COUSE CREEK

RIVER MILE 7.5-9

LOW-TECH, PROCESS-BASED RESTORATION 15% DESIGN REPORT

PREPARED FOR:

WALLA WALLA BASIN WATERSHED COUNCIL

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PROJECT SUMMARY

The Walla Walla Basin Watershed Council (WWBWC) is leading low-tech, process-based restoration (LTPBR) actions in Couse Creek, a tributary to the Walla Walla River in Oregon. These projects are designed to create hydraulic and geomorphic diversity, encourage sediment sorting, and expand floodplain connection in key areas of the valley bottom margin. This report presents a design for River Mile 7.5 to 9 (hereinafter, RM8) and builds upon previous LTPBR implementation at RM 4 to 5. This report plans for multiple phases of treatment, scaling restoration actions to the scope of degradation in Couse Creek.

Couse Creek has been identified as an important spawning stream for an ESA-listed steelhead population. Improving spawning habitat for threatened steelhead is a priority of the WWBWC, and an assessment was conducted in 2020 to identify stream restoration opportunities. Many reaches of Couse Creek have been simplified by past industry and natural resource management. Recent floods have further reduced ecological function and diminished the quality of stream habitat. Limiting factors of habitat for threatened fish in Couse Creek include stream temperature, sediment homogeneity, low frequency of wood, and reducing duration of seasonal surface flows.

The goal of restoration on RM8 of Couse Creek is to create a healthy and resilient riverscape that supports ecological function and provides high quality habitat for vulnerable steelhead. The objectives of restoration are to:

1. Increase in-channel complexity by diversifying geomorphic unit assemblages
2. Increase channel floodplain connectivity
3. Increase seasonal duration of surface flow
4. Increase wetland and riparian vegetation extent

Structural additions that simulate natural wood accumulations and beaver dams are suggested as a treatment method aimed at bolstering the fluvial processes that result in these end goals. This document outlines the 15% restoration design for approximately one and a half miles along Couse Creek between river miles 7.5-9, and provides an overview of the project location, restoration goals and objectives, an assessment of resources, the restoration design approach including estimated structure types and quantities, an assessment of potential risks to infrastructure, and an overview of adaptive management for the project.

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INTRODUCTION

The Walla Walla Basin Watershed Council (WWBWC) is pursuing restoration actions on Couse Creek as part of a pilot effort to demonstrate low-tech process-based restoration (Wheaton et al. 2019) in the watershed. Couse Creek is a tributary to the Walla Walla River in Oregon, flowing northwest from the foothills of the Blue Mountains to the confluence of the Walla Walla River at river mile 47. The WWBWC recently conducted an assessment and developed an action plan for Couse Creek to identify impairments and restoration opportunities to benefit fish and wildlife while supporting sustainable agriculture (WWBWC 2020).

The Couse Creek watershed is part of the Walla Walla River Major Spawning Area (MaSA) for ESA-listed Mid-Columbia steelhead (*Oncorhynchus mykiss*) and has accounted for a significant portion of the observed spawning in the Walla Walla subbasin. Couse Creek historically supported chinook (*Oncorhynchus tshawytscha*), and bull trout (*Salvelinus confluentus*) have also historically been observed (NPCC 2004). Past land management activities including grazing, agriculture, timber harvest, road construction, and the removal of wood from streams along with recent flood events have decreased the quality and quantity of stream habitat within the Couse Creek watershed. Current factors limiting steelhead spawning and rearing success include increased temperatures and fine sediment loads, reduced wood accumulations (e.g., large wood jams), reduction of geomorphic diversity (i.e., pool and off-channel habitat), channel-floodplain connectivity, riparian vegetation extent, and baseflows. Much of lower Couse Creek goes dry for portions of the year.

The restoration design outlines LTPBR actions at RM8 on Couse Creek to achieve project goals and objectives. LTPBR practices use simple, cost-effective, hand-built structures that mimic beaver dams (beaver dam analogues) and large wood accumulations (i.e., post-assisted log structures; (Wheaton et al., 2019). These structural elements will be strategically installed in the stream in accordance with a design intended to initiate and amplify natural eco-geomorphic processes that accelerate the recovery of Couse Creek and address limiting factors. This project may also be used as a demonstration for additional LTPBR projects in the watershed in the future.

PROJECT LOCATION AND CONTEXT

The start of the project area on Couse Creek is located approximately seven and a half miles upstream from the confluence with the Walla Walla River, near the town of Milton-Freewater in Oregon. Throughout the project area, the valley bottom ranges between 60 to 200 feet wide, with an average approximate stream gradient of 3%. The Couse Creek watershed originates at moderate elevations (~4300 ft.) in the Blue Mountain and is approximately 25 mi^2 in area. Within the watershed, precipitation ranges from 18 inches in the lowlands to 40 inches in the headwaters and vegetation ranges from evergreen forests in the uplands transitioning to shrub and grasslands at lower elevations. Much of the lower to mid-elevation areas in the watershed are used for agriculture with a majority of the watershed in private ownership.

LITHOLOGY

The geologic background of the project area is driven by volcanic origin with Grande Ronde Basalt from the Miocene dominating the landscape. Inputs to Couse Creek, via bank erosion and alluvial fans, are predominantly N2 Grande Ronde Basalt and alluvium. The stream bed alluvium of RM8 project area consists largely of unconsolidated quaternary-age alluvial deposits ranging between cobble and gravel sizes (Madin, NA).

FLOW REGIME

At the location of the project area, Couse Creek drains approximately 12.8 square miles and experiences an average of 32 inches of precipitation annually. Like many streams originating in the Blue Mountains, a precipitation gradient aligns loosely with elevation, with lower grasslands and sage steppe in the basin receiving a much smaller ration of rainfall and snow than in the mountains. Peak flows tend to be rainfall driven and occur in winter and spring as rain on snow events (Figure 1). Localized, highly convective thunderstorms in late spring and early summer occasionally produce intense and short duration flood events. Low flows typically occur in summer and fall.

The peak discharge from the flow gage at RM 3.2 from 1967-1978 measured 550 cfs (OWRD 2022) and 502 cfs from 2018-2020 (WWBWC, unpublished data, 2022). These peak flows represent approximate 100-year flow events (WWBWC staff, personal communication, 2021). Low-flow statistics are not available for the project area, however field observations in 2023 by WWBWC staff indicate that perennial surface flows are only present in the upper project reach and that the lower half to third of the project goes dry during the summer months. Figures illustrating mean flows and flow exceedance tables from measurements during the two time periods can be found in the Appendix C.

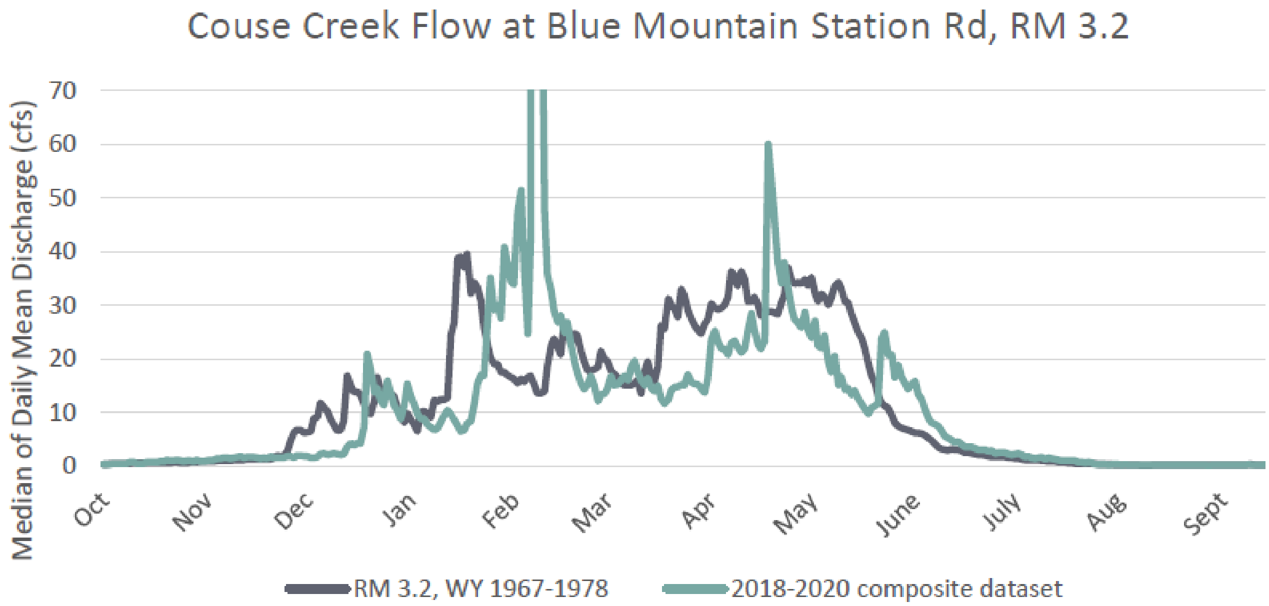

Figure 1: Hydrograph showing mean daily discharge (cfs) from gage data collected from 1967-1978 (OWRD) and 2018-2020 (WWBWC) at RM 3.2 on Couse Creek. Figure from WWBWC (2020).

PROJECTED CHANGES TO STREAMFLOW

Flows in the Walla Walla Watershed have been highly altered through contemporary irrigation diversions, levees, and canals. In addition to increasing habitat conditions within the project area, this restoration project broadly seeks to create and/or improve conditions to be more resilient climate change. Here we report projected climate-change driven impacts, as documented by the Tribal Climate Tool (Accessed 05/19/2024). Throughout the Umatilla Ceded basins of the CTUIR, annual precipitation is projected to increase between 0.8 - 2.0 inches by 2100 (relative to historic records, 1971-2000). The range of values reflects different emissions scenarios. Nearly all of this increase is projected to occur during the rainy season of October-March. Despite an increase in overall precipitation, April 1 Snow Water Equivalent (SWE) is projected to decrease in by 1.2 – 3.5 inches by the end of the century. These changes are projected to lead to a decrease in summer baseflows and an increase in streamflow during the winter months. In short, climate change is expected to shift the timing and magnitude of runoff in the Walla Walla subbasin by increasing winter flows and reducing duration of snowmelt driven runoff in the spring and summer. This may have adverse effects to anadromous fishes returning to Couse Creek to spawn.

SEDIMENT REGIME

The Blue Mountains rise steeply from the Walla Walla basin and have dramatic topographic relief in the dissected canyons that characterize the upper sections of Couse Creek. As such, ample sediment production initiates in the steep draws throughout the watershed and sediment contributions are conveyed to the valley bottom through hillslope mechanisms and alluvial fans. Additionally, sediment is periodically recycled from storage areas in stream banks, floodplains, channel bedforms. sediment composition in Couse Creek is predominantly homogenous with cobbles and coarse gravels making up much of the channel bed composition. Diverse sediment size classes in RM 8 is minimal, likely due to planar, featureless reaches. Present bars adjacent to wood jams exhibit diverse sediment arrangements, a line of evidence suggesting further heterogeneous sediment composition is plausible within the project reach.

WOOD REGIME

Couse Creek is a 3rd order stream with potential for recruiting wood from banks and riparian areas. As described by Kramer and Wohl in their 2017 paper on wood dynamics, natural log jam storage and movement can be expected in Couse Creek due to its classification as a medium-sized river. Wood storage within Couse Creek is expected to be close to random and governed by the size of the input, with larger pieces of wood likely to be transported less frequently and stored longer, while smaller pieces may be transported more readily and stored more briefly (Kramer et al. 2017). Storage capacity is likely higher in areas where the valley bottom widens, and channel braiding occurs than in narrower, single threaded reaches with high banks.

ALTERATIONS TO WOOD REGIME

Anthropogenic pressures within the Walla Walla Watershed have resulted in alterations of the frequency and size of inputs. Alterations are results of logging at mid elevations in the watershed and land clearing at lower elevation for agricultural purposes. Snag removal was also a common practice in river management in the past, and likely resulted in reduced jam formation and wood storage.

BEAVER DYNAMICS

Beaver do not currently play a large role in the stream dynamics in Couse Creek. A 2020 WWBWC assessment found no beaver dams within Couse Creek. The Beaver Restoration Assessment Tool (BRAT) model suggests that frequent dams (5-15 dam/km) are possible within the project reach, however this may be overestimated by the model as the lower half to third of the project area goes dry for portions of the year. Additionally, substrate within the restoration reach is predominately cobbles, making damming more difficult for beavers due to a lack of fine sediment to plug structures.

Riparian vegetation within the valley bottom consists of mainly of cottonwood stands, with some patches of willow species near the channel margin and on floodplain surfaces. Outside these areas, vegetation consists of grasses, forbs, and various non-native, noxious weeds. The potential for beaver to establish dams and occupy habitat in the project area may currently be limited by a reduction in wood (e.g., willows) as a source of food and building material, higher stream power in the main channel leading to dam breaching, and/or a reduction in off/side channel habitat.

PROJECT GOALS AND OBJECTIVES

The overall goal of restoration on Couse Creek is to promote natural fluvial processes that result in a healthy and resilient riverscape and increase habitat quantity, quality, and diversity for threatened steelhead. Within this broad management goal, restoration objectives provided by the WWBWC include:

- trapping sediment and aggrading the channel,
- inundate floodplains to improve riparian conditions,

- increase surface water retention and groundwater recharge, and
- increase channel complexity and pool area/frequency

Later in the planning process we revisit these goals and objectives and recommend indicators to evaluate the effectiveness of restoration and help facilitate the adaptive management process.

PLANNING AND DESIGN APPROACH

The Couse Creek riverscape restoration design follows an adaptive management framework that has three phases: 1) Collection and Analysis (focused on planning), 2) Decision Support (design), and 3) Application and Evaluation (implementation, monitoring, and additional phases as needed; Figure 3). In this report, the planning process includes components specific to riverscape restoration that are consistent with LTPBR designs and practices with the overall intent of presenting the preliminary restoration goals and objectives of the project, conducting resource assessment, risk, and recovery assessment, using those results to refine/recast the goals and objectives of the conceptual design, and arrive at measurable indicators to evaluate progress toward objectives (Wheaton et al. 2019).

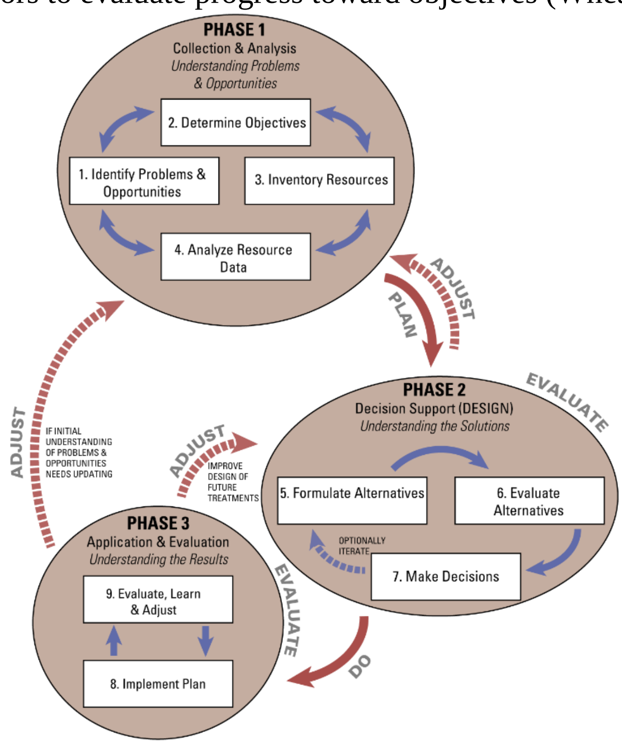

Figure 2: Outline depicting an adaptation of NRCS's Conservation Planning Process used to guide the Couse Creek restoration planning and design process (from Wheaton et al. 2019).

LOW-TECH PROCESS-BASED RESTORATION

LTPBR is based on a set of riverscape and restoration principles that are applied based on the characteristics and limitations set by individual riverscapes (Appendix A). The first question we seek to answer before developing a LTPBR design is "is the riverscape structurally starved?" Structural-starvation (i.e., the absence of wood, beaver dams, and/or dense vegetation) in riverscapes is one of the most common impairments affecting riverscape health. Generally, a structurally-starved riverscapes drains quickly, has limited lateral connectivity, is more prone to incision, and has simple and homogenous habitat. By contrast, a riverscape with a natural amount of structure has obstructions to flow leading to structurally-forced hydraulic diversity and geomorphic diversity resulting in a more resilient riverscape that provides diverse habitat and a suite of ecosystem services (Bisson et al., 1987; Roni et al., 2015; Wohl et al., 2019).

LTPBR approaches use the addition of structural elements to mimic, promote, and sustain natural riverscape processes. Rather than trying to create a specific channel form, implementation of LTPBR relies on stream power (or beaver) to “do the work”. LTPBR explicitly acknowledges that one treatment of structural elements is unlikely to reverse decades or longer of management impacts and that successful restoration is likely to include multiple treatments (i.e., phases). Therefore, LTPBR designs include phases, and work best when projects are monitored to determine when new phases or maintenance are required. The following design is presented within an adaptive management framework to incorporate monitoring and phased implementation in a transparent and structured plan (Figure 9).

DESIGN RATIONALE

Several alternative channel and floodplain restoration approaches have been considered for riverscape recovery at RM 8 on Couse Creek. In general, these alternatives are characteristic of traditional engineered plans for valley bottom regrading, channel realignment, or engineered log structures, similar to those placed during previous restoration efforts. Given the design, permitting, implementation costs, and potential disturbance caused by heavy machinery necessary for engineering-based restoration approaches, LTPBR approaches were selected as the proposed design. Multiple lines of evidence provided in the condition assessment suggest that RM 8 is well suited for LTPBR implementation. Some of those include:

Site characteristics – The climatic, topographic, and hydrologic catchment conditions within Couse Creek support periodic high flows, sediment supply, and a recovering riparian area.
Lack of human infrastructure – There is minimal human infrastructure in and above the project area — only a small dirt road enters some floodplain areas and crosses Couse Creek at two locations. This characteristic of the project area offers a high potential for expansion of the active channel and floodplain while posing minimal risk to infrastructure.
Accessibility – The project area is easily accessed by road and is a short drive from the WWBWC office in Milton-Freewater. This accessibility lends itself to convenient project monitoring, easy LTPBR equipment transport, and provides a visible, easily accessible site to use as a demonstration project for LTPBR in the watershed.

RESOURCE ASSESSMENT

The following section provides an assessment of resources and potential risks within the project area. The results from these assessments were used to evaluate potential future conditions and pathways to riverscape recovery. We used desktop analyses, a site visit, aerial imagery, previously collected data, information outlined in the Couse Creek Watershed Assessment and Action Plan (2020), and personal communication with WWBWC staff to assess the following resources.

FISHERIES AND LIMITING FACTORS

Improving spawning habitat for an ESA-listed population of steelhead is a high priority for the WWBWC. The restoration actions proposed in this design are intended to address multiple limiting factors for spawning habitat such as homogenous channel structure, reduced riparian function, diminished flow refugia and cover, and floodplain connectivity. It is inferred that the installment of PALS, BDAs, and strategically placed whole trees will drive hydraulic diversity that will lead to habitat complexity. Adding structure to Couse Creek will likely force overbank flows, create the hydraulic diversity necessary for sorting sediments, and inundate a greater extent of riparian communities over a wider range of flow stages. These outcomes have been linked to more suitable habitat because they nourish the development of bars and pool-riffle sequences and attenuate the effect of peak discharges by dispersing high energy runoff to the surrounding floodplain. Finally, improvements to the riparian zone will provide important cover and refuge for all life stages of steelhead.

Stream habitat within the Walla Walla basin has experienced similar reductions in ecological function as other watersheds of the Blue Mountains and more broadly, the intermountain west. It is thought that improving conditions for the rearing and spawning stages in the life cycle of anadromous fishes will translate to increased production. Structural additions to Couse Creek aim to improve habitat for rearing and spawning life stages.

The restoration actions outlined in this design propose to address a number of these potential limiting factors including reduced riparian vegetation and floodplain connectivity, and address degraded channel structure and complexity, and habitat quality and quantity.

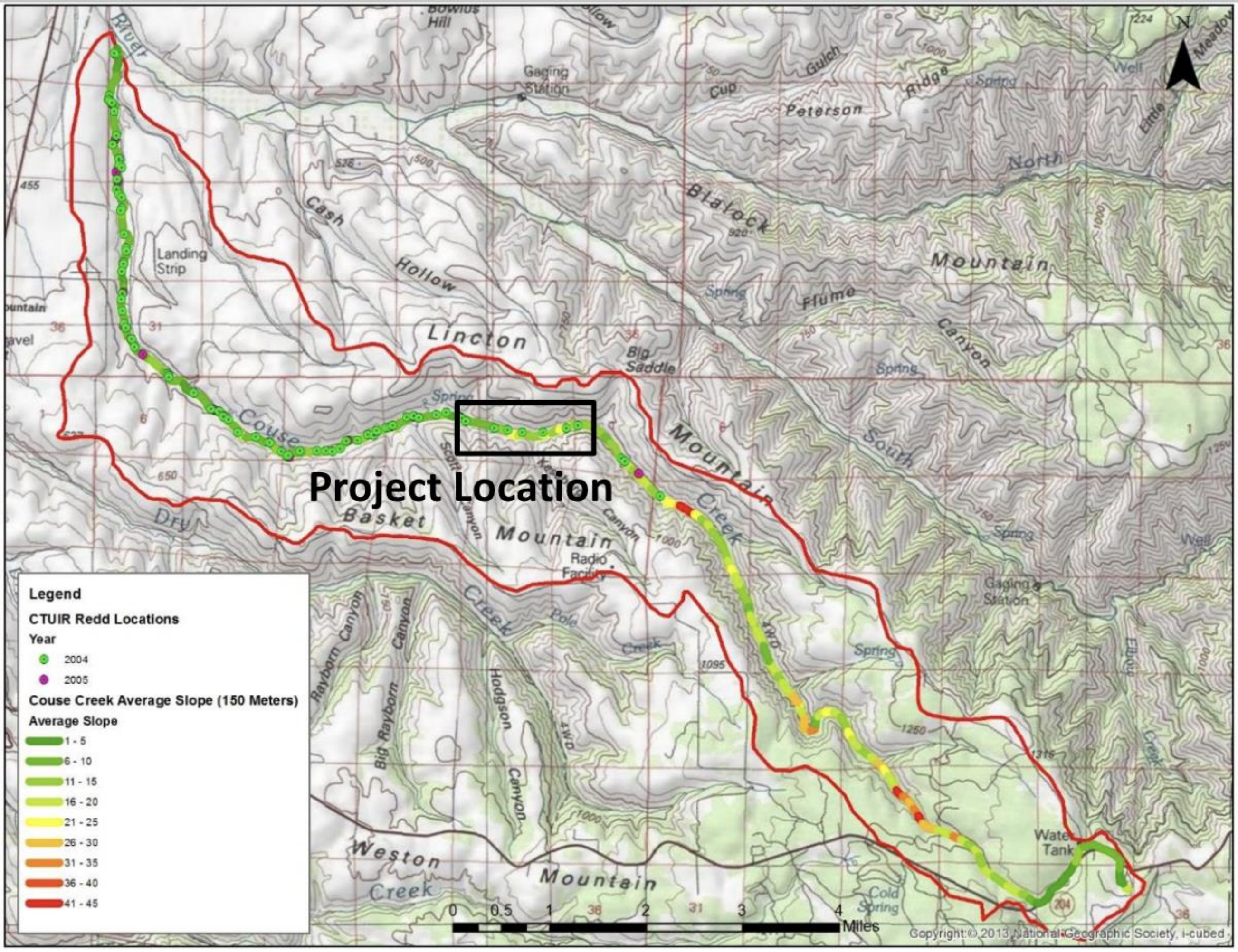

Figure 3: Location of steelhead redds in Couse Creek during 2004 and 2005 Confederated Tribes of the Umatilla Indian Reservation (CTUIR) surveys. Figure modified from WWBWC (2020).

VALLEY SETTING (REACHES)

The project area represents a single valley setting characteristic of a partly confined reach consisting of a moderately wide valley bottom ranging from 60-200 feet in width. Hillslopes are the dominant confining margin, with inactive floodplains playing a role in regulating channel migration in some reaches.

VALLEY BOTTOM GEOMORPHIC COMPOSITION

We assess the overall health of a riverscape by identifying the existing composition of geomorphic attributes within the valley bottom that include the active channel, active floodplain and inactive floodplain. Valley bottom attributes were delineated within the project area based on consideration of geomorphic and vegetative indicators during the field visit, and through evaluation of orthoimagery (Figure 4). The proportion and arrangement of floodplain varies depending on valley setting and reach type, but generally the more anthropogenic actions limit natural rates and magnitudes of overbank flow and floodplain connection (i.e., active floodplain) the more degraded the riverscape is. We define the valley and its components as (Wheaton et al. 2015):

Valley – relatively flat, low-lying area between hills or mountains, typically containing a watercourse. Contains the geomorphic units: channel(s), floodplain(s), terrace(s), and fan(s).
Valley Bottom – low-lying area in a valley containing the stream channel and contemporary (i.e., or genetic) floodplain. The valley bottom represents the current maximum possible extent of channel movement and riparian areas. It may be bounded by hillslopes, terraces, and/or alluvial fans.
Active Channel – area between the tops of banks that is geomorphically active during typical (i.e., 1-2 year) flows, and is characterized by sediment entrainment, deposition and transport. It is identified by open water and/or the presence of bare surfaces that are the result of scour or deposition, and have not been colonized by perennial vegetation.
Active Floodplain - area within the valley bottom that is inundated by 5 – 10-year recurrence interval flows (i.e., the 5 – 10-year floodplain), and is generally capable of recruiting and supporting riparian vegetation. Estimates of active floodplain were derived from aerial imagery and a site visit delineating areas with evidence of recent flows (erosion, deposition, etc.) however these estimates should not be treated as exact.
Inactive Floodplain - area which could flood under the current flow regime, but is not hydrologically connected during 5 – 10-year recurrence interval flows. We specifically identify this area as the inactive floodplain, rather than the commonly used term 'terrace' to differentiate valley bottom features that are the result of anthropogenic disturbances from those that are the product of historic climatic or geomorphic events and conditions that are different from contemporary (natural) hydrological rates and magnitudes. Unlike the distinction between a terrace and floodplain, which are distinguished by differences in elevation, both the active floodplain and inactive floodplain may be present at the same elevation but are distinguished by their lateral displacement from the active channel.

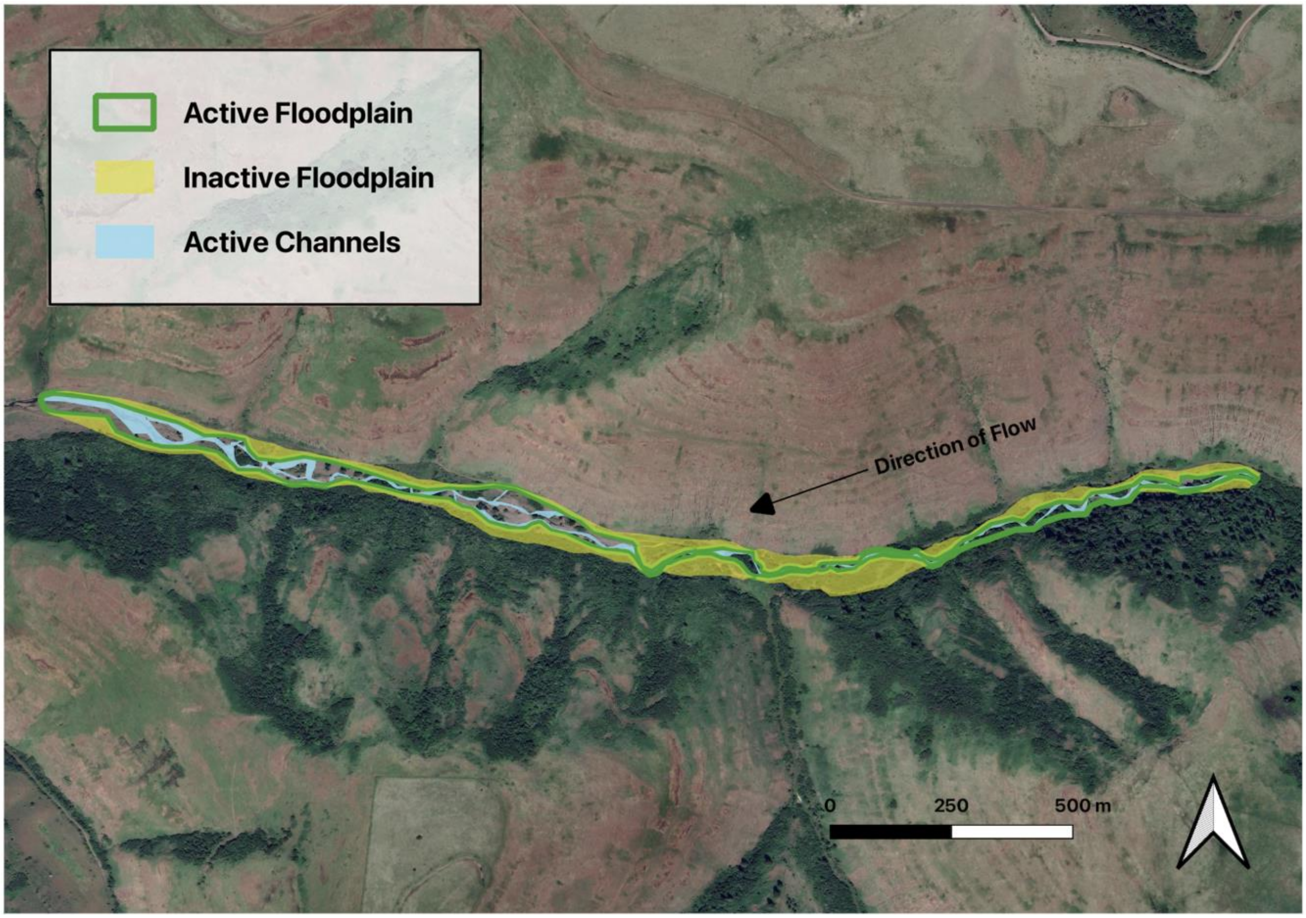

Figure 4: Schematic of the project area valley bottom estimated geomorphic composition. In this reach, there is potential to access the entire valley bottom.

Within the project area, the active channel and active floodplain comprise approximately 44% of the valley bottom. The inactive floodplain comprises approximately 56% of the valley bottom.

CHANNEL CHARACTERISTICS

Throughout the upper two-thirds of project area, the stream channel is primarily a single-thread and moderately sinuous (Figure 5). The lower third of the project area supports more braiding at base flows. However, the bedforms of many of these channels appear to be planar and featureless. Channel reaches with limited sediment sorting also have homogenous geomorphic unit assemblages. Channel forms consist primarily of planar units (e.g., runs), occasional bars and pools, and minimal sediment size diversity, largely composed of coarse gravels and cobbles. The level of incision varies throughout the project but is generally about 2’ – 4’ with exposed banks. There is evidence of large wood recruitment from streambanks and in 2024, but an average of less than 1 log jam per 100 yards was identified within the active channel at the project area. The lack of structural elements may be a result of past land management or due to recent floods eliminating elements from the project area. Much of the active channel was changed during high flows in February 2020 which was estimated to be a 100-year flow event (WWBWC 2020).

Figure 5: Upper left: Featureless, plane bed, and single threaded reach depicting arrested recruitment of LWD. Upper Right: Sediment source from an alluvial fan in roughly the middle of the project area. Lower Left: High banks anchored by dense stand of uniformly aged cottonwood stand. Lower Right: Example of diagonal mid-channel bar where valley bottom width permits sediment storage and channel bedform heterogeneity. See Appendix B for additional project area photos.

POTENTIAL RISKS

Risks were assessed as the potential for impacts to infrastructure (road crossings, buildings, etc.) within and adjacent to the valley bottom. A dirt road parallels much of the project area, passing through sections of the floodplain and crossing Couse Creek in two locations. Below the project area, the nearest infrastructure in the valley bottom is a barn and home approximately 0.34 miles downstream. It is not expected that restoration would negatively impact these locations by either: 1) direct flooding due to restoration structures forcing overbank flow or 2) the mobilization and downstream transport of woody material that could become trapped at road crossings.

NATURAL RECOVERY TRAJECTORY

Evaluation of historic aerial photos reveal that the riverscape within Couse Creek is beginning to exhibit signs of recovery toward a channel and floodplain more characteristic of its valley setting (Figure 6; Google Earth). That is, land use changes have allowed for increased development of riparian vegetation and resulted in the establishment of roughness elements along margins, sediment deposition and bar formation, lateral channel migration, and overbank flow onto disconnected floodplain surfaces. While this natural response is promising, review of the rates at which these processes are in play reveal a slow progression toward recovery. This slow progression is likely attributable to a lack of structural elements (i.e., wood, beaver dams) within the project area that would otherwise accelerate the natural recovery process.

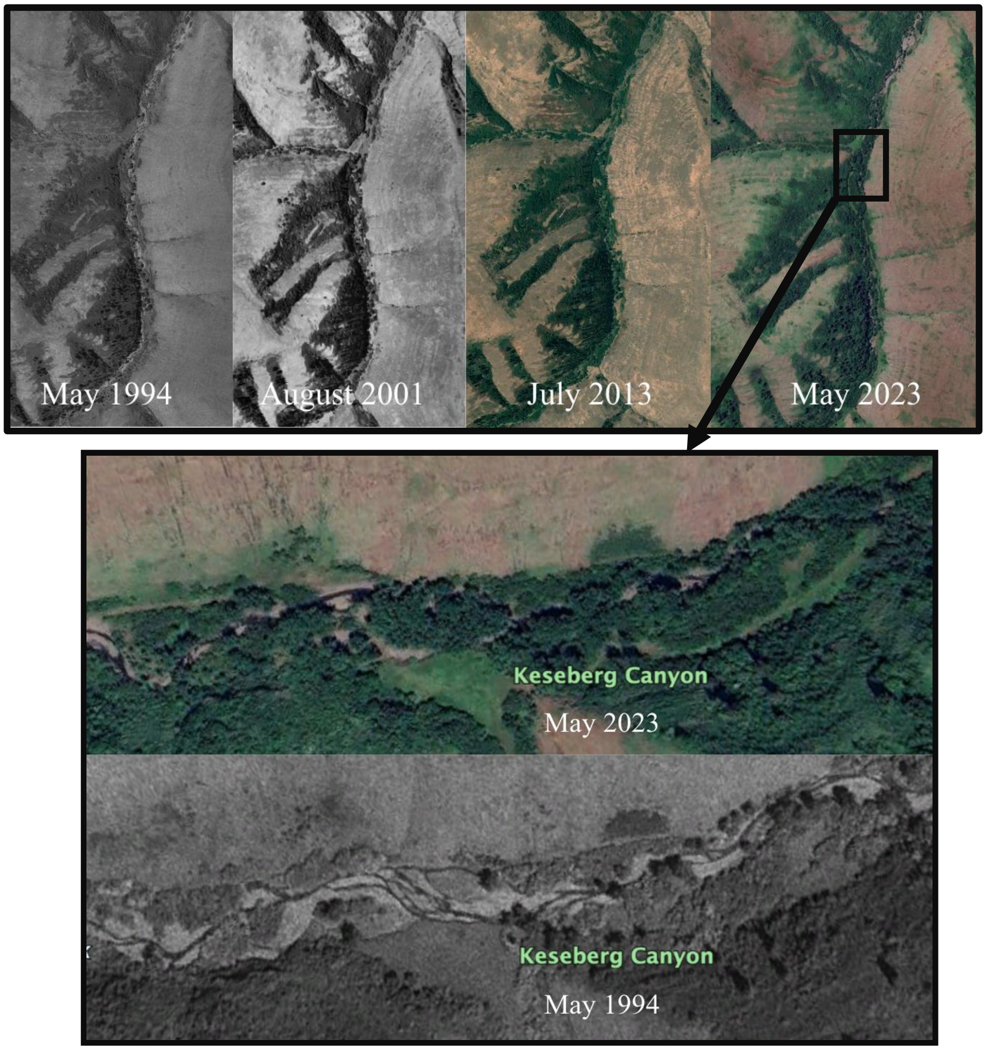

Figure 6: Aerial imagery (Google Earth) used to demonstrate the extent and timeline of natural recovery within the project area. Repeat imagery shows how some riparian vegetation has expanded, but little changes to channel planform and floodplain connectivity have occurred over a roughly 29 year time period.

POTENTIAL FUTURE CONDITION

Prior to human alteration, many riverscapes, such as Couse Creek, were characterized by substantial eco-geomorphic complexity, making them more resilient to disturbance and containing greater habitat quality and quantity for fish and wildlife. Reference conditions of similar streams serve to represent plausible future conditions and allow for measurable restoration outcomes.

Streams in the Umatilla National Forest surveyed by Eco Logical Research between 2009-2011 can collectively serve as reference conditions due to their similarities in ecology, topography, and river styles. These sites were found to have an average of 320.7 of Large Woody Debris pieces per mile and an average pool count of 59.8 per mile (Wheaton et al. 2012). Both of these metrics indicate relatively higher levels of structure, geomorphic unit complexity, and more suitable habitat conditions for salmonid species than the current conditions at the Couse Creek project area.

Without active structural additions it could be decades before Couse Creek naturally recovers to near similar conditions. The condition and trajectory of ESA-listed Mid-Columbia steelhead necessitate an urgency to intervene and accelerate habitat improvements. The purpose of LWD additions within the project site are to initiate and increase the speed of natural restoration trajectories. Structural treatment *mimics* natural wood accumulations and beaver dams and *promotes* hydro-geomorphic processes underlying river dynamism, however the longevity of habitat improvements depend on how well the system can *sustain* these processes. Examples of processes that sustain river dynamism and resiliency include natural wood recruitment, frequent reshaping of channel bedform, and beaver colonization. These processes are positive system responses signaling the effect of restoration actions.

PROJECT OBJECTIVES

The preliminary project objectives are revisited and modified here to ensure they are consistent with riverscape restoration goals and reflect the current conditions and potential for recovery in the project area. The Couse Creek restoration goals and objectives support recovery planning actions aimed at improving the quality and quantity of habitat and addresses several factors limiting steelhead production including riparian vegetation, floodplain connectivity, channel structure and complexity, and habitat quality and quantity.

RESTORATION OBJECTIVES

Restoration goals are supported by S.M.A.R.T (Specific, Measurable, Achievable, Relevant, Time bound, from Skidmore et al. 2011) restoration objectives that have been developed to create expectations for project outcomes, establish restoration indicators, and guide adaptive management. The restoration objectives were developed based on initial project objectives and the assessment of current conditions and recovery potential (Table 2).

Objective	Description	Link to Restoration Goals
1	Increase in-channel geomorphic diversity.	Geomorphically diverse streams provide higher quality habitat for adult and juvenile steelhead.

2	Increase the proportion of the valley bottom inundated during high flows.	Increased active channel and floodplain areas inundated during high flows contributes to the expansion of wetland and riparian vegetation and increasing steelhead habitat quantity and diversity.
3	Increase perennial surface flow extent and duration.	Surface flow creates conditions that support woody riparian vegetation establishment, steelhead habitat quantity and quality, and suggests efforts to attenuate flow are successful.
4	Increase wetland and riparian vegetation extent, diversity, and abundance.	Riparian vegetation is essential to support natural wood recruitment and accumulations, and as forage and building material for beaver.
5	Increase the abundance of large wood accumulations and beaver dams.	Both large wood accumulations (e.g., large wood jams) and artificial and natural beaver dams increase in-channel habitat diversity and help to accelerate recovery. An expanding beaver population is indicative of self – sustaining riverscape processes.

Table 1: Restoration objectives and their link to broader management goals.

RESTORATION INDICATORS

There is potential for restoration success in Couse Creek due to the lack of infrastructure, limited grazing pressure in the valley bottom, the application of best management practices in the uplands, and indications that riparian conditions have begun to recover. However, restoration success may be limited by factors such as agricultural pressures and a changing climate.

In keeping with SMART project objectives, a series of restoration targets and indicator metrics are recommended for evaluating the effectiveness of restoration. For each indicator, estimates of current and potential (i.e., target) values have been developed that correspond to broad recovery timelines (Table 3). All metrics are intended to be summarized through monitoring efforts using methods such as those described within the LTPBR Implementation and Monitoring Protocol (Weber et al. 2020). These methods allow quantification of indicator metrics via aerial imagery acquisition or through measurements taken during rapid field habitat surveys.

RESTORATION INDICATOR METRICS

Pool Frequency – Frequency (count/100m) of in-channel concave geomorphic units (Wheaton et al. 2015; e.g., pools) created by erosion, and/or damming. Expected to increase in response to structural treatments. Pool habitat provides refuge for juvenile steelhead during periods of drought and high temperatures, and velocity refuge during high – flow periods.
Bar Frequency – Frequency (count/100m) of in-channel convex geomorphic units created through deposition (Wheaton et al. 2015; e.g., point bars, mid-channel bars, riffles). Expected to increase resulting from the structural intervention as a function of increased in-channel hydraulic diversity. Bars are indicative of sediment sorting and spawning habitat used by adult steelhead.
Side Channel Frequency – Total number of active confluences and diffluences within the project reach at a given spring runoff. Expected to increase because of increased lateral connectivity. Side channels reflective of braiding activity, increased lateral exchange, and increased quantity of suitable habitat. Side channels offer off-channel refuge, crucial nursery habitat for parr and fry life stages.

High Flow Inundation Area – Percent and area of the valley bottom inundated during a typical (2-year) high flow. Expected to increase resulting from structural intervention due to overbank flows, pond creation, floodplain connectivity, and creation of multi-threaded channels.

Perennial Surface Flow Percent – Percent of channel length with persistent surface flow during low flow periods. Surface flow should be recognized if present in any channel (i.e., primary or secondary channels). Expected to increase in response to flow attenuation, temporary storage, and increased surface – groundwater exchange.

Wetland and Riparian Vegetation Extent – Percent and area of the valley bottom in which the community is composed of wetland and/or riparian plant species. Expected to increase with an expanding active channel and floodplain, floodplain inundation frequency, and groundwater elevation.

Large Wood and Beaver Dam Abundance – Count of large wood accumulations (e.g., jams) natural beaver dams, and artificial dams within the project area. Artificial dams and large wood accumulations will increase immediately after restoration treatments. Natural beaver dams and self-sustaining beaver populations have the potential to increase over short to longer time periods with the creation of deep-water cover from restoration treatments and over longer time periods following the expansion of riparian vegetation communities and side channel habitat.

Indicator	Status: Current	Target Metrics: As-Built	Short-Term 2 – 5 years	Medium-Term 5 – 10 years	Long-Term 10-20 years
Objective 1: Increase in-channel geomorphic diversity					
Pool Habitat Frequency (count/100m)[1]	1-3 / 100m	1-3 / 100m	1-4 / 100m	2-5 / 100m	3-6 / 100m
Bar Habitat Frequency (count/100m)[1]	2-3 / 100m	2-3 / 100m	2-5 / 100m	3-5 / 100m	4-6 / 100m
Active Side Channel Frequency (# active confluences/diffluences at standardized flow)	10-15	10-15	12-15	15-20	15-25
Objective 2: Increase the proportion of the valley bottom inundated at high flows					
High Flow Inundation Area (% & acres) [2, 3]	8-18% 3-6 acres	8-18% 3-6 acres	9-24% 3-8 acres	15-29% 5-10 acres	24-50% 8-17 acres
Objective 3: Increase perennial surface flow extent during low flow periods					
Perennial Surface Flow Length (% and length)	0-5%, 0-50 meters	0-5%, 0-50meters	0-8%, 0-75 meters	5-20%, 50-200 meters	10-75%, 100-750 meters
Objective 4: Increase wetland and riparian vegetation extent					
Wetland and Riparian Vegetation Extent (% & area)[2, 3]	6-15%, 2-5 acres	6-15%, 2-5 acres	8-18%, 3-6 acres	15-29%, 5-10 acres	29-50%, 10-17 acres
Objective 5: Increase abundance of beaver dams and large wood accumulations					
Natural Beaver Dams (count)	0 dams	0 dams	0-2 dams	0-5 dams	0-10 dams
Artificial Beaver Dams (count)	0 dams	5-10 dams	5-10 dams	5-10 dams	5-10 dams
Large Wood Accumulations (count)[4]	0-5 / jams	60-144 / jams	40-144 / jams	45-150 / jams	50-150 / jams

1: Assumes treatments will form pool and bar complexes after flood events.
2: Primarily based on expectations for expansion of the active floodplain through overbank flows.
3: Target extent will depend on snowpack and rain events annually.
4: Assumes a combination of natural and artificial large wood accumulation in the project area.

Table 2: Current and target indicator metrics and their link to specific project objectives for the project area. Target metrics are estimated for the As-Built project occurring just after the first phase of implementation and short, medium, and long-term time periods following subsequent phases. Ranges in future target metrics indicate uncertainty in the timeline and outcomes from the restoration treatment. Current metrics were estimated from aerial imagery and spatial analysis.

RESTORATION DESIGN

The LTPBR restoration design consists of the following components used to guide the implementation of treatments over time:

Temporal Design – The temporal design is used to guide initial and subsequent implementation phases (i.e., temporally punctuated structural treatments inclusive of new structures, maintenance, and structure enhancement). Note that the temporal design is conceptual and the timing of the implementation of phases hinges on the adaptive management process along with future funding and personnel.

Spatial Design – Reach Delineation – Restoration reach delineation based on valley setting. The delineation of reaches is used to set specific objectives and adjust restoration expectations according to limitations set by the riverscape.

Structural Elements and Complex Design – Description of structure types and their organization, distribution, and function within project area complexes (i.e., groups of multiple structures). Includes riparian fencing.

TEMPORAL DESIGN

Temporal design should take into consideration both the expectations for flood events of a given magnitude, as well as rates of vegetative, geomorphic, and hydrologic recovery. Therefore, the restoration design takes a phased approach to implementation to help facilitate the adaptive management process. The specific timing of additional treatments, while likely to correspond to the timeframes listed below are in practice driven by adaptive management, and progress towards meeting restoration objectives. We recommend a pilot in select areas followed by implementation in the entire project area (Phase 1). A second structural treatment (Phase 2) would follow at least 1-2 typical (2-year return interval) flow events. A third treatment phase would take place after several moderate floods and at least one large flow (>5-year year return interval). Additional phases could be added based on progress towards restoration targets and/or establishing self-sustaining process. Additional benefits of a phased approach include the advantages of enabling implementers to work out initial logistics at a smaller scale and scale up restoration more efficiently. The phased approach also fits an iterative process that can be applied to multiple ongoing restoration projects over large spatial scales.

Phase	Year(s)	Restoration Actions	Structure Estimate
1	1	▪ Pilot restoration in select reaches ▪ Evaluate pilot restoration	New: 60-154
	2	▪ Implement restoration throughout project area ▪ Structure maintenance and additions in areas of pilot restoration	New and maintained: 30-60
2	2-5	▪ Evaluate Phase 1 restoration ▪ Structure maintenance and additions within project area	New and Maintained: 0-50

3	**5-10**	▪ Evaluate Phase 2 restoration ▪ Structure maintenance and additions within project area	New and Maintained 0-50
Additional	**10+**	▪ Evaluate the establishment of self-sustaining processes ▪ Potential beaver reintroduction	New and Maintained 0-50

Table 3: Estimated time table for phased implementation on Couse Creek. Structure estimates are approximations. The number of new structures and those that need maintenance in subsequent phases will be assessed through the adaptive management process.

SPATIAL DESIGN - REACH DELINEATION

Significant geomorphic characteristics within the valley bottom such as channel gradient and valley width are not highly variable throughout the project area. As such, we consider the project area is subject to similar large-scale geomorphic and hydrologic drivers, and consequent process-rates. We therefore treat the entire project area as a single management reach.

STRUCTURAL ELEMENTS

Structural elements proposed in the design include large wood accumulations (this includes Post-Assisted Log Structures (PALS), wood jams not supported by posts (constructed via direct felling of trees and grip hoisting), and Beaver Dam Analogues (BDAs). These structure types can be built using a variety of locally sourced material (from adjacent floodplains and hillslopes or forest management activities) and installed using manual labor or small equipment that will result in minimal impact to existing riparian vegetation and in-stream habitat. Appendix D provides details on BDA and PALS construction methods, different structure types, how different structure types should be used to promote specific responses, and design schematics. Additionally, the implementation of riparian fencing and cattle exclusions could be added within the lower two complexes of the restoration design to allow for increased vegetative growth within the first 5-10 years of the project. Establishment of native riparian vegetation could be bolstered should grazing pressures be limited.

Post-Assisted Log Structures (PALS)

PALS are composed of woody debris assembled to mimic a wood jam and stabilized by driving untreated wooden posts into the streambed. PALS are positioned to mimic hydraulic effects of natural wood accumulations. PALS are designed to increase geomorphic diversity, force lateral channel migration, force overbank flows, and encourage aggradation and channel braiding (Figure 11; Appendix D). However, PALS can also be built on the floodplain and disconnected side-channels to add roughness and in anticipation of high flow events. PALS can be bank-attached, span the channel, or positioned in the middle of the channel. Bank-attached PALS are used to widen channels, recruit sediment, promote bed scour, and develop bars, pools, and riffles. Mid-channel PALS are used to diverge flows, build mid-channel bars, and provide wake and eddy hydraulics in higher flows. Channel-spanning PALS are used to force aggradation, promote overbank flow during high flow, and develop plunge and structurally forced pools. Different types of PALS are often used in combination with beaver dam analogues to produce a variety of localized geomorphic affects. PALS are typically built in high densities such that if a PALS is blown out woody material is likely to be captured by downstream structures (i.e., safety in numbers restoration principle; Appendix A). The diversity of structure types and orientations mimic the natural diversity of large wood accumulations observed in fluvial networks.

Beaver Dam Analogues (BDAs)

Beaver dam analogues (BDAs) mimic the structure and function of natural beaver dams (Figure 15). BDAs are temporary, permeable structures built with or without posts using a combination of locally available woody material and sediment (Appendix D). The design and implementation of BDAs is a simple and cost-effective method to restore the processes that are responsible for physically complex channel and floodplain habitat. They can be used to support existing populations of beaver by increasing the stability of existing dams; create immediate deep-water habitat for beaver translocation, or used to promote many of the same processes affected by natural beaver dams such as increased channel-floodplain connectivity during both high and low flow conditions, increased hyporheic exchange, expansion of riparian vegetation and wetland areas, increased hydraulic diversity such as deep-slow water habitat (e.g., lentic), and incision recovery through channel-widening and aggradation (Pollock, 2014; Bouwes, 2016).

Figure 7: Example of a channel-spanning PALS after multiple years of additional wood accumulation (left photo) and a beaver dam analogue reinforced with posts (right photo).

COMPLEX DESIGN

While individual structures (PALS and BDAs) may have local influence, they are unlikely to achieve project restoration objectives unless they are coordinated in a larger reach-scale effort. Thus, individual structures are designed to work together in complexes to meet multiple objectives. A complex may be composed of a single structure type (e.g., BDAs) or a mix of structure types (i.e., PALS and BDAs) and be composed of as few as two structures or as many as 10s of structures. Individual PALS and BDAs that are part of a complex help to increase the stability of any given structure within the complex. Four complexes within the project area have been delineated and designed to meet multiple objectives. Figure 8 provides a conceptual restoration design including structure types and locations. Table 5 provides a list of primary objectives for each complex along with a description and estimate of structure numbers and types. A more detailed description of complex objectives and their intended physical and biological responses can be found in Appendix E. More detailed maps of complex designs can be found in Appendix F. The number, type, and location of structures is subject to change based on ground conditions.

Additional Complex Design Option - Riparian Fencing

Riparian fencing reduces pressures on vegetation by excluding cattle and other grazers. The addition of riparian fencing within complex 3 and complex 4 of the design may increase the rate of woody vegetation recovery by reducing or eliminating grazing pressure. Riparian fencing is often considered a process-based restoration measure and is occasionally coupled with LT-PBR structural treatments, especially in stream corridors where riparian vegetation is depleted. With improved soil development from predicted overbank flows, it is plausible that adding riparian fencing would bolster the recovery of native riparian vegetation. Although this design does not include the exact location, dimensions, or duration of fencing, this component may be considered by involved parties to best suit their goals.

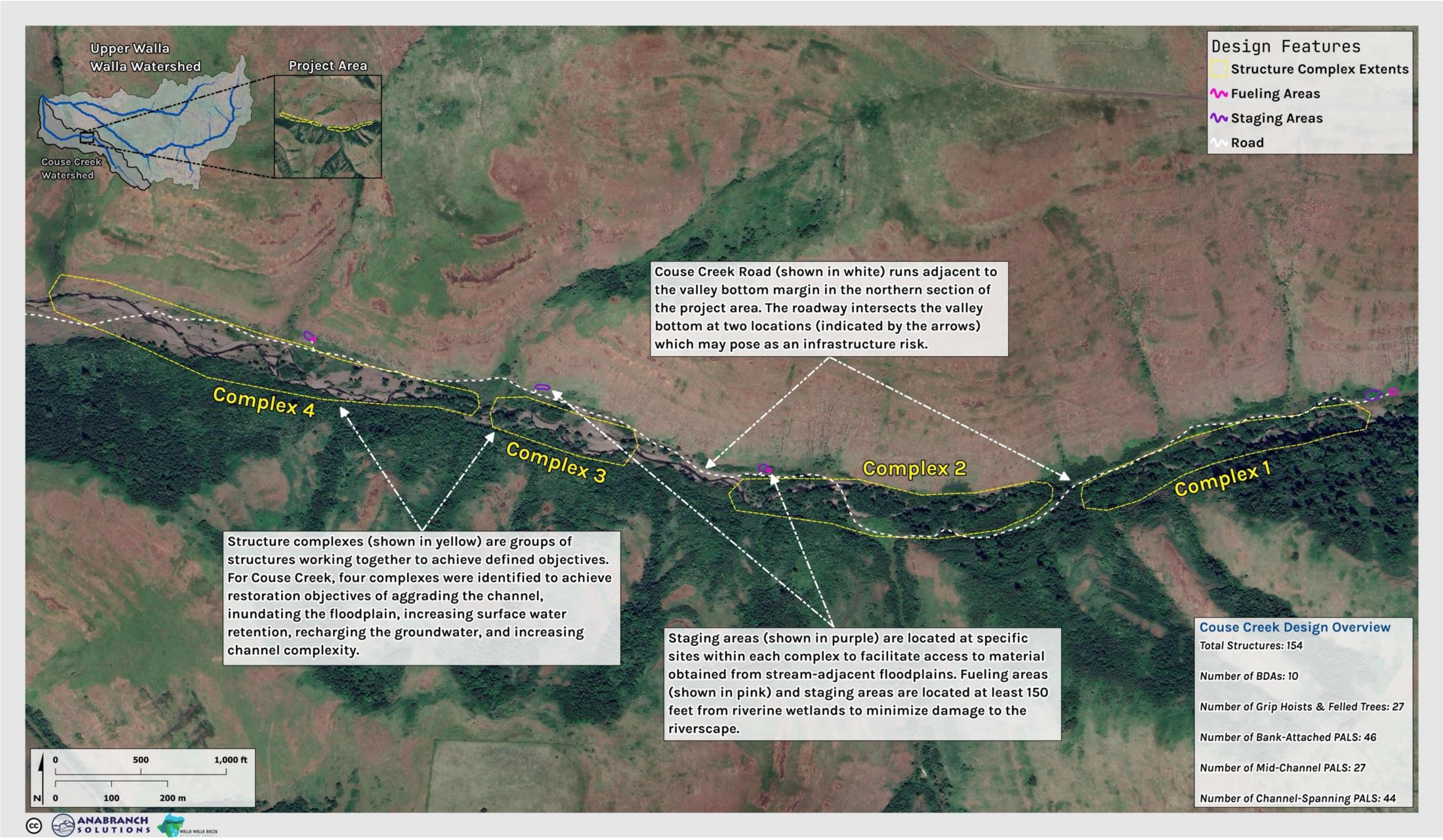

Figure 8: Restoration design illustrating complex locations, structure totals, and staging, fueling, and access routes. Table 1 provides a description of specific objectives for each reach. More detailed maps of complex design components can be found in the Appendix.

Complex Number (length)	Objectives	Description	PALS	BDAs
1 (503 m)	Increase Geomorphic Complexity Force Hydraulic Variance Force Overbank Flows (floodplain connection) Channel Widening and Aggradation	Bank-attached PALS and mid-channel PALS to promote sinuosity, side-channel connection, and bar development. Griphoisting and direct felling to promote and sustain future recruitment of wood inputs. Channel-spanning PALS and BDAs to deposit sediment, pond water, and create distribution of flow patterns that may increase temporal extent of seasonal runoff.	38	10
2 (571 m)	Diversify Geomorphic Unit Assemblages Force Hydraulic Variance Aggradation and Ponding	Large wood inputs via griphoisting and direct tree felling to encourage geomorphic diversity through creation of pools and bars. Mid-channel PALS to promote bar formation via varied flow distributions. Channel-spanning PALS to slow temporal flows and encourage sediment deposition. BDAs to deposit sediment, pond water, and create distribution of flow patterns that may increase temporal extent of seasonal runoff.	33	0
3 (260 m)	Diversify Geomorphic Unit Assemblages Increase Fine Sediment Deposition Lateral Exchange	Bank-attached and mid-channel PALS to increase sinuosity and braiding, lateral channel migration, and diversified flow paths. Channel-spanning PALS to encourage sediment deposition by slowing and ponding temporal flows.	15	0
4 (782 m)	Increase Fine Sediment Deposition and Aggradation Lateral Exchange Force Hydraulic Variance	Bank-attached and mid-channel PALS to increase sinuosity and braiding, lateral channel migration, and diversified flow paths. Channel-spanning PALS to encourage sediment deposition by slowing and ponding temporal flows.	58	0
		Totals:	**144**	**10**

Table 4: Reach descriptions outlining risk, objectives, and an estimate of structure types and numbers.

ADAPTIVE MANAGEMENT

LTPBR is more appropriately thought of as an ongoing-process of restoration and management than a 'one-and-done' effort. Here is a discussion on how adaptive management can be used to guide future phases of restoration. The term 'phases' here refers to any restoration action taken, rather than when a specific restoration objective has been met. Adaptive management plays a major role in 1) evaluating the response to restoration through monitoring and 2) determining how the response to restoration guides future restoration actions (Figure 9). LTPBR projects can be evaluated at multiple scales, ranging from the scale of an individual structure to the entire project area. It is better to focus on the complex and project scale rather than the scale of individual structures, since project objectives are not met at the scale of individual structures.

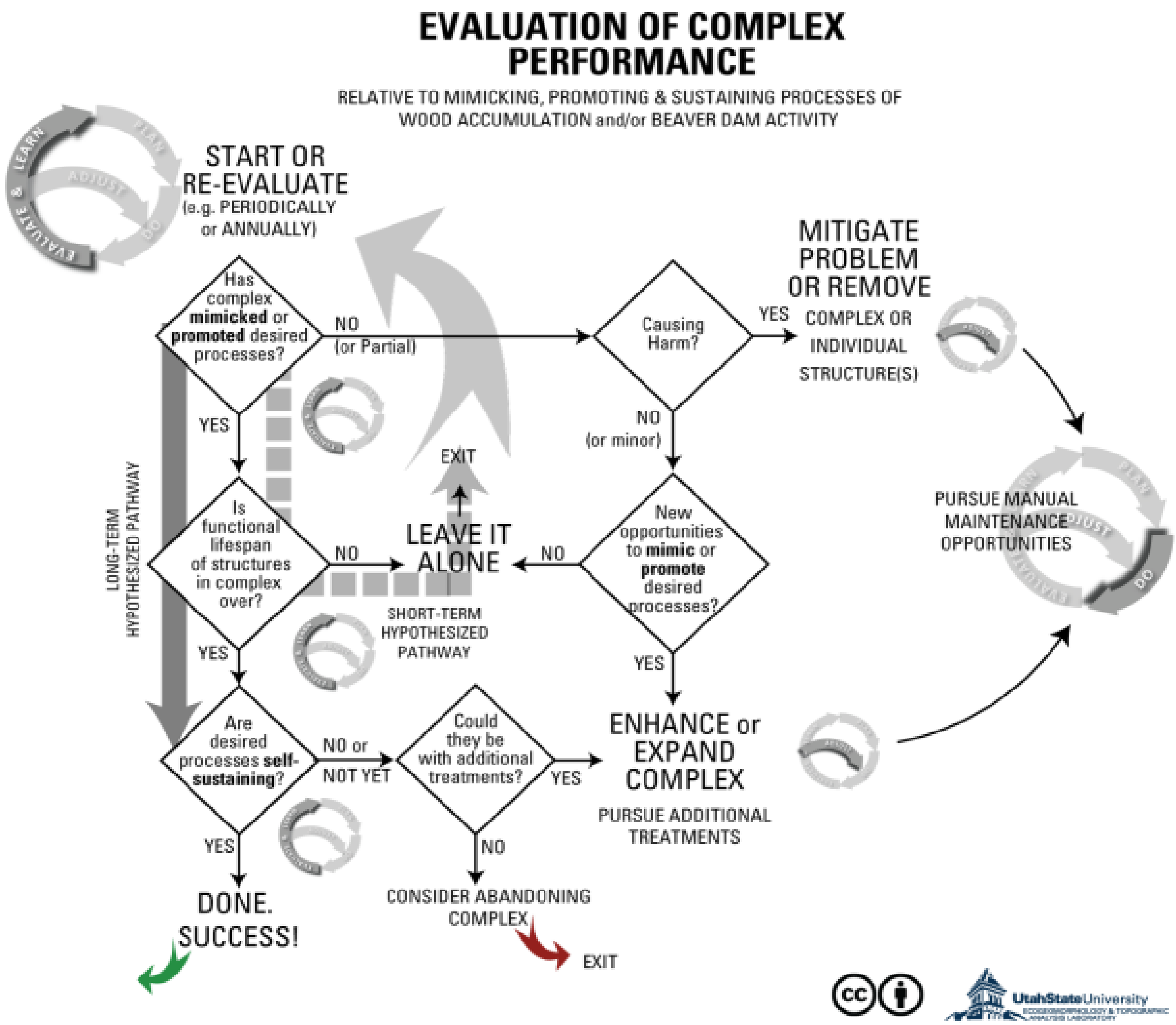

Figure 9: Conceptual adaptive management pathways for monitoring and ongoing restoration of LTPBR complexes. Many of the concepts illustrated may also be applicable at the scale of an individual structure or the entire project. From Chapter 6 of Wheaton et al. (2019; http://lowtechpbr.restoration.usu.edu).

MONITORING AND ADAPTIVE MANAGEMENT FRAMEWORK

To help facilitate adaptive management on Couse Creek, Appendix G provides a generalized framework to support adaptive management decision making based on requirements outlined in BPA's HIP Handbook.

Common maintenance or phased restoration actions which necessarily occur at the scale of individual structures within a complex or project area include:

- Lateral extension of structures through adding wood
- Increase structure height through adding wood
- Plugging gaps through adding more wood
- Adding posts to existing structures
- Repair minor breaches
- Building new structures
- Removing structures if causing harm

The specific actions taken at an individual structure or location depend on the specific complex objectives and the specific structure objective within that complex.

CONSTRUCTION PLAN AND LOGISTICS

Construction and logistical considerations are specific to material sourcing, site access, staging and refueling areas, and conservation measures that guide implementation and/or permitting of the restoration design.

MATERIAL SOURCING

To reduce costs and increase the efficiency of implementation, the landowner has agreed for wood to be sourced onsite. The size of individual wood pieces will vary but are not likely to exceed 18 inches diameter at breast height (DBH) by 30 feet in length since they will be transported and placed by hand or small machinery (e.g., ATV, skidsteer; not to exceed 15,000 lbs.). Wood exceeding 12 inches DBH by 15 feet in length will be sourced from the floodplain and moved using a grip hoist or small machinery. It is anticipated that approximately 2,800-3,200 pieces of wood will be needed for the first phase of implementation. Ongoing wood additions after the initial treatment phase will be assessed during subsequent phases.

SITE ACCESS, MATERIAL STAGING, AND FUELING/EQUIPMENT STORAGE

Site access and travel within the valley bottom will be limited to foot and small machinery. Prior to the construction of instream structures, wood and posts will be transported from designated staging areas and placed near structure locations by hand or small machinery. Several staging areas, and fueling/equipment storage locations have been identified that will be used during implementation. See Appendix I for natural materials staging areas and fueling equipment storage areas.

IMPLEMENTATION

EQUIPMENT

The equipment requirements for installation of LTPBR structures (e.g., PALS and BDAs) consist of a hydraulic post pounder, small machines (skid steers, excavators, etc.) chainsaws, loppers, shovels, picks, and 5-gallon buckets. The hydraulic power source for the pounder is mounted on a rolling frame that can be moved between structure locations by a 2-3 people. If access allows, an ATV will be used to transport the hydraulic post driver and power pack between structures during construction. A grip hoist will also be used to transport larger wood pieces from hillslopes or floodplains to the stream channel. Additionally, as access with minimal site disturbance allows, a skid steer (under 15,000lbs) with a post pounder attachment may be used to secure structures with larger posts (4-8 inches diameter, 3-4 feet in height) in the lower two complexes.

CONSTRUCTION

PALS are constructed by hand-placing the wood in the channel and then using a post pounder to pound 2-8" diameter untreated wooden posts into the channel to secure the wood. Posts are typically driven in 2-3' into the streambed and cut off at approximately bankfull height.

BDAs are built using a variety of local materials including willow, cottonwood, and conifer that are woven in between wooden posts driven in the bed in the same manner as PALS. The main difference between BDAs and PALS is that BDAS are always channel spanning and require local fill from the banks or bed to promote ponding of water during low-flow conditions. The fill is typically sourced from the banks and bed upstream of the structure from the area that will be inundated by the pool formed by the BDA. The fill is placed on the upstream side of the BDA to slow water moving through the structure and increase ponding. Fill material will consist of sand, gravel, cobble, and sod. Material will be collected using shovels and picks and moved by hand using 5-gallon buckets. More detail on construction and design aspects of PALS and BDAs can be found in Appendix D.

CONSERVATION MEASURES

All activities will follow HIP General Conservation Measures (see Appendix J) and those outlined for small wood projects where applicable (see Appendix K). References to select conservation measures are provided below:

Fueling/Equipment Storage and Natural Material Staging Areas

Fueling and storage for equipment with gas tanks >5 gallons will take place at locations >150 feet from streams and wetlands while staging areas for wood and natural materials may be located <150 feet from streams and wetlands.

Timing of In-Stream Work

Instream work will be conducted during the established work window determined by the Oregon Department of Fish and Wildlife.

Work Area Isolation and Fish Salvage

The proposed design calls for minimal excavation within the wetted channel. During the construction of BDAs, some substrate will be excavated using hand tools (e.g., shovels) and transported using 5-gallon buckets. No work area isolation or fish salvage is expected.

Turbidity

The construction of PALS involves driving 2-4" wood posts into the streambed and adding wood, which creates little to no turbidity. The construction of BDAs involved driving wood posts, weaving woody material between the posts, and adding some substrate/fill to the upstream side of the structure which produces limited turbidity for a short-time. While small amounts of fine sediment may be introduced to the water column as substrate is disturbed during installation, the resulting increase in turbidity occurs at a small spatial scale (~10-20 m), for a short duration (1-2 hours), and at levels that are not thought to significantly impact salmonids.

Stream Crossings

Stream crossings within the project area will be limited to foot traffic except at previously established crossings or by small equipment when the streambed is dry.

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APPENDIX A - PRINCIPLES OF RIVERSCAPE HEALTH AND RESTORATION

RIVERSCAPE PRINCIPLES

1. **Streams need space**. Healthy streams are dynamic, regularly shifting position within their valley bottom, re-working and interacting with their floodplain. Allowing streams to adjust within their valley bottom is essential for maintaining functioning riverscapes.
2. **Structure forces complexity and builds resilience.** Structural elements, such as beaver dams and large woody debris, force changes in flow patterns that produce physically diverse habitats. Physically diverse habitats are more resilient to disturbances than simplified, homogeneous habitats.
3. **The importance of structure varies.** The relative importance and abundance of structural elements varies based on reach type, valley setting, flow regime and watershed context. Recognizing what type of stream you are dealing with (i.e., what other streams it is similar to) helps develop realistic expectations about what that stream should or could look (form) and behave (process) like.
4. **Inefficient conveyance of water is often healthy.** Hydrologic inefficiency is the hallmark of a healthy system. More diverse residence times for water can attenuate potentially damaging floods, fill up valley bottom sponges, and slowly release water, elevating baseflow and producing critical ecosystem services.

RESTORATION PRINCIPLES

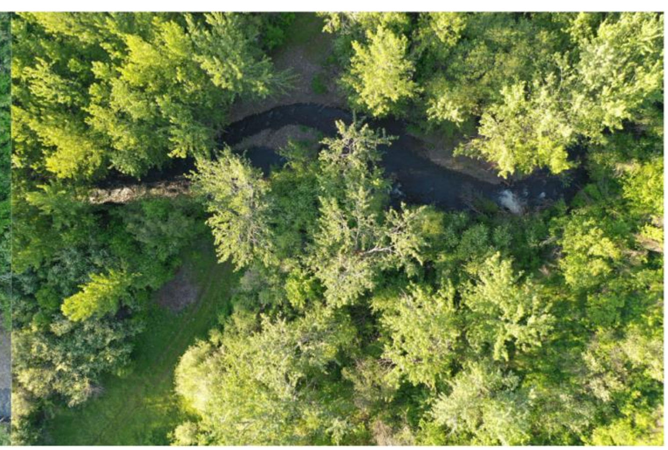
5. **It's okay to be messy**. When structure is added back to streams, it is meant to mimic and promote the processes of wood accumulation and beaver dam activity. Structures are fed to the system like a meal and should resemble natural structures (log jams, beaver dams, fallen trees) in naturally 'messy' systems. Structures do not have to be perfectly built to yield desirable outcomes. Focus less on the form and more on the processes the structures will promote.
6. **There is strength in numbers.** A large number of smaller structures working in concert with each other can achieve much more than a few isolated, over-built, highly-secured structures. Using a lot of smaller structures provides redundancy and reduces the importance of any one structure. It generally takes many structures, designed in a complex (see Chapter 5: Shahverdian et al., 2019c), to promote the processes of wood accumulation and beaver dam activity that lead to the desired outcomes.
7. **Use natural building materials**. Natural materials should be used because structures are simply intended to initiate process recovery and go away over time. Locally sourced materials are preferable because they simplify logistics and keep costs down.
8. **Let the system do the work.** Giving the riverscape and/or beaver the tools (structure) to promote natural processes to heal itself with stream power and ecosystem engineering, as opposed to diesel power, promotes efficiency that allows restoration to scale to the scope of degradation.
9. **Defer decision making to the system**. Wherever possible, let the system make critical design decisions by simply providing the tools and space it needs to adjust. Deferring decision making to the system downplays the significance of uncertainty due to limited knowledge. For example, choosing a floodplain elevation to grade based on limited hydrology information can be a complex and uncertain endeavor, but deferring to the hydrology of that system to

build its own floodplain grade reduces the importance of uncertainty due to limited knowledge.

10. **Self-sustaining systems are the solution.** Low-tech restoration actions in and of themselves are not the solution. Rather they are just intended to initiate processes and nudge the system towards the ultimate goal of building a resilient, self-sustaining riverscape.

APPENDIX B – AERIAL PROJECT AREA PHOTOS



APPENDIX B – GROUND-BASED PROJECT AREA PHOTOS




Characterizing streamflow characteristics is an important component of planning for LTPBR projects because it helps develop realistic expectations for what restoration may be able to achieve. It is not intended as an input for hydrologic modeling, or other computational exercises. Rather, it is meant to provide a more general background understanding of the magnitudes of flow experienced at the project area. For example, to make distinctions between project areas where 2-year peak flows are 30 cfs versus those where they are 300 cfs. Both sites may be appropriate for LTPBR, the question is one of which types of LTPBR strategies are most likely to be effective and how they relate to restoration objectives. The following figures and tables provide information on mean discharge and flow exceedance at RM 3.2 from 1965-1978 and from 2018-2020 (from WWBWC 2020).

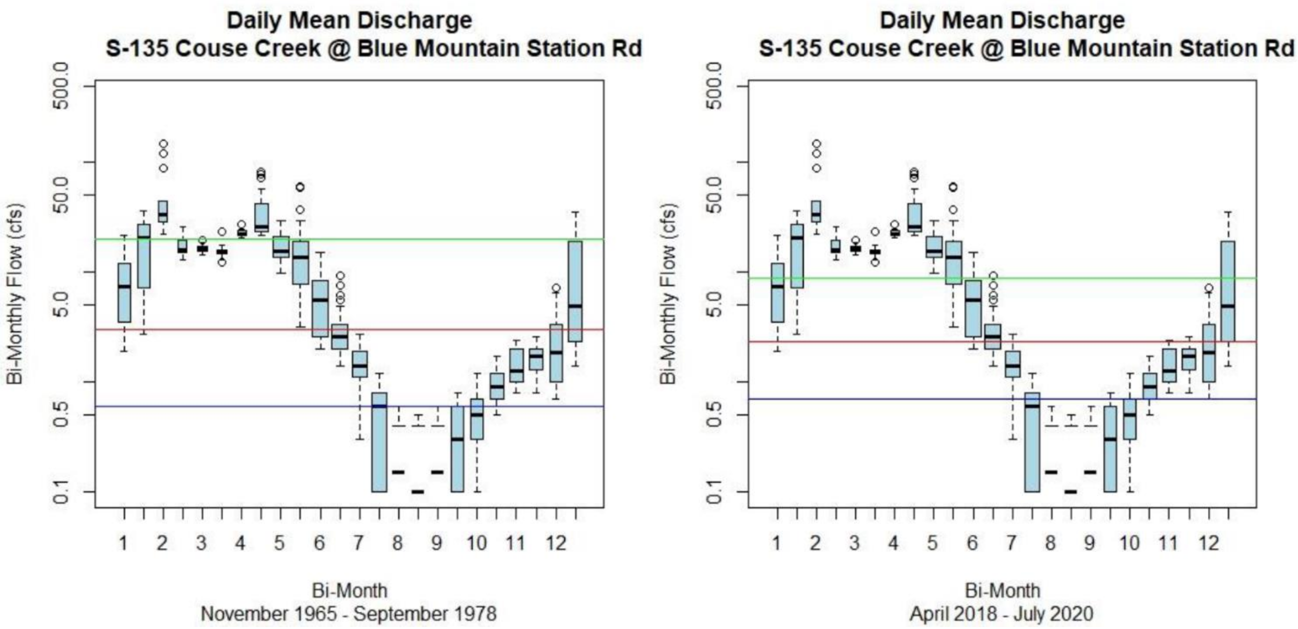


Figure 10: . Boxplot of daily mean discharge in Couse Creek at RM 3.2 from November 1965 to September 1978 (OWRD) and November April 2018 to July 2020 (WWBWC). Figures from Appendix G in WWBWC (2020).

BiMonth	MeanDischarge.Min	MeanDischarge.Median	MeanDischarge.Max	MeanDischarge.Mean	MeanDischarge.Quantile.10%	MeanDischarge.Quantile.25%	MeanDischarge.Quantile.50%	MeanDischarge.Quantile.75%	MeanDischarge.Quantile.90%	MeanDischarge.Var	MeanDischarge.N
1	0.2	12	309	22.66	1.22	5	12	28.25	46.7	1310.35	195
1.5	0.4	22	302.5	41.55	3.04	11	22	51.5	108.75	2366.74	208
2	1.3	14	84	20.01	2.94	8.125	14	27.75	42.7	286.88	195
2.5	1.3	19.5	135.5	27.23	3.845	11.5	19.5	32.5	62.55	608.91	172
3	1.95	16.5	204	26.63	7.57	9.975	16.5	34	59.6	771.63	195
3.5	3.6	27.5	170.5	34.79	8.675	17.375	27.5	40.625	64.3	852.46	208
4	4.85	32	98.5	38.16	10.7	19	32	54.75	79.3	621.94	195
4.5	4.85	31.5	110	33.57	7.35	14.13611	31.5	48	61.8	486.43	195
5	3	29	145	31.84	4.52	7.7	29	44.5	67	748.32	195
5.5	2	9.125	86	14.56	2.4	3.4	9.125	20.375	33	225.42	208
6	1.1	3.25	52	6.62	1.5	1.95	3.25	6.7	14.5	75.61	195
6.5	0.55	1.6	13	2.42	0.8	0.95	1.6	3.35	5.21	4.44	195
7	0	1.05	4.75	1.17	0.32	0.55	1.05	1.6	2.1	0.69	195
7.5	0	0.45	2.75	0.59	0	0.1	0.45	1	1.2	0.27	208
8	0	0.2	0.85	0.23	0	0	0.2	0.475	0.6	0.06	195
8.5	0	0.2	0.6	0.19	0	0	0.2	0.3	0.5	0.04	208
9	0	0.2	0.9	0.22	0	0	0.2	0.35	0.6	0.05	195
9.5	0	0.3	2.45	0.33	0	0.1	0.3	0.4	0.5	0.15	195
10	0	0.4	1.65	0.46	0.1	0.3	0.4	0.7	0.8	0.08	181
10.5	0	0.7	2.2	0.66	0.1	0.4	0.7	0.8125	1.1	0.14	192
11	0.2	1	78	3.21	0.5	0.6	1	1.6	2.84	106.47	194
11.5	0.6	1.5	98.5	7.52	0.8	1.025	1.5	6.175	23.3	203.83	195
12	0.65	7.1	213	20.37	1	1.125	7.1	22.75	55.9	1112.23	195
12.5	0.8	10.225	170	19.61	1	1.9125	10.225	22.625	45.3	829.43	208

Table 5: Flow exceedances in Couse Creek at RM 3.2 derived from OWRD data from November 1965 to September 1978. Quantiles should be interpreted as follows: 10% quantile=90% exceedance, 25% quantile=75% exceedance, etc. Bi-Month: 1 = Jan 1-15. 1.5=Jan 16-31, 2=Feb 1-14, 2.5=Feb 15-28, etc. Reproduced from Appendix G., in WWBWC (2020).

BiMonth	MeanDischarge.Min	MeanDischarge.Median	MeanDischarge.Max	MeanDischarge.Mean	MeanDischarge.Quantile.10%	MeanDischarge.Quantile.25%	MeanDischarge.Quantile.50%	MeanDischarge.Quantile.75%	MeanDischarge.Quantile.90%	MeanDischarge.Var	MeanDischarge.N
1	1.9	7.35	21.7	8.36	3	3.575	7.35	11.925	14.24	28.28	30
1.5	2.7	20.35	36.5	18.12	3.52	7.4	20.35	27.025	34.04	136.18	28
2	22.3	33.4	149	50.45	26.34	28.95	33.4	43.95	109.06	1470.42	15
2.5	12.9	15.75	25.9	17.5	14.03	15	15.75	18.975	23.73	16.29	14
3	14.5	16.5	19.7	16.59	15.26	15.6	16.5	17.2	18.26	1.89	15
3.5	12.3	15.55	23.1	15.63	13.1	14.675	15.55	15.95	17.1	5.84	16
4	20.7	22.4	27.3	22.83	21.24	21.7	22.4	23.75	24.72	3.16	15
4.5	21.5	26.05	82.9	36.27	22.95	23.375	26.05	40.725	71.95	370.78	36
5	9.8	15.6	29.2	17.31	12.5	13.8	15.6	21	23.36	21.6	45
5.5	3.2	13.55	60.4	15.73	4.47	7.85	13.55	18.9	26.82	144.03	48
6	2	5.5	15	6.18	2.34	2.6	5.5	8.3	11.42	13.28	45
6.5	1.4	2.6	9.3	2.97	1.64	2	2.6	3.3	4.86	2.6	45
7	0.3	1.4	2.7	1.46	0.64	1.1	1.4	1.9	2.2	0.33	45
7.5	0	0.6	1.2	0.51	0	0.1	0.6	0.8	1.02	0.17	39
8	0	0.15	0.6	0.22	0	0	0.15	0.4	0.5	0.05	30
8.5	0	0.1	0.5	0.19	0	0	0.1	0.4	0.4	0.04	32
9	0	0.15	0.6	0.2	0	0	0.15	0.4	0.41	0.04	30
9.5	0	0.3	0.8	0.35	0	0.1	0.3	0.6	0.7	0.08	30
10	0.1	0.5	1.2	0.51	0.1	0.3	0.5	0.7	0.9	0.09	30
10.5	0.5	0.9	1.7	0.95	0.6	0.7	0.9	1.2	1.29	0.09	32
11	0.8	1.25	2.4	1.48	0.8	1	1.25	2	2.31	0.34	30
11.5	0.8	1.7	2.6	1.65	1	1.3	1.7	1.975	2.41	0.27	30
12	0.7	1.85	7.1	2.35	0.9	1	1.85	3.3	3.6	2.86	30
12.5	1.4	4.95	35.1	10.97	1.81	2.3	4.95	18.9	25.45	105.56	32

Table 6: Flow exceedances in Couse Creek at RM 3.2 derived from WWBWC data from April 2018 to July 2020. Quantiles should be interpreted as follows: 10% quantile=90% exceedance, 25% quantile=75% exceedance, etc. Bi-Month: 1 = Jan 1-15. 1.5=Jan 16-31, 2=Feb 1-14, 2.5=Feb 15-28, etc. Reproduced from Appendix G in WWBWC (2020).

APPENDIX D - PALS AND BDA CONSTRUCTION METHODS, STRUCTURE TYPES, AND SCHEMATICS

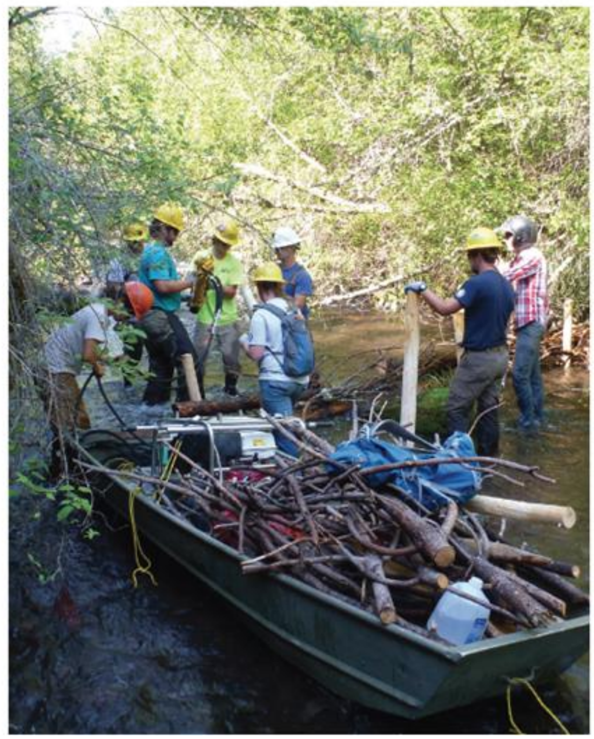
This section outlines general construction methods, the different structure types, how different structure types should be used to promote specific hydraulic and geomorphic responses, and design schematics for Post-Assisted Log Structures (PALS) and Beaver Dam Analogs (BDA). More details can be found in Wheaton et al. 2019.

PALS Construction

POST-ASSISTED LOG STRUCTURES

HOW TO BUILD PALS

1. Decide location of PALS, configuration (e.g., orientation and type of PALS) as part of the design of a complex of structures (multiple structures working together).
2. Position larger logs on the base of the structure to make the general shape of structure.
3. Limb branches from one side of the logs so that much of the log comes in contact with the bed to increase interaction between the flow and the structure, even at low flows.
4. Pin large pieces in place with posts; drive posts at angles and downstream to help hold wood in place at high flows.
5. Add more logs, and pack and wedge smaller material to fill spaces in the structure.
6. Build up the structure to desired crest elevation, but crest elevation need not be uniform.



PALS Structure Types and Schematics

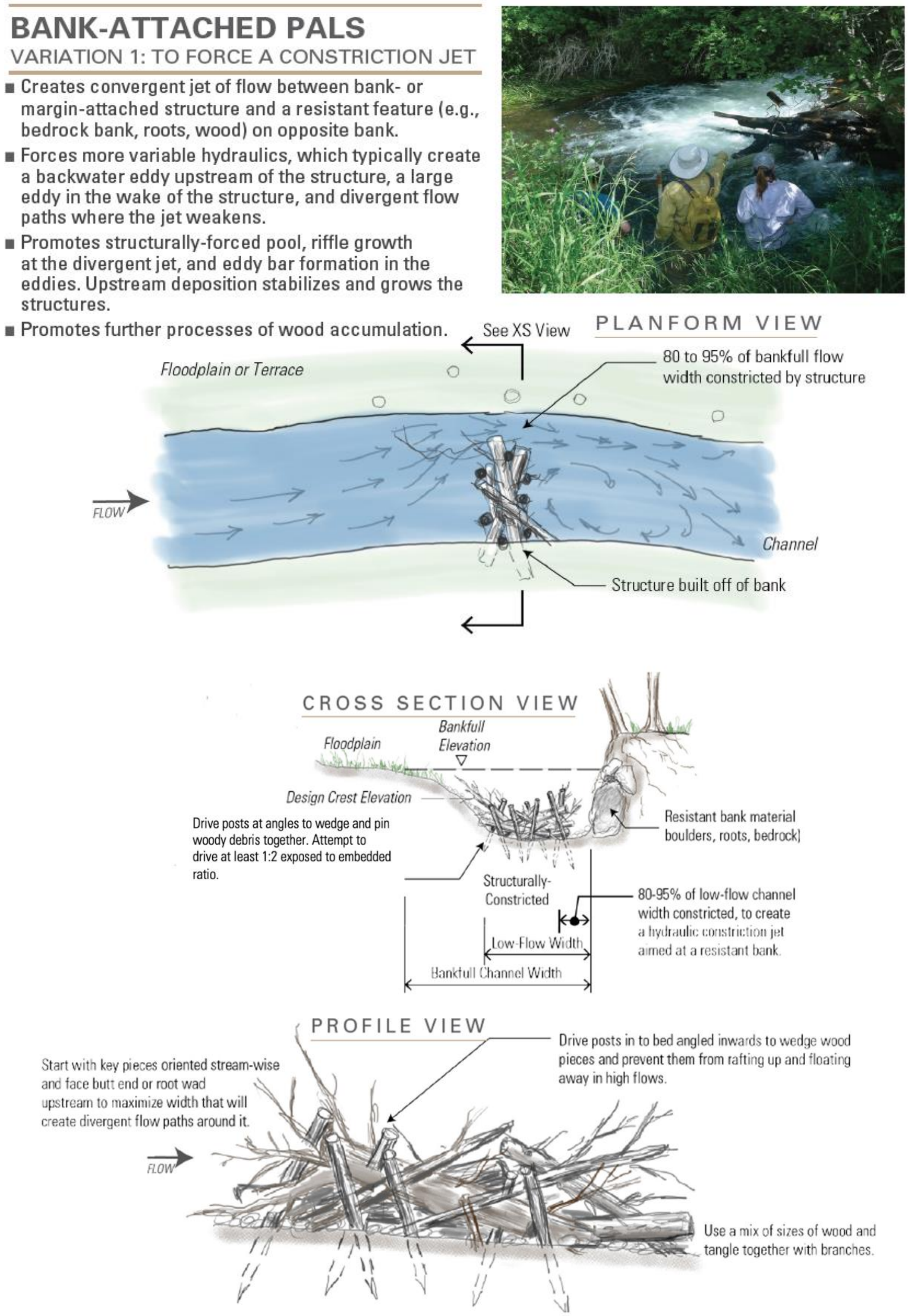
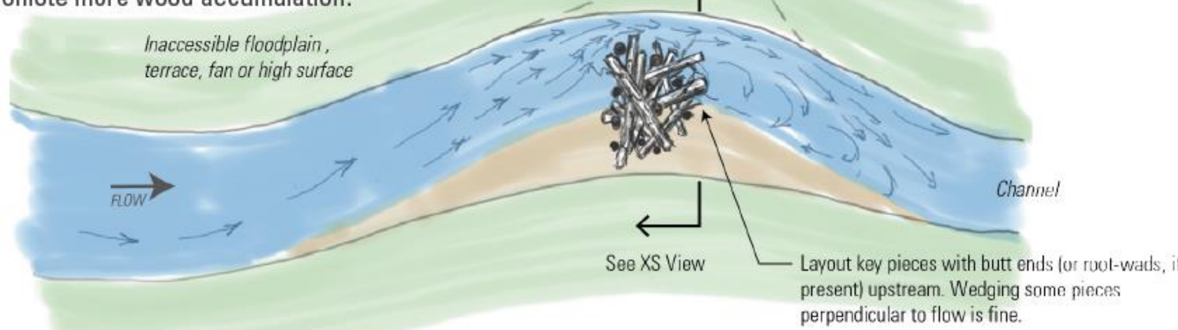


Figure 11: Typical schematic sketches of a bank-attached PALS intended to cause lateral channel migration through deposition of material on point and diagonal bars and erosion of high bank features. From Chapter 4 of Wheaton et al. (2019: : [http://lowtechpbr.restoration.usu.edu).](http://lowtechpbr.restoration.usu.edu)

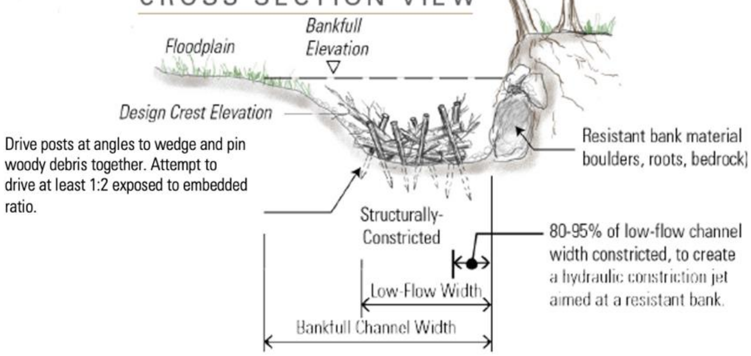
BANK-ATTACHED PALS:
VARIATION 2: BANK BLASTER

- Accelerates lateral widening via bank erosion of an erodible bank opposite of the structure.
- Shunting of flow forces more variable hydraulics, which typically create a backwater eddy upstream of the structure, an eddy downstream of structure, and temporary jet aimed at opposite erodible bank.
- Leads to lateral shift of channel (no more than one channel width typically). Further lateral migration occurs if bar growth continues on inside bend, further natural woody debris accumulates on structure, or subsequent treatment is extended off structure.
- If surface above bank is growing woody vegetation, structures can also recruit wood to channel and promote more wood accumulation.

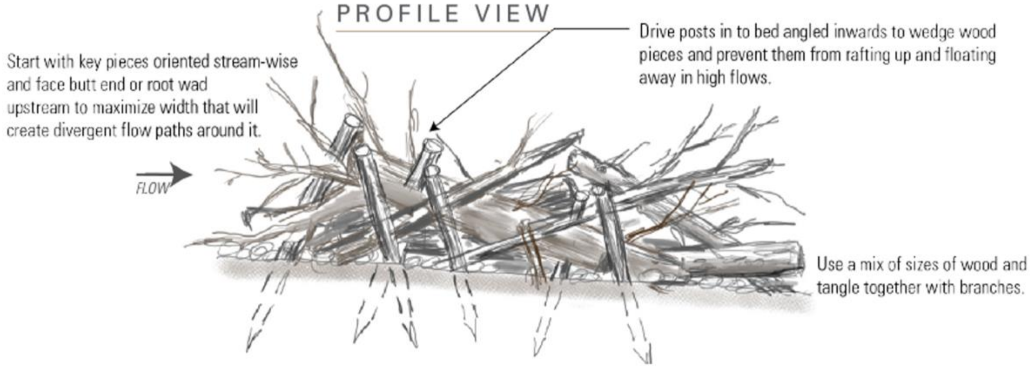
PLANFORM VIEW



CROSS SECTION VIEW



PROFILE VIEW



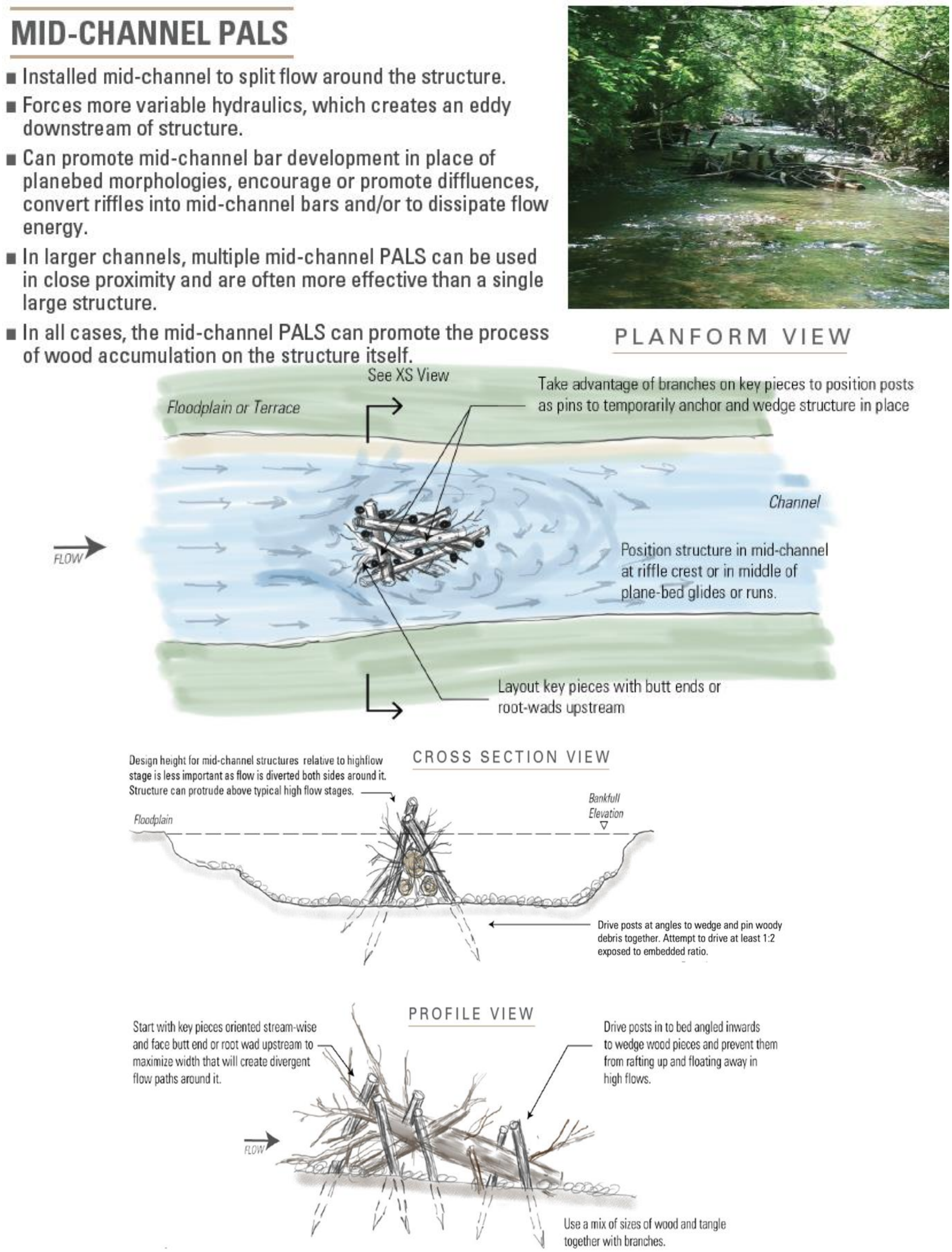


Figure 12: Typical schematics of a mid-channel PALS designed to induce channel complexity, encourage mid-channel deposition, and encourage channel avulsion. From Chapter 4 of Wheaton et al. (2019: http://lowtechpbr.restoration.usu.edu).

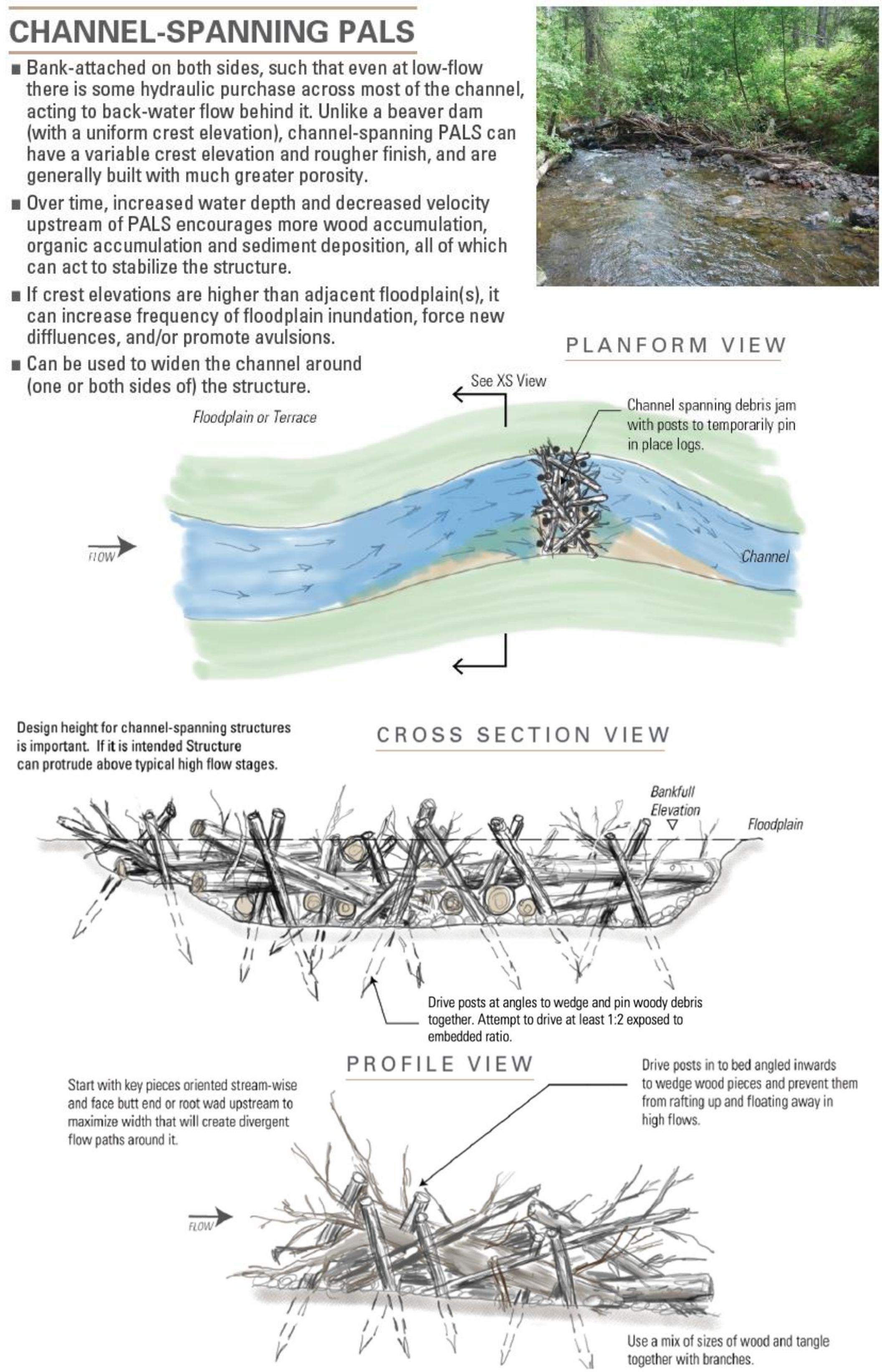


Figure 13: Typical schematics of a channel-spanning PALS. Channel spanning PALS are designed to be passable by fish at all flows. From Chapter 4 of Wheaton et al. (2019: http://lowtechpbr.restoration.usu.edu).

Figure 14: Example of PALS evolution over the course of one year promoting processes of wood accumulation. A and B show a mid-channel PALS becoming a bank-attached PALS, C and D show a bank-attached PALS becoming a debris jam, and E and F show a bank-attached PALS becoming a mid-channel PALS. The geomorphic changes imposed by the presence of the PALS in each example shows clear alterations to the channel bed and hydraulics. From Chapter 4 of Wheaton et al. (2019: http://lowtechpbr.restoration.usu.edu).

BDA Construction

HOW TO BUILD BDAs

1. Decide location of BDA dam crest orientation, configuration (e.g., straight or convex downstream), and crest elevation (use landscape flags if necessary). Position yourself with your eye-level at the proposed crest elevation of the dam (make sure it is < 5′ in height). Look upstream to find where the pond will backwater to. Adjust crest elevation as necessary to achieve desired size of pond, inundation extent, and overflow patterns. If concerned about head drop (water surface elevation difference) over BDA, build a secondary BDA downstream with a crest elevation set to backwater into base of this BDA (and lessen head drop or elevation difference between water surface in pond and water surface downstream of BDA).

2. Build up first layer or course by widening base upstream and downstream of crest to flat height of 6 to 12″ above existing water surface, and make sure it holds back water.

   a. If larger key pieces (i.e., larger logs, cobble or small boulders) are locally abundant, these can be used to lay out the crest position across the channel. Optionally, they can be 'keyed' in by excavating a small trench (no need to be deeper than ~1/3 of the height of key piece diameter) and place key pieces in and pack with excavated material.

   b. Lay out first layer of larger fill material, being careful not to go to higher than 6″ to 12″ above existing water surface. The first layer should be just high enough to backwater a flat water surface behind it.

   c. Using mud, bed material & turf (typically sourced from backwater area of pond) as fine fill material to plug up leaks, combine with sticks and branches of various sizes to build a wide base. Make sure base is wide enough to accommodate anticipated dam height (most dams will have a 1.5:1 to 3:1 (horizontal : vertical) proportions.

   d. Build up first layer only to top of key pieces from first layer. Make sure the crest is level across the channel and water is pooling to this temporary crest elevation.

3. Build up subsequent layer(s) in 6″ to 12″ lifts, packing well with fine fill material until ponding water to its next temporary crest elevation.

> Repeat step 3 as many times as necessary to build up to design crest elevation.

> Work a overflow mattress (laying branches parallel to flow) into dam on downstream side and build to provide energy dissipation to overtopping flows.

> If desired, and time permits, attempt to plug up BDA with mud and organic material (small sticks and turf) to flood pond to crest elevation. Optionally, you can leave this for maintenance by beaver or for infilling with leaves, woody debris and sediment.

BDA Structure Types and Schematics

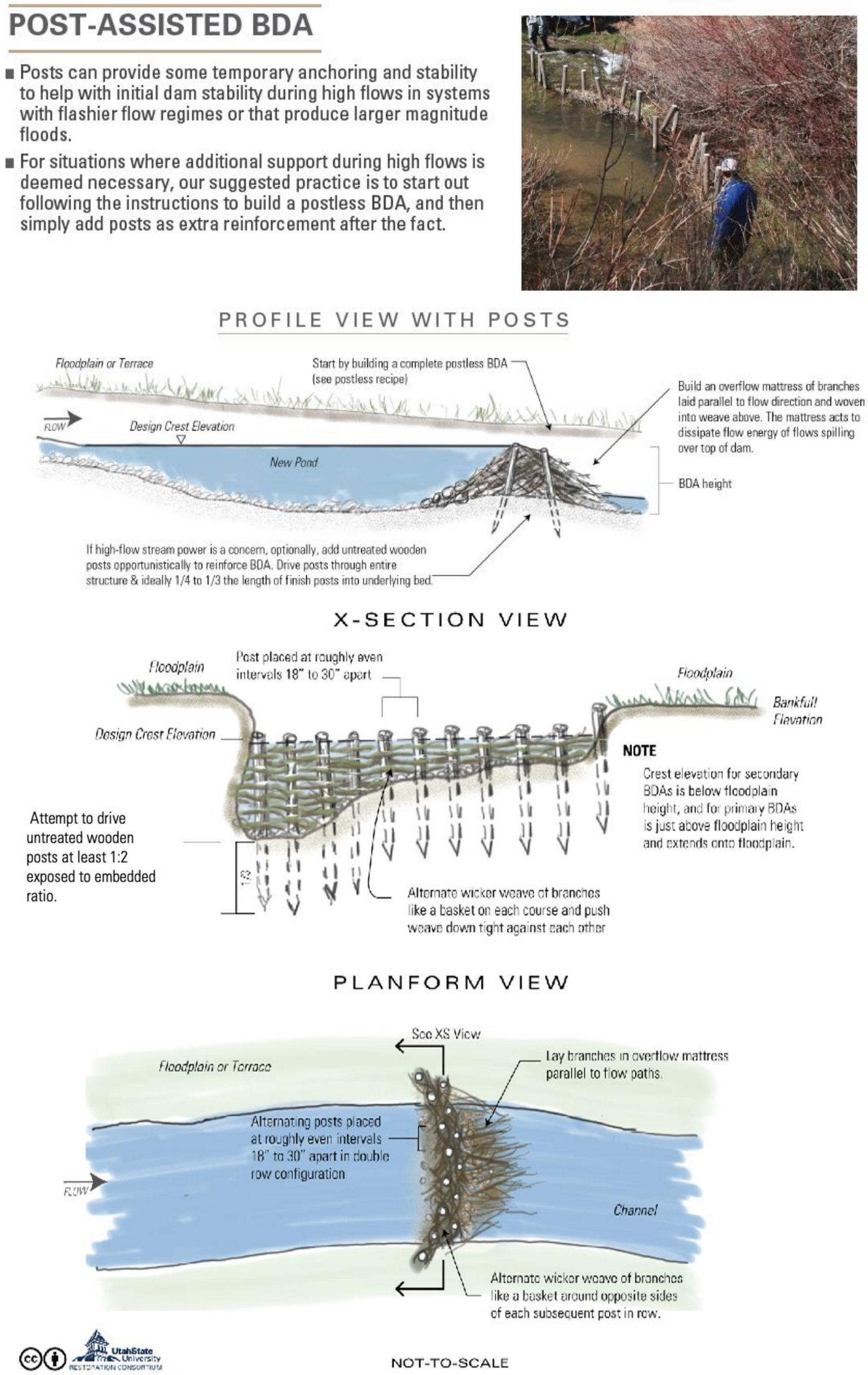


Figure 15: Schematic of post-assisted BDA. From Chapter 4 of Wheaton et al. (2019: http://lowtechpbr.restoration.usu.edu).

POST-LINE WICKER WEAVE

- BDAs can be constructed using post-line wicker weaves, to initially mimic beaver dam activity and later promote it.
- Posts used to layout a crestline, and long branches are woven between the posts to provide most of the structure.
- Post-line wicker weaves have been used for at least 150 years as instream structures, but have most often been used in check-dam or weir designs, which have higher crest elevations along the banks, and concentrate flow over the middle of the structure. By contrast, post-line wicker weave BDAs have a constant crest elevation as to not concentrate flow at any point.

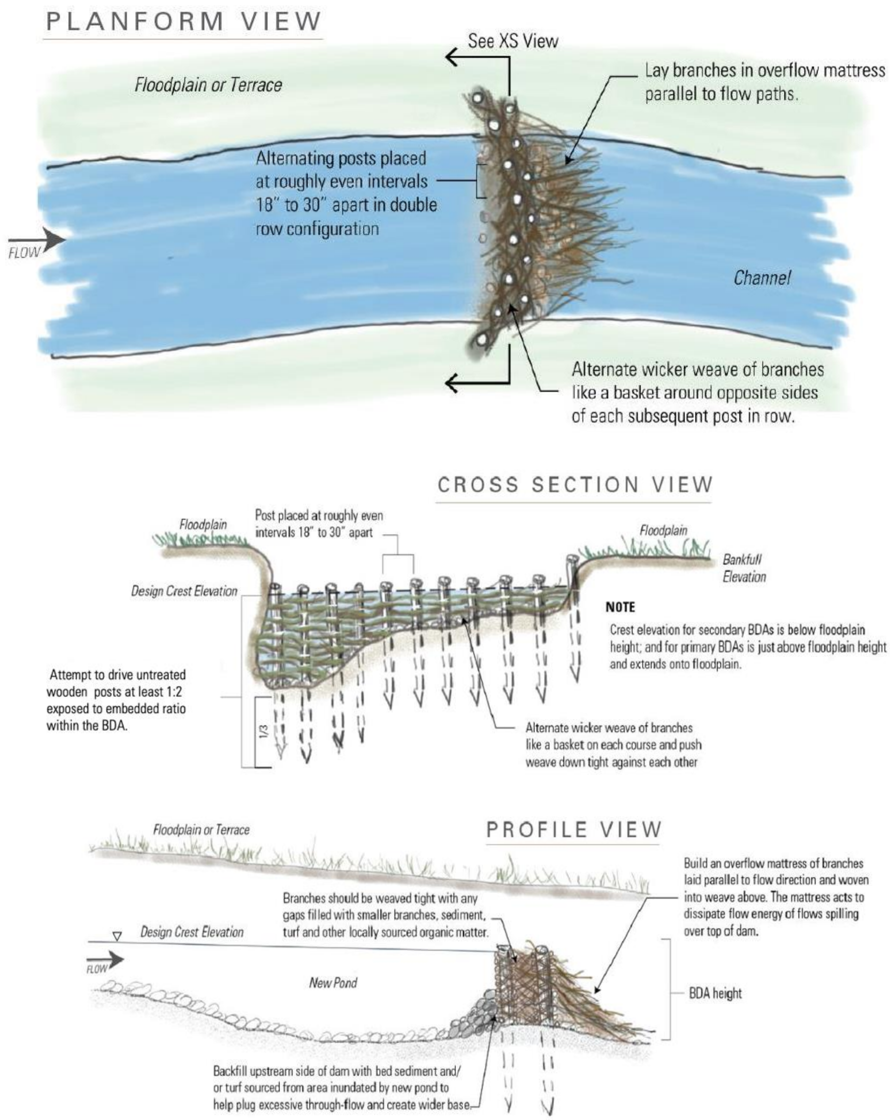
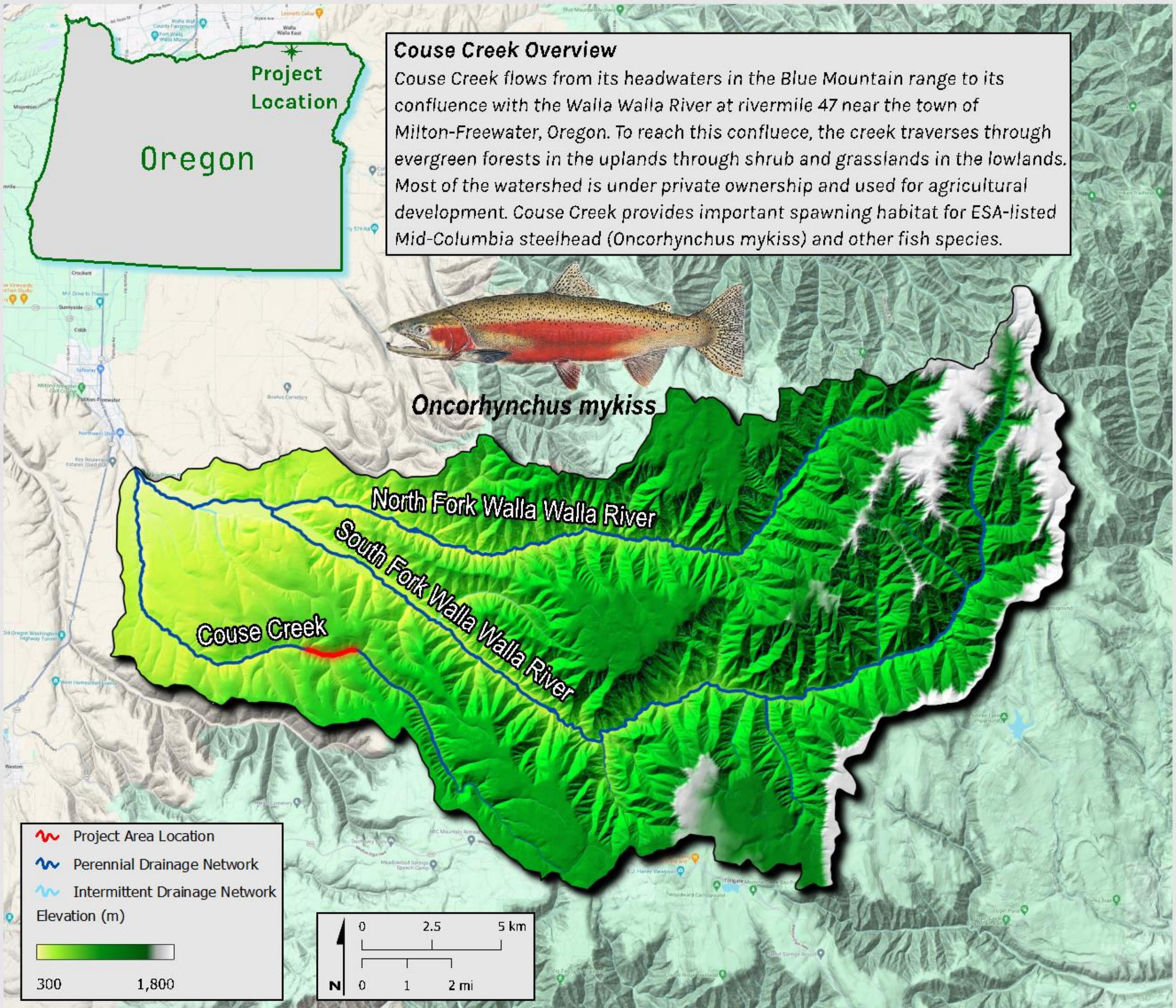


Figure 16: Schematic of post-line wicker weave. From Chapter 4 of Wheaton et al. (2019: http://lowtechpbr.restoration.usu.edu).

Reach/Complex Objective	Function Overview	Physical Response	Biological Response
Force overbank Flow (Channel-Floodplain Connectivity)	Addition of structural elements to increase the frequency, duration, and extent of overbank flows.	Creation of multi-threaded channels as a result of headcut progression across floodplain. Newly formed channels may also serve to recruit existing woody vegetation material as new roughness elements.	Creation of off-channel juvenile salmonid rearing habitat. Increase connection of flow to the valley bottom also allows expansion of riparian vegetation communities.
Increase Geomorphic Diversity	Structural elements to promote complex patterns of erosion and deposition leading to heterogeneity in geomorphic form and geomorphic units (i.e., pools and bars).	Creation of a patchwork of geomorphic units that includes scour pools accompanied by the formation of bars.	Provides more diverse habitat for utilization by salmonids including pools for rearing and sediment sorting for spawning and improved egg survival.
Widening and Aggradation	Generally a goal in straightened and/or incised reaches where overbank flow is difficult.	Sediment recruitment from banks. Roughness elements and channel widening decreases stream power and high flow velocity.	Widening when combined with roughness elements creates more available habitat for juvenile and adult salmonids.
Pond / Wetland Creation	Use of BDAs to force upstream ponding, creating slow, deep water habitat.	Ponded flow increases surface - groundwater exchange and water table elevation. Sediment deposition can often lead to channel aggradation and greater floodplain connectivity.	Water table elevation allows proliferation of riparian plant communities. Slow - water refugia creates ideal rearing conditions for early life-stages of many salmonid species and eventual beaver colonization. Deposition of fine sediment increases production of many invertebrate species.

Lateral Channel Migration	Encourage bar deposition and outside meander erosion to enhance rate of lateral channel migration across valley bottoms.	Sediment recruitment from outside meanders often accompanied by creation of scour pools and downstream bar deposition. Recruited sediment can be captured by aggregational complexes downstream.	Pool creation and bar deposition often result in sediment sorting ideal for utilization by adult spawning salmonids and germination sites for riparian vegetation. Can also recruit large wood from streambanks.

Table 7: Description of general process-based reach objectives and intended physical and biological responses.



Project Overview

Project Summary

The Walla Walla Basin Watershed Council is leading low-tech, process-based restoration actions in Couse Creek; a tributary to the Walla Walla River in Oregon. These projects are designed to create hydraulic and geomorphic diversity, encourage sediment deposition, and expand floodplain connection in key areas of the valley bottom margin. Building upon previous restoration at rivermile four on Couse Creek, this project will expand the footprint of restoration actions to rivermile eight and nine.

The overall goal of restoration is to create a healthy and resilient riverscape that provides high quality fish habitat. Objectives to achieve this goal include: 1) increase the abundance of beaver dams and large wood accumulations, 2) increase in-channel geomorphic diversity, 3) increase channel-floodplain connectivity, 4) increase perennial surface flow, and 5) increase wetland and riparian vegetation extent.

Regional Management Context

The Couse Creek watershed is part of the Walla Walla River Major Spawning Area for ESA-listed Mid-Columbia steelhead and has accounted for a significant portion of the observed spawning in the Walla Walla subbasin. Couse Creek historically supported chinook, and bull trout have also historically been observed. Past land management activities including grazing, agriculture, timber harvest, road construction, and the removal of wood from streams, along with recent flood events, have decreased the quality and quantity of stream habitat within the Couse Creek watershed. Results of these influences are increased temperatures and sediment loads, reduced wood accumulations (e.g. large wood jams), geomorphic diversity (i.e. pool and off-channel habitat), channel-floodplain connectivity, riparian vegetation, and base flows. Much of the lower Couse Creek goes dry for portions of the year.

Riverscape Overview

Riverscape Summary: Upper Walla Walla Watershed
Miles of Stream: 560
Miles of Perennial Stream (% of overall): 190 (34%)
Miles of Intermittent Stream (% of overall): 370 (66%)

Watershed Summary: Upper Walla Walla Watershed
Basin Area: 102,000 acres
Minimum Basin Elevation: 1,150 ft
Mean Basin Elevation: 3,520 ft
Maxiumum Basin Elevation: 5,870 ft
Mean Annual Precipitation: 41 in

Flow Regime: Couse Creek
95 Percent Exceedance Annual Flow: 0.4 cfs
Average Annual Flow: 3.81 cfs
5 Percent Exceedance Annual Flow: 46 cfs
Predicted 2-year Flood: 152 cfs

Figure 17: Overview map of the Couse Creek Watershed and RM8 project area.

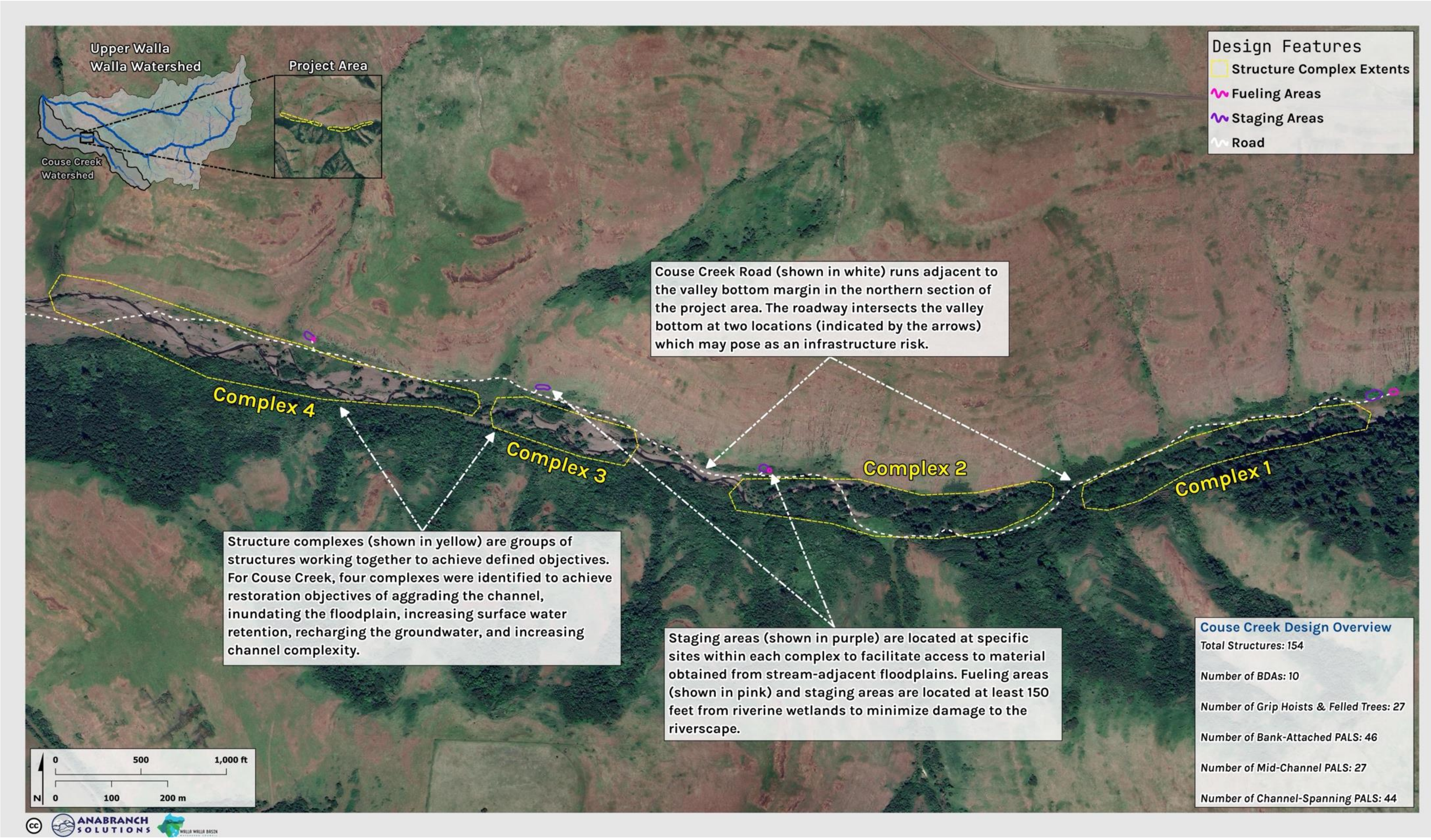


Figure 18: Project overview map illustrating complexes, roads, staging, and fueling areas.

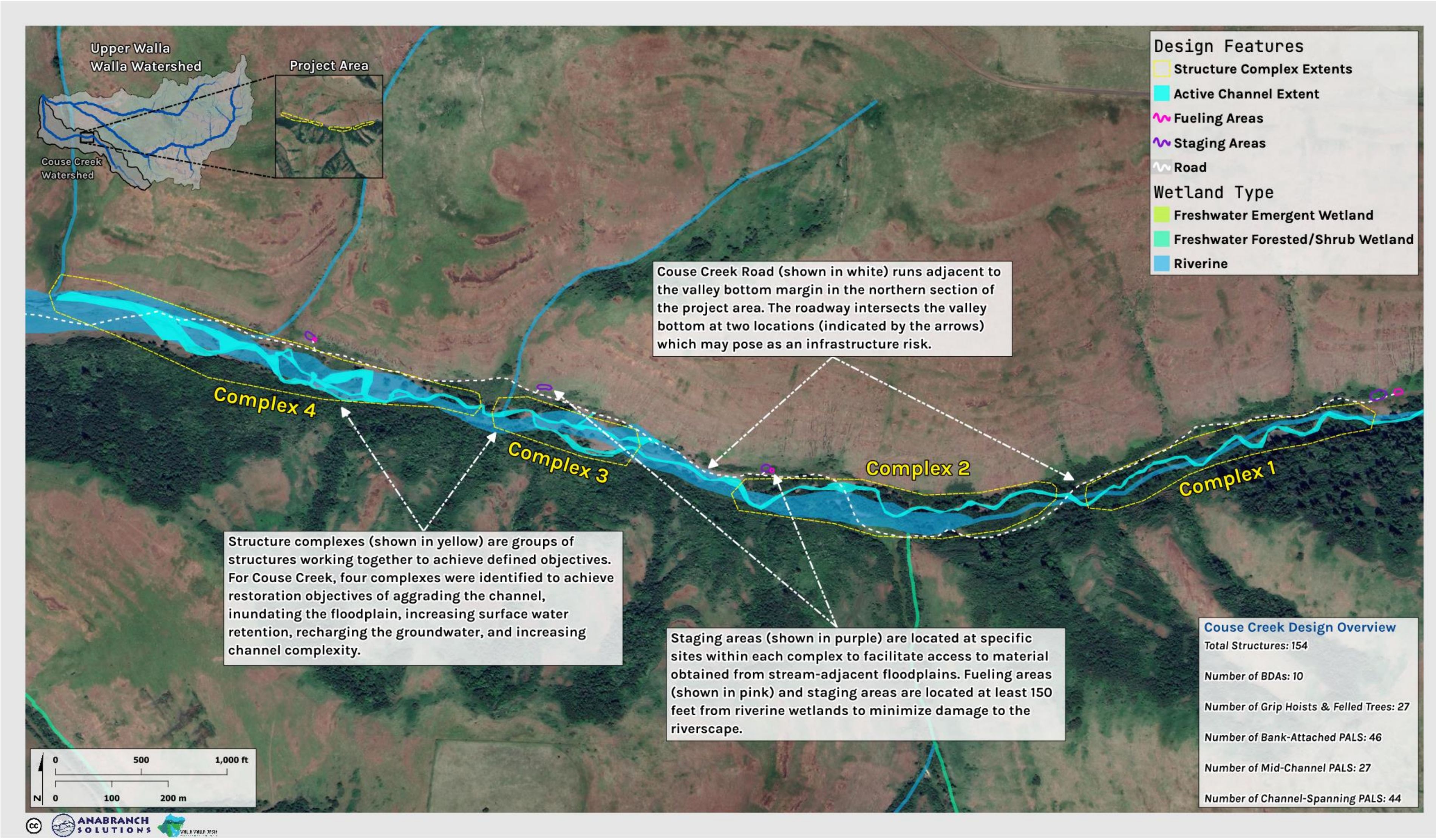


Figure 19: Project overview illustrating design features, active channel extents, and wetlands.

Figure 20: Complex 1 design.

Figure 21: Complex 2 design.

Figure 22: Complex 3 design.

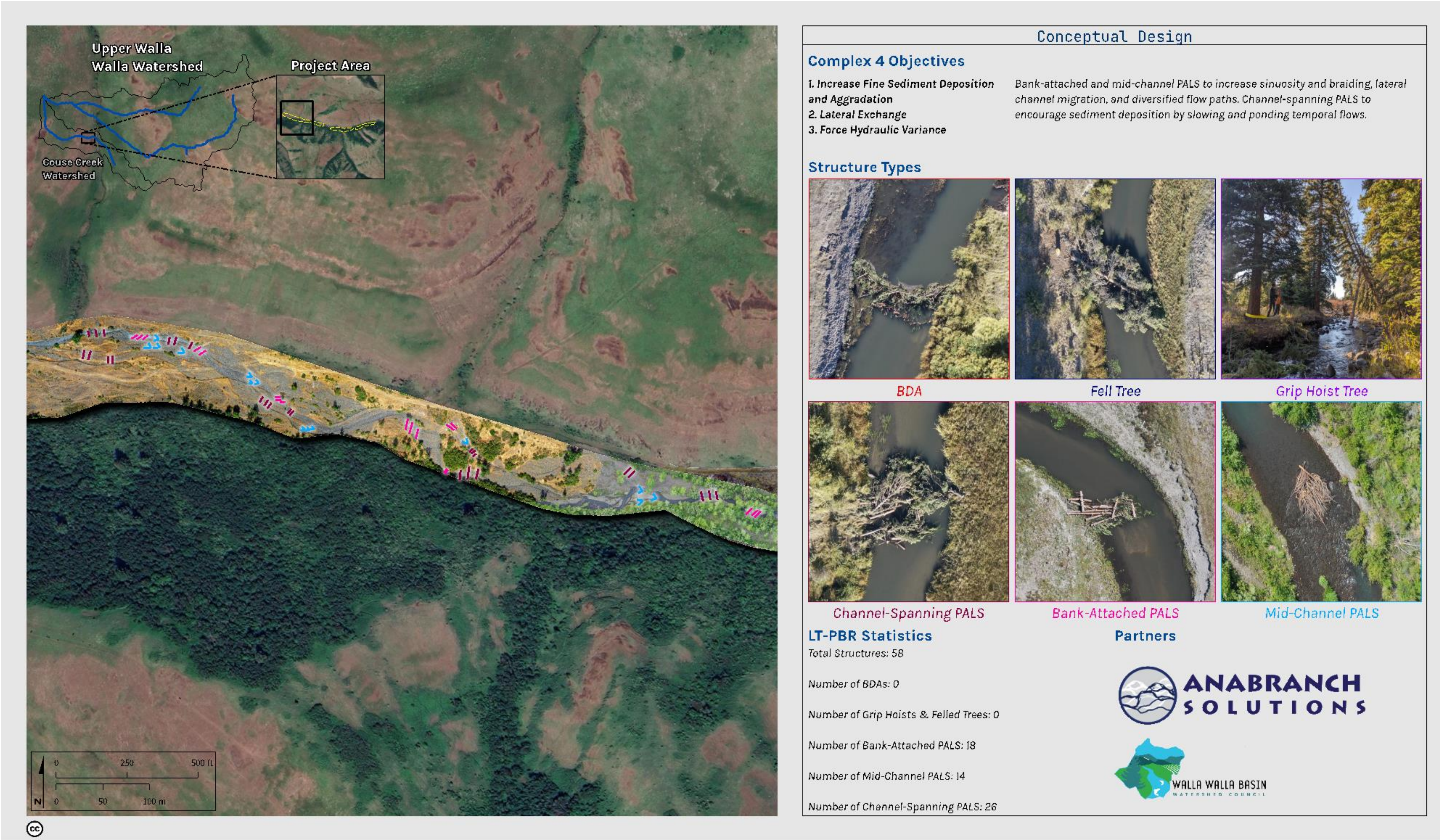


Figure 23: Complex 4 Design

APPENDIX G - ADAPTIVE MANAGEMENT FRAMEWORK

1. & 2. Introduction and Responsible Parties Involved

The following monitoring and adaptive management plan will be used by the WWBWC to assess the effectiveness of LTPBR and guide the implementation of future implementation and maintenance. Monitoring will take place at intervals after project implementation and complement ongoing monitoring efforts in the subbasin. However, this is not an Action Effectiveness Monitoring Plan. Funding for adaptive management is not guaranteed and shall be approved by the BPA COR and EC Lead. When adaptive management is needed, a memo will be developed justifying the need for adaptive management (limitations of existing performance) with a description of proposed work (quantities, locations, and structural details if different from original design)."

3. Assessment Protocols			**4. Adaptive Management Triggers**	
Assessment Element	**Performance Question**	**Monitoring Method**	**AM Trigger(s)**	**Potential AM Actions**
Complex Function	Is the Complex promoting desired responses?	Assessment of complex function.	The complex is not contributing to improved riverscape processes (e.g., sediment sorting and transport, channel development, water routing, vegetation establishment/growth, etc.).	Improve existing structures (e.g., add wood, add posts) or build new structures to achieve desired response. However, Modifications to existing structures shall not exceed 20% of the materials used in the original structure. Modifications in excess of 20% will trigger a new BPA HIP/engineering review. New structures shall not exceed two per year.
Structure Integrity & Function	Is the structure intact and achieving desired responses?	Assessment of structure function.	a) The structure is not intact and achieving the desired process OR promoting another desired process. b) The structure needs modification in order to continue achieving or improving process based benefits?	Improve/extend structure (e.g., add wood), relocate structure, or modify function by installing adjacent structures to produce a beneficial function. Modifications shall follow aforementioned amounts.
Risk to Infrastructure	Are structures causing a risk to infrastructure?	Assessment of damage or potential damage to infrastructure.	The structure is causing harm to or at risk of causing harm to infrastructure?	Remove or modify structure to stop or avoid damage to infrastructure.
Risk to Riverscape Function	Are complexes and structures creating a risk to riverscape or ecological function?	Assessment of damage to riverscape and ecological processes.	The structure is causing harm to riverscape or ecological function?	Remove or modify the structure to mimic or promote desired process.
Risk to Fish Passage	Are structures inhibiting fish passage?	Assessment of fish passage.	The structure is preventing the upstream passage of fish during seasons of migration.	Remove or modify the structure to allow for passage.
Restoration Indicators	What is the current status of restoration indicators?	Remote or field-based surveys.	Target metrics for select indicators are not met.	Use assessment elements to determine factors inhibiting success and recommended AM actions.

5. Assessment Frequency, Timing, and Duration

a) Baseline Pre-Project Survey: refer to design report for current conditions.

b) As-built Survey: an as-built survey will be completed after initial implementation.

c) Site Layout Photo Documentation and Visual Inspection: Photos will be taken for documentation and during visual inspections post implementation.

d) Fish Passage Qualitative Narrative: Project area will be monitored to ensure that project actions do not negatively impact fish passage.

6 & 7. Data Storage and Quality Assurance Plan

All photos and survey data collected will be stored by the WWBWC and their contractor(s). The WWBWC and contractor(s) will be responsible for insuring that the design and monitoring plan is followed.

APPENDIX H - FUELING/EQUIPMENT STORAGE AND STAGING AREAS MAPS

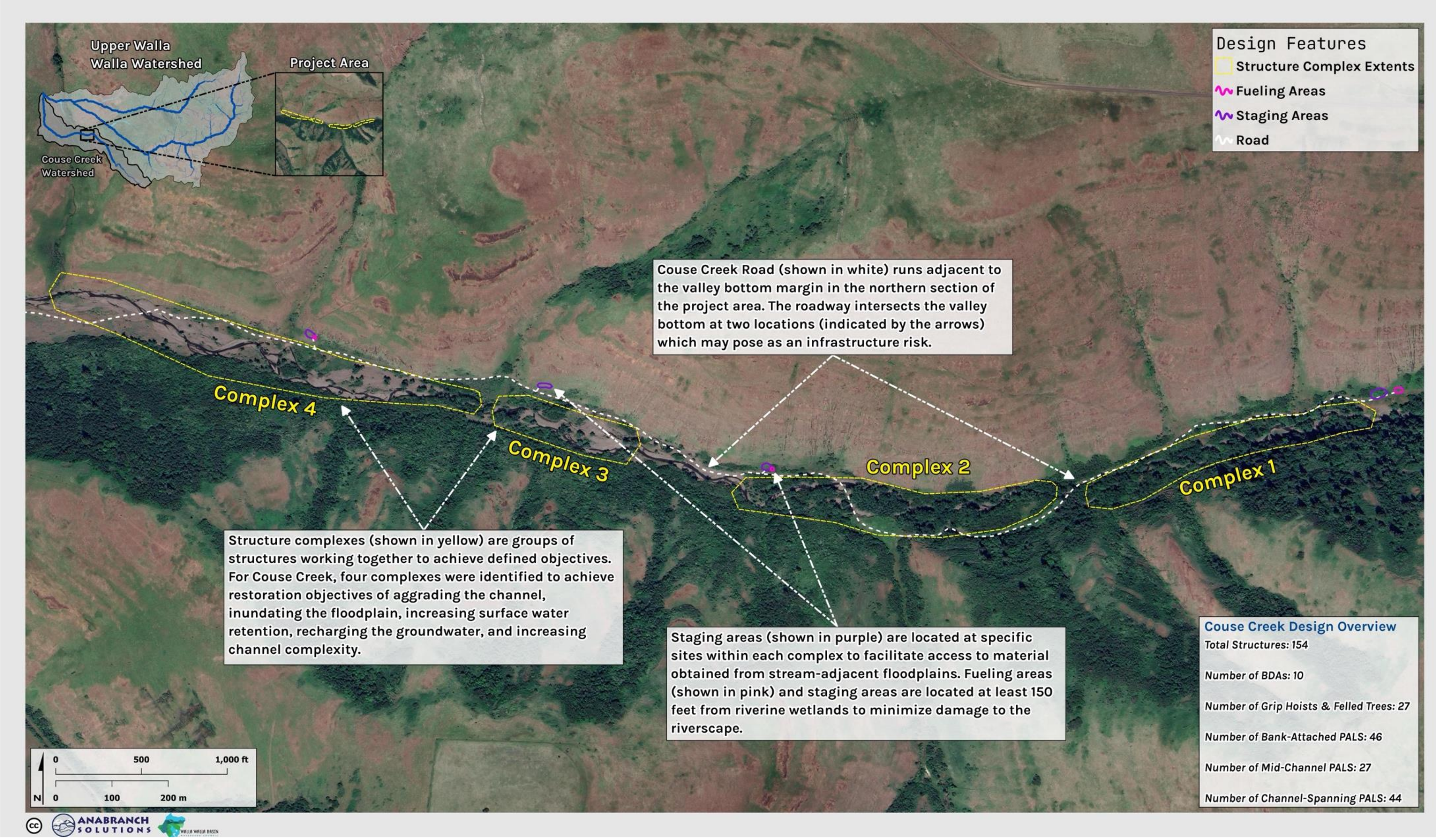


Figure 24: Fueling/equipment storage areas, natural materials staging areas, and roads/access pathways for Couse Creek.

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APPENDIX I - HIP GENERAL CONSERVATION AND IMPLEMENTATION MEASURES

HIP GENERAL CONSERVATION MEASURES APPLICABLE TO ALL ACTIONS

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

PROJECT DESIGN AND SITE PREPARATION.

1. STATE AND FEDERAL PERMITS.

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

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

2. TIMING OF IN-WATER WORK.

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

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

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

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

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

3. CONTAMINANTS.

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

B. THE SITE ASSESSMENT WILL SUMMARIZE:

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

4. SITE LAYOUT AND FLAGGING.

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

B. AREAS TO BE FLAGGED WILL INCLUDE:

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

5. TEMPORARY ACCESS ROADS AND PATHS.

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

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

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

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

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

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

6. TEMPORARY STREAM CROSSINGS.

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

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

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

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

7. STAGING, STORAGE, AND STOCKPILE AREAS.

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

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

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

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

8. EQUIPMENT.

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

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

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

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

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

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

9. EROSION CONTROL.

A. TEMPORARY EROSION CONTROL MEASURES INCLUDE:

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

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

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

10. DUST ABATEMENT.

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

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

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

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

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

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

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PROJECT DESIGN AND SITE PREPARATION (CONTINUED).

11. SPILL PREVENTION, CONTROL, AND COUNTER MEASURES.

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

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

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

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

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

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

12. INVASIVE SPECIES CONTROL.

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

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

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

WORK AREA ISOLATION AND FISH SALVAGE.

1. WORK AREA ISOLATION.

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

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

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

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

2. FISH SALVAGE.

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

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

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

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

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

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

3. ELECTROFISHING.

A. INITIAL SITE SURVEY AND INITIAL SETTINGS.

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

B. ELECTROFISHING TECHNIQUE.

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

C. SAMPLE PROCESSING.

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

D. BULL TROUT ELECTROFISHING.

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

E. LARVAL LAMPREY ELECTROFISHING.

1. PERMISSION FROM EC LEAD WILL BE OBTAINED IF LARVAL LAMPREY ELECTROFISHER IS NOT ONE OF FOLLOWING PRE-APPROVED MODELS: ABP-2 "WISCONSIN", SMITH-ROOT LR-24, OR SMITH-ROOT APEX BACKPACK.
2. LARVAL LAMPREY SAMPLING WILL INCORPORATE 2-STAGE METHOD: "TICKLE" AND "STUN".
3. FIRST STAGE: USE 125 VOLT DC WITH A 25 PERCENT DUTY CYCLE APPLIED AT A SLOW RATE OF 3 PULSES PER SECOND. IF TEMPERATURES ARE BELOW 10 DEGREES CELSIUS, VOLTAGE MAY BE INCREASED GRADUALLY (NOT TO EXCEED 200 VOLTS). BURSTED PULSES (THREE SLOW AND ONE SKIPPED) RECOMMENDED TO INCREASE EMERGENCE.
4. SECOND STAGE (OPTIONAL FOR EXPERIENCED NETTERS): IMMEDIATELY AFTER LAMPREY EMERGE, USE A FAST PULSE SETTING OF 30 PULSES PER SECOND.
5. USE DIP NETS FOR VISIBLE LAMPREY. SIENES AND FINE MESH NET SWEEPS MAY BE USED IN POOR VISIBILITY.
6. SAMPLING WILL OCCUR SLOWLY (>60 SECONDS PER METER) STARTING AT UPSTREAM AND WORKING DOWNSTREAM.
7. MULTIPLE SWEEPS TO OCCUR WITH 15 MINUTES BETWEEN SWEEPS.
8. POST-DRAWDOWN "DRY-SHOCKING" WILL BE APPLIED IF LARVAL LAMPREY CONTINUE TO EMERGE. ANODES TO BE PLACED ONE METER APART TO SAMPLE ONE SQUARE METER AT A TIME FOR AT LEAST 60 SECONDS. FOR TEMPERATURES LESS THAN 10 DEGREES CELSIUS, MAXIMUM VOLTAGE MAY BE GRADUALLY INCREASED TO 400 VOLTS (DRY-SHOCKING ONLY).

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WORK AREA ISOLATION AND FISH SALVAGE (CONTINUED).

4. DEWATERING.

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

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

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

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

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

CONSTRUCTION AND POST CONSTRUCTION CONSERVATION MEASURES.

1. FISH PASSAGE.

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

B. FISH PASSAGE ALTERNATIVES WILL BE APPROVED BY THE BPA EC LEAD UNDER ADVISEMENT BY THE NMFS HABITAT BIOLOGIST.

2. CONSTRUCTION AND DISCHARGE WATER.

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

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

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

3. TIME AND EXTENT OF DISTURBANCE.

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

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

4. CESSATION OF WORK.

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

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

5. SITE RESTORATION.

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

B. PROJECT-RELATED WASTE WILL BE REMOVED.

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

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

6. REVEGETATION.

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

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

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

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

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

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

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

7. SITE ACCESS AND IMPLEMENTATION MONITORING.

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

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

8. CWA SECTION 401 WATER QUALITY CERTIFICATION.

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

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

STAGED REWATERING PLAN.

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

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

1. TURBIDITY MONITORING PROTOCOL WILL BE APPLIED TO REWATERING EFFORTS.
2. PRE-WASH THE AREA BEFORE REWATERING. TURBID WASH WATER WILL BE DETAINED AND PUMPED TO THE FLOODPLAIN OR SEDIMENT CAPTURE AREAS RATHER THAN DISCHARGING TO FISH-BEARING STREAMS.
3. INSTALL SEINE NETS AT UPSTREAM END TO PREVENT FISH FROM MOVING DOWNSTREAM UNTIL 2/3 OF TOTAL FLOW IS RESTORED TO THE CHANNEL.
4. STARTING IN EARLY MORNING INTRODUCE 1/3 OF NEW CHANNEL FLOW OVER PERIOD OF 1-2 HOURS.
5. INTRODUCE SECOND THIRD OF FLOW OVER NEXT 1 TO 2 HOURS AND BEGIN FISH SALVAGE OF BYPASS CHANNEL IF FISH ARE PRESENT.
6. REMOVE UPSTREAM SEINE NETS ONCE 2/3 FLOW IN REWATERED CHANNEL AND DOWNSTREAM TURBIDITY IS WITHIN ACCEPTABLE RANGE (LESS THAN 40 NTU OR LESS THAN 10% BACKGROUND).
7. INTRODUCE FINAL THIRD OF FLOW ONCE FISH SALVAGE EFFORTS ARE COMPLETE AND DOWNSTREAM TURBIDITY VERIFIED TO BE WITHIN ACCEPTABLE RANGE.
8. INSTALL PLUG TO BLOCK FLOW INTO OLD CHANNEL OR BYPASS. REMOVE ANY REMAINING SEINE NETS.
9. IN LAMPREY SYSTEMS, LAMPREY SALVAGE AND DRY SHOCKING MAY BE NECESSARY.

TURBIDITY MONITORING.

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

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

1. 50 FEET DOWNSTREAM FOR STREAMS LESS THAN 30 FEET WIDE.
2. 100 FEET DOWNSTREAM FOR STREAMS BETWEEN 30 AND 100 FEET WIDE.
3. 200 FEET DOWNSTREAM FOR STREAMS GREATER THAN 100 FEET WIDE.
4. 300 FEET FROM THE DISCHARGE POINT OR NONPOINT SOURCE FOR LOCATIONS SUBJECT TO TIDAL OR COASTAL SCOUR.

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

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

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

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

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

Designed
Drawn
Checked
Approved
Title

HIP GENERAL CONSERVATION MEASURES

BONNEVILLE POWER ADMINISTRATION: ENVIRONMENT, FISH AND WILDLIFE DIVISION

File Name: *2021 HIP GCA*

Drawing No.

Sheet 3 of 3

Table 8: HIP Conservation and implementation measures.

APPENDIX J - HIP SMALL WOOD CONSERVATION MEASURES

1) Small wood placements shall be conducted by hand or small machinery not to exceed 15,000 lbs. operating weight. If heavy equipment is required, project shall adhere to Large Wood conservation measures.
2) Small wood placements shall be constructed for floodplain reconnection in stream systems less than 4% stream gradient.
3) Additional potential effects of structures may include channel aggradation and associated channel widening, bank erosion, increased channel meandering, and decreased channel depth. The Basis of Design Report must demonstrate how these potential impacts have been addressed.
4) Structures must be porous, must provide for a water surface differential of no more than one-foot at low flows, or otherwise provide a clear path for fish passage over, through or around the structure during low flows.
5) Structures shall have crest elevations that extend no more than 3 feet above the stream bed. Vertical posts (if utilized) shall be cut flush and not extend above the proposed crest elevation.
6) Vertical posts (if utilized) must be driven to a depth at least 1.5 times the expected scour depth of the waterway or a ratio of 1:2 for exposed – embedded length whichever is more conservative. A minimum 1.5-foot clear space is recommended between posts.
7) For incised channels, an adaptive management approach using lower elevation structures that trap sediment and aggrade the channel, with future and subsequent project phases is preferred over tall structures with excessive drop and increased risk of failure.
8) All primary materials used in small wood placements must consist of non- treated wood (e.g. fence posts) and must be constructed from a materials source collected outside the riparian area.
9) Placement of inorganic material is limited to the minimum quantity necessary to prevent under-scour of structure and manage pore flow sufficient to ensure adequate over-topping flow and side flow to facilitate fish passage where required.
10) No cabling, wire, mortar or other materials that serve to affix the structure to the bed, banks or upland is allowed.
11) Structures cannot unreasonably interfere with use of the waterway for navigation, fishing or recreation.