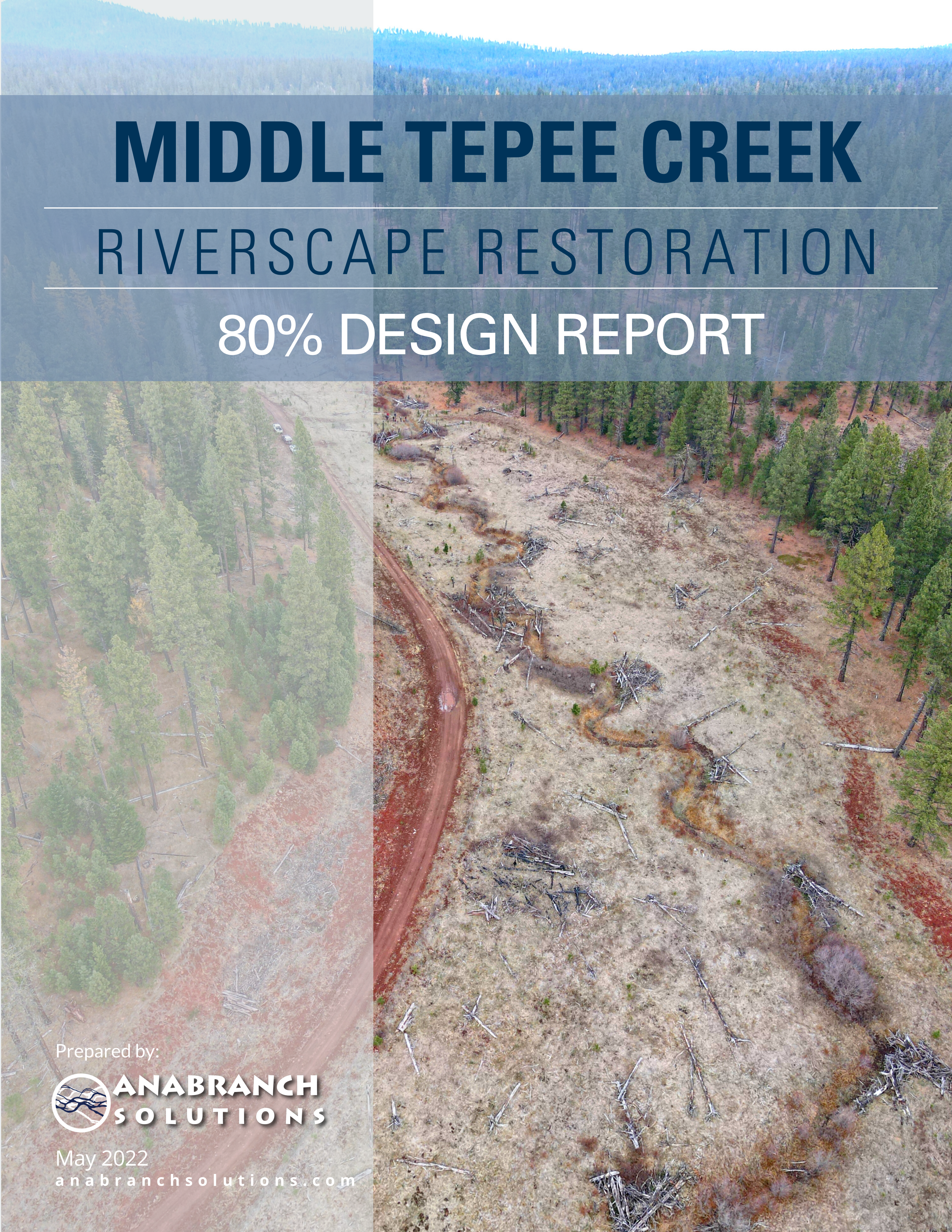

MIDDLE TEPEE CREEK

RIVERSCAPE RESTORATION

80% DESIGN REPORT

Prepared by:

ANABRANCH SOLUTIONS

May 2022

anabranchsolutions.com

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PREPARED FOR:
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PROJECT SUMMARY

The Yakama Nation is pursuing low-tech process-based restoration actions (LTPBR; Wheaton et al. 2019) as part of an integrated effort to restore culturally significant populations of salmonids in the Klickitat River subbasin on Tribal territory both on Reservation lands and in partnership with private landowners (YNFP 2020). In addition to restoring salmonid habitat and fish populations, the Yakama Nation strives to train a tribal workforce in LTPBR practices and increase engagement and traditional ecological knowledge (TEK) in watershed restoration. This document outlines the 80% restoration design for five miles of middle Tepee Creek, a tributary to White Creek, located in the Klickitat River subbasin.

Tepee Creek is part of the White Creek Major Spawning Area (MaSA) for ESA-listed Mid-Columbia steelhead (*Oncorhynchus mykiss*). The White Creek drainage is considered one of the most significant spawning areas in the subbasin, accounting for approximately 41% of the observed steelhead spawning. Tepee Creek has accounted for up to 14% of spawning in the White Creek drainage in recent years (2002-2019).

Past land management activities including grazing, timber harvest, road construction, and the removal of wood from streams have decreased the quality and quantity of stream habitat within the Tepee Creek watershed including: reduced wood accumulations (e.g., large wood jams), geomorphic diversity (i.e., pool and off-channel habitat), channel-floodplain connectivity, riparian vegetation, and baseflows. Much of Tepee Creek is incised and the stream goes dry for substantial portions of the year (~5 months).

The overall goal of restoration on Tepee Creek is to improve the quality and quantity of habitat for threatened steelhead by promoting sustainable fluvial processes that result in a healthy and resilient riverscape. Within this broad management goal, objectives for restoration include: 1) increase the abundance of beaver dams and large wood accumulations, 2) increase in-channel geomorphic diversity, 3) increase the proportion of the valley bottom inundated at high flows, 3) increase wetland and riparian vegetation extent, diversity, and abundance, and 5) increase perennial surface flow extent during low flow periods.

The restoration design outlines Low-Tech Process-Based Restoration methods (Wheaton et al., 2019) in Tepee 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). These structural elements will be strategically introduced to the stream in a design intended to initiate and amplify natural hydrologic, geomorphic, and biological processes that accelerate the recovery trajectory of Tepee Creek and address limiting factors.

This design report describes the project location, goals and objectives, and planning and design approach, and provides a resource assessment, restoration design, adaptive management framework, and details regarding implementation and logistics.

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INTRODUCTION

The Yakama Nation is pursuing low-tech process-based restoration actions (LTPBR; Wheaton et al. 2019) as part of an integrated effort to restore culturally significant populations of salmonids in the Klickitat River subbasin on Tribal territory both on Reservation lands and in partnership with private land owners (YNFP 2020). In addition to restoring salmonid habitat and fish populations, the Yakama Nation also strives to train a tribal workforce in LTPBR practices and increase engagement and traditional ecological knowledge (TEK) in watershed restoration.

Past land management activities including grazing, timber harvest, road construction, and the removal of wood from streams have decreased the quality and quantity of stream habitat within the Tepee Creek watershed including: reduced wood accumulations (e.g., large wood jams), geomorphic diversity (i.e., pool and of-channel habitat), channel-floodplain connectivity, riparian vegetation, and streamflow. Much of Tepee Creek is incised and the stream goes dry for substantial portions of the year (~5 months). Tepee Creek is part of the White Creek Major Spawning Area (MaSA) for ESA-listed Mid-Columbia steelhead (*Oncorhynchus mykiss*). The White Creek drainage is considered one of the most significant spawning areas in the subbasin, accounting for approximately 41% of the observed steelhead spawning. Tepee Creek has accounted for up to 14% of spawning in the White Creek drainage in recent years (2002-2019). The overall goal of restoration on Tepee Creek is to improve the quality and quantity of habitat for threatened steelhead by promoting natural fluvial processes that result in a healthy and resilient riverscape. An LTPBR design has already been completed on the lower 1.75 miles of Tepee Creek and implementation will begin in spring of 2022. This design is meant to complement and extend work in lower Tepee Creek.

This document provides an 80% design report for 5 miles of middle Tepee Creek. The design follows planning, implementation, and project management guidelines identified by the Natural Resources Conservation Service's (NRCS) Conservation Planning Process built within an adaptive management framework. This report provides an overview of the project location, restoration goals and objectives, an assessment of resources, the restoration design approach that includes estimated structure types and quantities, an assessment of potential risks to infrastructure, and an overview of adaptive management for the project.

PROJECT LOCATION AND CONTEXT

Tepee Creek is a tributary to White Creek in the Klickitat River subbasin in south-central Washington (Figure 1). The Tepee Creek watershed encompasses 21.4 mi^2 with a maximum elevation of 3,980 feet near Simon Butte and a minimum elevation of 2,580 feet at its confluence with White Creek (Figure 2). Annual precipitation averages 31 inches and vegetation consists of ponderosa pine parkland and mixed conifer forests in the uplands and mixed deciduous and wetland species in riparian areas within valley bottoms. The entire watershed is part of the Yakama Reservation and managed by the Yakama Nation.

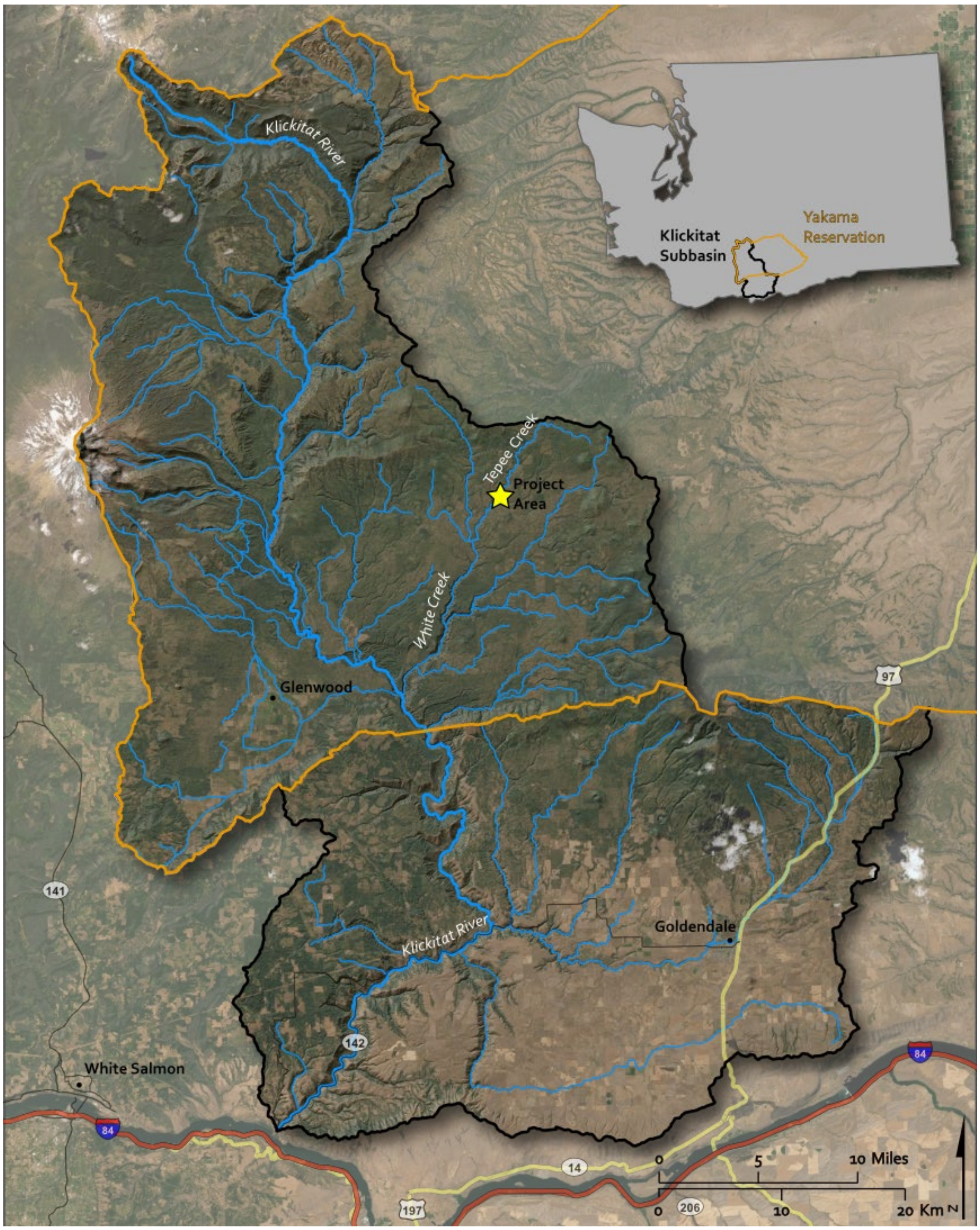

Figure 1. Project area location within the White Creek drainage and Klickitat River subbasin in south-central Washington.

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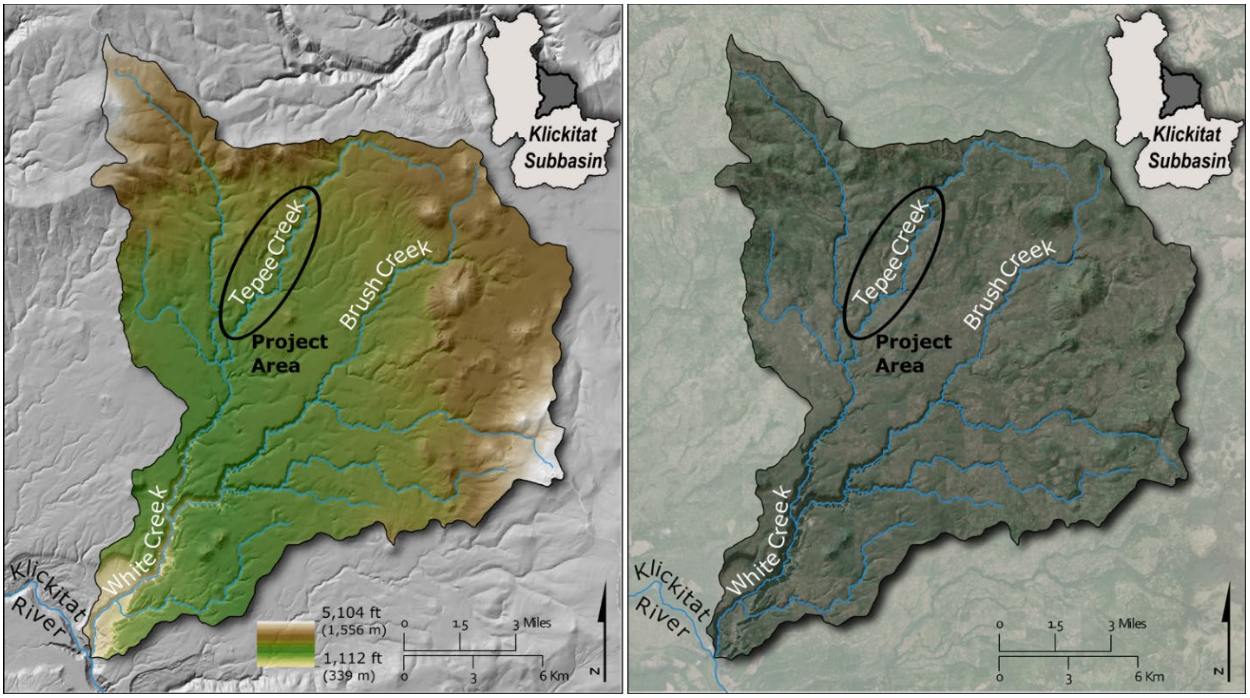

Figure 2. Project area location on Tepee Creek within the White Creek drainage: left panel provides elevation and right panel provides aerial imagery. The project area starts approximately 1.75 miles upstream from the confluence with White Creek and extends for five miles.

The project area begins 1.75 miles upstream from the confluence with White Creek and extends for five miles (Figure 2, Figure 3). Within the project area, the valley bottom width averages approximately 140 feet and consists smaller meadow sections interspersed between sections with more narrow valleys with small discontinuous pockets of floodplain. The valley bottom gradient is 1.3% over the entire project area.

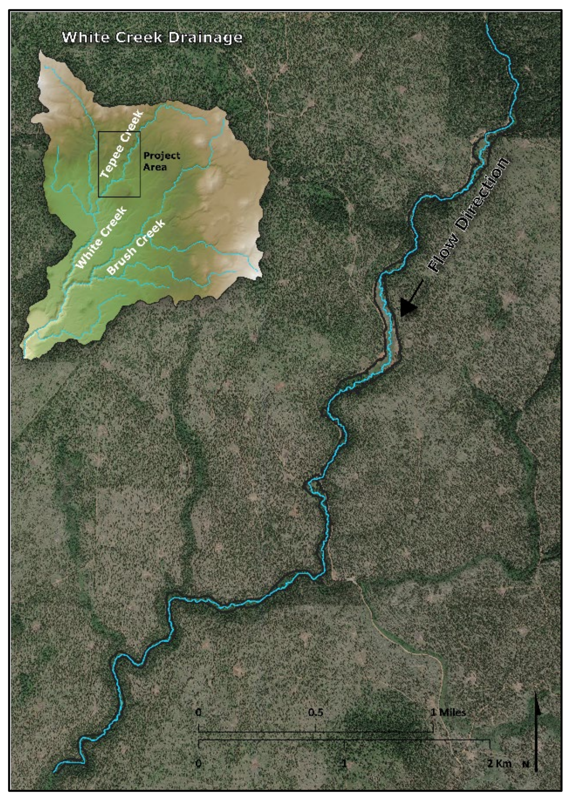

Figure 3. Overview map of the middle Tepee Creek project area. Black lines represent valley bottom margins.

PROJECT GOALS

The overall goal of restoration on Tepee 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, specific goals include:

- increasing the frequency of overbank flows
- enhancing in-channel habitat conditions
- increasing the duration of low flows
- reducing active channel hydraulic severity
- improving shallow aquifer storage/recharge
- increasing valley bottom suitability for culturally significant plants

PLANNING AND DESIGN APPROACH

The Tepee 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 4). 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).

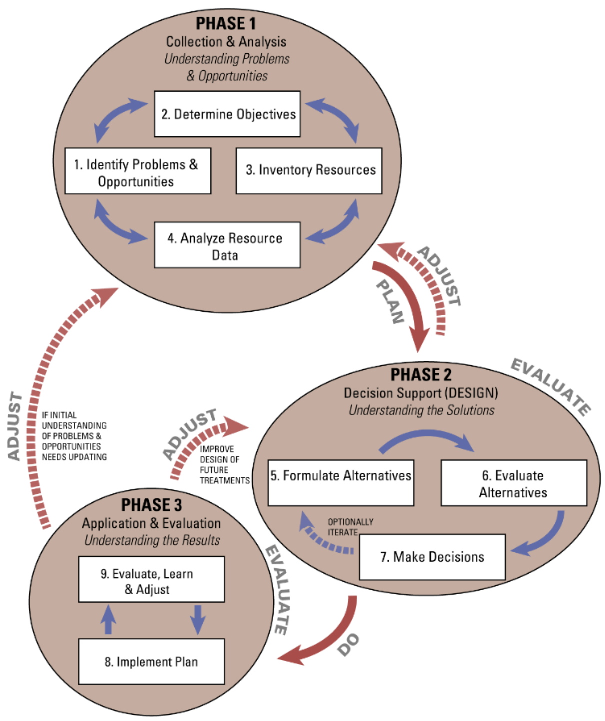

Figure 4. Outline depicting an adaptation of NRCS's Conservation Planning Process used to guide the Tepee Creek restoration planning and design process (from Wheaton et al. 2019).

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 in order 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 4).

RATIONALE FOR DESIGN

Several alternative channel and floodplain restoration approaches have been considered for riverscape recovery on Tepee Creek. In general, these alternatives are characteristic of traditional engineered plans for valley bottom regrading and channel realignment. Given the design, permitting, implementation costs, and potential disturbance caused by machine access associated with engineered restoration over larger spatial extents, LTPBR approaches were selected as the proposed design alternative.

There are a number of project area characteristics that make it well-suited for implementing LTPBR designs. Furthermore, LTPBR projects are well suited to the Yakama Nation's vision to engage tribal members with stewardship of their natural resources.

Site characteristics – The climatic, topographic, and hydrologic catchment conditions within Tepee Creek support reliable flood events, the presence of nearby beaver populations and suitability of Tepee Creek to support beaver, and a recovering riparian area and forested uplands.

Lack of human infrastructure – There is limited human infrastructure such as houses, outbuildings, or bridges in the project area. This characteristic of the project area offers a high potential for expansion of the active channel and floodplain while posing little risk.

Tribal member engagement – The implementation of LTPBR projects lends itself to creating a workforce of tribal members that provides economic and cultural incentives to improve riverscape health.

RESOURCE ASSESSMENT

The following section provides an assessment of fisheries resources and limiting factors, geomorphic, hydrologic, and riparian conditions, 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, site visits, aerial imagery, previously collected data, and personal communication with Yakama Nation staff to assess the following resources:

FISHERIES RESOURCES AND LIMITING FACTORS

Tepee Creek is part of the White Creek Major Spawning Area (MaSA) for ESA-listed Mid-Columbia steelhead (*Oncorhynchus mykiss)* which is considered one of the most significant spawning areas in the subbasin (Klickitat Lead Entity 2015). The distribution of steelhead extends approximately 10 miles upstream from the confluence with White Creek. There are no other ESA-listed species in Tepee Creek. On average, the White Creek drainage accounts for approximately 41% of the observed steelhead spawning in the subbasin and Tepee Creek itself has accounted for up to 14% in recent years (Yakama Nation staff, personal communication, 2020).

Limiting Factors in the White Creek drainage include (NMFS 2009):

Streamflow, habitat quality and quantity, impaired fish passage, altered sediment routing, degraded water quality (temperature), competition, and degraded channel structure and complexity. The restoration actions outlined in this design propose to address a number of limiting factors including:

- flow (low flows),
- habitat quality and quantity,
- degraded channel structure and complexity, and
- floodplain connectivity.

VALLEY SETTING (REACHES)

Two types of valley settings are present in the project area:1) confined reaches with relatively narrow valley bottoms (100-200 ft.) are the primary valley setting and 2) meadow reaches with wider valley bottoms (200-350 ft.).

CHANNEL CHARACTERISTICS

Channel characteristics in Tepee Creek vary between reach types. Within meadow reaches, the stream is more incised with highly erodible banks that are sparsely covered with riparian vegetation. The stream channel has very little geomorphic diversity with few structural elements (e.g., LWD and/or beaver dams). In confined reaches, the channel is less incised, but still disconnected from the floodplain with low to moderate amounts of structural elements and limited geomorphic diversity.

HYDROLOGY

Tepee Creek, at the project area drains approximately 20 square miles, end experiences an average of 31 inches of precipitation annually. Peak flows tend to be rainfall driven and occur in winter and spring as rain on snow events (Liermann et al. 2012). Predicted streamflow for the 2, 5, 10, 25, 50, and 100-year recurrence intervals is shown in Figure 5. Low-flow statistics are not available for the project area, however field observations indicate that baseflows are typically <1 cfs and the stream goes dry for approximately 5 months out of the year (Yakama Nation staff, personal communication, 2020). A table of the predicted streamflow values as well as a longer discussion of their utility in LTPBR planning and design can be found in the Appendix C of this report.

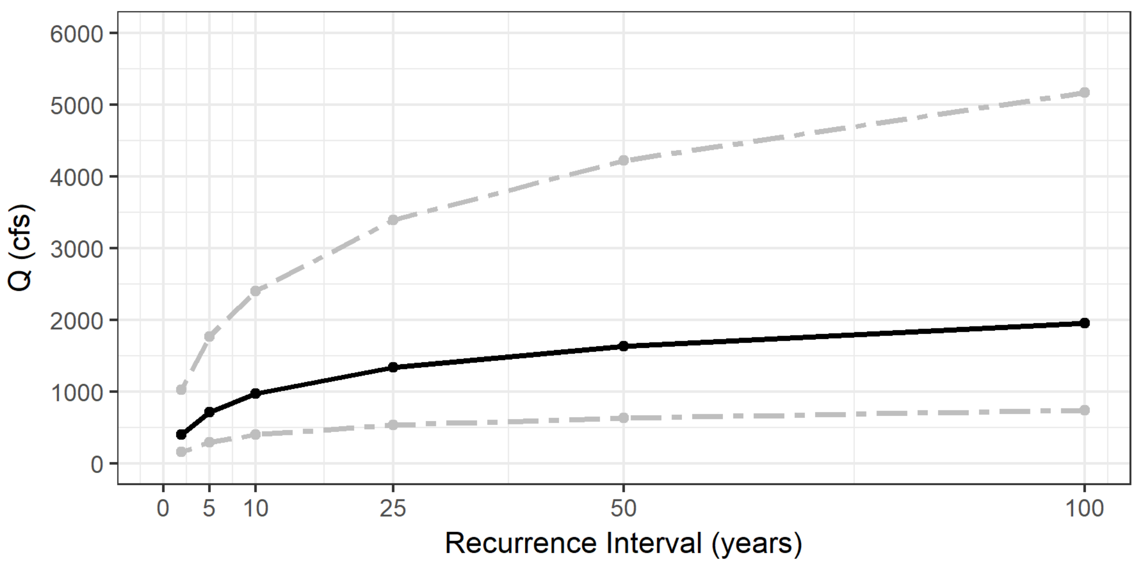

Figure 5. Predicted values of streamflow on Tepee Creek for up to 100-year recurrence interval events. Solid black line represents the predicted value, dotted grey lines represent the upper and lower prediction interval. Data retrieved from Streamstats (https://streamstats.usgs.gov/ss/) Accessed 01/06/2022 and are based on Mastin et al. (2016).

RIPARIAN ASSESSMENT AND POTENTIAL TO SUPPORT BEAVER

Headwater streams in the Klickitat River subbasin generally have the capacity to support frequent to pervasive beaver dams. We used the Beaver Restoration Assessment Tool (BRAT; Macfarlane et al., 2017) to assess the current and historic capacity to support beaver dams across the Klickitat River subbasin. Importantly, BRAT relies on regional hydrological data when assessing whether flow conditions are conducive to, or will limit beaver dam activity. In Tepee Creek, dry streamflow conditions currently are likely to limit the capacity/likelihood to support beaver dam activity. However, beaver have been observed to extend the duration of streamflow in intermittent systems. It is with this understanding that we assessed the current capacity to support beaver dams in Tepee Creek, based on riparian and upland vegetation characteristics and channel gradient. Within the project area, Tepee Creek currently has the capacity to support 30-50 beaver dams. Historically, the project area could support 40 – 60 dams. Reductions in capacity are likely due to a decrease in the woody riparian vegetation preferred by beavers for forage and dam building. There are currently no beaver dams within the project area. As such there is the potential for significant uplift if restoration activities can encourage the colonization of the project area by beaver and promotion of beaver dam activity. The limited reduction in beaver dam capacity, relative to historic condition, suggests that encouraging beaver dam activity is an appropriate restoration strategy provided that forage and dam building resources become sufficient. Furthermore, the upper portions of Tepee Creek, as well as nearby streams have the capacity to support beaver dams. This capacity is important to creating realistic expectations for the likelihood of future beaver dam activity within the project area. Alternative sites may either provide a source of dispersing beaver (if or once established) or be areas that may be colonized at the expense of colonization within the project area.

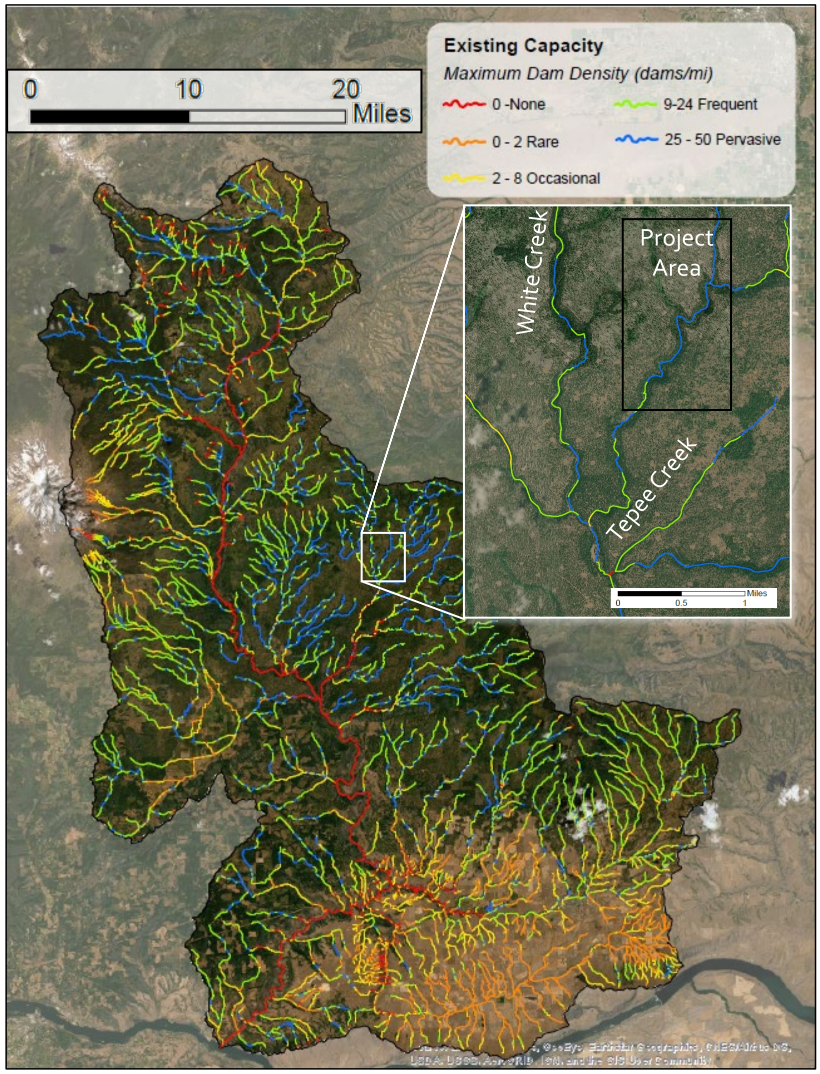

Figure 6. Existing capacity to support beaver dams within the Klickitat River subbasin and near the Tepee Creek project area. The surrounding area is shown in order to provide context regarding the future likelihood that beaver move into the project area based on the capacity of nearby streams.

RISK ASSESSMENT

Risks were assessed as the potential for impacts to infrastructure (road crossings, buildings, etc.) within and adjacent to the valley bottom. There are two road crossings within the valley bottom of the project area. One bridge and one culvert. A dirt road also runs parallel to the valley bottom margin in some location. There is potential risk to the road during high flow events this risk is relatively low due to the riparian and floodplain buffer that is present between the active channel and the road prism. Risks and constraints will be further evaluated and managed using adaptive management.

POTENTIAL FUTURE CONDITION

Prior to human alteration, many riverscapes such as Tepee Creek (especially in meadow reaches) were characterized by multiple channels and high channel-floodplain connectivity, and were also more resilient to disturbance. The stream evolution model presented by Cluer and Thorne (2014) describes valley bottoms characterized by multiple channels and high channel-floodplain connectivity as "Stage 0", and describes how the hydrologic, hydraulic, substrate, geomorphic, and ecological benefits of this stage are greater than other stages in the stream evolution cycle (Figure 7; Table 1). This concept, when applied to either meadow or confined reaches provides an overarching target for restoration and potential pathways of recovery.

Without active structural additions it will likely be decades before Tepee Creek naturally recovers to near Stage 0 conditions. With targeted restoration actions, there is potential to access the entire valley bottom throughout a majority of the project area. In confined reaches, recovery potential may be recognized within short to medium time scales (years to decades). In meadow reaches, achieving full recovery potential may take longer due to the relatively degraded conditions and greater area of disconnected floodplain, but when recognized, provide a greater amount of ecosystem benefits and uplift such as flow attenuation, groundwater storage, and more diverse habitat for steelhead. Ultimately, self-sustaining riverscape conditions may not be recognized without the processes of natural wood recruitment or beaver activity, which restoration can help to initiate.

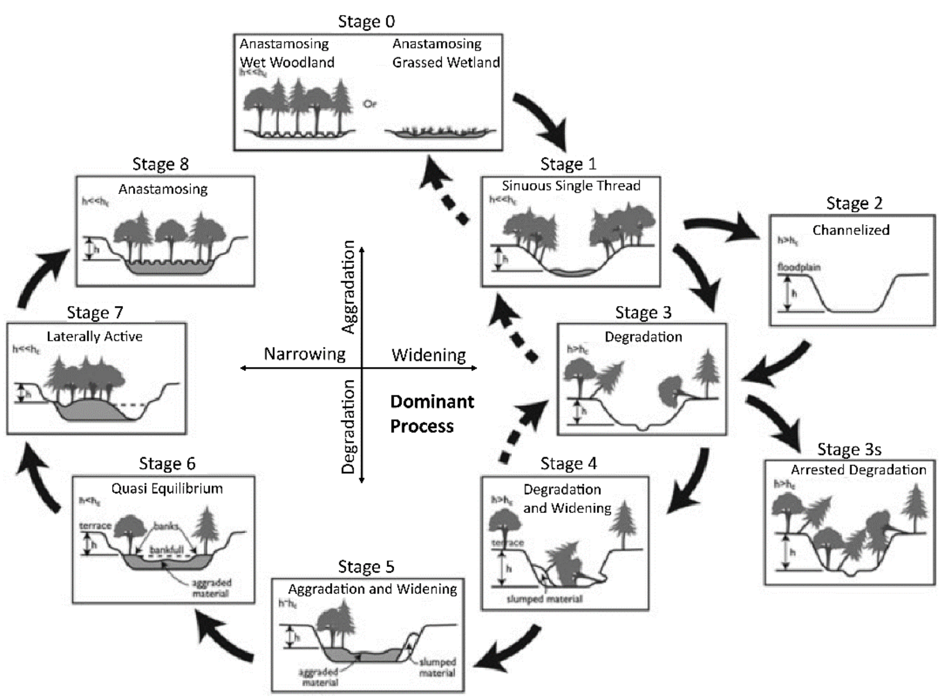

Figure 7. Stream evolution model (SEM) proposed by Cluer and Thorne (2014) illustrating approximate stages and pathways associated with recovery to Stage 0. Restoration in Tepee Creek is intended to accelerate recovery trajectories.

Table 1. Description of dominant hydrologic, hydraulic, substrate, and morphological characteristics of Stage 0 channels. Adapted from Cluer and Thorne (2014).

Stage 0 Description	Hydrologic Regime	Hydraulics and Substrate	Morphology
Dynamically meta-stable network of anabranching channels with vegetated islands	Floods cover width of floodplain; Maximum flood attenuation; High water table	Maximum in-channel hydraulic diversity; Wide range of depth/velocity combinations; Wide range of substrate sizes in well-sorted patches	Multiple channels; Low bank height; Fully connected floodplain; High capacity to store sediment and wood

PROJECT OBJECTIVES

The middle Tepee Creek restoration goals and objectives support recovery planning actions aimed at improving the quality and quantity of habitat and address several factors limiting steelhead production in the Klickitat River subbasin including low flows, high water temperatures, lack of instream complexity, and floodplain connectivity (NMFS 2009).

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 goals provided by Yakama Nation and the assessment of current conditions and recovery potential (Table 2).

Table 2. Restoration objectives and their link to broader management goals.

Objective	Description	Link to Restoration Goals
1	Increase the abundance of beaver dams and large wood accumulations.	Both artificial and natural beaver dams along with large wood accumulations (e.g., large wood jams) increase in-channel habitat diversity and help to accelerate recovery. An expanding beaver population is indicative of self – sustaining riverscape processes.
2	Increase in-channel geomorphic diversity.	Geomorphically diverse streams provide higher quality habitat for adult and juvenile steelhead.
3	Increase the proportion of the valley bottom inundated at high flows.	Increased active channel and floodplain area contributes to the expansion of wetland and riparian vegetation and increasing steelhead habitat quantity.
4	Increase wetland and riparian vegetation extent, diversity, and abundance.	Riparian vegetation is essential to support wood accumulation, as forage and building material for beaver, and suitability for culturally significant plants.
5	Increase perennial surface flow extent during low flow periods.	Surface flow creates conditions that support woody riparian vegetation establishment, steelhead habitat quantity, and suggests efforts to attenuate flow are successful.

RESTORATION INDICATORS

There is a high potential for restoration success in middle Tepee Creek due to the lack of infrastructure and grazing pressure in the valley bottom, the application of best management practices and minimal disturbance in the uplands, and indications that riparian conditions have begun to recover. However, restoration success may be limited by a number of factors including: a flashy hydrograph, the availability of sediment to aggrade the channel, and the cohesion of banks which can influence the ability to widen incised channels and provide local sources of sediment.

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 orthoimagery acquisition using a consumer level drone, 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 spawning habitat used by adult steelhead.

High Flow Inundation Extent – Percent and area of the valley bottom inundated during high flow periods. Expected to increase 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, groundwater elevation, as well as due to grazing management and riparian vegetation planting treatments.

Beaver Dam and Large Wood Accumulation Abundance – Count of natural beaver dams, artificial dams, and large wood accumulations 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.

Table 3. 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 pool and large wood accumulation metrics were derived from habitat data collected in lower Tepee Creek (Yakama Nation, unpublished data).

	Status	Target Metrics			
Indicator	**Current**	**As-Built**	**Short-Term 2 – 5 years**	**Medium-Term 5 – 10 years**	**Long-Term 10-20 years**
Objective 1: Increase In-Channel Habitat Complexity					
Pool Habitat Frequency (count/100m)[1]	1-2 / 100m	1-2 / 100m	1-3 / 100m	2-6 / 100m	4-8 / 100m
Bar Habitat Frequency (count/100m)[1]	0-2 / 100m	0-2 / 100m	1-4 / 100m	3-8 / 100m	4-10 / 100m
Objective 2: Increase Valley Bottom Inundation					
High Flow Inundation Extent (% & acres)	35-45% 29-37 acres	35-50% 29-42 acres	35-60% 29-50 acres	40-75% 33-62 acres	50-90% 42-75 acres
Objective 3: Increase Perennial Surface Flow Extent					
Perennial Surface Flow Length (% and length)	0-5%, 0-400 meters	0-5%, 0-400 meters	0-7%, 0-560 meters	2-20%, 160-1600 meters	5-75%, 400-6000 meters
Objective 4: Increase Wetland and Riparian Vegetation Extent					
Wetland and Riparian Vegetation Extent (% & area)[2]	10-25%, 8-21 acres	10-25%, 8-21 acres	15-30%, 12-25 acres	20-40%, 17-33 acres	25-45%, 21-37 acres
Objective 5: Increase Abundance and Distribution of Beaver Dams and Large Wood Accumulations					
Natural Beaver Dams (count)	0 dams	0 dams	0-5 dams	0-20 dams	15-30 dams
Artificial Beaver Dams (count)	0 dams	10-25 dams	0-25 dams	5-30 dams	20-30 dams
Large Wood Accumulations (count)[3]	0 - 6 jams	60-100 jams	40-120 jams	60-150 jams	80-150 jams

1: Assumes treatments will form pool and bar complexes after flood events.
2: Primarily based on expectations for expansion of the active floodplain and planting treatment.
3: Assumes a combination of natural and artificial large wood accumulations in the project area.

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 Reach Design – Description of structure types and their organization, distribution, and function within structure complexes (i.e., groups of multiple structures).

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 in order 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. This phased approach can also be informed by LTPBR actions in lower Tepee Creek. We recommend a pilot in select reaches followed by implementation in the entire project area (Phase 1). A second structural treatment (Phase 2) would follow after 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 while in the meantime training and building a local workforce. The phased approach also fits an iterative process that can be applied to multiple ongoing restoration projects over large spatial scales.

Table 4. Estimated time table for phased implementation on middle Tepee 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.

Phase	Year(s)	Restoration Actions	Structure Estimate
1	1	▪ Pilot restoration in select reaches (one meadow and one confined) ▪ Evaluate pilot restoration	New: 50-100
	2	▪ Implement restoration throughout project area ▪ Structure maintenance and additions in areas of pilot restoration ▪ Riparian planting within pilot restoration reaches	New and maintained: 50-100
2	2-5	▪ Evaluate Phase 1 restoration ▪ Structure maintenance and additions within project area ▪ Riparian planting throughout project area	0-50
3	5-10	▪ Evaluate Phase 2 restoration ▪ Structure maintenance and additions within project area ▪ Additional riparian plantings (if necessary)	0-50
Additional	10+	▪ Evaluate the establishment of self-sustaining processes ▪ Potential beaver reintroduction	0-50

SPATIAL DESIGN - REACH DELINEATION

As part of the resource assessment, two distinct reach types were identified within the project area. These types include reaches with relatively narrow valley bottoms (i.e., confined) and meadow reaches with wider valley bottoms. The spatial orientation of these reach types led to the delineation of seven management reaches within the project area (Figure 8). Identifying and delineating distinct reaches allows for better management of project expectations given the differences in valley bottom characteristics and helps guide where more restoration effort may be invested. For example, given the larger area of potential floodplain in meadow reaches, and the higher capacity to store water and attenuate flows, more effort and resources may be invested in these areas. Also, to meet certain objectives in downstream reaches (i.e., aggradation), specific actions upstream may be required (e.g., building numerous bank-attached structures designed to mobilize sediment that can be captured in downstream channel spanning structures). Management reaches also provide the setting for reach level designs (i.e., groups of structures designed to work together for specific objectives) and establishing complex objectives.

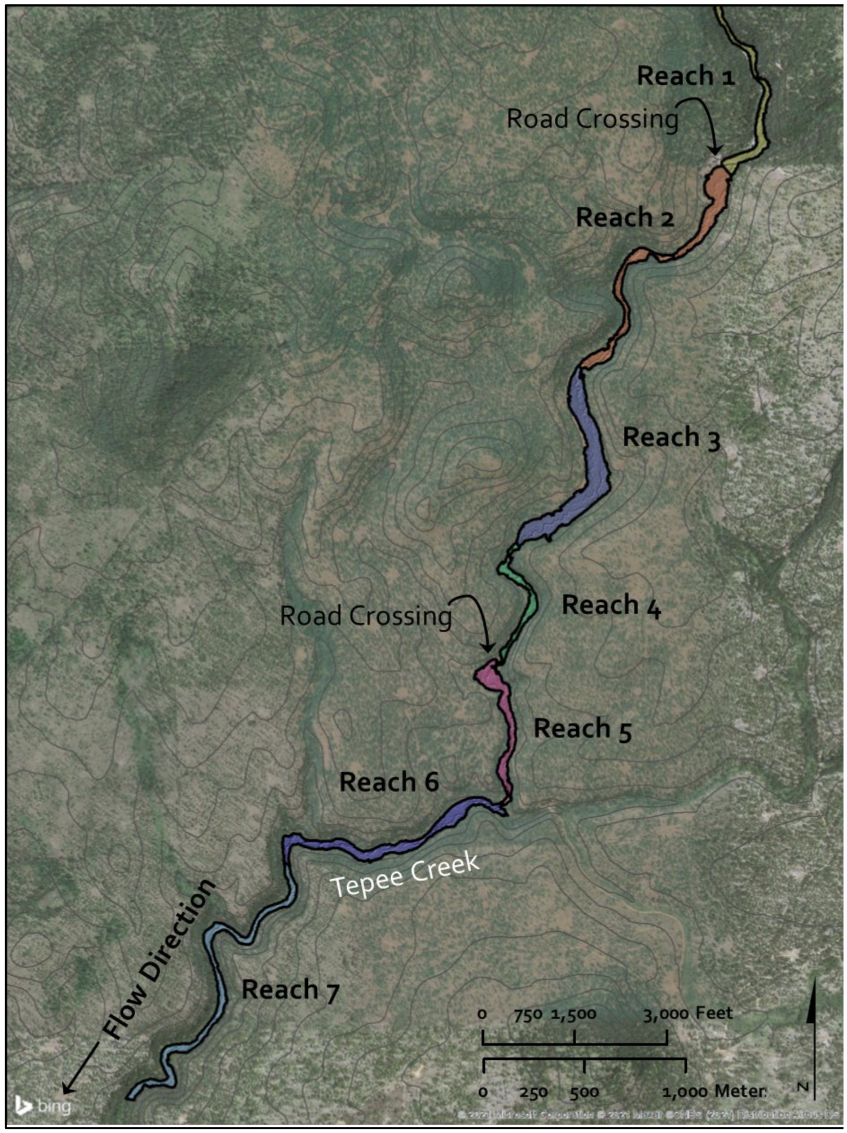

Figure 8. Reach delineation within the project area. Reach breaks were determined by both anthropogenic and natural variables, including road crossings, valley bottom width, valley bottom gradient, and tributary junctions. Reaches are numbered from upstream-to-downstream.

STRUCTURAL ELEMENTS

Structural elements proposed in the design include unsecured trees/large wood accumulations, Post-Assisted Log Structures (PALS), and Beaver Dam Analogues (BDAs). These structure types can be constructed 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.

Large Wood Accumulations

Low-tech large wood accumulations are constructed using a variety of methods including tree falling (Carah et al. 2014), grip-hoisting downed wood, or wood transported to the site that is too large to move by hand (Figure 9). Any of these actions can be combined or used individually depending on available material and site conditions. Low-tech large wood additions do not preclude the use of tractors or other machinery to move wood where site conditions allow access with machinery with minimal disturbance to riparian habitat. Generally, falling and positioning on-site trees and downed wood should be prioritized as it is the most efficient way to add large wood compared to bringing it in from off-site, assuming other environmental considerations are accounted for.

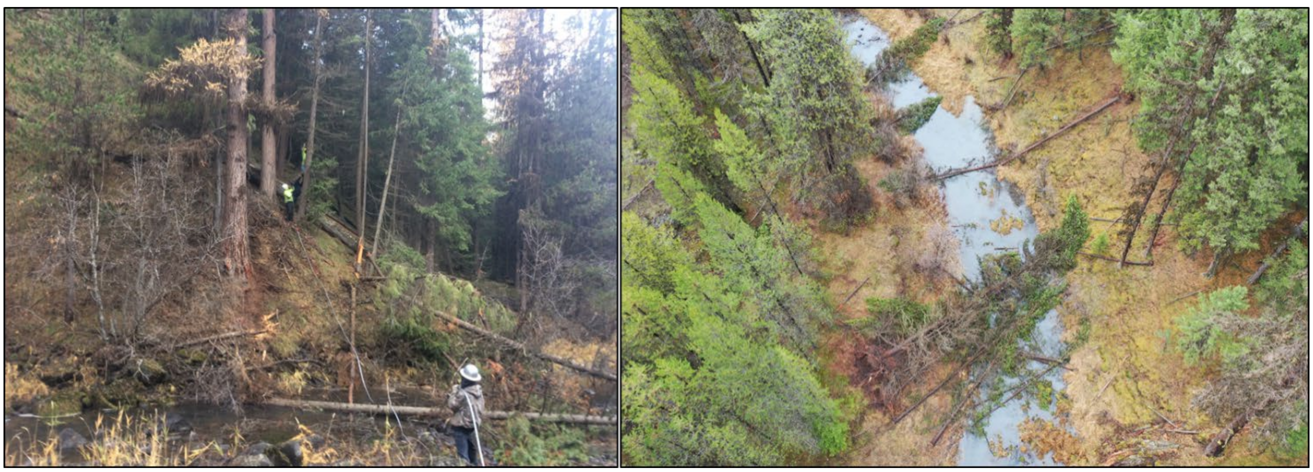

Figure 9. Preparing to utilize a griphoist and cable to pull large wood from the adjacent hillslope into the stream channel (left photo) and example of unanchored large wood cut and pulled into channel, and pulled over with rootwad using a griphoist (right photo).

Post-Assisted Log Structures (PALS)

PALS are a good alternative to falling trees where on-site trees are not available or are too small to build relatively stable structures. PALS can be built with small diameter wood (1-12" diameter) and used to mimic much large pieces by securing multiple smaller pieces using untreated wooden posts driven into the substrate and positioned to mimic natural wood accumulations (Figure 10). Both PALS and unsecured large wood accumulations can increase geomorphic diversity, force lateral channel migration, force overbank flows, encourage widening, and encourage aggradation and channel avulsion (Appendix D). They can also be built on the floodplain and disconnected side-channels in anticipation of floodplains being reactivated.

There are three basic types/orientations of large wood accumulations/PALS: bank-attached, mid-channel, and channel spanning. Bank-attached structures are used to widen channels, recruit sediment, promote scour pools, and build bank-attached bars. Mid-channel structures are used to split flows, build mid-channel bars, scour pools, and recruit sediment. Channel-spanning structures are used to force aggradation, promote overbank flow during high flow, and promote plunge and dam pools. Different types of structures are often used in combination with beaver dam analogues to produce a variety of localized geomorphic affects. Large wood accumulations/PALS are typically built in high densities (3-5/100m) such that if a structure 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 mimics the natural diversity of large wood accumulations observed in natural settings.

Beaver Dam Analogues (BDAs)

Beaver dam analogues (BDAs) mimic the form and function of natural beaver dams (Figure 10). 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 groundwater recharge, expansion of riparian vegetation and wetland areas, increased hydraulic diversity including deep-slow water habitat, and incision recovery through channel-widening and aggradation.

Figure 10. 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).

REACH 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 to meet multiple objectives. Figure 11 provides a conceptual restoration design for the project area. Table 5 provides a list of objectives for each reach along with a description and estimate of structure numbers and types. A more detailed description of reach objectives and their intended physical and biological responses can be found in Appendix E. More detailed maps of reach designs can be found in Appendix F and spatial data is available here. The number, type, and location of structures is subject to change based on ground conditions.

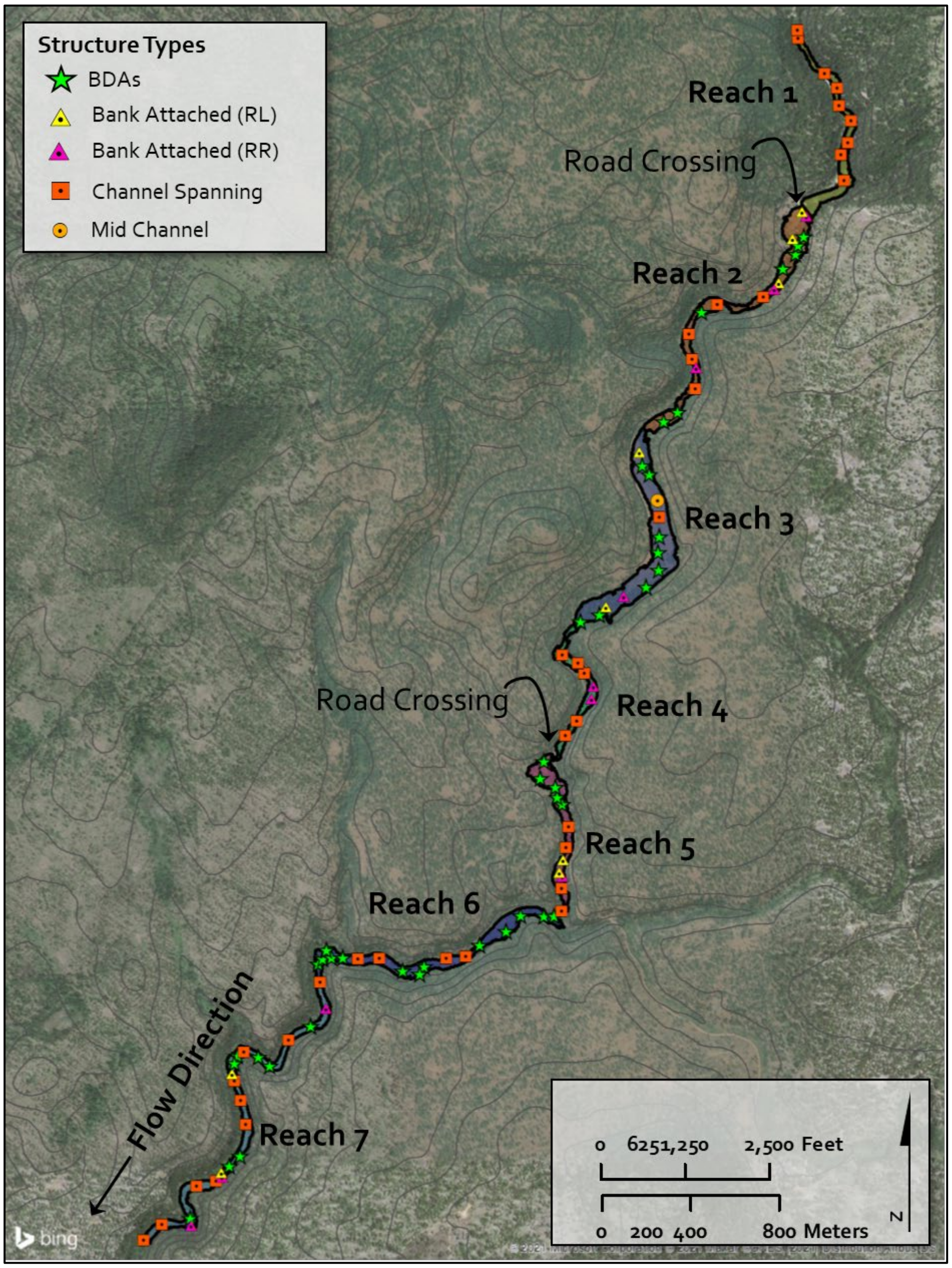

Figure 11. Conceptual restoration design illustrating structure types and locations within the Tepee Creek project area. Table 5 provides a description of specific objectives for each complex. A more refined mapview of reach designs can be found in Appendix F.

Table 5. Complex descriptions outlining risk, objectives, and an estimate of structure types and numbers.

Reach (length)	Risk	Complex Objectives	Description	Large Wood Accumulations or PALS	BDAs
1 (3280 ft.)	Limited risk; Road crossing at bottom of reach	Increase Geomorphic Diversity Force Overbank Flows	Bank-attached structures to promote erosion and lateral migration; Channel-spanning wood accumulations to capture sediment, aggrade the channel, and promote overbank flows (channel-floodplain connectivity)	10-20	0-5
2 (4550 ft.)	Limited risk; No infrastructure	Increase Geomorphic Diversity Force Overbank Flows Pond/Wetland Creation	Bank-attached structures to promote erosion and lateral migration; Channel-spanning wood accumulations and BDAs to capture sediment, aggrade the channel, promote overbank flows (channel-floodplain connectivity) and reconnect side channels; BDAs to pond water at low flow	10-20	5-10
3 (3500 ft.)	Limited risk; Road in valley bottom for short distance	Increase Geomorphic Diversity Force Overbank Flows Pond/Wetland Creation	Bank-attached structures to promote erosion and lateral migration; Channel-spanning wood accumulations and BDAs to capture sediment, aggrade the channel, promote overbank flows (channel-floodplain connectivity) and reconnect side channels; BDAs to pond water at low flow	10-20	5-10
4 (2305 ft.)	Limited risk; Road in valley bottom for short distance; Crossing at downstream end	Increase Geomorphic Diversity Force Overbank Flows	Bank-attached structures to promote erosion and lateral migration; Channel-spanning wood accumulations to capture sediment, aggrade the channel, and promote overbank flows (channel-floodplain connectivity)	5-15	0-5
5 (2570 ft.)	Limited risk; Road in valley bottom for short distance	Increase Geomorphic Diversity Force Overbank Flows Pond/Wetland Creation	Bank-attached structures to promote erosion and lateral migration; Channel-spanning wood accumulations and BDAs to capture sediment, aggrade the channel, promote overbank flows (channel-floodplain connectivity) and reconnect side channels; BDAs to pond water at low flow	5-15	5-10
6 (4110 ft.)	Limited risk; No infrastructure	Increase Geomorphic Diversity Force Overbank Flows Pond/Wetland Creation	Bank-attached structures to promote erosion and lateral migration; Channel-spanning wood accumulations and BDAs to capture sediment, aggrade the channel, and promote overbank flows (channel-floodplain connectivity); BDAs to pond water at low flow	5-10	10-20
7 (6000 ft.)	Limited risk; No infrastructure	Increase Geomorphic Diversity Force Overbank Flows	Bank-attached structures to promote erosion and lateral migration; Channel-spanning wood accumulations and BDAs to capture sediment, aggrade the channel, and promote overbank flows (channel-floodplain connectivity); BDAs to pond water at low flow	15-25	5-10
			Totals:	**60-125**	**30-70**

ADAPTIVE MANAGEMENT

LTPBR is more appropriately thought of as an ongoing-process of restoration and management than a 'one-and-done' effort. Here we discuss how adaptive management can be used to guide future phases of restoration. We use the term 'phases' here to refer 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 12). LTPBR projects can be evaluated at multiple scales, ranging from the scale of an individual structure to the entire project area. Here we focus on the complex/reach and project scale rather than the scale of individual structures, since project objectives are not met at the scale of individual structures.

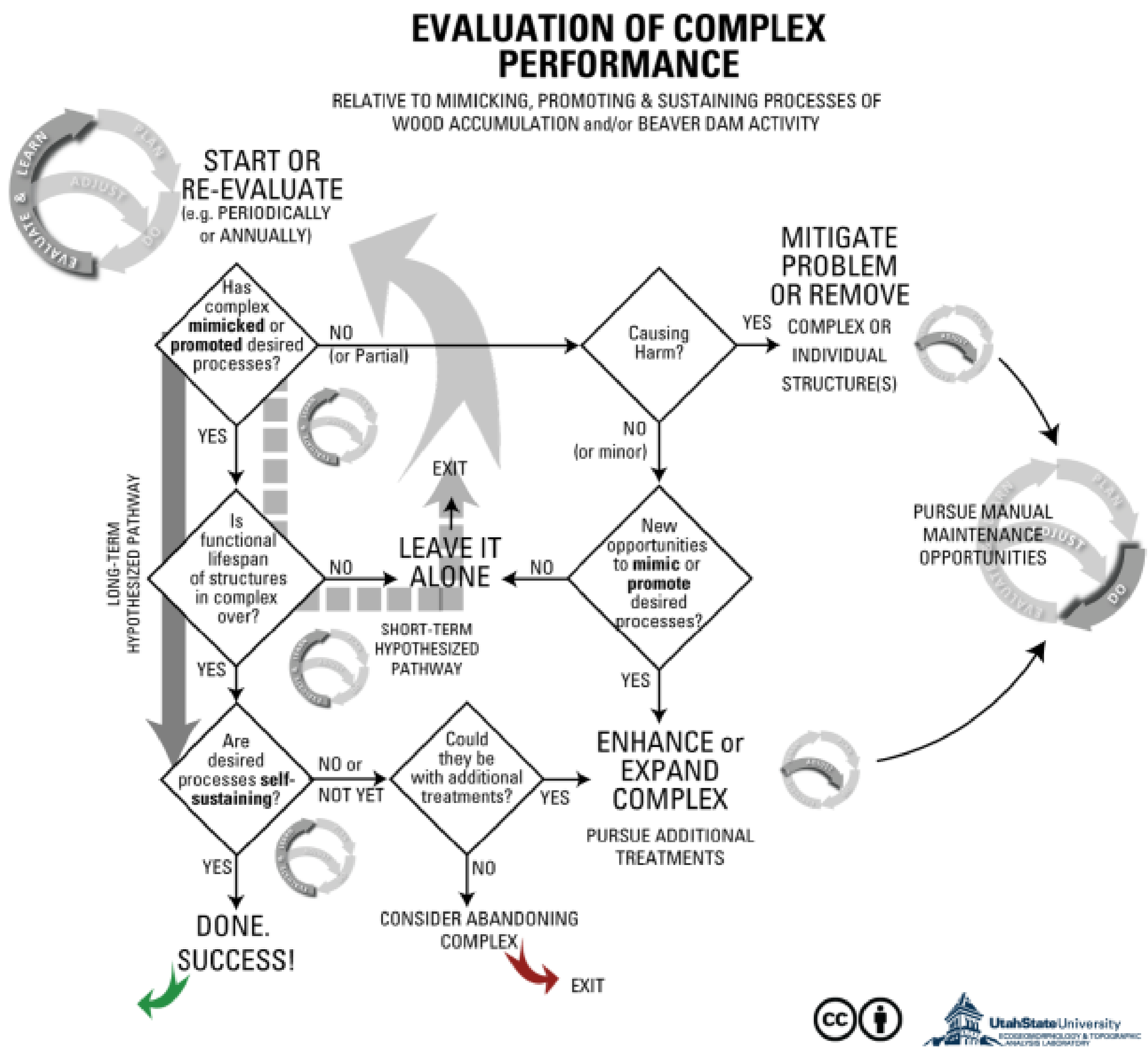

Figure 12. Conceptual adaptive management framework for monitoring and ongoing restoration of LTPBR complexes or reaches. Many of the concepts illustrated are also applicable at the scale of an individual structure or the entire project. From Chapter 6 of Wheaton et al. (2019; http://lowtechpbr.restoration.usu.edu).

MONITORING AND ADAPTIVE MANAGEMENT FRAMEWORK

To help facilitate adaptive management, Appendix G provides a 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 reach 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 reach objectives and the specific structure objective within that reach.

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, wood will be sourced from nearby forest thinning and/or fuels reduction projects and staged in select locations throughout the project area and/or sourced directly from adjacent floodplains and hillslopes. The size of individual wood pieces will vary but are not likely to exceed 12 inches diameter at breast height (DBH) by 15 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.). Some wood exceeding 12 inches DBH by 15 feet in length may be used if directly sourced from the floodplain or adjacent hillslopes. It is anticipated that approximately 1500-2000 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. Material and fill estimates can be found in Appendix H.

SITE ACCESS, MATERIAL STAGING, AND FUELING/EQUIPMENT STORAGE

Site access and travel within the lower project area (Reaches 6 and 7) will be limited to foot and small machinery (e.g. ATVs). There are no maintained roads that lead directly to the valley bottom but old skid paths and decommissioned roads are present from past forest management activities. These existing pathways will be used to access the project area and transport wood from upslope staging areas. A maintained dirt road parallels the valley bottom for a majority of the upper project area (Reaches 1-5) allowing for access. 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. See Appendix I for maps of site access, 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, 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 griphoist may also be used to transport larger wood pieces from the floodplain to the channel.

Construction

PALS are constructed by hand-placing the wood in the channel and then using the hydraulic post pounder to pound 2-4" diameter untreated wooden posts into the channel to secure the wood. Posts are typically driven in 2-3' and cut off at approximately bank-full height. BDAs are built using a variety of local materials including willow, alder, 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. Structure height should not exceed 18" above the low flow water surface elevation unless conditions warrant a taller structure without impacting fish passage.

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-Water Work

Instream work will be conducted during the established work window determined by Yakama Nation staff (likely July-October 15). Work outside this window may occur in dry portions of the stream channel upon approval from Yakama Nation staff.

Construction timing and noise limits will adhere to conservation measures outlined for northern spotted owls (Appendix L).

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. The channel is also dry for a majority of the year. Therefore, 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 mostly be limited to foot traffic. If stream crossing is found to be necessary for small machinery (e.g., ATVs, skidsteer), it will be done in the dry portion of the channel.

On-Site Harvest of Large Wood

Any large wood harvested from adjacent floodplains or hillslopes will follow best management practices and adhere to forest/riparian management guidelines set forth by the Yakama Nation and guidelines outlined in the conservation measures for northern spotted owls (*Strix occidentalis caurina*) when applicable *(*Appendix L).

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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 - PROJECT AREA PHOTOS

Figure 13. Photos illustrating channel and riparian conditions in a meadow reach where previous restoration actions occurred.

APPENDIX C - PREDICTED STREAMFLOW VALUES AND THEIR UTILITY

Table 6. Predicted streamflow intervals at the downstream end of the project area on middle Tepee Creek.

Recurrence Interval (year)	Predicted Discharge (cfs)	Lower prediction interval (cfs)	Upper prediction interval (cfs)	Standard Error
2	402	158	1020	52.5
5	715	289	1770	50.6
10	974	396	2400	50.5
25	1340	530	3390	51.7
50	1630	629	4220	52.9
100	1950	735	5170	54.2
200	2270	836	6160	55.5
500	2770	977	7850	58

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 values presented here are likely overestimates of flows along Tepee Creek (David Lindley, personal communication, 2020) that are the product of the manner in which geographic regions are delineated in order to develop streamflow regression equations across the state of Washington. In short, the project area is located near the margin of three different regions, and is grouped with an area that encompasses the spine of the Cascades, which experiences significantly different precipitation patterns.

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

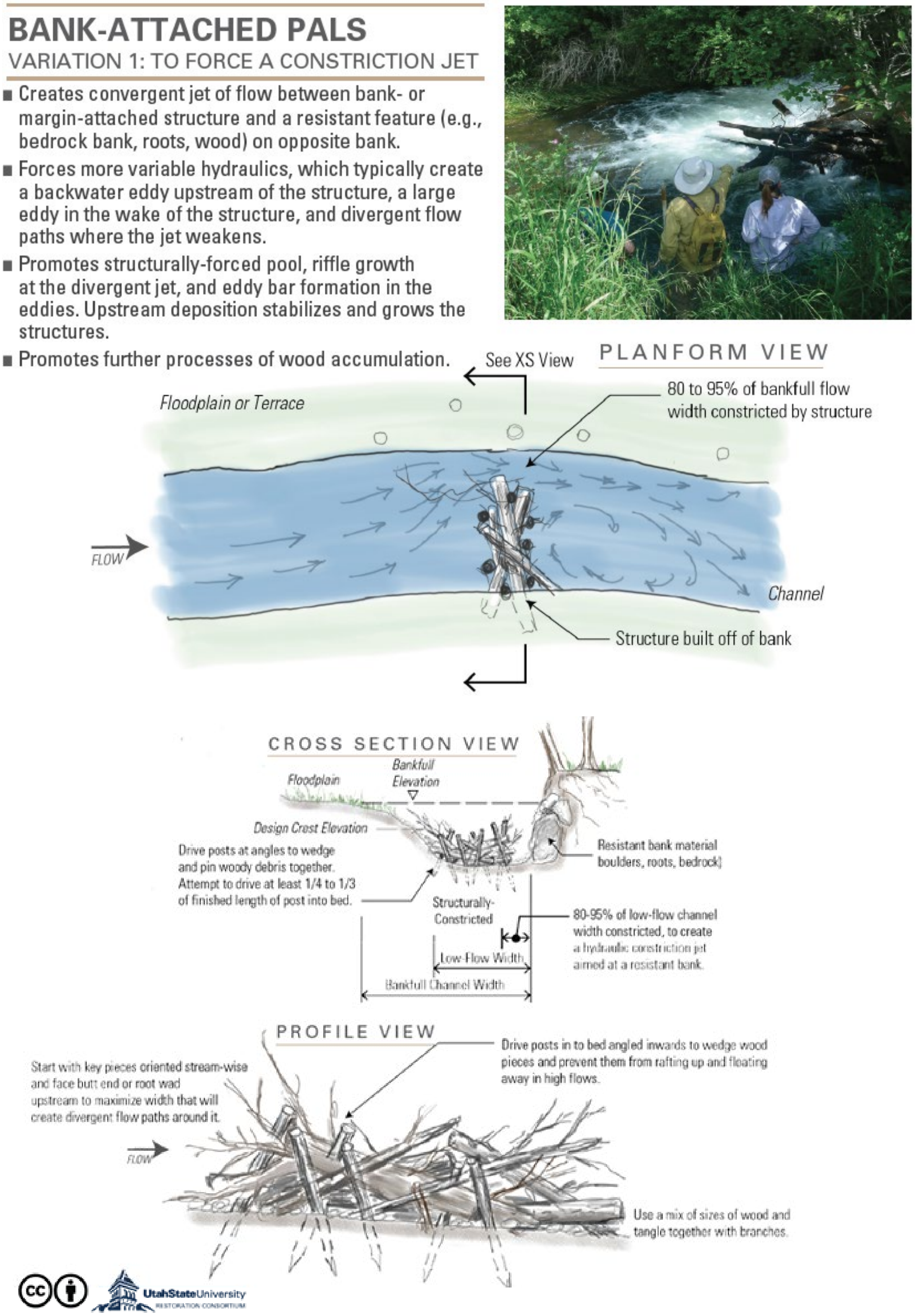

Figure 14. Typical schematic sketches of a bank-attached PALS directed at a resistant bank intended to force a constriction jet. From Chapter 4 of Wheaton et al. (2019: http://lowtechpbr.restoration.usu.edu).

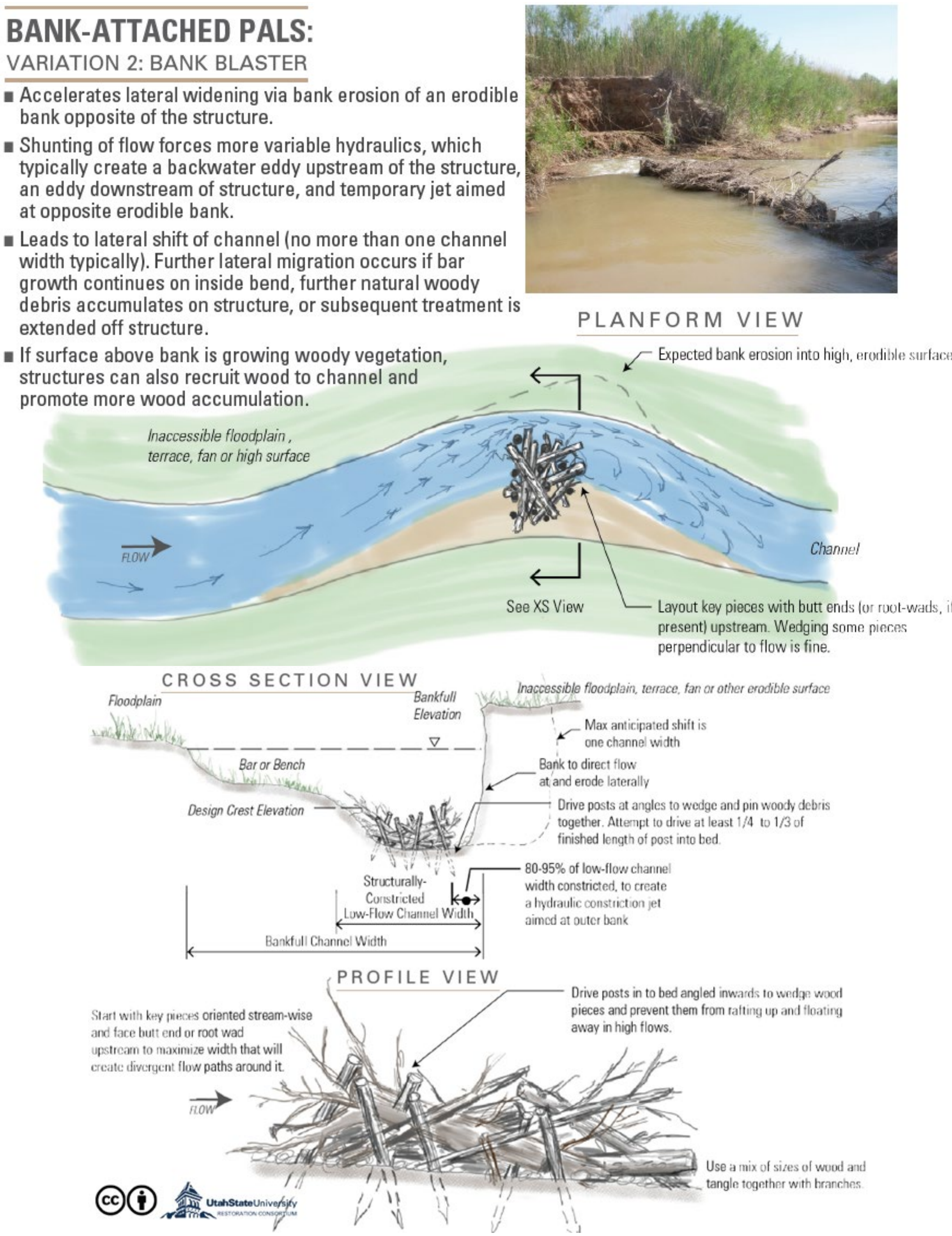

Figure 15. Typical schematic sketches of a bank-attached PALS intended to cause lateral channel migration through deposition of material on point and diagonal bars and erosion of high bank features. From Chapter 4 of Wheaton et al. (2019: http://lowtechpbr.restoration.usu.edu).

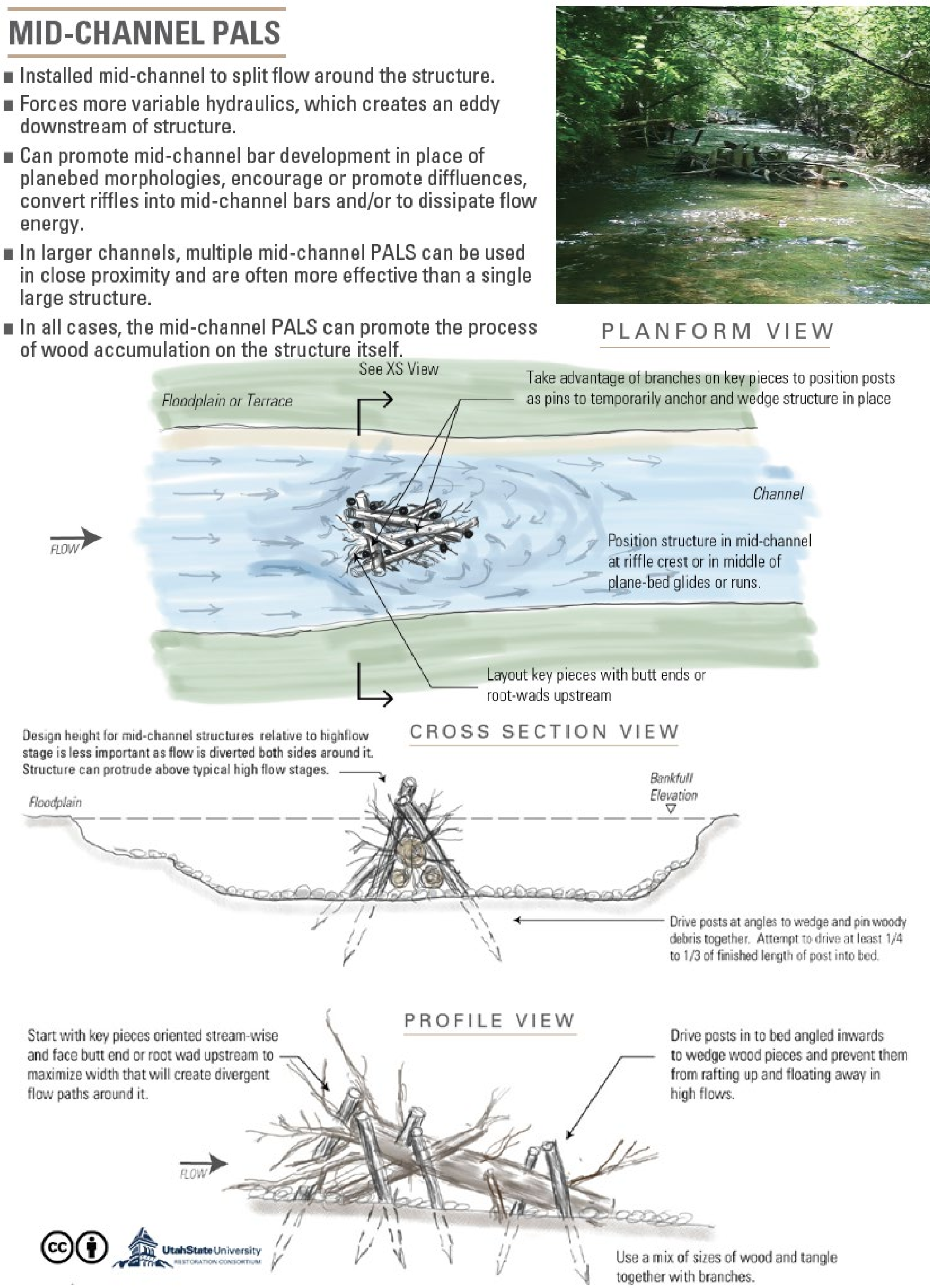

Figure 16. Typical schematics of a mid-channel PALS designed to induce channel complexity, encourage mid-channel deposition, and encourage channel avulsion. From Chapter 4 of Wheaton et al. (2019: http://lowtechpbr.restoration.usu.edu).

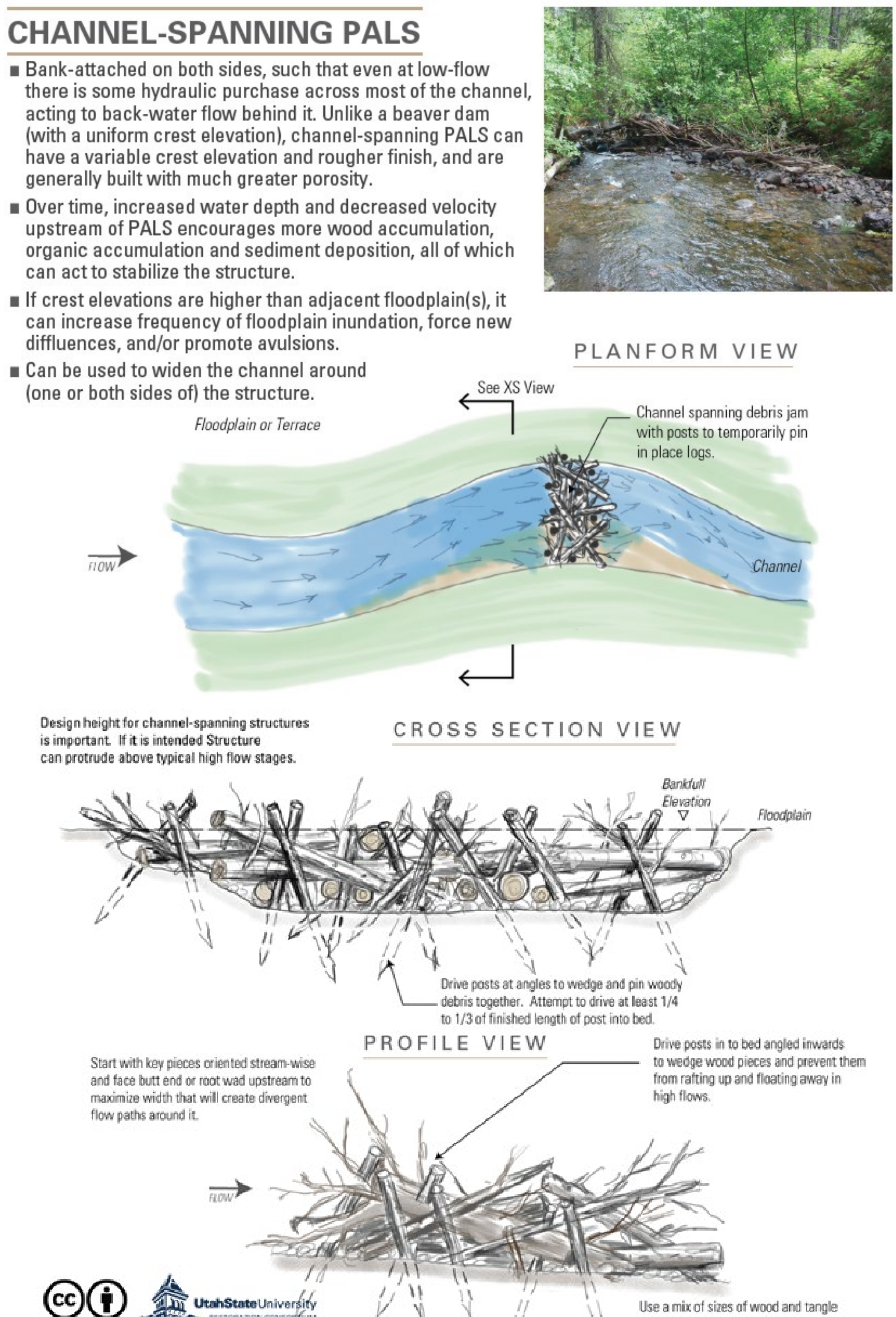

Figure 17. Typical schematics of a channel-spanning PALS. Channel spanning PALS are designed to be passable by fish at all flows. From Chapter 4 of Wheaton et al. (2019: http://lowtechpbr.restoration.usu.edu).

Figure 18. 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

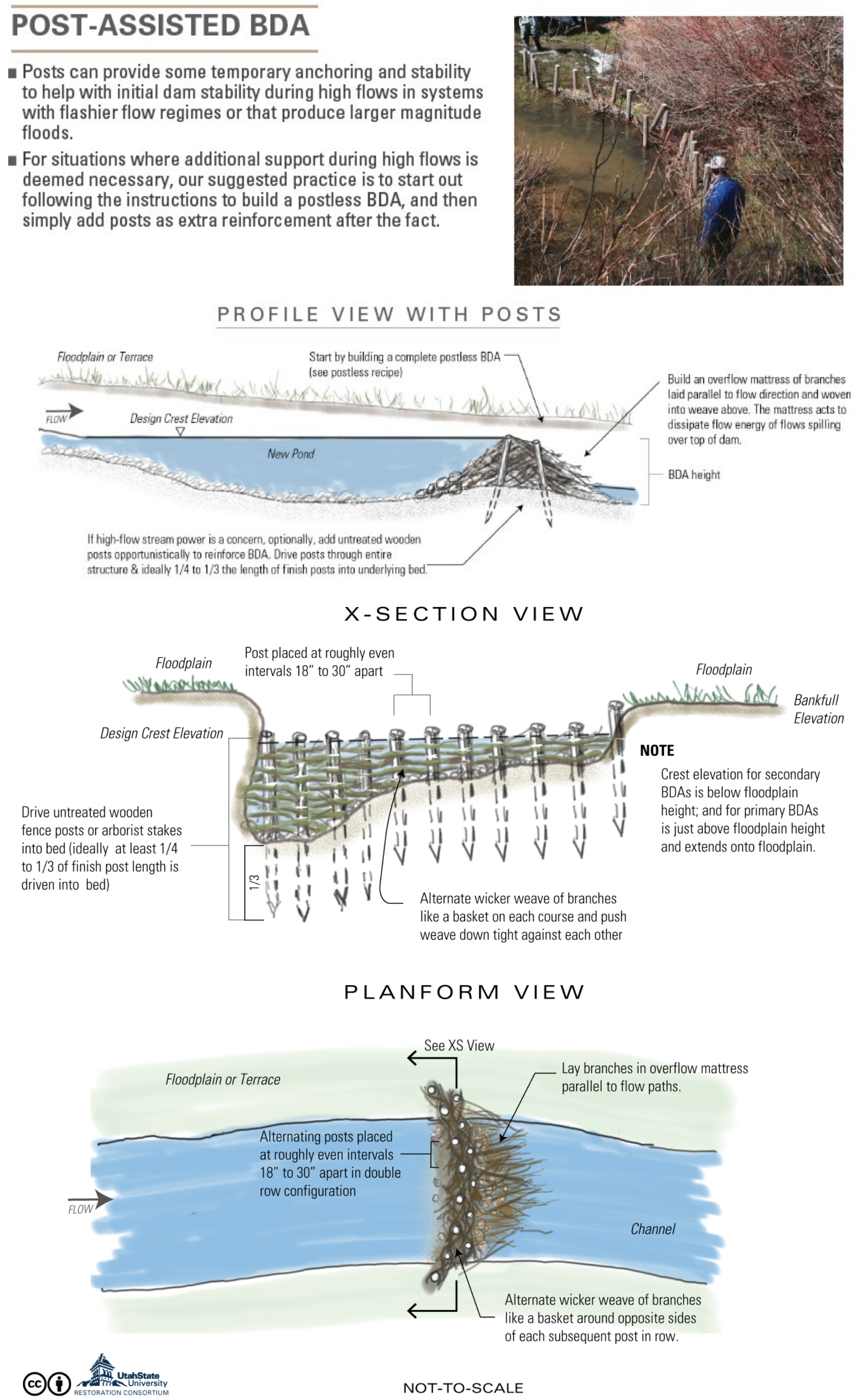

Figure 19. Profile schematic of post-assisted BDA. From Chapter 4 of Wheaton et al. (2019: http://lowtechpbr.restoration.usu.edu).

APPENDIX E - REACH OBJECTIVES

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

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 bars for spawning.
Widening and Aggradation (Incision Recovery)	Generally a goal in straightened and/or incised reaches where overbank flow is difficult.	Sediment recruitment from incision trench walls. 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.

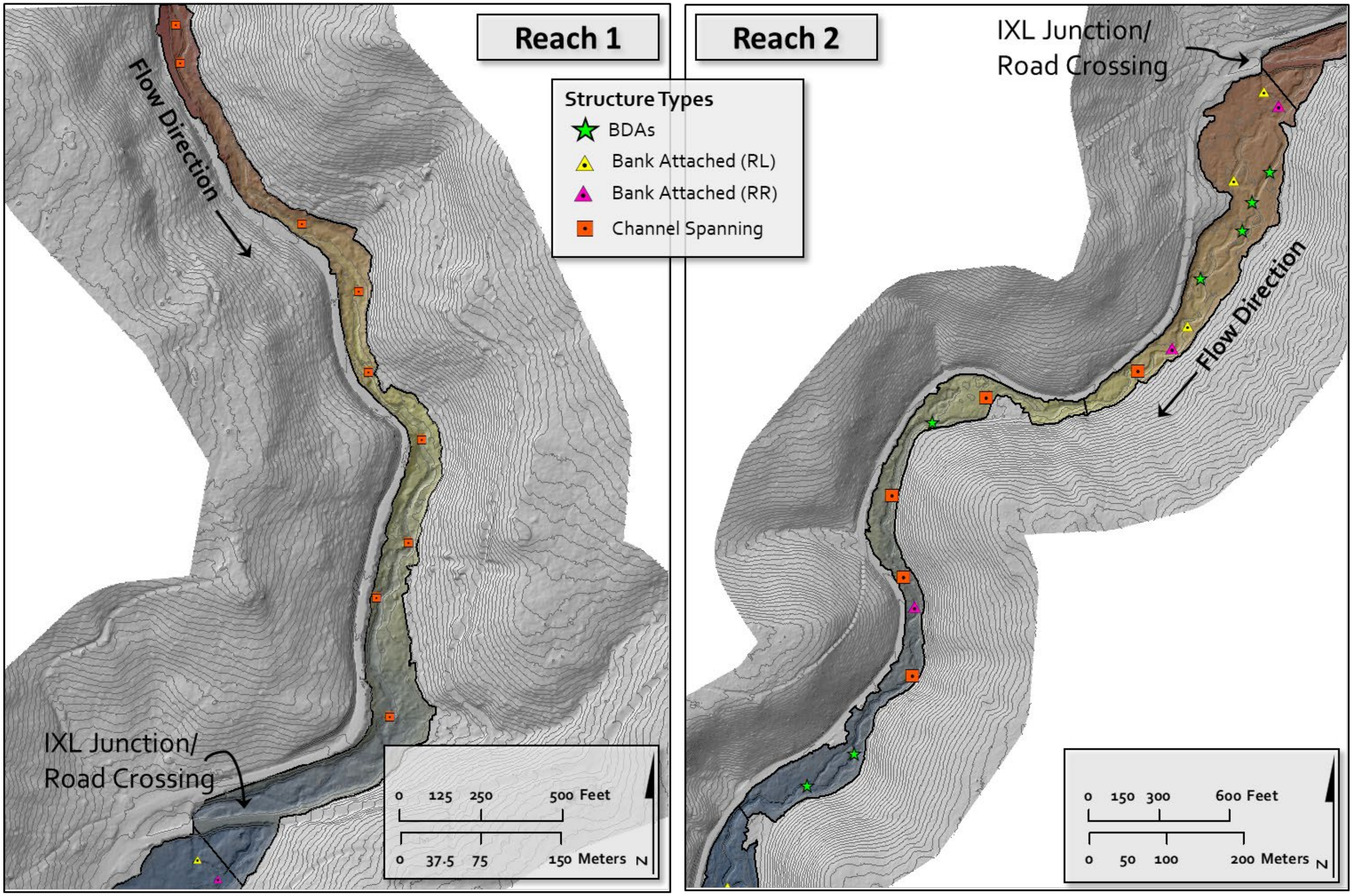

Figure 20. Restoration design outlining structure type and location for Reach 1 and 2 on middle Tepee Creek.

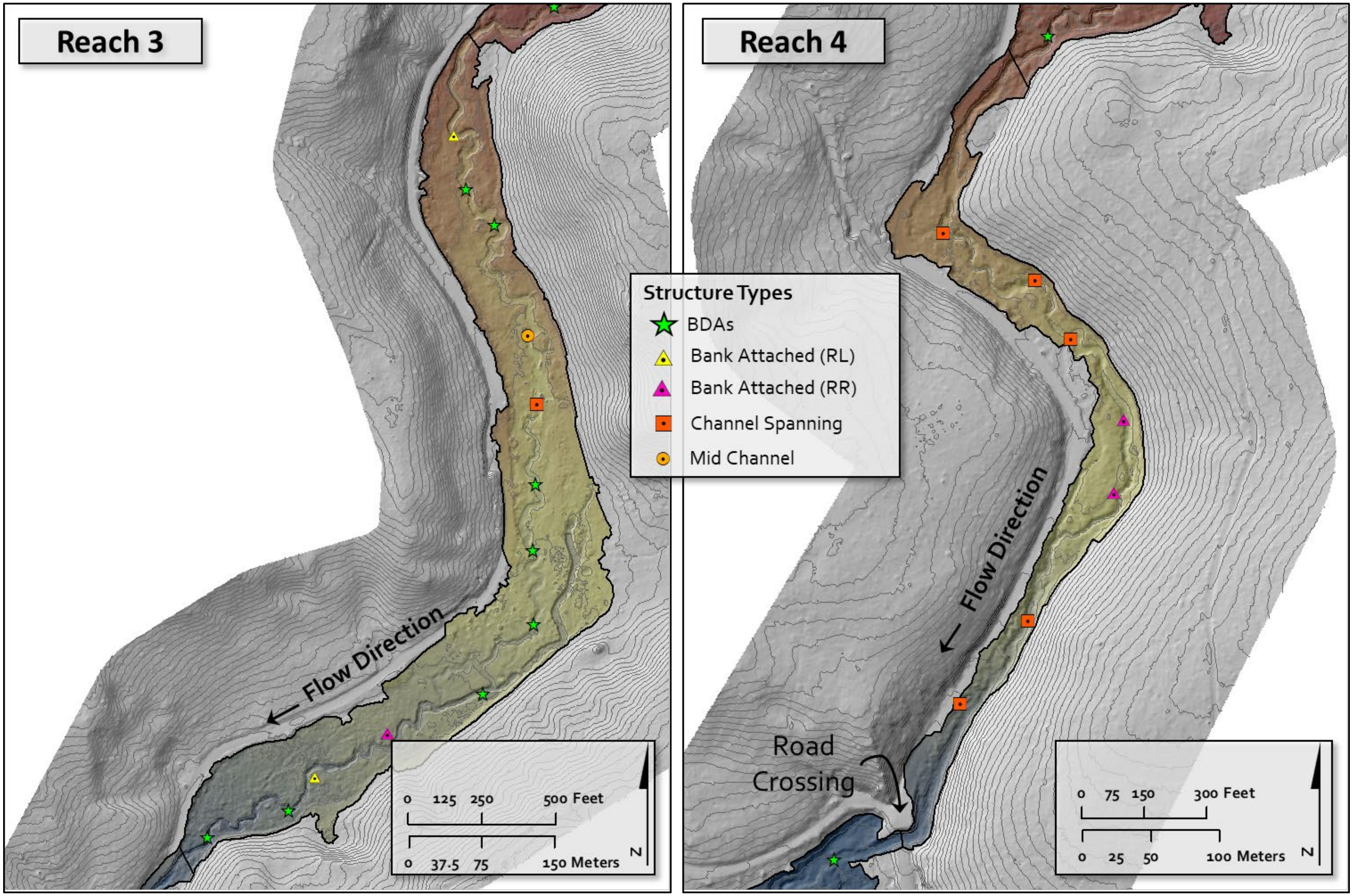

Figure 21. Restoration design outlining structure type and location for Reach 3 and 4 on middle Tepee Creek.

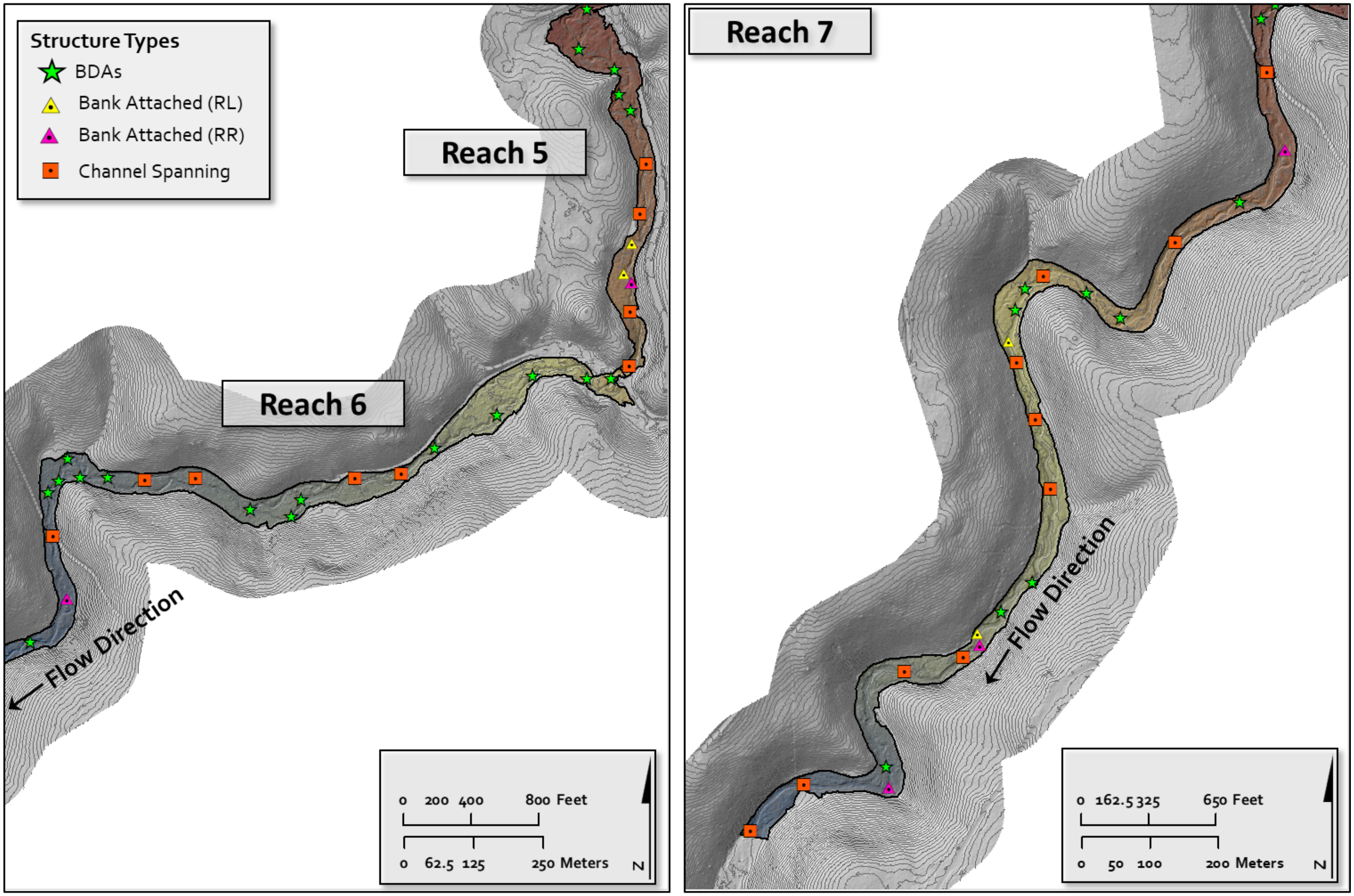

Figure 22. Restoration design outlining structure type and location for Reach 5, 6, and 7 on middle Tepee Creek.

APPENDIX G - ADAPTIVE MANAGEMENT FRAMEWORK

1. & 2. Introduction and Responsible Parties Involved

The following monitoring and adaptive management framework will be used by the Yakama Nation 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. Note that BPA coordination and EC compliance check are required for BPA funding of adaptive management or additional structures.

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.
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.
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 Yakama Nation and their contractor(s). The Yakama Nation and contractor(s) will be responsible for insuring that the design and monitoring plan is followed.

APPENDIX H - MATERIAL AND FILL ESTIMATES

The restoration structures (i.e., PALS and BDAs) are intended to be temporary fixtures on the landscape. They may be remobilized and transported or decay over time and are replaced by naturally occurring structural elements. To that end, structures will be constructed entirely of organic material and untreated wooden fence posts. Material calculations are presented here to inform material requirements for staging, assist with budget estimates for material acquisition and hauling costs, and to assist with fill estimates that might be used in permitting required for implementation.

Material estimates are provided below with respect to structure type (i.e., PALS or BDA) and for each of the three expected phases of restoration (see Temporal Design section above). Material estimates rely on the following pieces of information relevant to implementation and structure construction.

Structure Length – Linear distance of BDA and PALS are used to inform estimates of required posts and woody material.

Posts – Untreated wood fenceposts, sourced at 6-foot length and approximately 3 inches in diameter. Assumed to be installed at a density of approximately 1 post for every 2 linear feet of structure crest length.

Deciduous Woody Vegetation – Willow and alder that can be harvested on site, assumed to have an average stem diameter of 1-4 inches and average length of 6-8 feet.

Coniferous Woody Vegetation – Coniferous woody vegetation harvested primarily off-site. Three sizes of coniferous woody material were used in fill calculations:

- *Small Coniferous* – Small sized coniferous trees and large branches with a DBH of approximately 4-6 inches and length of 6-8 feet.
- *Medium Coniferous* – Medium sized coniferous trees and large branches with a DBH of approximately 8-10 inches and length of 10-12 feet.
- *Large Coniferous* – Large coniferous trees with a DBH of approximately 10-12 inches and length of 12-15 feet.
- *X-Large Coniferous* – Large coniferous trees with a DBH greater than 12 inches and greater than 15 feet in length. These trees should be harvested opportunistically on-site and be used to supplement structure material.

Table 8. Estimate for the number of individual pieces of each material type needed to construct an average sized PALS or BDAs. Material estimates include woody material, posts, and dirt/substrate fill.

Structure Type	Average Structure Length (ft.)	Pieces Per Structure				Total posts	Typical Soil/Substrate Fill Volume (yards³)
		Deciduous Woody Material (count)	Coniferous Woody Material (count)				
			Small	Medium	Large		
PALS	15	0	8	6	3	8-10	0
BDA	15	50 *or*	10	5	0	8-12	0.5

Table 8 provides an estimate of average structure length, the number of pieces from each woody material size class needed to build each structure type (e.g., PALS and BDAs), and a post estimate. Structure estimates were then used to develop a total estimate of required fill material and counts of material types for the first phase of restoration implementation (Table 9).

Table 9. Woody material and fill estimates expected for the first phase of restoration implementation. Separate estimates are listed for number of required posts, as well as individual pieces of deciduous and coniferous material that will largely be transported to the project site.

Phase	Type	Estimated Structure Count	Deciduous Woody Material (count)		Coniferous Woody Material (count)			Posts	Total Soil/Substrate Fill (yards^3)
					Small	Medium	Large		
1	PALS	100	0		800	600	300	1000	0
	BDAs	50	2500	*or*	500	250	0	600	25

APPENDIX I - FUELING/EQUIPMENT STORAGE AND STAGING AREA MAPS

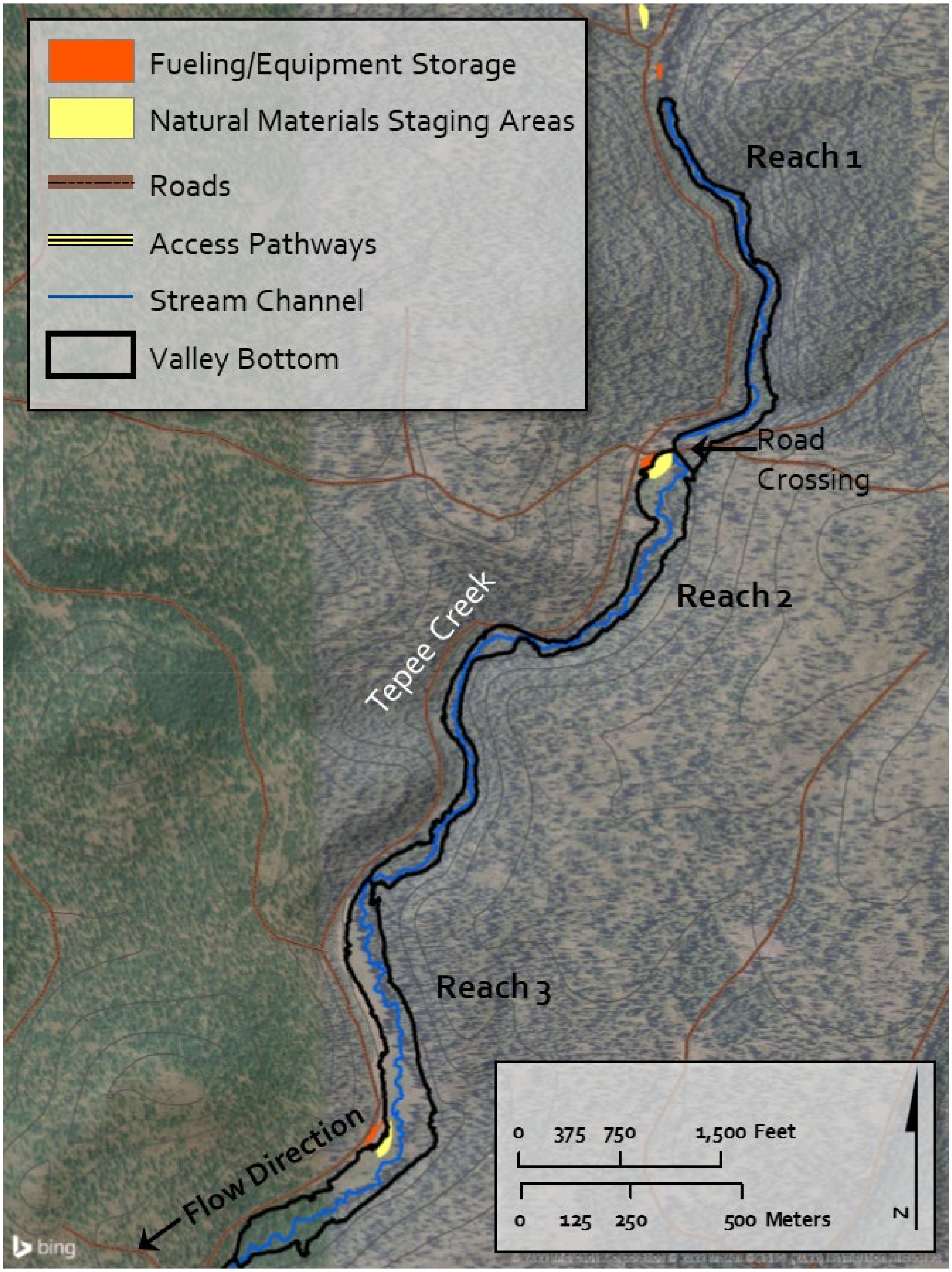

Figure 23. Fueling/equipment storage areas, natural materials staging areas, and roads/access pathways for Reaches 1, 2, and-3 on Tepee Creek.

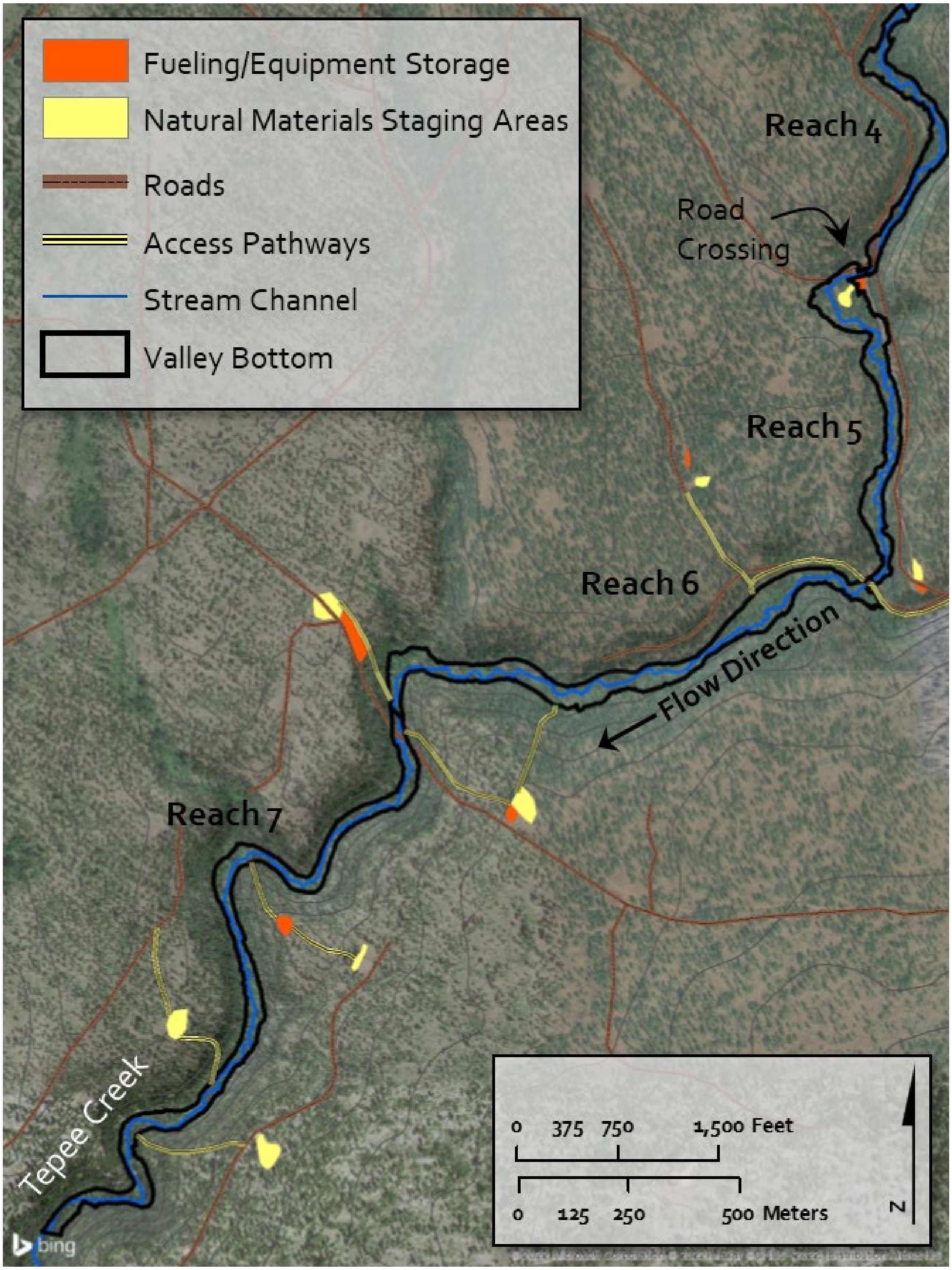

Figure 24. Fueling/equipment storage areas, natural materials staging areas, and roads/access pathways for Reach 5, 6, and 7 on Tepee Creek.

APPENDIX J - 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.

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 1 of 3

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).

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APPENDIX K - 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 2:1 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.

APPENDIX L - NORTHERN SPOTTED OWL CONSERVATION MEASURES

1) To reduce adverse effects to NSO, projects will not occur during the critical breeding period, typically March 1 through July 15, but may vary by location. Timing can be locally revised based on current information available from the appropriate USFWS field office. Projects should be delayed until after the critical breeding season (unless action involves Type I helicopters, which extends the critical nesting window to September 30), or it is determined that young are not present.

2) The USFWS wildlife biologist may extend the restricted season based on site-specific information (e.g., a late or recycled nesting attempt).

3) Table 10 shows disruption distances applicable to the equipment. These distances can be locally altered based on current information and concurred with by appropriate USFWS official.

Table 10. Disturbance, disruption (harass) and/or physical injury (harm) distance thresholds for NSO. Distances are to a known occupied NSO nest tree or suitable nest trees in unsurveyed habitat.

Project Activity	No Effect (Mar 1 – Sep 30)	NLAA **"may affect" disturbance distance** (Mar 1 – Sep 30)	LAA – Harass **early nesting season disruption distance** (Mar 1–Jul 15[11])	LAA – Harass **late nesting season disruption distance** (Jul 16[11]–Sep 30)	LAA – Harm **direct injury and/or mortality** (Mar 1 – Sep 30)
Light maintenance (e.g., road brushing and grading) and heavily-used roads	>0.25 mile	≤ 0.25 mile	NA[1]	NA	NA
Log hauling on heavily-used roads (FS maintenance levels 3, 4, and 5)	>0.25 mile	≤ 0.25 mile	NA[1]	NA	NA
Chainsaws (includes felling hazard/danger trees)	>0.25 mile -	66 yards to 0.25 mile -	≤ 65 yards[2]	NA	NA
Heavy equipment for road construction, road repairs, bridge construction, culvert replacements, piling removal, etc.	>0.25 mile	66 yards to 0.25 mile	≤ 65 yards[2]	NA	NA
Helicopter: Chinook 47d	>0.5 mile	266 yards to 0.5 mile	≤ 265 yards[3]	≤ 100 yards[4] (hovering only)	NA
Helicopter: Boeing Vertol 107, Sikorsky S-64 (SkyCrane)	>0.25 mile	151 yards to 0.25 mile	≤ 150 yards[5]	≤ 50 yards[4] (hovering only)	NA
Helicopters: K-MAX, Bell 206 L4, Hughes 500	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards[6]	≤ 50 yards[4] (hovering only)	NA

1. NA = not applicable. Based on information presented in Temple and Guttiérez (2003, p. 700), Delaney et al. (1999, p. 69), and Kerns and Allwardt (1992, p. 9), we anticipate that spotted owls that select nest sites in close proximity to open roads either are undisturbed by or habituate to the normal range of sounds and activities associated with these roads.

2. Based on Delaney et al. (1999, p. 67) which indicates that spotted owl flush responses to above-ambient equipment sound levels and associated activities are most likely to occur at a distance of 65 yards (60 m) or less.
3. Based on an estimated 92 dBA sound-contour (approximately 265 yards) from sound data for the Chinook 47d presented in Newman et al. (1984, Table D.1).
4. Rotor-wash from large helicopters is expected to be disruptive at any time during the nesting season due the potential for flying debris and shaking of trees located directly under a hovering helicopter. The hovering rotor-wash distance for the Chinook 47d is based on a 300-ft radius rotor-wash zone for large helicopters hovering at < 500 above ground level (from WCB 2005, p. 2 – logging safety guidelines). We reduced the hovering helicopter rotor-wash zone to a 50-yard radius for all other helicopters based on the smaller rotor-span for all other ships.
5. Based on an estimated 92 dBA sound contour from sound data for the Boeing Vertol 107 the presented in the San Dimas Helicopter Logging Noise Report (USFS 2008, chapters 5, 6).
6. The estimated 92 dBA sound contours for these helicopters is less than 110 yards (e.g., K-MAX (100 feet) (USFS 2008, chapters 5, 6), and Bell 206 (85-89 dbA at 100 m)(Grubb et al. 2010, p. 1277).

4) No hovering or lifting within 500 feet of the ground within occupied spotted owl habitat during the critical breeding season by ICS Type I or II helicopters would occur as part of any proposed action addressed by the programmatic consultation.

5) Tree Removal for Large Wood Projects. The following Conservation Measures apply to tree removal within the range of NSO.

a. Forested stands less than 80 years old that are not functioning as foraging habitat within a NSO home range

i. This section does not apply to tree selection in older stands or hardwood-dominated stands unless stated otherwise.

ii. A wildlife biologist must be fully involved in all tree-removal planning efforts and be involved in making decisions on whether individual trees are suitable for nesting or have other important documented bird habitat values.

iii. Outside of one site-potential tree height from streams , trees can be removed to a level not less than a relative density (RD) of approximately 35 (stand scale), which is considered as fully occupying a site. This equates to approximately 60 trees per acre in the overstory and a tree spacing averaging 26 feet. Additionally, 40% canopy cover would be maintained when in NSO critical habitat, or when dispersal habitat for NSO is limited in the area.

iv. Tree species removed should be relatively common in the stand (i.e., not "minor" tree species).

v. Snags and trees with broad deep crowns ("wolf" trees), damaged tops or other abnormalities that may provide a valuable wildlife habitat component shall not be removed.

vi. No gaps (openings) greater than 0.5 acre will be created in northern spotted owl critical habitat. No gaps greater than ¼ acre will be created in marbled murrelet critical habitat.

b. Forested stands greater than 80 years old, or stands that are functioning as foraging habitat within NSO home range

i. Individual trees or small groups of trees should come from the periphery of permanent openings (e.g., roads) or from the periphery of non-permanent openings (e.g., plantations, along recent clear-cuts, etc.).

ii. A minimum distance of one site-potential tree height should be maintained between individual or group removals.

iii. No known NSO nest trees or alternate nest trees are to be removed, including historical nest sites. Potential NSO nest trees may only be removed in limited instances when it is confirmed with the USFWS wildlife biologist that nest trees will not be limited in the stand after removal.

iv. When within either NSO critical habitat, stands greater than 80 years old providing suitable habitat, or within stands providing foraging habitat to NSO home ranges , gaps will be restricted to 1/2 acre openings or less.