

JANUARY 2021

# UPPER THIRTYMILE CREEK RIVERSCAPE RESTORATION PLAN

LOW – TECH  
PROCESS – BASED  
RESTORATION

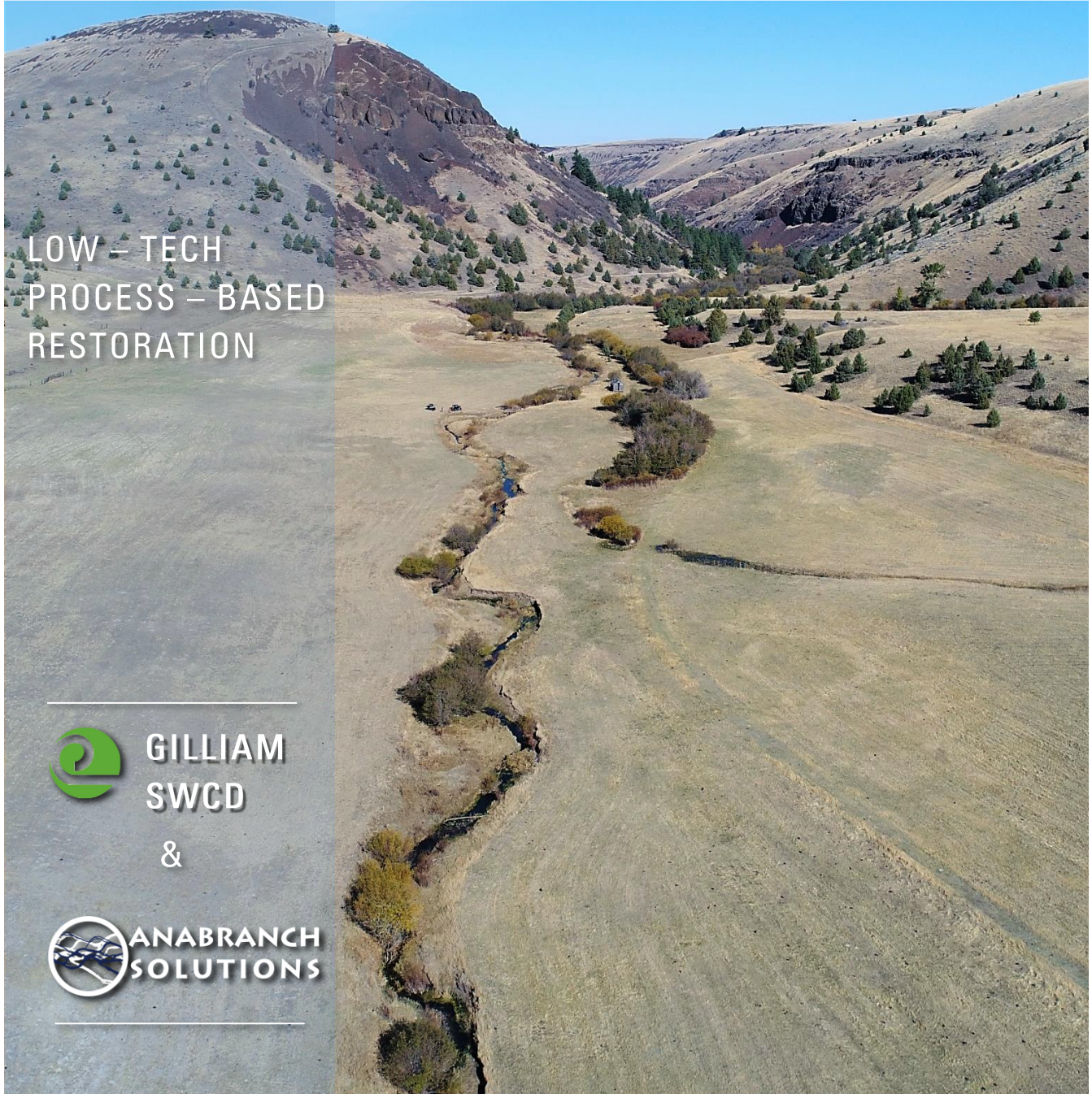


GILLIAM  
SWCD

&



ANABRANCH  
SOLUTIONS





# UPPER THRITYMILE CREEK

LOW – TECH PROCESS – BASED RESTORATION

PLANNING AND DESIGN REPORT

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**PREPARED BY**

ANABRANCH SOLUTIONS

BEND, OR

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**IN COLLABORATION WITH**

GILLIAM SOIL AND WATER CONSERVATION DISTRICT

CONDON, OR.

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*VIEW OF THE PROJECT AREA ON THIRTYMILE CREEK DEPICTING THE HIGHLY SIMPLIFIED AND STRUCTURALLY STARVED CHANNEL. THIS SECTION AT THE UPSTREAM END OF THE PROJECT AREA OFFERS AN EXTENSIVE AMOUNT OF SPACE FOR EXPANSION OF AQUATIC HABITAT. PHOTO TAKEN DURING THE FALL OF 2020 PRIOR TO RIPARIAN AND CHANNEL RESTORATION ACTIONS SCHEDULED TO BEGIN IN 2023.*

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## PROJECT SUMMARY

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The following document describes a low – tech process – based riverscape restoration (LTPBR, see [Wheaton et al. 2019](#)) plan for approximately 5.7 miles of mainstem habitat within the Thirtymile Creek watershed. The restoration plan is designed to promote natural fluvial processes and ultimately result in development of a healthy and dynamic aquatic ecosystem with greater habitat quality and quantity for the threatened steelhead population that rely on the watershed for spawning and rearing (NWPC 2005).

The design document details a structural treatment plan consisting of *ca.* 325 restoration structures that mimic large woody debris accumulations (i.e., post-assisted log structures, PALS) and beaver dams (beaver dam analogs, BDAs). The restoration plan also recommends a set of complementary restoration actions intended to promote beneficial geomorphic, vegetative, and hydrologic processes over a 5 – 10-year period at which point these processes may be expected to become self-sustaining ([Beechie et al. 2010](#)). During this period, this planning and design document should be relied upon to support acquisition of additional implementation funding, prepare and acquire permits, document restoration effectiveness, and/or support other implementational components that may allow riverscape restoration to proceed. This restoration plan includes the following sections:

- Section [1 Project Introduction and Scope](#) provides a high-level introduction to the Thirtymile Creek watershed within the context of regional and local management goals.

- Section [2](#) presents an assessment of [Project Area Resources and Recovery Potential](#) that were used to inform development of baseline indicators of riverscape health and help to set reasonable expectations and timelines for recovery of riverscape processes.
- Section [3](#) extends sections [1](#) & [2](#) into a clear articulation of [Project Goals and Objectives](#), complete with a series of indicator metrics that can be used to rapidly evaluate restoration progress and effectiveness.
- Section [4](#) describes the temporal and spatial [Restoration Design](#), and includes specifications for BDA structure types, placement, and expected function.
- Section [5](#) on [Implementation](#) covers practical components of project implementation, as well as best management practices that help to minimize adverse impacts to sensitive vegetation, wildlife, and human infrastructure.
- Several [Appendices](#) also contain supplementary resources including site – specific plans for the first phase of structural treatments, and a description of spatial data products developed during the restoration design process.

#### **ACKNOWLEDGEMENTS**

The restoration plan was developed by Anabran Solutions, LLC. in collaboration with the Gilliam County Soil and Water Conservation District. Multiple private landowners in the Upper Thirtymile Watershed have provided the opportunity for this restoration action on their land. Funding for the planning and design development process was provided by the Confederated Tribes of Warm Springs.

*January 2021*

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# 1 PROJECT INTRODUCTION AND SCOPE

Thirtymile Creek flows for approximately 30 miles from its headwaters near Fossil, OR to its confluence with the John Day River at river mile 83. The 272 mi.<sup>2</sup> watershed encompasses mostly private agricultural and rangelands within Gilliam County (Figure 1). The project area falls across six parcels of private lands and five different landowners and will focus on approximately 5.7 miles of Thirtymile Creek, just downstream of its confluence with Elbow Canyon.

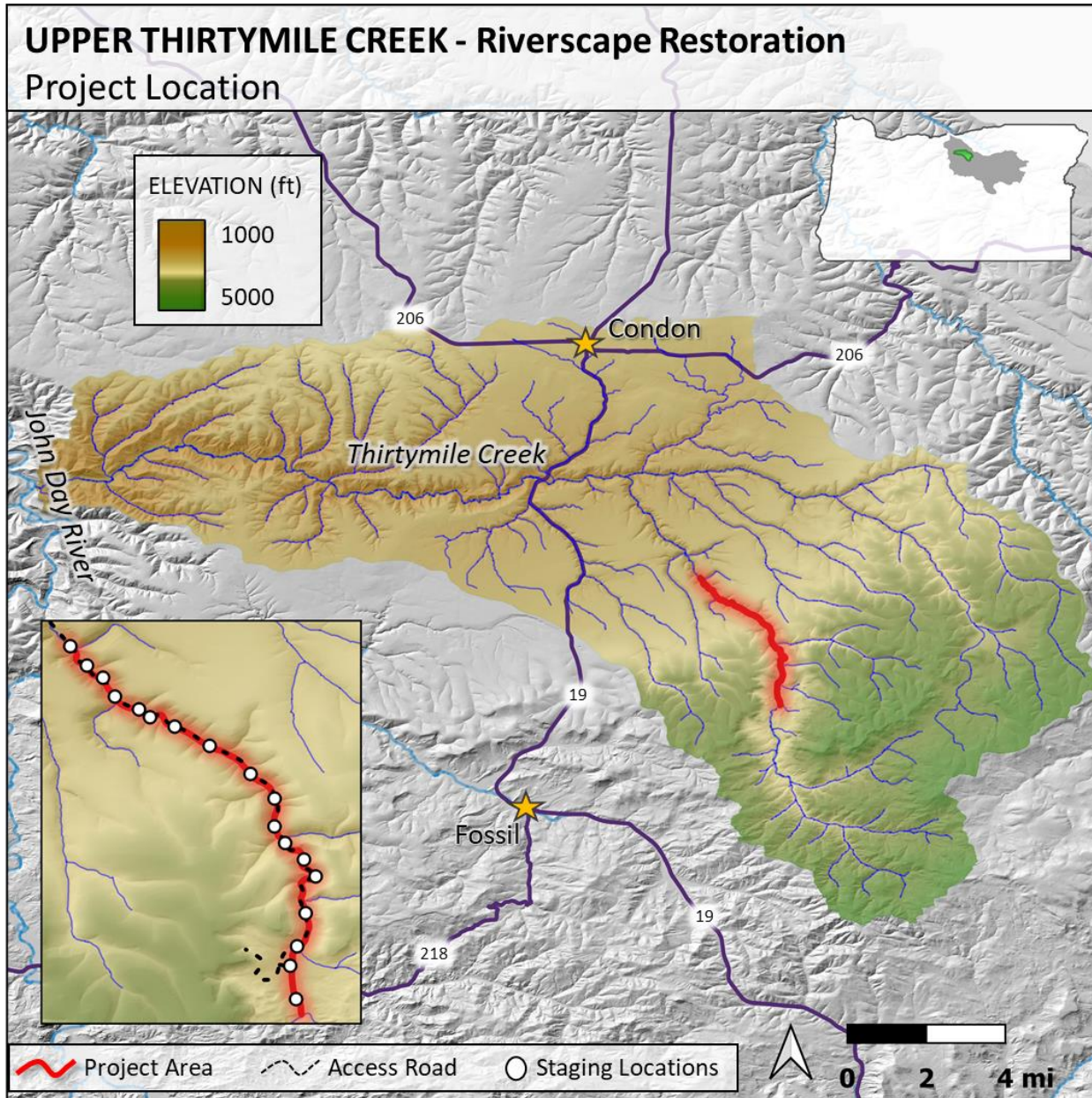


FIGURE 1. LOCATION OF THE THIRTYMILE CREEK SUB-WATERSHED WITHIN THE GREATER JOHN DAY WATERSHED. THE RESTORATION PROJECT AREA SPANS APPROXIMATELY 5.7. MILES IN THE UPPER REACHES OF THIRTYMILE CREEK.

## 1.1 REGIONAL MANAGEMENT CONTEXT

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Broad management goals for the Thirtymile Creek watershed are linked to federal recovery planning for Mid-Columbia steelhead listed as threatened under the Endangered Species Act (NWPC 2005). The ecologically distinct Lower John Day steelhead population depend on tributary habitat within Thirtymile Creek for spawning and rearing. Federal recovery planning for Columbia Basin salmonid populations listed under the ESA have specifically listed tributary habitat quantity and quality as a primary factor limiting their population productivity (NMPS 2009).

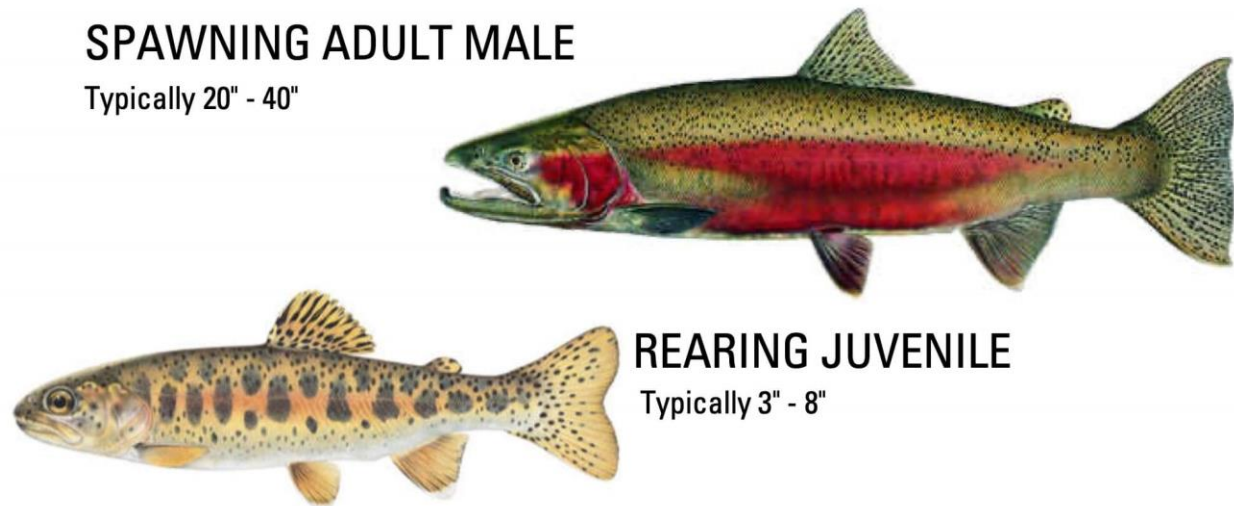


FIGURE 2. ARTIST RENDITION (CREDIT JOSEPH TOMELLERRI) DEPICTING TWO LIFE-STAGES OF STEELHEAD THAT UTILIZE TRIBUTARY HABITAT WITHIN THE THIRTYMILE CREEK WATERSHED. ADULTS RETURN TO SPAWN IN LATE WINTER AND SPRING. JUVENILE STEELHEAD TYPICALLY REAR WITHIN THE THIRTYMILE CREEK WATERSHED FOR BETWEEN 1 AND 3 YEARS PRIOR TO MIGRATION TO THE OCEAN VIA THE JOHN DAY AND COLUMBIA RIVER.

### 1.1.1 LOCAL MANAGEMENT GOALS

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Thirtymile Creek and its tributaries provide critical spawning and rearing habitat for Mid-Columbia River steelhead (NWPC 2005). However, Thirtymile suffers from several geomorphic and hydrologic impairments that reduce both the quantity and quality of habitat available to this threatened population ([Figure 3](#)). Specific habitat impairments include:

- **EPIHEMERALLY LOW AND/OR INTERMITTENT SURFACE FLOW** - Much of the main channel on Thirtymile Creek is subject to low and intermittent surface flow during late summer and fall (i.e., June – Nov.), a period critical to the survival of rearing juvenile steelhead.
- **HIGH SURFACE WATER TEMPERATURE** – Low or non-existent surface flow also contributes to high summer stream temperatures that further reduce habitat quantity and quality during this critical rearing period.
- **LACK OF CHANNEL COMPLEXITY** – Structural starvation (i.e., lack of woody debris and beaver dams) and channel straightening has resulted in hydraulic, topographic, and substrate homogeneity that offers little benefit to threatened salmonids.

These impairments ultimately render the Thirtymile Creek watershed a population sink for threatened steelhead, in which a high number of spawning adults produce few surviving juveniles. Seasonal surface flow limits the establishment and expansion of riparian and wetland vegetation within the Thirtymile Creek riverscape. Not surprisingly, the John Day Subbasin Plan (NWPC 2005) has specifically listed flow restoration, riparian vegetation recovery, and enhancement of channel habitat quantity and quality as being high priorities for recovery of the lower John Day Steelhead population.

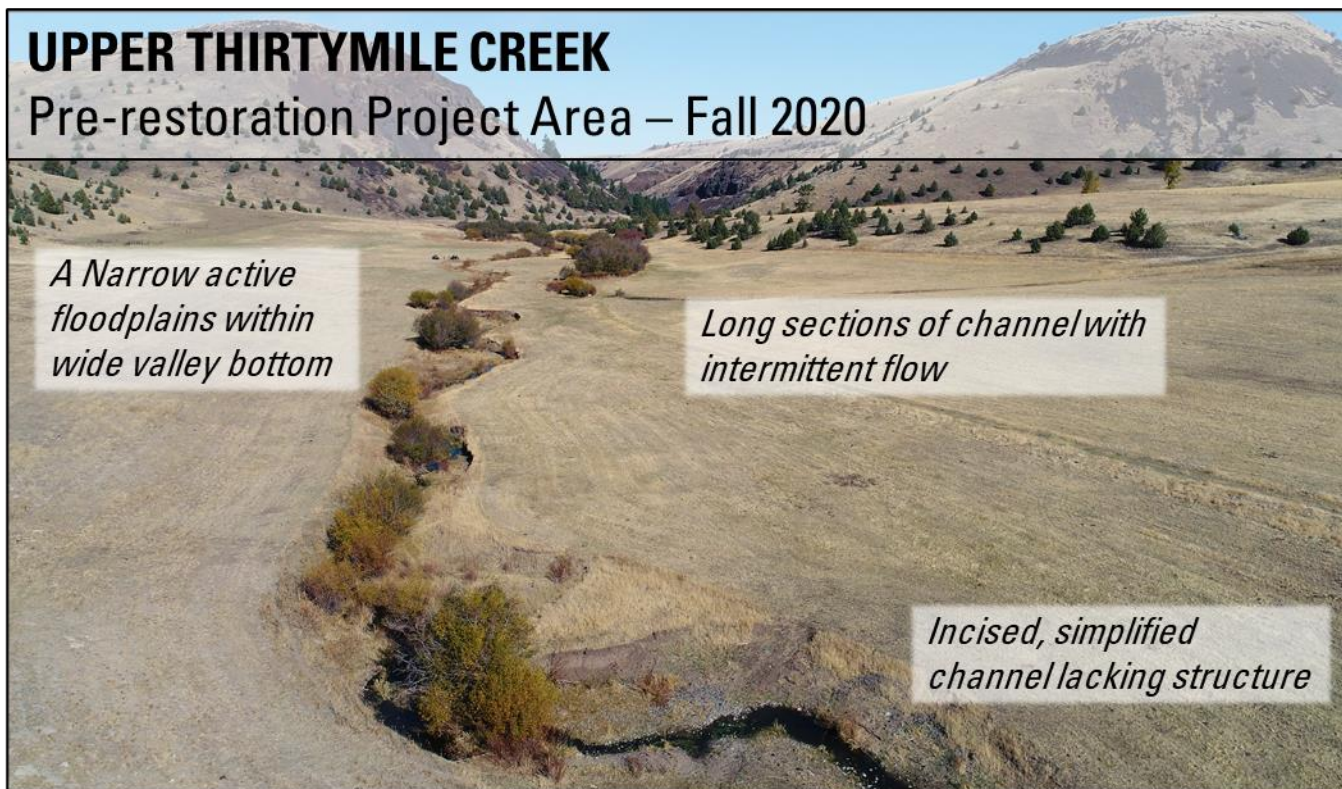


FIGURE 3. PHOTO CAPTURED DURING FALL OF 2020 SHOWING HABITAT CONDITIONS WITHIN THE PROJECT AREA ON THIRTYMILE CREEK.

The current hydrologic (seasonally reduced and/or ephemeral surface flow), geomorphic (incision and floodplain disconnection), biological (lack of riparian vegetation), and ecological (low habitat quality and quantity) condition found within the Upper Thirtymile Creek project area is the combined result of historic human induced impacts that intensive grazing, intensive agriculture, the eradication of beaver, and channel confinement from an abandoned railroad bed. Historic intensive upland grazing has decreased the duration of surface runoff and the infiltration of precipitation critical to groundwater recharge. This legacy of over-grazing has also resulted in reduction of riparian vegetation that has been slow to reestablish on degraded streams such as Thirtymile Creek where water table elevations have decreased and baseflow discharge is often low and ephemerally intermittent (Figure 3). Many portions of Thirtymile Creek have also been channelized, straightened, and realigned to valley margins to by the construction of the Condon to Kinzua Railroad that operated from 1927-1977. These historic stream alterations have resulted in low habitat diversity and a paucity of structural elements (e.g., woody debris) that are an integral component of healthy - functioning riverscapes (NWPC 2005).

Recognizing these impairments, management goals within Thirtymile Creek are being developed to influence geomorphic, hydrologic, and biological processes that provide immediate and long – term habitat benefits for

the threatened steelhead that utilize Thirtymile Creek and its tributaries. The structural restoration will be designed to attenuate high flow runoff by increasing surface water residence time and groundwater storage and release, while also increasing in-channel habitat complexity. The proposed restoration intervention will have positive impacts within the project area in the form of enhanced aquatic and wetland ecosystem services and increasing habitat quantity and quality for the threatened steelhead.

## 1.2 RESTORATION DESIGN APPROACH

The Thirtymile Creek riverscape restoration design follows planning, implementation, and project management guidelines identified by the Natural Resources Conservation Service’s (NRCS) [Conservation Planning Process](#). This planning and design document is primarily concerned with elements described in phase 1 of the planning process. The planning process has also been adapted to include components specific to riverscape restoration that are consistent with Low – Tech Process – Based Restoration designs and practices ([Wheaton et al. 2019, Figure 4](#)).

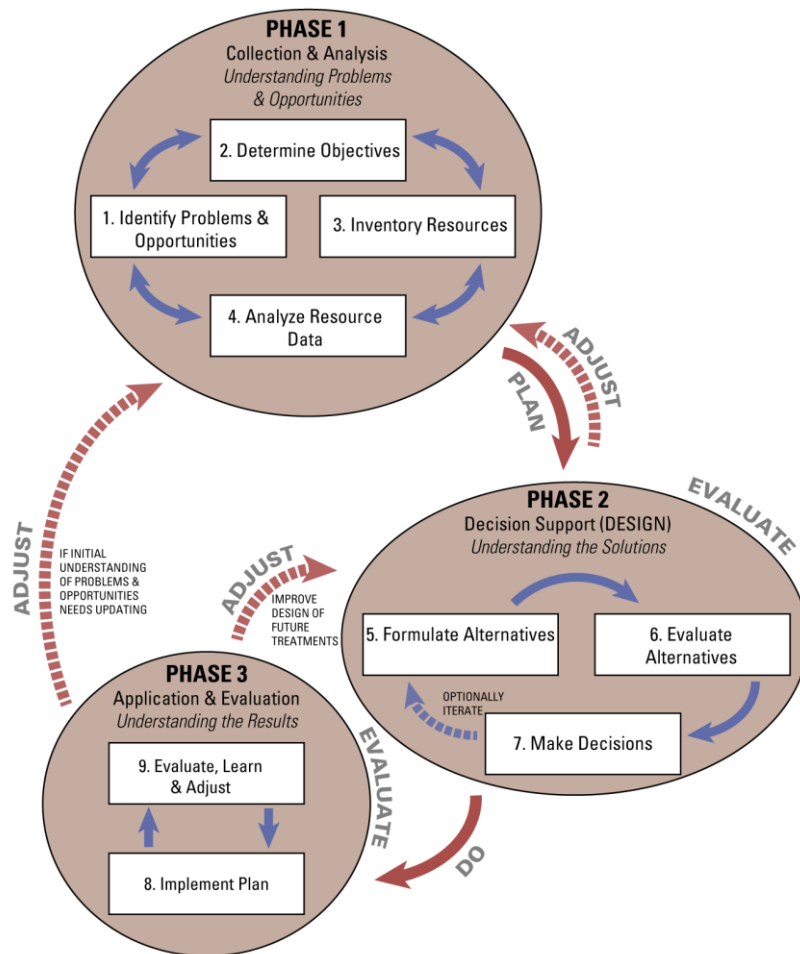


FIGURE 4. OUTLINE DEPICTING THE NATURAL RESOURCES CONSERVATION SERVICE’S CONSERVATION PLANNING PROCESS WHICH HAS BEEN ADAPTED HERE TO GUIDE THE THIRTYMILE CREEK RESTORATION PLANNING AND DESIGN PROCESS.

### 1.2.1 LOW – TECH PROCESS – BASED RESTORATION

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LTPBR practices utilize simple, cost-effective, hand-built structures that mimic beaver dams (i.e., beaver dam analogs, or BDAs) and wood accumulations (i.e., post-assisted log structures, or PALS); structural elements that occur in abundance within intact – functioning stream systems. Within an LTPBR design, structural elements are strategically introduced to the river system in a design intended to amplify natural hydrologic, geomorphic, and biological processes that accelerate the recovery trajectory of degraded streams. Unlike more traditional practices that rely on engineering plans and heavy construction equipment (e.g., excavators) to impose channel and floodplain restoration designs, LTPBR ultimately defers design decisions to the characteristics of and limitations set by individual riverscapes. Reducing design and implementation costs and allowing natural stream processes to do much of the restoration “work” minimizes economic and ecological risks associated with stream restoration and renders LTPBR a practice capable of scaling to stream degradation over large spatial extents.

### 1.2.2 ALTERNATIVE RESTORATION APPROACHES

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Several alternative channel and floodplain restoration approaches have been considered for riverscape recovery within the Upper Thirtymile Creek project area. These alternative designs are characteristic of traditional engineered channel restoration plans that involve valley bottom regrading and channel realignment. As these types of invasive restoration actions result in extensive ground disturbance, major revegetation planting treatments were also considered as integral components to this approach. Given the large spatial extent of the project area (5.7 mi. of stream), the design, permitting, and implementational costs associated with heavily engineered restoration planning were determined unfeasible. Additionally, the cost of complete revegetation treatments that follow valley bottom regrading were also prohibitive in this context. Because of these factors, the LTPBR approach emerged as the preferred design alternative within the current Upper Thirtymile Creek project area. This decision was also supported by several project area characteristics that are ideally for successful LTPBR planning and effectiveness, including:

- *Site suitability* – The climatic, topographic, and hydrologic catchment conditions within Thirtymile Creek support reliable flood events, the presence and suitability for beaver dam building, and a high potential for proliferation and accumulation of woody riparian vegetation.
- *Lack of human infrastructure* – Treatment locations within the project area present little to no human infrastructure such as houses, outbuildings, or equipment. This characteristic of the project area offers a high – potential for expansion of the active channel and floodplain while posing little economic risk. Because of this, more detailed engineering plans or expensive hydraulic model predictions are not required for the design and implementation of a successful restoration plan capable of meeting project goals and objectives.

### 1.2.3 COMPLEMENTARY RIVERSCAPE RESTORATION PRIORITIES

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Low – Tech Process – Based restoration is intended to first *mimic*, then *promote*, and finally *sustain* key geomorphic and biological processes that ultimately lead to healthy and dynamic fluvial systems (See [Wheaton et al. 2019](#)). These processes include the dam building of beavers and accumulations of woody vegetation. In this case, the structural treatment component of the riverscape restoration efforts within the Upper Thirtymile Creek project area are *mimicking* the dam building activity of beaver, and several complementary restoration actions should be considered that will be essential to *promoting* and eventually *sustaining* riverscape processes:

**GRAZING MANAGEMENT** – A structured grazing management plan that limits the duration and extent of cattle grazing within the valley bottom will also be essential to the establishment of riparian and wetland vegetation. A grazing management plan is already in place through much of the project area where access exclusion limits the grazing adjacent to the channel to a few discrete locations.

**RIPARIAN VEGETATION TREATMENTS** – The ability to support beaver, and to recruit woody vegetation as structural elements will depend on establishment of woody riparian vegetation. The structural treatments will support increased survival and expansion of riparian vegetation treatments within the valley bottom.



FIGURE 5. CONCEPTUAL DIAGRAM OF KEY COMPONENTS AND MANAGEMENT ACTIONS THAT SHOULD BE CONSIDERED AS PART OF A LONG – TERM PROCESS – BASED RIVERSCAPE RESTORATION PROJECT.

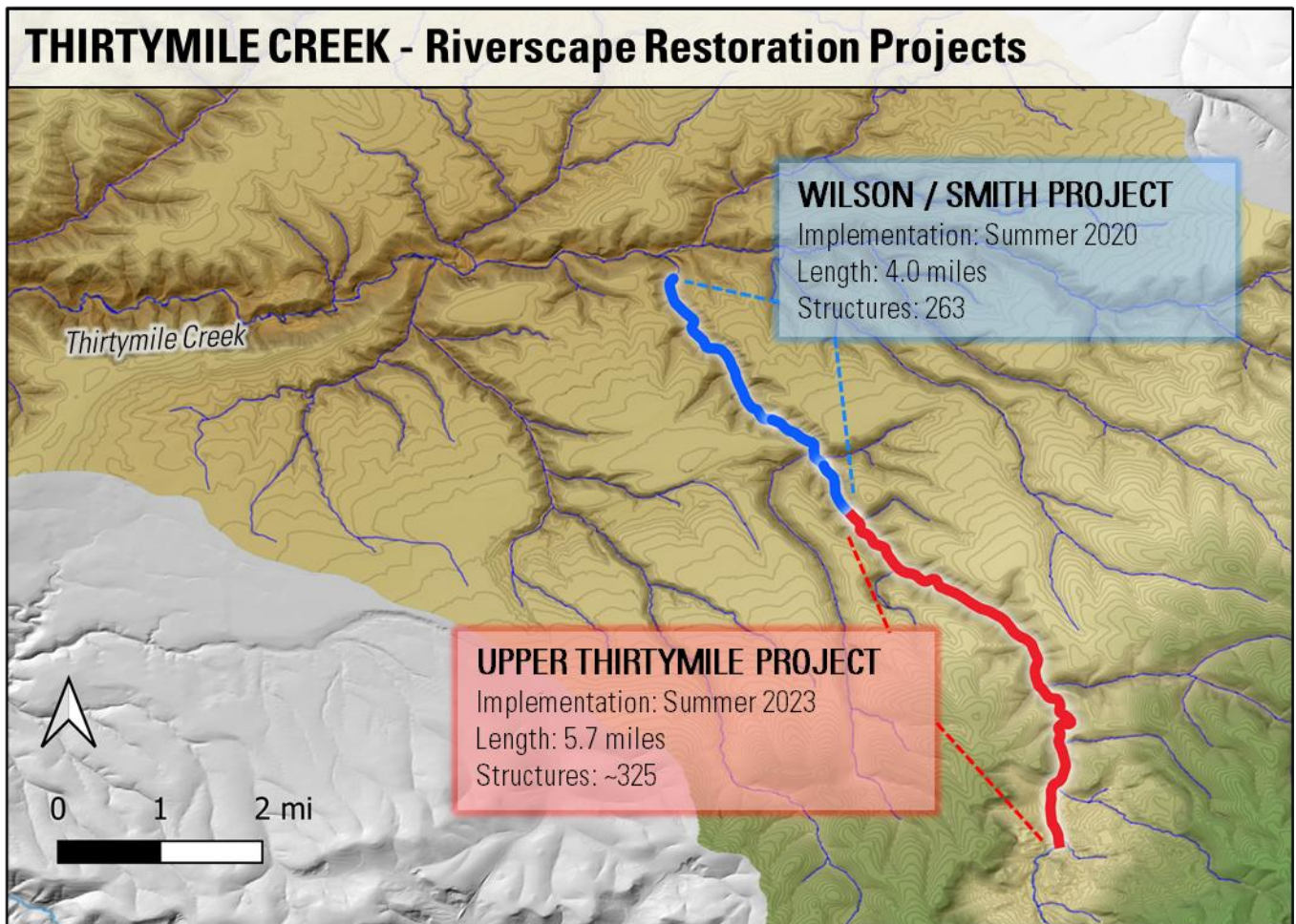


FIGURE 6. LOCATIONS OF THE WILSON / SMITH LTPBR RESTORATION PROJECT AND THE UPPER THIRTYMILE LTPBR RESTORATION PROJECT WITHIN THE CONTEXT OF THE THIRTYMILE CREEK WATERSHED.

The Thirtymile Creek watershed has been targeted for extensive restoration and recovery actions as part of the Oregon Watershed Enhancement Board’s [John Day focused investment partnership \(FIP\)](#). To date, a similar restoration plan was implemented in the Summer of 2020 on a section of Thirtymile Creek directly downstream of the Upper Thirtymile Creek project area. The Wilson / Smith LTPBR Project consisted of 263 PAL and BDA structures distributed over 4 miles of tributary habitat (Figure 6). The project was implemented by the Gilliam County Soil and Water Conservation District during the summer of 2020 (Figure 7).





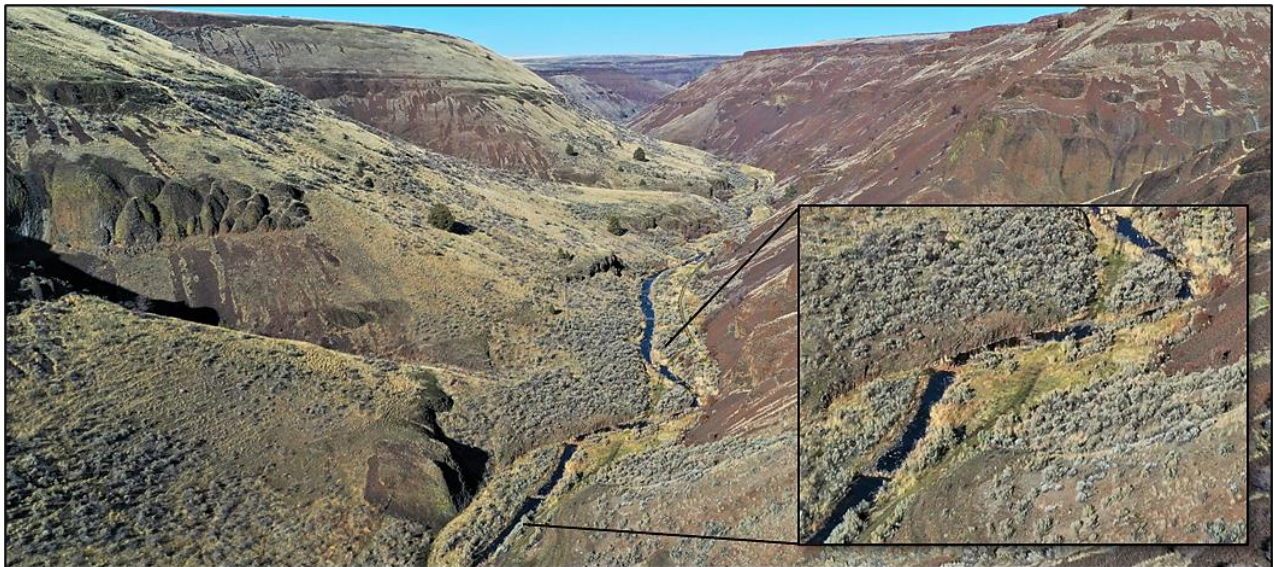
FIGURE 7. JT HAND AND KYLE HAND INSTALL SUPPORTING POSTS TO A NEWLY INSTALLED PALS IN THE LOWER SMITH REACH OF THE THIRTYMILE – WILSON / SMITH LT-PBR PROJECT.

Lessons learned from the Wilson / Smith LTPBR project will be directly applicable to the implementation and management of this design (i.e., Upper Thirtymile section). This experience will contribute to the design of individual structures and sets of structures as well as construction efficiencies by informing:

- **CHOICE OF BUILDING MATERIAL** – Sagebrush has proven to be an effective source of vegetation fill material for LTPBR structures, especially within the construction of BDAs (Figure 8). Alder trunks are also effective for rapid harvest and construction of PALS within incised and heavily vegetated sections.
- **SURFACE FLOW EXPANSION** – Priority will be placed on intermittent sections that still contain surface flow at the start of the instream work window (July 15<sup>th</sup>). Building in flowing sections of channel allows construction crews to adapt structure designs (i.e., types and amount of fill material) that more effectively induce ponding during low – flow.
- **STAGE SPECIFIC STRUCTURE FUNCTION** – Monitoring of structure function at different flow stages (Figure 9) will allow further refinement of structure and structure complex designs for meeting specific objectives (i.e., erosion vs. overbank flow dispersal and floodplain connectivity).



*FIGURE 8. A SERIES OF BDAs CONSTRUCTED FROM LOCALLY HARVESTED SAGEBRUSH AT THE UPPER EXTENT OF THE WILSON / SMITH LT-PBR PROJECT. MUCH OF STRUCTURE CONSTRUCTION WAS DONE DURING DROUGHT PERIODS WHERE SURFACE FLOW WAS ABSENT.*



*FIGURE 9. AN AERIAL IMAGE OF THIRTYMILE CREEK LOOKING DOWNSTREAM ALONG THE WILSON REACH OF THE WILSON / SMITH LTPBR PROJECT FOLLOWING STRUCTURAL TREATMENT IMPLEMENTATION. THE IMAGE WAS CAPTURED IN EARLY DECEMBER AFTER THE RETURN OF SURFACE FLOWS THAT WERE ENTIRELY LACKING DURING THE SUMMER AND FALL OF 2020*

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## 2 PROJECT AREA RESOURCES AND RECOVERY POTENTIAL

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LTPBR relies on the addition of structural elements (e.g., BDAs and PALS) to mimic, promote, and sustain the processes of wood accumulation and beaver dam activity such that geomorphic, hydrologic, and biological processes can maintain riverscape health. The assessment of current and potential structural element (i.e., beaver activity and wood accumulation) abundances and flow regime characteristics presented here was used as a starting point for development of the LTPBR restoration plan, and to develop short and long – term restoration expectations and timelines.

### 2.1 VALLEY BOTTOM GEOMORPHIC COMPOSITION

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The historic, existing, and target distribution of geomorphic surfaces (i.e., geomorphic composition), including the active channel, current active floodplain, and inactive floodplain set the template for riverscape recovery potential and are ultimately used to provide the spatial context for a restoration design. Recovery potential will also dictate the location, type, and prioritization of individual structural treatments, and treatment complexes.

Geomorphic surfaces were delineated within the project area based on consideration of geomorphic and vegetative indicators during field visits, and through evaluation of contemporary high-resolution ortho-imagery and topographic data acquired during project scoping ([Figure 10](#)). These geomorphic surfaces include:

- **VALLEY BOTTOM** - Low-lying area between hillslopes, fans, or terraces containing the stream channel and contemporary floodplain. The valley bottom represents the current maximum possible extent of channel adjustment, riverscape expansion, and riparian / wetland vegetation distribution.
- **ACTIVE FLOODPLAIN** - Area of the valley bottom at an elevation and position relative to the active channel that will be inundated during a typical flood event (i.e., flood event with a 2-year recurrence interval). Floodplains are likely to show recent signs of inundation such as deposition and/or scour of alluvial material and racking of woody and other organic debris. In the long term, active floodplains are likely to exhibit increased abundances of wetland and riparian vegetation as a function of increased frequency and duration of flow inundation and/or elevational proximity to groundwater.
- **ACTIVE CHANNEL** – Between the banks, being areas of the valley bottom where frequent depositional and erosional processes have resulted in a lack of vegetative cover and substrates dominated by alluvial material. The active channel also includes all areas of the valley bottom inundated during baseflow discharge (i.e., resulting from ponding by restoration structures, natural beaver dams, or other flow obstructions).

Combined with the identification and location of infrastructural and other risks (see [2.5 Risk Assessment](#)), these surfaces will ultimately be used to determine the recovery potential for the restoration area and expectations for the project.

# VALLEY BOTTOM GEOMORPHIC COMPOSITION

## UPPER THIRTYMILE CREEK

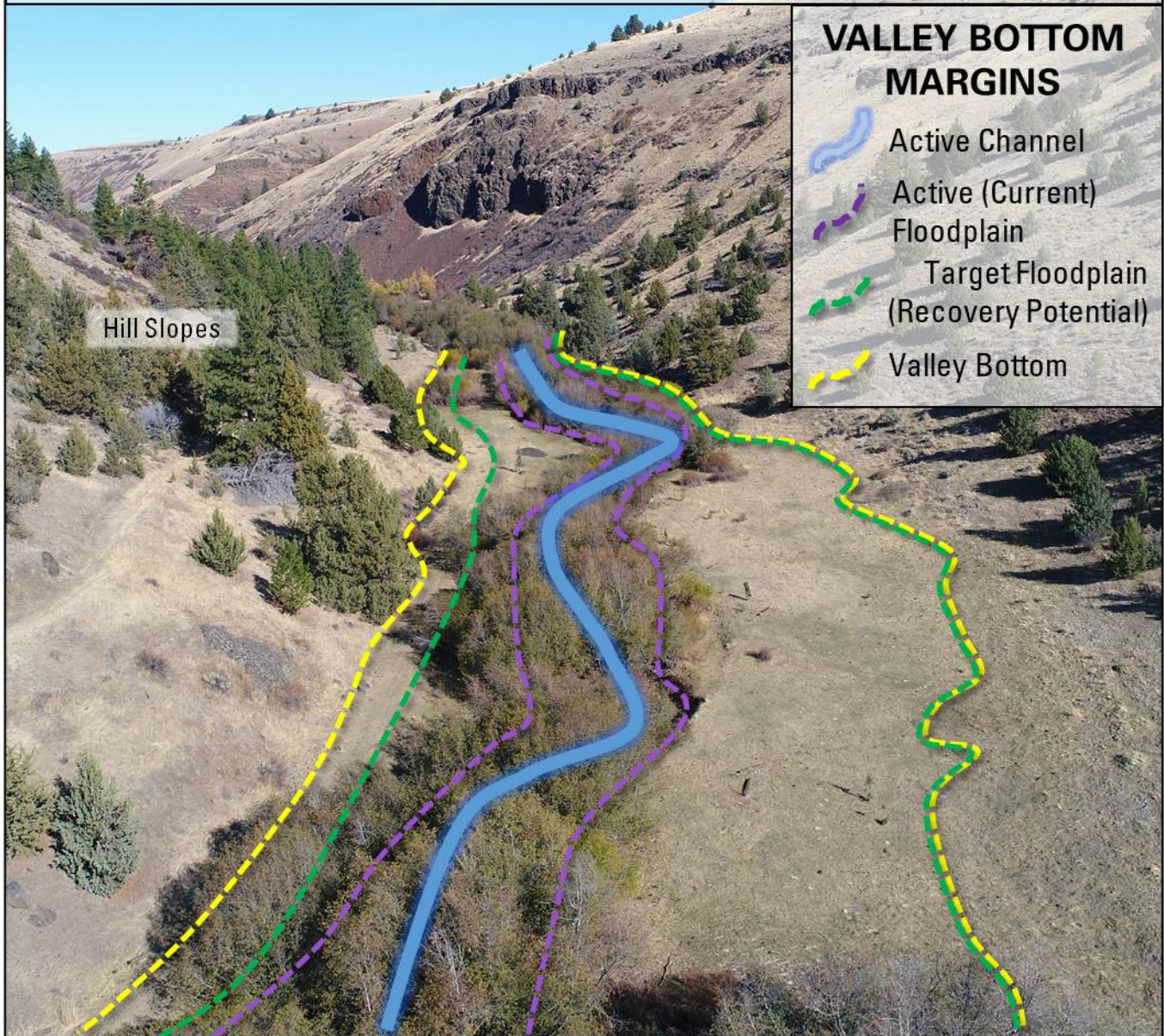


FIGURE 10. SCHEMATIC OF VALLEY BOTTOM GEOMORPHIC SURFACE COMPOSITION IDENTIFIED FOR THE ENTIRETY OF THE UPPER THIRTYMILE CREEK PROJECT AREA. ABOVE EXAMPLE SHOWS TYPICAL VALLEY BOTTOM CONFIGURATION FOR THE CABIN CANYON TREATMENT REACH.

Classification of geomorphic surface distributions shows that only 27 acres of the total 119 - acre valley bottom area is currently functioning as part of the active channel and/or floodplain (Table 5). This portion of the valley bottom equates to only 23% of the area available for riverscape expansion. Estimates of recovery potential

suggest that the structural intervention could triple the area functioning as either active channel and/or floodplains within reasonable restoration timelines (i.e., 5 – 10 years).

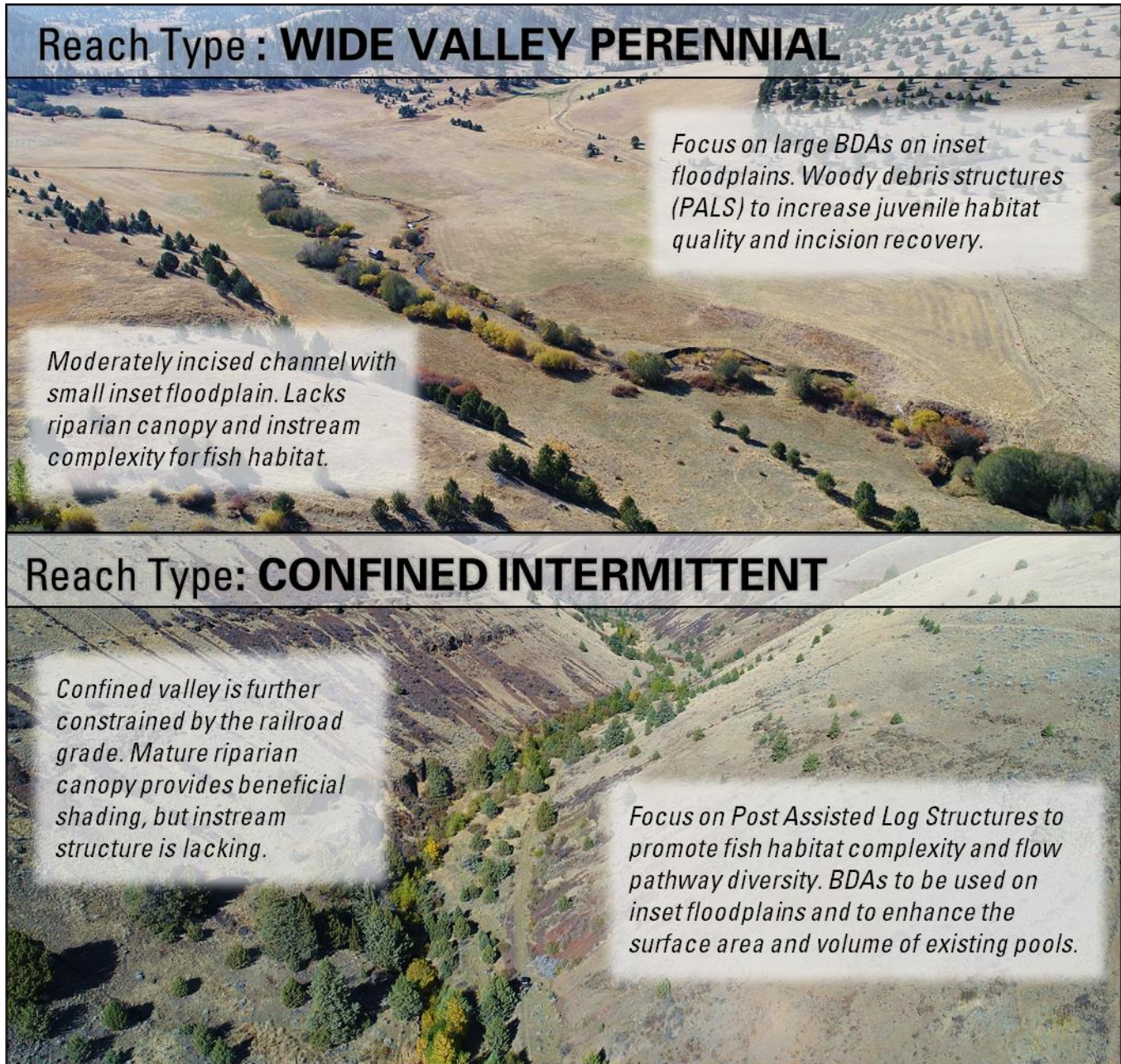


FIGURE 11. REACH TYPES TYPICAL OF THE UPPER THIRTYMILE CREEK PROJECT AREA ACCORDING TO VALLEY BOTTOM GEOMORPHIC COMPOSITION. THE COMPOSITION AND CHARACTERISTICS OF BOTTOM SURFACES IS ULTIMATELY USED TO INFORM THE RESTORATION DESIGN AND SET EXPECTATIONS FOR RECOVERY POTENTIAL.

## 2.2 FLOW REGIME AND FLOOD INTERVAL

The restoration plan explicitly considers basin hydrology to establish expectations for flood frequency, magnitude, and the invocation of geomorphic and hydraulic processes. Flood frequencies and flow durations were evaluated on Thirtymile Creek just below its confluence with Elbow Canyon.

Thirtymile Creek has a rain dominated hydrologic regime and large floods are typically generated from spring rains on frozen ground (Figure 12). There is limited discharge data for Thirtymile Creek but typical baseflows appear to be less than 3 cfs (Figure 13), with flow becoming entirely subsurface or consisting of intermittent isolated pools. Predicted discharge from regional curves suggest that the 2-year return interval for Thirtymile Creek within the project area may exceed 144 cfs, 10-year floods may exceed 513 cfs, and 50-year floods events may exceed 1110 cfs (Figure 14). Based on this information, the frequency and magnitude of flood events on Thirtymile Creek are likely sufficient to invoke many of the processes that would be essential to a process – based riverscape restoration plan. When combined with structural treatments (i.e., PALS), the magnitude of frequent floods is expected to result in sediment scour, transport, and depositional processes necessary for channel aggradation, and creation of increased bedform topographic and substrate heterogeneity. As floodplains become more accessible, moderate floods will also result in active channel and floodplain expansion as a function of valley bottom regrading (i.e., lateral erosion and/or head-cut development).

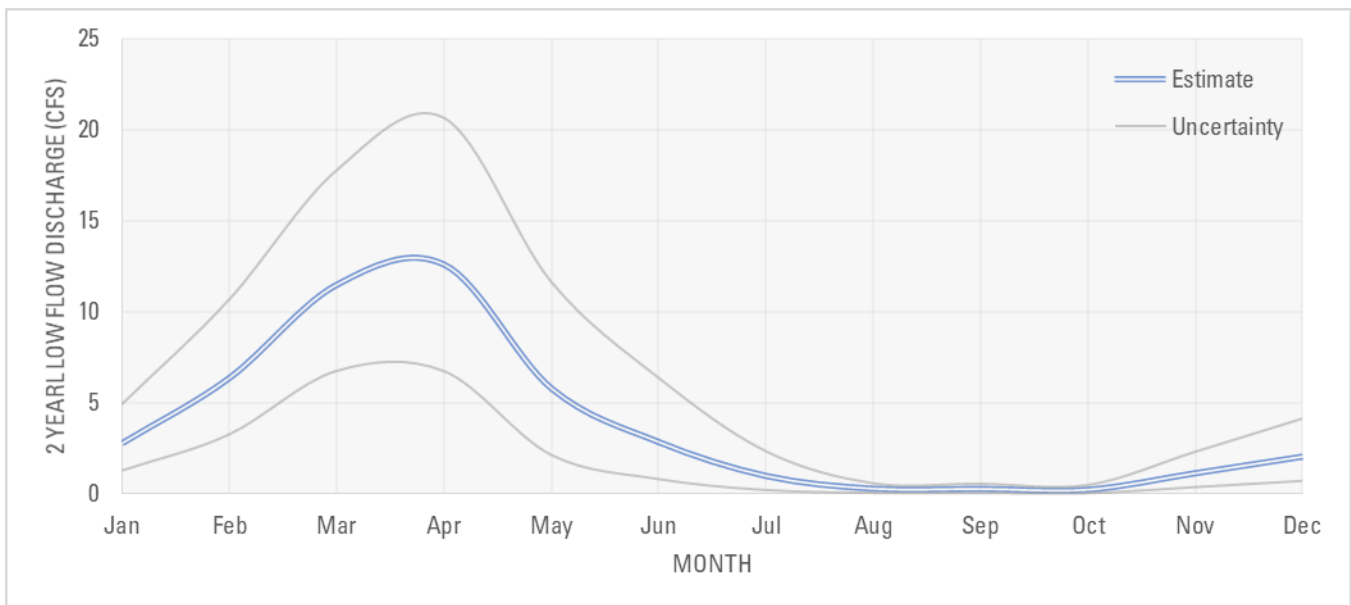


FIGURE 12. LOW FLOW ESTIMATE BY MONTH INFORMATION BASED ON [STREAMSTATS](#). FLOW STATISTICS ARE PRESENTED FOR THIRTYMILE CREEK BELOW ITS CONFLUENCE WITH ELBOW CANYON.

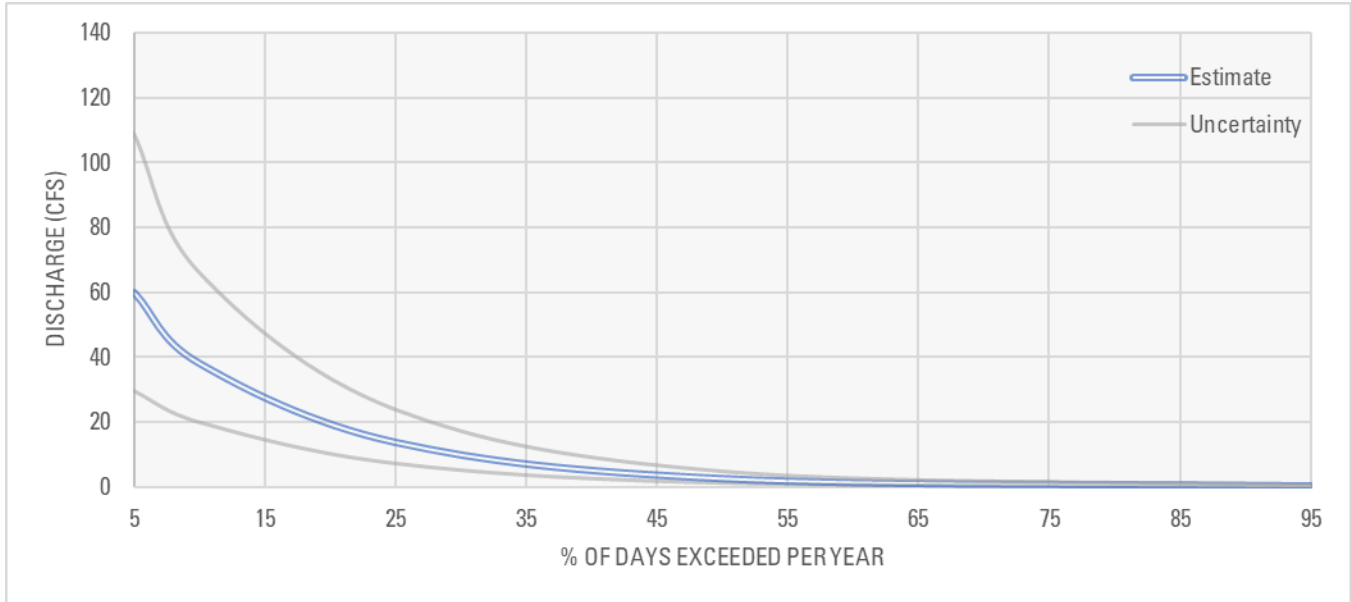


FIGURE 13. PERCENTAGE OF DAYS PER YEAR WHERE THIRTYMILE CREEK (BELOW ITS CONFLUENCE WITH ELBOW CANYON) MEETS OR EXCEEDS LOW FLOW DISCHARGE. INFORMATION BASED ON [STREAMSTATS](#).

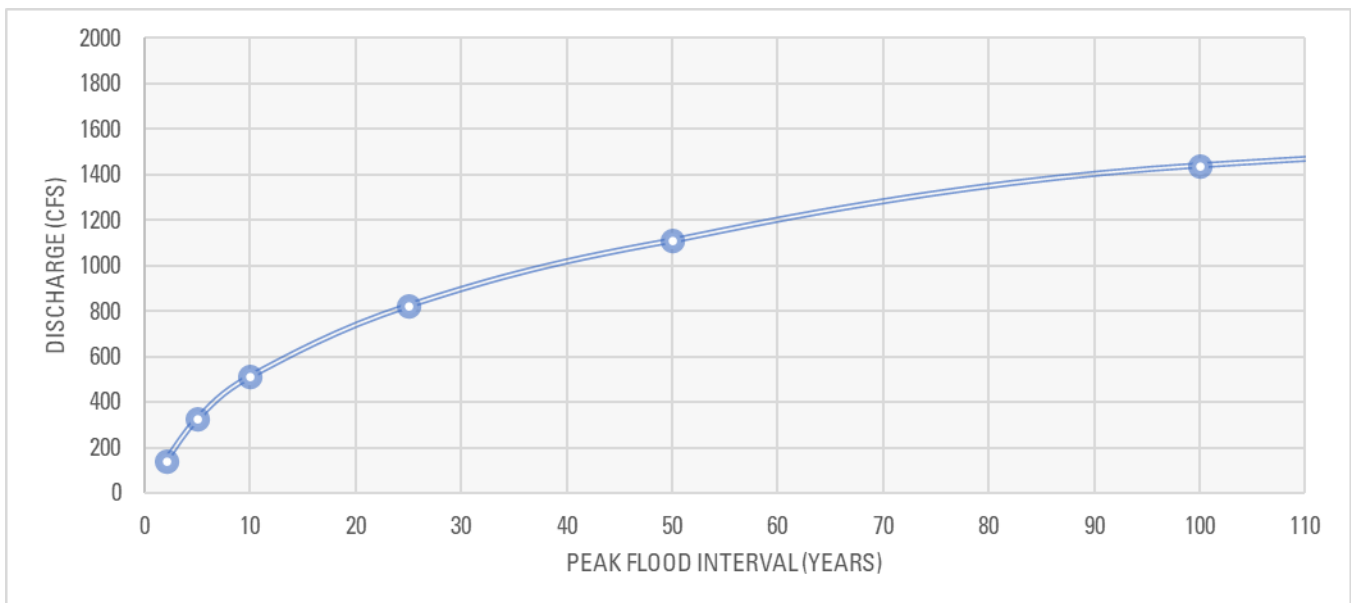


FIGURE 14. ESTIMATED DISCHARGE AT PEAK FLOOD INTERVALS (2,5,10,25,50, AND 100 YEARS) FOR THE MAINSTEM OF THIRTYMILE CREEK BELOW ITS CONFLUENCE WITH ELBOW CANYON. INFORMATION BASED ON [STREAMSTATS](#).

## 2.3 RIPARIAN VEGETATION AND WOODY DEBRIS ACCUMULATION

Current woody riparian vegetation composition and extent varies considerably within the project area. However, catchment climatic and hydrologic conditions should be ideal to support an abundant riparian forest with a high potential for the production, recruitment, and accumulation of woody debris jams. This potential is evident within the majority of the project area where abundant woody riparian vegetation (i.e., alder and willow) occur in proximity to the active channel. However, the existing abundance and distribution of woody riparian vegetation is severely limited in the [Comstock Basin](#) reach and occupies only a small portion of the valley bottom.

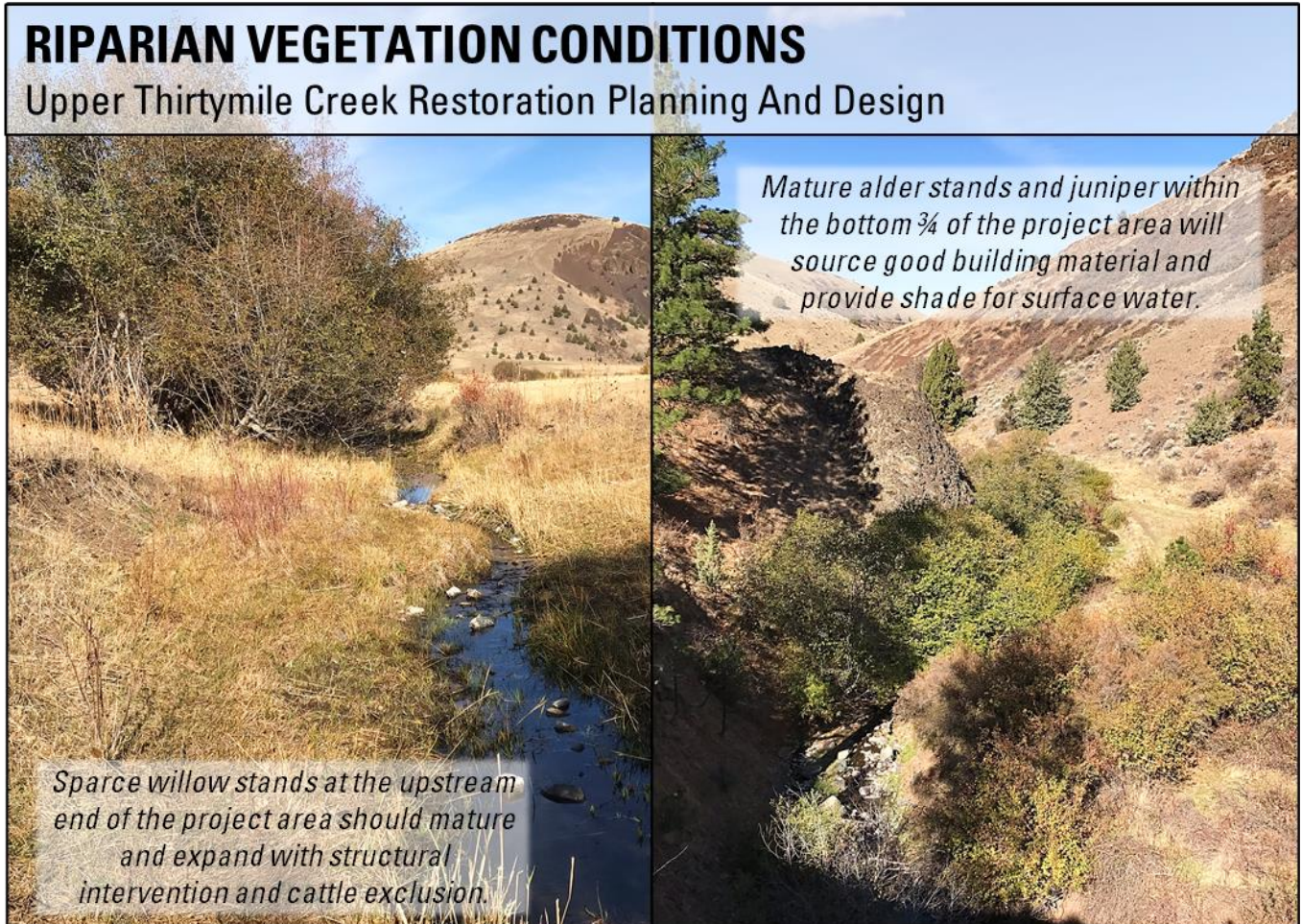


FIGURE 15. CHARACTERISTIC VEGETATION CONDITIONS FOUND WITHIN THE UPPER THIRTYMILE CREEK PROJECT AREA PRIOR TO RESTORATION IMPLEMENTATION DOCUMENTED DURING FALL, 2020. PHOTOS SHOW TWO DISPARATE RIPARIAN VEGETATION COMMUNITIES THAT DIFFER IN ABUNDANCE AND EXTENT WITHIN THE PROJECT AREA.

## 2.4 CAPACITY TO SUPPORT BEAVER DAM BUILDING

Catchment characteristics within the Thirtymile Creek project area; including stream size and valley/channel gradients, are within a range ideal to support beaver dam building (MacFarlane et al. 2017). However, low availability of food and building material (riparian vegetation) may limit habitat suitability for beaver within the



Upper Thirtymile Creek project area (Figure 16). Beaver activity and dam building has been observed within the Thirtymile Creek watershed, with known active colonies and dam complexes located downstream of the project area. As such, beaver should be considered potential partners in efforts to invoke process – based riverscape recovery within Thirtymile Creek, and many of the restoration efforts included in this plan will support expansion of beaver populations and colonization throughout the project area. If recolonization by beaver does occur it will depend on landowner tolerance of beaver’s propensity to build dams and may also require the landowners to invoke beaver management strategies (e.g., pond levelers).

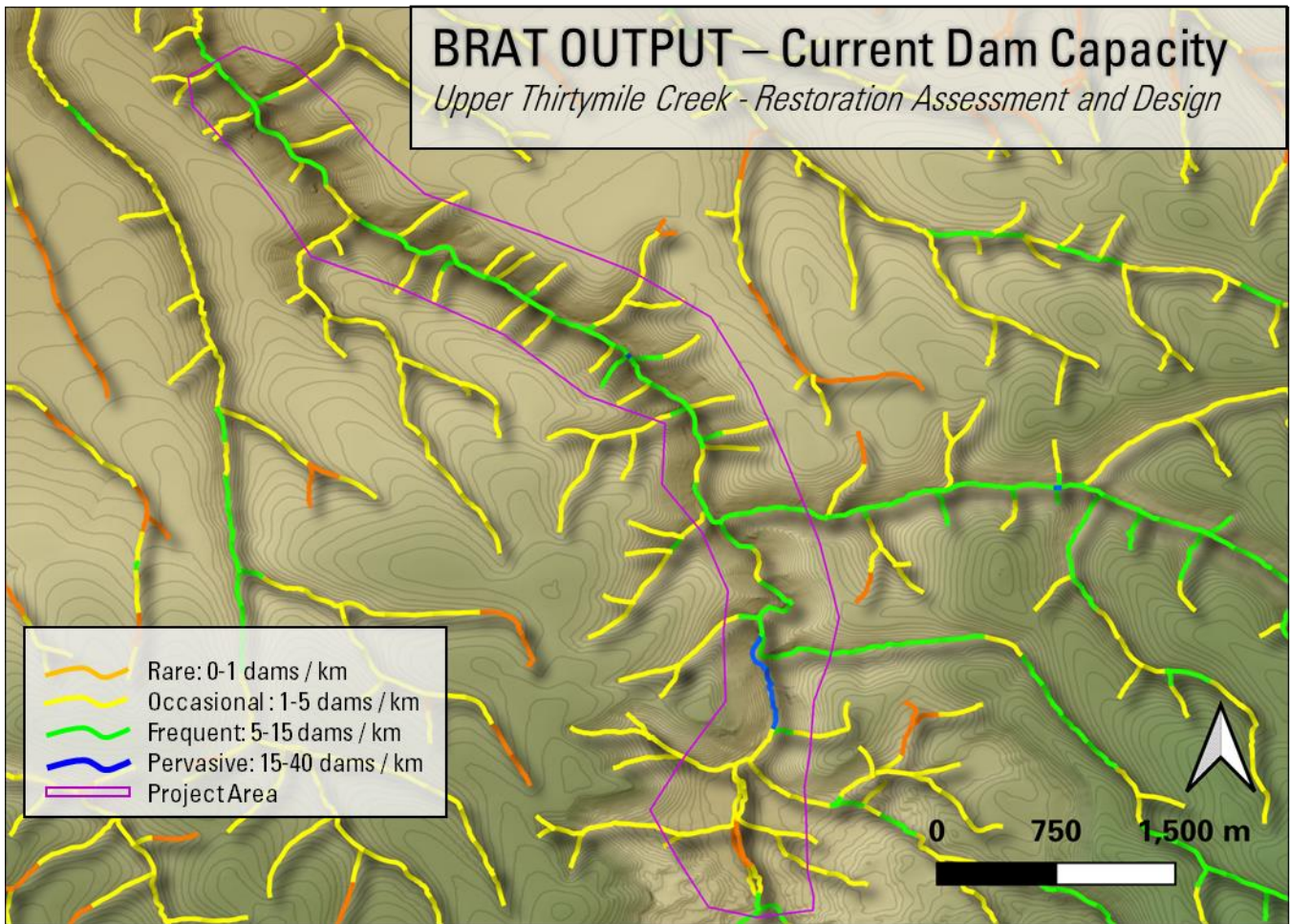


FIGURE 16. BEAVER RESTORATION ASSESSMENT TOOL (BRAT) ESTIMATE OF THE CURRENT POTENTIAL TO SUPPORT BEAVER DAM BUILDING WITHIN THE PROJECT AREA.

As part of the design process, the beaver restoration assessment tool (BRAT, MacFarlane 2017) was used to develop reasonable estimates of historic and potential dam capacity within the project area. Estimates of beaver dam capacities (Figure 16) suggest that in its current state the upper Thirtymile project area is capable of supporting moderate dam densities. These estimates were further verified during design development, and expanded to produce reach specific estimates of historic, current, and potential dam abundances for each reach in the restoration design (8.3 Appendix: BRAT Estimates of Beaver Dam Potential). Expected (i.e., future) estimates of beaver dam capacities were generated as a function of geomorphic responses to the structural treatment design and expansion of riparian vegetation. These estimates also assume that restoration

trajectories will allow streamside and valley bottom vegetation to become more suitable and abundant as dam building material and forage.

TABLE 1. HISTORIC AND EXPECTED BEAVER DAM CAPACITY FOR THE PROJECT AREA BASED ON AN EVALUATION OF HYDROLOGIC AND GEOMORPHIC CHARACTERISTICS AND POTENTIAL FOR EXPANSION OF WOODY RIPARIAN VEGETATION. ESTIMATES RELY ON THE FRAMEWORK AND TESTING OF BEAVER DAM CAPACITY MODELS DESCRIBED BY (MACFARLANE ET AL. 2017).

EXPECTATION TIME PERIOD	VEGETATION SUITABILITY		STREAM POWER				Beaver Dam Capacity
	Streamside	Riparian / upland	Baseflow	2-year flood	Dam capacity (dams/km.)	Channel Length (km, treatment)	
HISTORIC (< 1800)	Preferred	Preferred	Can build dam	Occasional breach	Frequent: 5 - 15	13.9	70 - 200 dams
CURRENT (2021)	Moderately suitable	Unsuitable	Can build dam	Blowout	Rare: 0 - 1	9.2	0 - 9 dams
AS BUILT (2021)	Moderately suitable	Unsuitable	Can build dam	Occasional blowout	Occasional: 1 - 5	9.7	10 - 50 dams
MEDIUM (3 - 5 YEARS)	Suitable	Barely Suitable	Can build dam	Occasional blowout	Frequent: 5 - 15	10.3	50 - 150 dams
LONG (5 - 10 YEARS)	Suitable	Barely Suitable	Can build dam	Occasional breach	Frequent: 5 - 15	11.0	50 - 150 dams

## 2.5 RISK ASSESSMENT

Risks were assessed as the potential for impacts to infrastructure (road crossings, buildings, etc.) within and adjacent to the valley bottom. Risks to infrastructure would include impacts from erosion and floodplain expansion (i.e., floodplain inundation) that occur directly or indirectly as a result of the implementation of the structural treatment plan. Risks to human infrastructure include the access road paralleling the creek which is often within the valley bottom. Besides the access road, agricultural fields within the Comstock Basin reach are the only other infrastructure risks within the project area (Figure 17).

The restoration treatment design, specifically the choice of treatment locations and positioning of individual and groups of structures (i.e., structure complexes) has been tailored to minimize any potential for damage to existing infrastructure. Within treatment reaches, structures have been positioned to avoid the potential for erosion or flooding of the access road that runs the length of the project area. That being said, the locations of the existing road within the valley bottom and active floodplain likely already experiences seasonal flooding.

## 2.6 RECOVERY POTENTIAL

Recovery potential represents the combined area of the valley bottom expected to function as either active floodplain or active channel (see Figure 10) resulting from the structural treatment plan. Identification of the

recovery potential area be used to develop reasonable project objectives, set expectations, establish recovery timelines, and for ensuring that any infrastructure is not within the expected area of floodplain expansion.

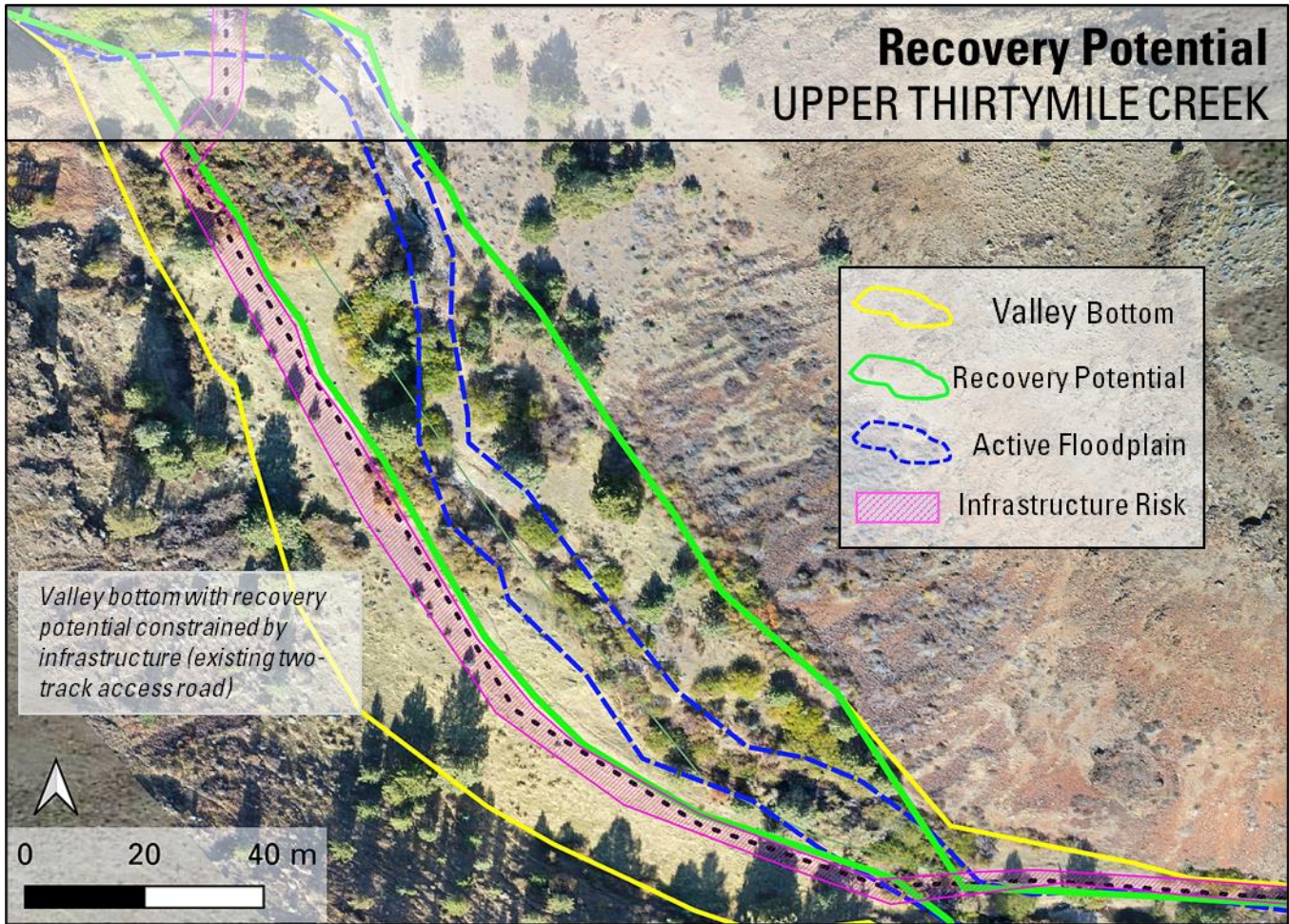


FIGURE 17. SCHEMATIC OF GEOMORPHIC SURFACE DELINEATION WITHIN THE UPPER THIRTYMILE CREEK PROJECT AREA. DELINEATION WAS DEFINED BASED ON FIELD VISITS AND EVALUATION OF HIGH – RESOLUTION ORTHOIMAGERY AND TOPOGRAPHIC SURFACES CAPTURED DURING THE FALL OF 2020. THIS SCHEMATIC SHOWS A VALLEY BOTTOM CONFIGURATION WHERE THE ACCESS ROAD IS WITHIN THE VALLEY BOTTOM AND LIMITS THE EXTENT OF RECOVERY POTENTIAL.

## 3 PROJECT GOALS AND OBJECTIVES

The Upper Thirtymile Creek project specific goals support regional recovery planning actions aimed at increasing listed steelhead productivity and habitat quantity and quality (see [1.1 Regional Management Context](#) above). Project goals also reflect local management priorities and habitat impairments of high surface water temperatures, lack of geomorphic complexity, and low habitat quantity in the form of ephemerally intermittent surface flow.

**GOAL 1:** *Support development of a hydrologically inefficient riverscape that contributes to increased surface flow volume, duration, and extent, and ultimately an increase in salmonid habitat quantity and quality.*

**GOAL 2:** *Accelerate the recovery of self-sustaining hydrologic, geomorphic, and biological processes that increase the extent and diversity of wetland, riparian, floodplain, and channel habitat within the Thirtymile Creek.*

Project restoration goals are also directly 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 guide implementation management, and to establish expectations for project outcomes.

### 3.1 RESTORATION OBJECTIVES

Restoration objectives were developed based on initial project scoping and exploration of [Project Area Resources and Recovery Potential](#), and have further been set to support restoration goals. The timing of subsequent structural treatments (see [4.1 Temporal Design](#)) are also recognized by restoration objectives.

TABLE 2. RESTORATION OBJECTIVES, THEIR DESCRIPTION, AND A DESCRIPTION OF EACH OBJECTIVES LINK TO BROADER MANAGEMENT GOALS FOR THE THIRTYMILE CREEK PROCESS BASED RESTORATION PROJECT.

OBJECTIVE	DESCRIPTION	LINK TO MANAGEMENT GOALS
OBJ. 1	Increase in-channel geomorphic complexity.	Geomorphic complexity is indicative of increasing habitat quality for adult and juvenile steelhead.
OBJ. 2	Increase the proportion of the valley bottom composed of active channel and active floodplain.	Increased active channel and floodplain area suggests a less efficient riverscape and contributes to expansion of wetland and riparian vegetation and increasing steelhead habitat quantity.
OBJ. 3	Increase perennial surface flow extent during drought periods.	Surface flow creates conditions that support woody riparian vegetation establishment, steelhead habitat quantity, and suggests efforts to attenuate flow are successful.
OBJ. 4	Increase wetland and riparian vegetation extent, diversity, and abundance.	Riparian vegetation is essential to support processes of wood accumulation, and as forage and building material for beaver.
OBJ. 5	Increase the distribution and abundance of beaver activity.	An expanding beaver population increases in-channel habitat diversity and is indicative of self – sustaining riverscape processes.

## 3.2 RESTORATION INDICATORS

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In keeping with SMART project objectives (see [Skidmore et al. 2011](#)), a series of indicator metrics are recommended for evaluating the effectiveness of the restoration treatments. These indicators have been chosen to provide a measure of progress toward expected project outcomes. For each indicator, estimates of historic, current, and potential (i.e., target) values have been developed that correspond to broad recovery time horizons ([Table 3](#)) for the project. Indicator metric values specific to each reach in the restoration design have also been developed (see [8.2 Appendix: Reach Specific Objectives and Indicator Metric Values](#)). All metrics are designed to be easily measured through a minimal amount of sampling effort using survey methods described within the LTPBR Implementation and Monitoring Protocol ([Weber et al. 2020](#)). These methods allow quantification of indicator metrics via orthoimagery acquisitions using a consumer level drone, or through measurements taken during rapid field surveys.

### 3.2.1 RESTORATION INDICATOR METRICS

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- **POOL FREQUENCY** – Frequency (pools / km) of pools created by bed scour. Expected to increase resulting from the 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 (bars / km) of in-channel depositional geomorphic units within the project area. Depositional bars are indicative of spawning habitat used by adult steelhead. Expected to increase resulting from the structural intervention as a function of increased in-channel hydraulic diversity.
- **PERCENT OF VALLEY BOTTOM ACTIVE** – Proportion (%) of the valley bottom functioning as part of the active channel and active floodplain. Expected to increase resulting from structural intervention due to pond creation, floodplain connectivity, and creation of multi-threaded channels.
- **PERCENT VALLEY BOTTOM SURFACE FLOW** – Percent of the valley bottom longitudinal length (as measured along the center of the valley bottom) with persistent surface flow during late summer drought periods. Surface flow should be recognized if present in any channel (i.e., primary or non-primary channel). Expected to increase in response to flow attenuation and increased surface – groundwater exchange.
- **PERCENT VALLEY BOTTOM RIPARIAN DOMINATE** – Proportion of the valley bottom in which the dominate plant 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.
- **DAM ABUNDANCE** – Count of beaver dams and artificial dams within the project area. Beaver activity and populations are expected to increase resulting from increased riparian vegetation, and creation of deep-water cover from structural restoration treatments.

TABLE 3. HISTORIC, CURRENT, AND TARGET EXPECTATIONS FOR EACH INDICATOR METRIC, AND THEIR LINK TO SPECIFIC PROJECT OBJECTIVES. TARGET VALUES ARE GIVEN FOR AN AS BUILT EXPECTATION OCCURRING JUST AFTER THE FIRST PHASE OF IMPLEMENTATION, AS WELL AS FOR A MEDIUM (1 – 5 YEARS) AND LONG (5 – 10 YEARS) TIME HORIZON. INDICATOR VALUES PRESENTED HERE REFER TO THE ENTIRE PROJECT AREA.

INDICATOR	STATUS AND CONTEXT			TARGET EXPECTATIONS	
	Historic ca. 1800s	Current 2021	As Built 2023	Medium 2 – 5 years	Long 5 – 10 years
<b>OBJECTIVE 1: INCREASE IN-CHANNEL HABITAT COMPLEXITY</b>					
<b>POOL HABITAT FREQUENCY (POOLS / KM)<sup>1</sup></b>	20 - 40 / km.	10 / km	15 – 20 / km	15 – 20 / km	20 - 40 km
<b>BAR HABITAT FREQUENCY (BARS / KM)<sup>1</sup></b>	20 - 40 / km.	10 / km	15 – 20 / km	15 – 20 / km	20 - 40 km
<b>OBJECTIVE 2: INCREASE PROPORTION OF ACTIVE VALLEY BOTTOM</b>					
<b>% OF VALLEY BOTTOM ACTIVE (%)</b>	80 - 100%	23%	25 - 35%	30 - 40%	40 - 60%
<b>OBJECTIVE 3: INCREASE PERENNIAL SURFACE FLOW EXTENT AND DURATION</b>					
<b>% PERENNIAL SURFACE FLOW (%)</b>	60 - 100%	25-40%	30 - 45%	40 - 60%	40 - 70%
<b>OBJECTIVE 4: INCREASE WETLAND AND RIPARIAN VEGETATION ABUNDANCE</b>					
<b>% VALLEY BOTTOM RIPARIAN DOMINATE (%)<sup>2</sup></b>	70 - 95%	15 - 25%	15 - 25%	25 - 40%	25 - 50%
<b>OBJECTIVE 5: INCREASE BEAVER DAM ABUNDANCE AND DISTRIBUTION</b>					
<b>DAM ABUNDANCE (DAM COUNT)<sup>3</sup></b>	130 - 360 dams	0 dams	105 – 145 dams	115 – 165 dams	140 – 220 dams

1: Assumes PALS treatments will form pool and bar complexes after flood events.

2: Primarily based on expectations for expansion of the active floodplain (i.e., recovery potential) and planting treatment.

3: Assumes a combination of natural and artificial dams in the project area.

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## 4 RESTORATION DESIGN

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

- **TEMPORAL DESIGN** – The temporal design is used to guide subsequent implementation phases (i.e., temporally punctuated structural treatments inclusive of new structures, maintenance, and structure enhancement).
- **SPATIAL DESIGN – REACH DELINEATION** – Restoration reach delineation based on valley setting and determinates of recovery potential. The delineation of reaches can be used to set specific objectives and adjust restoration expectations according to limitations set by the riverscape.
- **STRUCTURAL TREATMENT DESIGN** – Description of structure types and their organization, distribution, and function within structure complexes (i.e., groups of multiple structures).

### 4.1 TEMPORAL DESIGN

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Temporal considerations for the structural treatment should take into consideration both the expectations for flood events of a given magnitude, as well as rates of vegetative, geomorphic, and hydrologic recovery. Ideally, a second structural treatment would follow at least 1 – 2 moderate flow events (i.e., 2 - year recurrence of ~ 300 cfs floods). This interval would give the active channel and floodplain time to expand based on a greater extent and duration of floodplain inundation, incision trench erosion, overbank flow, and formation of multi-threaded or new channels. Another treatment phase should be considered after several moderate floods and one large flood (i.e., recurrence interval of 5 years, ~ 500 cfs).

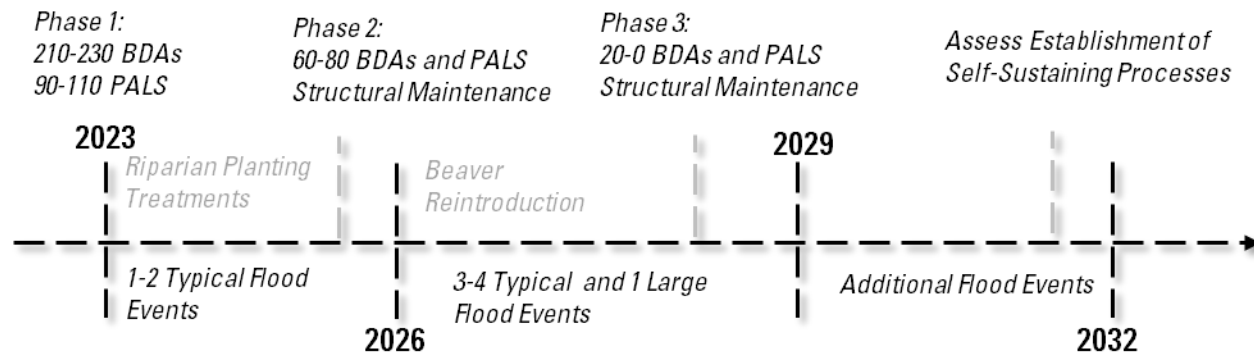


FIGURE 18. IDEALIZED TIMELINE FOR STRUCTURAL TREATMENTS IN RELATION TO EXPECTATIONS FOR CHANNEL FORMING FLOOD EVENTS THAT WILL CONTINUE PROCESS – BASED RECOVERY TRAJECTORIES. APPROXIMATE TIMELINES FOR COMPLEMENTARY RIVERSCAPE RESTORATION ACTIONS ARE ALSO SHOWN WITHIN THE RECOVERY TIMELINE

TABLE 4. IDEALIZED TIMELINE, STRUCTURE COUNT, AND DESIGN GUIDELINES FOR THE MULTI-PHASED STRUCTURAL TREATMENT PLAN.

IMPLEMENTATION PHASE AND TIMELINE	IMPLEMENTATION DESCRIPTION
<b>PHASE 1</b> SUMMER 2023	300 – 340 BDAs and PALS structures - Initial and most aggressive treatment phase. Extensive pond formation within inset floodplain channels should begin to attenuate and extend the duration of surface flow. Where floodplain access is possible, multi-threaded channel formation will occur via flow dispersal and head-cut formation. In more confined valley settings PALS will widen and lengthen inset floodplains and increase channel habitat complexity.
<b>PHASE 2</b> 2025 – 2026, FOLLOWING SEVERAL HIGH FLOW EVENTS	Between 60 – 80 new BDAs and PALS new additional structures and structure enhancements – Treatment should focus new BDAs within new secondary or high-flow channels, and extension or increased elevation of existing structures. Material (sediment and vegetation) additions at existing structures to encourage low – flow pond formation.
<b>PHASE 3</b> 2026 – 2029, FOLLOWING SEVERAL HIGH - FLOW AND AT LEAST 1 LARGE FLOOD EVENT	Between 20 – 40 new BDAs and PALS and structure enhancements – New BDA structures in non-primary channels. Increased elevation of existing BDA structures that may have aggraded to encourage complete channel avulsion where possible. Material (sediment and vegetation) additions at existing structures to encourage low – flow pond formation.

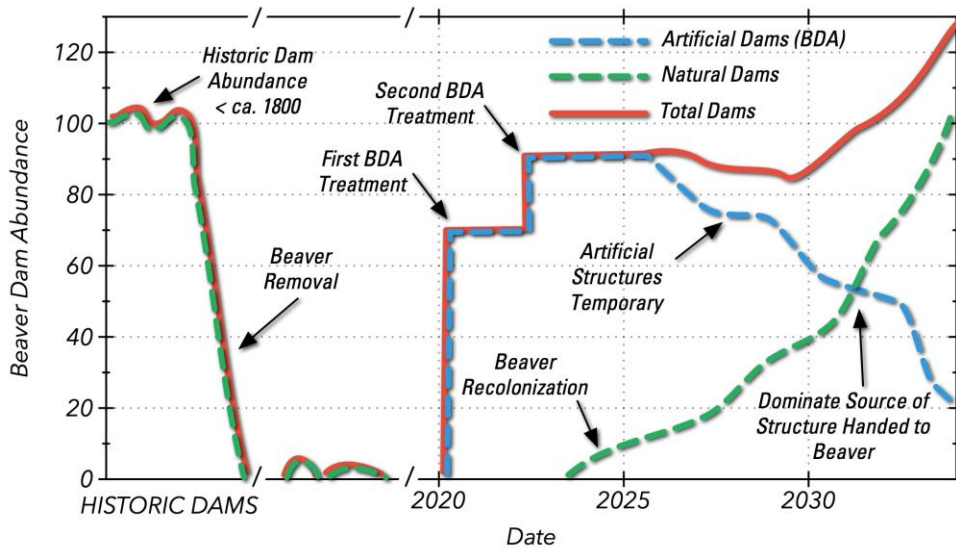


FIGURE 19. CONCEPTUAL REPRESENTATION OF AN LTPBR PROJECT TRAJECTORY IN WHICH NATURAL BEAVER COLONY EXPANSION AND DAM BUILDING BECOMES THE PRIMARY SOURCE OF STRUCTURAL ELEMENTS WITHIN THE RIVERSCAPE. BEAVER AS WELL AS RIPARIAN VEGETATION RECRUITMENT AND ACCUMULATION ARE EXPECTED TO FUNCTION AS A SOURCE OF STRUCTURE WITHIN THE THIRTYMILE CREEK PROJECT AREA.



## 4.2 SPATIAL DESIGN – REACH DELINEATION

Four distinct reaches were delineated as part of the Upper Thirtymile Creek structural treatment plan (Table 5; Figure 20). Apart from these locations, reach delineations were based on existing channel and floodplain geomorphology and valley bottom geometry that determine recovery potential and trajectories (Figure 10, Figure 20) and structural treatment design. The delineation of distinct reaches allows management of project expectation and eases the determination of where restoration effort might be directed. For example, given the perennial flow hydrology and active floodplain expansion potential, greater restoration effort and resources may be invested within the Comstock Basin and Cabin Canyon restoration reaches as opposed to the Jump Off Joe reach where floodplain expansion potential is limited by the existing railroad grade that constrains the active channel.

TABLE 5. APPROXIMATE AREA AND PROPORTION OF THE VALLEY BOTTOM, CURRENT FLOODPLAIN, AND TARGET FLOODPLAIN (RECOVERY POTENTIAL) FOR EACH DESIGN REACH. RECOVERY POTENTIAL REPRESENTS THE AREA OF THE VALLEY BOTTOM THAT MIGHT BECOME ACTIVE FLOODPLAIN AS A RESULT OF THE RESTORATION PLAN.

REACH (LENGTH - MILES)	CURRENT ACTIVE FLOODPLAIN AREA			RECOVERY POTENTIAL (FLOODPLAIN AREA)	
	Valley Bottom (ac.)	Current Floodplain Area (ac.)	Current % Floodplain	Target Floodplain Recovery Potential (ac.)	Target % Active
<b>COMSTOCK BASIN (0.9)</b>	32.8	5.6	17%	31.6	96%
<b>CABIN CANYON (0.6)</b>	12.6	3.6	29%	10.7	85%
<b>SALMON FORK (1.0)</b>	13.0	4.7	36%	7.9	61%
<b>JUMP OFF JOE (3.3)</b>	60.8	13.1	22%	44.3	73%
<b>TOTAL</b>	<b>119.2</b>	<b>27.0</b>	<b>23%</b>	<b>94.5</b>	<b>79%</b>

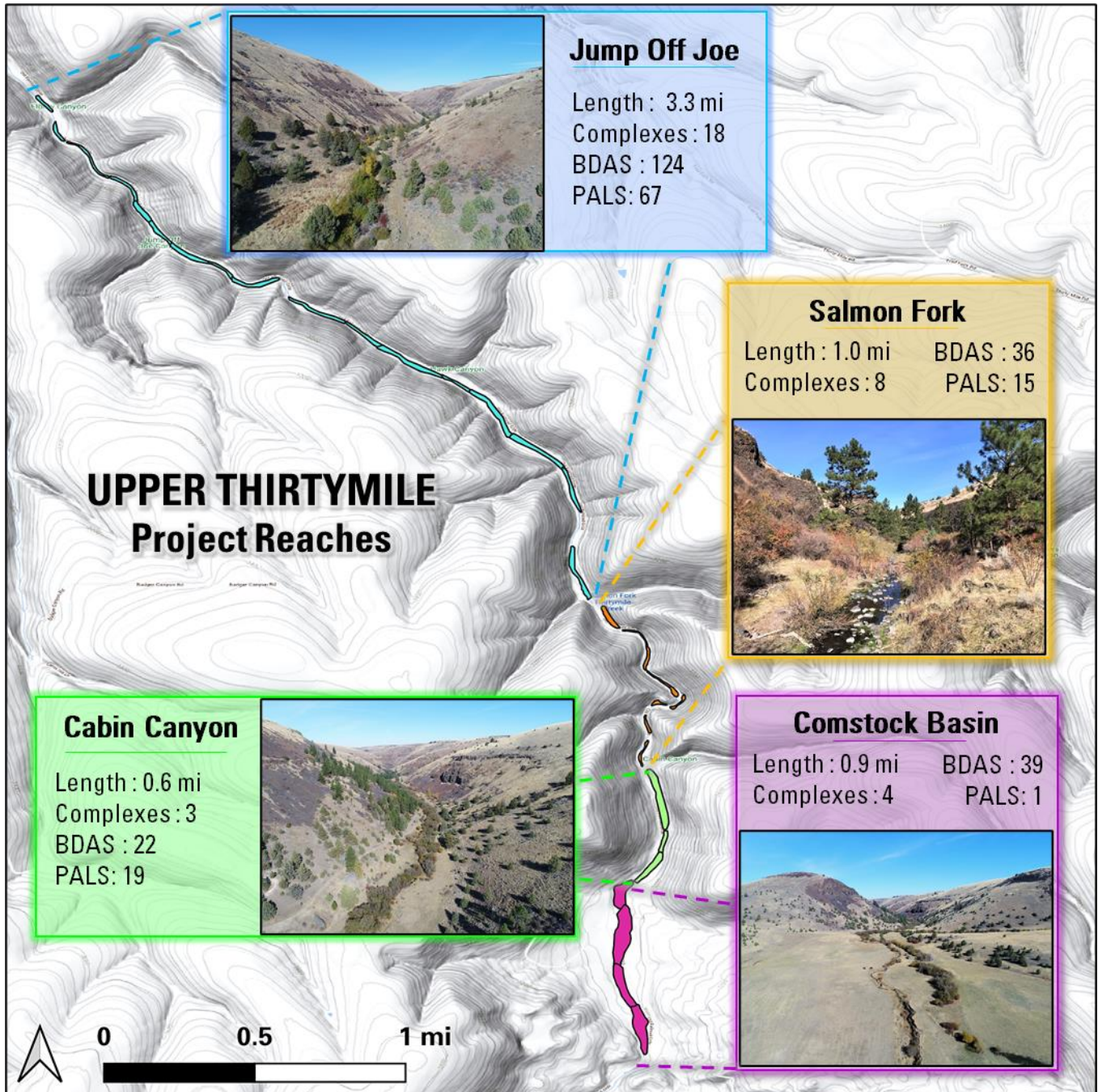
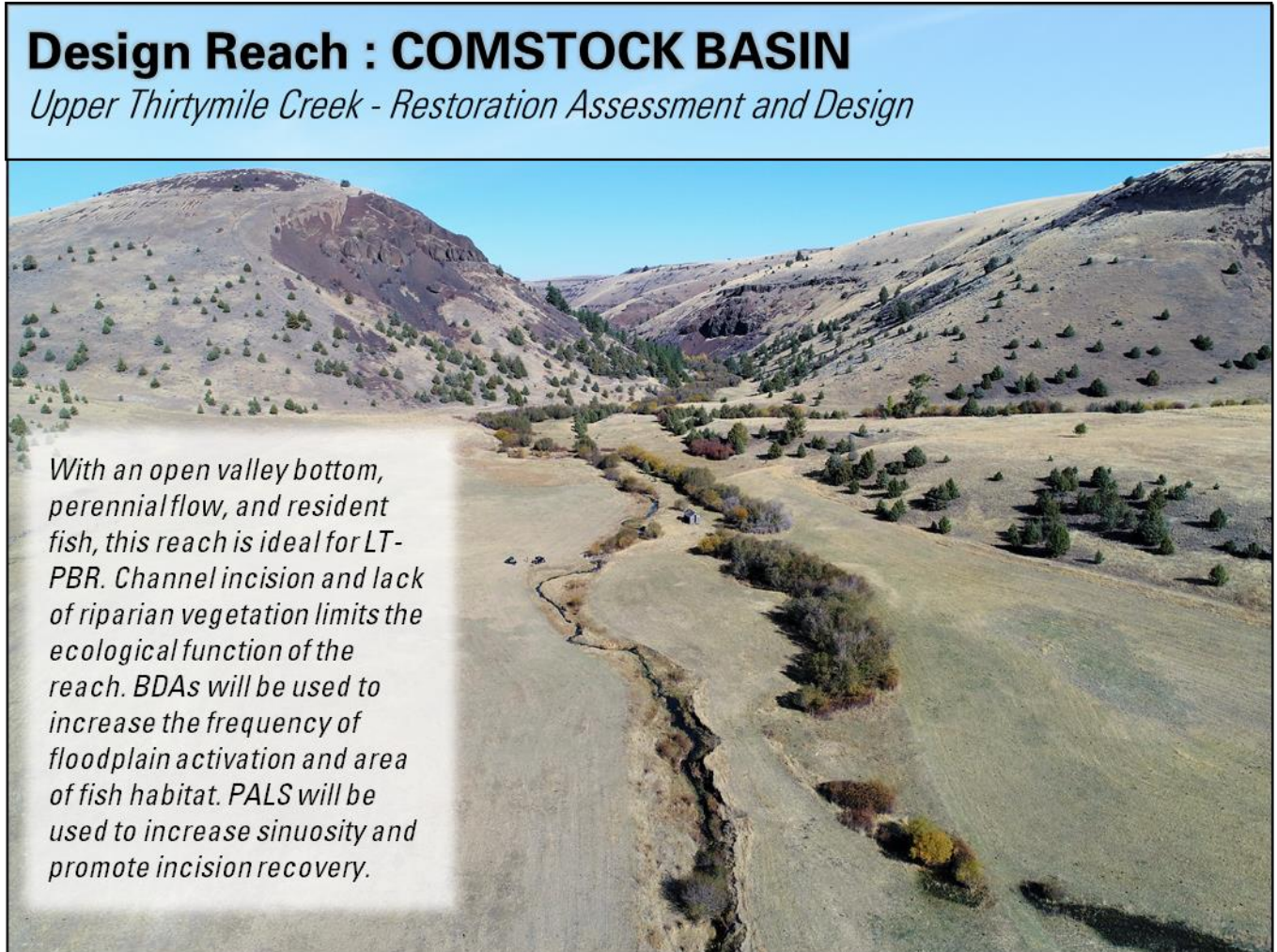


FIGURE 20. RESTORATION DESIGN REACHES AND MAJOR DESIGN COMPONENTS.

## 4.3 DESIGN REACH DESCRIPTIONS

Short summaries describing the dominate riverscape characteristics, habitat impairments, and restoration design approach for each design reach (Figure 20).

### 4.3.1 DESIGN REACH: COMSTOCK BASIN



In its current state, the Comstock Basin Reach is characterized by sparse riparian vegetation, an incised channel with a limited inset floodplain, and low in-channel habitat complexity for rearing juvenile steelhead. However, the wide valley bottom, low elevation of channel incision, and mostly perennial flow offer exceptional restoration potential. The wide valley bottom provides ample space for expansion of aquatic habitat through floodplain expansion, increased channel sinuosity, and the development of multithread channels. Structural treatments within this reach will consist of BDAs to increase the volume and area of surface flow, increase fish habitat quantity and complexity through pond development, and increase the frequency of floodplain inundation. Increased pond development and expansion of riparian will also increase the likelihood that beaver will establish natural dam complexes within the reach.

#### 4.3.2 DESIGN REACH: CABIN CANYON

Similar to Comstock Basin, the Canyon Cabin reach has a relatively wide valley bottom and perennial flow during years of typical precipitation. Cabin Canyon's band of mature alders provide shading for large pools that support rearing *O.mykiss* during summer drought periods. The mature alders within the reach provide ample building material for structure construction. Though the channel is currently incised (~ 1.0 m), erodible banks within this reach should contribute to incision recovery through widening and channel aggradation as a result of the structural treatments. Wide BDAs will primarily be utilized to promote floodplain saturation (i.e., groundwater recharge) and to increase surface flow volume, area, and duration (i.e., create ponds).



### 4.3.3 DESIGN REACH: SALMON FORK

Surface flow is largely lacking or intermittent within the Salmon Fork design reach during annual draught periods and increasing the duration and extent of perennial surface flow within the reach remains a primary design objective. This reach is typified by a narrow canyon than is observed upstream, an incised stream channel (~ 0.75 m) with frequent inset floodplain surfaces, and a riparian vegetation community mainly dominated by alder. In channel and floodplain substrate compositions feature abundant large cobbles with a porosity that may be contributing to intermittent flow during draught periods. The treatment design will consist of BDA structures placed at the downstream extent of inset floodplains where pond creation and inset floodplain connectivity can be maximized. Ideally, the BDA treatments will contribute to deposition and retention of fine sediment, and a bed composition that is more supportive of continuous surface flow.



Existing mature alder will provide ample structure building material to support the restoration treatments. However, expansion and colonization of riparian vegetation is being limited by intensive grazing within the floodplain and active channel. Grazing reduction/management will be essential within this reach if riparian vegetation abundances are expected to support beaver colonization and long-term complex establishment. The abandoned Kinzua to Condon railroad grade (currently used as a vehicle access road) within the valley bottom also sets a limit on the recovery potential within this reach.

#### 4.3.4 DESIGN REACH: JUMP OFF JOE

At 3.3 miles long, the Jump Off Joe reach is the longest design reach in the project area. This reach has intermittent flow hydrology, a mature band of riparian vegetation running its length, and a deeply (~2.0 m) incised channel and inset floodplain constrained by the abandoned Kinzua to Condon Railroad bed. Due to the level of incision, reconnection to the historic valley bottom is unlikely within this reach. The structural treatments will consist largely of BDA structures designed to induce ponding and groundwater recharge within the inset floodplain. PALS will also be used in narrow sections to widen the incision trench and enhance instream fish habitat complexity. Several structure complexes have been positioned near spring seeps to maximize the residency time and expand the foot of these sources of perennial surface flow.



## 4.4 STRUCTURAL TREATMENT PLAN

The Upper Thirtymile Creek structural treatment plan relies on a combination of channel spanning BDAs and PALS that mimic woody debris jams. BDA structures will be placed to encourage immediate ponding at low flows and increase floodplain extent and inundation frequency during moderate floods. PALS will be designed and positioned to enhance erosional and depositional rates that contribute to channel complexity and the widening of incision trenches in incised channel sections; and to divert flow into abandoned and high flow channels to increase active channel and floodplain extents. BDA structures will be the primary structure types used in treatment reaches featuring large perennial pools that the local fish populations depend on for late summer survival. Enhancing these perennial pools should increase the quantity and quality of habitat available to rearing *O.mykiss* during survival bottlenecks (i.e., summer/fall droughts).

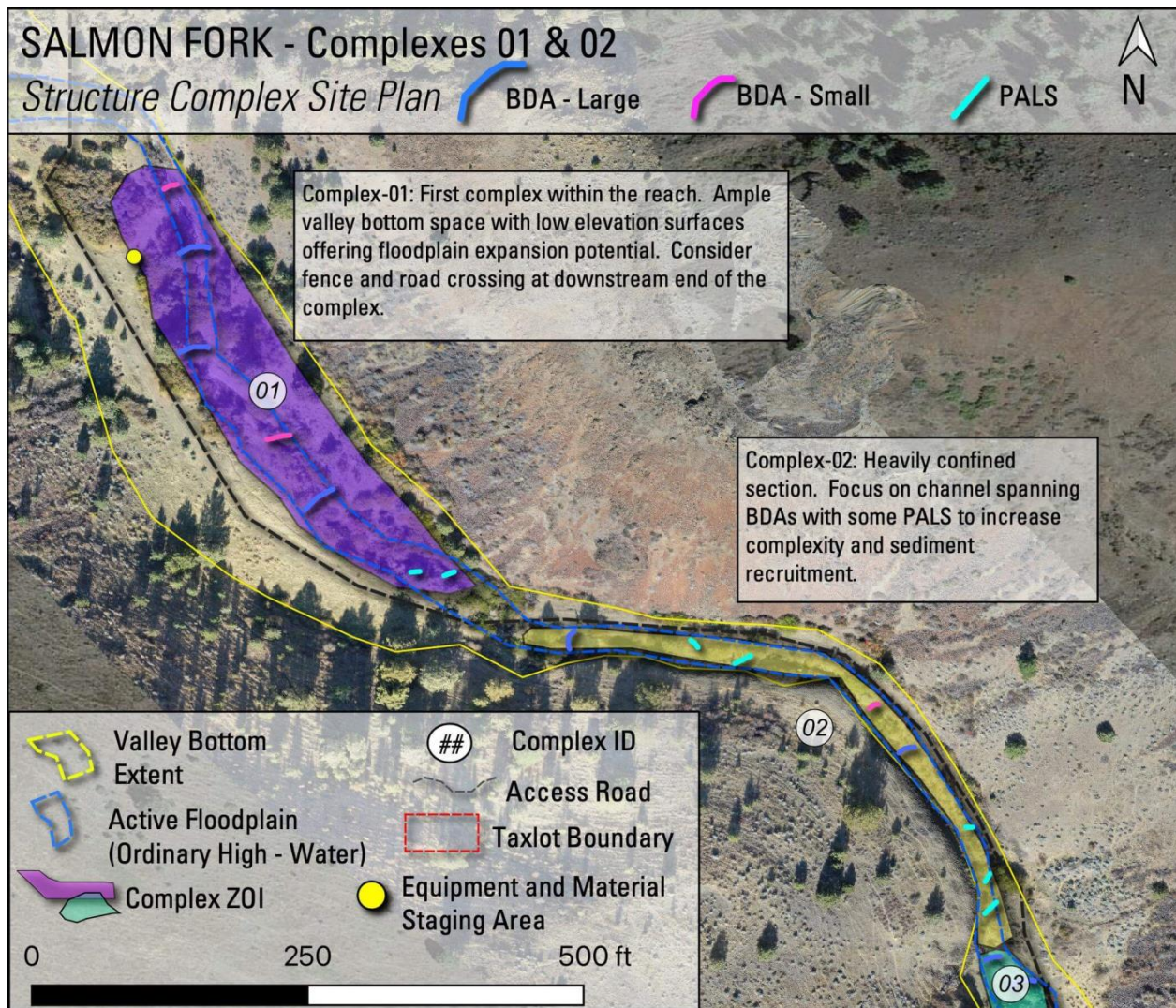


FIGURE 21. EXAMPLE OF A COMPLETE COMPLEX SITE PLAN FOR THE FIRST PHASE OF STRUCTURAL TREATMENTS. SITE PLANS ARE USED TO CONVEY THE APPROXIMATE PLACEMENT AND TYPES OF STRUCTURES, AS WELL AS EXPECTATIONS FOR THE STRUCTURE COMPLEX HYDRAULIC AND GEOMORPHIC ZONE OF INFLUENCE (ZOI).

The design presented here is specific to a first phase (i.e., phase 01) of structural treatments. The phase 01 design consists of roughly 325 BDA and PALS distributed among the three design reaches. The number and locations of individual structures are also prescribed according to 33 structure complexes. Structure complexes are groups of structures designed to work together to accomplish local geomorphic and/or hydrologic outcomes. Complex level site plans are used to convey the design intent and used to guide construction crews during implementation. Complete complex level site plans can be found in Appendix [8.1 Appendix](#). Each complex level site plan includes the following pieces of information:

- **COMPLEX NAME** – A unique name used to reference and individual complex (i.e., Complex 01).
- **STRUCTURE SPECIFICATION** – Number of structures of each type (i.e., PAL or BDA structures) specified within the complex. Structure specifications are expressed as a range as in most cases the specific placement of individual structures will be fit during implementation.
- **DESIGN / CONSTRUCTION NARRATIVE** – A short narrative conveying the complex design intent, or considerations that should be recognized during implementation.
- **COMPLEX OBJECTIVE** - Individual complexes are also designed to directly support overall project objectives (see [3.1 Restoration Objectives](#)). Assignment of a primary objective to each complex helps to convey specifics of the design and allows future evaluation of complex effectiveness in achieving a specific set of outcomes.
- **COMPLEX ZONE OF INFLUENCE** – The complex zone of influence (ZOI) is the area that is expected to be either hydrologically or geomorphically influenced by the structures within a complex in response to a typical flood (i.e., ~ 2-year recurrence flood). The ZOI conveys much of the design intent for the structure complex, and treatment design.



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## 5 IMPLEMENTATION

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Implementation considerations are specific to site access, damage to existing riparian or wetland areas, channel material fill estimates, equipment hygiene, and other practical considerations that may influence implementation and/or permitting for the structural treatment plan.

### 5.1 SITE ACCESS

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Site access and travel within the project area is simple and formation of new roads will not be required during project implementation. A road entering the southern end of the project area parallels the channel and is suitable for trucks and trailers. In most cases, the access road is outside of areas within the valley bottom that may become active floodplain or be impacted by the active channel. Proximity of much of the project area to the road allows implementation to commence without the need for vehicles and equipment to damage existing fragile riparian areas.

### 5.2 STRUCTURE MATERIAL TYPES AND FILL VOLUME ESTIMATES

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Alder, willow, and other deciduous trees and shrubs are sufficient to support construction of BDAs and PALS throughout much of the project area. These materials can also be supplemented with sagebrush and juniper whenever possible. Vegetation for structure construction may be limiting within the Comstock Basin design reach. However, abundant vegetative material found just downstream offers an accessible source of material that can be efficiently transported to structure construction locations.

Typical structure sizes and fill volumes (yds<sup>3</sup>) are found in [Table 6](#), and [Table 7](#) also provides an estimated total project structure length and fill volumes in the format required for the DSL/USACE Joint Permit Application (JPA). These estimates are extended through the full three phases of the project as required by the JPA. Structural treatments in subsequent phases have been estimated at 15% of the material and effort needed to accomplish Phase 1, however the distribution of effort and materials may differ slightly according to project adaptive management considerations.

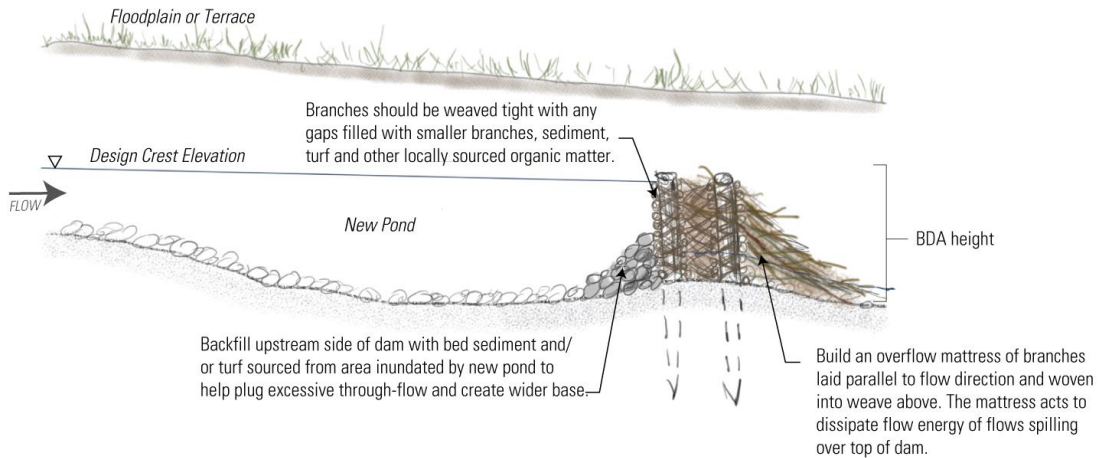
TABLE 6. DESCRIPTION AND TYPICAL DIMENSIONS FOR STRUCTURES TYPES WITHIN THE RESTORATION TREATMENT PLAN. ALSO SHOWING APPROXIMATE FILL VOLUME BASED ON THE VOLUME OF VEGETATIVE MATERIALS, POSTS, AND SEDIMENT THAT WOULD BE ADDED TO STRUCTURES.

STRUCTURE SPECIFICATION	DESCRIPTION	TYPICAL DIMENSIONS
BDA	BDA structures ranging between 15 and 40 ft. that will do most of the pond creation and flow dispersal. Structures will be typical in unconfined sections of channel with wide valley bottoms, and areas featuring wide inset floodplain surfaces.	Length: 15' – 50' Width: 1.5' – 3' Height: 1.5' – 3.5' Volume: 0.9 yds <sup>3</sup>
PALS	Will primarily be used in areas featuring a narrow-inset floodplain to enhance rates of inset floodplain widening and channel complexity (i.e., pool and bar creation). PALS should primarily be constructed of locally harvested mature alder, sagebrush, and juniper.	Length: 10' – 30' Width: 4' – 8' Height: 2' – 4' Volume: 0.5 yds <sup>3</sup>

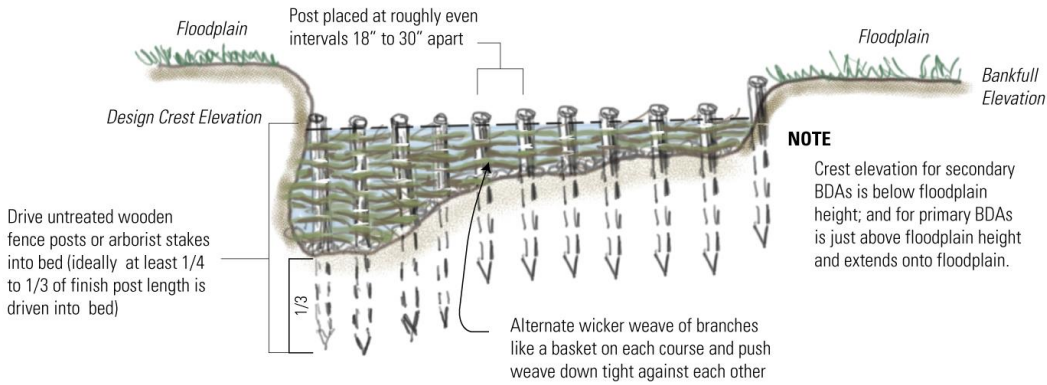
TABLE 7 FILL DIMENSIONS FOR THE DEPARTMENT OF STAT LANDS AND ARMY CORPS OF ENGINEERS JOINT PERMIT APPLICATION. THESE FILL ESTIMATES ARE CALCULATE FROM THE TOTAL FEET OF PALS AND BDAs IN THE DESIGN MULTIPLIED BY THE AVERAGE FILL VOLUME PER FOOT (0.031 YDS<sup>3</sup> FOR BDAs AND 0.019 YDS<sup>3</sup> FOR PALS).

Wetland / Waterbody Name*	Fill Dimensions					Duration of Impact	Material
	Length (ft.)	Width (ft.)	Depth (ft.)	Area (sq. ft. or ac.)	Volume (c.y.)		
Thirtymile – Phase 1	8169	2	1	16338	232.6	Permanent	70% Vegetation 17% Soil 13% Posts
Thirtymile – Phase 2	1225	2	1	2451	34.9	Permanent	70% Vegetation 17% Soil 13% Posts
Thirtymile – Phase 3	1225	2	1	2451	34.9	Permanent	70% Vegetation 17% Soil 13% Posts

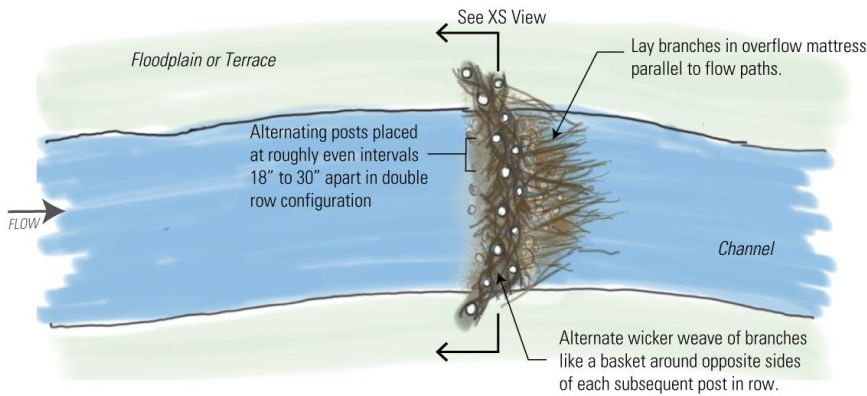
**PROFILE VIEW**



**X-SECTION VIEW**



**PLANFORM VIEW**



**FIGURE 22. BUILDING SCHEMATICS FOR POST – ASSISTED BEAVER DAM ANALOGS THAT WILL BE ADAPTED TO THE THIRTYMILE CREEK STRUCTURAL TREATMENT PLAN.**

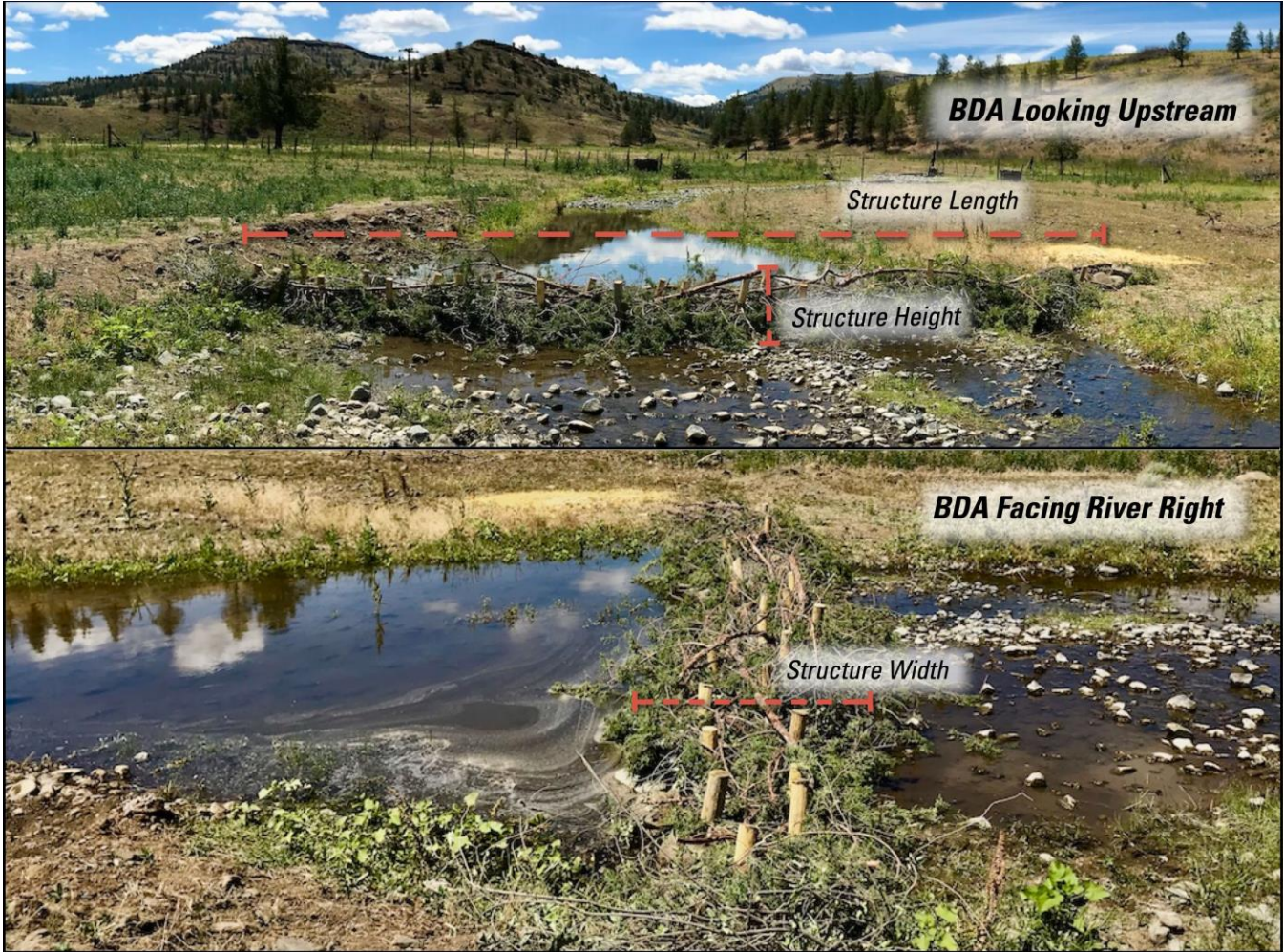


FIGURE 23. EXAMPLE OF BDA STRUCTURES BUILT USING SIMILAR MATERIALS AND OF SIMILAR DIMENSIONS TO THOSE EXPECTED FOR THE UPPER THIRTYMILE PROJECT.

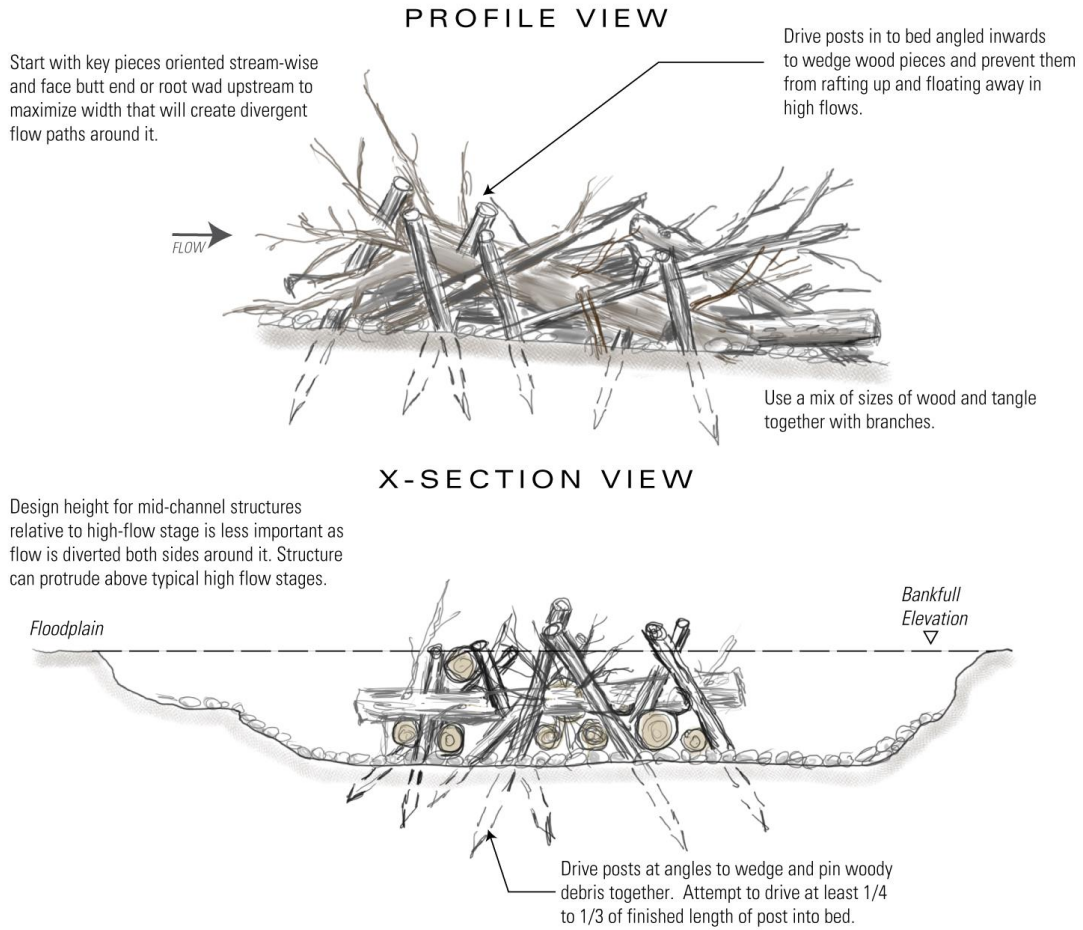


FIGURE 24. CONCEPTUAL SCHEMATIC OF A POST – ASSISTED LOG STRUCTURE (PALS).

**PALS - POST ASSISTED LOG STRUCTURE  
STRUCTURE DIMENSIONS**



FIGURE 25. TYPICAL EXAMPLE OF A POST – ASSISTED LOG STRUCTURES (PALS) SHOWING STRUCTURE DIMENSIONS USED IN STRUCTURE SPECIFICATION

### 5.2.1 BUILDING MATERIAL STAGING AND TRANSPORT

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LTPBR projects are designed to minimize the need for heavy equipment (i.e., excavators) generally required to move large pieces of woody debris and/or to regrade the channel and floodplain surfaces. Instead, the Thirtymile Creek LTPBR restoration approach relies on structural treatments that can be built using primarily human power (i.e., by 2 to 3 individuals). Woody material and posts are expected to be transported to locations proximal to structure construction using all-terrain vehicles (ATVs) and off-road vehicles (ORVs). However, no off-road travel by vehicles or trailers will be required over sensitive riparian areas or within the active channel. If access allows, an ATV or ORV will be used to transport the hydraulic post driver and power pack between structures during construction.

## 5.3 CAUTIONARY MEASURES TO MINIMIZE IMPACTS

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Several precautions will be undertaken to minimize the potential for adverse outcomes and impacts to sensitive species, with special consideration for the salmonids that utilize habitat within the project area. It is also worth noting that in many cases, structures may be installed within dry sections of channel where impacts to fish populations are not of concern. However, disturbance to fish populations during structure installation and maintenance is also thought to be minimal.

All in-stream work will be conducted during dates consistent with the in-stream work window set by the Oregon Department of Fish and Wildlife and meant to minimize impacts to threatened and endangered fish species.

To further minimize stress to any fish present, no installation or maintenance activities will occur within the wetted channel when stream temperatures exceed 20°C.

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 (~ 5 m) and for a short duration (several hours) and at levels that are not thought to impact juvenile steelhead.

Fish near structures during installation may respond by seeking cover elsewhere while personnel are present within the wetted channel. This displacement will be short-term, and the resulting restoration actions will result in increased cover by the structure and as water depths immediately increase.

The Thirtymile Creek restoration plan was also designed and will be implemented in accordance with criteria and recommendations provided by ODFW's Screening and Fish Passage Program to minimize the potential that structures could limit juvenile and adult steelhead passage. These design criteria include:

Maintaining a minimum horizontal spacing between untreated posts within each BDA greater than 1 ft.

- Building BDAs using a porous vegetation-weave that maintains numerous spaces greater than 3 inches.
- Structure designs that promote flow over and adjacent to the structure, which will insure adult steelhead passage during high flow.
- Maintaining a maximum difference between the upstream and downstream water surface elevation of no more than 6 inches.

### 5.3.1 EQUIPMENT MAINTENANCE AND HYGIENE

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The equipment requirements for installation of LTPBR structures (e.g., PALS & BDAs) is primarily limited to a hydraulic power source used to power a hydraulic post pounder ([Figure 26](#)). The hydraulic power source is mounted on a rolling frame and is roughly the size of a wheelbarrow and can be moved among restoration

locations by a single person. In most cases, posts will be driven to a depth of approximately 30 cm and will not exceed 60 cm. The amount of time spent at individual structures is low (e.g., several hours) and it is unlikely that these activities will result in the formation of permanent trails or significant soil disturbance.



FIGURE 26. TYPICAL HYDRAULIC POWER SOURCE AND POST POUNDER USED TO DRIVE POSTS REQUIRED FOR CONSTRUCTION OF BDAs.

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## 6 CONCLUSION

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This section of Thirtymile presents an impressive opportunity to restore aquatic ecosystem function and increase juvenile steelhead rearing and survival within a degraded riverscape. The restoration plan and design outline a pathway toward riverscape recovery in the form of specific restoration actions, implementation guidelines, and indicators of restoration progress. The project is also a part of greater than 30 river–miles of process – based aquatic habitat restoration that is being implemented within the Thirtymile Creek watershed as part of an OWEB focused investment partnership, which together represents a truly significant expansion of threatened steelhead population habitat quantity within the John Day Basin.

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## 7 REFERENCES

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- Beechie, T., Sear, D.A., Olden, J.D., Pess, G.R., Buffington, J.M., Moir, H., Roni, P. and Pollock, M.M., 2010. Process-based principles for river restoration. *Bioscience*, 60(3): 209-222. DOI: [10.1525/bio.2010.60.3.7](https://doi.org/10.1525/bio.2010.60.3.7)
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## 8 APPENDICES

The following appendices provide complete site – plans ([8.1 Appendix:](#)) for each phase 01 structure complex, as well as several other pieces of supplementary information. Supplementary information includes links to all figures ([8.4.4](#)) and spatial data products produced during the design development process ([8.4.2](#)), as well as permitting documents submitted for the first phase of structural treatments ([8.4.1](#)).

### 8.1 APPENDIX: STRUCTURAL TREATMENT DESIGNS

Complete site plans for phase 01 structural treatment planning for each reach. Complex plans showing the approximate placement of individual structures.

#### 8.1.1 COMPLEX DESIGNS: JUMP OFF JOE

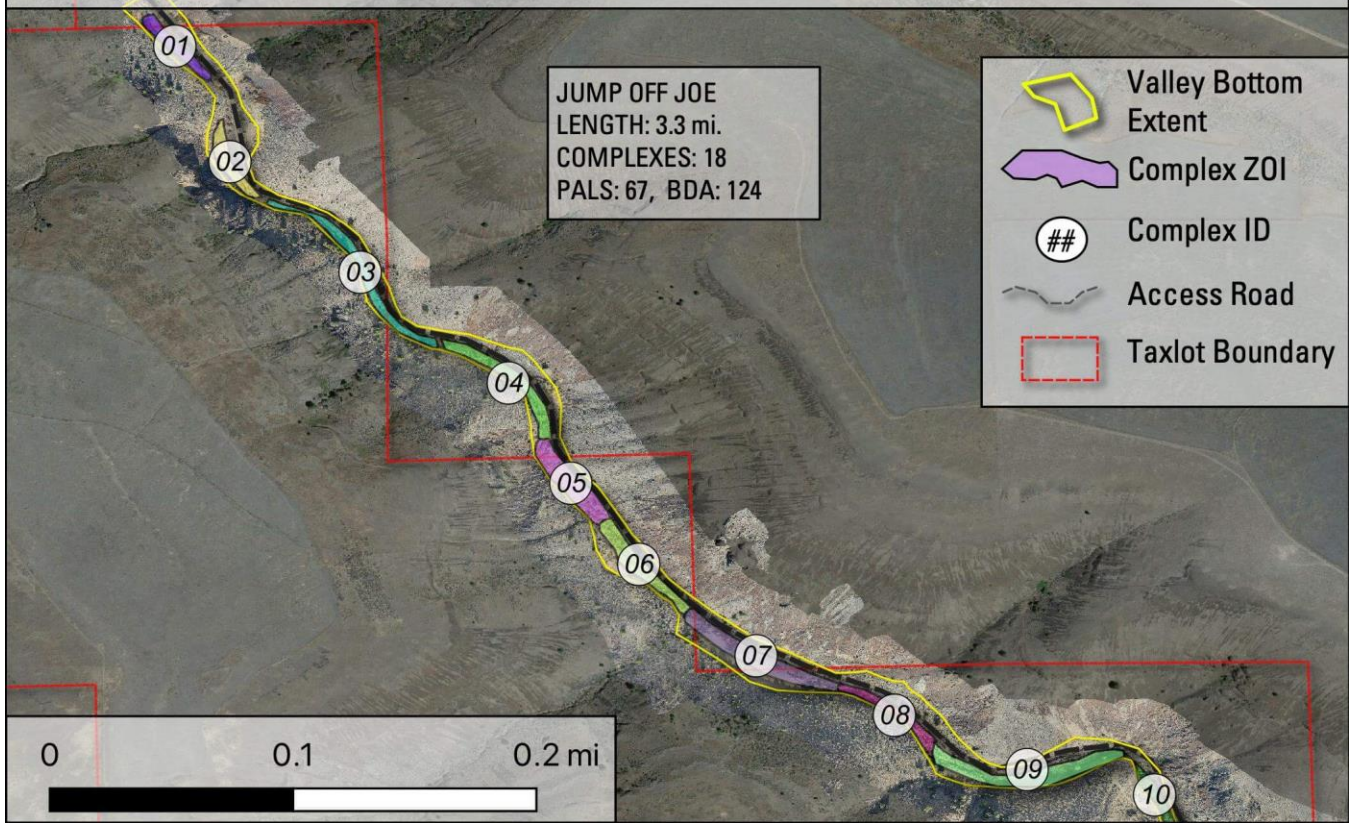
TABLE 8. DESIGN AND FUNCTION SPECIFICATION, COORDINATES, AND NUMBER OF STRUCTURES FOR THE JUMP OFF JOE TREATMENT REACH.

COMPLEX	DESCRIPTION	COORDINATES	BDA	PALS
1	Most downstream complex in incised channel section. Extend BDA structures onto inset floodplain where possible. Several PALS should be oriented to recruit sediment from hillslope river left.	-120.1258, 45.11443	5	3
2	Orient upstream PALS to continue lateral channel migration toward river left. BDA structures downstream should encourage aggradation and wetland expansion on low river right surface on inside of meander.	-120.12487, 45.11249	4	3
3	Long narrow section. Focus on building BDA structures in wide sections with inset floodplains. Use PALS in narrow sections to add complexity and enhance erosion rates.	-120.12268, 45.11063	8	5
4	Where possible orient structures near opportunities for surface flow / pond expansion on river left inset floodplains surfaces.	-120.12019, 45.10877	7	2
5	Extend BDA structures onto lower river right inset floodplain at downstream end of complex. PALS enhance complexity and erosion.	-120.11914, 45.10708	5	4
6	Long-term goal of floodplain establishment on river left high surface. Begin upstream erosion with PALS, and downstream BDA structures for aggradation.	-120.118, 45.10572	6	5
7	Complex should strive for floodplain develop and riparian expansion on river left high surface. Rely on BDA structures spanning inset channel for aggradation and pond creation.	-120.11603, 45.10418	4	6
8	Long narrow section offering little in terms of floodplain expansion. potential Focus on development of pools and ponds using combination of BDA and PALS.	-120.1137, 45.10318	6	0
9	Some high elevation floodplain pockets that may allow inset floodplain expansion. BDAs should be placed among multi-threaded channels within the inset floodplain.	-120.11147, 45.10227	12	2

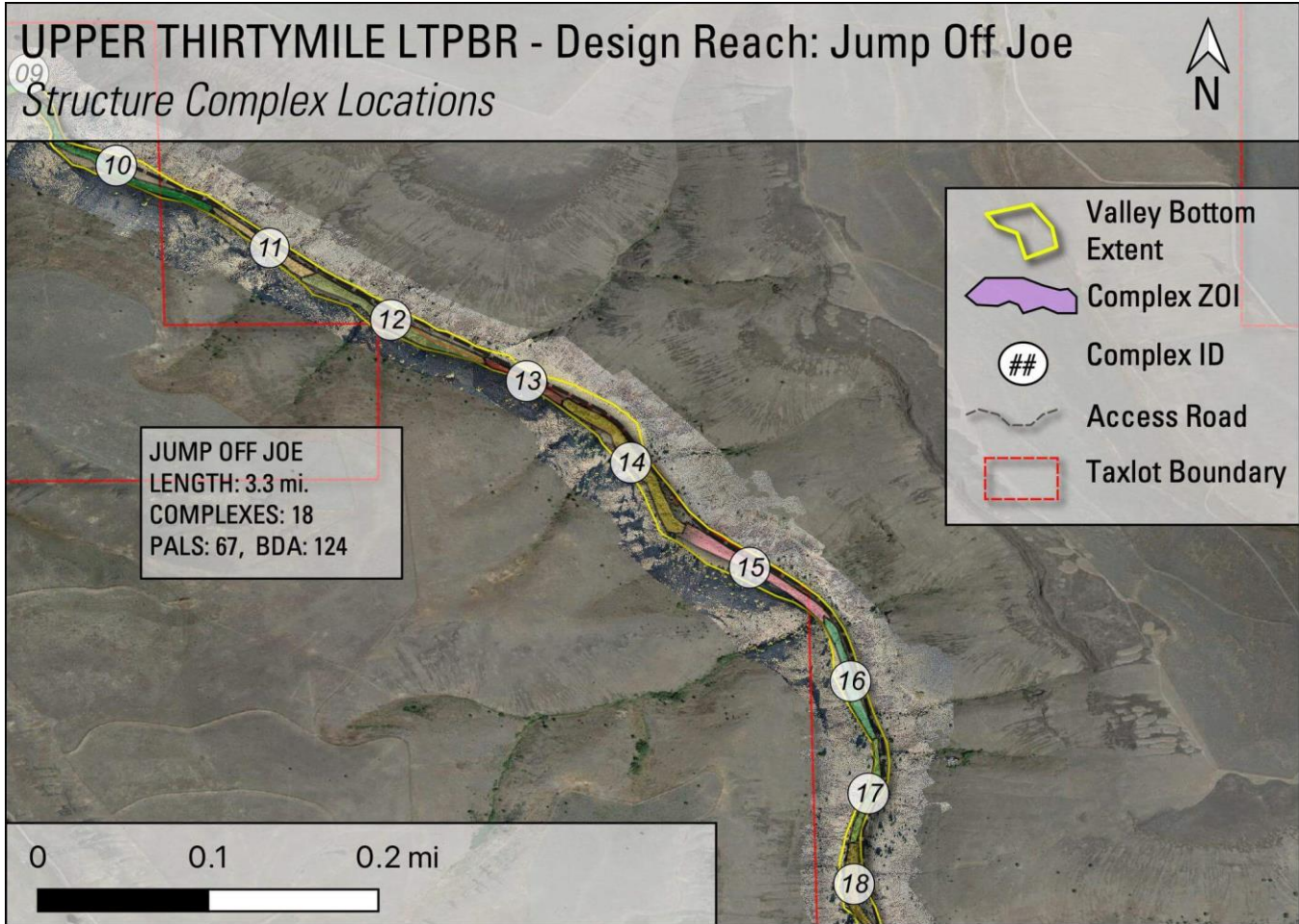
COMPLEX	DESCRIPTION	COORDINATES	BDA	PALS
10	Section with more extensive valley bottom as high floodplains left and right. Long-term goal for floodplain and/or riparian expansion on these surfaces through lateral erosion (widening) or floodplain connectivity. PALS at lower end of complex should contribute to sediment recruitment to downstream BDA complex.	-120.10767, 45.10063	12	4
11	Long, straight, incised section. Focus on PALS to induce erosion of trench walls for capture and aggradation at downstream complex.	-120.10399, 45.09865	4	4
12	Primary focus on pond creation within inset floodplain pockets using BDA structures. Several PALS should contribute to incision trench widening.	-120.10107, 45.09693	12	5
13	Completely incised section between valley walls. PALS may offer increases in habitat complexity and sediment mobilization for aggradation at downstream complexes. Include several BDA structures where ponding is possible.	-120.09782, 45.09546	3	4
14	Extend BDA structures onto lower inset floodplains for pond creation and surface water storage.	-120.09531, 45.0935	8	2
15	Long-term potential for riparian vegetation expansion across extensive high elevation floodplain surface river left. Utilize BDA structures within incision trench for aggradation and pond creation.	-120.09246, 45.09097	9	2
16	Several upstream PALS should be followed by series of BDA structures downstream	-120.09003, 45.08825	7	4
17	Long incised section. Primary focus will be on alternating river left and right PALS to encourage complexity and sediment recruitment for downstream aggradation. Post-less jams may be constructed in bedrock dominated areas.	-120.0896, 45.08555	2	9
18	BDA structures should focus on floodplain expansion on lower river right surfaces.	-120.08963, 45.08263	11	2
			<b>125</b>	<b>66</b>

# UPPER THIRTYMILE LTPBR - Design Reach: Jump Off Joe

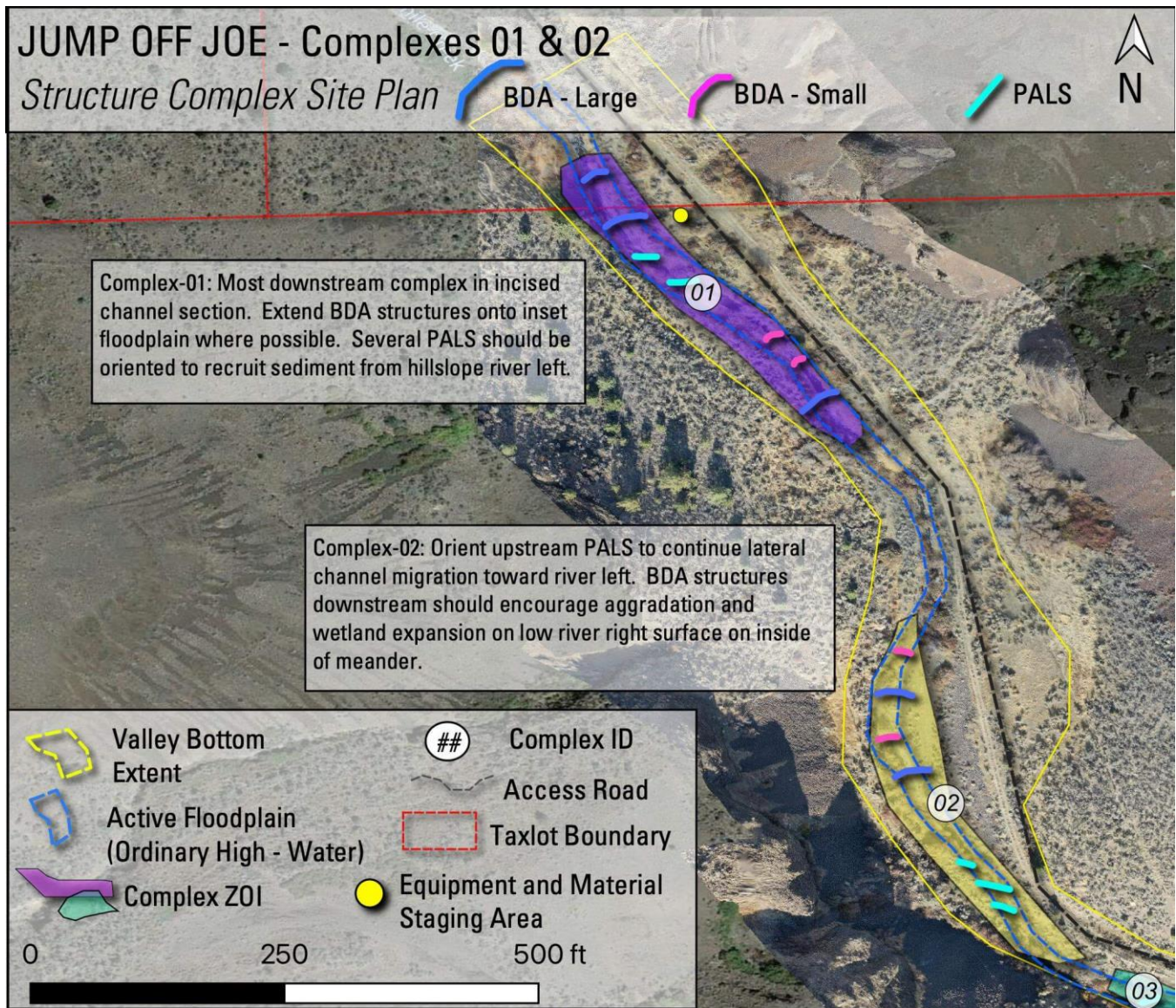
*Structure Complex Locations 01 - 09*



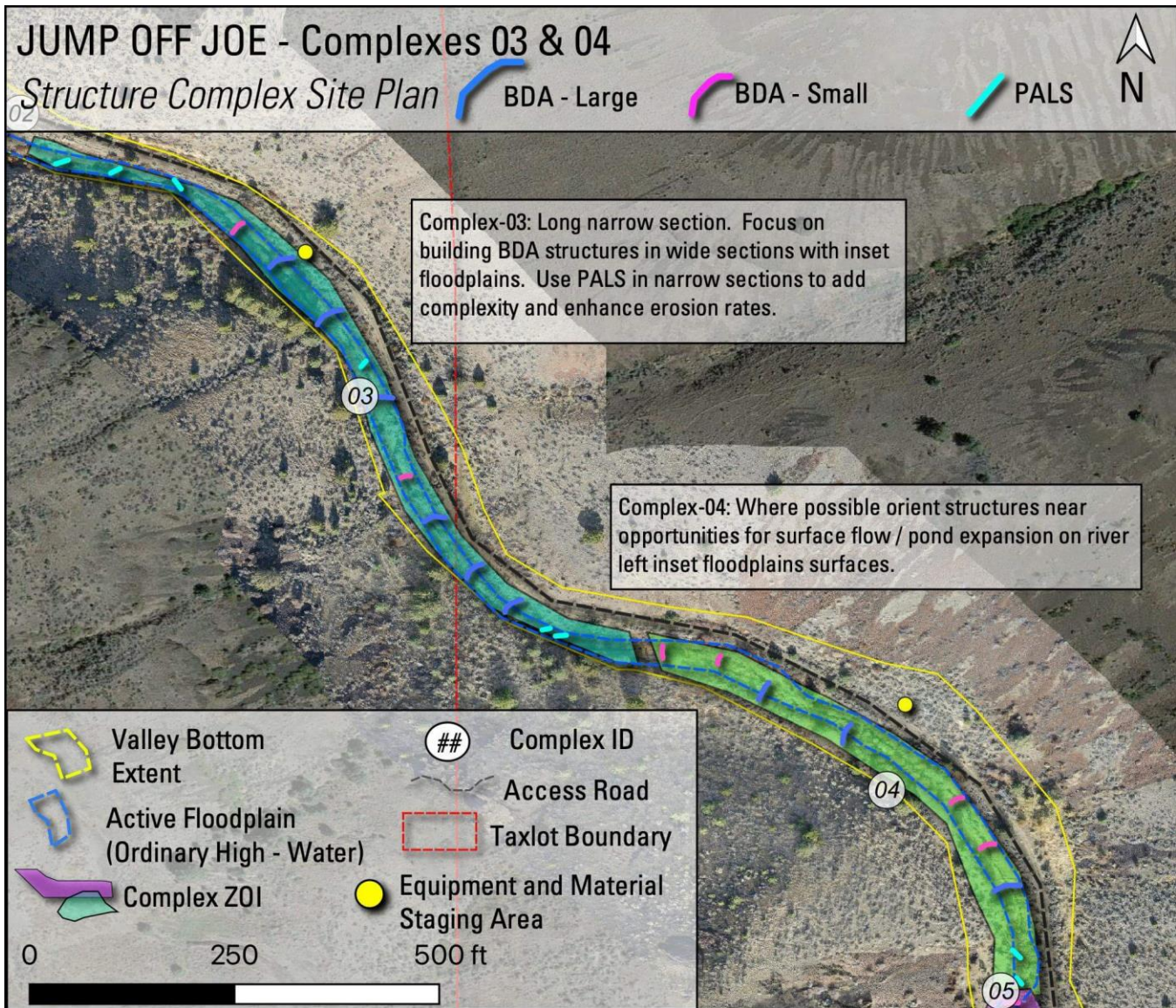
OVERVIEW OF THE RESTORATION REACH SHOWING THE LOCATION OF EACH STRUCTURE COMPLEX.



OVERVIEW OF THE RESTORATION REACH SHOWING THE LOCATION OF EACH STRUCTURE COMPLEX.



STRUCTURE COMPLEX SITE PLAN




STRUCTURE COMPLEX SITE PLAN

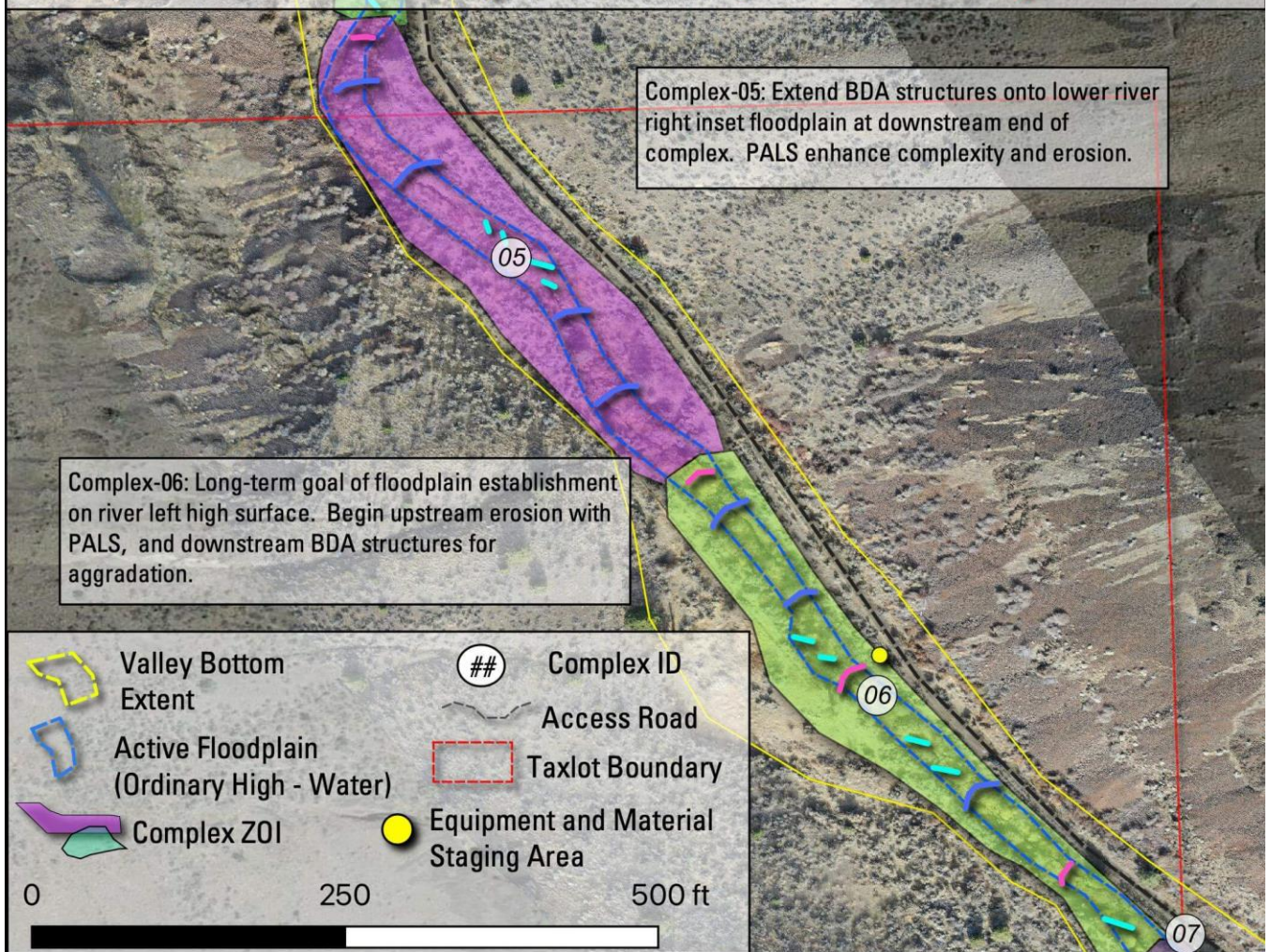
# JUMP OFF JOE - Complexes 05 & 06

## Structure Complex Site Plan

 BDA - Large

 BDA - Small


 PALS




STRUCTURE COMPLEX SITE PLAN

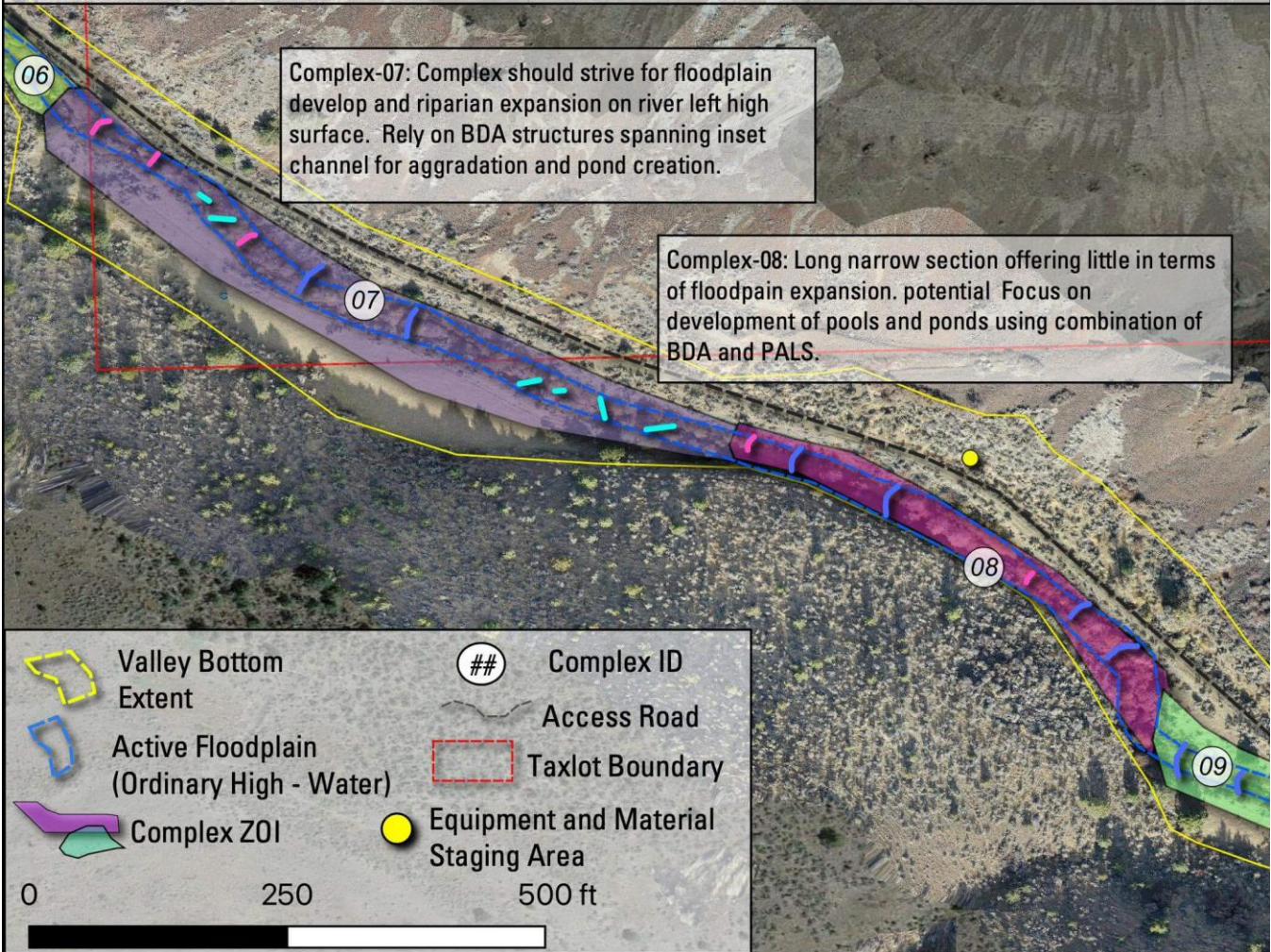
# JUMP OFF JOE - Complexes 07 & 08

## Structure Complex Site Plan

 BDA - Large

 BDA - Small

 PALS





STRUCTURE COMPLEX SITE PLAN



# JUMP OFF JOE - Complexes 09 & 10

## Structure Complex Site Plan

 BDA - Large

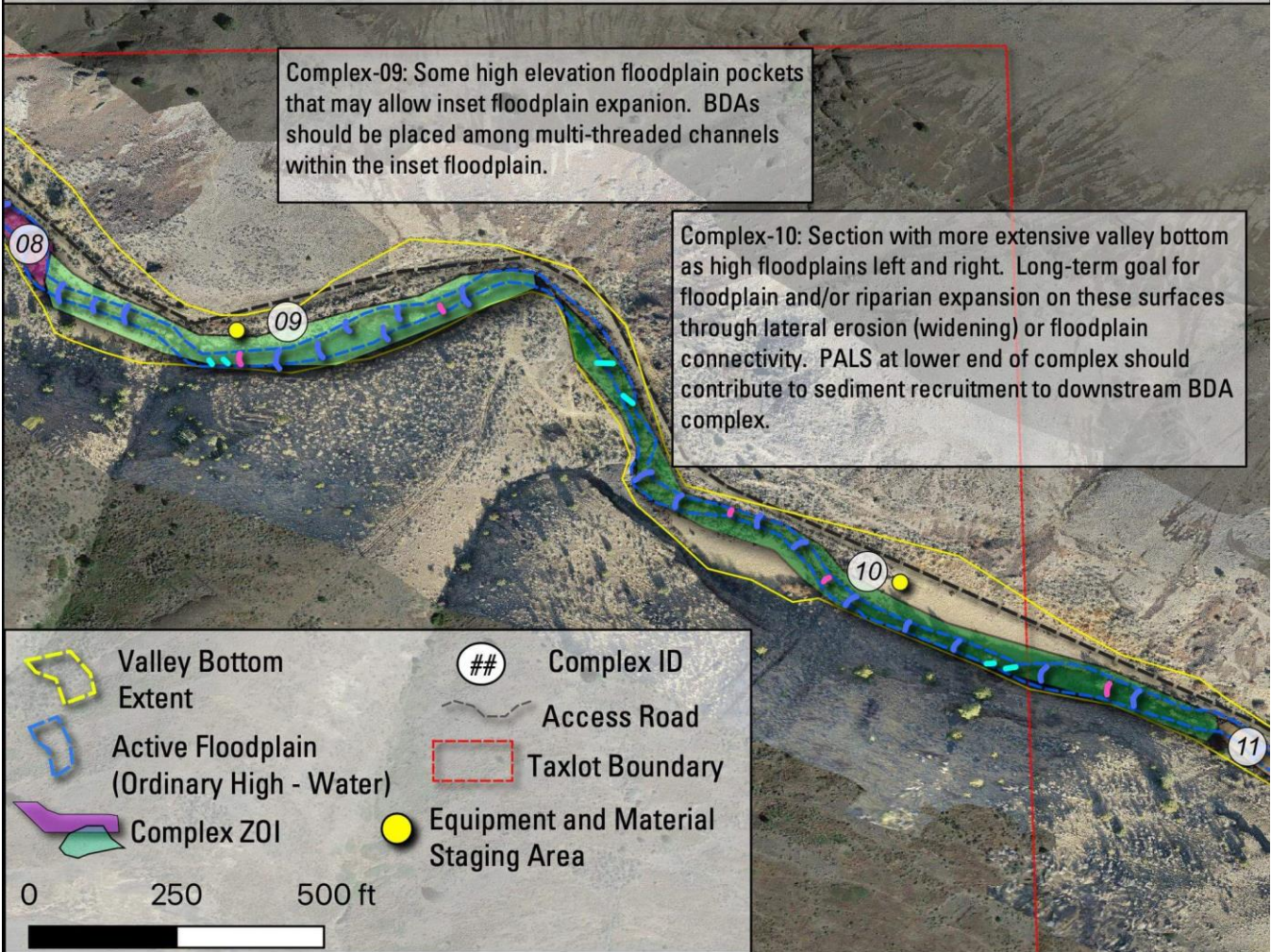
 BDA - Small

 PALS



Complex-09: Some high elevation floodplain pockets that may allow inset floodplain expansion. BDAs should be placed among multi-threaded channels within the inset floodplain.

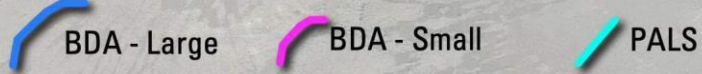
Complex-10: Section with more extensive valley bottom as high floodplains left and right. Long-term goal for floodplain and/or riparian expansion on these surfaces through lateral erosion (widening) or floodplain connectivity. PALS at lower end of complex should contribute to sediment recruitment to downstream BDA complex.



STRUCTURE COMPLEX SITE PLAN

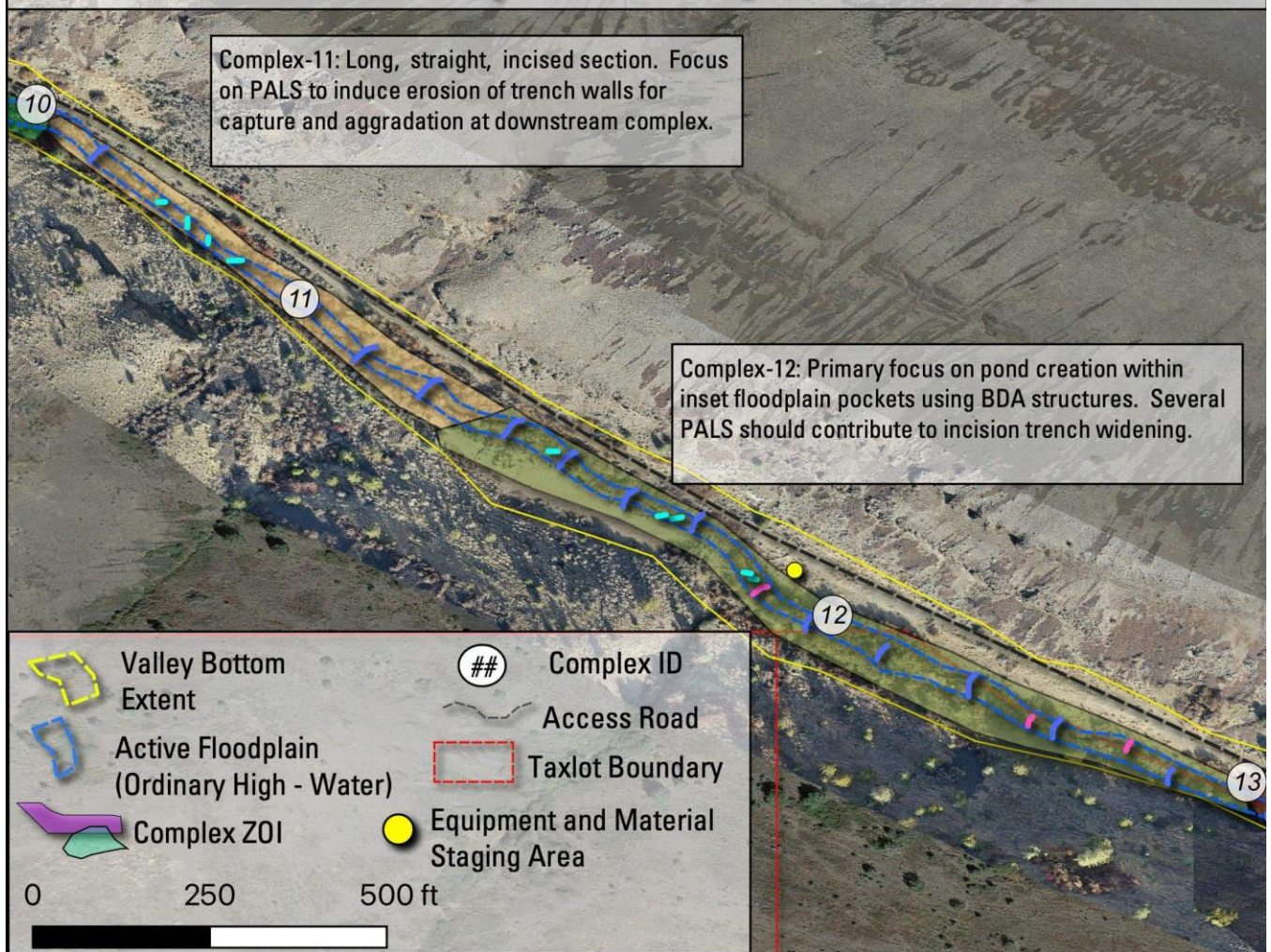
# JUMP OFF JOE - Complexes 11 & 12

## Structure Complex Site Plan



Complex-11: Long, straight, incised section. Focus on PALS to induce erosion of trench walls for capture and aggradation at downstream complex.




Complex-12: Primary focus on pond creation within inset floodplain pockets using BDA structures. Several PALS should contribute to incision trench widening.

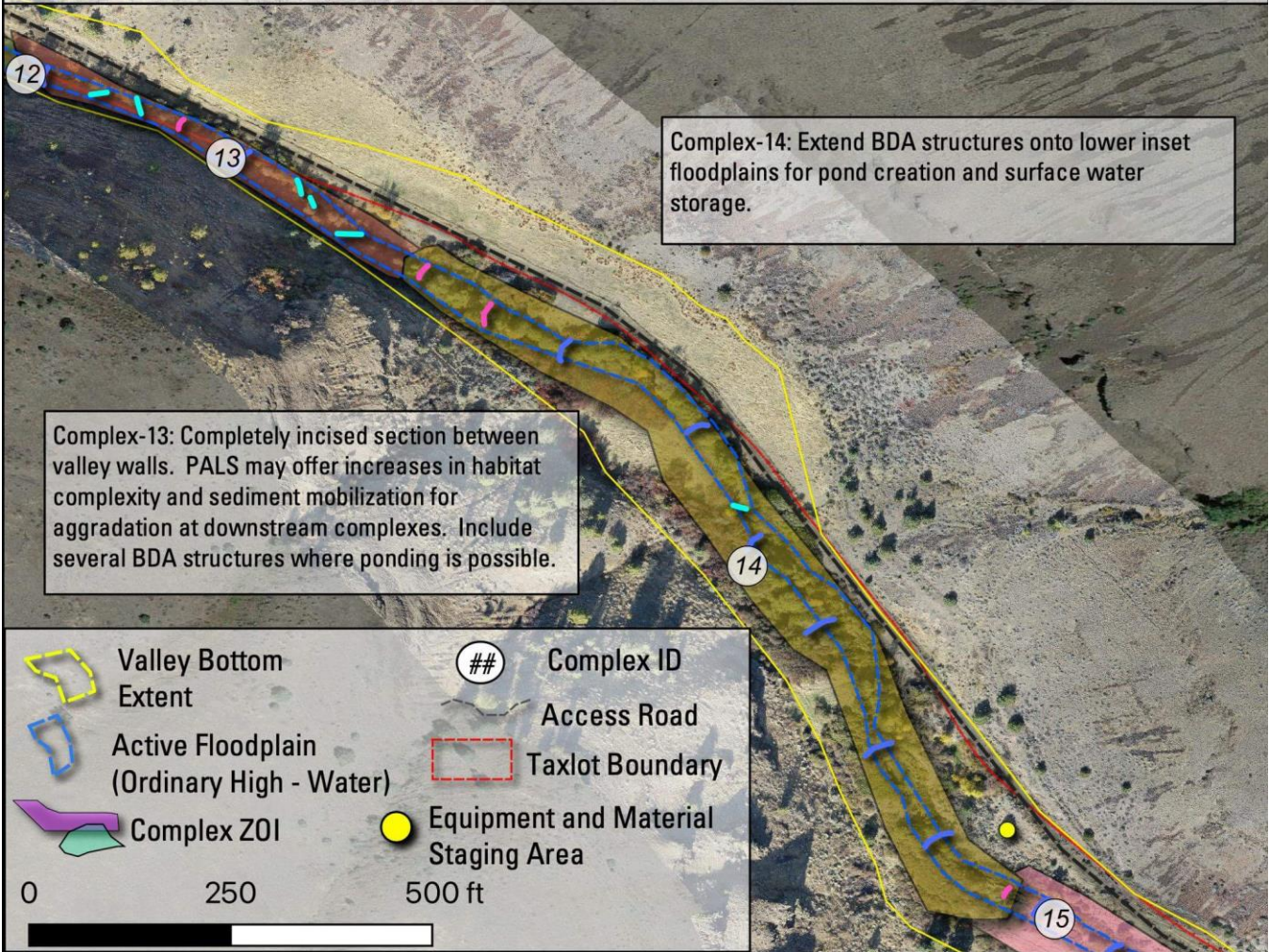


STRUCTURE COMPLEX SITE PLAN

# JUMP OFF JOE - Complexes 13 & 14

## Structure Complex Site Plan


 BDA - Large    
  BDA - Small    
  PALS





STRUCTURE COMPLEX SITE PLAN

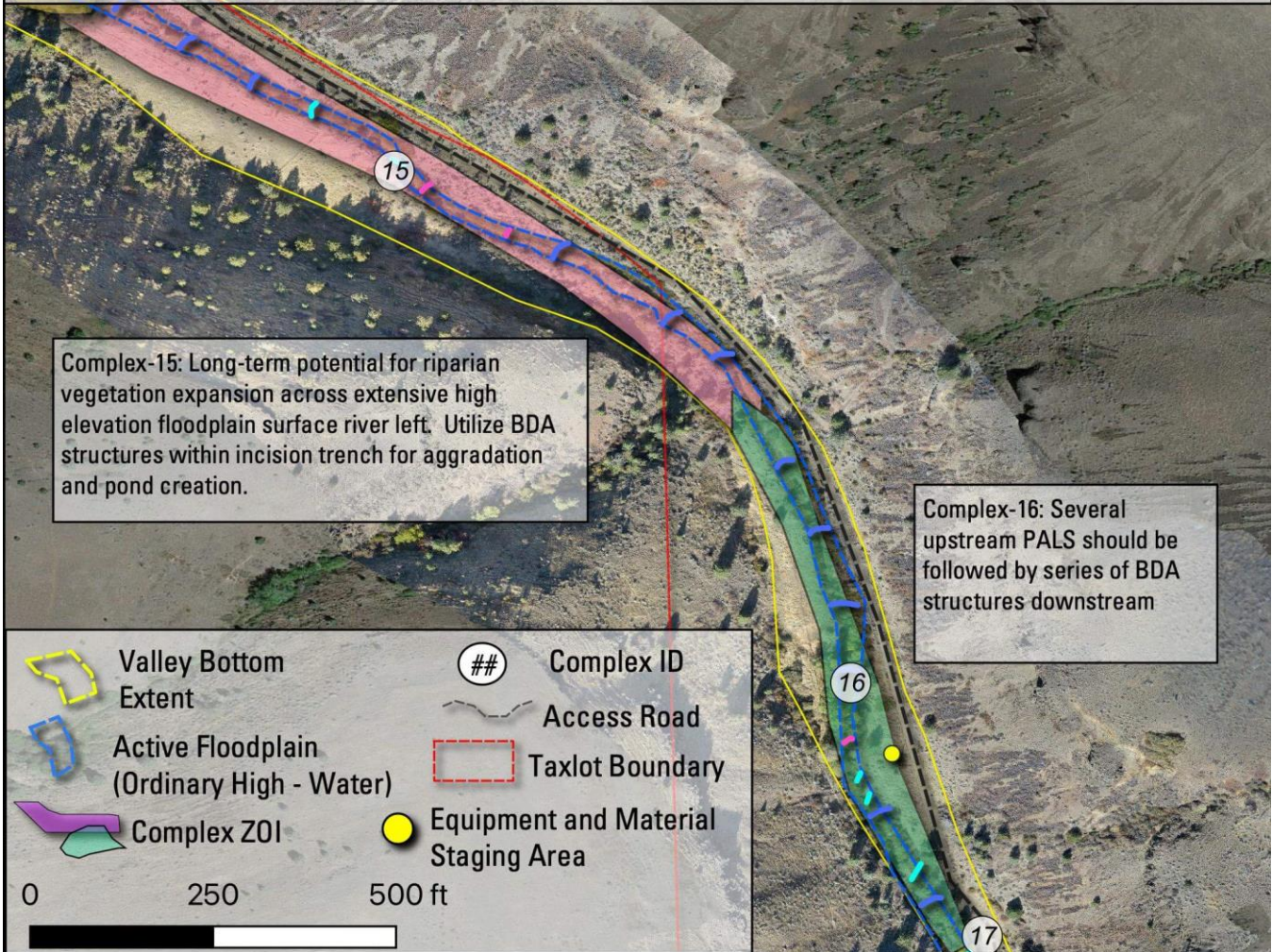
# JUMP OFF JOE - Complexes 15 & 16

## Structure Complex Site Plan

 BDA - Large








 BDA - Small

 PALS



Complex-15: Long-term potential for riparian vegetation expansion across extensive high elevation floodplain surface river left. Utilize BDA structures within incision trench for aggradation and pond creation.

Complex-16: Several upstream PALS should be followed by series of BDA structures downstream

 Valley Bottom Extent	 Complex ID
 Active Floodplain (Ordinary High - Water)	 Access Road
 Complex ZOI	 Taxlot Boundary
	 Equipment and Material Staging Area

0      250      500 ft

STRUCTURE COMPLEX SITE PLAN

# JUMP OFF JOE - Complexes 17 & 18

## Structure Complex Site Plan

BDA - Large








BDA - Small

PALS



Complex-17: Long incised section. Primary focus will be on alternating river left and right PALS to encourage complexity and sediment recruitment for downstream aggradation. Postless jams may be constructed in bedrock dominated areas.

Complex-18: BDA structures should focus on floodplain expansion on lower river right surfaces.

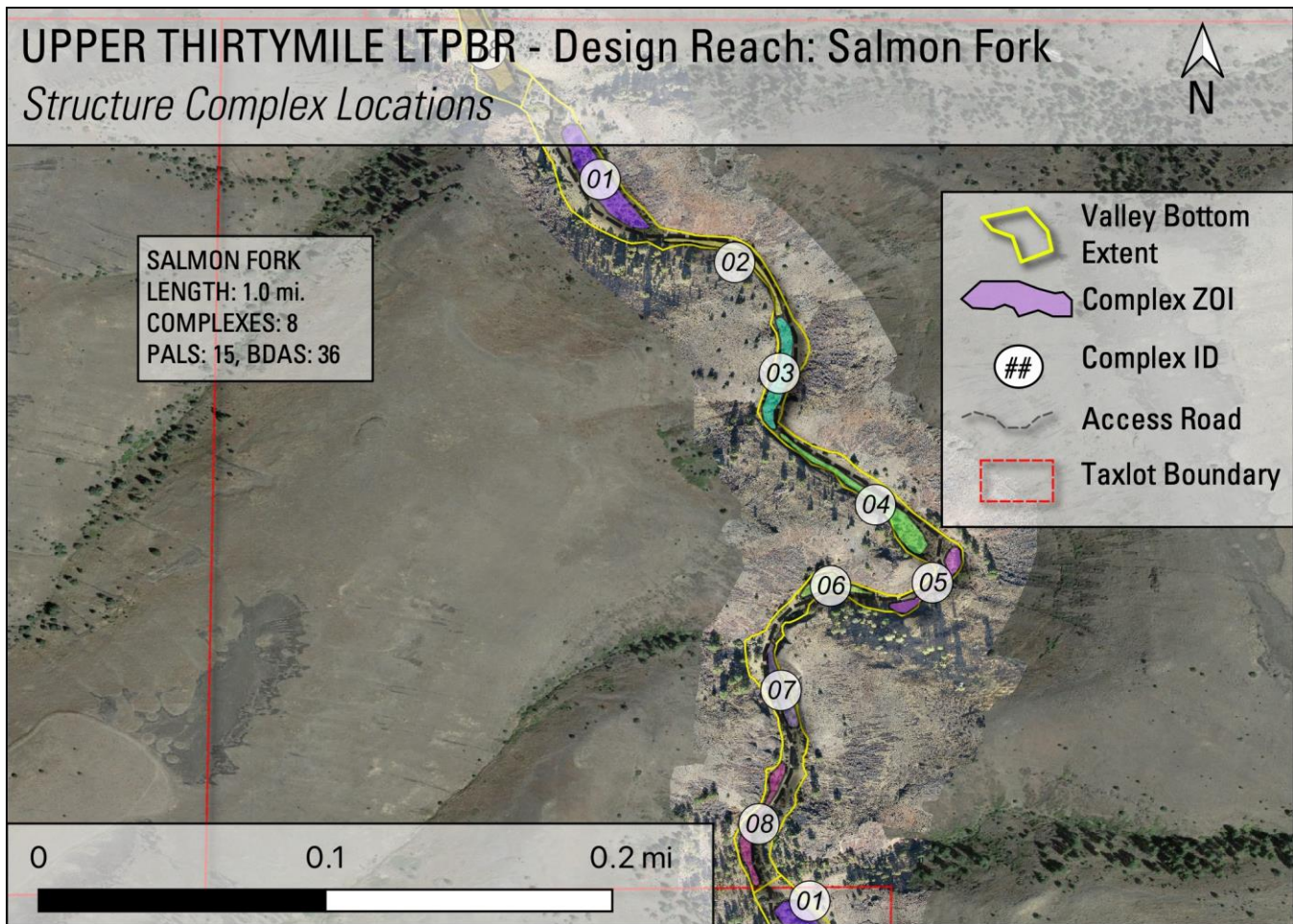
	Valley Bottom Extent		Complex ID
	Active Floodplain (Ordinary High - Water)		Access Road
	Complex ZOI		Taxlot Boundary
0      250      500 ft			Equipment and Material Staging Area

STRUCTURE COMPLEX SITE PLAN

8.1.2 COMPLEX DESIGNS: SALMON FORK

TABLE 9. DESIGN AND FUNCTION SPECIFICATION, COORDINATES, AND NUMBER OF STRUCTURES FOR THE SALMON FORK TREATMENT REACH.

COMPLEX	DESCRIPTION	COORDINATES	BDA	PALS
1	First complex within the reach. Ample valley bottom space with low elevation surfaces offering floodplain expansion potential. Consider fence and road crossing at downstream end of the complex.	-120.08749, 45.0796	5	2
2	Heavily confined section. Focus on channel spanning BDAs with some PALS to increase complexity and sediment recruitment.	-120.08557, 45.07841	3	5
3	Ample low elevation surface for floodplain expansion on valley left using large BDA structures.	-120.08493, 45.07683	5	0
4	Narrow and confined complex. Build BDAs in proximity to low surfaces and PALS near erodible hillslopes. Several large BDA structures at upstream end of complex.	-120.08356, 45.07496	8	4
5	Pond development at low elevation floodplains through BDA construction. Bedrock may limit building in some locations. Avoid flooding of road crossings when possible.	-120.08275, 45.07385	4	2
6	BDA should be used to enhance inundation frequency of valley left floodplain feature. Avoid structure construction on road crossings.	-120.0842, 45.0738	3	0
7	Use channel and floodplain spanning BDAs to increase pond development and complexity. Bedrock in lower end of complex may limit post ponding.	-120.08491, 45.07231	4	0
8	Most upstream complex in reach. Focus large BDA construction at floodplain pockets between bedrock confined sections. Potential for PALS to increase erosional rates on erosive hillslopes.	-120.08522, 45.07041	4	2
			<b>36</b>	<b>15</b>



OVERVIEW OF THE RESTORATION REACH SHOWING THE LOCATION OF EACH STRUCTURE COMPLEX.

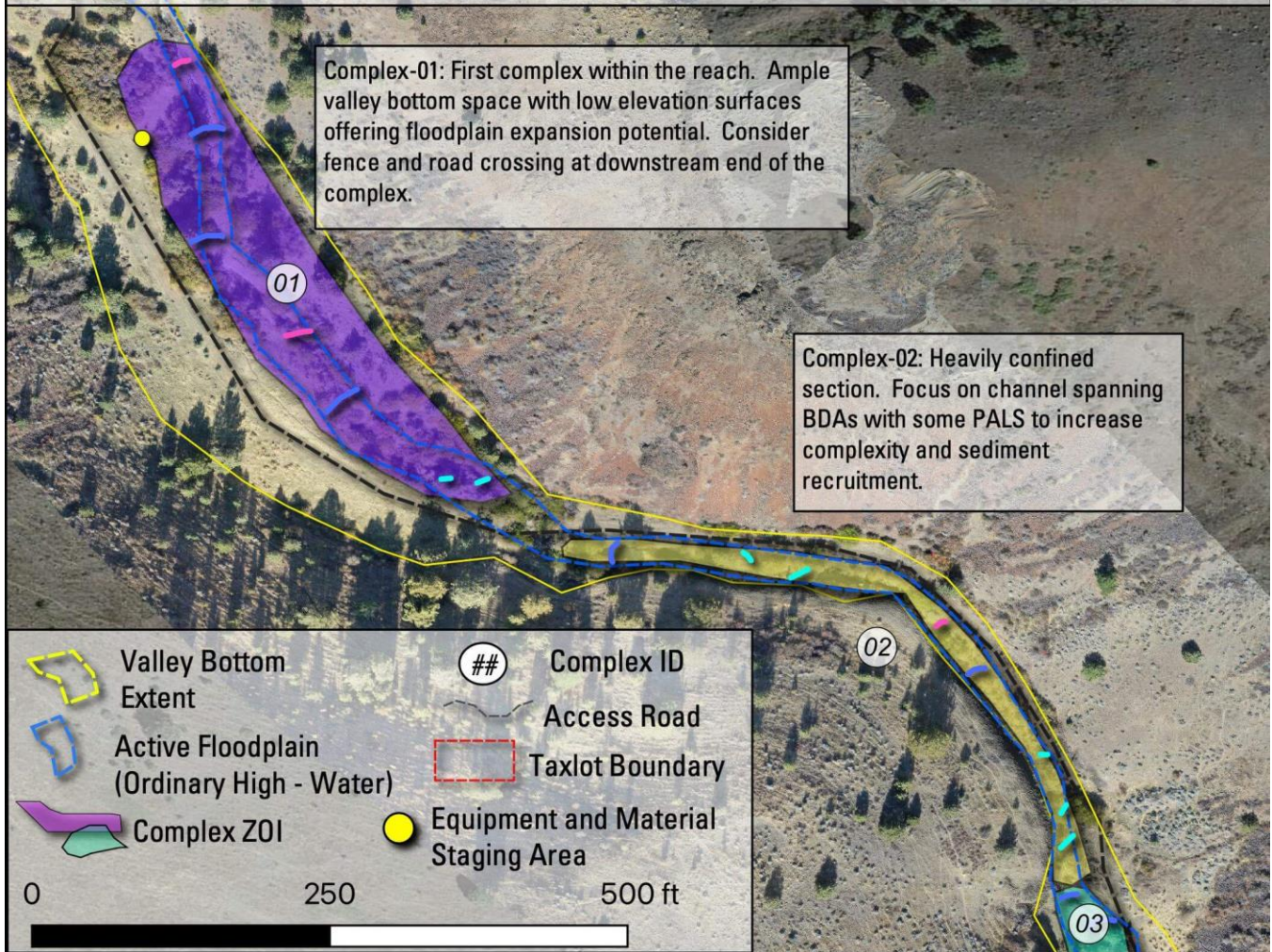
# SALMON FORK - Complexes 01 & 02

## Structure Complex Site Plan

BDA - Large

BDA - Small

PALS



STRUCTURE COMPLEX SITE PLAN




# SALMON FORK - Complexes 03 & 04

## Structure Complex Site Plan









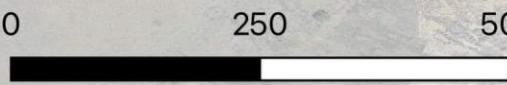

 BDA - Large

 BDA - Small

 PALS

Complex-03: Ample low elevation surface for floodplain expansion on valley left using large BDA structures.

Complex-04: Narrow and confined complex. Build BDAs in proximity to low surfaces and PALS near erodible hillslopes. Several large BDA structures at upstream end of

 Valley Bottom Extent	 Complex ID
 Active Floodplain (Ordinary High - Water)	 Access Road
 Complex ZOI	 Taxlot Boundary
	 Equipment and Material Staging Area

STRUCTURE COMPLEX SITE PLAN

# SALMON FORK - Complexes 05 & 06

## Structure Complex Site Plan

BDA - Large

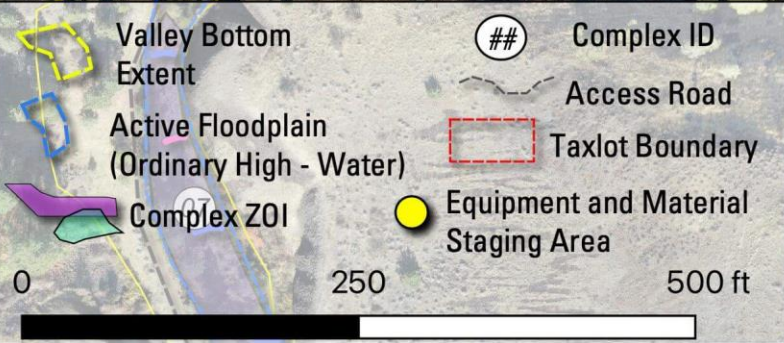
BDA - Small

PALS



Complex-06: BDA should be used to enhance inundation frequency of valley left floodplain feature. Avoid structure construction on road crossings.


Complex-05: Pond development at low elevation floodplains through BDA construction. Bedrock may limit building in some locations. Avoid flooding of road crossings when possible.




STRUCTURE COMPLEX SITE PLAN

# SALMON FORK - Complexes 07 & 08

## Structure Complex Site Plan

 BDA - Large








 BDA - Small

 PALS



Complex-07: Use channel and floodplain spanning BDAs to increase pond development and complexity. Bedrock in lower end of complex may limit post ponding.

Complex-08: Most upstream complex in reach. Focus large BDA construction at floodplain pockets between bedrock confined sections. Potential for PALS to increase erosional rates on erosive hillslopes.

	Valley Bottom Extent		Complex ID
	Active Floodplain (Ordinary High - Water)		Access Road
	Complex ZOI		Taxlot Boundary
			Equipment and Material Staging Area

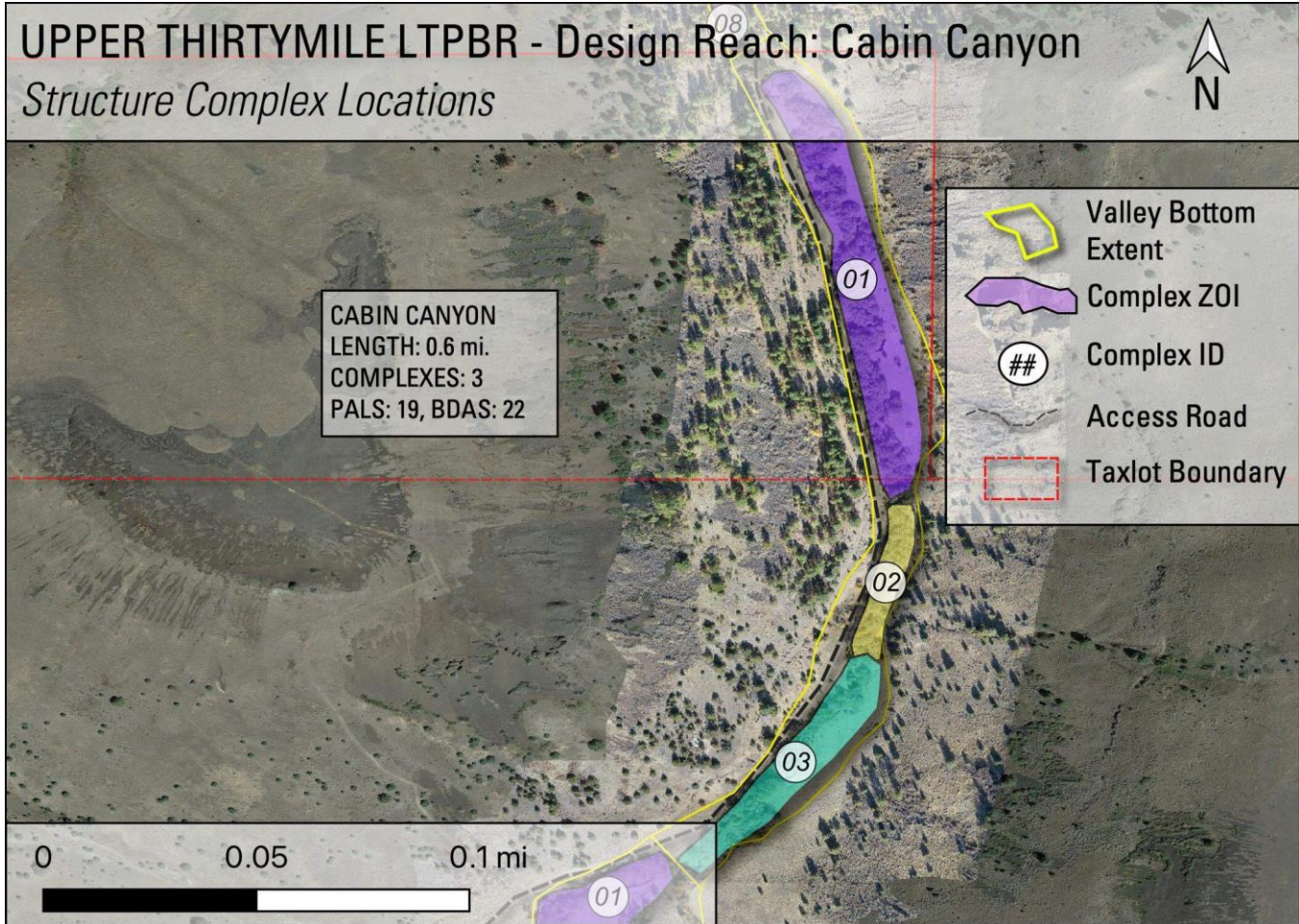
0                      250                      500 ft

STRUCTURE COMPLEX SITE PLAN

### 8.1.3 COMPLEX DESIGNS: CABIN CANYON

TABLE 10. DESIGN AND FUNCTION SPECIFICATION, COORDINATES, AND NUMBER OF STRUCTURES FOR THE CABIN CANYON TREATMENT REACH.

COMPLEX	DESCRIPTION	COORDINATES	BDA	PALS
1	Ample space on river right for floodplain and riparian vegetation expansion through connectivity and lateral channel migration. PALS on outside bends encourage lateral channel migration.	-120.08409, 45.06732	9	9
2	Series of high - density BDA structures should be designed to increase pond formation and floodplain expansion in this confined channel section.	-120.08381, 45.06441	5	5
3	Large and relatively high - elevation river right disconnected floodplain surface. BDA should be used to increase floodplain extent through combination of overbank flow and/or lateral channel migration through erosion.	-120.08468, 45.06269	8	5
			<b>22</b>	<b>19</b>



OVERVIEW OF THE RESTORATION REACH SHOWING THE LOCATION OF EACH STRUCTURE COMPLEX.

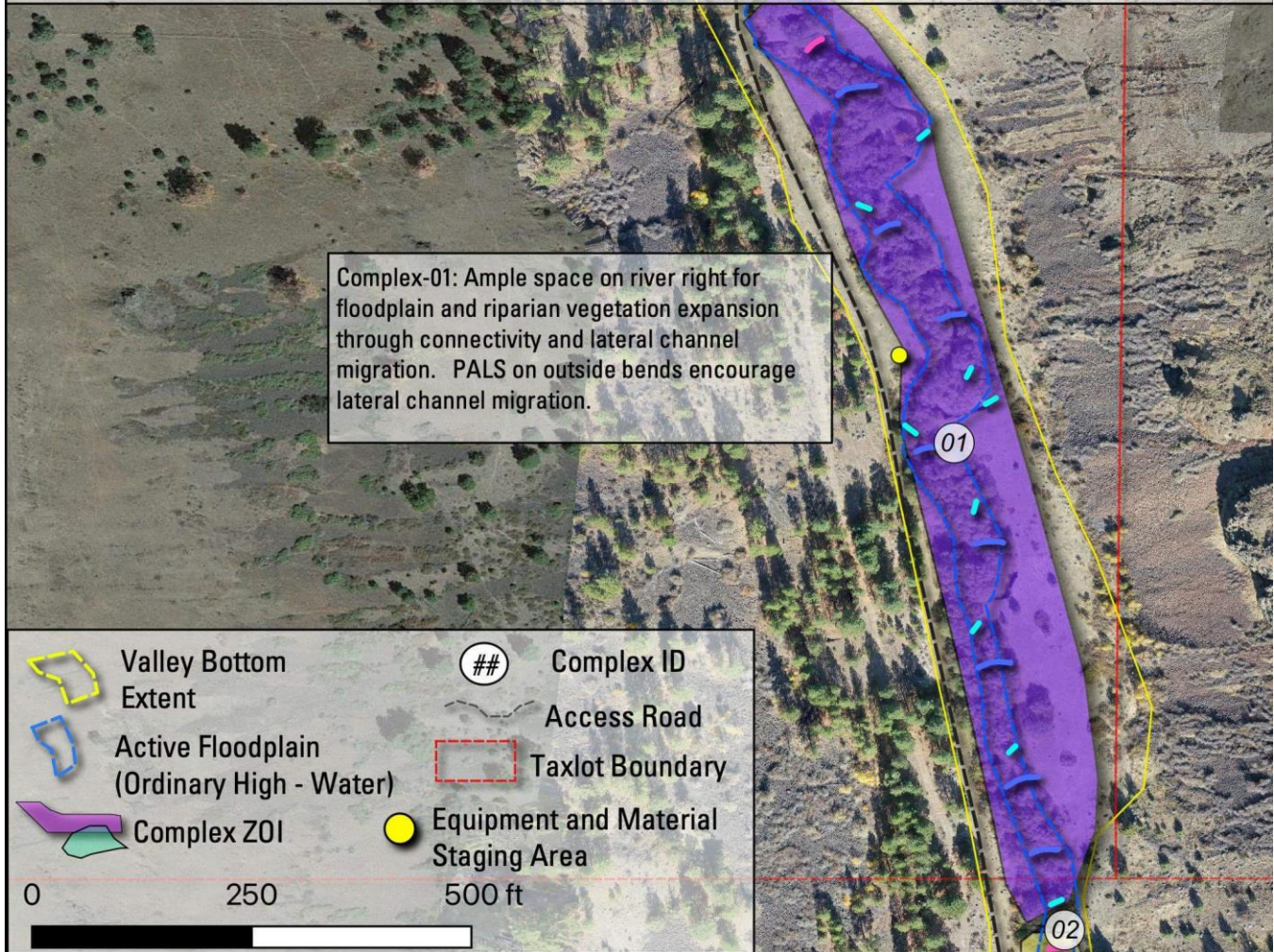
# CABIN CANYON - Complex 01

## Structure Complex Site Plan








BDA - Large

BDA - Small

PALS

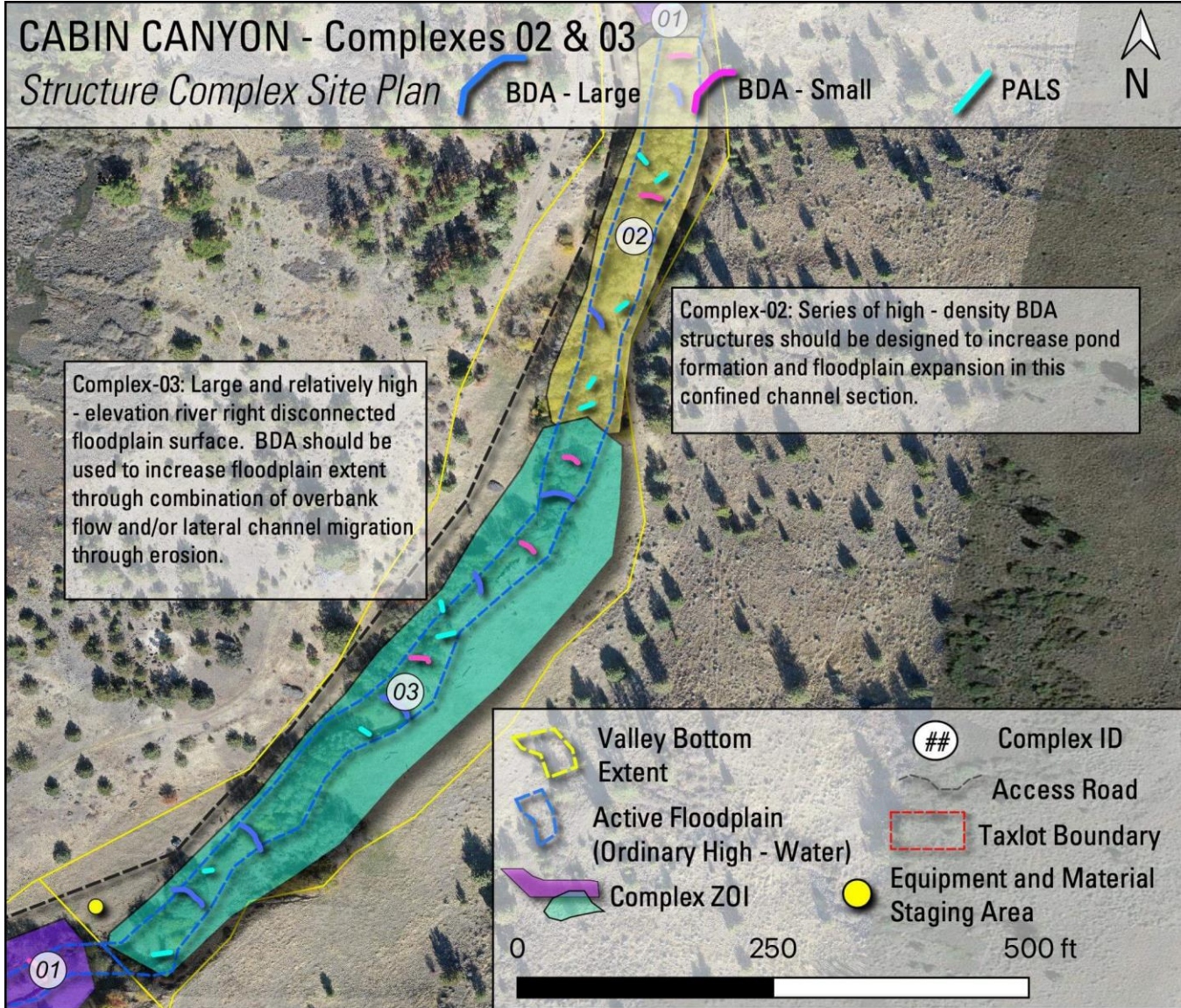


Complex-01: Ample space on river right for floodplain and riparian vegetation expansion through connectivity and lateral channel migration. PALS on outside bends encourage lateral channel migration.

 Valley Bottom Extent	 Complex ID
 Active Floodplain (Ordinary High - Water)	 Access Road
 Complex ZOI	 Taxlot Boundary
 Equipment and Material Staging Area	

0                      250                      500 ft

STRUCTURE COMPLEX SITE PLAN



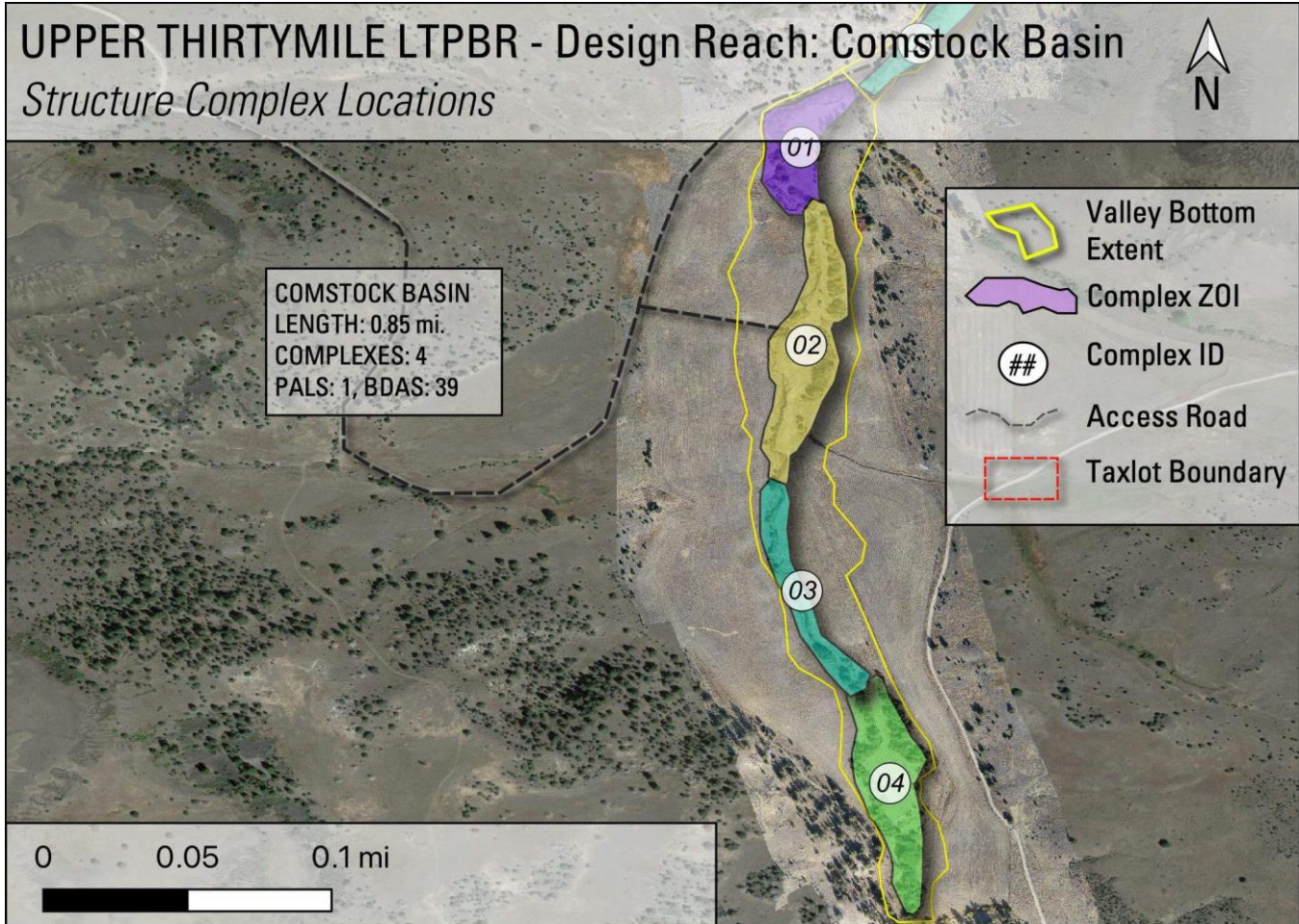
STRUCTURE COMPLEX SITE PLAN

8.1.4 COMPLEX DESIGNS: COMSTOCK BASIN

TABLE 11. DESIGN AND FUNCTION SPECIFICATION, COORDINATES, AND NUMBER OF STRUCTURES FOR THE COMSTOCK BASIN TREATMENT REACH.

COMPLEX	DESCRIPTION	COORDINATES	BDA	PALS
1	Long term goals seeking floodplain expansion river right. Large BDA structures should completely span area of inset floodplain and extend toward disconnected river right floodplain surface.	-120.08664, 45.06088	8	1
2	Long term goal is connectivity and flow capture within existing high - flow / relic channel on valley bottom right. Also build several small BDA structures within valley bottom right riparian area / wetland.	-120.08656, 45.05808	17	0
3	BDA structures should be used for pond development and aggradation toward increased floodplain connectivity valley bottom left and right.	-120.08662, 45.0546	7	0
4	Goal should be toward increasing flow capture and active channel establishment on existing riparian / wetland toward valley bottom right. Build several small BDA structures in valley bottom right wetland area.	-120.08537, 45.05187	9	0
			<b>41</b>	<b>1</b>





OVERVIEW OF THE RESTORATION REACH SHOWING THE LOCATION OF EACH STRUCTURE COMPLEX.

# COMSTOCK BASIN - Complexes 01 & 02

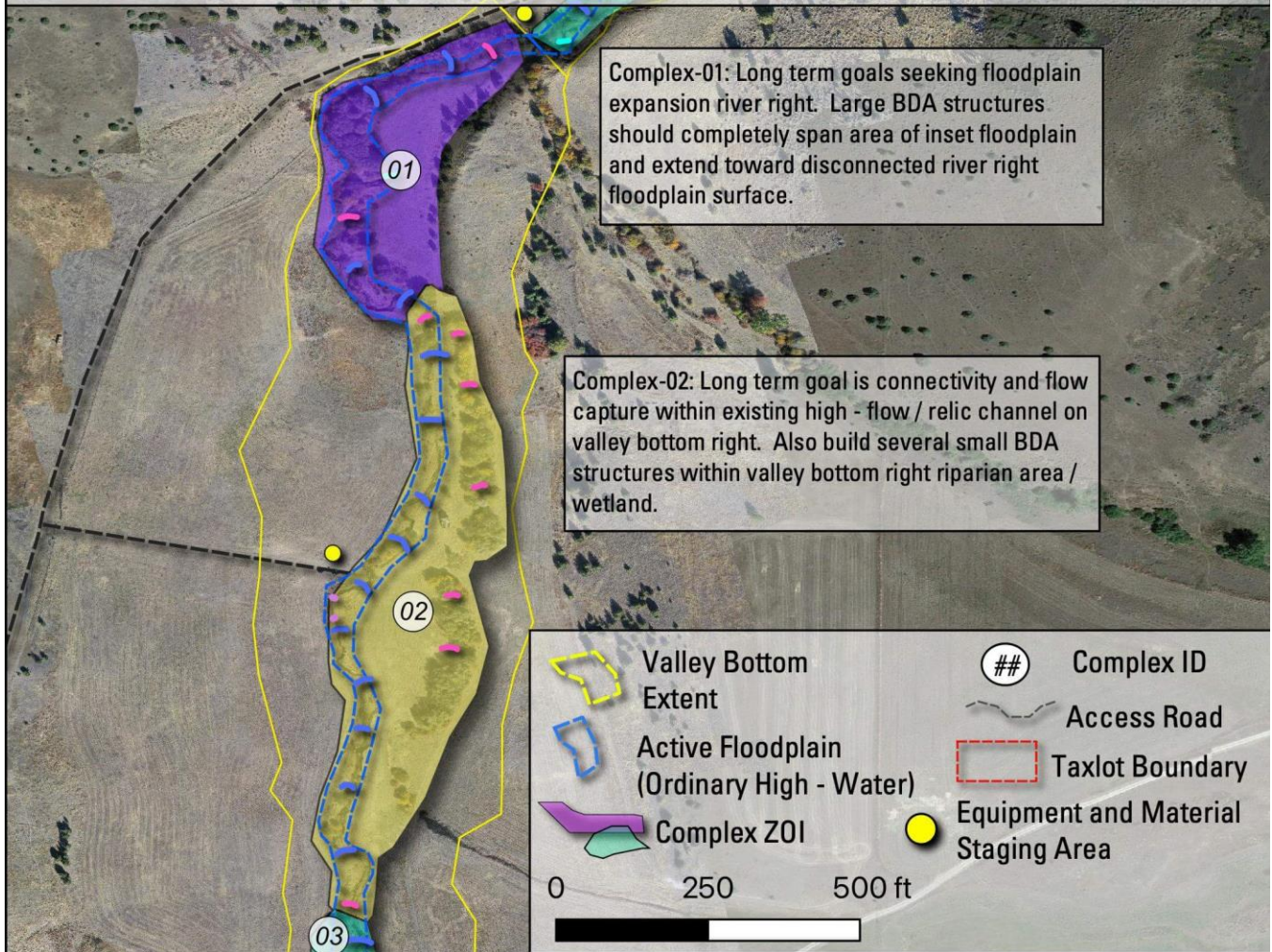
## Structure Complex Site Plan



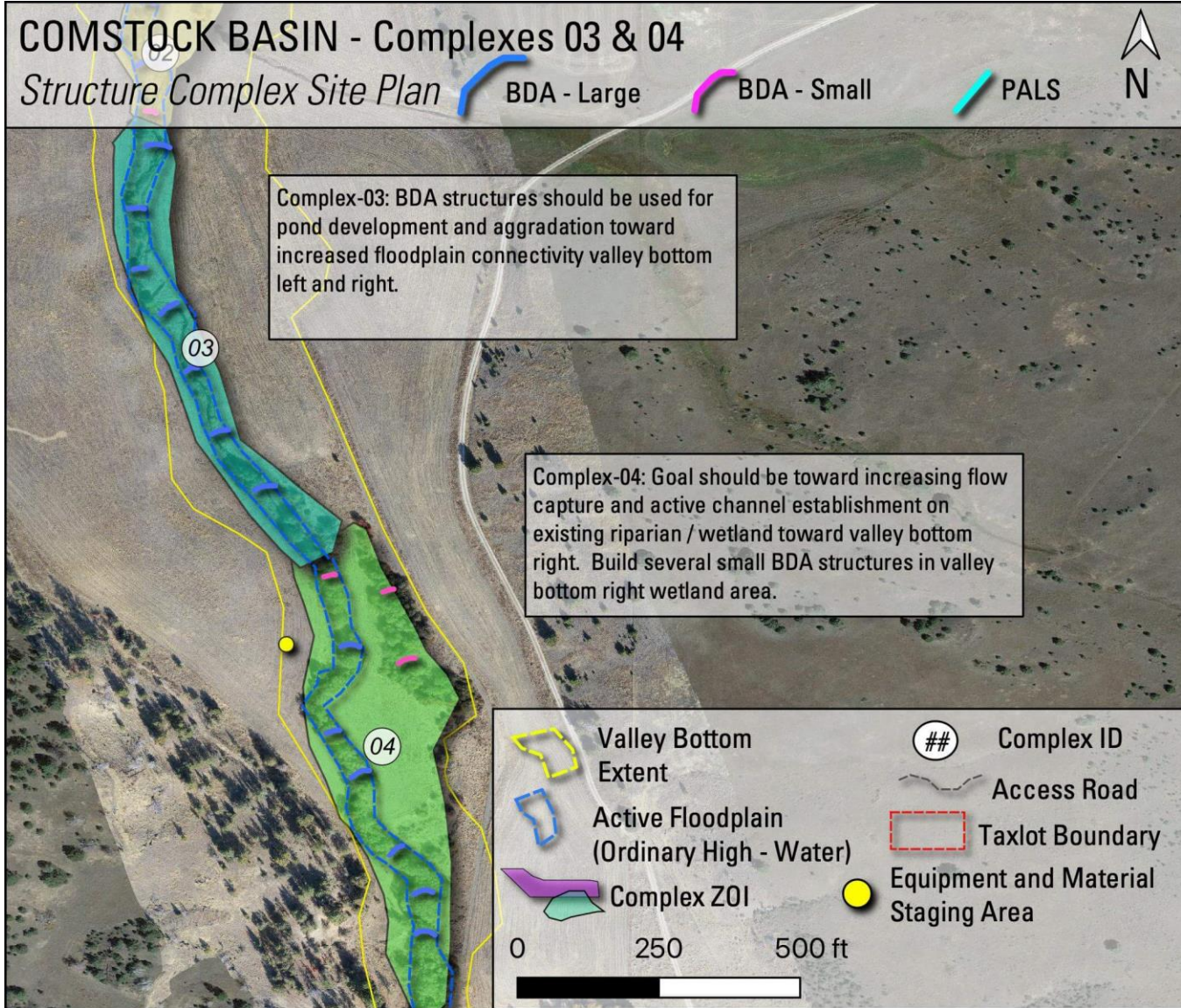
BDA - Large

BDA - Small

PALS



STRUCTURE COMPLEX SITE PLAN



STRUCTURE COMPLEX SITE PLAN

## 8.2 APPENDIX: REACH SPECIFIC OBJECTIVES AND INDICATOR METRIC VALUES

Indicator metrics under each project objective developed for each of the 4-restoration design reaches (see [3 Project Goals and Objectives](#)).

COMSTOCK BASIN RESTORATION INDICATOR METRICS.

INDICATOR	STATUS AND CONTEXT			TARGET EXPECTATIONS	
	Historic ca. 1800s	Current 2021	As Built 2022	Medium 2 – 5 years	Long 5 – 10 years
<b>OBJECTIVE 1: INCREASE IN-CHANNEL HABITAT COMPLEXITY</b>					
POOL HABITAT FREQUENCY (POOLS / KM)	20 - 40 / km.	16 / km	20 – 25 / km	20 – 30 / km	20 – 30 / km
BAR HABITAT FREQUENCY (BARS / KM)	20 - 40 / km.	16 / km	20 – 25 / km	20 – 30 / km	20 - 30 / km
<b>OBJECTIVE 2: INCREASE PROPORTION OF ACTIVE VALLEY BOTTOM</b>					
% OF VALLEY BOTTOM ACTIVE (%)	80 - 100%	17%	20 - 25%	30 - 40%	40 - 70%
<b>OBJECTIVE 3: INCREASE PERENNIAL SURFACE FLOW EXTENT AND DURATION</b>					
% PERENNIAL SURFACE FLOW (%)	60 - 100%	100%	100%	55 - 70%	55 - 80%
<b>OBJECTIVE 4: INCREASE WETLAND AND RIPARIAN VEGETATION ABUNDANCE</b>					
% VALLEY BOTTOM RIPARIAN DOMINATE (%)	80 - 100%	1 - 4%	1-4%	25 - 50%	25 - 70%
<b>OBJECTIVE 5: INCREASE BEAVER DAM ABUNDANCE AND DISTRIBUTION</b>					
DAM ABUNDANCE (DAM COUNT)	40 - 100 dams	0 dams	20 – 25 dams	20 – 30 dams	30 – 50 dams

CABIN CANYON RESTORATION INDICATOR METRICS.

INDICATOR	STATUS AND CONTEXT			TARGET EXPECTATIONS	
	Historic ca. 1800s	Current 2021	As Built 2022	Medium 2 – 5 years	Long 5 – 10 years
<b>OBJECTIVE 1: INCREASE IN-CHANNEL HABITAT COMPLEXITY</b>					
<b>POOL HABITAT FREQUENCY (POOLS / KM)</b>	20 - 40 / km.	12 / km	15 – 20 / km	15 – 20 / km	20 - 30 km
<b>BAR HABITAT FREQUENCY (BARS / KM)</b>	20 - 40 / km.	12 / km	12 – 20 / km	15 – 20 / km	20 - 30 km
<b>OBJECTIVE 2: INCREASE PROPORTION OF ACTIVE VALLEY BOTTOM</b>					
<b>% OF VALLEY BOTTOM ACTIVE (%)</b>	80 - 100%	29%	30 - 40%	40 - 50%	40 - 70%
<b>OBJECTIVE 3: INCREASE PERENNIAL SURFACE FLOW EXTENT AND DURATION</b>					
<b>% PERENNIAL SURFACE FLOW (%)</b>	100%	100%	100%	100%	100%
<b>OBJECTIVE 4: INCREASE WETLAND AND RIPARIAN VEGETATION ABUNDANCE</b>					
<b>% VALLEY BOTTOM RIPARIAN DOMINATE (%)</b>	80 - 100%	25-35%	25 - 35%	40 - 50%	40 - 70%
<b>OBJECTIVE 5: INCREASE BEAVER DAM ABUNDANCE AND DISTRIBUTION</b>					
<b>DAM ABUNDANCE (DAM COUNT)</b>	20 - 100 dams	0 dams	15-20 dams	15 – 20 dams	20 – 30 dams

SALMON FORK RESTORATION INDICATOR METRICS.

INDICATOR	STATUS AND CONTEXT			TARGET EXPECTATIONS	
	Historic ca. 1800s	Current 2020	As Built 2021	Medium 2 – 5 years	Long 5 – 10 years
<b>OBJECTIVE 1: INCREASE IN-CHANNEL HABITAT COMPLEXITY</b>					
<b>POOL HABITAT FREQUENCY (POOLS / KM)</b>	20 - 40 / km.	8 / km	15 – 20 / km	15 – 20 / km	20 - 40 km
<b>BAR HABITAT FREQUENCY (BARS / KM)</b>	20 - 40 / km.	8 / km	15 – 20 / km	15 – 20 / km	20 - 40 km
<b>OBJECTIVE 2: INCREASE PROPORTION OF ACTIVE VALLEY BOTTOM</b>					
<b>% OF VALLEY BOTTOM ACTIVE (%)</b>	80 - 100%	36%	45 - 55%	50 - 60%	50 - 60%
<b>OBJECTIVE 3: INCREASE PERENNIAL SURFACE FLOW EXTENT AND DURATION</b>					
<b>% PERENNIAL SURFACE FLOW (%)</b>	50 - 100%	0%	0 - 10%	10 - 20%	10 - 40%
<b>OBJECTIVE 4: INCREASE WETLAND AND RIPARIAN VEGETATION ABUNDANCE</b>					
<b>% VALLEY BOTTOM RIPARIAN DOMINATE (%)</b>	70 - 90%	10 - 15%	10 - 15%	15 - 30%	30 - 50%
<b>OBJECTIVE 5: INCREASE BEAVER DAM ABUNDANCE AND DISTRIBUTION</b>					
<b>DAM ABUNDANCE (DAM COUNT)</b>	10 - 40 dams	0 dams	20 – 25 dams	20 – 30 dams	20 – 40 dams

*JUMP OFF JOE RESTORATION INDICATOR METRICS.*

INDICATOR	STATUS AND CONTEXT			TARGET EXPECTATIONS	
	Historic ca. 1800s	Current 2020	As Built 2021	Medium 2 – 5 years	Long 5 – 10 years
<b>OBJECTIVE 1: INCREASE IN-CHANNEL HABITAT COMPLEXITY</b>					
POOL HABITAT FREQUENCY (POOLS / KM)	15 - 25 / km.	7 / km	10 – 15 / km	15 – 20 / km	15 - 30 km
BAR HABITAT FREQUENCY (BARS / KM)	15 - 25 / km.	7 / km	10 – 15 / km	15 – 20 / km	15 - 30 km
<b>OBJECTIVE 2: INCREASE PROPORTION OF ACTIVE VALLEY BOTTOM</b>					
% OF VALLEY BOTTOM ACTIVE (%)	80 - 100%	21%	25 - 30%	30 - 35%	30 - 40%
<b>OBJECTIVE 3: INCREASE PERENNIAL SURFACE FLOW EXTENT AND DURATION</b>					
% PERENNIAL SURFACE FLOW (%)	50 - 100%	0-25%	0 - 25%	10 - 35%	10 - 50%
<b>OBJECTIVE 4: INCREASE WETLAND AND RIPARIAN VEGETATION ABUNDANCE</b>					
% VALLEY BOTTOM RIPARIAN DOMINATE (%)	50 - 90%	25 -35%	25 - 35%	30 - 35%	30 - 40%
<b>OBJECTIVE 5: INCREASE BEAVER DAM ABUNDANCE AND DISTRIBUTION</b>					
DAM ABUNDANCE (DAM COUNT)	60 - 120 dams	0 dams	50 – 75 dams	60 – 85 dams	70 – 100 dams

### 8.3 APPENDIX: BRAT ESTIMATES OF BEAVER DAM POTENTIAL

Reach specific estimates of potential beaver dam abundance for each reach within the restoration design. Estimates are based on the framework described within the beaver restoration assessment tool (BRAT, MacFarlane et al. 2017). Estimates are based on existing and expected channel area and vegetation composition and abundance.

COMSTOCK BASIN DESIGN REACH ESTIMATES OF HISTORIC, CURRENT, AND POTENTIAL BEAVER DAM ABUNDANCES.

EXPECTATION TIME PERIOD	VEGETATION SUITABILITY		STREAM POWER				
	Streamside	Riparian / upland	Baseflow	2-year flood	Dam capacity (dams/km.)	Channel Length (km, treatment)	Beaver Dam Capacity
<b>HISTORIC</b> (< 1800)	Preferred	Preferred	Can build dam	Dam persists	Pervasive: 15 – 40	2.4	40 - 100 dams
<b>CURRENT</b> (2021)	Unsuitable	Unsuitable	Can build dam	Occasional blowout	None	1.4	0 dams
<b>AS BUILT</b> (2021)	Barely suitable	Unsuitable	Can build dam	Occasional breach	Rare: 0 - 1	1.5	0 – 2 dams
<b>MEDIUM</b> (3 – 5 YEARS)	Moderately Suitable	Moderately Suitable	Can build dam	Occasional breach	Occasional: 1 -5	1.7	2 – 5 dams
<b>LONG</b> (5 – 10 YEARS)	Preferred	Suitable	Can build dam	Dam persists	Frequent: 5 – 15	2.0	10 – 30 dams



CABIN CANYON DESIGN REACH ESTIMATES OF HISTORIC, CURRENT, AND POTENTIAL BEAVER DAM ABUNDANCES.

EXPECTATION TIME PERIOD	VEGETATION SUITABILITY		STREAM POWER		Dam capacity (dams/km.)	Channel Length (km, treatment)	Beaver Dam Capacity
	Streamside	Riparian / upland	Baseflow	2-year flood			
<b>HISTORIC (&lt; 1800)</b>	Preferred	Preferred	Can build dam	Dam persists	Pervasive: 15 – 40	1.5	20 - 100 dams
<b>CURRENT (2021)</b>	Barely suitable	Unsuitable	Can build dam	Occasional blowout	Rare: 0 - 1	0.9	0 – 1 dams
<b>AS BUILT (2021)</b>	Barely suitable	Unsuitable	Can build dam	Occasional breach	Rare: 0 - 1	1.0	0 – 1 dams
<b>MEDIUM (3 – 5 YEARS)</b>	Moderately Suitable	Barely Suitable	Can build dam	Occasional breach	Occasional: 1 - 5	1.2	1 - 5 dams
<b>LONG (5 – 10 YEARS)</b>	Suitable	Moderately Suitable	Can build dam	Dam persists	Frequent: 5 – 15	1.3	6 – 20 dams

SALMON FORK DESIGN REACH ESTIMATES OF HISTORIC, CURRENT, AND POTENTIAL BEAVER DAM ABUNDANCES.

EXPECTATION TIME PERIOD	VEGETATION SUITABILITY		STREAM POWER				
	Streamside	Riparian / upland	Baseflow	2-year flood	Dam capacity (dams/km.)	Channel Length (km, treatment)	Beaver Dam Capacity
<b>HISTORIC (&lt; 1800)</b>	Preferred	Preferred	Can build dam	Occasional breach	Frequent: 5 – 15	2.5	10 - 40 dams
<b>CURRENT (2021)</b>	Moderately Suitable	Barely Suitable	Can build dam	Occasional blowout	Occasional: 1 -5	1.6	1 – 5 dams
<b>AS BUILT (2021)</b>	Moderately Suitable	Barely Suitable	Can build dam	Occasional breach	Occasional: 1 -5	1.7	2 – 10 dams
<b>MEDIUM (3 – 5 YEARS)</b>	Suitable	Moderately Suitable	Can build dam	Occasional breach	Frequent: 5 – 15	1.8	5 - 15 dams
<b>LONG (5 – 10 YEARS)</b>	Suitable	Suitable	Can build dam	Dam persists	Frequent: 5 – 15	2.0	10 – 30 dams

*JUMP OFF JOE DESIGN REACH ESTIMATES OF HISTORIC, CURRENT, AND POTENTIAL BEAVER DAM ABUNDANCES.*

EXPECTATION TIME PERIOD	VEGETATION SUITABILITY		STREAM POWER				
	Streamside	Riparian / upland	Baseflow	2-year flood	Dam capacity (dams/km.)	Channel Length (km, treatment)	Beaver Dam Capacity
<b>HISTORIC</b> ( <b>&lt; 1800</b> )	Preferred	Preferred	Can build dam	Occasional breach	Frequent: 5 – 15	7.5	60 - 120 dams
<b>CURRENT</b> ( <b>2021</b> )	Moderately suitable	Unsuitable	Can build dam	Blowout	Rare: 0 - 1	5.3	0 – 5 dams
<b>AS BUILT</b> ( <b>2021</b> )	Moderately suitable	Unsuitable	Can build dam	Occasional blowout	Occasional: 1 -5	5.5	6 – 20 dams
<b>MEDIUM</b> ( <b>3 – 5 YEARS</b> )	Suitable	Barely Suitable	Can build dam	Occasional blowout	Frequent: 5 – 15	5.6	25 - 50 dams
<b>LONG</b> ( <b>5 – 10 YEARS</b> )	Suitable	Barely Suitable	Can build dam	Occasional blowout	Frequent: 5 – 15	5.7	30 – 60 dams

## 8.4 APPENDIX: SUPPLEMENTARY RESOURCES

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Included as part of this riverscape restoration are several supplementary resources intended to assist with the management and implementation of restoration actions within the Thirtymile Creek project area. These resources should be drawn upon and updated to track restoration effectiveness, progress toward goals and objectives, and to assist with future permit and/or implementation funding acquisition.

### 8.4.1 PERMITS

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Copies of permit applications submitted for the first round of restoration implementation on the Thirtymile Creek.

#### [LINK-TO-RESOURCES](#)

- **DEPARTMENT OF STATE LANDS** – Joint removal and fill permit submitted to Oregon Department of State Lands and Army Corps. Of Engineers.
- **STATE BEAVER DAM ANALOG FISH PASSAGE APPROVAL** – Oregon Department of Fish and Wildlife consultation on beaver dam analog implementation.

### 8.4.2 GIS DATA

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GIS (geographic information system) data used during LTPBR project planning and design development. All GIS information is housed within individual shapefile format (ESRI), in the EPSG:26911 – NAD83 UTM zone 11N coordinate reference system. All design GIS information is specific to only the first phase of structural treatments. GIS resources include:

#### [LINK-TO-RESOURCES](#)

- *Valley-Bottom.shp*: Polygons showing the extent of the valley bottom within the project area.
- *Active-Channel.shp*: Polygons depicting the pre-restoration active channel extent.
- *Active-Floodplain.shp*: Polygon depicting the pre-restoration active floodplain (including active channel area) extent.
- *Recovery-Potential.shp*: Polygon depicting the expected recovery potential for the project area. Recovery potential represents the expected extent of the active channel and/or floodplain in response to the riverscape restoration treatment plan.
- *Reaches.shp*: Lines showing the location of each design reach along the center of the valley bottom.
- *Complex-ZOI.shp*: Polygons depicting the hypothesized geomorphic and/or hydraulic extent for each structure complex.
- *Structures.shp*: Lines depicting the approximate location of individual structures.

### 8.4.3 STRUCTURAL DESIGN SITE PLANS

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Individual PDF site plans for the first phase of the structural design. Each PDF has embedded spatial reference information, allowing visualization of structure positions on desktop GIS applications or in the field using common mobile GIS applications (e.g., [Avenza maps](#)).

[LINK-TO-RESOURCES](#)

### 8.4.4 FIGURES

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All figures used in the design document preparation that can be used in report, permit, or funding acquisition that may occur for the project area in the future.

[LINK-TO-RESOURCES](#)



January 2021