are taken.
- Do not increase erosion potential near public or private infrastructure or in other areas identified by landowners, unless compensating/mitigation measures are taken.
- Provide stabilization of placed large woody material to withstand the 25-year peak flow, with a factor of safety commensurate with the risk to public safety and property damage.

Risk of Failure to Perform

Failure to perform in the engineering and risk category may create a hazard to the public and increase the risk to private property and infrastructure. The consequences of failure to perform on the habitat geomorphology/hydrology project criteria need to be balanced against and viewed with regard to the consequences of failure related to public safety, health and welfare. These include hazards such as: floods, loss of property via. erosion, damage to property via. LWS destabilization, and other safety hazards that may develop as a result of project failure. This standard of engineering practice is established in the first canon of engineering ethics:

> *"Engineers shall hold paramount the safety, health and welfare of the public and shall strive to comply with the principles of sustainable development in the performance of their professional duties. … Engineers should be committed to improving the environment by adherence to the principles of sustainable development so as to enhance the quality of life of the general public." (ASCE 20017).*

Therefore, the projects design has been approached with the objective of improving habitat (i.e. the environment) and restoring natural processes while holding paramount the safety, health and welfare of the public. Given the projects setting, the risk to public and private infrastructure as well as the safety, health and welfare of the public are minimal. The road bridges upstream (Luckenbill Rd.) and downstream (Touchet North Rd.) of the project site are outside the extent of hydraulic influence from the project. The downstream bridge does not have any piers, and the next downstream bridge is over 1 mile downstream. The are no insurable structures within the extent of the project's hydraulic influence. Therefore, the consequences of LWS failing to perform are local to the project extent and were used to calibrate the level of design stability.

1.6.5 Construction Impacts

Construction impacts will be reduced to the extent practicable by following these guidelines:

- Minimize impacts to fish during the construction process by reducing the need for dewatering, river diversion, and worksite isolation during construction.
- Locate and configure construction access routes to use existing access where possible and to minimize impacts to existing mature riparian vegetation.
- Work with onsite resources or plan floodplain alignments to take advantage of existing natural features where feasible (e.g. trees, low swales in landscape)
- Phase work so that the interrelated benefits of invasive species removal, LWS construction, and revegetation can realize their benefits without excessive inputs of sediment to the system.

Risk of Failure to Perform

Failure to perform in the construction impacts category may result in excessive short-term degradation of the environment and potentially a direct loss of fish. Construction impacts are generally reduced through thoughtful design, clear and practical permit requirements, and best management practices. This project has been designed to incorporate each of these things. Additionally, the presence of the design engineer (or representative), the client's representative, and landowners during construction can help avoid unnecessary impacts by adjusting the design to preserve desirable features (e.g., trees and other native vegetation) without reducing the project's habitat benefit.

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

Areal extents of project elements are included on the Plans. Construction will take place during the permitted in-water work window, unless otherwise coordinated and approved in writing by appropriate regulatory agencies.

2. Resource Inventory and Evaluation

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

The project area has been directly impacted by intensive riparian clearing, floodplain grading, channelization, bank armoring, and levee construction. In addition to substantial local impacts to the channel, floodplain, and riparian corridor, degraded watershed conditions have led to a variety of impacts which are experienced across much of the Touchet and Walla Walla basins. Degraded watershed conditions include the following items which impact habitat formation and maintenance at the project site:

- *Large scale soil erosion across the basin due to agriculture*. The Walla Walla and Touchet basins have a long record of elevated suspended sediment loads (USGS 1969) and documentation which highlights large-scale soil erosion throughout much of the watersheds and the region following the commencement of agriculture in the area (USDA 1979, USGS 1998). Observations made by Beechie, and others (2008) suggest that up to 1m of soil loss has occurred in the last 135 years at a site near to the project area. The Touchet basin is estimated to have an annual sediment yield of approximately 1,500,000 m^3 (USGS 1969). It is acknowledged that remedying soil loss and potential transport from soil erosion sites into the project reach is outside the scope of this effort.
- *Summertime water availability and temperature:* The Touchet River and the unconfined gravel aquifer which it flows through are heavily allocated for irrigation, which has led to reduced summertime streamflow (CCD 2020; Scherberg et al. 2018). For example, a discharge of less than 10 cfs was recorded at the nearby DEO gage over 800 days between 2003 and 2021, and a value of less than 2 cfs was recorded for over 150 days in that same period. Low baseflow discharge has combined with high summertime water temperatures to make conditions unsuitable or lethal for salmonids and other aquatic species for portions of the year in the lower portions of the basin. CTUIR is involved in a parallel effort within this project area to return some instream flow during baseflow periods via relinquishing senior irrigation rights.

2.1.1 Examples of Impacts to the Channel, Floodplain, and Riparian Corridor

Key impacts to the channel, floodplain, and riparian corridor at the project site can generally be grouped into three categories, which are described in the following bullets:

- *Channelization and bank stabilization*. Observations of aerial imagery and LiDAR suggest the current channel has been straightened in several locations throughout the project site, and the channel may have been forced to the valley margins in places (Figure 9). Several straightened channel segments bounded by pushup berms and/or bank armoring are present at the site, and a test pit excavated along these straightened reaches (Figure 28) revealed coarse non-alluvial material in the subsurface, which was likely placed during the channelization process (Figure 9). Riprap was found in multiple locations throughout the project site, both related to discrete infrastructure protection (pumps, road crossings, etc.) and in continuous placements along sections of the bank.

Figure 9: Photo of straightened channel segment at the project site (left). Photo of test pit excavated along the right bank of the photo at left showing substantial coarse, angular non-alluvial material likely placed during the channelization process.

- *Floodplain grading*. At several locations in the project site, the floodplain was graded to remove floodplain channels and/or swales to expand the area of agricultural fields in the valley and/or to improve access to fields (Figure 10). The commencement of valley bottom agriculture predates the aerial photo record of the site (1952-present), but several instances of floodplain grading are recorded in the photo series, and substantial floodplain grading is likely to have occurred prior to 1952.

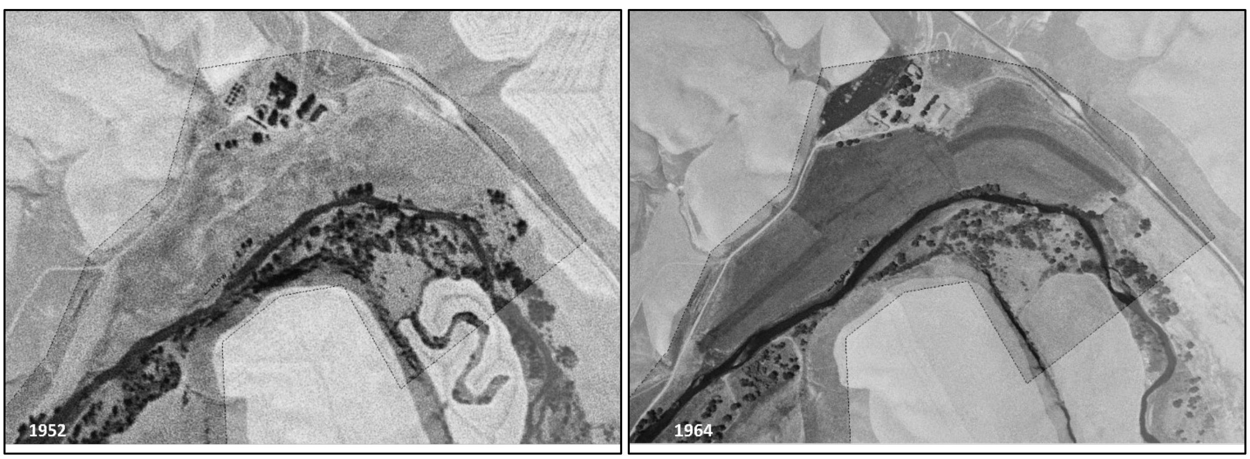


Figure 10: Aerial photos from 1952 (left) and 1964 (right) focusing on the uppermost portion of the project area where a well-defined floodplain channel visible in the 1952 image (valley left upstream end) was filled and incorporated into an agricultural field by 1964.

- *Riparian forest clearing*. Journal entries from Lewis and Clark suggest that the site supported "some" and "partial" presence of riparian forest prior to Euro-American settlement:
  - "There is some timber on this Creek. It consists of Cotton wood, birch, the Crimson haw, red willow, Sweet willow, Choke Cherry, yellow Current, goose berry, white berried honey suckle, rose bushes, Seven bark, Shoemate, and rushes in some parts of the bottoms" (*Second Lieutenant William Clark | April 30, 1806*).

- "…narrow bottoms partly covered with Small timber." *Sargent John Ordway | April 30, 1806*

While riparian vegetation likely had been substantially diminished by 1952 (the beginning of the aerial photo record), the aerial photo record recorded clearing of much of the remaining riparian vegetation from 1952 to the 1990s (Figure 11). Conservation measures have returned some riparian vegetation along the channel since the 1990s, but the contemporary riparian corridor is narrow, and the corridor is composed of small shrubs which provide limited shade and are not large enough to persist in the channel, moderate lateral migrations processes, and drive complexity and habitat forming processes.

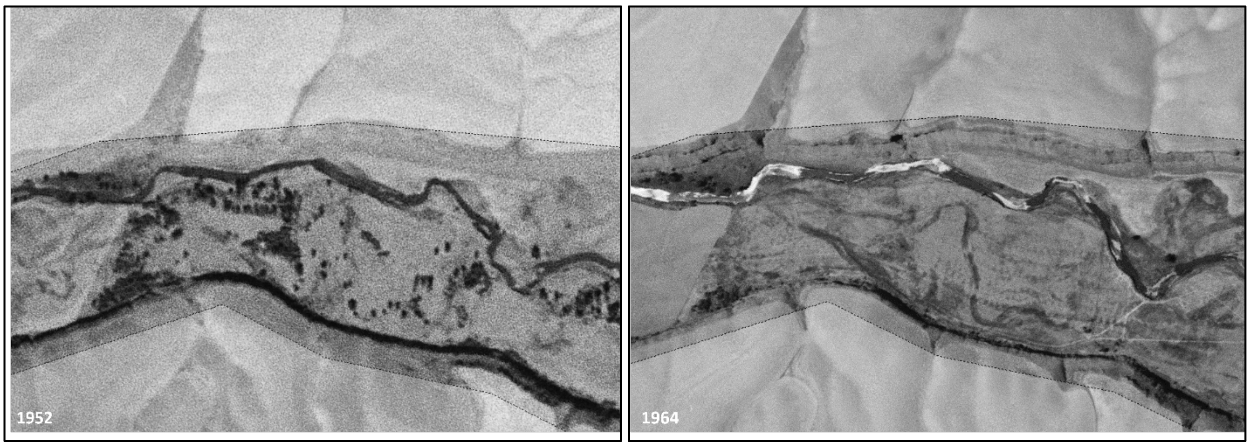


Figure 11: Aerial photos from 1952 (left) and 1964 (right) focusing on the lower portion of the project area where floodplain vegetation (likely cottonwoods) in the 1952 image were removed by the 1964 image.

2.1.2 Historical Valley Bottom Change at the Project Site

Building off the previous section, the earliest written descriptions of the valley bottom come from Lewis and Clark Journals. These 1806 notes provide some description of historical vegetation and channel form, including:

"…a bold[8] Creek 10 yards wide."

"…deep and has a bold Current."

"…the narrow bottoms of this Creek is fertile. tho' the plains are pore & Sandy."

"We encamped at the place we interspersed the Creek where we had the pleasure once more to find a sufficiency of wood for the purposed of making ourselves comfortable fires, which had not been the case since we left Rock fort Camp."

[8] Terms similar to "Bold Creek" in the Lewis and Cark expedition journals are used consistently to describe either 1) a water way with a single dominate channel having concentrated current and sufficient depth that you could navigate with a boat or canoe, or 2) a fast-moving stream with clear water that is prominent on the landscape.

"There is some timber on this Creek. It consists of Cotton wood, birch, the Crimson haw, red willow, Sweet willow, Choke Cherry, yellow Current, goose berry, white berried honey suckle, rose bushes, Seven bark, Shoemate, and rushes in some parts of the bottoms."

Second Lieutenant William Clark | April 30, 1806

"We had the pleasure to once more find an abundance of good wood for the purposes of making ourselves comfortable fires…"

"…through an open level sandy plain to a bold Creek 10 yds. wide."

"…it appears to be navigable for canoes; it is deep and has a bold current."

"…the narrow bottom of this is very fertile, tho' the plains are poor and sandy."

"I observed the corngrass and rushes in some parts of the bottom."

Captain Meriwether Lewis | April 30, 1806

"…narrow bottoms partly covered with Small timber."

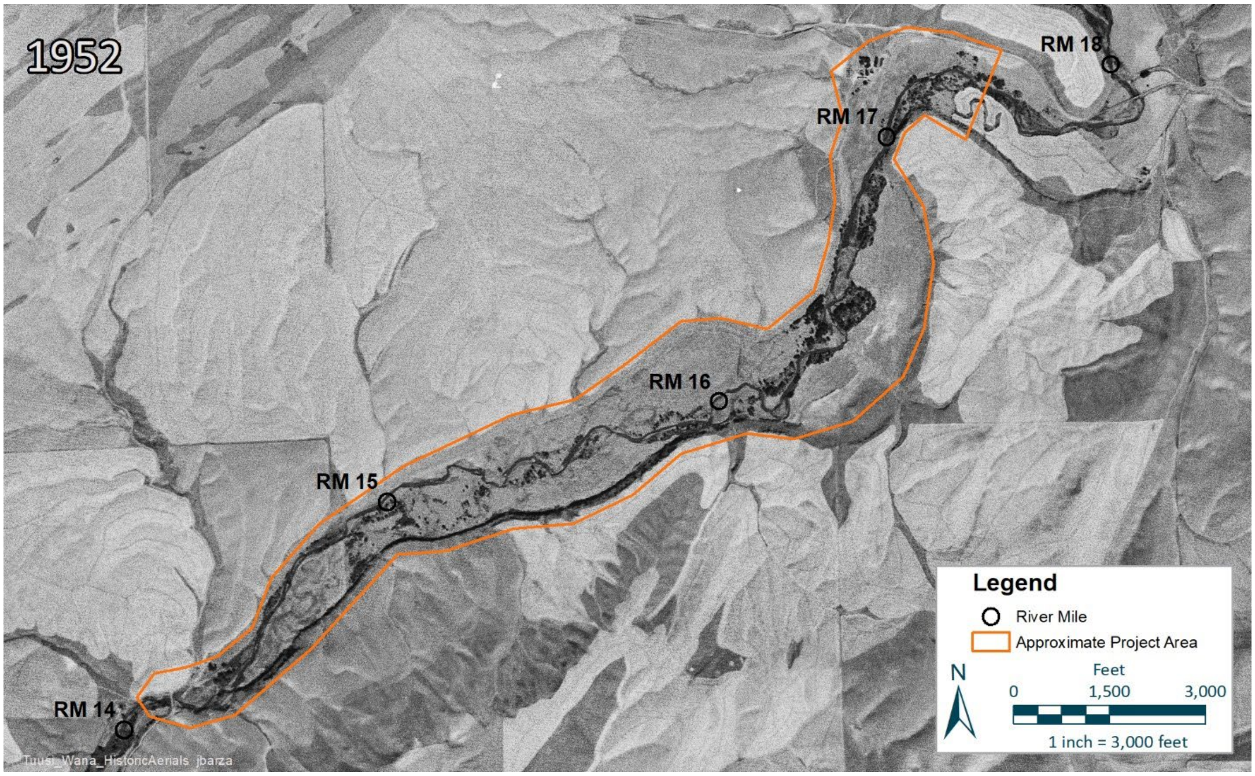
Sargent John Ordway | April 30, 1806

Building off these clues regarding vegetation composition and channel form, this section includes the full available aerial image record of the site from 1952 to the present (Figure 12, Figure 13, Figure 14, Figure 15) and a discussion of impacts to the valley bottom in the historical period.

A departure from the conditions Lewis & Clark describe is evident by 1952, when channelization, floodplain grading, vegetation clearing, and bank armoring appear to have been evident. This continued to accelerate in scope and scale through the 1970s. These actions are evident by meander scars and channels visible in the 1952 aerial disappearing by the 1964 aerial (Figure 12). These actions were likely both a desire to maximize land productive for agriculture and as a reaction to flooding in the 1960s and early 1970s and have straightened the channel and reduced its ability to migrate within the floodplain as compared with historical conditions.

The 1952 aerial image shows farm fields along both sides of the river, with Luckenbill Bridge already in place. The group of farm buildings and the associated farmhouse are already in place in the same location today. A sinuous planform of the river channel is visible at the upstream end of the approximate project area (Figure 12, 1952 aerial), and is soon not visible due to apparent agricultural-related floodplain grading (Figure 12, 1964 aerial). Some riparian clearing has occurred by this time (when compared with the Lewis & Clark notes), and no in-channel wood is visible. Further, multiple sinuous swales and off-channel features that are visible in the 1952 aerial and are lined with apparent cottonwood trees, appear cleared and graded by 1964 and 1976. The riparian area along both banks was largely cleared between 1964 and 1976. Large areas of scour or grading are located along the floodplain, and nearly all trees are cleared by the 1976 aerial along the floodplain and both banks. Beginning in the 1996 aerial, aerial images show a return of trees and shrubs in several areas along the channel. Today, the riparian community is spare and lacks large trees which provide shade and cover to the channel and off-channel habitats and could serve as geomorphically effective pieces of large wood in the channel.

While the project area has been altered by floodplain aggradation, channelization, bank armoring, and riparian/floodplain clearing it should be noted that natural flow regimes can also impact site conditions. Flood frequency analysis, and comparison with historical aerials, can provide an overview of when large-scale flood events have driven channel change and associated responses. While the nearby Touchet River gages have limited periods of record, the Walla Walla River has been used as a reference gage (Section 4.1.20) to gain a general sense for when large flow events likely occurred in the Touchet River. These recurrences are therefore very approximate and are only used here to scale interpretation of the below aerial photographs and may have led to apparent high flow channel scars and associated cottonwood germination events. Approximate 5-year events occurred in February 1952 and January 1953, 1969, and 1971; a 10-year event occurred in February 1996; a near 25-year event occurred in January 1959; a near 50-year event occurred December 1964; and a near 100-year event occurred in January 1949 (see Figure 29).



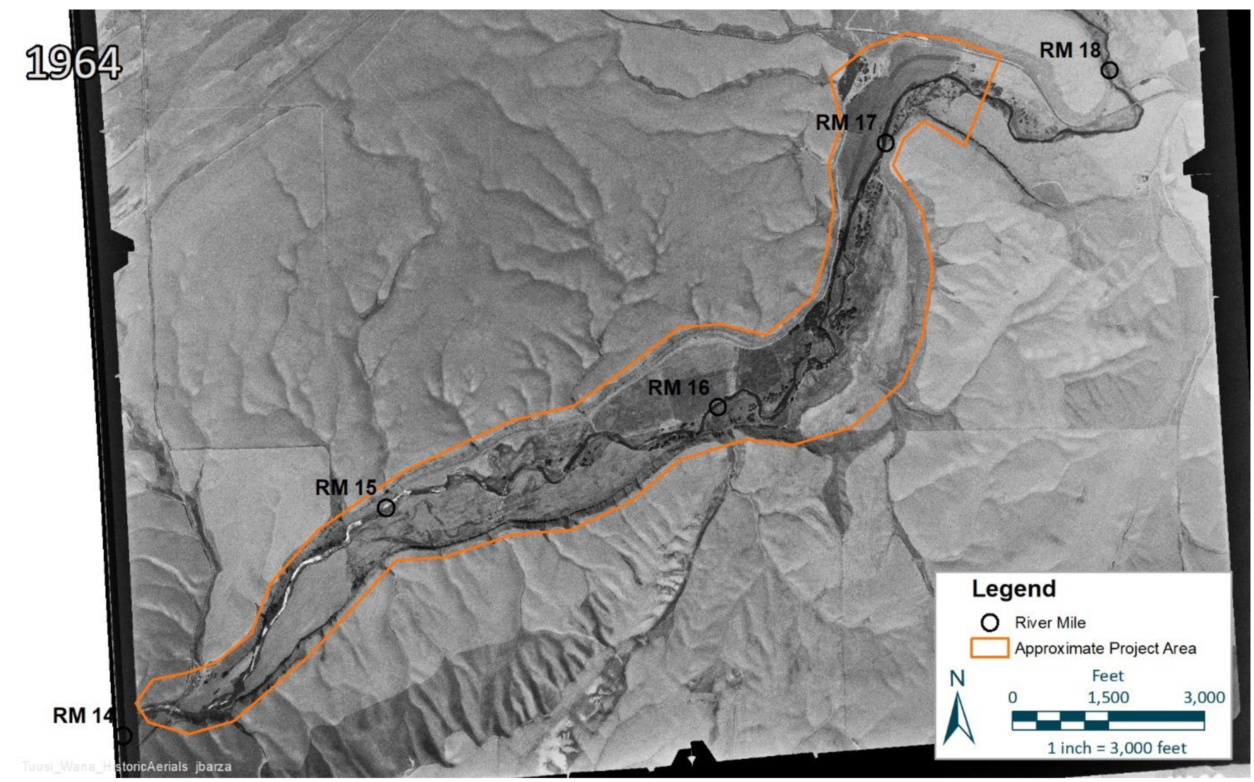
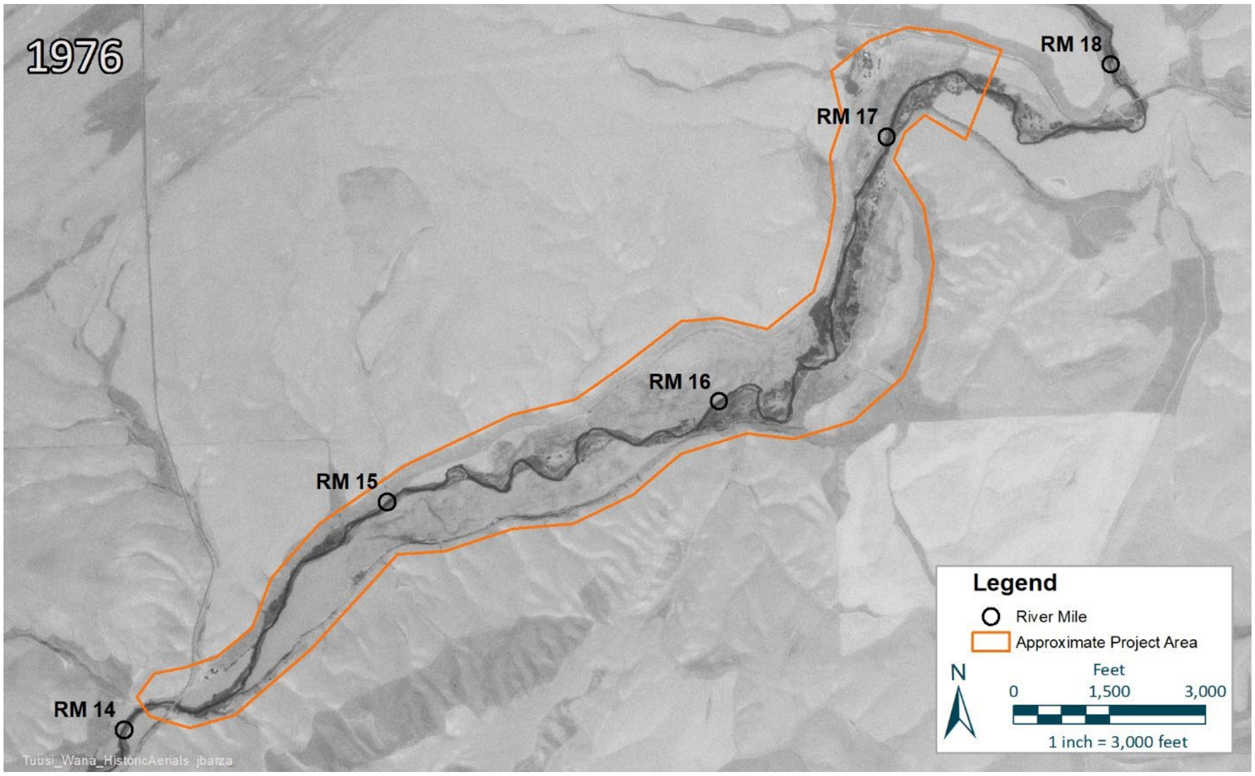


Figure 12: Aerial imagery from 1952 and 1964. Note, a nearly 100-year event occurred in 1949, approximate 5-year events occurred in 1952, 1953, a near 25-year event occurred in 1959, and a near 50-year event occurred in December 1964.



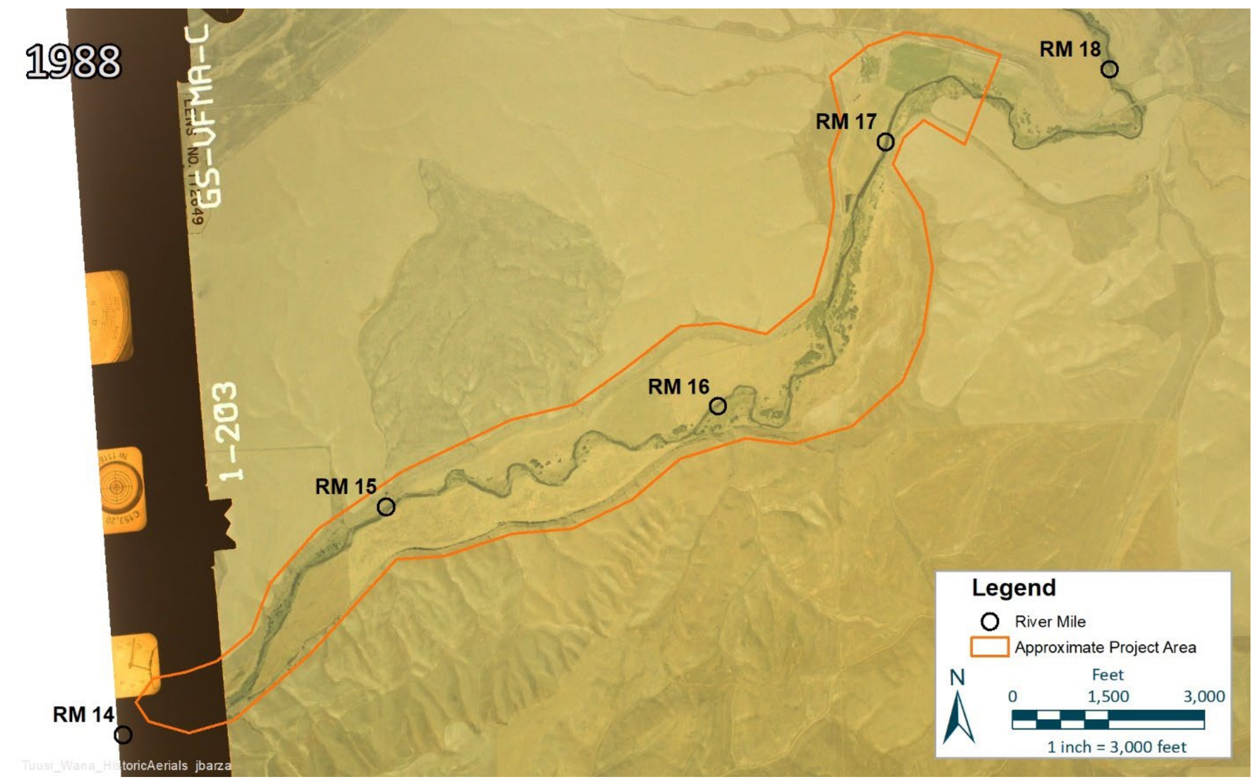
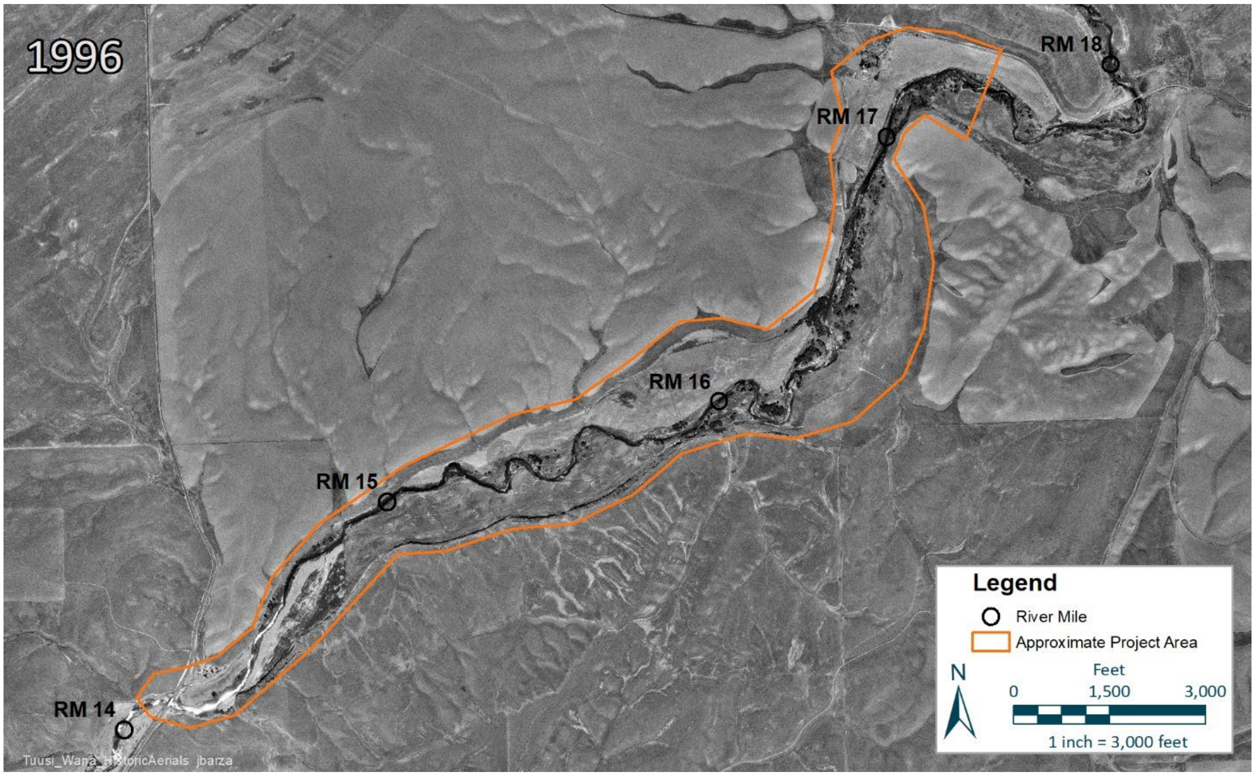


Figure 13: Aerial imagery from 1976 and 1988. Note, approximate 5-year events occurred in 1969 and 1971.



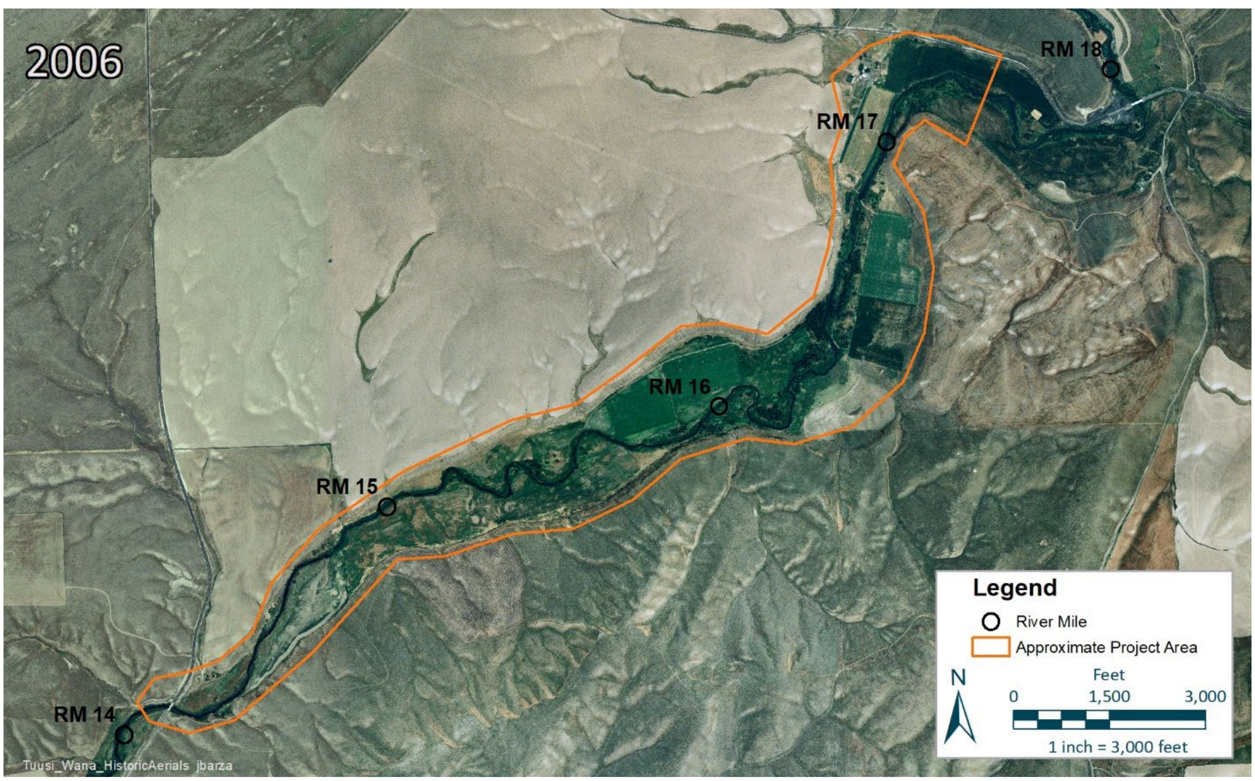


Figure 14: Aerial imagery from 1996 and 2006. Of note a 10-year event occurred in 1996.

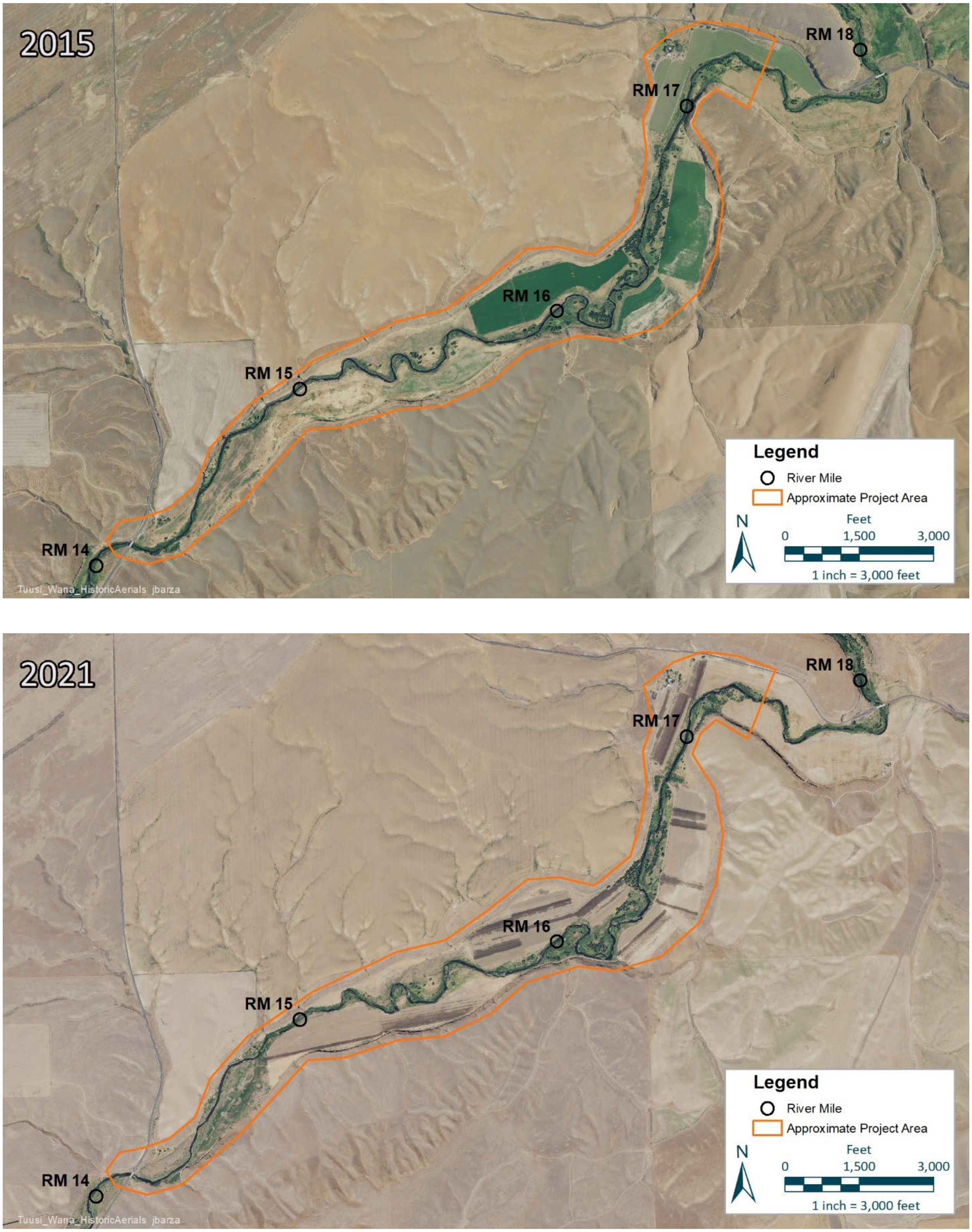


Figure 15: Aerial imagery from 2015 and 2021.

2.2 DESCRIPTION OF EXISTING GEOMORPHIC CONDITIONS AND CONSTRAINTS ON PHYSICAL PROCESSES.

The following subsections provide background regarding the geology and geomorphology of the project site and discuss existing and impaired geomorphic processes to provide context for design decisions described elsewhere in this report.

2.2.1 Geology, Valley Morphology, and Late-Quaternary Landscape Evolution

The project area occupies the entire Touchet River valley bottom from roughly RM 14 – 17. At the site, the Touchet River has a channel slope of 0.2% and drains a watershed of 700 mi^2 which receives roughly 25 inches of annual precipitation, when averaged across the basin. The Touchet River valley bottom at the project site lies roughly 100-200 feet in elevation below the neighboring hills, and the valley bottom is bounded by steep, often near-vertical, valley sides composed of exposed outcrops of basalt bedrock or basalt mantled by shallow colluvium. The channel is laterally unconfined as the valley bottom width at the project area ranges from roughly 700-2000 feet. An overview of the morphology of the Touchet River valley at the project site is shown in Figure 16.

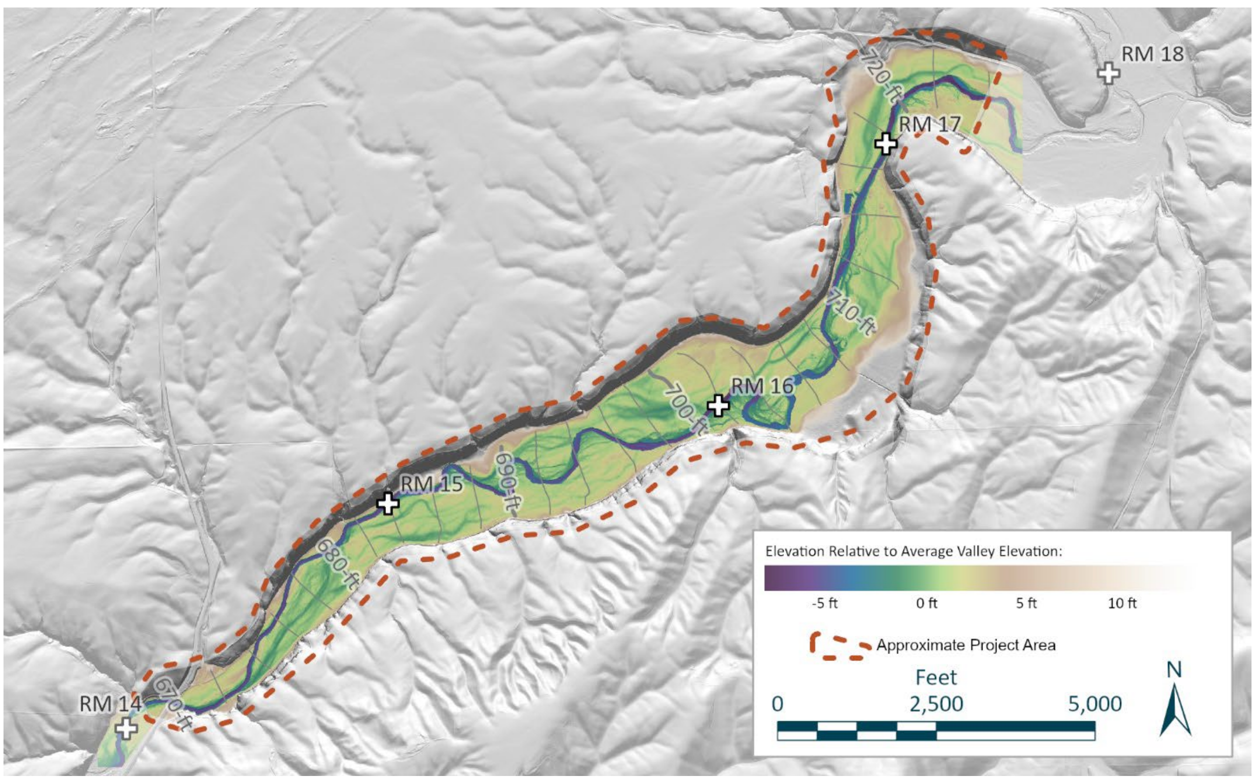


Figure 16: LiDAR elevation data of the project area, showing hillslopes, and historical floodplain areas.

Geologic mapping of the project area (Washington Division of Geology and Earth Resources 2016) identifies the following units within the project area (Figure 17), listed in age from oldest to youngest:

- Miocene age basalt bedrock (Mv(wfs)) outcropping along the valley walls.
- Pleistocene age Touchet Beds (Qfs(t)) are present along the valley walls and margins.
- Quaternary age (likely Holocene) alluvium (Qa) extending across the valley bottom.
- Quaternary age (likely Holocene) alluvial fans (Qaf) located along the valley margins where ephemeral drainages join the valley.
- Additionally, while not mapped within the project area, Quaternary age dunes (Qd) and eolian loess (Ql) are mapped on the hillslopes surrounding the project area.

Geologic mapping of the site was performed at 1:100,000 scale, so the location of some geologic contacts may not match the exact location of outcrops at the site, and several small landforms/outcrops that were observed in the field are not noted by the Washington Division of Geology and Earth Resources (2016) mapping, but field observations from site visits for this project agree with the general geologic framework shown for the site. In general, the valley is bound by basalt bedrock hillslopes, which were covered by fine grained Pleistocene outburst flood backwater deposits (Touchet Beds) during the Missoula Floods, occurring from roughly 12 - 15 kiloannum (k.a.) ago (Spencer and Knapp 2009). Missoula Flood deposits in the project area vicinity are present due to backwatering of the flood waters upstream of Wallula Gap, and these deposits consist of graded silt and sand deposited in a series of rhythmic beds (Bjornstad 1980) associated with over 40 mega flood events (Waitt 1980; 1985). Sediment deposits associated with later phases of the Missoula Floods were placed contemporaneously with the Mt. St. Helens S tephra (roughly 13 k.a. ago) which provide age control and telltale marker for late-stage Missoula Flood sediments (Bjornstad 1980; Clague et al. 2003).

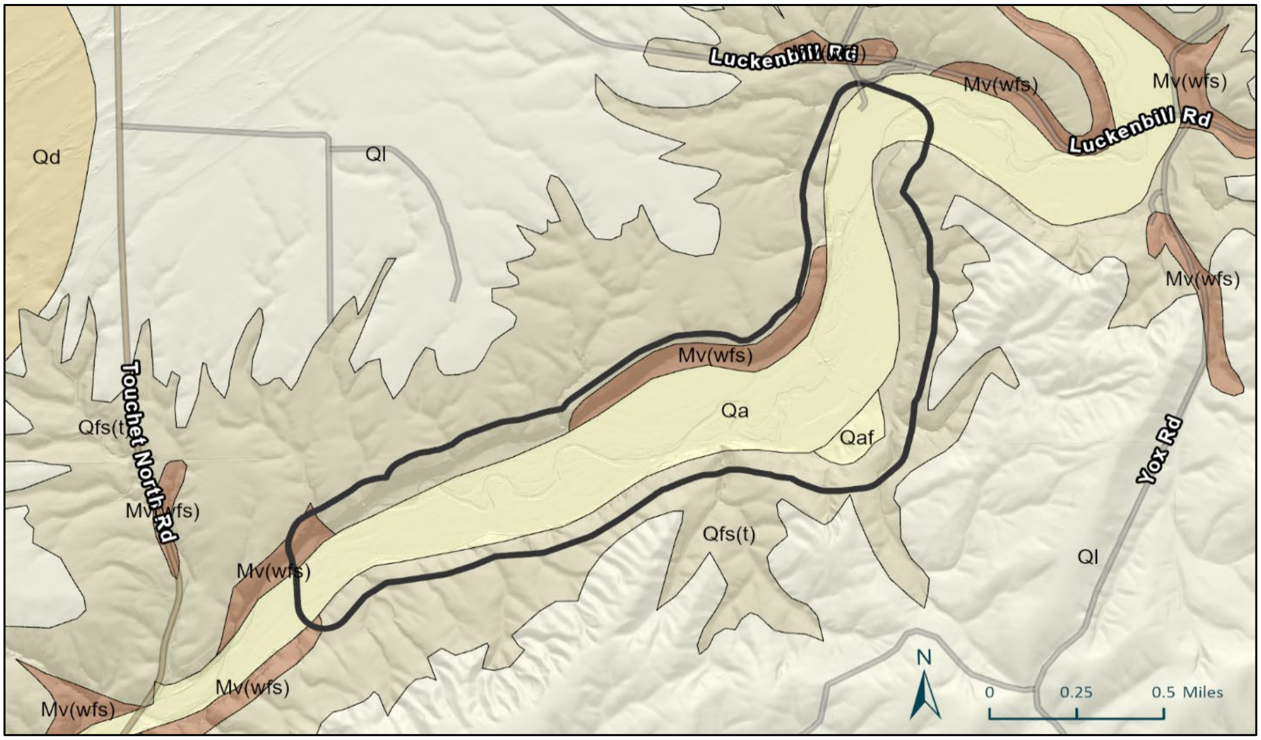


Figure 17: Geologic map of the project area. Geologic data are from Washington Division of Geology and Earth Resources (2016).

Following Missoula Flood deposition in the project area, fluvial and hillslope processes have eroded reworked Touchet Bed material stored in the Touchet Valley, preserving Touchet Bed material in places along the valley margins, like that documented by Spencer and Knapp (2009) a few miles upstream of the project area (Figure 18). Eolian deposition of loess and potentially sand sourced from a nearby dune field may overlie Touchet Bed and other late-Quaternary sediments in the project area that are stable over longer time periods, also like the findings of Spencer and Knapp (2009). Alluvial fans and valley bottom surfaces have developed at the site, and while these landforms likely incorporate sediments reworked from Touchet Bed deposits, these alluvial deposits reflect modern fluvial processes of erosion, transport, and deposition responsible for their formation.

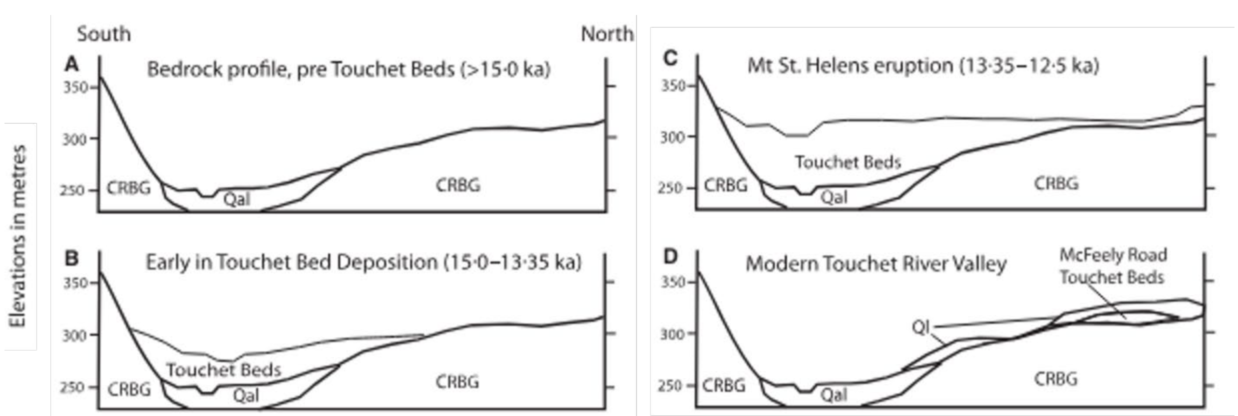


Figure 18: Generalized Late-Quaternary evolution of the Touchet River Valley (modified from Spencer and Knapp (2009)).

Field and desktop observations suggest that Touchet Beds may be preserved in limited locations through the project area as valley-margin terraces where the channel has not migrated and removed the sediments, though these locations have not been thoroughly analyzed to confirm the presence of Touchet Bed deposits in the valley bottom of the project area. At least one of these older landforms which may be composed of Touchet Bed material is actively eroding, pointing to the limits on residence times by fine sediments in valley bottoms (Figure 19).

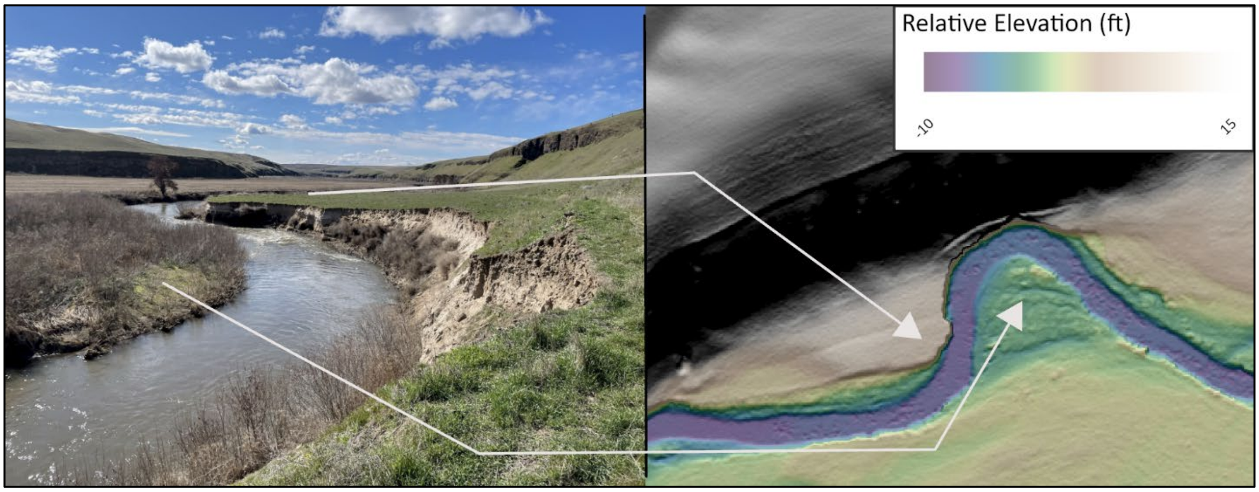


Figure 19: Photo of a high, valley-margin terrace which displays distinct bedding of fine sediments (left) and a relative elevation map of the same landform (right).
The stratigraphy and landscape position of this landform suggest that this may be a rare example of preserved Missoula Flood sediments (Touchet Beds) in the project area.

Lack of discernable stratification along channel banks and within test pits (Figure 23) suggests the surface comprising the majority of the valley bottom was formed by large scale floodplain aggradation during one or multiple large floods. This is primarily evidenced by an unstratified layer of sandy silt eight to ten feet above gravel alluvium observed along channel banks and within test pits as well as an absence of discernable alluvial stratigraphy and/or substates associated with in-channel or channel margin deposition and a lack of buried soil horizons in the valley bottom stratigraphy. It is acknowledged that there is uncertainty regarding this hypothesis and that test pits were limited to the river right side of the project area due to channel crossing limitations. Of note, planned additional test pits for the Spring of 2024 requested by the SRFB were unable to occur due to equipment challenges. A ground penetrating radar (GPR) evaluation of valley bottom sediment and groundwater characteristics was attempted in summer 2024 to inform design efforts, but these investigations were not successful due to an equipment malfunction which limited the depth of radar imaging to roughly 1-2 feet. The data collected as a part of this investigation is not suitable to evaluate the sedimentological and stratigraphic properties of valley bottom sediments to the degree required to satisfy review comments and substantively change the design approach at this time. Further investigation by test pits and trenches was attempted, but access constraints and technical issues provided only limited data insufficient to fill the data gap.

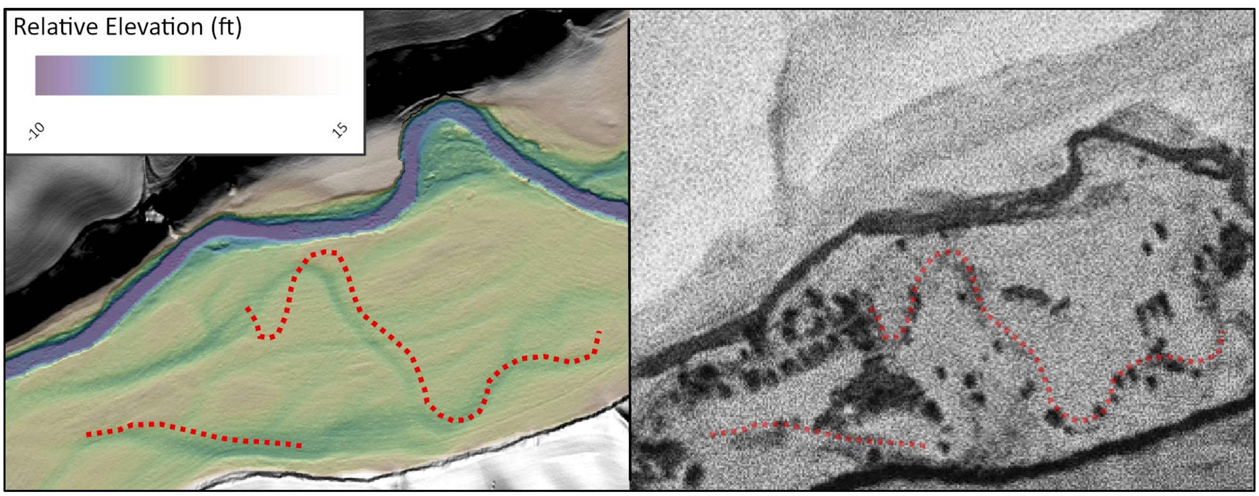


Figure 20: Relative elevation mapping (left) and 1952 aerial imagery (right) of the abandoned floodplain surface which comprises much of the project site.
Red lines highlight former channel scars or swales visible on both maps.

The most recently formed alluvial surface (Figure 21) at the project site is a connected floodplain inset to elevated valley bottom surface. This contemporary floodplain has formed in response to lateral channel changes and active fluvial reworking of sediments in the channel bed and banks. This surface is approximately 2-4 feet above the modern channel bed, displays substantial local topographic variability, shows evidence of fluvial reworking, and is mostly found in areas where the channel has occupied since approximately 1950 and since migrated away from that location (Figure 22). This surface is connected to the channel at semi-regularly occurring flows (~2-year return period), and woody riparian species densely cover this surface along the channel margins in most locations.

Figure 21 : Active contemporary (modern) alluvial surface (left) and material on active point bar (right).
This surface correlates with channel traces and signatures visible on LiDAR (Figure 21).

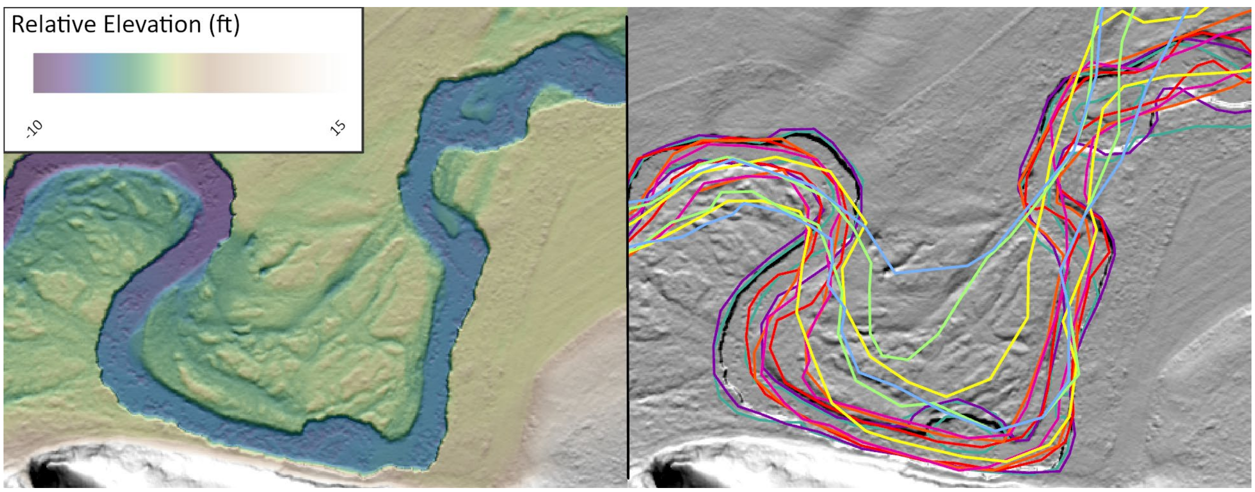


Figure 22: Relative elevation mapping (left) and a LiDAR hillshade overlain with channel traces (right) delineated from historical images (1952-2021) highlighting areas of modern, inset floodplain at the site.
The modern floodplain is located in areas where the channel has recently been located and reworked the valley bottom.

2.2.2 Modern Geomorphic Conditions, Processes, and Constraints

Geomorphic conditions in the project area have been heavily impaired by fine sediment inputs, channelization, bank armoring (riprap), floodplain grading, and riparian clearing. The channel is isolated from the valley bottom throughout most of the site, with 8-10+ foot tall banks composed of silt-sized sediment overlying 1-2 feet of basal gravel commonly found along the channel, including in banks and on point and mid-channel bars being actively reworked by the channel. Test pit excavations on the floodplain show that the primary valley bottom surface displays similar stratigraphy to that of the banks (Figure 23) (8 to 10+ of silt with no discernable organic matter layers or alluvial sorting overlaying basal gravels 1-2 feet atop the water table). Recently formed gravel bars in the channel have similar elevations to the tops of basal gravels visible in the channel banks, and to basal gravel elevations observed in test pits. This finding, coupled with a lack of stratigraphic evidence in the test pits (such as alluvial deposits, remnant organic matter/material) or channel banks lack conclusive evidence that the channel occupied higher bed elevation throughout the project. These observations suggest aggradation of fine sediment on the floodplain, rather than channel incision, a primary driver of disconnection between the channel and the floodplain, however it is acknowledged that there has been no carbon dating of the floodplain surfaces as part of this or any parallel efforts. Through the external review of this project with Beechie and Kondolf (Inter-Fluve 2024), there was acknowledgement by reviewers that there have been competing hypotheses since in recent decades regarding the fine sediment stored in the valley bottom and there is no conclusive evidence (e.g., carbon dating sourced from floodplain stratigraphy) to corroborate the most likely root cause of the valley bottoms elevation above alluvial channel bed since European settlement began

Riparian clearing has reduced wood recruitment potential and floodplain roughness. While cottonwood stands were likely limited historically to the channel margins and active channel migration corridor (see Lewis & Clark notes), this historically would have driven lateral channel change (e.g., split flow conditions, moderated rates of lateral channel migration) and promoted the development of in-channel complexity. Anthropogenic alterations have resulted in a simplified and confined channel, and the channelization, straightening, and associated loss of length of the river has potentially led to minor channel incision at the site. The impaired wood and excess sediment regimes and anthropogenic confinement of the channel at the site has decreased the channel’s ability to adjust laterally and create a modern, connected floodplain throughout much of the site, and only small areas of connected floodplain associated with recent meander migration are present.

Figure 23: Annotated example of a test pit dug at Túuši Wána project area.
The water-table was measured at 12 feet below existing ground, with alluvium measuring 8 to 10 feet below existing ground surface. The elevation of the alluvium and water table closely matches the alluvium and water table elevations at the river.

2.3 DESCRIPTION OF EXISTING RIPARIAN CONDITION AND HISTORICAL RIPARIAN IMPACTS.

Lewis and Clark passed near the project site from April 30 to May 1, 1806. Their journals describe the following (University of Nebraska Press 2005):

> *"…small cotton trees, birch, elder rose, Crimson haw, red willow, Sweet willow, Choke Cherry, yellow current, goose berry, white berried honey suckle, rose bushes, Seven bark, Shoemate, and rushes."*
>
> *"…we had the pleasure once more to find an abundance of good wood for the purpose of making ourselves comfortable fires, which has not been the case since we left rock fort camp"*

Riparian clearing began early in Euro American settlement and has occurred throughout the project area, continuing until at least 1996. This has resulted in an immature riparian community which provides limited shade, limited structure to drive and moderate channel migration, and limited instream wood sources compared to historical conditions. Floodplain aggradation also disconnected substantial portions of the valley bottom from intermediate flood events (e.g., 2-year, 5-year). This, combined with agricultural clearing and grading and assertion by non-native riparian species (e.g., False Indigo), has resulted in a valley bottom largely devoid of floodplain vegetation assemblages that would be typical of the region's intermediate floodplain surfaces (e.g., cottonwood). Field observation and examination of the aerial photo record suggest surfaces were cleared of the remainder of vegetation by the 1970s and consequently contain primarily pasture grasses with few remnant cottonwoods visible from historical flood events. In recent decades, as the smaller inset point bars and floodplains have developed along the actively migrating channel corridor, riparian plant assemblages have occupied these surfaces. Many of these surfaces have been occupied by False Indigo (*Amorpha fruticosa*), which was planted by the Civilian Conservation Corps in an effort to halt stream erosion (J. Gailey, personal communication, May 5, 2022). False indigo now occupies the habitat niche that historically was likely occupied by shrub-type willows (Figure 24). Notably, a project in the early 2000s was completed to remove the False Indigo completely. However, a flood event following the False Indigo removal led to reoccupation of the project area by False Indigo.

Figure 24: Representative image of False indigo likely occupying the historical niche of shrub willow (e.g., Salix exigua)

Given the absence of shrub-type willows within the project area, False Indigo growth conditions were assessed as a proxy for shrub willow. This assessment was completed to inform the development of target grading surfaces ("Floodplain reveals") and riparian planting plans. The height above the river surface (HAR) of False Indigo was estimated using methods adapted from Bair et al. (2021) to approximate the height above the low water table (baseflow condition) that willows could establish within project area. Areas of False Indigo was first mapped by using a NAIP Aerial Imagery (2023) and later verified using 12 RTK GPS transects surveyed on May 14, 2024. From here, the lower and upper elevations of False Indigo growing adjacent to the river channel were derived from LiDAR (2018) and survey. This information was used to create a HAR surface, which approximates the elevation at which False Indigo is growing relative to the August low flow water surface elevation (derived from August low flow hydraulic model results and LiDAR (2018). HAR within zones vegetated by False Indigo is shown in Figure 25.

Establishing riparian vegetation at the project area is expected to be extremely challenging due to the project area's climate, the project area's scale, the historical management of the project site, the mobilization of fine sediment during flood events, and the presence of aggressive non-native vegetation within the watershed. Given these challenges, targeting a surface where passive revegetation of riparian species may occur was desirable. To identify this proposed surface height, the HAR of target species (willow, cottonwood) was used to inform target grading surface elevations for the 'Floodplain Reveals' project reach. For the Floodplain Reveal Treatment reach, creating a smaller relative elevation difference between the low water table and the floodplain surface that is less than or equal to the False Indigo HAR is expected to support both the active revegetation and future passive recruitment of riparian and emergent vegetation, which serve as important components of juvenile fish rearing habitat. It is expected that a target floodplain HAR in the Floodplain Reveal Treatment reach will allow riparian shrubs to establish on a timeline that meets the CTUIR's target timelines. This includes the objectives of increasing riparian cover (shade) in 5 to 20 years, increasing vegetation structure and diversity in 10 years, and increasing areas suitable for cottonwood seedling recruitment immediately following construction. The primary challenge and risk for this reach will be if vegetation growth can outpace aggradation, which will be dependent upon post-project flow conditions.

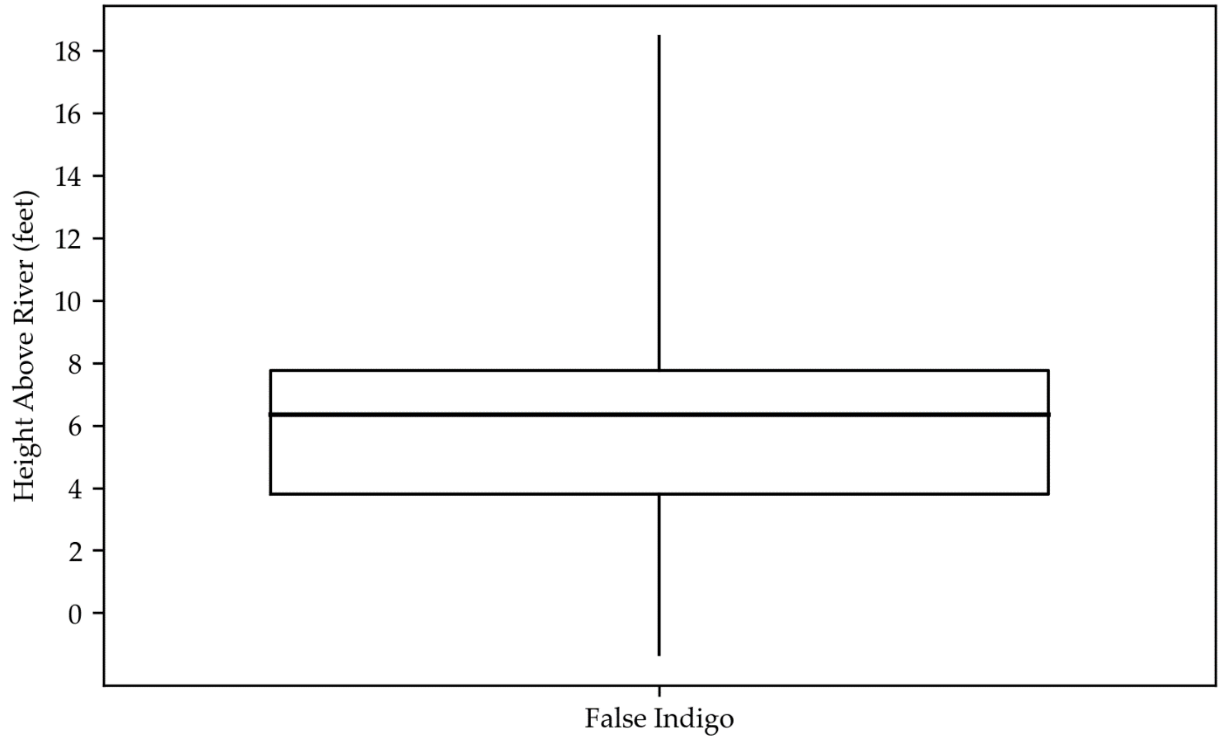


Figure 25. Box plot showing False Indigo Height Above River (HAR) estimated using NAIP aerial imagery.
The box represents the first and third quartiles, and the horizontal bar represents the median. The vertical lines extend to the minimum and maximum False Indigo HAR estimated within the project area.

2.4 DESCRIPTION OF LATERAL CONNECTIVITY TO FLOODPLAIN AND HISTORICAL FLOODPLAIN IMPACTS.

Lateral connectivity in the project area is heavily impaired by channelization, riprap, and riparian clearing. Riparian clearing, lack of hydraulic roughness due to reduced root mass and vegetation present along channel banks has accelerated lateral migration rates when compared with historical conditions in certain locations, and evidence of armoring and prior conservation measures (e.g., planting and fabric placement) in an effort to halt or slow erosion. As the lateral migration of the channel has been restricted in some areas, it has responded by rapidly eroding in other locations. Previous sections of this report contain a more comprehensive description of lateral channel processes, channel-floodplain connectivity, and modern floodplain formation within the project site. See Appendix 7.5 for hydraulic model inundation figures for pre-project (existing) conditions that show the lack of lateral connectivity.

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

There is no tidal influence in the project area.

3. Technical Data

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

HIP conservation measures have been incorporated into project elements included in the design (see accompanying Project Plans). As the project elements are refined, additional information will be provided as needed.

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

3.2.1 Topographic and Bathymetric Data

A LiDAR data set (Quantum Spatial 2018) was available to supplement onsite topographic data collection. Topographic and bathymetric survey data were collected within the project area by Inter-Fluve[9] in May 2022. Topographic survey data were collected using total station and RTK GPS. Bathymetric survey data was collected using an echo-sounder connected to RTK GPS. These data were collected to ground-truth existing LiDAR and provide bathymetry for hydraulic modeling and design. In general, good agreement was found between the LiDAR bare earth surface raster and ground survey data. An analysis of 352 upland ground survey points indicated that the survey elevations are an average of 0.24-feet lower than the LiDAR bare earth elevations (Figure 26). Survey elevations that are lower than LiDAR elevations are typical for areas with dense vegetation cover which reflect LiDAR returns prior to the waveform reaching the ground surface and areas with ongoing erosion where the ground surface has changed since LiDAR acquisition. To provide the best representation of expected pre-project conditions, the bathymetric and ground survey data were combined with the 2018 LiDAR data to construct a pre-project conditions surface for design and hydraulic modeling.

The May 2022 site survey served as the primary site survey for this project, but subsequent minor topographic survey data was collected to supplement other analysis. Additional site visits which involved survey data acquisition are as follows:

- Survey of test pit stratigraphy, and basal gravel and low-water water surface elevations; November 2022.
- Survey of riparian vegetation communities; May 2024.

[9] Consistent with the Washington Board of Registration for Professional Engineers and Land Surveyors Policy No. 42 on incidental survey work (WBRPELS 2007), site surveys were conducted under the direction of a licensed professional engineer at Inter-Fluve and are intended for use toward the development this project's engineered design.

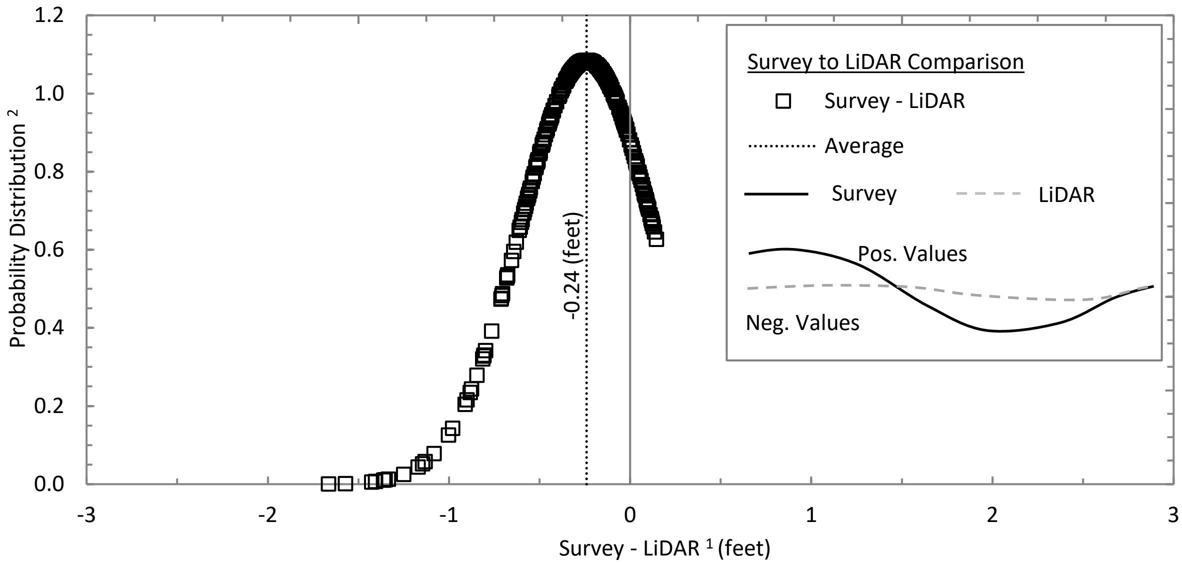


Figure 26: Survey comparison to LiDAR ground elevations.

Figure Notes:

[1] Difference in elevation is the May 2022 survey point elevation minus the 2018 LiDAR bare earth elevation for the raster cell containing the survey point.

[2] Probability distribution calculated using 352 upland ground survey points with a standard deviation of 0.37-feet.

3.2.2 Bed Material Data

The Touchet River is a gravel bed river system (e.g., Church 2010) in the vicinity of the project site. The channel readily transports gravel-sized sediment as bedload at regularly occurring flows (annual peak flows, or less, based on field observations), and the deposition of gravel-sized sediment creates bed and bar forms which drive the morphology of the river channel. Much of the gravel which is transported to the site likely is generated in the headwaters, but local, secondary sources of gravel include colluvial inputs and gravel eroded from channel banks. Figure 27 provides a representative example of bar substrate at the site.

Figure 27: Representative photo of gravel bar substrate in the project area.

Figure 28 shows the locations where channel bed grain size data were collected and representative grain size distribution data from two sites within the bankfull channel, it also shows the test pit locations. Grain size data were collected by performing Wolman Pebble Counts (Wolman 1954) consisting of 100 or more clasts sampled using a step-toe random-walk approach across selected bars and islands which were exposed and/or shallowly inundated and safe to access at the time of the site visit. Alluvial bed material is relatively well sorted, and the average size of sediment forming bars and islands in the channel is roughly 0.1–0.25 ft in diameter. Bed material at riffles was roughly 0.25-0.5 ft in diameter, but no pebble counts were conducted at riffles as those sites were not accessible at the time of the field visit. Coarse cobble and boulder sized material was observed sporadically in the channel in areas which had been anthropogenically modified and where the channel flows against bedrock outcrops along the valley margins. These grain size data support previous qualitative observations regarding the sedimentary characteristics of coarse alluvium found at the site. Appendix 7.7 includes summary plots of all pebble count data collected at the site.

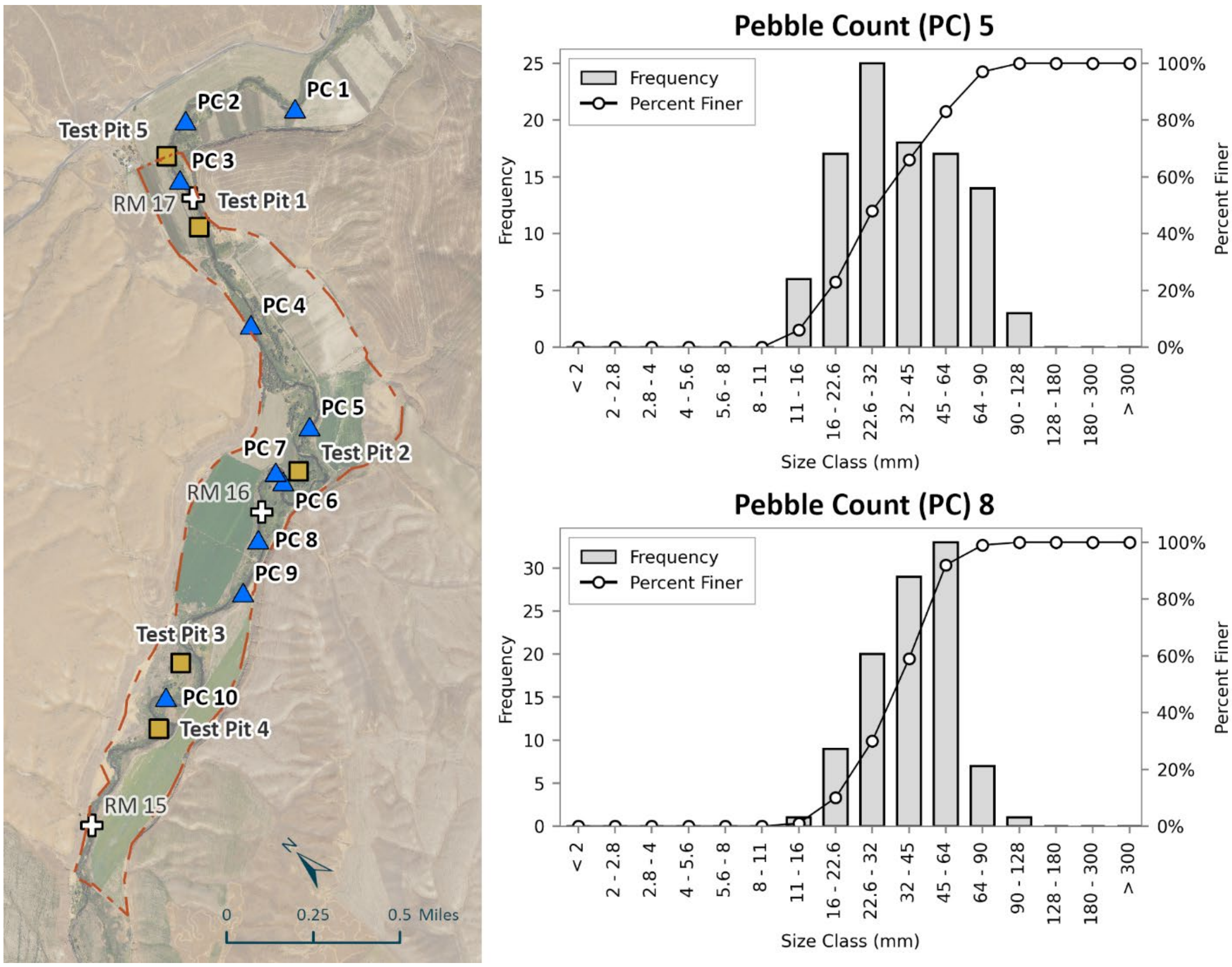


Figure 28: Map of pebble count and test pit locations. Data from two representative pebble counts is shown at right.

Fine, silt sized sediment is present along the channel margins and in slack water areas. Silt sized sediments compose the bulk of the valley bottom above the gravel lens throughout the project area. Along the channel margins and on the modern inset floodplain, silt sized material was observed at depths of three or more feet during the survey. Five test pits were excavated in November 2022 at the site to determine depth to coarse alluvium and the water table below the valley bottom surface. These test pits show a close correlation between the river's water surface elevation and the water table elevation in the valley bottom. These test pits also demonstrated a close correlation between the maximum elevation of coarse alluvium (gravel, cobble) in the channel banks and modern bar tops to the maximum elevation of coarse alluvium in the valley bottom subsurface. Test pits generally indicated an average of 8 to 10 feet of fine sediment atop alluvium (see Table 7 and Figure 23).

3.2.3 Aerial Photography and Historical Survey Records

Historical aerial images of the site were obtained from USGS Earth Explorer and CTUIR. Imagery of the project area was compiled for 1952, 1964, 1976, 1996, 2006, 2015, and 2021 to evaluate historical land use changes at the site. An orthomosaic image created from UAV collected imagery was also created for the site in May 2022. Lewis and Clark notes from 1806 were also reviewed.

3.2.4 Fish Use Data

Juvenile and adult fish use data were provided by the Snake River Salmon Recovery Board, Washington Department of Fish and Wildlife, and Walla Walla Subbasin Salmonid Monitoring and Evaluation Reports (Mendel et al. 2014). This data was used to characterize existing and potential future use of the project area by salmon, steelhead, and other fish species.

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

3.3.1 Hydrology Data

Relevant streamflow gages are located on the Touchet River and on the Walla Walla River near the confluence with the Touchet River. These gages include:

- Touchet River at Luckenbill Rd.
  WADOE Gage 32B090, period of record May 2022 to present.
- Touchet River at Cummins Road (near Touchet, WA)
  WADOE Gage 32B075, period of record June 2002 to present.
  USGS Gage 14017500, period of record 1942 to 1964
- Walla Walla River near Touchet, WA
  USGS Gage 14018500, period of record 1949 to present.

Stream flow data from these gages were used for annual and monthly hydrologic analyses (Table 5 and Figure 29). To compensate for the more limited and periodic period of record on the Touchet River a discharge relationship analysis was completed relative to the much longer period of record on the Walla Walla River. This relationship was used to transfer peak flow statistics for the 2- through 25-year recurrence interval events from the Walla Walla gage to the Touchet River gage at Cummins Road. Data from the recently installed gage WADOE gage located immediately upstream of the project area was used to verify the efficacy of the previously performed gage transfer.

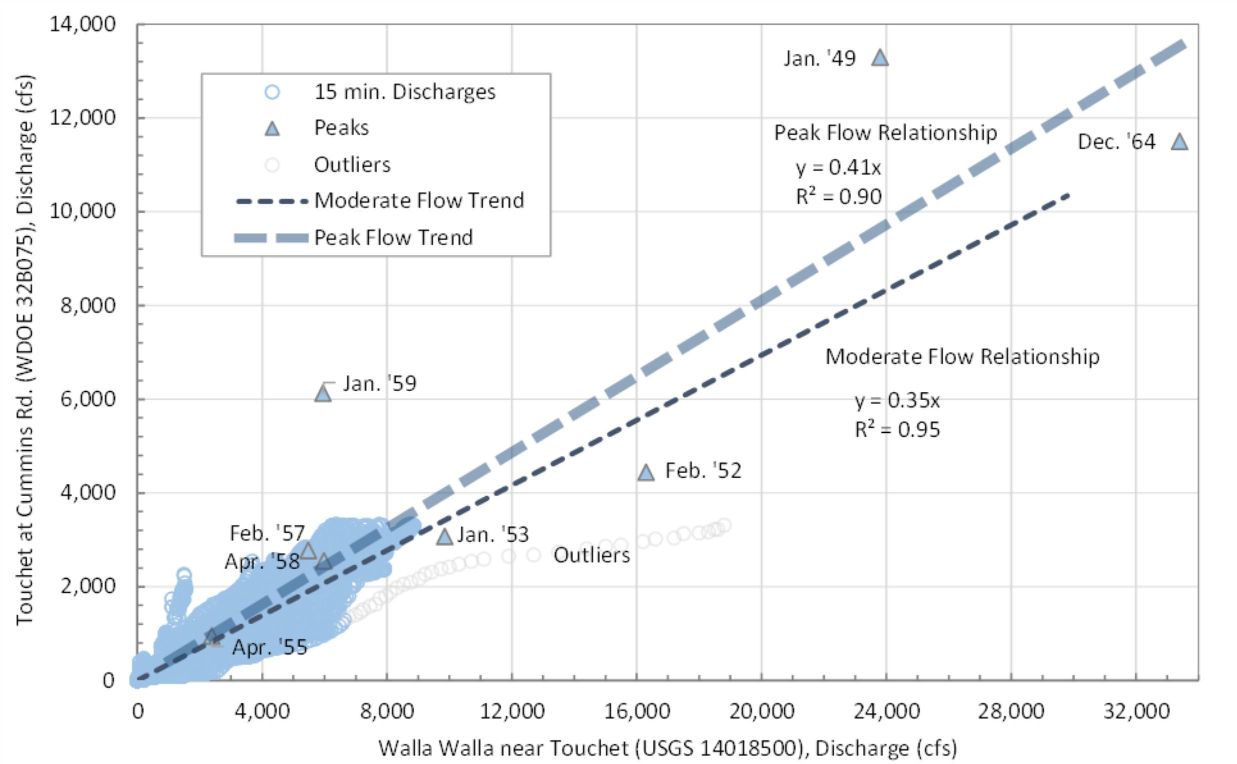


Figure 29: Flow relationship between the Walla Walla River near Touchet and the Touchet River at Cummins Road.

3.3.2 Peak Flows

The project reach peak flow estimates are presented in Table 5.

Table 5: Project Reach Peak Flows.

Discharge Statistic	Discharge (cfs)	Source
2-year (equivalent to OHW)	2,048	Gage transfer values [A]
5-year	3,605	Gage transfer values [A]
10-year	4,900	Gage transfer values [A]
25-year	7,954	Gage transfer values [A]
50-year	13,930	Regional analysis [B]
100-year	16,850	Regional analysis [B]
200-year	19,960	Regional analysis [B]
500-year	24,580	Regional analysis [B]

Table Notes:

[A] Uses gage transfer techniques from the flood frequency analysis on the Walla Walla USGS Gage 14018500. Values not scaled to the project site from the Touchet River gage at Cummins Road as these peak flows are generated from hydrologic events (snow melt and rainfall) upstream of the project site and Cummins Road gage.

[B] Uses regional regression techniques per Mastin 2018. Values scaled to the project site from the Touchet River gage at Cummins Road to account for a decrease in contributing watershed area during these events likely driven by both local and upper watershed hydrologic events.

Design Peak Flows

The estimated peak discharge for the 25-year (Q25) recurrence interval will be used as the design discharge for LWS stability. The 2-year peak discharge (Q2) was found to agree with the observed ordinary high water (OHW) marks and was used to extend the OHW delineation throughout the project.

3.3.3 Seasonal Flows

The project reach seasonal flow estimates are presented in Figure 30 and Table 6.

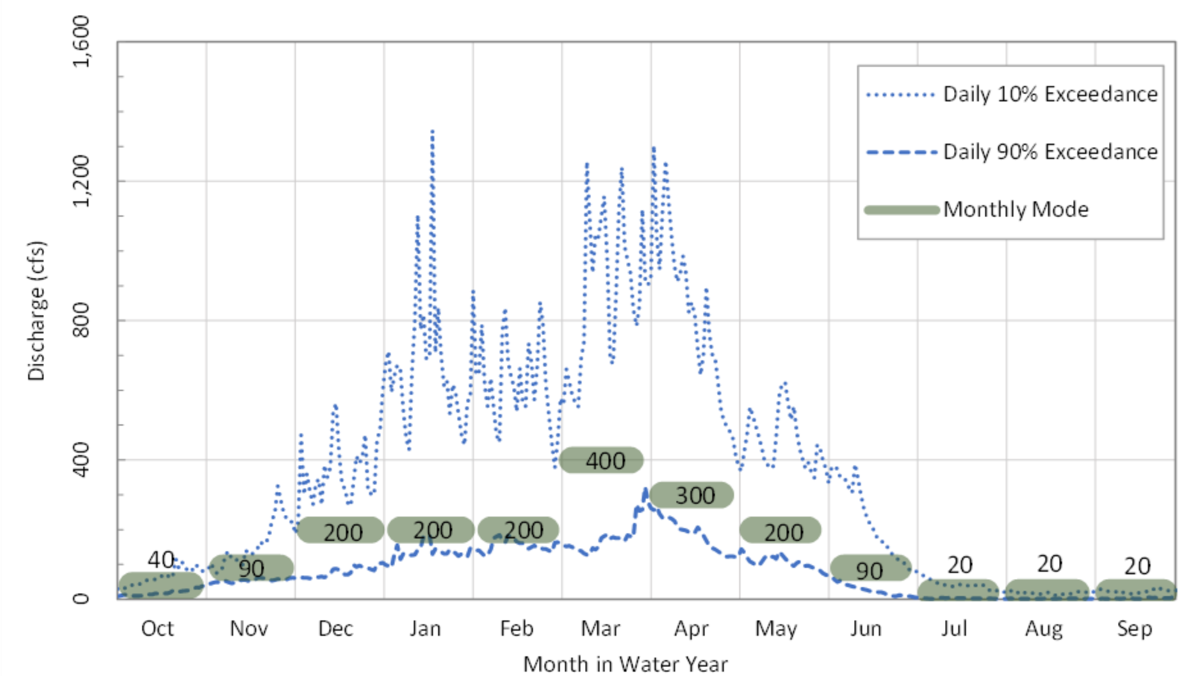


Figure 30: Annual Hydrology Statistics | Touchet River at RM 14 | Water Years 2003 to 2021.
Uses statistical analysis of gage data from WADOE Gage 32B075 (period of record Water Year 2003-2021) with discharge values adjusted from the gage near river mile 3 to the project site near river mile 14 using a direct basin area correction.

Table 6: Project Reach Seasonal Flows.

Discharge Statistic	Discharge (cfs)	Source
Minimum Recorded	0	Gage analysis [C]
August Average	9	Gage analysis [C]
December Average	197	Gage analysis [C]
November '22 Survey	270	Gage data [D]
Fish 14-Day Exceedance Flow	400	Gage analysis [C, E]
March Average	472	Gage analysis [C]
Fish Peak Flow	750	Selected value [F]
May '22 Survey Average	1,000	Gage data [D]

Table Notes:
[C] Uses statistical analysis of gage data from WADOE Gage 32B075 (period of record Water Year 2003-2021) with discharge values adjusted from the gage near River Mile 3 to the project site near River Mile 14 using a direct basin area correction.
[D] Gage data from WADOE Gage 32B090
[E] 400 cfs is the March mode and is exceeded at least 14 continuous days in most years
[F] Selected based on the median March flow representative of a high spring flow during the juvenile migration period likely to occur every year (~1-year return period).

Design Seasonal Flows

Two regularly occurring discharge targets were selected to inform floodplain grading habitat enhancement efforts. The lower of the two design discharge values was selected by calculating the median discharge magnitude which was met or exceeded for 14 consecutive days during the months of March, April, and May, which is a key juvenile rearing and migration period for the species of interest for the project, and when the site traditionally receives its highest flows (e.g., Jeffres et al. 2009). The median 14-day exceedance flow for this period is 409.5 cfs for the project area, which was simplified to 400 cfs to align with the March mode discharge for the site. A secondary, high-flow design discharge of 750 cfs was selected. This discharge was selected as a representative flow that occurs annually in almost all water years during the March–May juvenile migration period of interest.

These design discharge values, along with the HAR (see Section 2.3), were used to guide the proposed elevations for floodplain excavation in the Floodplain Reveal Treatment Reach. This reach is focused on providing response times that are commensurate with CTUIR's desired response time framework (see project objectives). These surfaces are designed so that channel-floodplain connection initiates at the 14-day exceedance flow (400 cfs), and that the floodplain can offer suitable habitat area, velocity refugia, and hydraulic heterogeneity across the floodplain by the peak fish flow (750 cfs). This approach for selecting design discharge magnitudes and relating these discharges to floodplain functions is based on the work of Jeffres et al. (2008) which found that ephemerally connected and variable floodplain habitats provide optimal growth conditions for juvenile salmonids.

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

Field observations and valley bottom test pits indicate that the site experiences substantial suspended sediment loads which deposit silt sized material at the site under a wide range of flow conditions. Suspended sediment is deposited along the channel margins and in other areas of low velocity, such as alcoves, inset floodplain locations, split flow locations, and agricultural road crossings, among many locations. In regularly inundated areas which have low velocity, such as the location pictured in Figure 31, over two feet of fine sediment was present during the site assessment. Additionally, the valley bottom surface at the site stores a very large volume of fine sediment (Table 7), which is believed to have been sourced primarily by alluvial deposition during floods on the Touchet River. Additional discussion regarding the genesis of valley bottom sediments at the site can be found in previous subsections, but these field observations are supported by a long record of elevated suspended sediment loads in the basin (USGS 1969) and documentation which highlights large-scale soil erosion throughout much of the watershed and the region following the commencement of agriculture in the area (USDA 1979, USGS 1998). Silt sized sediments may also have been delivered to the valley bottom of the project site as a part of agricultural grading efforts and via aeolian deposition of silts sourced from the surrounding hillslopes. Research regarding the fate of fine sediment in the nearby Umatilla basin suggests that large amounts of fine sediment sourced from soil erosion of agricultural fields is stored for intermediate timescales on floodplains, and the remobilization of this material from eroding banks can maintain high suspended sediment loads in streams even after upland soil erosion rates decrease (Nagel and Ritchie, 2004). At one valley bottom sediment deposit, Nagel and Ritchie (2004) found 150 cm (4.9 ft) of fine sediment overlying a log that was dated to be younger than 1945 using radiocarbon. Elsewhere in their study site, the authors found thick deposits of fine sediments overlying barbed wire, fence posts, and other evidence which points to extensive post-settlement valley bottom sedimentation. Fine sediment deposition is anticipated to continue in areas which are regularly inundated by low velocity flows, but this material is anticipated to be regularly reworked at higher flow conditions to form small-scale topographic features controlled by vegetation roughness patterns on the inset valley bottom surface.

Bed material of the Touchet River at the site is composed of gravel-cobble sized sediments, and field observations suggest that gravel and cobble sized material are mobilized by the channel under semi-regularly occurring flow conditions. Commonly mobilized coarse sediment in the channel is primarily 0.1–0.25 feet (~1 to 3 inches) in diameter, based on grain size analysis, and field observations suggest that this is the most common size of bedload delivered to the site. Previous subsections describe coarse sediment characteristics and grain size data in greater detail. Proposed floodplain grading will decrease stage-discharge relationships at the project site for flows which mobilized bed material, and it is anticipated that proposed project actions will enhance in-channel bedload deposition and cause the sediment dynamics of the site to more closely favor response rather than transport reach conditions. Sediment transport modeling has not been completed at the current design phase. Given the episodic nature of significant sediment aggradation, aggradation within the Floodplain Reveals reach that has the potential to outpace vegetation growth potential risk. This episodic nature is also a primary challenge in the varied response timescales of aggradation expected (60 to 150 years (Beechie et al. 2008)) where the Large Wood Treatment approach was selected to move forward.

Figure 31: Fine sediment along the banks near RM 15.7. Deposit was from a single year of spring runoff flows.

Table 7: Test pit data demonstrating the range of depths from the floodplain ground surface to alluvium (gravel/cobble) and the modeled low water surface.

Floodplain Test Pit	Modeled Low Water Surface Elevation	Ground Surface Elevation	Depth From Ground to Low Water Surface	Alluvium Elevation (Gravel/Cobble)	Depth From Ground Surface to Alluvium
1	706.7	717.1	10.4	710.07	7.0
2	683.4	695.2	11.8	686.19	9.0
3	681.7	694.1	12.4	686.53	7.6
4	680.5	687.6	7.1	685.88	1.7*
5	708.22	720.5	12.3	712	8.5

Notes: The modeled low water surface at the time of the test pits was derived from comparison of calibrated surveyed water surface elevations at the time of the test pits (270 cfs) to modeled low flow (9 cfs). Test pit 4 was located in a low swale within the contemporary active floodplain, and this site is believed to have experienced sediment deposition (silt, sand, and gravel) during 2020 flooding.

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

For the proposed project, two-dimensional (2D) hydraulic models were developed for the pre-project conditions, and the proposed design conditions. The 2D hydraulic models for the site were developed in the U.S. Army Corps of Engineers HEC-RAS 6.5 software (USACE 2024) for modeling the hydraulics of water flow through natural rivers and other channels. The following sections describe HEC-RAS 6.5 and document the development and output processing of the existing and proposed conditions models.

3.5.1 Model Capabilities and Limitations

HEC-RAS 6.5 was used in its two-dimensional (2D) unsteady flow simulation mode with the capacity to model the complex flow patterns, on-site water storage, and temporally variable boundary conditions. The 2D hydraulic model calculates depth averaged water velocities (including magnitude and direction), water surface elevation, and mesh cell face conveyance throughout the simulation. Other hydraulic parameters, such as depth, shear stress, and stream power, can be calculated after the simulation. The model does not simulate vertical variations in velocities or complex three-dimensional (3D) flow eddies.

3.5.2 Model Extent

The project reach model extends from approximately river mile 14.3 upstream of the Touchet North Road bridge up to river mile 17.7 downstream of the Luckenbill Rd Bridge, and spans across the valley to elevations well above the 100-year flood elevation. Both the upstream and downstream boundaries of the model are located in a relatively confined section of the valley. The boundaries are also sufficiently far away from the bridges to avoid their effects.

3.5.3 Model Terrain

The base-line conditions model terrain was developed using both ground/bathymetric survey data collected by Inter-Fluve staff in 2022 along with aerial LiDAR acquired in 2018 (Quantum Spatial 2018). More information can be found in Section 3.2.1 of this report. The model terrain is projected on the Washington State Plane South Zone, North American Datum 1983 (NAD83), coordinate system with US feet distance units. The terrain elevations are in US feet relative to the North American Vertical Datum of 1988 (NAVD88). The proposed conditions terrain was developed in AutoCAD Civil 3D.

3.5.4 Model Geometry

The 2D model geometry used a flexible computational mesh adjusted according to terrain complexity and areas of interest. The nominal mesh spacing was 50 feet in the floodplain and 10 feet in the channel. Break lines were added to further refine the mesh along the tops of banks and channel alignments. Although the average computation mesh size was greater than the terrain resolution, the modeling capabilities of HEC-RAS 6.5 integrates the sub-grid terrain into the computations. This capability allows small features such as narrow channels and floodplain hummocks to be shown in the model output.

3.5.5 Model Roughness

Roughness coefficients (Manning's n values) are used by the 2D model to calculate flow energy losses, or frictional resistance, caused by channel bed materials and floodplain vegetation. Existing conditions roughness coefficients were applied across the model extent to represent the distinct types and densities of vegetation or surface conditions. In general, roughness regions were delineated based on field observations and aerial photos. Roughness values for each region were selected using published guidelines (Arcement & Schneider 1989) for channel types and vegetation conditions. Table 8 summarizes the roughness coefficients used in the models.

Table 8: Roughness coefficients used in the 2D model.

Region Description	Manning's n Value
Main active river channel; typical cobble/gravel bed	0.022
Riparian Vegetation	0.08 – 0.12
Grass on Valley Hills	0.05
Channel Islands/ Bars	0.06
Farm fields; seasonal crops or similar	0.04
Paved Roads	0.015
Residential Buildings	0.085
Exposed Dirt	0.04
Proposed Willow Scroll & Cottonwood Cluster Plantings	0.12
Proposed Large Wood Structures (LWS)	0.25
Proposed Grading Areas	0.06

3.5.6 Model Discharges

The modeled discharges of interest included all the flows listed in Table 5 and Table 6. These discharges were incorporated into a synthetic hydrograph with periods of steady flow (at the discharges of interest and other intermediate discharges) connected by smooth transition periods to create a stair-step like pattern. The periods of steady flow allow the model to come to a quasi-steady state condition improving the interpretation of hydraulics at specific discharges.

3.5.7 Model Boundary Conditions

HEC-RAS 6.5 2D models require boundary conditions at the upstream and downstream ends of the model to control the flow into and out of the model extent. The synthetic hydrograph described above was applied as the upstream boundary condition. The flow was initially distributed along the boundary assuming normal flow depth at a friction slope estimated from the average channel slope upstream of the model (0.004 feet per foot). The downstream boundary condition assumed normal flow depth at a friction slope estimated from the average channel slope downstream of the model (0.003 feet per foot).

3.5.8 Model Output

To examine the inundation patterns, velocities, and other hydraulic parameters within the model extent for existing and proposed conditions, the RAS Mapper utility of HEC-RAS 6.5 was used to generate results in the form of raster data sets at the discharges of interest. These raster data sets were then loaded into an ESRI ArcMap file to prepare various figures depicting inundation extent, velocity magnitude, and sediment mobility for existing and proposed conditions. These figures are included in Appendix 7.5.

3.5.9 Model Validation

The model was validated by comparing the model water surface elevations (WSE) at 1,000cfs to elevations that were surveyed during the May 2022 topo/bathy survey, which occurred when the Touchet river was 1,000 cfs on the DOE 32B090 gage. 3740 points were used for the comparison. The difference between the surveyed WSE and Modeled WSE are shown in Figure 32. The root mean square average of the difference in WSE was 0.27 ft, suggesting a good agreement between the model and surveyed conditions.

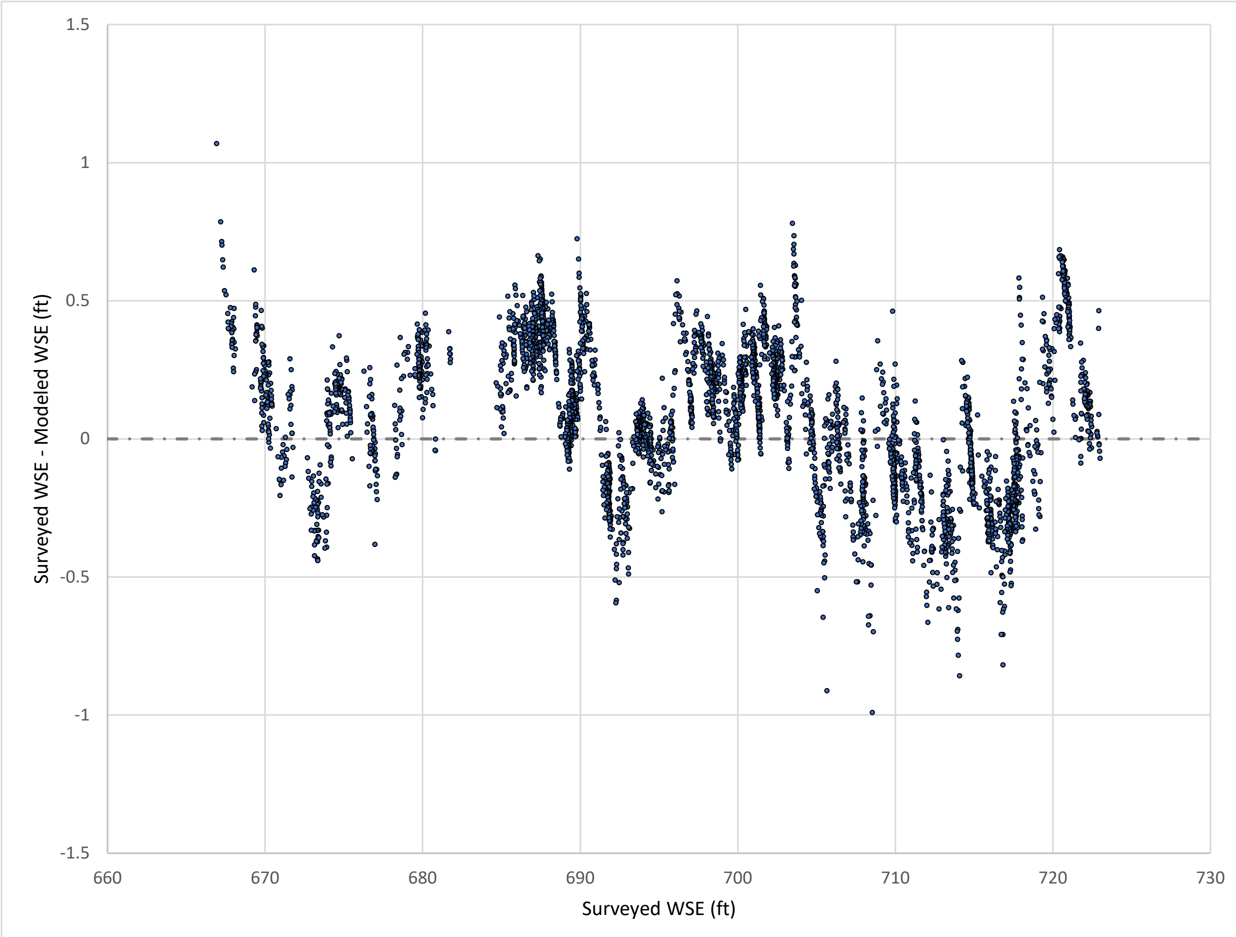


Figure 32: Touchet River Model Validation at 1,000 cfs.

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

Stability analysis and computations for project elements will follow professional practice guidelines for large wood design (Knutson et. al. 2014 and USBR/ERDC 2016), stream habitat restoration (Cramer 2012), bank treatments (Cramer 2003), and institutional knowledge combined with professional judgment for the design of specific project elements.

The project setting includes downstream and upstream bridges, agricultural and residential structures, overhead powerlines & utility poles in the floodplain, tilled and untilled agricultural fields on the floodplain, and irrigation pump stations along the channel. Recreational use is low in the project reach. The LWS characteristics include locations within the active channel and on the outside of bends, they are designed to have low strainer potential, and egress is moderate. Sight distance to LWS will be moderate to high and the depth x velocity at recreational use flows will be moderate to low. Given this setting, the project LWS are being designed assuming a 'low' public safety risk and a 'moderate' property damage risk level (Knutson et. al. 2014). Using these risk levels results in recommended minimum factors of safety in the horizontal and vertical directions of 1.5

and 1.75, respectively at the 25-year peak flow, to maintain a stable structure under design conditions (Knutson et. al. 2014). Proposed conditions 2D hydraulic model outputs for the 25-year peak flow event (Table 5) were used to determine conservative design velocities upstream of each structure type, and conservative assumptions relative to the sizes of individual log members were made in accordance with the Project Plans and Specifications. The computed factor of safety is shown to equal or exceed the recommended factors of safety for each structure type, indicating that the structures can be considered stable for the assumed risk profile. The key results of the stability analysis are summarized in Table 9, and may be further refined during subsequent design phases. Additional detailed LWS stability analysis documentation is provided in Appendix 7.9.

Table 9: Summary of Large Wood Structure stability evaluation.

Large Wood Structure Type	**Recommended Factors of Safety** [A]		**Calculated Factors of Safety**				**Meets Guidance**
	Horizontal (Sliding)	**Vertical** (Buoyancy)	**Horizontal** (Sliding [B])	**Horizontal** (Timber [C])	**Vertical** (Piles [D])	**Vertical** (Backfill [E])	
Apex	1.5	1.75	1.7	**1.6**	3.0	1.3	Yes
Bank - Buried	1.5	1.75	4.3	**1.8**	2.9	2.6	Yes
Floodplain	1.5	1.75	**1.6**	N/A	N/A	2.6	Yes
Off-Channel PALS	1.5	1.75	**1.7**	4.6	3.7	N/A	Yes

Table Notes: *[A] Knutson et. al., 2014 | | [B] Vertical log (timber pile) soil strength and bed friction factor of safety. | [C] Vertical log (timber pile) factor of safety against breaking off. | [D] Vertical log (timber pile) factor of safety against pulling up and out of the ground. | [E] Vertical factor of safety provided by backfill that may be present over the LWS.*

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

The technical analyses described in this document have been incorporated into the design drawings, which will be included as part of the construction contract. The construction contract documentation will specifically define values for parameters critical to their performance based on the technical analysis described above. The parameter values (dimensions, weights, and other material properties) will be set to allow for a reasonable amount of variation to improve constructability without compromising project performance. Additionally, it is generally expected that the design engineer, or their representative, will be on site during critical phases of construction to assist in making field designs adjustments that are consistent with the project intent and technical analysis.

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

Not applicable.

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

Not applicable.

4. Construction – Contract Documentation

4.1 INCORPORATION OF HIP GENERAL AND CONSTRUCTION CONSERVATION MEASURES

All HIP general and construction conservation measures will be met unless otherwise indicated through a variance request at later design phases.

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

See accompanying Project Plans.

4.3 LIST OF ALL PROPOSED PROJECT MATERIALS AND QUANTITIES.

See accompanying Project Plans and Opinion of Probable Construction Costs (OPCC).

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

4.4.1 Site Access, Staging, and Sequencing Plan.

The site access, staging, and sequencing plan will be in conformance with the HIP General Aquatic Conservation Measures (see Project Plans). Site access will be from Luckenbill Road. The primary staging areas will be on the Touchet River Ranch property in the locations shown on the Plans. The staging areas will be entirely above the ordinary high-water elevation. Straw wattles will be installed on the downslope sides of the staging areas in the event of wet weather during construction. Depending upon site conditions during construction, a stabilized rock construction entrance may also be installed at the access point off Luckenbill Road to minimize tracking of fine sediment off site.

4.4.2 Work Area Isolation and Dewatering Plan.

Work area isolation and dewatering will be in conformance with the HIP General Aquatic Conservation Measures (see Plan Sheet 3, 4, and 5 including *Work Area Isolation & Fish Salvage*). Work areas in the wetted channel during construction will be isolated from surface water flow and de-fished prior to excavation, pile driving, and large wood placement. Surface water isolation measures may include bulk bag, sheet pile, or concrete block coffer dams. Turbidity curtains and fish exclusion nets may be used on their own in slack water areas to isolate the work area where dewatering is not needed or in conjunction with coffer dams as needed to further limit turbidity releases and exclude fish from the work area. Work requiring dewatering will be kept pumped down to below the working level. Water from dewatering pumping is expected to be turbid and will be discharged to an upland location for infiltration. The Plans show recommended work area isolation measures; however, a final plan will be developed by the contractor for review and acceptance by the construction contracting agency. The construction contractor will be responsible for adherence to and implementation of the accepted plan.

4.4.3 Erosion and Pollution Control Plan.

The project erosion and pollution control plan will be in conformance with the HIP General Conservation Measures (see Plan Sheet 3 including *Item 9 and Item 10*) as well as applicable State and local regulations. The Plans show recommended erosion and pollution control measures; however, the final plan will be developed by the contractor for review and acceptance by the construction contracting agency. The construction contractor will be responsible for adherence to and implementation of the accepted plan.

4.4.4 Site Reclamation and Restoration Plan.

Site reclamation and restoration will be in conformance with the HIP General Conservation Measures (see Plan Sheet 3 including *Item 5*). All temporary construction access roads and staging areas will be returned to pre-project conditions or better. Where revegetation is required to restore pre-project conditions areas will be mulched and seeded with a native species mix. Given the scale of the project area, and associated costs of large-scale revegetation, it is expected that long-term revegetation (multiple phases) and active stewardship of the project area will be needed.

4.4.5 List proposed equipment and fuels management plan.

The construction contractor will be required to provide a list of proposed equipment and a fuel management plan for review and acceptance by the construction contracting agency. The equipment brought onto the site and fuel management plan prepared by the contractor will be in conformance with the HIP General Conservation Measures (see Plan Sheet 3 including *Item 8* and Plan Sheet 4 *Item 11)*. The contractor will also be responsible for development and implementation of a spill prevention, control, and counter measures plan that conforms to the HIP General Aquatic Conservation Measures (see Plan Sheet 3 including *Item 11*) as well as applicable State and local regulations. The plan will be reviewed and accepted by the construction contracting agency prior to mobilization. The construction contractor will be responsible for adherence to and implementation of the accepted plan. In general, it's expected that construction equipment could include; tracked excavators, wheeled loaders, tracked log loaders, off-highway haul trucks, on-road dump trucks, chain saws, gas, electric, or air powered drills, gas powered abrasive cut-off saws, excavator mounted hydraulically driven side grip vibratory pile driver, work trucks, and other small power/hand tools. Equipment will be stored in the primary upland staging, outside the ordinary high-water line, while not in use.

4.5 CALENDAR SCHEDULE FOR CONSTRUCTION/IMPLEMENTATION PROCEDURES.

To be completed following the advertisement for bids.

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

The Contracting Officer, or their representative, will be on site frequently to monitor the construction Contractor's compliance with the approved pollution prevention plan and document any work done to abate site erosion, turbid water, or chemical spills.

5 Monitoring and Adaptive Management Plan.

Section 5 and all subsequent sections to be completed by the Tribes in a separate document(s).

5.1 INTRODUCTION

5.2 EXISTING MONITORING PROTOCOLS

5.3 PROJECT EFFECTIVENESS MONITORING PLAN

5.3.1 Objective 1

5.3.2 Objective 2

5.4 PROJECT REVIEW TEAM TRIGGERS

5.5 MONITORING FREQUENCY, TIMING, AND DURATION

5.5.1 Baseline Survey

5.5.2 As-Built Survey

5.5.3 Monitoring Site Layout

5.5.4 Post-Bankfull Event Survey

5.5.5 Future Survey (Related to Flow Event)

5.6 MONITORING TECHNIQUE PROTOCOLS

5.6.1 Photo Documentation and Visual Inspection

5.6.2 Longitudinal Profile

5.6.3 Habitat Survey

5.6.4 Survival Plots

5.6.5 Channel and Floodplain Cross-Sections

5.6.6 Fish Passage

5.7 DATA STORAGE AND ANALYSIS

To be completed by the Tribes in a separate document(s).

5.8 MONITORING QUALITY ASSURANCE PLAN

To be completed by the Tribes in a separate document(s).

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7 Appendices

7.1 PROJECT PLAN SHEETS

See accompanying Project Plans: Túuši Wána Floodplain Enhancement, Touchet River RM 14-17 | Preliminary (90%) Design

7.2 PLANTING PLAN

The planting plan is included in the associated Plan Set (Appendix 7.1) and generally follows the principles outlined Guillozet et al. 2014, with modifications specific to Eastern Washington and the local ecosystem. Quantities of plants are shown on the Plans are for the entire project area and it is expected this will be worked into a phased approach as part of the Final Design submittal. Washington Department of Transportation Standard Specifications have been amended and revised to control plant installations for this particular project and are shown on the Plans.

7.3 OPINION OF PROBABLE CONSTRUCTION COSTS

See attached opinion of probable construction costs for the work shown on the Project Plan Sheets.

7.4 BID FORM

To be developed in a subsequent design phase.

7.5 HYDRAULICS FIGURES

Accompanying hydraulic model results figures for existing and proposed conditions include:

- Existing Model Results | 14 Day Sustained Fish Flow - 400 cfs
- Proposed Model Results | 14 Day Sustained Fish Flow - 400 cfs
- Existing Model Results | Fish Flows - 750 cfs
- Proposed Model Results | Fish Flows - 750 cfs
- Existing Model Results | 1,000 cfs
- Proposed Model Results | 1,000 cfs
- Existing Model Results | 2-Year Event - 2,048 cfs
- Proposed Model Results | 2-Year Event - 2,048 cfs
- Existing Model Results | 25-Year Event - 7,954 cfs
- Proposed Model Results | 25-Year Event - 7,954 cfs
- Existing Model Results | 100-Year Event - 16,850 cfs
- Proposed Model Results | 100-Year Event - 16,850 cfs

7.6 EXTERNAL EXPERT TECHNICAL REVIEW PROCESS RESULTS AND UPDATED CONCEPTS

See attached External Expert Technical Review Process Results and Updated Concepts Memo.

7.7 PROJECT AREA PEBBLE COUNT DATA

See attached pebble count data plots and map of sampling locations.

7.8 HABTITAT SUITABILITY INDEX FIGURES

See attached Habitat Suitability Index Figures.

Notes on Habitat Suitability Index Modeling

To help understand the likely changes to salmonid habitat from the proposed project, habitat suitability index modeling (HSI) was completed during this design phase. HSI provides a means to predict habitat conditions within a stream reach under key flow conditions. The model uses a physical representation of the reach (e.g. channel topography, substrate grain sizes and overhead cover conditions) coupled with species specific habitat velocity and depth preferences for various life stages to predict habitat availability. The suitability index curves for salmonids are from the *Instream Flow Study Guidelines: Technical and Habitat Suitability Issues Including Fish Preference Curves: Updated January 25, 2022* (Beecher 2022).

There are several limitations and simplifications inherent in the habitat suitability modeling approach that should be considered when interpreting results presented in the attached figures and Table 3. First, future geomorphic trajectory is not represented in the model and therefore, model results only represent a snapshot in time. Any future changes in topography would likely affect the predictions of habitat area (higher or lower). Additionally, the Habitat Suitability Model (HSI) is based on a two-dimensional hydraulic model, which uses depth-averaged velocities withing computational mesh cells. This technological limitation represents a simplification of real-world conditions where fish can often seek out preferred velocities in otherwise unsuitable conditions. Finally, note that habitat suitability does not predict fish behavior and therefore use. Behavior often varies especially in circumstances where one fish may select substrate conditions over depth or prefer cover availability during mid-day periods over velocity while another fish may prefer different combinations.

As a consequence of these limitations, characterizing relative changes (increases or decreases) in habitat area between pre-project (existing) and with-project (proposed) conditions or between various flows is more appropriate than concluding the efforts represent the exact area of habitat that may be created by the project.

7.9 LARGE WOOD STRUCTURE STABILITY ANALYSIS

See attached calculation sheets for the LWS stability analysis.

7.10 DESIGN GEOSPATIAL DATA

See provided .zip file for select design linework in an ArcGIS package.