Yakama Nation Fisheries

Columbia River
Honor. Protect. Restore.

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Twisp River
Horseshoe Side Channel Version 2
Restoration Design and Engineering Services

Request for Proposals
January 28, 2016

Yakama Nation Fisheries is seeking proposals from qualified engineering firms to award a design and engineering services contract in support of salmon habitat restoration activities taking place in the Twisp River near Little Bridge Creek in Okanogan County, Washington. Based upon the proposals received under this solicitation the Confederated Tribes and Bands of the Yakama Nation will award a design contract to the best quality bidder for the Scope of Work described within this RFP. Services rendered under this contract will be performed between the contract start date (to be determined) and December 31, 2016.

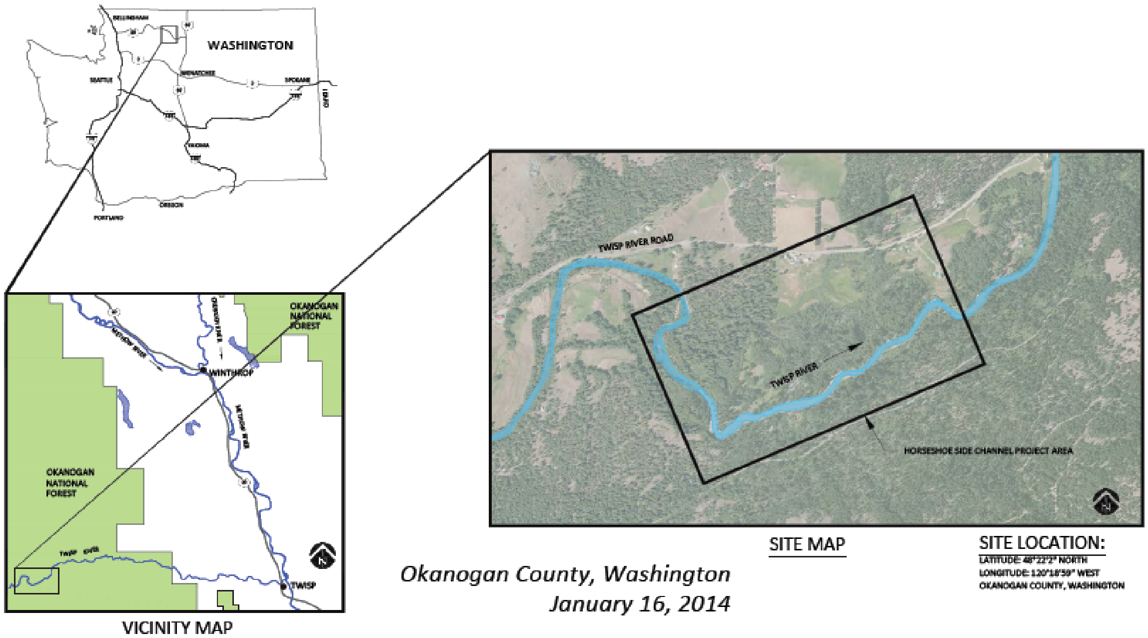
Project Background

The 2015 Reach Assessment of the Middle Twisp River identified the Horseshoe Side Channel project area as a priority location for improving habitat conditions for rearing juvenile salmonids. Project opportunities include side channel enhancements, stream bank restoration, and large wood enhancements to the main river channel. The design services contract created through this RFP process will be used to develop restoration actions in the Horseshoe Side Channel project area in an expanded region from project development activities that took place in 2015 under a separate design services contract.

At the time of the release of the Middle Twisp River Reach Assessment, the design firm InterFluve, Inc. created a more detailed project concept design report for the full Horseshoe Side Channel project area (see attached report). In support of creating the concept design report, extensive topographic and bathymetric survey were conducted in the most of the project reach, as well as tracking of fluctuating water surface elevations.

Because the larger project area described in the concepts report involves a larger mix of private and public land ownerships, only projects involving just supportive private landowners were slated for immediate project development in 2015, as smaller private land projects tend to come to fruition faster than projects involving public lands. In 2015 InterFluve, Inc. was selected to receive a full design services contract for just the private lands of the Horseshoe Side Channel project area.
Yakama Nation Fisheries is now desirous of developing a larger suite of restoration actions involving both private and public land ownerships in the Horseshoe Side Channel project zone. Work done under this proposed contract will build upon the work done by InterFluve, Inc. to create the 2015 project concept design report.

Project Location



Aerial Image of Project Area

Link to the 2015 Middle Twisp River Reach Assessment

http://yakamafish-nsn.gov/restore/projects/uchrp

Proposed Scope of Work

Phase 1 - Site investigation

Task 1 –Existing data review

The contractor will review existing data to be provided by Yakama Nation Fisheries or any other private or government entity that would aid future analysis and design. It is assumed this data consists of fish habitat survey, stream flow data, historical air photos, geomorphic field survey, hydrology, and hydraulic analysis from the 2015 Reach Assessment. This will also consist of previous concept reports and drawings illustrating proposed restoration actions at the project site. Some data collected to produce the 2015 Concepts Design Report can also be made available to support further design work.

Task 2 – Geomorphic Field investigation and site survey

To gain a perspective of river process, including fluvial geomorphology and sediment continuity, the river will be walked within the site boundaries and sufficient distances up and downstream to gain a reach level understanding of conditions. Air photos will be used during this investigation. An overview of reach conditions will be documented with general field notes and photos. Appropriate hydraulic cross sections will be identified and marked on maps and in the field for topographic survey.

A site survey will be conducted using a total station or survey grade GPS to collect survey data required for hydraulic analysis, conceptual designs and drawings. LIDAR data may be used in floodplain areas to complete hydraulic cross sections where appropriate.

Topographic and bathymetry survey will be completed on all lands from which ownership permission can be obtained by the Yakama Nation. Cross section survey and profile will be completed to develop a reach level hydraulic model. Survey will be based on an existing horizontal and vertical datum. A number of temporary bench marks using wooden hubs will be established for reference during construction. River and floodplain cross sections will be surveyed to develop both 1 and 2 dimensional models of the entire reach. Obvious infrastructural elements such as riprap, levees, bridges, irrigation diversions, well heads, power lines, building foundations, and/or other such elements shall be surveyed.

Stream substrate size will be documented by collection of pebble counts. Pebble count locations of representative bed load materials will be determined in the field. The data will be used in design considerations of sediment continuity and stream stability.

Existing riparian vegetative composition will be noted including species and elevations with respect to the stream.

Field and survey data will be downloaded into and summarized in appropriate software (i.e. Excel, AutoCAD).

Assumptions: *Consent for access will be provided. *Stream flows will be low enough to wade.

Task 3 – Hydrology

Peak stream flow frequencies will be estimated or obtained from previous BOR, USGS, and Yakama Fisheries work efforts. If necessary peak flow frequencies can be estimated using available gage data and/or using published regression equations appropriate for the site.

Task 4 – Hydraulic analysis

Hydraulic conditions will be modeled using both 1 dimensional and 2 dimensional models. Site survey collected in Task 2 will be used to build an existing conditions model. Manning's n values will be estimated from reference literature, professional experience and opinion. In support of the alternatives analysis and design tasks, the existing conditions model will be copied and modified for project conditions.

The U.S. Army Corps of Engineer's one-dimensional HEC-RAS hydraulic model will be used to consider and certify FEMA flood impacts. Two-dimensional modeling will be used to estimate surface flow behaviors at various stream discharges, including analyzing for changes in flow direction, sheer stress, and bed mobility based on the proposed conditions.

Phase 2 – Concept Development

Task 5 – Development of Conceptual Report and Drawings

Based on Site Investigation findings, the contractor will provide restoration/enhancement strategies and options to benefit adult and juvenile salmonid habitats at range of discharges and where possible low summer river stage. Restoration strategies shall be developed with consideration of the 2014 UCSRB RTT Biological Strategy and the 2015 Twisp River Reach Assessment. The contractor will work closely with Yakama Nation UCHRP staff to ensure restoration designs address top priority ecological concerns in the project reach.

Task deliverables will include a report of findings from Phases 1 and 2, a drawing set of conceptual restoration designs, planning estimates, and a power point presentation for stakeholder meetings.

Task 6 - Stakeholder Meetings and Communications

Following conceptual report completion, the contractor will present such findings to landowners and agency stakeholders. The presentation will focus on existing river processes, future trends, project benefits, relative project costs, project risks, future river processes as they relate to each project opportunity and how each potential project fits within existing and likely future conditions.

Phase 3: Draft Construction Plan

Task 7 - Design level survey (if additional survey is needed)

As agreed to between the Yakama Nation project manager and the contractor, supplementary site survey may be completed to gather additional field data on existing conditions so that robust restoration designs can begin to be produced. Supplementary surveys may include further topographic/bathymetric surveys, groundwater testing, and/or geologic surveys, among other things.

Task 8 - Development of Permit level Construction Plan

The contractor will proceed with producing engineered designs of the preferred restoration concept(s) as directed by UCHRP staff. Design deliverables provided under this task will provide suitable detail to allow for environmental permits to be acquired for the project (includes accurate depiction of areas being impacted and estimates of material quantities). Please refer to the attached HIP III Checklist for an overview of the design and data criterion needed to obtain the necessary permits.

Task 9 - Stakeholder Meetings and Communications

If requested, the contractor will assist in presenting the Phase 3 Construction Drawing Set to landowners and agency stakeholders for additional feedback and buy-in.

Bid Directions

Please note that subcontracting will not be allowed.

Each engineering firm seeking to be eligible for a contract award under this Request for Proposals must submit two hardcopies of their proposal in writing to:

Yakama Nation Fisheries
Attn: Jackie Olney
PO Box 151
401 Fort Road (if using a shipping service)
Toppenish, WA 98948

Proposals must be received by Close of Business, Wednesday, February 24, 2016. Only hand deliveries and/or mail or parcel delivery service submittals will be accepted. Please clearly state "Twisp River Horseshoe Design RFP" on the shipping envelope and the cover letter of the proposal. It is recommended that all shipping and/or delivery confirmation receipts are retained past the proposal due date to ensure proof of submission.

Each proposal must include a roster of qualified staff proposed to work under this contract, including resumes. Please also include a detailed cost proposal based upon the Scope of Work provided, a company fee schedule detailing all billing rates, a schedule/timeline proposal for completing the described tasks by December 31, 2016, and certify the cost proposal as being valid for at least 150 days.

Project related questions should be directed to:

Hans Smith, UCHRP Habitat Biologist
Phone: 509-996-5005
E-mail: smih@yakamafish-nsn.gov

Limitations

The Yakama Nation reserves the right to accept or reject any and all of the proposals received as a result of this request, or to cancel in part or entirely this request if it is in the best interest of the Yakama Nation to do so. This request does not commit the Yakama Nation to pay any costs incurred in the preparation of a proposal.

The contractor shall furnish all supervision, labor, equipment and tools necessary to complete the work as outlined in the Scope of Work.

Twisp River Horseshoe Side Channel
Concept Design Report

SUBMITTED TO
Yakama Nation Fisheries

JANUARY 2015

Twisp River
Horseshoe Side Channel
Concept Design Report

JANUARY 2015

SUBMITTED TO
Yakama Nation Fisheries
401 Fort Road
Toppenish, WA

PREPARED BY
Inter-Fluve, Inc.
501 Portway Ave, Suite 101
Hood River, OR 97031
(541) 386-9003

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Introduction

OVERVIEW

The Horseshoe Side Channel project area is located in the middle segment of the Twisp River, just upstream of the Newby Narrows Project site and approximately 11 miles upstream of the confluence with the Methow River. See the attached concept design plans for site information. The overall project goal is to improve habitat conditions for ESA-listed salmon and steelhead in accordance with the Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan (UCSRB 2007) and the associated Biological Strategy (RTT 2014). The goal of this phase of the project is to present concept design alternatives for restoration of the Horseshoe Side Channel project area. This report describes existing information, describes the data collection and analysis to support designs, and presents the various alternatives that were examined.

This report summarizes:

- Goals and objectives
- Design criteria
- Background on site conditions
- Site assessment
- Description of project components
- Conceptual designs

PROJECT AREA DESCRIPTION

The Horseshoe Side Channel project area is located between River Mile (RM) 11.1 and 12.2 of the Twisp River. The project reach is located largely on private land, with land from RM 11.5 to 11.8 bordered by the Okanogan National Forest on both sides of the river. Overview maps are included in Figure 1 and Figure 2.

The channel through the project area is moderately steep (0.57% gradient) and locally degraded, or incised, with only the largest floods inundating the adjacent floodplain. The Twisp River Road parallels the channel to the north of the floodplain edge along the entire length of the project area. Site access is easier on the north side of the valley, but poor on the south side, which is bounded by steep slopes and cut banks along alluvial fan edges and high terraces. Abandoned meanders are visible throughout the left, or north floodplain area. Remnants of channel modification are present throughout the site, including constructed or pushup levees, channelized segments, riprap and channel cutoff berms. In-stream fish habitat is generally limited throughout the reach, primarily due to channel confinement, floodplain disconnection and the predominance of plane-bed conditions. A thorough description of site geomorphology can be found in Inter-Fluve (2015).

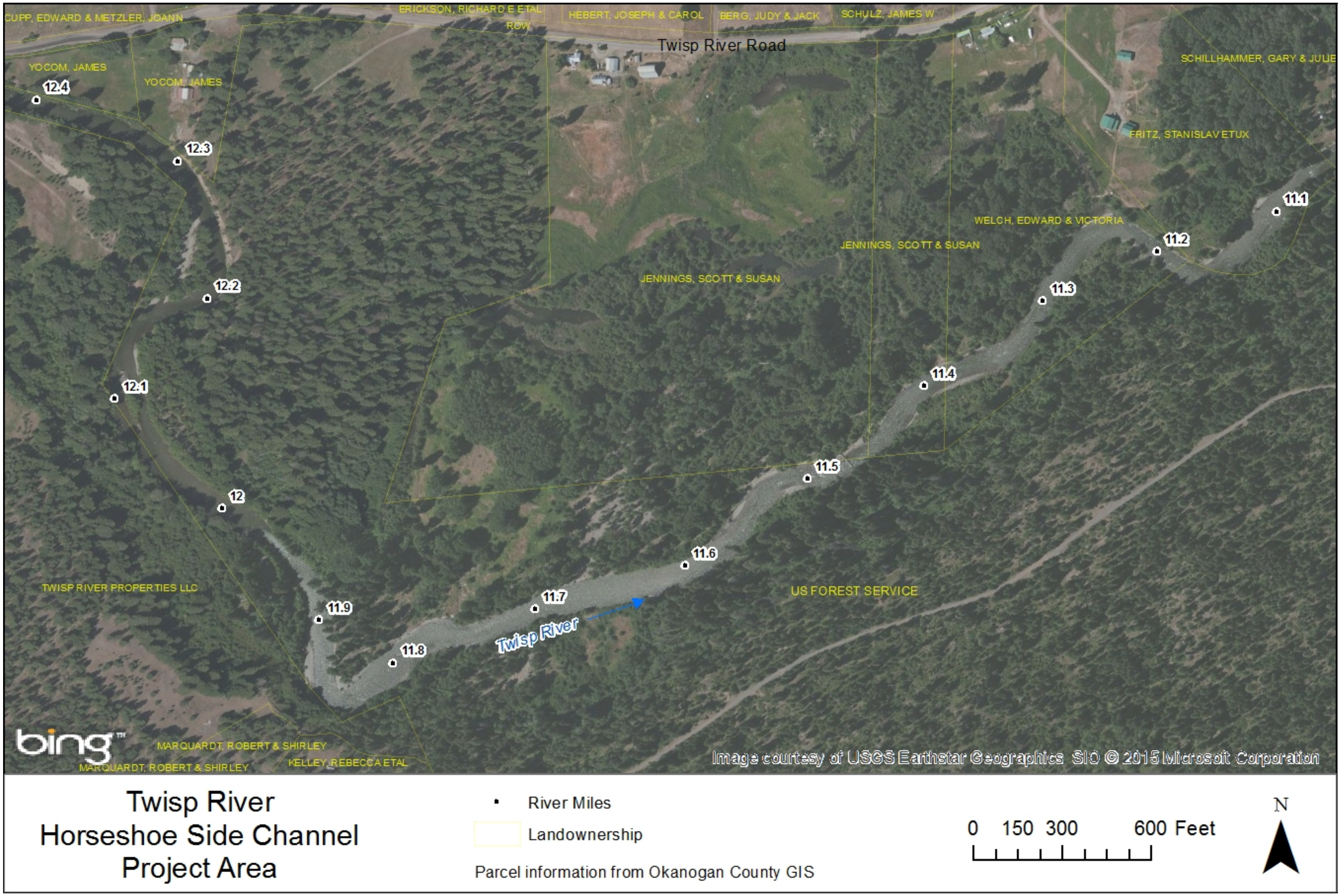

Figure 1. Overview map of Horseshoe Side-Channel project area with aerial photo.

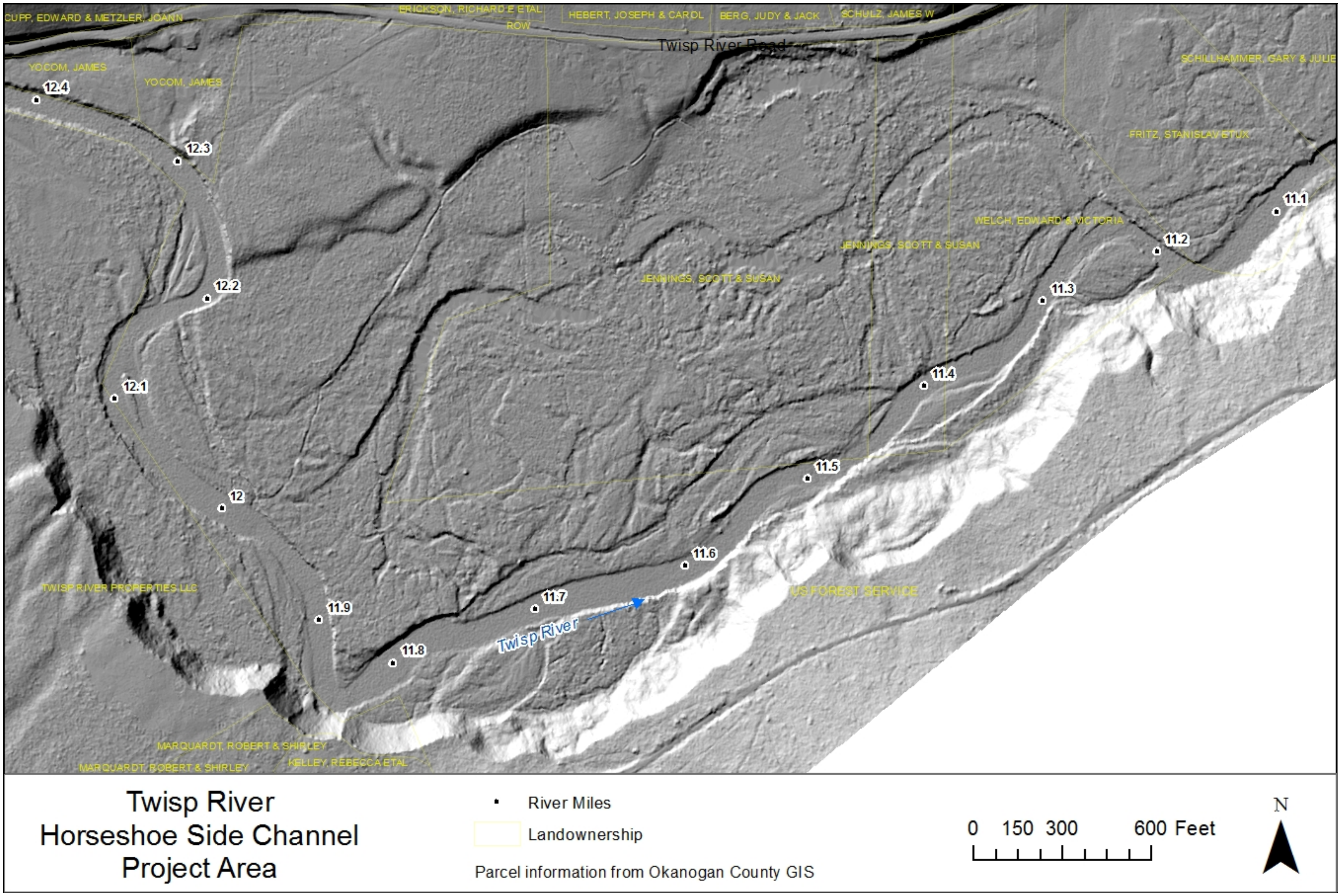

Figure 2. Overview map of Horseshoe Side-Channel project area with 2006 LiDAR hillshade.

GOALS AND OBJECTIVES

Regional Objectives

Regional objectives that inform fish habitat work in the Upper Columbia are summarized in the document titled *A Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region* (2014), developed by the Upper Columbia Salmon Recovery Board Regional Technical Team (RTT). It serves as a guide for all restoration activities in the Upper Columbia River, and is an important appendix to the Upper Columbia Spring Chinook Salmon and Recovery Plan (UCSRB 2007). The Biological Strategy has identified several assessment units within each of the major Upper Columbia tributaries that differentiate broad scale physical and biological attributes. The Horseshoe Side Channel project area is located in the Lower Twisp River Assessment Unit.

The unit is a major spawning area for migratory salmonids, including spring Chinook and steelhead. Resident spring Chinook use the area for rearing, foraging and over wintering. Fluvial bull trout are known to use the project reach for migration to and from major spawning areas above Buttermilk Creek. Rearing may occur within the project reach as well.

The Lower Twisp Assessment Unit (RM 0 – 14) has been characterized as a Tier 1 priority habitat for protection and Tier 2 priority habitat for restoration based on its existing biological and physical attributes and future habitat potential. The RTT has determined that the main factors affecting habitat conditions for salmonids in the Lower Twisp Assessment Unit are the following (note: factors that do not apply to the project area are not included):

- Low instream flows and high water temperatures in the lower Twisp River affect several species at several life history stages (The lower Twisp River is listed on the Washington State 303(d) list for inadequate instream flow and for temperature exceedance).
- The Twisp River (from Buttermilk Creek to the mouth) has been cut off from its floodplain and side channels through dikes and riprap in places, resulting in a simplified channel.
- Large wood levels and recruitment potential on the Lower Twisp River are well below geomorphic potential.
- Development of riparian and floodplain areas has impaired channel migration, riparian condition and floodplain function.
- Residential development has impacted riparian conditions in many locations.

The above factors have cumulatively impacted stream ecological systems and salmonid habitat in the project reach. The RTT has prioritized a list of restoration actions to address these key ecological concerns impeding salmon recovery goals for the Lower Twisp Assessment Unit. Prioritized actions that are relevant to the Horseshoe Side Channel project area are listed below.

1. **Water Quantity** (Decreased Water Quantity): Improve natural water storage by allowing off-channel connection, floodplain function, and beaver recolonization.

2. **Channel structure and form** (Bed and Channel Form, Instream Structural Complexity below Buttermilk Creek): Remove levees and install large wood and engineering log jams in strategic locations to provide short-term habitat benefits and intermediate-term channel form and function benefits. Scale and locations should be consistent with the biological objectives and geomorphic potential for the reach and site.
3. **Peripheral and Transitional Habitat** (Side Channel and Wetland Connections): Reconnect disconnected side channels or where low wood loading has changed the inundation frequency, improve hydraulic connection of side channels and wood complexity within the side channels.
4. **Riparian Condition:** Restore condition in degraded areas associated with residential development or where there are legacy effects from past riparian logging practices.

Concept alternatives for the Horseshoe Side Channel project area were developed with the above factors in mind, as well as in consideration of the habitat restoration and preservation objectives described in the Recovery Plan (UCSRB 2007). These objectives are consistent with other regional goals as described in the Methow Subbasin Plan (KWA et al 2004) and the Methow Watershed Plan (MBPU 2005).

2006 Bureau of Reclamation – Jennings Habitat Complexity Project

In 2006, the US Bureau of Reclamation (BOR) published the results of a study of habitat restoration potential on the Horseshoe Side Channel area, also known as the Jennings Reach (BOR 2006). The primary objective of the concept alternative analysis was to develop concepts for projects that would "improve spawning, rearing and high flow refugia for Chinook Salmon and Steelhead Trout". The BOR report presented three alternatives that featured the following elements:

- Removal of a Forest Service log revetment and fish screen;
- Primary side channel construction through the historic channel and wetlands on the north side of the project area;
- Secondary side channel construction throughout the project, varying by alternative chosen;
- Removal of all levees for floodplain and side channel connectivity;
- Placement of large wood in side channels;
- Engineered log jams and root wads in the main channel;
- Boulder clusters;
- Engineered riffles; and
- Isolated log structures in main channel

The BOR report recognizes the limiting factors as being potential flooding, changes in sediment transport and changes in main river channel geomorphology, and recommends further investigation during design.

Middle Twisp River Reach Assessment and Restoration Strategy

The Middle Twisp Reach Assessment and Restoration Strategy, which covers the Twisp River from RMs 7.8 to 18.1, was completed in 2013-2014 (Inter-Fluve 2015). This assessment included geomorphic and habitat surveys and assessments within the Horseshoe Side Channel project area. The goal of the assessment was to evaluate aquatic habitat and watershed/geomorphic process conditions in the Middle Twisp River and to identify habitat restoration strategies. The study involved examination of historical information, surficial geology, hydrology, hydraulics, sediment transport, topographic data (LiDAR), channel geometry, riparian vegetation, and habitat conditions. Supporting appendices included detailed analyses of habitat, reach-based ecosystem indicators (REI), historical data, and schematic sketches of potential restoration projects.

A comprehensive review of the geology and geomorphology of the Horseshoe Side Channel site was described in the report. The Horseshoe Side Channel site has a more well-connected floodplain and has a slightly lower gradient than the downstream reach. The channel largely consists of riffles (69%) with limited pool habitat and relatively homogenous and mobile cobble bed material. There are no significant tributaries entering the site, but there are hyporheic flow and groundwater inputs to the side channel and main channel. The riparian area is varied, with an overstory of cottonwood, Douglas fir and ponderosa pine. The understory varies from grazed grass to dogwood and alder dominated shrub wetlands. Abandoned channel segments are primarily open water or contain cattails growing on accumulated organic matter. Human disturbance includes floodplain filling, berm construction, possible channelization, logging, and crossings. The geomorphology of the site, combined with human disturbance, has resulted in degraded in-channel habitat and poor floodplain connectivity.

Restoration strategies were developed by comparing existing aquatic habitat conditions to target conditions obtained from reference areas and regional habitat thresholds. General restoration strategies included protection of quality habitat, restoration of riparian communities, reconnection of habitat via infrastructure modification, placement of structural habitat elements, and construction of off-channel habitat enhancement features. Specific to the Horseshoe Side Channel project area, the following restoration techniques were recommended:

- Side channels on river right and river left, activated by select excavation and protected by apex log jams.
- Wetland and side-channel complex reconnection in the left floodplain – The 2014 report recognized numerous possibilities for side-channel and off-channel reconnection in the expansive abandoned oxbow wetland complex in the left floodplain. This would be accomplished via select excavation to connect remnant oxbow wetlands.
- Removal of road crossings (fill), artificial berms/dikes and push-up levees to reconnect side channels and floodplains.
- Large wood cover added to off-channel habitat.
- Riprap and fill removal - The riprap bank and floodplain fill at RM 11.2 on the left bank is not protecting infrastructure and could be removed.
- Place log jams for interim stability until restored riparian vegetation can become established.
- Riparian restoration, including reforesting streambanks and cleared riparian areas.

PRELIMINARY DESIGN CRITERIA

A suite of preliminary design criteria have been developed that incorporate stakeholder objectives, the RTT Biological Strategy, the YN Reach Assessment, physical river constraints, construction impacts, aesthetics, and recreational user risk. Design criteria serve three primary purposes: 1) to clearly document and communicate specific project objectives and constraints, 2) to help inform and guide the design process so that objectives are met, and 3) provide a basis for future performance monitoring. The design criteria include preliminary performance criteria as well as prescriptive criteria. The design criteria will be refined as the design process moves forward and as more information becomes available to make criteria more specific and quantitative. The design criteria are divided into 6 categories: Habitat, Geomorphology/Hydrology, Engineering and Risk, River Safety, and Construction Impacts.

Habitat

- Increase the quantity and quality of main channel and off-channel spawning and rearing habitat for ESA-listed salmon and steelhead, including
  - Overhead cover
  - Hydraulic complexity
  - Pool scour
  - Velocity refuge
  - Increased food sources
  - Off-channel rearing
  - Sediment/bedload retention, storing, and sorting
- Design projects that restore or mimic the historical channel structure and complexity that salmonids have adapted to

Geomorphology/Hydrology

- Design projects that are consistent with current and projected hydrologic and geomorphic patterns and processes
- Allow for naturally dynamic and deformable processes to operate, within the constraints imposed by existing landownership, infrastructure, and safety considerations
- Address channel incision by increasing the frequency, duration, and magnitude of floodplain inundation at frequent recurrence interval floods (1- to 10-year events)
- Increase the potential for future large wood recruitment and retention
- To the extent possible, remove fill/levees and bank armoring that disconnects side-channels and reduces floodplain connectivity.
- To the extent possible, design side-channels to maintain sediment transport continuity in order to maximize design life and reduce in-filling
- Preserve the quantity of existing functional wetland habitat or allow that habitat to modify to a new wetland type based on future expected hydrogeomorphic condition

Engineering and Risk

- Do not increase flooding or erosion risk of public or private infrastructure
- Provide adequate ballasting of placed logs to withstand high flows that overtop the structures (i.e. compensate for buoyancy)

- Specific stability and other design criteria of placed structures to be determined in subsequent design phases

River Safety

- Take into account visibility of structures from upstream
- Take into account structure form to minimize entrapment potential
- Minimize channel encroachment to the extent possible to allow for avoidance by river users

Construction Impacts

- Minimize impacts to intact wetland habitat
- Minimize impacts to fish during the construction process by reducing the need for dewatering and worksite isolation during construction
- Locate and configure construction access routes to utilize existing access where possible and to minimize impacts to existing mature riparian vegetation
- Utilize onsite resources or plan channel alignments to take advantage of existing natural features where feasible (e.g. trees, beaver dam locations)

Site Conditions

SITE SURVEY AND DATA COLLECTION

Topographic and bathymetric data were collected in September, 2014 using rtkGPS and total station survey equipment. The data collection concentrated between the bank tops of the main channel and the side and overflow channel areas in the north floodplain. We relied on existing LiDAR data for other floodplain areas where detail was not necessary for preliminary site analysis and where restoration treatments are unlikely to occur. Additional follow-up survey is anticipated after a preferred alternative is moved forward in subsequent design phases. Control points for the survey were established around the eastern and northern perimeter of the site using wooden stakes. These points were placed in locations that are likely to be outside the disturbance limits during construction.

To locate the survey data in space, we collected static data at the rtkGPS base unit, and the data was adjusted using the National Geodetic Survey's (NGS) Online Positioning User Service (OPUS, http://www.ngs.noaa.gov/OPUS/). These data were based on the Washington State Plane North coordinate system with the North American Vertical Datum of 1988. Metadata from NGS solution indicated a root mean squared error within 0.6 inches for the horizontal coordinates and less than 0.9 inches for the elevation.

After adjusting the survey data with the OPUS solution, we integrated the LiDAR data (Watershed Sciences 2007). However, elevations between the two data sets did not correlate well. The LiDAR data was consistently 2-3 ft higher than the survey data. We confirmed that these errors were associated with the LiDAR data after processing four different sets of survey data in the Middle Twisp Reach with OPUS. To calibrate the LiDAR data, we tabulated survey points on harder surfaces in open areas where vegetation would likely not interfere with LiDAR data. The average shift in LiDAR was 2.454 ft with a standard deviation of 0.627 ft. Accordingly, the LiDAR data was lowered by 2.454 ft to match the survey data. Had the correction not been applied, the hydraulic analysis would have revealed a much smaller extent of floodplain inundation.

Pebble counts were also completed to characterize sediment sizes and their relative mobility (Table 1). Two channel bed locations were sampled: (1) in a riffle at river mile 11.2 where riprap has been placed along the east bank to impede channel migration, and (2) at river mile 11.7 where the channel has a relatively long run with a plane bed morphology. The pebble count at river mile 11.2 represented some of the largest grain sizes observed in the reach; however, this material may have an anthropogenic origin. The pebble count at river mile 11.7 was representative of the plane-bed reaches in the site where habitat is relatively poor.

Four additional pebble counts were completed to understand the composition of sediment moving through the reach. The armor and sub-armor layers of bars at river miles 11.5 and 12.05 were sampled. The grain sizes in the bars were noticeably smaller than the channel bed, and the largest grains in the armor layer were larger than the largest grains in the sub-armor layer. The size distribution in both bars, however, was very consistent suggesting that these sizes are likely transported during relatively frequent flood events.

Table 1. Summary of grain size distributions in the project reach. Percentage finer grain sizes are shown in inches.

River mile	Description	D_{16}	D_{50}	D_{84}
11.2	Riffle	2.58	5.69	8.77
11.5	Bar sub-armor layer	<0.1	0.21	0.85
	Bar armor layer	0.95	1.81	3.23
11.7	Riffle	0.62	2.32	4.95
12.05	Bar sub-armor layer	0.11	0.35	1.10
	Bar armor layer	1.08	1.97	3.42

FISH USE AND HABITAT CONDITIONS

The Horseshoe Side Channel project area currently supports ESA-listed spring Chinook salmon (Endangered) and steelhead trout (Threatened), ESA-listed bull trout (Threatened), and non-listed rainbow trout, cutthroat trout, brook trout, and westslope cutthroat trout.

Spring Chinook salmon and steelhead trout spawn and rear in the project area. Spring Chinook spawning primarily occurs on the Twisp River between RM 10 and RM 27 throughout August and September. In the mainstem Twisp, juvenile rearing occurs year-round in the project area. Steelhead trout use the entire Twisp River for spawning, in- and out-migration, and rearing. Steelhead spawning occurs March through May and juveniles rear year-round (USBR 2008, App F). Bull trout use the upper Twisp River and tributaries for spawning and the middle Twisp for migration, foraging, and overwintering (Mullen et al. 1992, NMFS 1998). Most bull trout spawning occurs upstream of RM 22 (USBR 2008, App F).

Spawning ground surveys are performed annually throughout the Methow Basin. The project area falls within a 2.3 mile long reach that contained 24 spring Chinook redds and 25 steelhead redds during the

2012 survey (Snow et al. 2014). Surveyed locations of steelhead and Chinook redds from 2003 to 2012 are shown in Figure 3 and Figure 4.

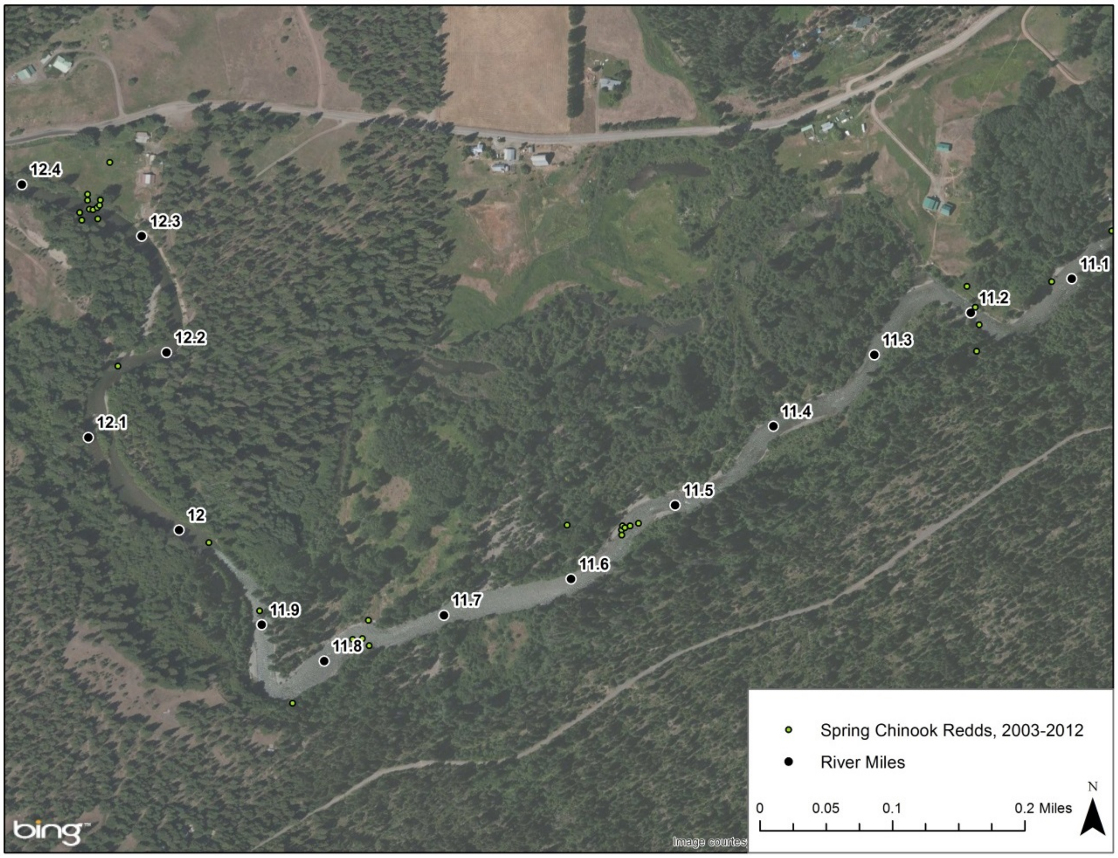

Figure 3. Spring Chinook redds. Data acquired from UCSRB online GIS and Data Library, retrieved 12 January 2015.

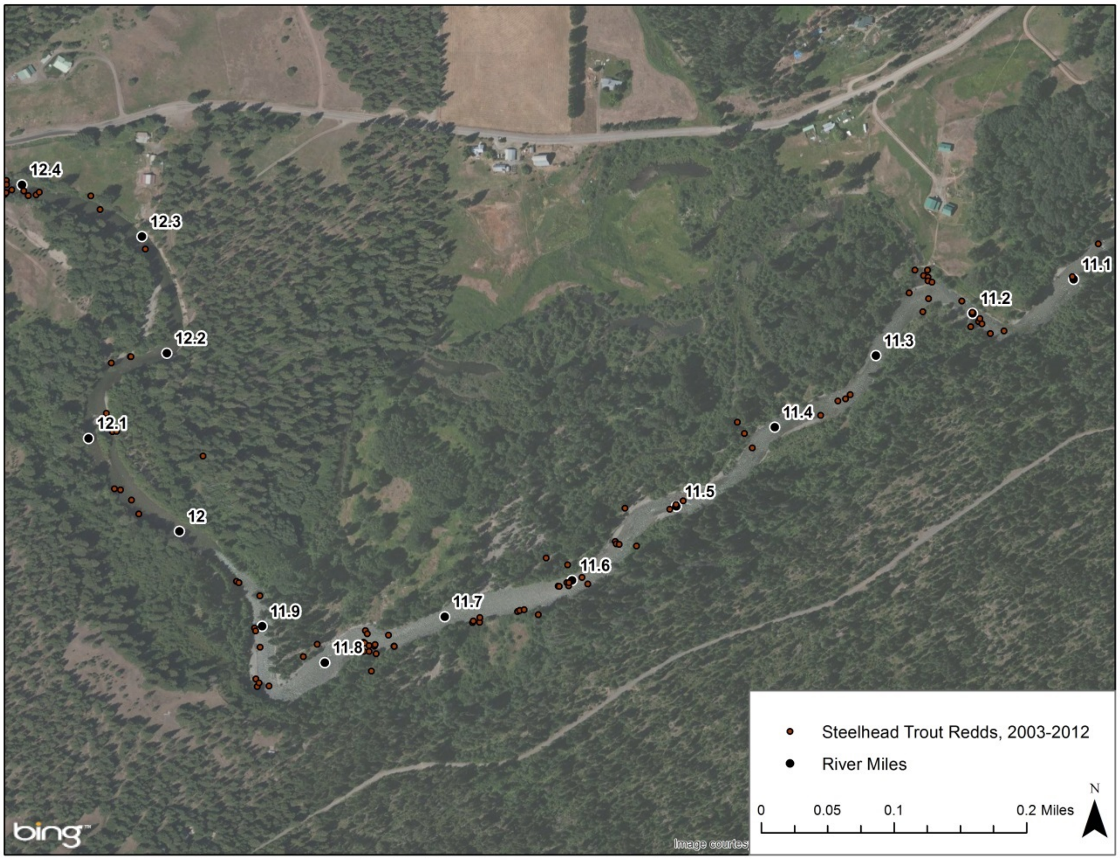

Figure 4. Steelhead trout redds. Data acquired from UCSRB online GIS and Data Library, retrieved 12 January 2015.

Considered "stream-type" salmonids, both steelhead and spring Chinook spend one or more years in freshwater. The length of residency for adult and juvenile life histories causes them to rely more heavily on quality freshwater habitat versus those fish species that migrate rapidly downstream following redd emergence. The duration of time that juvenile steelhead reside in freshwater streams is highly variable. In the cold rivers of the Upper Columbia region, the average length of residency for steelhead is two years, but durations of up to seven years have been observed (Pevin et al. 1994, Mullan et al. 1992).

The Washington Department of Fish and Wildlife seasonally operates a rotary screw trap on the lower Twisp River just upstream from the confluence with the Methow River. This trap is used to capture out-migrating salmonid smolts from the Twisp River basin. Permanent PIT tag arrays are located just downstream of the trap. Mark-recapture studies have been performed year round on the Twisp River using information from both of these sources. The information gained from these surveys can be used to estimate fish abundance.

Spring Chinook smolts captured from summer 2012 through spring 2013 reflect the success of 2011 brood year adults. The total number of emigrating wild spring Chinook produced by the 2011 brood year population was estimated to be 12,759 (± 1,744, 95% CI). Rates of survival to different life stages have been calculated using this information in conjunction with information obtained from spawning ground surveys and carcass surveys. Eggs deposited by the 2011 brood year spring Chinook had a 4.7% chance of surviving to become smolts. This rate can be expanded to estimate that an average of 203 smolts were produced per redd during that year. Average survival from smolt to adult for fish from brood years 2003-2008 was 0.61% (Snow et al. 2014).

Since there is so much variability in the age at which steelhead emigrate from their natal rivers, estimating the total success of a particular brood year requires four years of emigration data from the basin. The total number of smolts produced by the 2009 brood was estimated to be 6,913 (± 1,089, 95% CI) fish. Egg to emigrant survival rate was 0.31% for this brood which corresponds to a total of 19 emigrants produced per redd. Smolt to adult survival survival rates can vary substantially from year to year. Fish which migrated out of the basin in 2010 had a 1.1% chance of returning as adults. Fish leaving the basin in 2011 had a 0.33% of returning as adults (Snow et al. 2014).

The WA Department of Ecology listed the Twisp River as a "waters of concern" for temperature in 2012. This classification was based on measurements collected in 1999 at station 'Twisp River at War Creek CG' which exceeded the established temperature criterion developed for ESA-listed salmonids. More recently, measurements show that the lower Twisp River continues to have high temperatures throughout the summer months; data from 2008 and 2009 continue to show 7-day average daily maximum temperatures with over 15% exceedance of 16°C consistently from mid-July through mid-September at the mouth of the Twisp River (USBR 2008, App I).

In 2001 and 2009, airborne thermal infrared remote sensing surveys were performed on the Twisp River. The data show a general warming trend over the 33 miles of the Twisp River as the water moves downstream from the headwaters to the confluence with the Methow River. None of the three notable locations where the temperature decreases along the profile are located within the Horseshoe Side Channel project area, although two of these localized cooling trends are located just outside of the project area- one upstream (near RM 14.48) and the other just downstream of the project area (near RM 10.08).

A 2013 stream habitat survey (Inter-Fluve 2015) recorded information on habitat unit composition, habitat unit characteristics including pool depth, substrate size, large wood quantity, riparian conditions, and bankfull channel dimensions. The Horseshoe Side Channel project falls within Reach 3 of the habitat assessment. The predominant habitat type in Reach 3 was riffles (69%), with glides at 15% of the total habitat area and pools at 14%. The quality of pools in Reach 3 was low, with 73% of pools having residual depths less than 3 feet. Side channels in this reach are few, totaling 2% of the habitat area available. The Horseshoe side channel reach has relic meanders and side channels accessible during high flows, but cutoff during low flows due to levee construction and channel straightening. The localized habitat composition for the Horseshoe Side Channel site is very similar to the reach averages, with long riffles comprising the primary habitat type with short pools or glides in between. Bed substrate in Reach 3 consisted mostly of cobbles (69%) and gravels (17%). The size, availability, and quantity of wood were lower than what would have been expected historically, which has affected instream channel dynamics and habitat suitability for salmonids. Riparian vegetation in the reach is highly variable, with a range of class sizes and species. The results of the REI analysis (Reach-Based Ecosystem Indicators), performed as part of the Reach Assessment, are included in Table 2.

Table 2. Results of the Reach-Based Ecosystem Indicators Analysis (Inter-Fluve 2015).

General Characteristics	General Indicators	Specific Indicators	Reach 3 – Horseshoe Side Channel
Habitat Assessment	Physical Barriers	Main Channel Barriers	Adequate
Habitat Quality	Substrate	Dominant Substrate/Fine Sediment	Adequate
	LWM	Pieces per mile at bankfull	Unacceptable
	Pools	Pool frequency and quality	At Risk
	Off-Channel Habitat	Connectivity with main channel	At Risk
	Dynamics	Floodplain connectivity	At Risk
		Bank stability/Channel migration	At Risk
		Vertical channel stability	At Risk
Riparian Vegetation	Condition	Structure	At Risk
		Disturbance (human)	At Risk
		Canopy Cover	Unacceptable

PREVIOUS RESTORATION WORK

It is unknown whether or not previous restoration work has been conducted at the site. As described previously in the Goals and Objectives section, the US Bureau of Reclamation performed a coarse-scale feasibility study for conducting habitat restoration work at this site (USBR 2006). In their report, they recommend the removal of a Forest Service log revetment and fish screen. These features were not observed during site surveys in 2014 and so may have been removed as part of a previous restoration effort.

GEOMORPHIC SETTING AND HISTORICAL TRENDS

Geomorphic Setting

The Twisp River main channel drops over a mile of elevation in its 30 miles, draining an area of 244 square miles and entering the Methow River at RM 40.2. Roughly 90% of the land in the Twisp River subbasin is managed by the USFS, including nearly all of the land above the valley floor upstream of RM 10, while most of the Twisp River valley bottom from the mouth to the confluence with Eagle Creek (RM 17) is privately owned (USBR 2008).

A major slope break occurs at RM 10 along the longitudinal profile of the Twisp River, corresponding to the downstream limit of the last glacial advance. Glacial erosion upstream resulted in a wider valley with a more gentle valley slope. The channel incised through glacial deposits downstream, resulting in a more confined valley with steeper channel slopes. The Horseshoe Side Channel area is just upstream of the grade change, and represents a transitional area between the lower gradient upstream and the steeper reaches downstream. The main channel is confined within the project reach due to a combination of natural local downcutting and human induced channelization, levee construction, and bank armoring. The historical aerial photos, discussed below under Historical Trends, show that channel length and sinuosity have decreased significantly since the 1940s, likely as a result of bank armoring, levee construction, and a reduction in instream large wood from direct removal and riparian clearing.

Currently, anthropogenic features within the floodplain and stream include riprap, push up levees, trails, access roads (one driveway), and ditches. These features, combined with channelization and localized incision, limit flood access to side and overflow channels. The Horseshoe Side Channel reach (Reach 3 in Inter-Fluve 2015) has very low large wood density. The scarcity of large wood is due in part to the channel width, but also due to past clearing of the channel and timber harvesting in the riparian zone (USFS 2001). Riparian clearing has resulted in a relatively young forest stand incapable of contributing significant amounts of wood to the channel. This in turn has reduced the quality and density of habitat components formed by recruited large wood. For a more detailed examination of Twisp River geomorphology, see Inter-Fluve (2010, 2015) and USBR (2008).

Historical Trends

A series of historical aerial photos is presented in Figure 5 to Figure 8 below. The earliest photos (1948) are not early enough to capture pre-disturbance conditions; significant agricultural and rural residential uses appear to be well-established by then. There is nevertheless a significant increase in land-use disturbance and channel change that occurs between 1948 and contemporary times. One of the most dramatic changes has been the abandonment of the large horseshoe-shaped side channel between RM 11.27 and 11.45. This occurred sometime after the 1948 flood (see Hydrology section below for flood history) and before the 1953 photo was taken. The 1948 photo shows considerable scour associated with the 1948 flood, which was the flood of record and occurred in May. Much of the floodplain within the project area was scoured of vegetation, and overbank deposits, likely of sand and gravel, can be seen in many areas.

Following 1948, the continued expansion (scrolling) of the big north bend is likely what led to its eventual cut-off sometime prior to 1953. Channel scars indicate that a similar scale meander cut-off occurred further upstream sometime prior to 1948. It is possible that human intervention for property protection may have been involved with the cut-off of the large horseshoe bend. Channel manipulations to protect property were common following the devastating 1948 floods. The bank armoring and levee at RM 11.2, and additional levees on the river-left bank upstream near RM 11.5, contributed to further straightening, confinement, and incision of the channel through the project reach. The bank armoring at RM 11.2 may have been in place by 1968, but it is difficult to determine from the photography. The 1975 photos reveal some recent flood scarring through the floodplain to the north from RM 11.2 to 10.7. This likely occurred during the 1972 flood, which was a significant flood in the region. These flood scars remain visible in the 1998 photos. LiDAR data and aerial photos suggest that this area was later filled and graded and houses were constructed. This floodplain filling and grading has also likely played a role in floodplain disconnection and channel incision. Since 2006, there have not been significant changes, except for continued maturation of previously cleared riparian and floodplain vegetation.

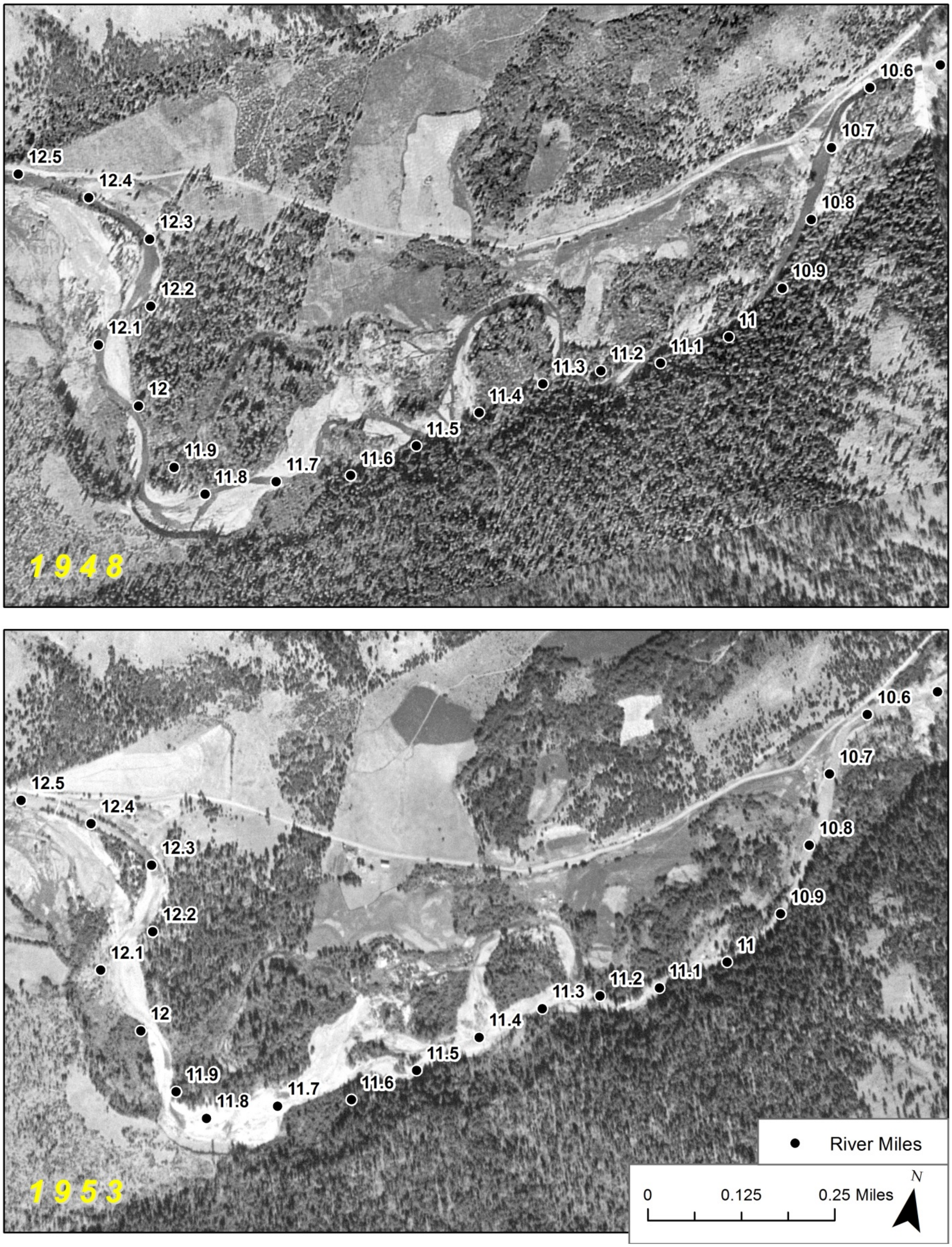

Figure 5. 1948 and 1953 aerial photographs.

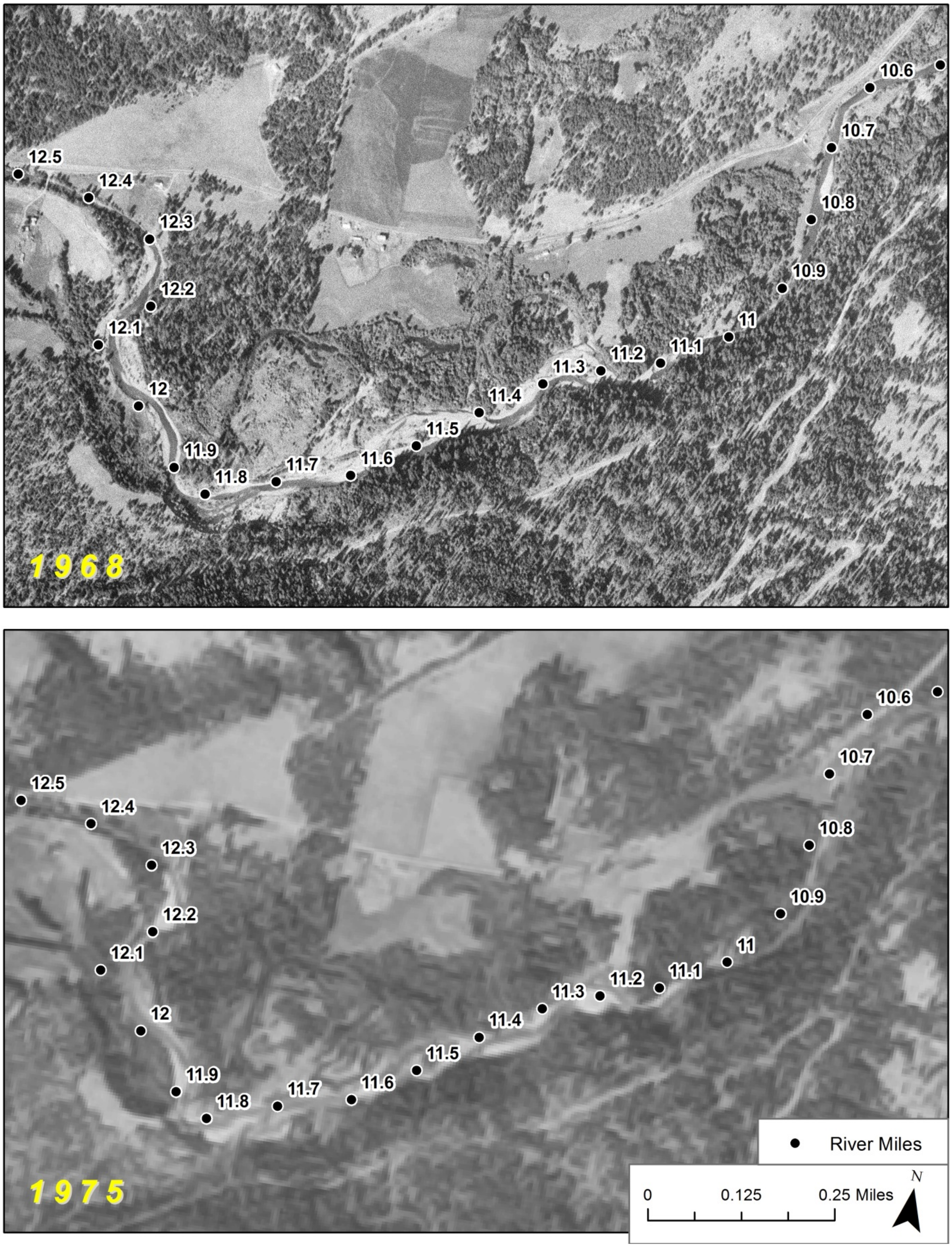

Figure 6. 1968 and 1975 aerial photographs.

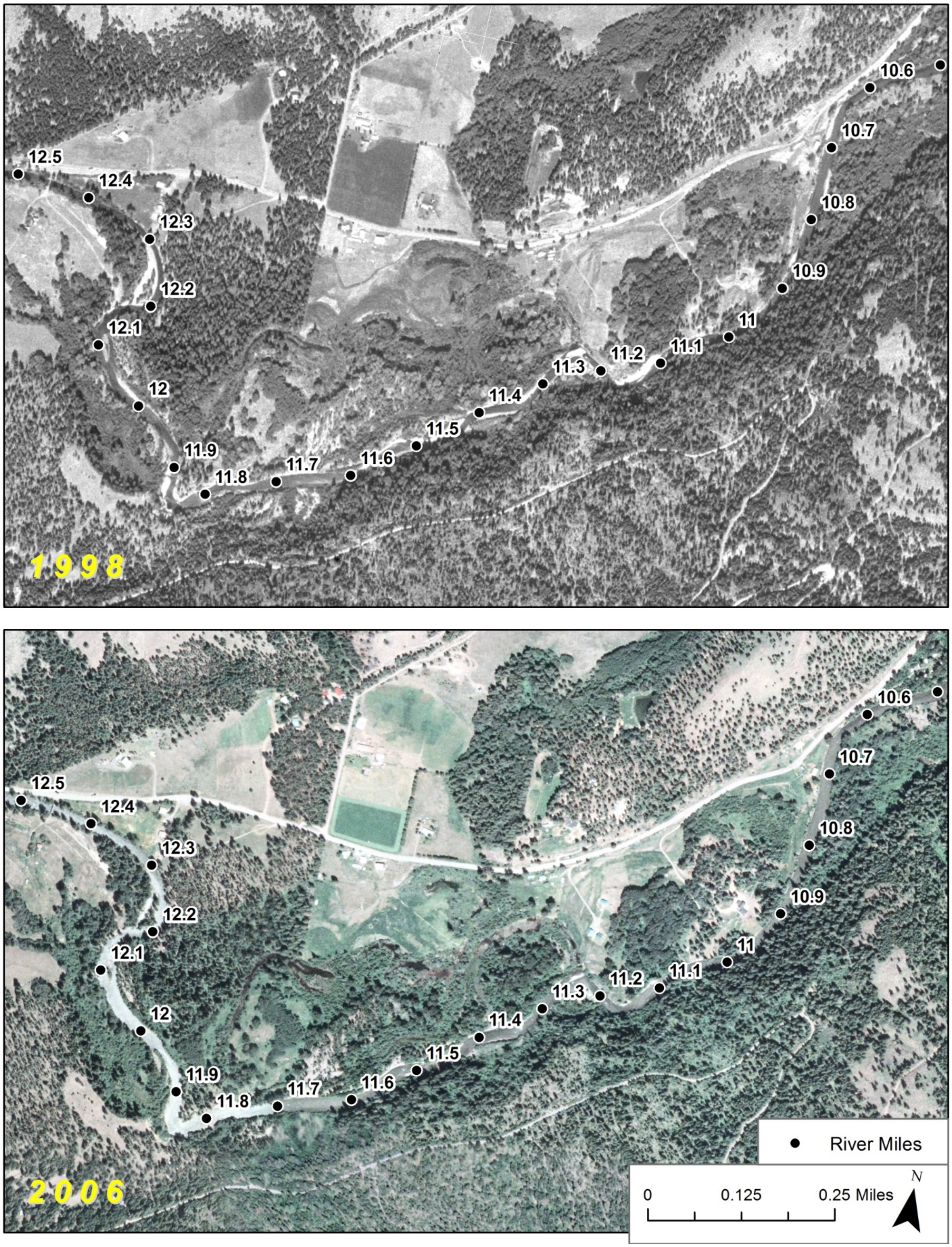

Figure 7. 1998 and 2006 aerial photographs.

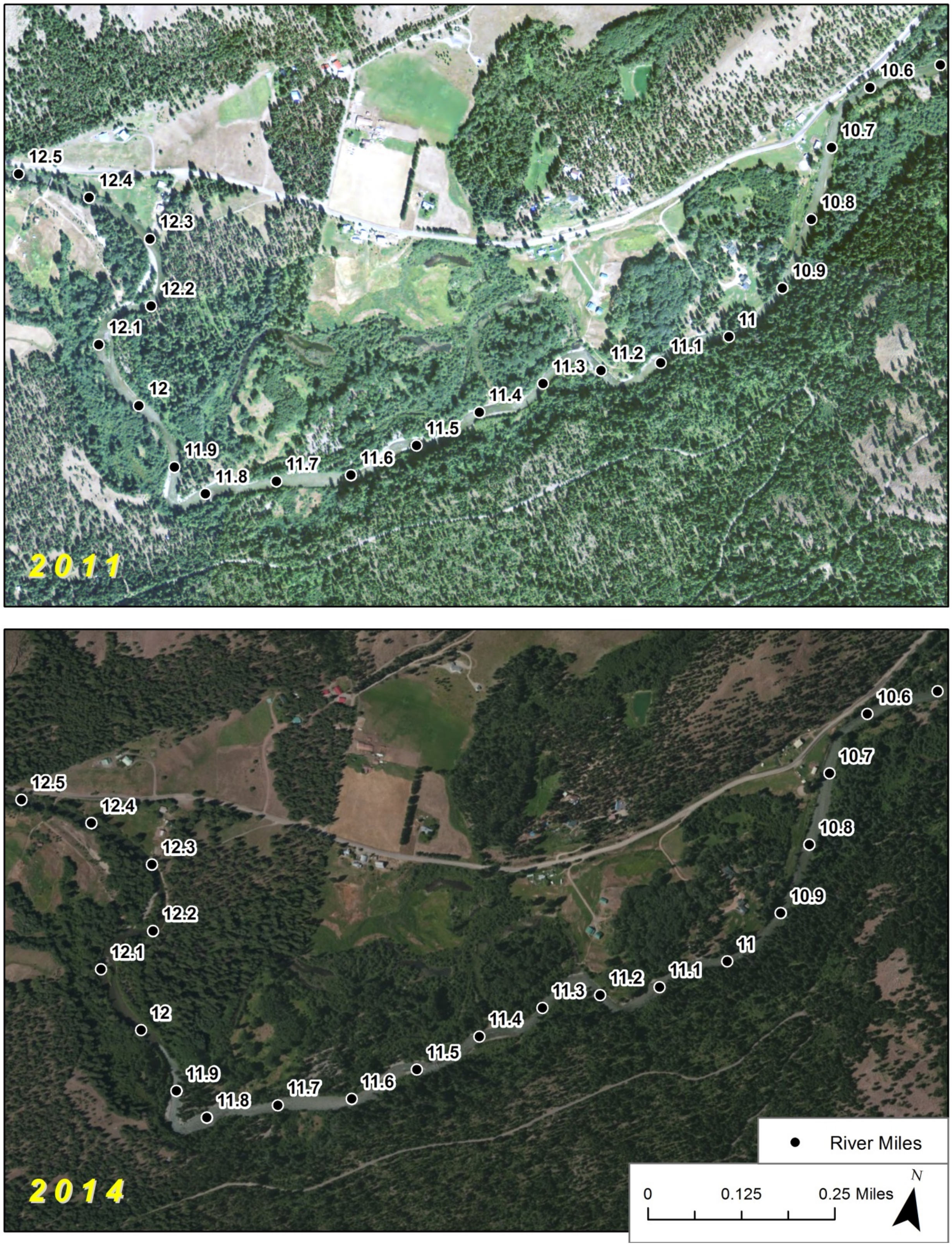

Figure 8. 2011 and 2014 aerial photographs.

HYDROLOGY

The Twisp River watershed is a sub-basin to the Methow River basin in western Okanogan County, Washington, in the eastern Cascades. The Methow River empties into the Columbia River near Pateros, Washington. There are no significant tributary inputs in the project area, although Buttermilk Creek enters the Twisp River upstream of the project area and both Little Bridge Creek (at RM 9.78) and Newby Creek (at RM 7.8) enter the Twisp downstream of the project area. Hyporheic flow is assumed to occur throughout the area in low gradient alluvial sections with higher sinuosity and the presence of gravel bars.

Dominant hydrologic patterns are driven by precipitation in the form of snow and the subsequent spring snowmelt. Precipitation amounts vary with elevation and distance from source areas. In the higher elevation areas of the basin, where maximum elevations are near 8,780 feet, average annual precipitation is 65-70 inches, falling mainly as snow. Mean annual precipitation in the Twisp River watershed is about 43 inches (USGS 2013). Peak runoff usually occurs from April to August, with the highest discharges typically in June (Figure 9). Baseflow discharge conditions typically return in the Twisp River by September.

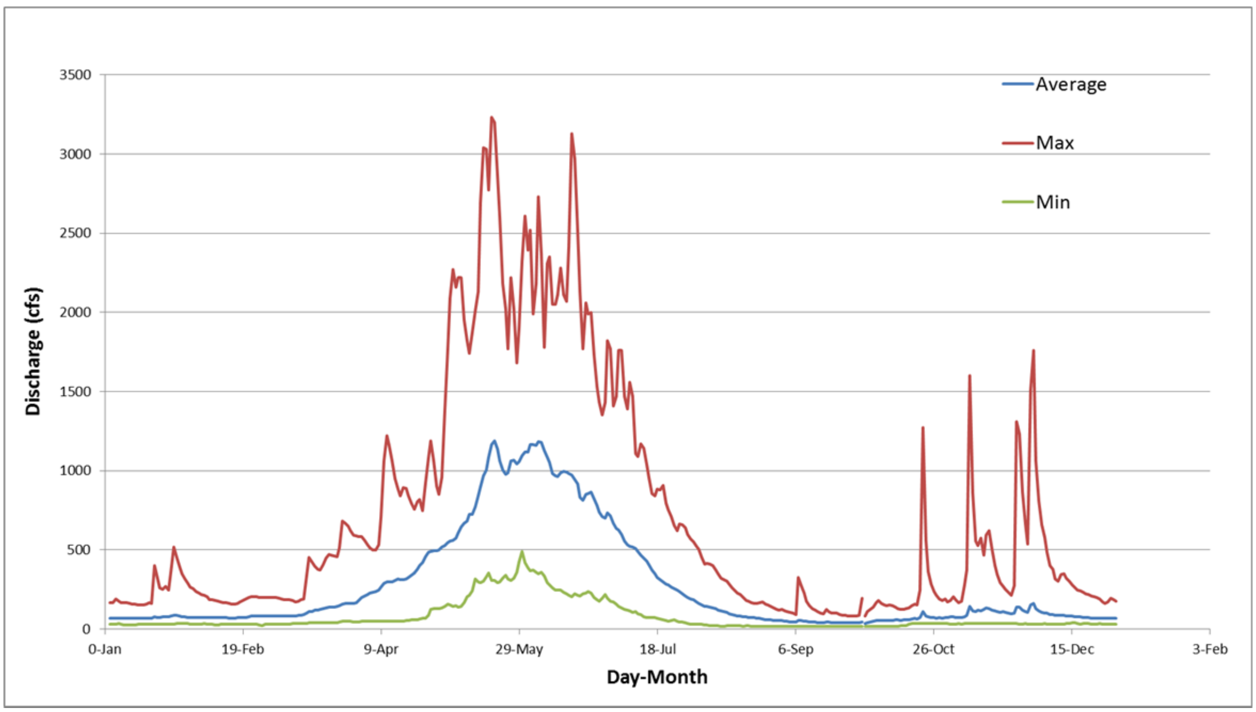

Figure 9. Average, maximum, and minimum values of average daily flows for the period between 10/1/1989 to 9/30/2013 (as measured at USGS gage number 12448998).

Flood History

There is one U.S. Geological Survey stream gage on the Twisp River (#12448998) located downstream of the project area at RM 1.6. The drainage area to the gage is 245 square miles while the drainage area to the project site is 180 square miles. The gage has been in operation continuously since 2002; additional data were collected for the years 1975-1979 and 1990-1999. A flood peak from the May1948 flood has also been documented by the USGS.

The largest flood event on record in the Twisp River was 9,440 cfs in 1948. Although the gaging station was not in operation, the U.S. Geological Survey estimated the magnitude based on a contracted opening method with high water marks. The magnitude of the flood was nearly 2.5 times the magnitude of the next largest flood, which occurred in May 2006. Other notable flood events occurred in the Methow Valley in 1894 and 1972, although there is no gage data available for the Twisp River for any of these years. Of the 28 annual peak discharges in the gage record, only two took place outside the months of May or June.

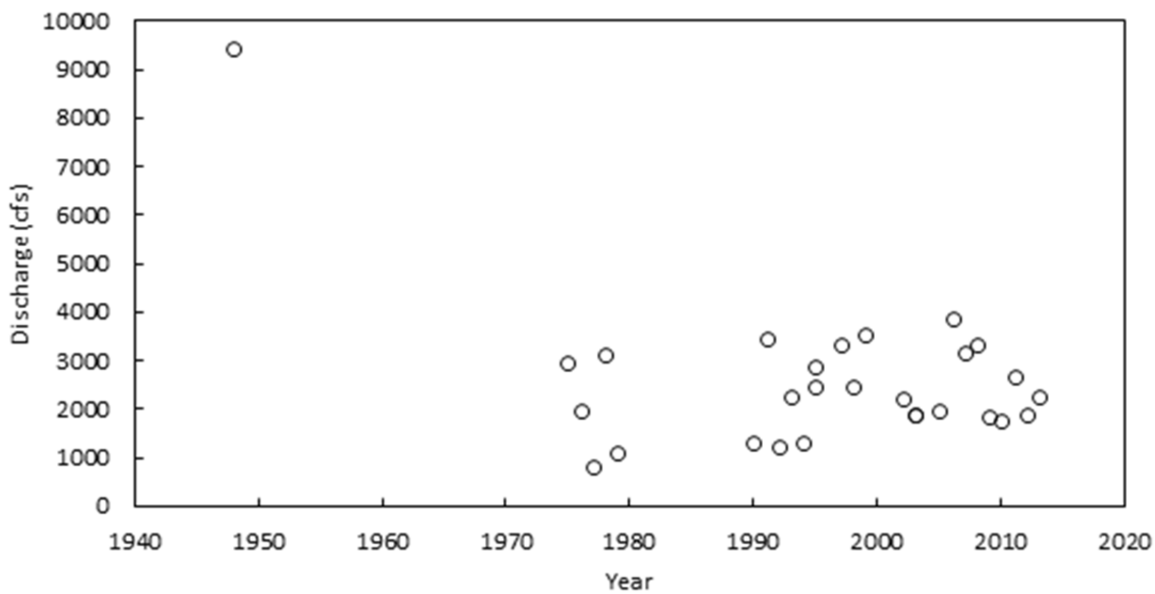

Figure 10. Annual peak floods at the Twisp River gage (USGS 12448998). The 1948 magnitude of 9,440 cfs was estimated using high water marks by the USGS.

Flood Quantiles

Flood magnitudes for specific recurrence intervals were estimated using the USGS gage on the Twisp River at Twisp, WA (#12448998). The data included annual instantaneous peak flood discharges for the years 1948, 1975-1979, 1990-1999, and 2002-2013. Quantiles were estimated by fitting these data to a log-Pearson Type III (LP3) probability distribution as recommended by the Interagency Advisory Committee on Water Data and described in Bulletin 17B (1981). Since the development of Bulletin 17B, however, there have been further improvements in flood quantile estimation. These improvements include the expected moments algorithm (EMA) for utilizing historic peak flood data (Cohn et al. 1997), a new procedure for estimating confidence intervals (Cohn et al., 2001), and the Multiple Grubbs-Beck (MGB) Test for low outliers (Cohn et al. 2013).

The LP3 procedure is based on the estimation of the first (average), second (standard deviation) and third (skew coefficient) moments of the annual peak flood data. Fitting the LP3 distribution to the data is particularly sensitive to the skew coefficient. To minimize anomalous data that could distort the long-term statistics of the Twisp River flood quantiles, we used a weighted skew coefficient. The weighted coefficient combines the station skew with the average skew coefficient from nearby gages in the region. The skew with a lower mean squared error has a stronger influence on the combined value. The Twisp River station skew was 0.566 and the regional average was -0.038. The combined value was 0.280.

The EMA was applied to the historic flood in 1948 and to handle the data gaps between 1980-1989 and 2000-2001. The MGB Test removed one low outlier from the analysis. The results at the gaging station are shown in Table 3.

To transfer the flood quantiles at the gage to the Horseshoe Side Channel site, we used the adjustment method described by Sumioka et al. (1998). The method multiplies the ratio of drainage areas by an exponent that was fitted to regional flood data.

Table 3. Flood quantiles at the Twisp River gage (USGS 12448998) and estimated at the Horseshoe Side Channel Project site.

Recurrence interval (years)	Q_{gage} (cfs)	Q_{site} (cfs)
1.5	1,860	1,376
2	2,254	1,668
5	3,357	2,484
10	4,185	3,097
25	5,345	3,955
50	6,292	4,656
100	7,314	5,412
500	10,020	7,414

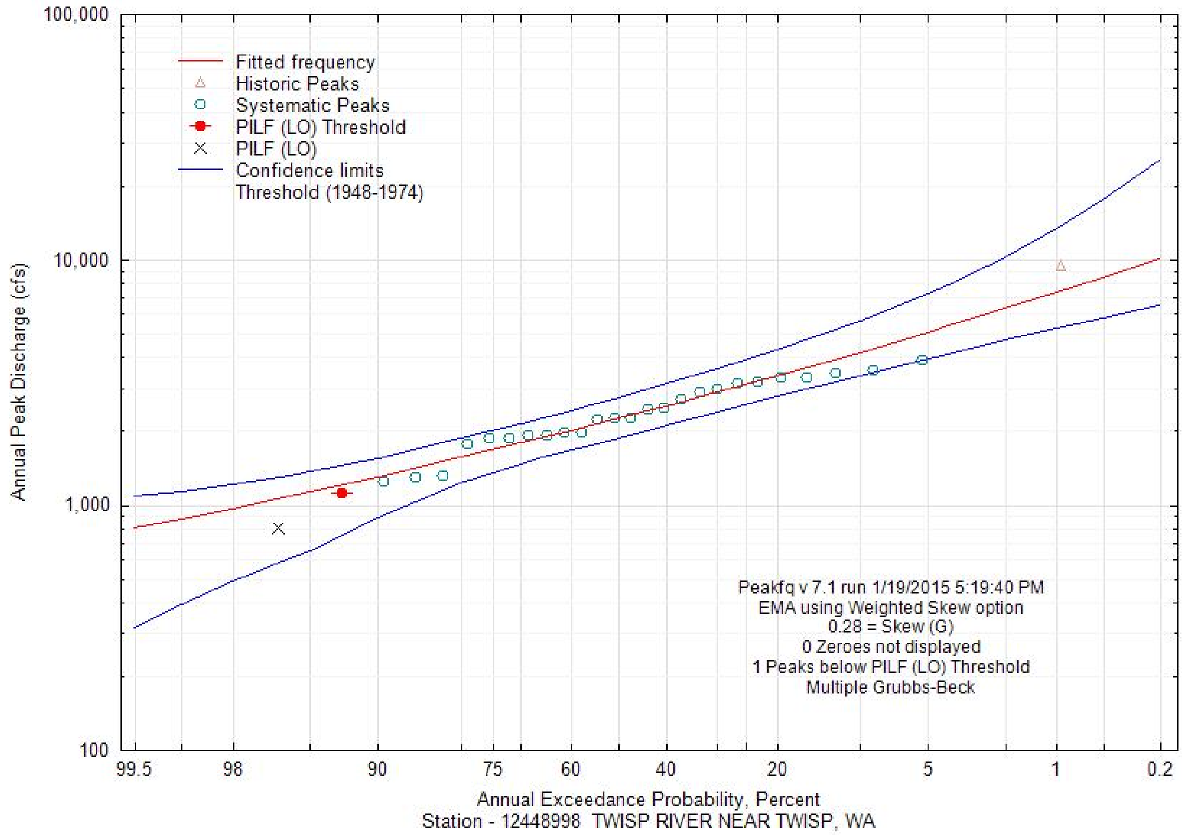

Figure 11. Flood quantiles for the Twisp River gage along with the corresponding confidence limits, low outlier, and historic peak data.

HYDRAULICS

The floodplain of the Twisp River includes many relict side channels and terraces with different elevations. Consequently, the activation and deactivation of these surfaces is relatively complex. Two-dimensional hydraulic models perform well in these situations. One-dimensional models can also produce relatively accurate results; however, multiple iterations are usually needed to break floodplains into different channel reaches and create pilot channels so that the model does not become unstable when flows are not conveyed in these floodplain areas. Accordingly, we developed a 2-D model for the Horseshoe Side Channel site.

Model Construction

The two-dimensional model was run with TUFLOW (BMT WBM 2010) using the Surface-water Modeling System (SMS; SMS 2014). Geometric data for the model were based on the integrated ground survey and LiDAR data. These data were imported into SMS and then sampled on a 5 ft by 5 ft rectilinear grid. With an average channel width of 100 ft in the reach, there was an average of about 25 geometry nodes across the river throughout the reach to define the bathymetry. Grade breaks across the channel typically occurred at scales larger than 5 ft. Thus, the 5 ft grid included sufficient detail to capture hydraulic controls.

Roughness values for the model were delineated in AutoCAD based on field observations and exported to SMS. One roughness value was specified throughout the main channel based on the pebble count data. The 84th percentile largest grain size was applied to Strickler's equation (Chow 1959) to obtain the estimate of 0.034. This value is consistent with the values predicted with the empirical approach described by Arcement and Schneider (1989). The value of 0.034 is slightly lower than the coefficient of 0.038 used for the HEC-RAS model in the reach assessment of the Twisp River (Inter-Fluve 2015). Other roughness values were estimated using the Arcement and Schneider (1989) method and look-up tables (Chow 1959).

Table 4. Manning's roughness coefficients used for the existing conditions TUFLOW hydraulic model.

Area	Manning's roughness value
Main channel	0.034
Side channel	0.034
Forest	0.12
Grass	0.07

The downstream boundary condition for the model was provided by the water surface results from the HEC-RAS model for the downstream Newby Narrows Project site. The upstream boundary condition was specified using the flood quantiles adjusted from the USGS Twisp River gage. All flows were modeled with a time step of about 0.5 seconds consistent with the Courant condition (see Wu 2007). Each flood quantile was routed through the model for at least 3 hours to allow sufficient time for steady-state hydraulic conditions to occur.

Model Results

Extent of Inundation

Anthropogenic modifications and relict sediment deposits from the 1948 flood have reduced the extent of floodplain connection in the Horseshoe Side Channel reach. During a 5-year flood quantile, some small terraces are inundated in places where recent channel migration has left lower depositional surfaces (Figure 13). Most of these terraces are in locations that have been occupied at some point since 1964. One exception occurs at station 12.22 where floods overtop the east bank and are conveyed along the floodplain as sheet flow until entering the relict side channels. The flow does not re-enter the main channel until stations 11.41, 11.35 and 11.25.

Another sizeable floodplain surface becomes inundated during the 10-yr flood to the north of the channel between stations 11.42 and 11.75 (Figure 14). This area has been occupied more recently with half of the area coinciding with the main channel in 1994 and the remaining portion having been occupied at some point since 1968.

Additional surfaces are inundated during a 10-yr flood event including the floodplain north of the river between stations 11.1 and 11.2 where riprap has been placed along the left bank (facing downstream). One high flow path is evident in the LiDAR data in this area. Its presence reinforces the model results suggesting the periodical activation of flow across this surface.

During the 25-yr flood, flow enters the floodplain in another location that has not been occupied since 1964 (Figure 15). At river mile 11.91, flow overtops the outside of a meander bend and is conveyed as sheet flow for about 400 ft until entering a relict side channel. This water remains in the side channel complex until at least river mile 11.52. The flow does not re-enter the main channel further upstream as a push-up levee is located at 11.74 preventing connection to the main channel.

More areas of the floodplain become inundated during the 50- and 100-yr flood quantiles (Figure 16 and Figure 17), but many areas of the historic alluvial floodplain do not become submerged. Some of these perched areas are where the main channel was located prior to the 1948 flood. Large sediment deposits coupled with incision through the reach have resulted in these areas becoming inactive former floodplains.

The inundated areas at the 100-yr flood quantile include nearby buildings. Water encroaches on the two houses located just north of the main channel at station 11.24 during the 50- and 100-yr floods. The water on the floodplain in these locations appears to continue flowing on the floodplain down the valley. Additional houses are located in this flow path to the north of the channel. Final design will need to consider any potential impacts to existing infrastructure.

HEC-RAS Model Comparison

The extent of inundation is considerably less than the extents estimated in the reach assessment (Inter-Fluve 2015) by the HEC-RAS model developed with LiDAR data. No side channels or floodplain surfaces are active during the 2-yr flood as shown with the HEC-RAS model. Part of the reduction in floodplain connection is due to slightly lower Manning's roughness coefficients; however, the more probable cause is that the TUFLOW model included larger flow areas. Survey data captured bathymetry that was not part of the LiDAR data used for the HEC-RAS model. Consequently, the HEC-RAS model was based on data with a smaller flow conveyance area and more water was artificially forced onto the floodplain.

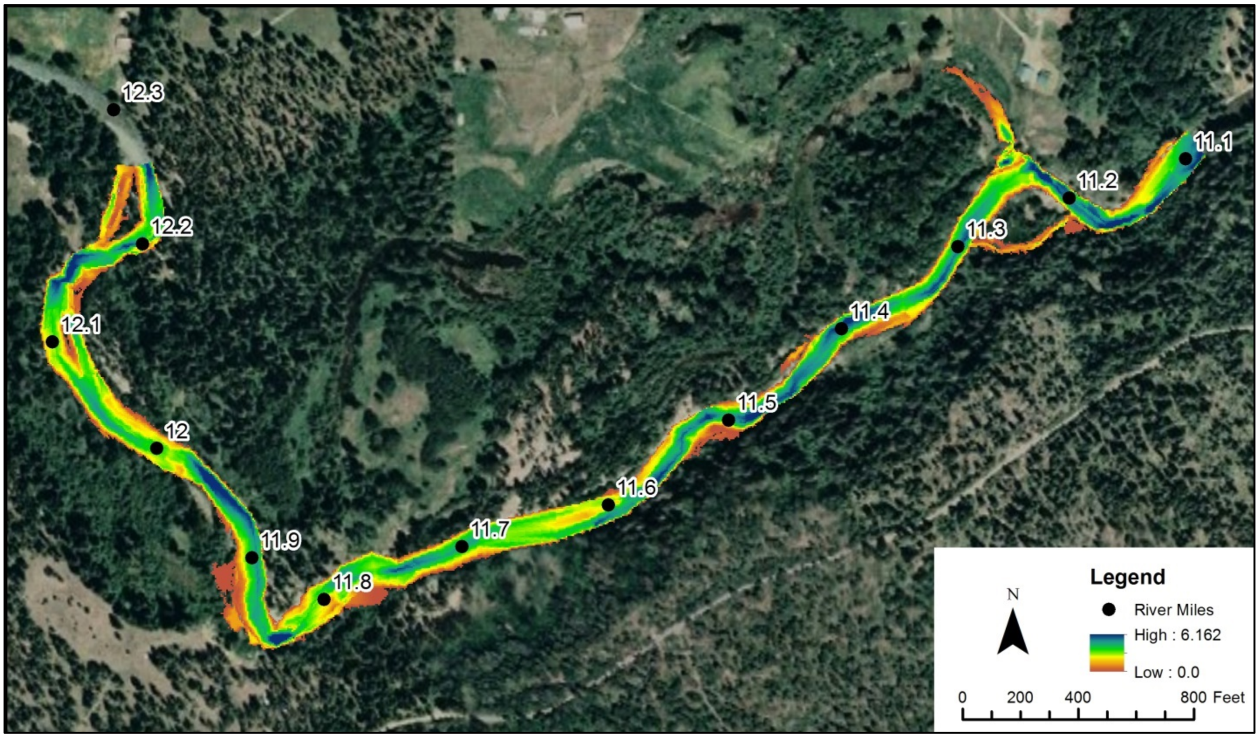

Figure 12. Water depths (in feet) during a 1.5-yr flood quantile under existing conditions.

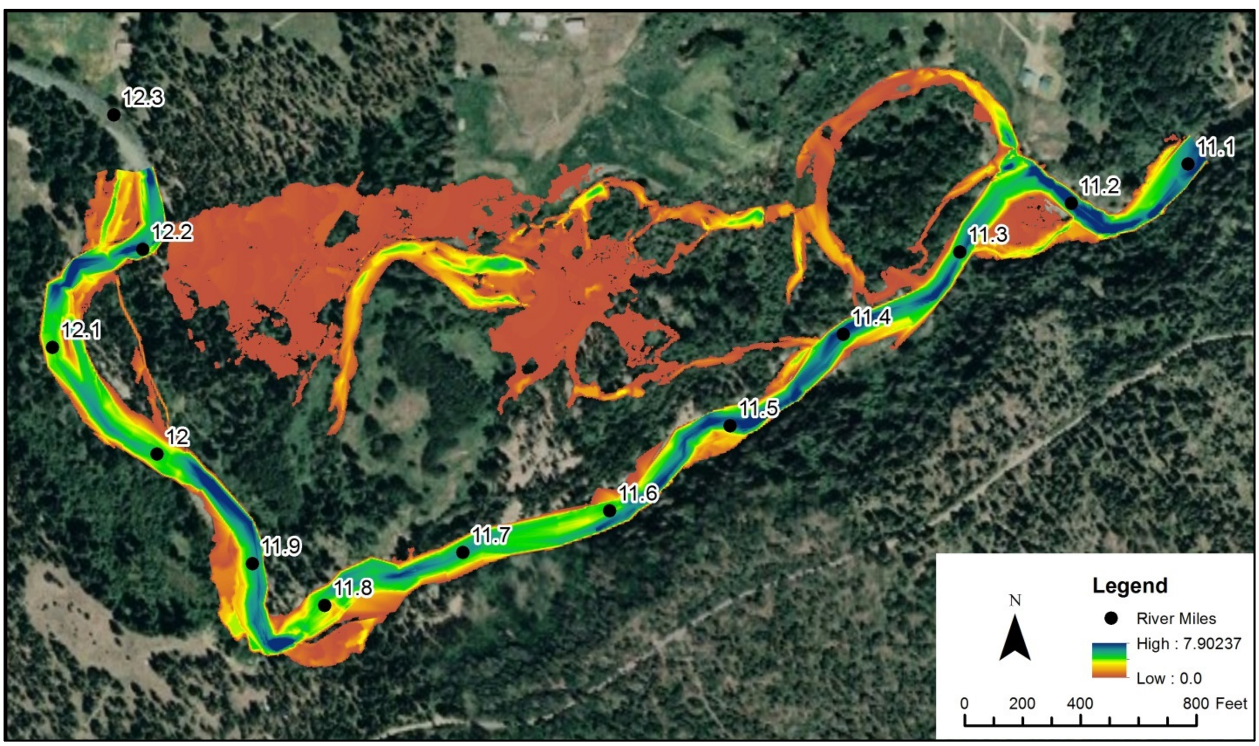

Figure 13. Water depths (in feet) during a 5-yr flood quantile under existing conditions.

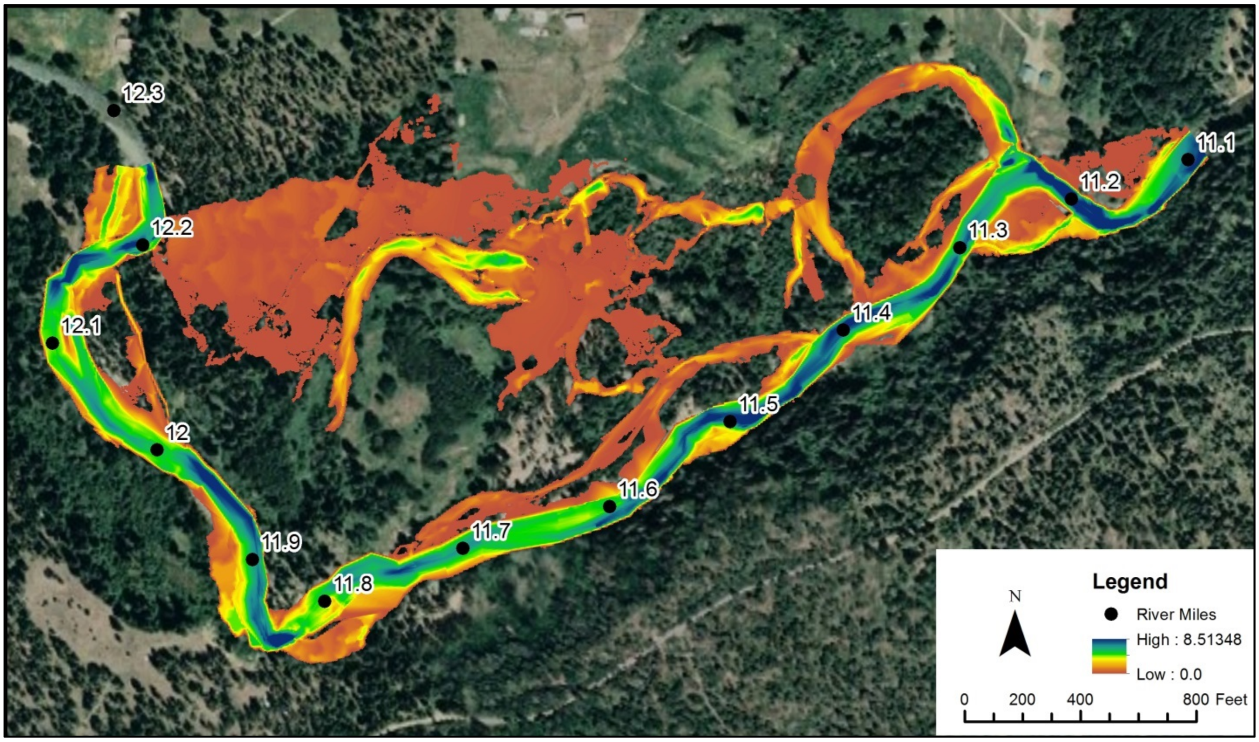

Figure 14. Water depths (in feet) during a 10-yr flood quantile under existing conditions.

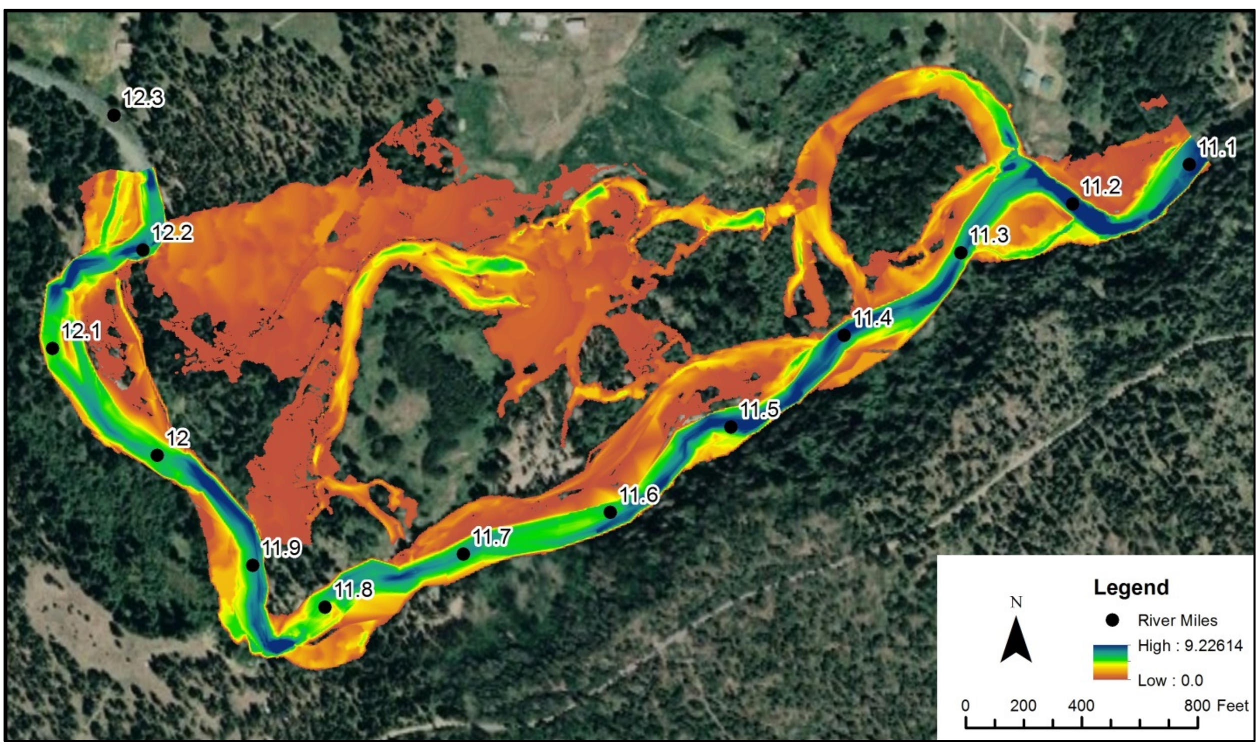

Figure 15. Water depths (in feet) during a 25-yr flood quantile under existing conditions.

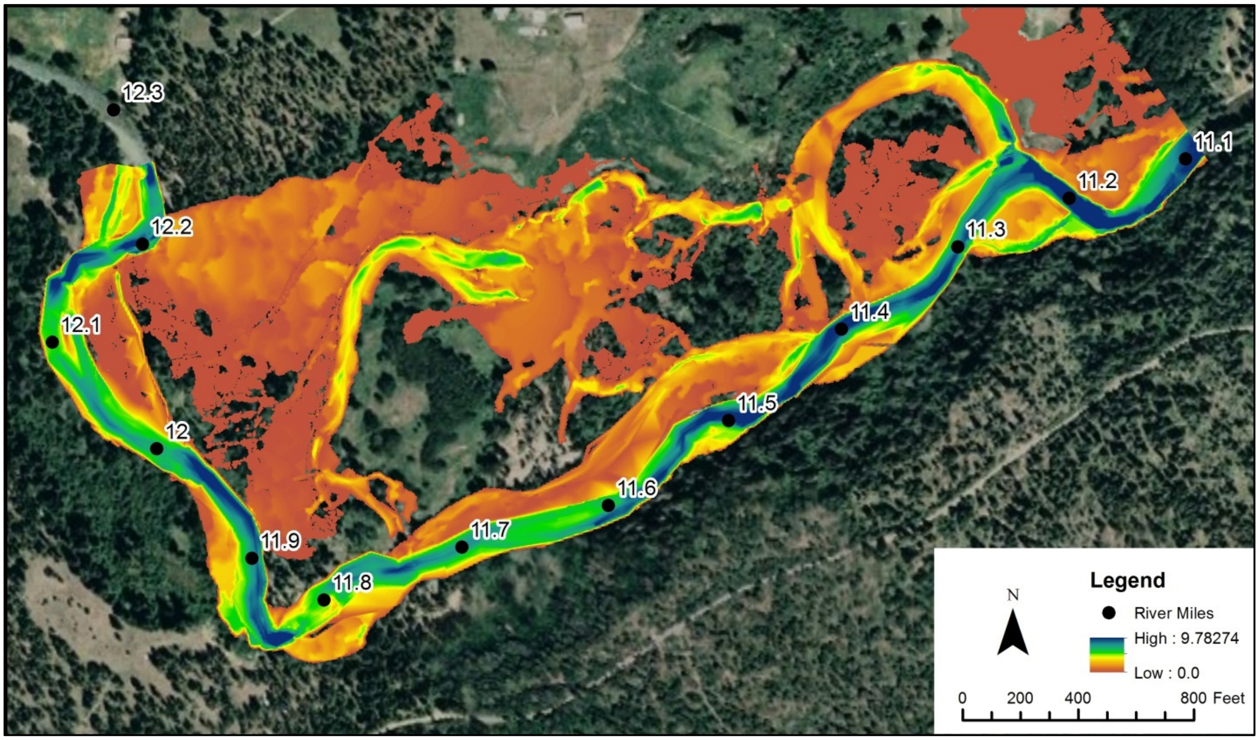

Figure 16. Water depths (in feet) during a 50-yr flood quantile under existing conditions.

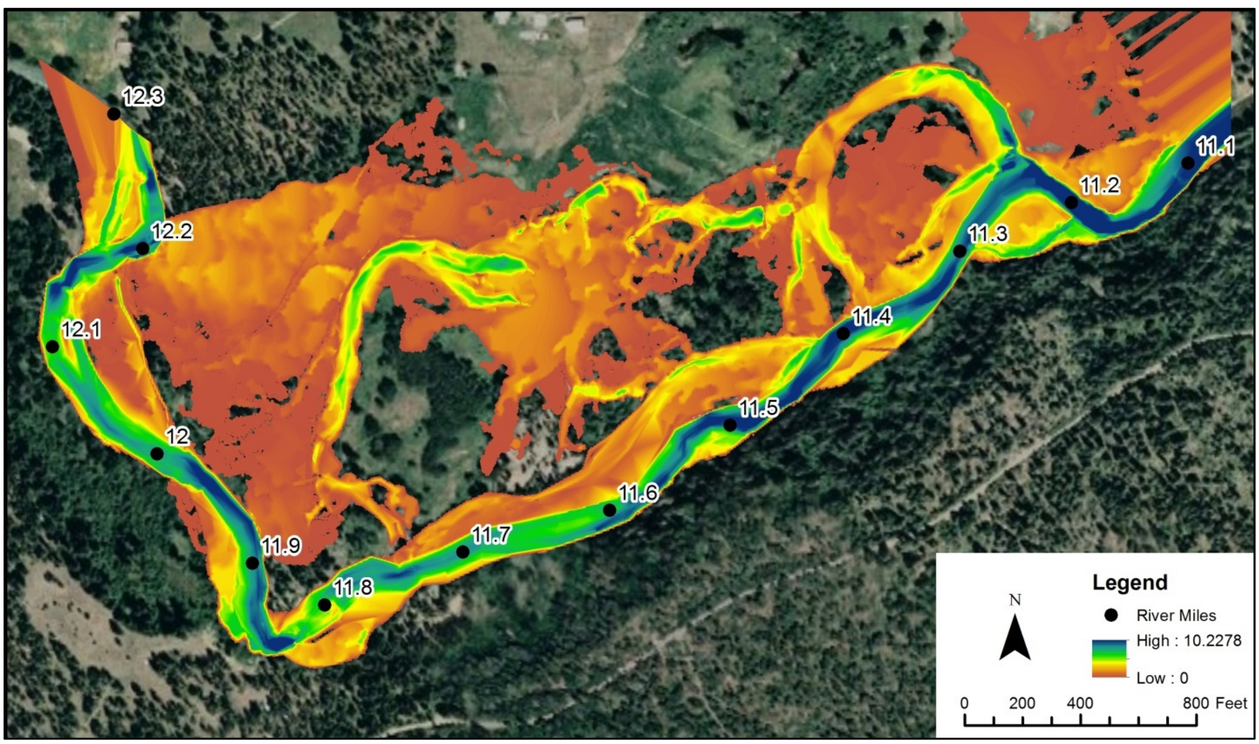

Figure 17. Water depths (in feet) during a 100-yr flood quantile under existing conditions.

VEGETATION

The Horseshoe Side Channel area has a diverse mix of coniferous forest, cattail wetlands, aspen stands, grasslands, and deciduous shrub communities. Ground surveying combined with canopy height information (Inter-Fluve 2015) allowed us to divide the project into several vegetation zones:

- Western right bank area – This area encompasses the right bank from the top of the project straight south to where the Twisp bends sharply to the east. This segment is dominated by low deciduous shrub cover (3-25 ft).
- North side channel/Horseshoe Side Channel – The wetlands that border the north floodplain wall and the Horseshoe Side Channel are dominated by cattail monoculture or open water. The riparian edge is dominated by willow, dogwood and alders 10-20 feet in height, with some black cottonwood scattered throughout.
- South Bank main channel - The south side slopes along the right bank of the Twisp are steep cut banks. These alluvial fan and terrace areas are mixed conifer forest varying 50-100+ feet in height.
- Interior – The area between the north side channel and the main Twisp channel is a mix of alluvial fan runout, former channel bed sediments and floodplain/terrace sediments. These areas have Douglas fir, Ponderosa pine, and cottonwood stands, with patches of aspen. Roughly 10% of this area, particularly in alluvial gravel and sand, is bare ground. Understory vegetation includes dogwood, alder, and other deciduous shrubs.
- North terrace – The uplands on the north side of the channel are dominated by pasture grass, but the area has not been grazed recently.

Black cottonwoods are found primarily in and adjacent to sites subject to groundwater flow and saturation. Cottonwoods are common along the Twisp River on the southern edge of the project area. The USBR (2008) noted a small amount of cottonwood crown dieback in the drier floodplain areas, and that floodplain disconnection had resulted in colonization of drier areas by Ponderosa pine. Cottonwood is present along the edges of the open water areas in the relict channel areas. Larger cottonwoods were noted along the drainage ditch south of the picnic area, and along the main channel left bank. No significant cottonwood regeneration was seen in either this or the USBR assessment (2008).

Description of Project Components

ALTERNATIVES CONSIDERED BUT NOT SELECTED FOR ADVANCEMENT

North Channel Relocation – One project considered was the complete relocation of the Twisp main channel through the north side channel complex. The concept involved diverting the main channel flow at the upstream end of the project area (RM 12.2) south through the picnic area and then meandering east through the relict channel segments and into the Horseshoe Side Channel, finally exiting at RM 11.24. This project would require extensive grading to fill or partially fill in the existing Twisp River main channel. The existing main channel would be converted to side channel and wetland habitat. Major concerns with this concept included cost, risk of erosion or flooding at the downstream end, anticipated landowner concerns, and regulatory issues.

Horseshoe Side Channel Relocation – This project is a scaled down version of the above North Channel relocation, and involves the diversion of the Twisp River main channel at RM 11.4 into the Horseshoe Side Channel. The Horseshoe Side Channel segment is approximately 1,800 feet long. Historic maps and aerial photos indicate that this segment was active until the middle of the 20th century. The relict channel may have been abandoned naturally or, in part, due to active channelization of the main stem of the Twisp River. In any case, the relict channel is intact, but does have cattail growth over 2-3 ft of organic material and sediment accumulation. This project would also include connecting the bend with the north side beaver dam/side channel complex for additional side channel habitat. The main problem with this plan is slope. Since the Horseshoe Side Channel was cutoff, the main channel has dropped in elevation. Connecting the bend again would likely require elevation of the main channel, which makes the project logistically challenging. This plan would also require extensive fill to block off the main channel of the Twisp River to prevent its re-occupation. Furthermore, the processes that resulted in the cutoff of this channel may still be in play and would make its persistence uncertain.

Twisp River Bed Elevation – In order to increase the inundation frequency of the side channels and floodplain to the north, we examined raising the bed of the Twisp River mainstem through the reach. This could involve extensive roughness introduction, grade control placement, channel fill, and/or multiple large log jams intended to occlude the channel and foster sediment deposition. We opted instead to include a moderate degree of channel roughness and occlusion using log jams at select locations where side-channels or floodplain surfaces could be activated over time, or in combination with selected excavation. This approach is expected to foster bed aggradation and increased floodplain connection over the long-term, but avoids the short-term impacts associated with filling or aggressively occluding portions of the main channel.

ALTERNATIVE 1 - NORTH SIDE CHANNEL (INLET AT RM 12.18)

The first alternative evaluated was the reconnection of the beaver ponds and relict channels occupying the north border of the floodplain. On the north side of the existing floodplain, there are two conspicuous relict channel segments, the Horseshoe Side Channel at the downstream end of the project and the north side channel that runs along the edge of the left terrace wall and is connected to the Horseshoe Side Channel. The concept for the north side channel involves excavating an access channel from just downstream of the campground area (RM 12.8 or Station 118+00 on the drawings) to a point east where the relict channel is largely intact (Station 96+00 on the side channel profile). From this point to the Horseshoe Side Channel, the relict channel is a mix of open water and cattail patches. Depth of refusal surveying during the topographic survey indicated that the relict channel bottom is composed primarily of boulders and cobbles. Roughly 50% of the relict channel complex is open water separated by cattail monoculture. In order to ensure water flow through the project area, restoration would involve construction of a pilot channel through selective removal of organic deposits. Additional habitat would be constructed as pool habitat and log complexes.

Potential Benefits

The main benefit of this side channel route is a significant increase in available side channel fish and wildlife habitat area with minimal invasive earth moving. This side channel route has existing groundwater seepage but fish cannot readily access the available habitat. Creating a connection to the main channel, increasing complexity, and excavating fine sediment will create valuable salmonid overwintering habitat, spawning habitat, overhead cover, and exceptional juvenile rearing habitat. The complexity of side channel habitat provides nesting habitat for waterfowl, cover for shore dwelling birds and cover for prey. Reptiles and amphibians utilize submerged and partially submerged log complexes as protection from predators and refugia during floods. The complex habitat features of wood, pools, riffles, and undercut banks provide adult and juvenile fish habitat and refugia during floods. Salmonids are visual predators. The complexity offered by wood in side channels creates three dimensional barriers that increase visual separation and thus increases the holding capacity of the reach. Logs and exposed gravel, cobble, and boulder substrates can increase the biomass and diversity of available food sources (e.g. benthic invertebrates). Added roughness helps to decrease the overall stream power of the reach.

Connecting the north side channel complex would improve floodplain connectivity. Increased inundation frequency would improve floodplain wetland function and increase infiltration and groundwater storage in the floodplain.

Design Considerations/Constraints

The most important design consideration will be sediment continuity through the side channel complex. These channels were once active, and the processes that filled in portions or caused their abandonment may still be at work. Balancing the historical human causes with the existing hydraulics and sediment transport process will be critical in keeping water flowing through the side channel. Entrance to the north side channel was considered at 94+00 and 106+00, but was abandoned in favor of the 118+00 entrance, which provides the best alternative for long term water flow with minimal sediment deposition. The other two inlet options have a low slope through the first 1,000 feet, which may result in sediment deposition blocking the side channel. This option has a steeper upper channel segment, which will help to ensure sediment transport through the inlet.

One challenge will be the excavation of the upper 1,000 feet of the side channel. The proposed channel bottom is roughly 6-8 feet below grade in this segment. There are some mature trees through this section, and these could be used as woody material in the newly constructed side channel. To direct flow into the side channel and also create an attracting feature (scour pool), an apex-type log jam is recommended at the downstream side of the side channel inlet, with an additional potential jam on the opposite bank to constrict flow through the main channel.

The existing relict channel, including the Horseshoe Side Channel, is approximately 60% occluded with organic sediment and cattail root mass. It will not be prudent to excavate the entire channel to its pre-abandonment cross section, since the entire flow of the Twisp will not be flowing through it under the proposed conditions and such action would have a larger impact on existing wetland vegetation. However, a significant amount of flow will be flowing through the north side channel/Horseshoe complex, particularly during larger flood events. Hydraulic and sediment transport analysis of the proposed pilot channel cross section, plan, and profile will need to be completed during the design process to ensure transport of fine sediment and to assess potential flooding impacts. This will also help to minimize excavation of cattails. As with the North Channel, an apex-type log jam is recommended at the downstream side of the side channel inlet.

Beaver have historically inhabited this segment, and will likely be attracted to increased flows. Beaver will need to be monitored for long term impacts as part of the long-term management plan for the project.

The landowner has expressed the desire to be able to access the floodplain for trail maintenance, general recreation, and wildlife viewing. Design should consider the existing trail layout and develop a system of crossings that minimizes disturbance and cost and maximizes ease of access.

Any change in channel pattern or floodplain inundation will need to be modeled to assess the impact of the project on the regulatory flood (100-yr). Diversion of water into the Horseshoe bend will need to consider the impact of erosion and flooding on any structures (buildings, roads) in the floodplain. In the immediate vicinity, dwellings are located only on the left floodplain, at Stations 50+00 and 66+00 on the Twisp River mainstem.

ALTERNATIVE 2 - NORTH SIDE CHANNEL WITH SOUTHWEST DIVERSION ENTRANCE (INLET AT RM 11.95)

Alternative 2 is similar to the North Side Channel reclamation, but with an entrance located downstream at RM 11.95, where the main channel once flowed. This side channel runs 1,200 feet to meet up with the North Side Channel complex at Station 108+00 on the plans (North side channel stationing). The Southwest side channel segment would begin at the remnant of an alluvial fan run-out, the base of which has been dissected by the Twisp between Station 88+00 (RM 11.5) and 104+00 (RM 12.0). Roughly 1,000 feet of this channel is a remnant channel bordered by aspen. The only major earth moving would be to open the side channel inlet. The remainder of the project would involve selective excavation and installation of habitat features such as pools, boulders and logs. To direct flow into the side channel and also create an attracting feature (scour pool), an apex-type log jam would be installed at the downstream side of the side channel inlet, with the possibility of another jam on the opposite bank to restrict flow in the mainstem.

Potential Benefits

The habitat benefits of Alternative 2 are similar to those described for the north side channel above. This includes increased fish and wildlife habitat quantity and quality, including fish spawning, rearing, overwintering habitat, flood refugia, and cover.

Design Considerations/Constraints

The main potential issue with this feature is slope. This channel inlet would have a slightly lower slope (0.0092 ft/ft) than the proposed North side channel inlet (0 .012 ft/ft), but is still steeper than the lower half of the channel complex. Final design would need to examine the possibility that the channel opening could eventually fill and become partially or wholly blocked at lower flows.

Many of the design considerations, such as flooding and access, are the same for this option as with Alternative 1. Access to the southern portion of the site is preferred by the landowner. The final designs will need to consider access to these areas.

LEFT BANK SIDE CHANNEL (INLET STATION 94+00 TO 76+00)

The Left Bank side channel is proposed to run through the low floodplain bench on the left bank of the Twisp mainstem, from Station 94+00 to 76+00. This channel would run parallel to the Twisp, no more than 250 feet away from the mainstem.

Potential Benefits

The benefits of the left bank side channel are the same as the previously described side channels, including increased fish and wildlife habitat quantity and quality, including fish spawning, rearing, overwintering habitat, flood refugia, and cover.

Design Considerations/Constraints

According to the historical aerial photo record, the left bank side channel was part of the active Twisp channel until the 1950s when channel migration and disturbance resulted in the channel moving to the south. The processes that led to the abandonment of the old channel location must be considered to properly define the performance window of the left bank side channel. This side channel can be considered an optional, stand-alone item, but the inlet and outlet design must be carefully integrated into the North, Southwest, and Horseshoe side channels, should they be part of the final design.

SPRING CREEK RESTORATION (NORTH VALLEY)

On the north side of the Jennings property, near Twisp River Road, there is a high capacity well that appears to tap into abundant spring flow. Adjacent to this well is a wetland pond complex to the north and west of the horseshoe side channel. This open water pond and wetland is an older relict meander. It may be possible to construct a spring creek connection from the pond to the horseshoe side channel, and it may also be possible to integrate flow from the well to feed the constructed spring creek, either via an additional spring creek or piped system.

Potential Benefits

The spring creek portion of the project could provide benefits to bull trout, spring Chinook, and steelhead. The benefits to bull trout would be to non-migratory, resident bull trout that spend most of their lives in small headwater streams. This channel could also provide spawning habitat for fluvial bull trout that inhabit the Twisp River but that spawn in small headwater tributaries. Bull trout require cleaner, colder water than other salmonids, and this type of small stream could be ideal habitat if connected to the Twisp. The channel could also provide cold water refugia and off-channel rearing habitat for juvenile Chinook and steelhead.

This tributary spring creek could include riffle and pool habitat, backwater rearing habitat, undercut banks, and dense wood complexes. This system could also provide spawning and overwintering habitat for migratory salmonids using the Horseshoe side channel area.

Design Considerations/Constraints

The current use of the well water will need to be identified and the amount of flow usable for spring creek restoration determined. If this option is desired, it may be necessary to collect additional topographic and bathymetric data for the well and wetland complex. Landowner access and long-term vision for the property will also need to be considered.

Channel analogs will be used to determine a range of channel geometry values and habitat features, and hydraulic modeling is recommended to determine the potential impact of flooding from the mainstem. It may be necessary to include floodplain roughness elements to ensure spring creek channel integrity.

RIPRAP AND LEVEE ALTERNATIVE 1 – WOOD ENHANCEMENT

Riprap currently lines the bank from Station 63+00 to 66+50 at RM 11.2. This riprap is large (>2ft) and blends into a steep riffle complex at the downstream end of the project area. This project would improve in-stream and riparian zone habitat by adding logs to the riprap area. Wood enhancement is included in the concepts as boulder-ballasted logs and in-stream habitat complexes. No other modification to the bank or floodplain is proposed.

Potential Benefits

Adding large wood to the riprap bank would provide added roughness and create scour under the structures. However, scour would be limited by the size of the substrate below the wood. Wood can create pool cover and offer hydraulic refugia for fish during high water. Wood also provides better water to land connectivity for terrestrial wildlife in the near-bank region.

Design Considerations/Constraints

This treatment-type is relatively easy to construct and the work can be conducted working from the top of the riprap bank. However, a challenging component of this type of treatment is configuring the bumper logs in a way that provides adequate safety for boaters; this is especially the case here due to the sharp bend in the river.

RIPRAP AND LEVEE ALTERNATIVE 2 – BACKWATER CHANNEL

This alternative includes the construction of just over 300 feet of backwater channel just downstream of the riprap bank at RM 11.2. The channel would be constructed by excavating in an existing high flow channel on the floodplain. Logs would be placed at the upstream end of the channel and within the channel for avulsion and erosion protection, and to provide additional fish and wildlife habitat. The head of the backwater channel would be separated from the mainstem Twisp River by 150 feet of floodplain and the existing riprap bank, which would not be modified.

Potential Benefits

The Backwater Channel would primarily benefit juvenile Chinook and steelhead rearing. The channel would directly increase off-channel rearing capacity and would provide high quality flood refugia with abundant cover and complexity. Depending on groundwater inputs, the channel might also provide greater potential for growth and productivity compared to the mainstem due to colder water rearing in the summer and warmer water rearing in the winter. This is also an area where the existing riprap bank is impeding the natural geomorphic processes necessary to create off-channel habitats. This treatment would mimic the type of off-channel floodplain habitat that would likely be available if processes were not impaired.

Design Considerations/Constraints

The backwater channel could present some risk of main channel avulsion through the new channel. The channel would be constructed just downstream of a 90 degree bend, and would be directly in line with the high flow vector. The existing conditions hydraulic model indicates that the floodplain in this area inundates at least once every 10 years. Preliminary engineering design would need to include consideration of hydraulics, soils, flood dynamics and risk of avulsion; and measures may be required to address avulsion risk.

RIPRAP AND LEVEE ALTERNATIVE 3 – DOWNSTREAM SIDE CHANNEL

This alternative involves removing (or potentially only breaching) the existing riprap bank and excavating a 600 foot long side channel through the floodplain to re-enter the Twisp River main channel downstream at RM 11.14. Logs would be placed at the upstream end of the channel and within the channel for avulsion and erosion protection, and to provide additional fish and wildlife habitat. The upstream tie-in to the Twisp would be protected with log jams that would also direct water into the side channel. The hydraulically rough entrance would limit flow into the channel to reduce risk of avulsion.

Potential Benefits

The benefits of the downstream side channel are the same as the previously described side channels, including increased fish and wildlife habitat quantity and quality, including fish spawning, rearing, overwintering habitat, flood refugia, and cover. This is also an area where the existing riprap bank is impeding the natural geomorphic processes necessary to create off-channel habitats. This treatment would remove this impediment to long-term function and would also create immediate high quality salmonid habitat.

Design Considerations/Constraints

The Downstream Side Channel, like the Backwater Channel, has a risk of avulsion. The channel would be constructed just downstream of a 90 degree bend, and would be directly in line with the high flow vector. One favorable hydraulic aspect of this alternative is that it may lower water surface elevations which could offset increases associated with other proposed design features. This is possible as the flow area below the floodplain surface would be increased. Preliminary engineering design will need to include consideration of hydraulics, soils, flood dynamics and risk of avulsion, while balancing the need for fish passage and habitat flows.

LOG JAMS – TWISP RIVER MAIN CHANNEL

Installing log jams in the Twisp River would mimic the habitat forming function of natural log jams and mitigate for the reduced wood inputs due to clearing of riparian forests. Log enhancement can buy time between installation of the structure and the time in which naturally recruited wood enters the channel from restored riparian areas. The Horseshoe Side Channel project area has roughly half of the wood density than the average for the Middle Twisp (Inter-Fluve 2015). A variety of human activities has led to a decrease in wood habitat including removing standing trees in the meander migration zone, clearing channels, and creating bank revetments that limit channel migration processes that would naturally recruit logs.

There are two primary large wood project types that could be completed along the Horseshoe Side Channel project area. They can be generally described as wood placements/log jams along the bank margin and wood placements/log jams at the apex of mid-channel bars or side-channel entrances.

Potential Benefits

Bank Log Jams

Bank logs jams could be employed along the outside of meander bends to enhance juvenile rearing and adult holding habitat. The density of the wood can vary from piles and single trees to larger buried bank jams encompassing up to 50 feet of bank and extending out into the river 15-20 feet. Bank Log Jam sites are shown in the concept drawings as pile ballasted log bank structures placed on channel margins. The zones are selected at areas where natural wood deposition would occur and natural habitats most likely form. Bank margin treatments are best suited for areas along the outsides of bends where wood would naturally accumulate via tree-fall from bank erosion but where, due to human impacts, the riparian trees are no longer available or are of insufficient size. Jams in these areas can limit unnatural rates of bank erosion and buy time until a mature riparian forest can become established. Bank jams can also be used in combination with other bank jams or apex jams to constrict the main channel cross-section to backwater flow to activate side-channels.

Bank Log Jams combine both active and passive habitat creation. Immediate habitat is created during installation as pools are excavated and complex wood formations provide overhead cover and visual separation among fish. Habitat is also created passively as the river responds to the structure through scour, shifting channel planform, and bar deposition.

Apex Log Jams

Apex log jams emulate a large tree depositing on a developing point bar and the subsequent accumulation of additional woody debris and the development of split-flow conditions. Gravel bars in the Horseshoe Reach show significant armoring through winnowing. Small pockets are also evident where high flows have begun to dismantle the armor layer. Apex log jams would encourage native wood deposition up against the constructed wood structure and gravel deposition in the hydraulic shadows produced by the structure. Logs placed on gravel bars encourage/enhance meander migration while creating high-flow habitats and floodplain complexity. Gravel bar structures are a form of passive habitat creation, whereby the geomorphology and hydraulics of the river respond to the structure and create complexity. Gravel bar jams also provide hiding and perching cover for birds and terrestrial wildlife.

Apex log jams also effectively create pools around the head of the structure to maintain side channel inlet flow. These features are important to help minimize deposition in hydraulically rough side channels that have less conveyance capacity than the main channel. Creating pools at the inlet to side channels where gradients are sufficiently steep will force water to flow down the side channel.

Design Considerations/Constraints

Bank Log Jams

Bank log jams can be configured to trap fluvially-transported wood. The Twisp main channel in the Horseshoe Side Channel reach has a top width of approximately 100 feet, and the channel is straighter than upstream reaches. This makes wood accumulation difficult, as the size of wood entering is more likely to transport through the reach. Wood trapping elements such as piles could be used to increase the potential for wood accumulation.

All log treatments would need to consider boater or recreational user safety and may result in a reduction in the intensity and profile of any wood treatment described above.

Apex Log Jams

Apex log jams encourage continued meander migration away from the wood and can also control channel flow within interior floodplain channels. Logs placed on gravel bars are best suited to areas where the goal is further river migration into mature valley bottom forests to enhance migration rate and large tree recruitment into the channel. Conversely, apex log jams are not recommended for areas that would encourage erosion into areas with low-density timber stands, very young floodplain forests (poor stabilization and poor wood recruitment), or areas where human infrastructure would be at risk. Apex log jams can also enhance side channel inlet conditions, and provide low-flow habitat by scouring deep pools at the head and margin of the jam.

Within the Horseshoe Side Channel reach, there are locations that, if treated, will require wet crossings with heavy equipment. The river is too wide to bridge and there is no viable access on the steep valley wall and high cut bank segments of the right (south) bank. Permitting agencies should be contacted early to assess the viability of accessing the site by crossing the river with equipment.

All log treatments would need to consider boater or recreational user safety and may result in a reduction in the intensity and profile of any wood treatment described above.

RIPARIAN ENHANCMENT

Segments of the floodplain are thinly vegetated, particularly those areas within the alluvial fan run out, or in post-flood depositional areas dominated by gravel and sand. Cottonwood and understory colonization is also poor in these areas. Previous assessments by the USBR (2008) and Inter-Fluve (2015) noted the possibility of cottonwood regeneration. To speed up riparian forest development, these areas could be actively planted with an excavator-mounted stinger capable of getting cottonwood rootstock deep into the ground. Other vegetation communities to be targeted for restoration include native shrubs along streambanks and areas disturbed during construction, and conifer plantings in some riparian and floodplain areas.

Potential Benefits

Impairments to riparian and floodplain vegetation structure affect hydraulic roughness, stream shading, nutrient exchange, and large wood recruitment. Woody material in the channel provides fish cover, reduces shear stress and stream power, creates pools and bars through scour and deposition, provides off-channel fish habitat, contributes to spawning gravel stability, provides flood refugia, and provides nutrients and unique habitat for invertebrate populations. Intact riparian areas provide important stream shading to the river, which moderates water temperature extremes.

Developing a healthy mixed-aged and mixed-species forest on the valley bottom will provide for important long-term process restoration. This is true for riparian areas close to channels as well as floodplain areas within the future potential channel migration zone.

Design Considerations/Constraints

Existing young cottonwoods growing on these floodplain surfaces appear to be drought stressed, likely due to the disconnection between the channel and floodplain. Therefore, it will be important to plant at depths close enough to summer low flows to allow roots to respond to water elevations and promote tree health and growth. Preliminary engineering design should include a detailed look at site hydrology, and could include piezometric monitoring to determine the best sites and depths for plantings. Hydraulic modeling can determine side channel area inundation and can also help to determine the best candidate sites and species communities to be used for riparian enhancement.

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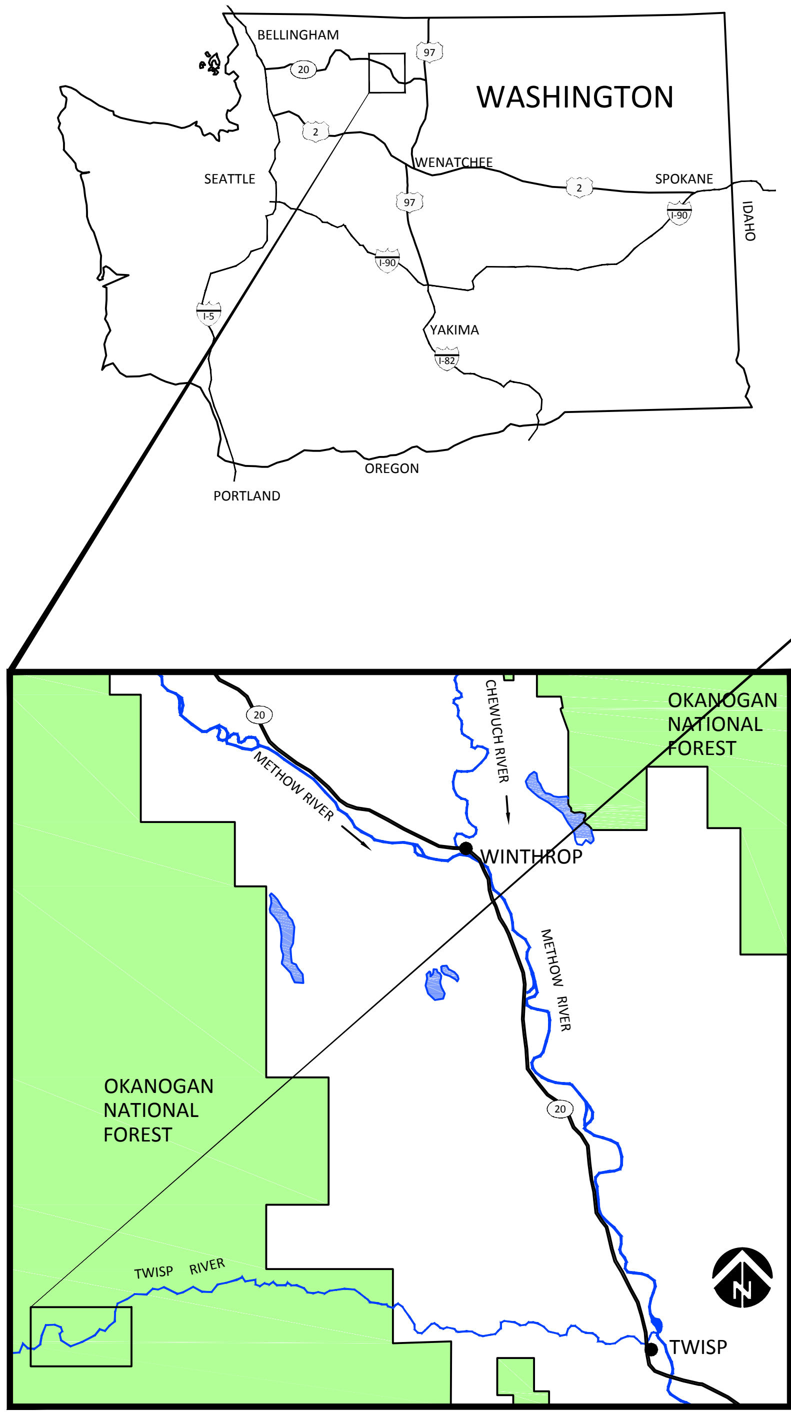
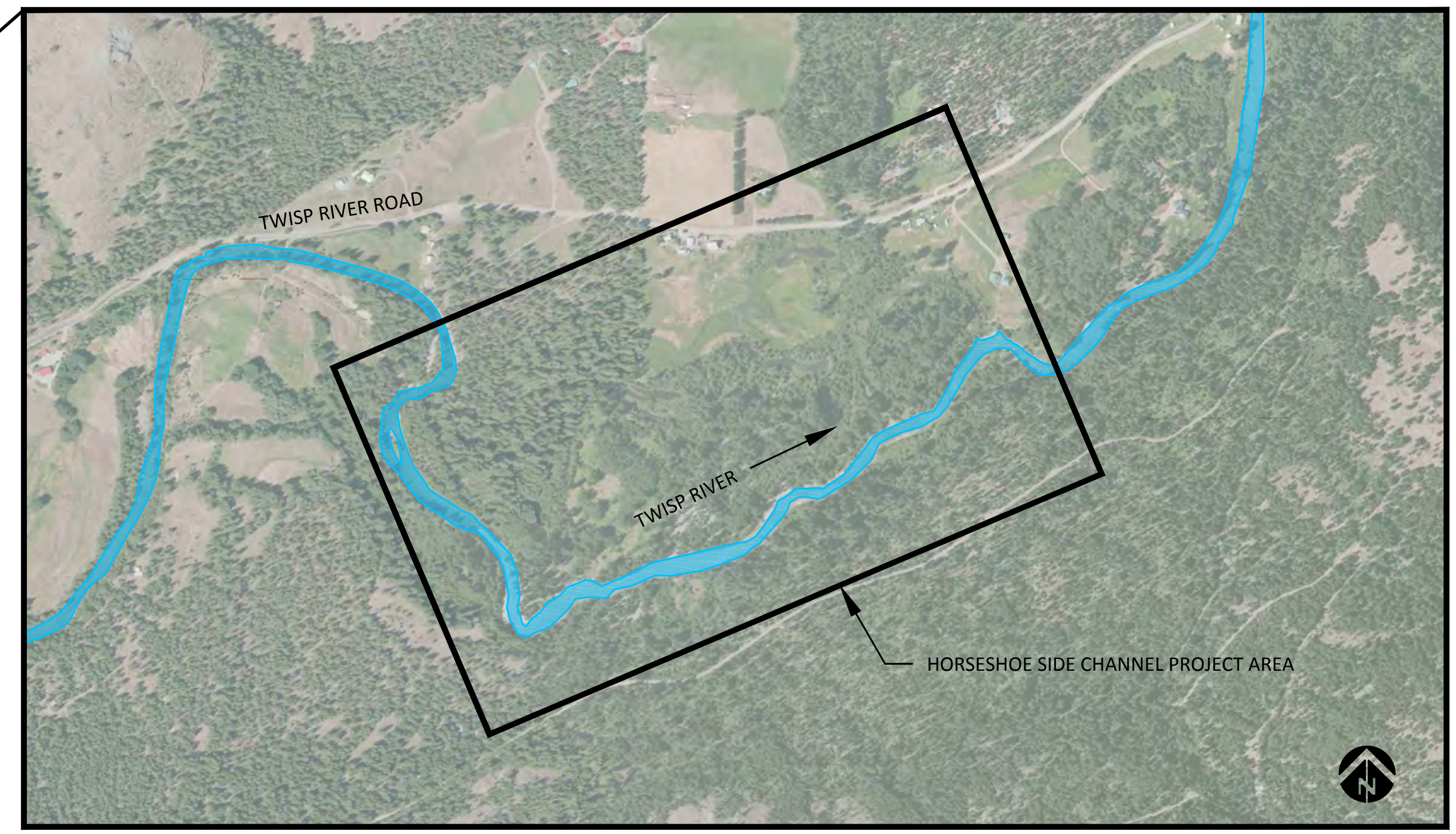
Middle Twisp River - Horseshoe Side Channel Project
Conceptual Restoration Project Designs
Okanogan County, Washington
January 16, 2014



VICINITY MAP



SITE MAP

SHEET INDEX

SITE LOCATION:

LATITUDE: 48°22'2" NORTH
LONGITUDE: 120°18'59" WEST
OKANOGAN COUNTY, WASHINGTON

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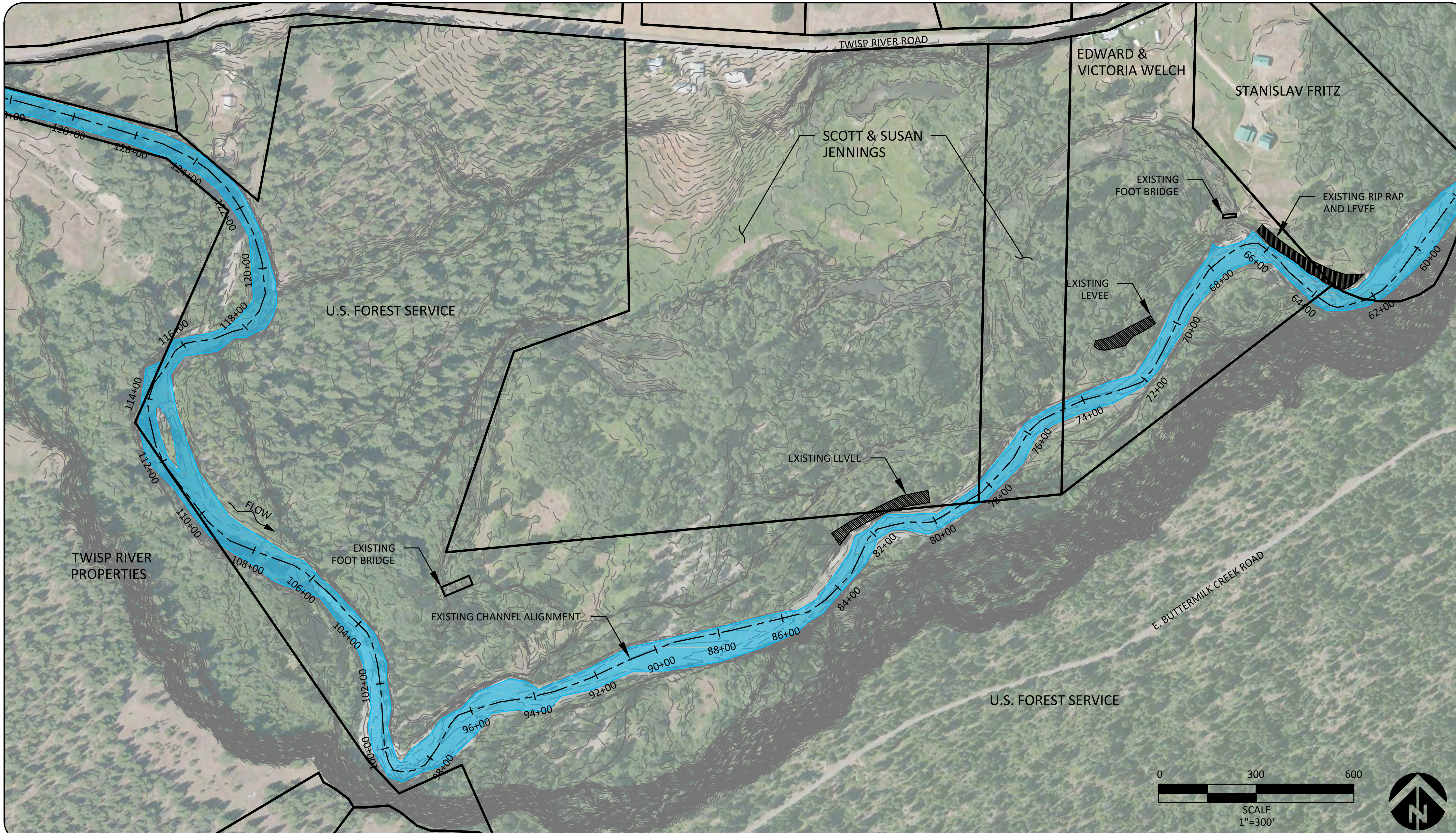
Project Location and Sheet Index



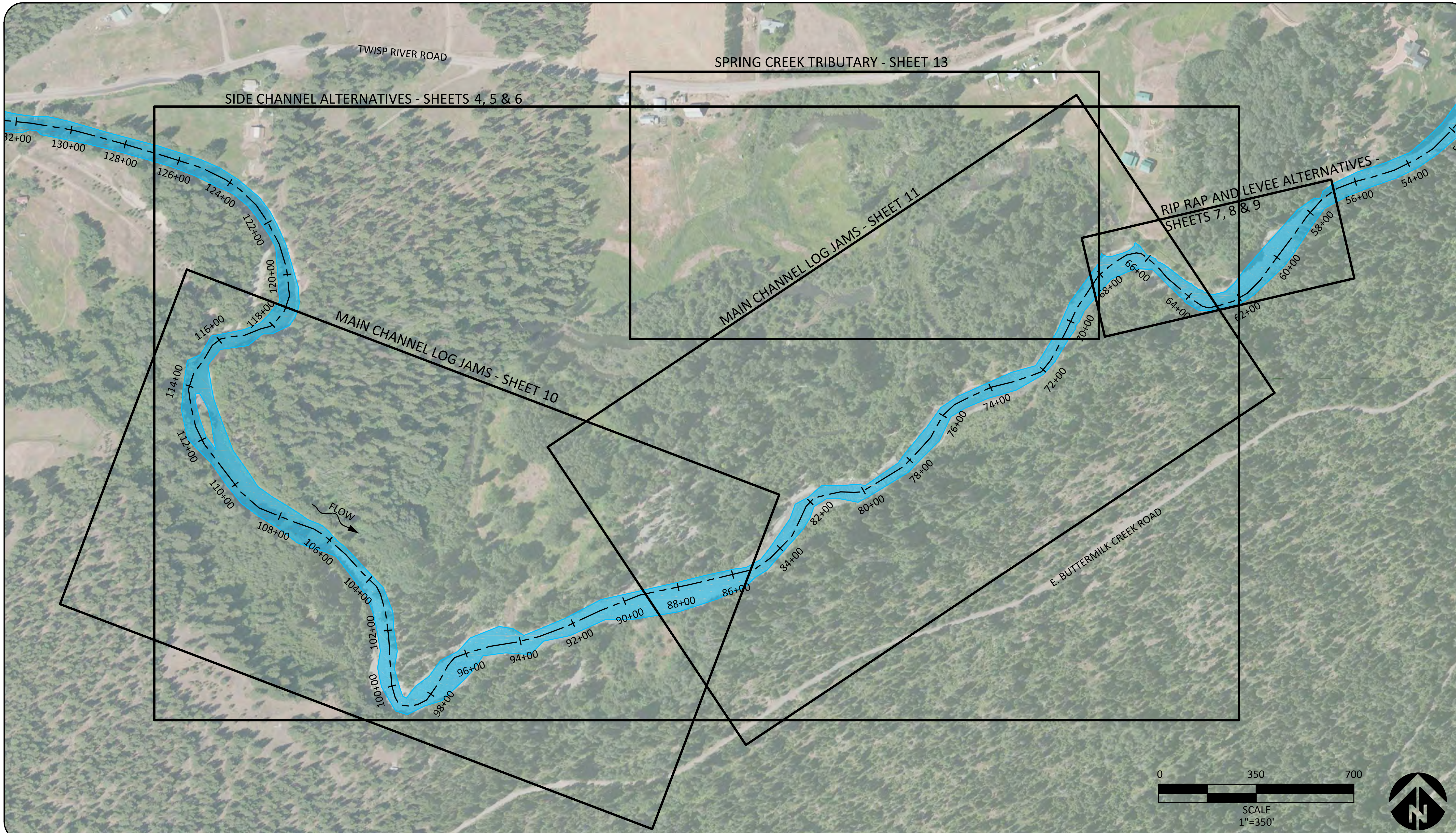
PLAN LEGEND

	EXISTING 1 FT CONTOURS
70+00	MAIN CHANNEL RIVER STATION
	EXISTING MAIN CHANNEL
	EXISTING LEVEES
	PROPERTY LINES

NOTE: PROPERTY LINES ARE APPROXIMATE. DATA PROVIDED BY OKANOGAN COUNTY.

inter·fluve

Existing Conditions & Site Overview



PLAN LEGEND

EXISTING 1 FT CONTOURS

MAIN CHANNEL RIVER STATION (70+00)

EXISTING MAIN CHANNEL

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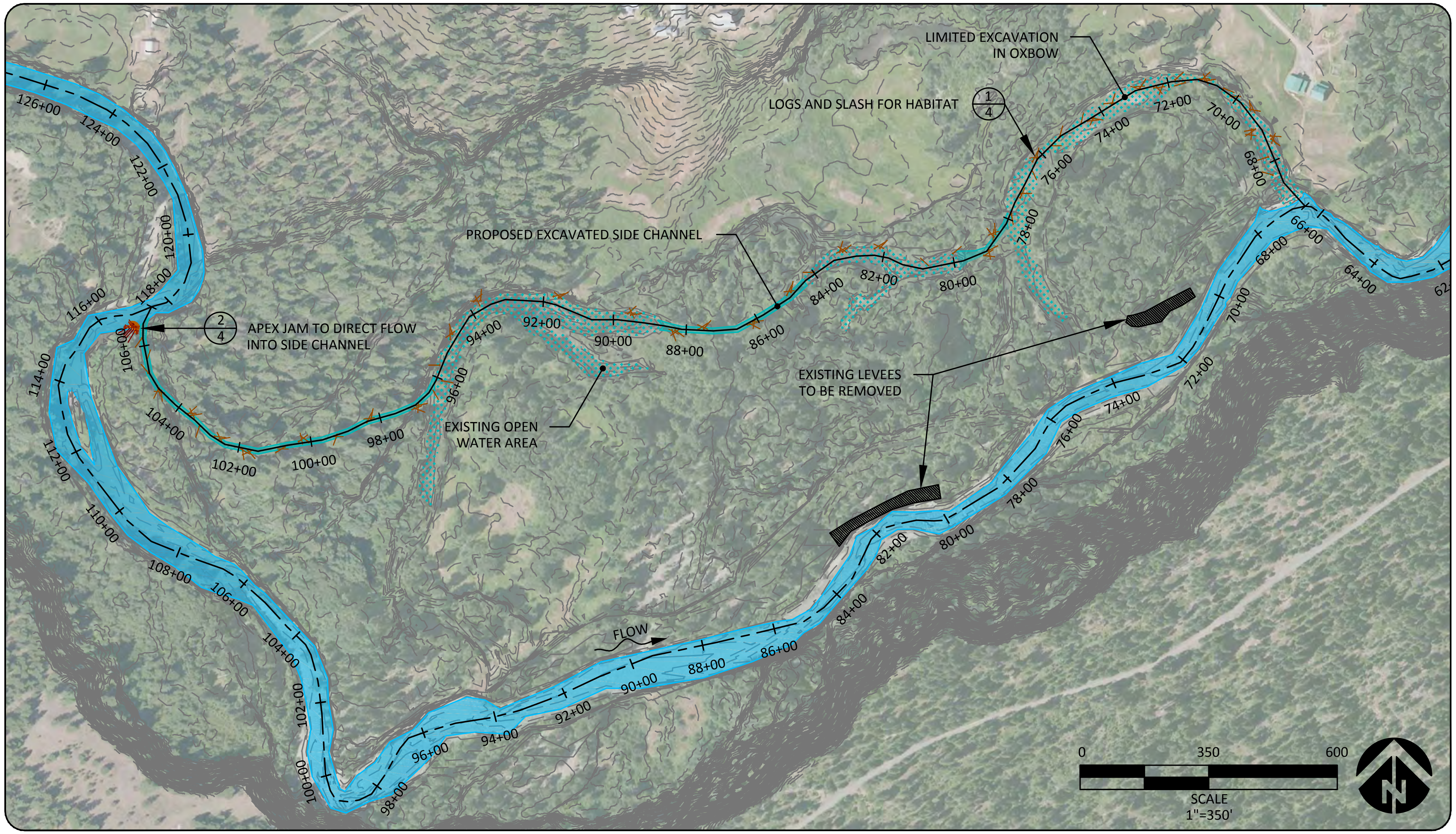
Index to Alternative Sheets



PLAN LEGEND

EXISTING 1 FT CONTOURS

70+00 MAIN CHANNEL RIVER STATION

70+00 SIDE CHANNEL RIVER STATION

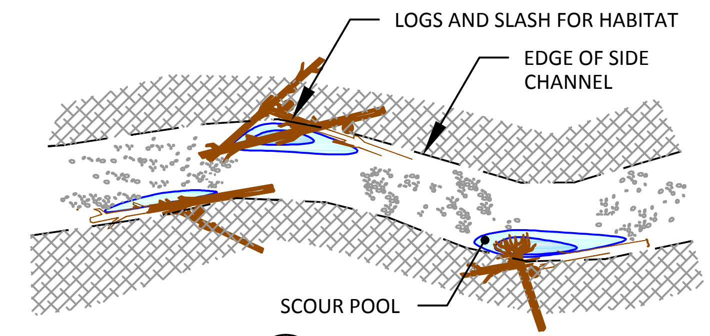
EXISTING MAIN CHANNEL

PROPOSED SIDE CHANNEL - EXCAVATED

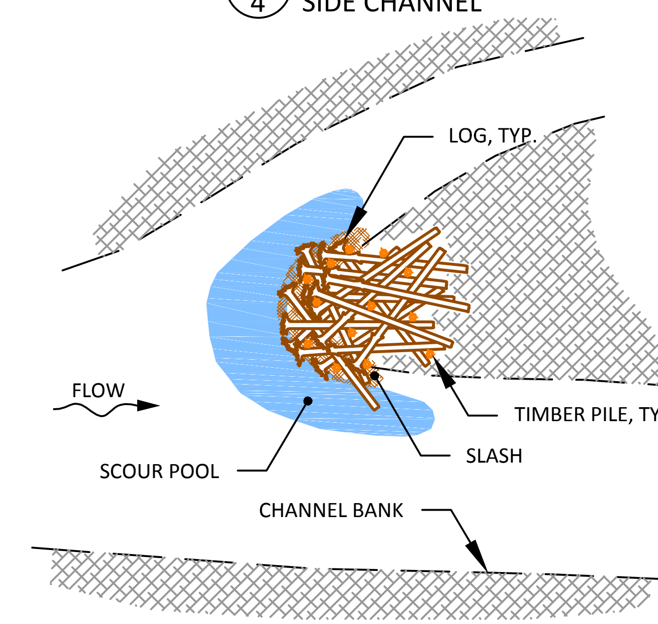
PROPOSED SIDE CHANNEL - NO EXCAVATION

EXISTING LEVEE TO BE REMOVED

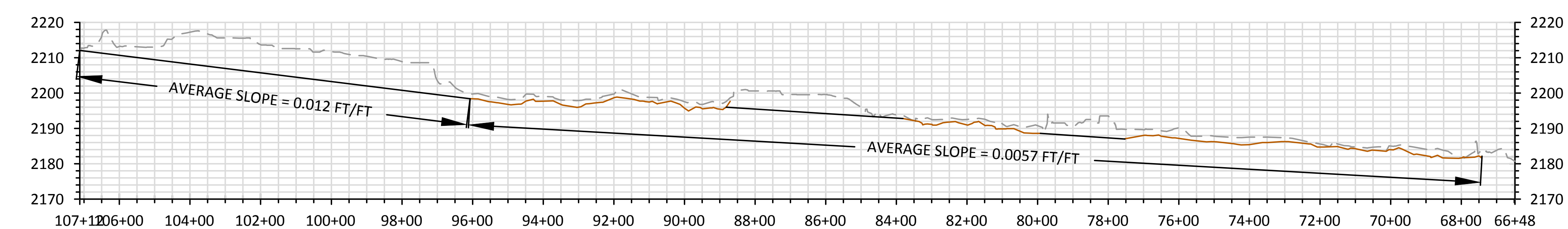
LOGS (LAYERS)



1/4 TYPICAL PLAN SIDE CHANNEL



2/4 TYPICAL PLAN BAR APEX LOG JAM



SIDE CHANNEL ALTERNATIVE 1 PROFILE

PROFILE LEGEND

EXISTING GROUND

REFUSAL SURFACE

PROPOSED GROUND

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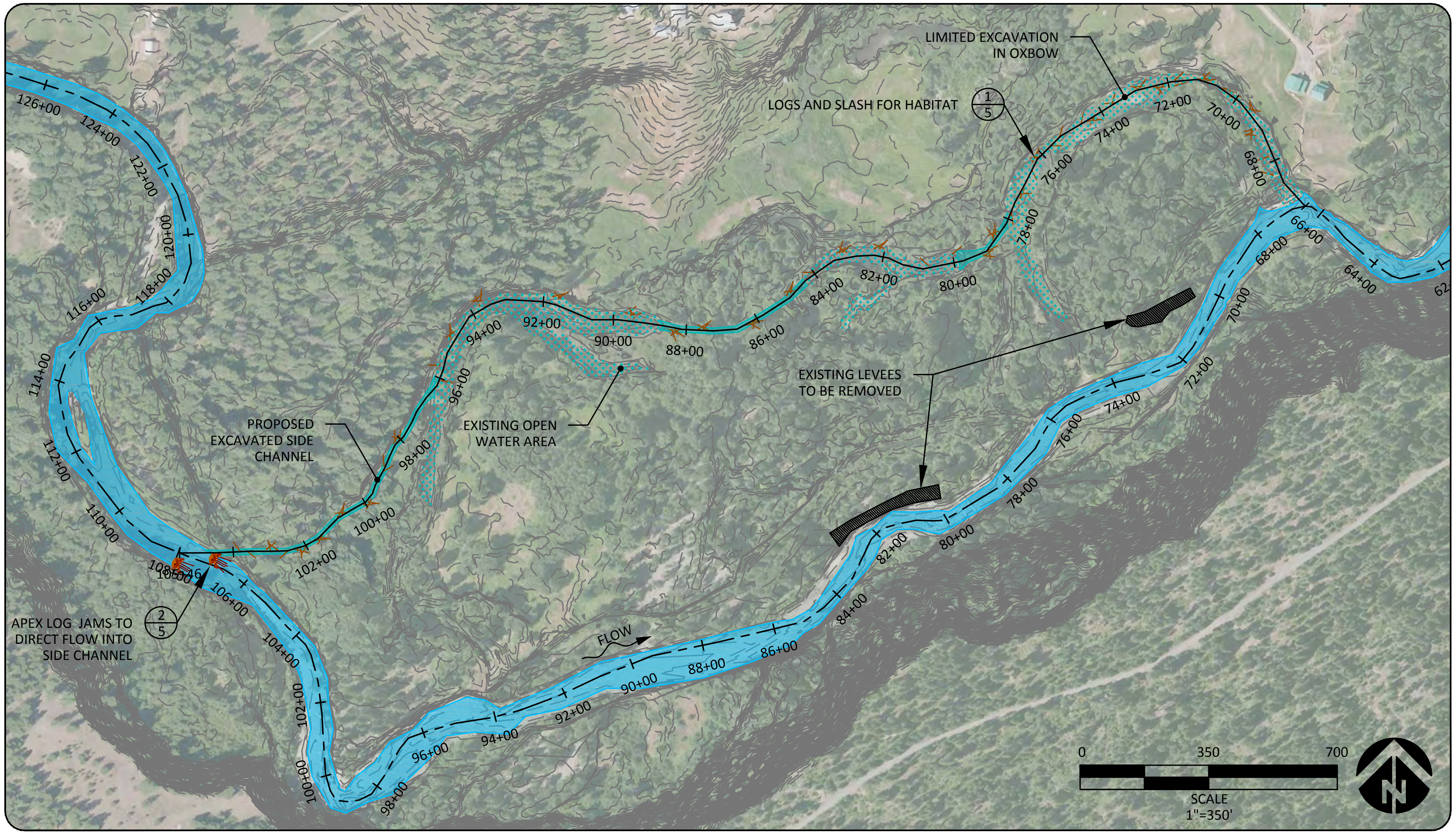
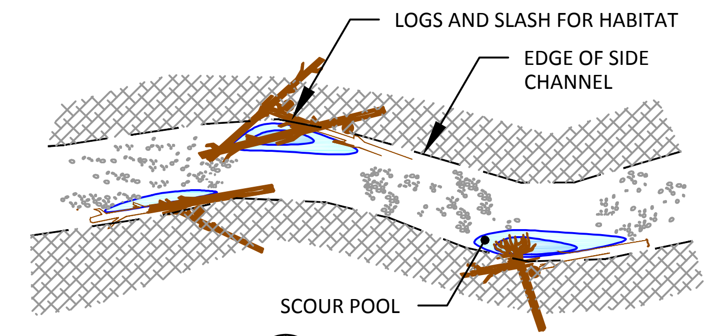
Side Channel Alternative 1

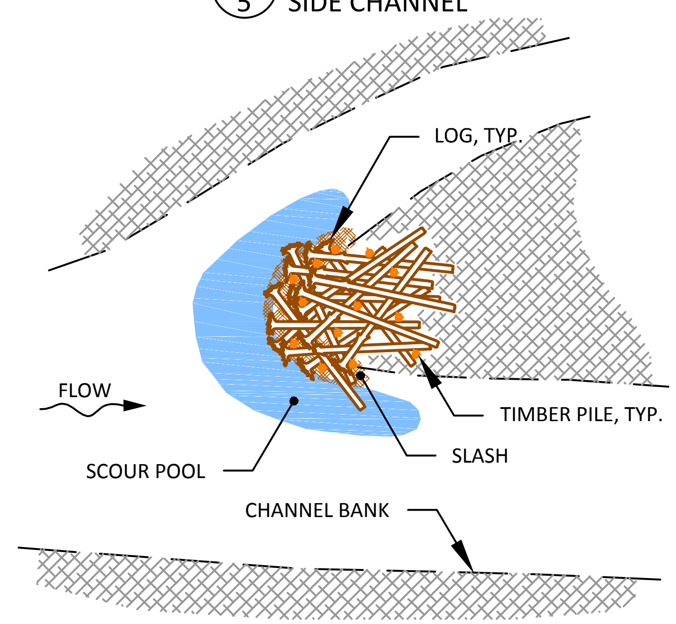


PLAN LEGEND

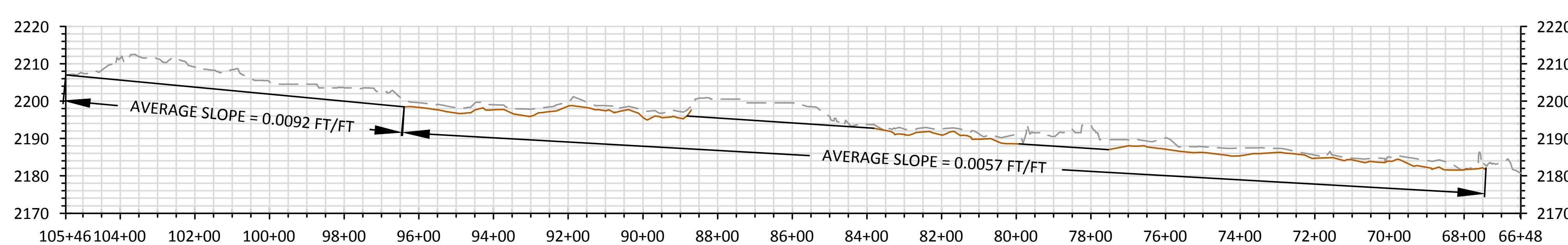
- EXISTING 1 FT CONTOURS
- MAIN CHANNEL RIVER STATION (70+00)
- SIDE CHANNEL RIVER STATION (70+00)
- EXISTING MAIN CHANNEL
- PROPOSED SIDE CHANNEL - EXCAVATED
- PROPOSED SIDE CHANNEL - NO EXCAVATION
- EXISTING LEVEE TO BE REMOVED
- LOGS (LAYERS)



1/5 TYPICAL PLAN SIDE CHANNEL



2/5 TYPICAL PLAN BAR APEX LOG JAM



SIDE CHANNEL ALTERNATIVE 2 PROFILE

PROFILE LEGEND

- EXISTING GROUND
- REFUSAL SURFACE
- PROPOSED GROUND

inter·fluve

Side Channel Alternative 2

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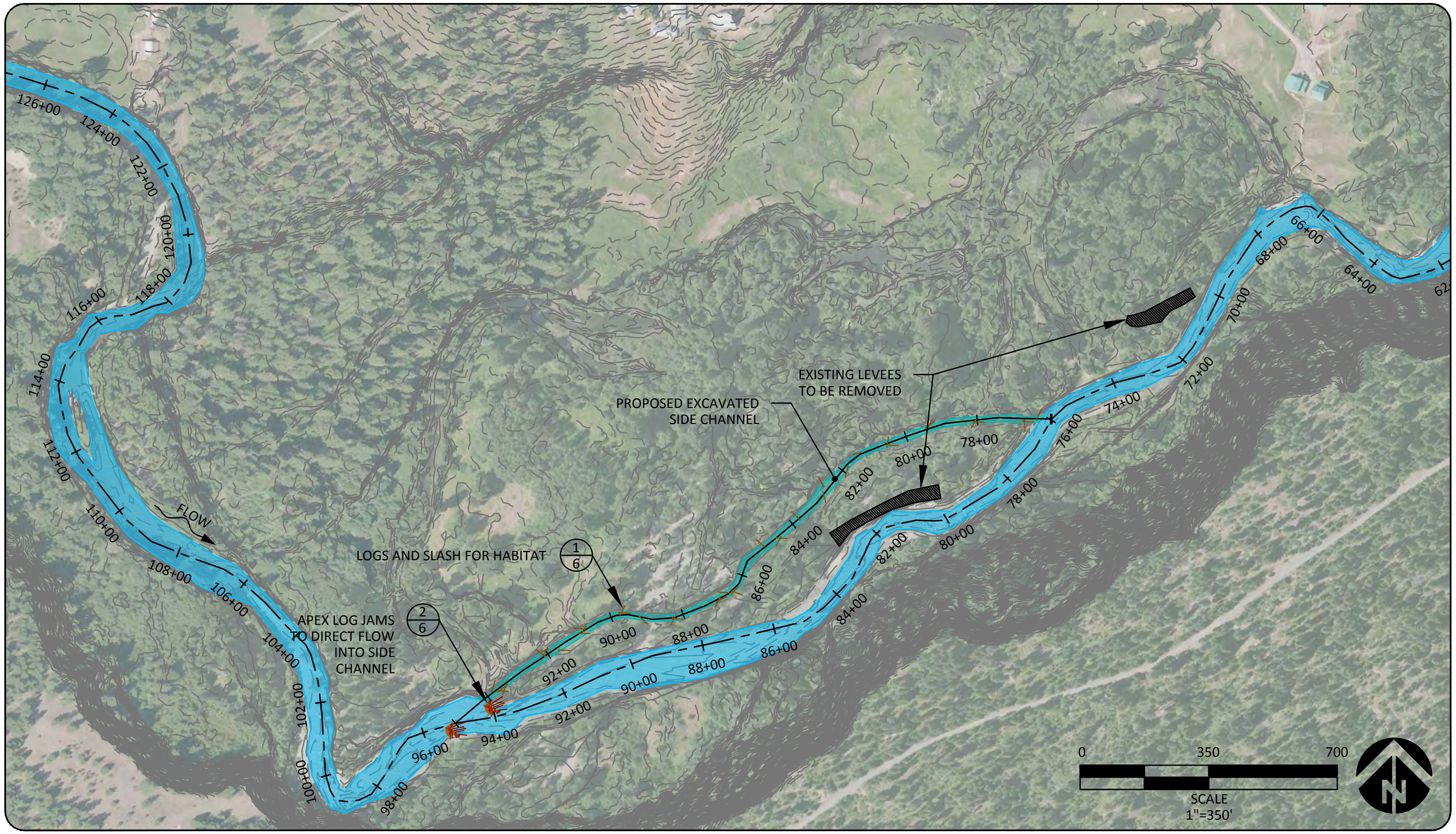
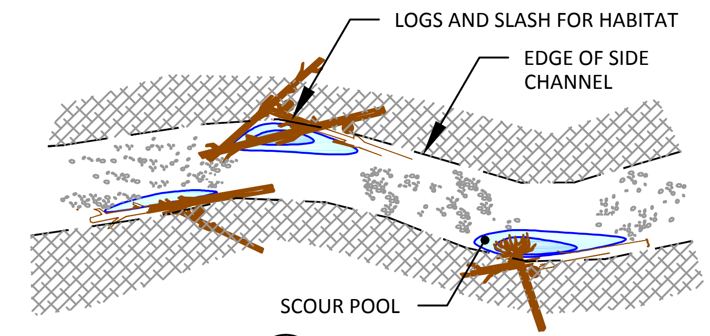
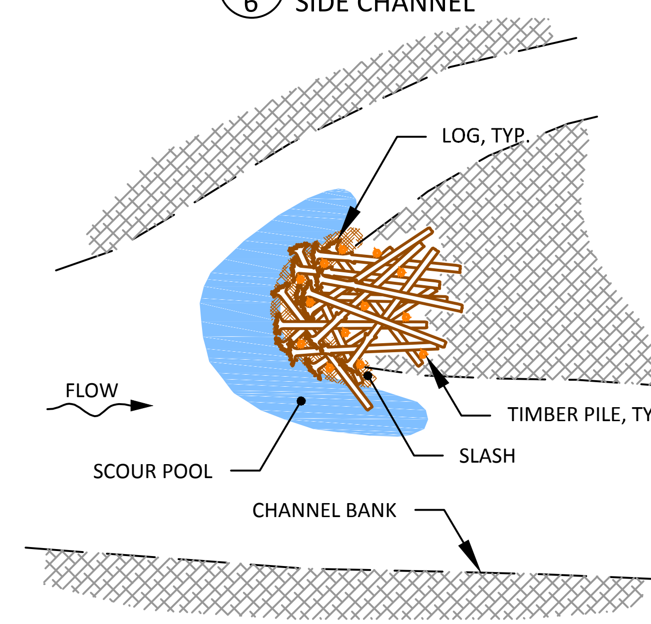


PLAN LEGEND

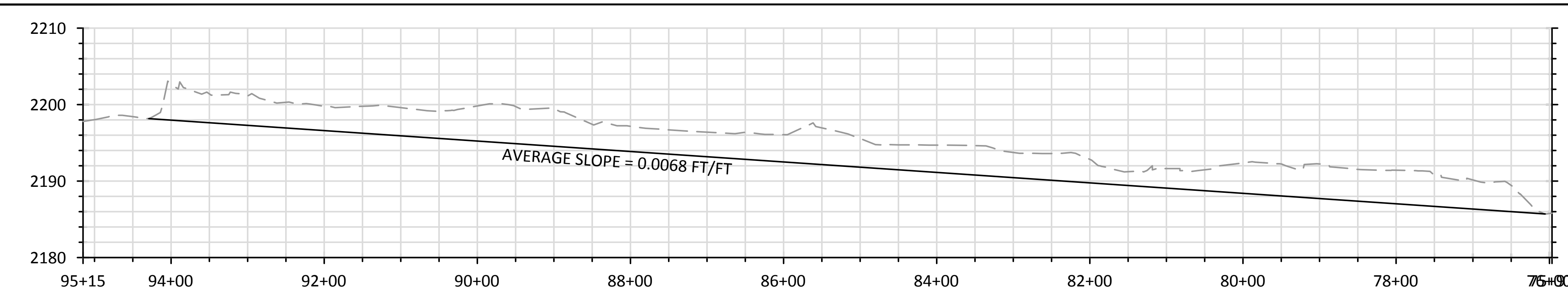
- EXISTING 1 FT CONTOURS
- MAIN CHANNEL RIVER STATION (70+00)
- SIDE CHANNEL RIVER STATION (70+00)
- EXISTING MAIN CHANNEL
- PROPOSED SIDE CHANNEL - EXCAVATED
- EXISTING LEVEE TO BE REMOVED
- LOGS (LAYERS)



1/6 TYPICAL PLAN SIDE CHANNEL



2/6 TYPICAL PLAN BAR APEX LOG JAM



SIDE CHANNEL ALTERNATIVE 3 PROFILE

PROFILE LEGEND

- EXISTING GROUND
- PROPOSED GROUND

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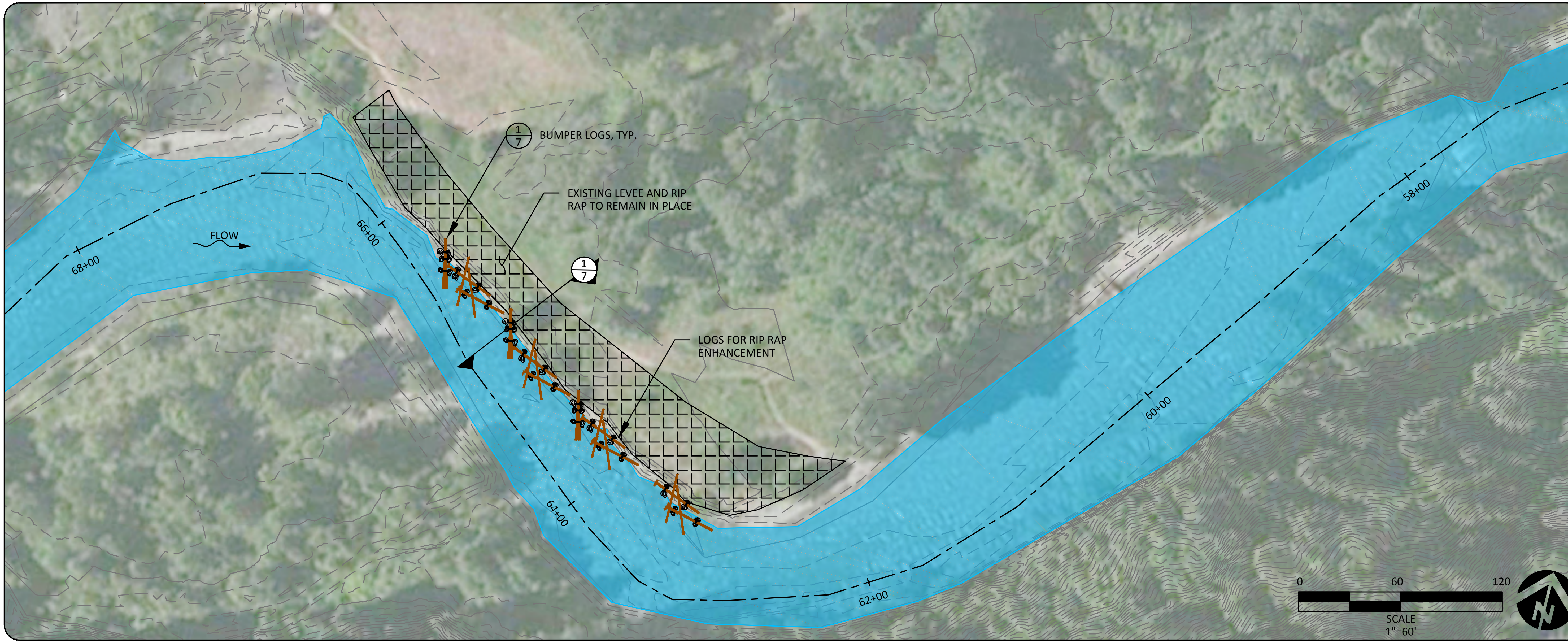
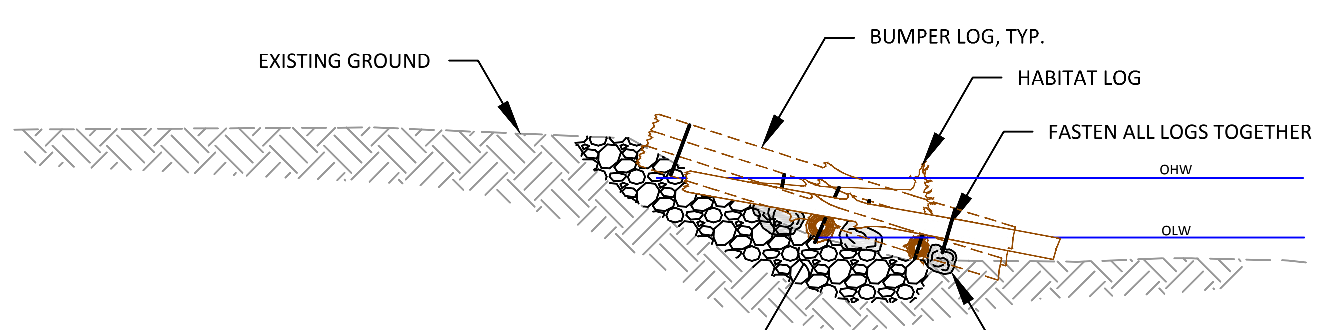
inter-fluve

Side Channel Alternative 3





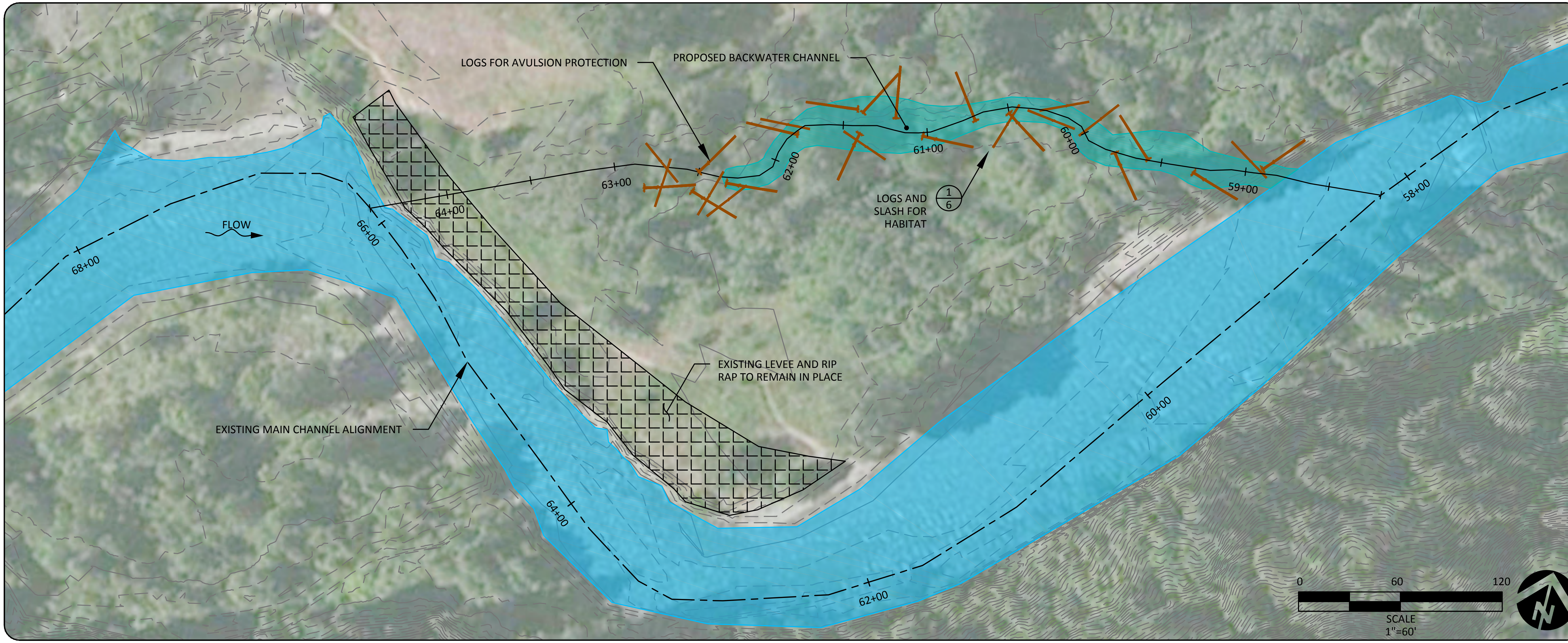
1/7 TYPICAL SECTION
RIP RAP LOG ENHANCEMENT

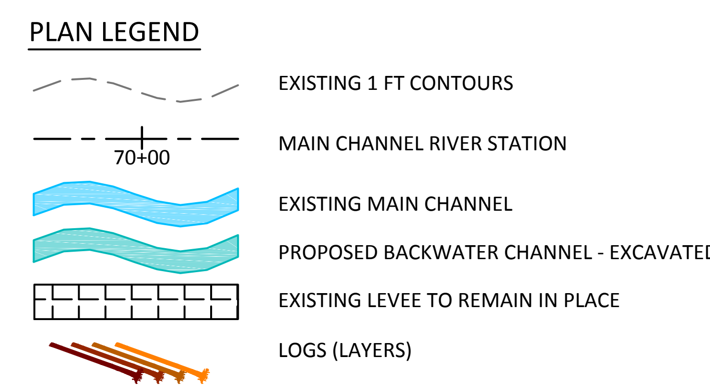
PLAN LEGEND

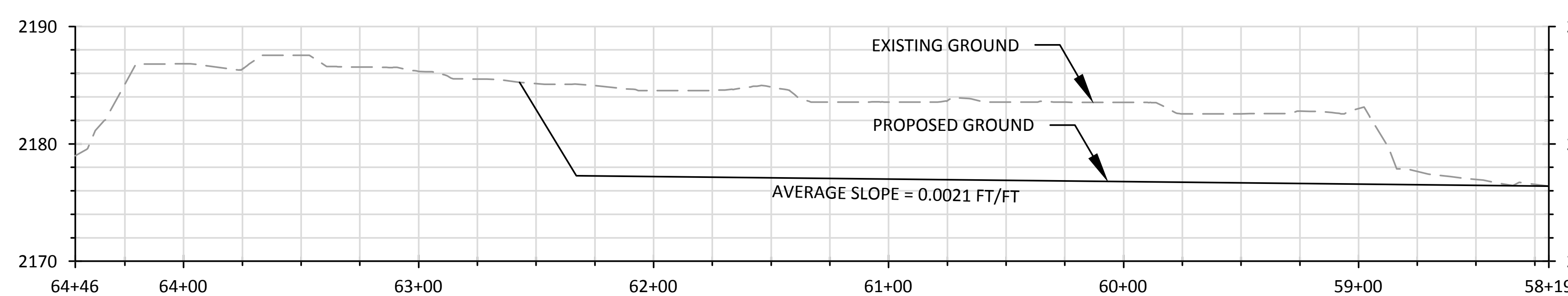
(dashed line)	EXISTING 1 FT CONTOURS
70+00	MAIN CHANNEL RIVER STATION
(blue band)	EXISTING MAIN CHANNEL
(hatched box)	EXISTING LEVEE AND RIP RAP TO REMAIN IN PLACE
(brown logs)	LOGS

inter·fluve

Rip Rap and Levee Alternative 1



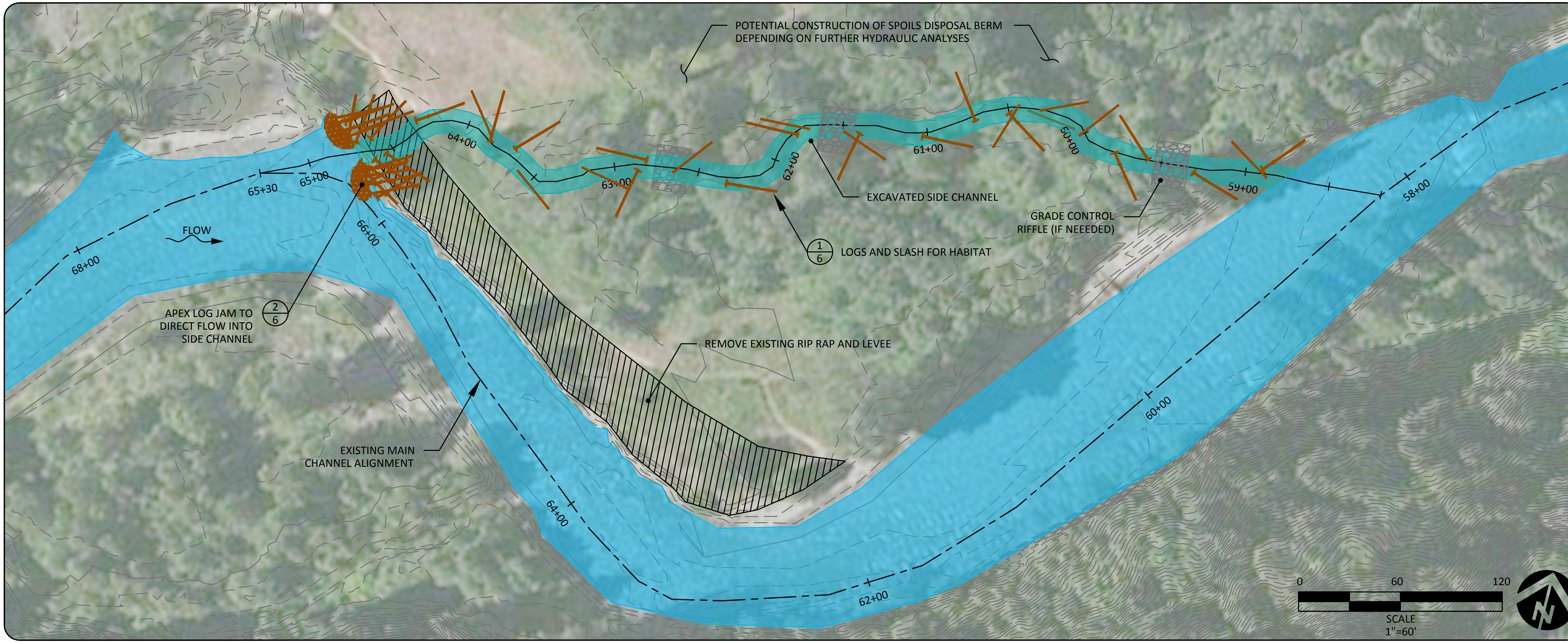


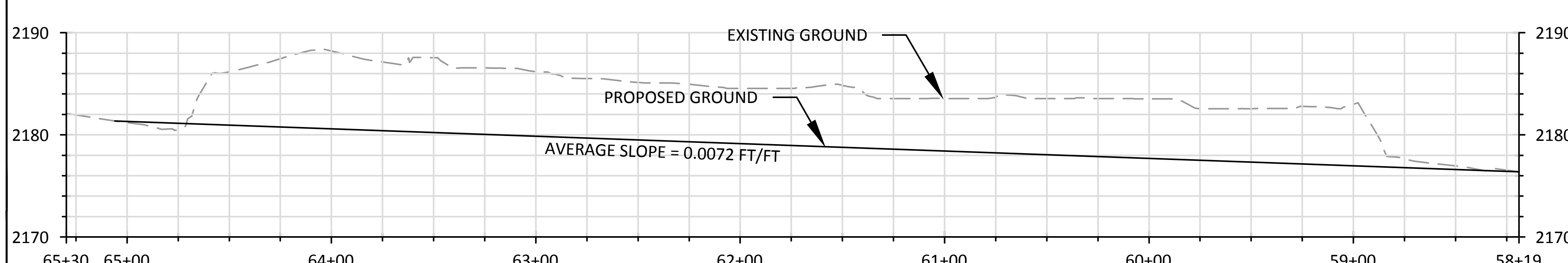


BACKWATER CHANNEL PROFILE

inter·fluve

Rip Rap and Levee Alternative 2





SIDE CHANNEL PROFILE

PLAN LEGEND

- EXISTING 1 FT CONTOURS
- 70+00 MAIN CHANNEL RIVER STATION
- EXISTING MAIN CHANNEL
- PROPOSED SIDE CHANNEL - EXCAVATED
- EXISTING LEVEE TO BE REMOVED
- GRADE CONTROL RIFFLE (IF NEEDED)
- LOGS

inter·fluve

Rip Rap and Levee Alternative 3

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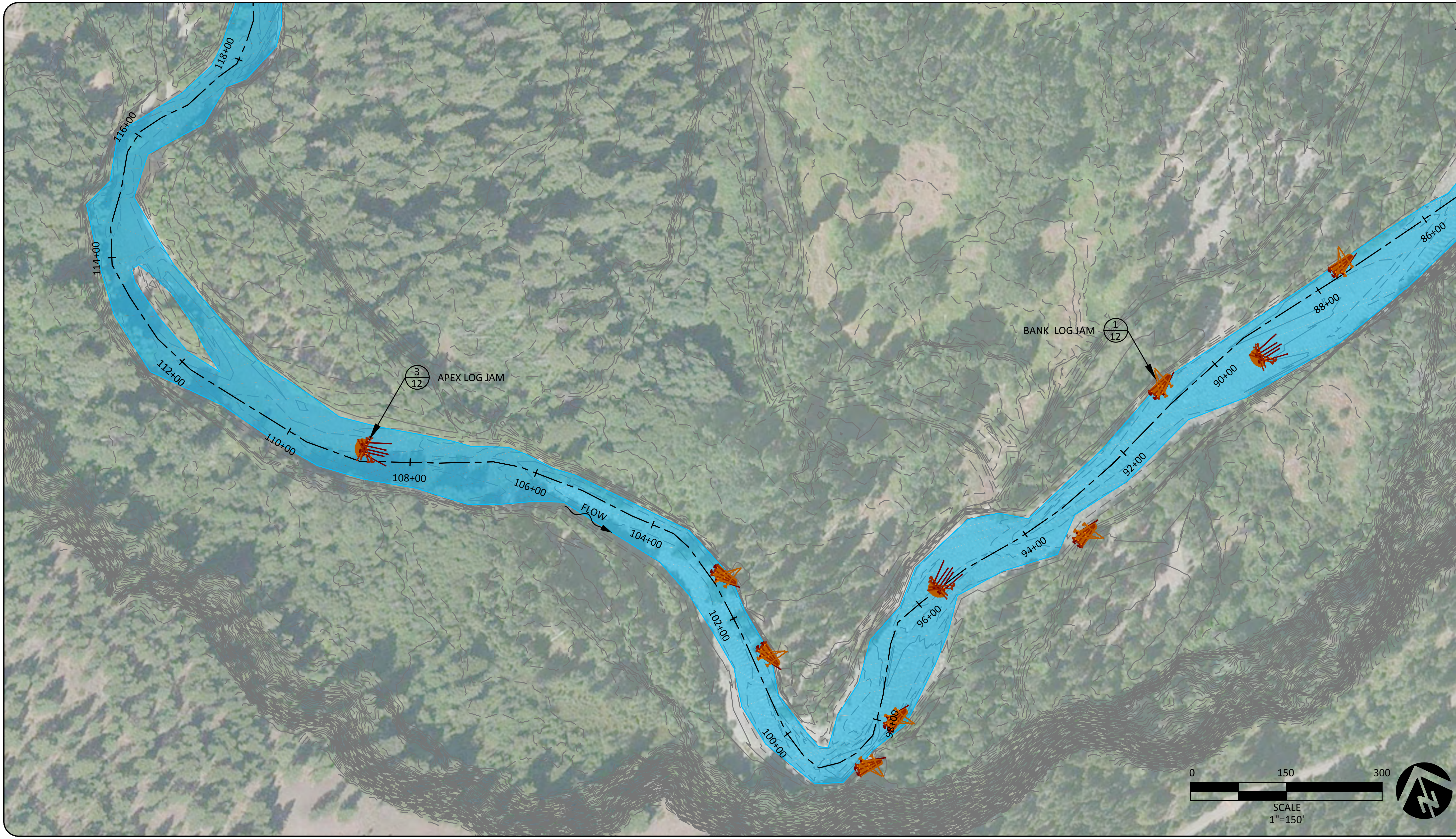


PLAN LEGEND

EXISTING 1 FT CONTOURS

MAIN CHANNEL RIVER STATION

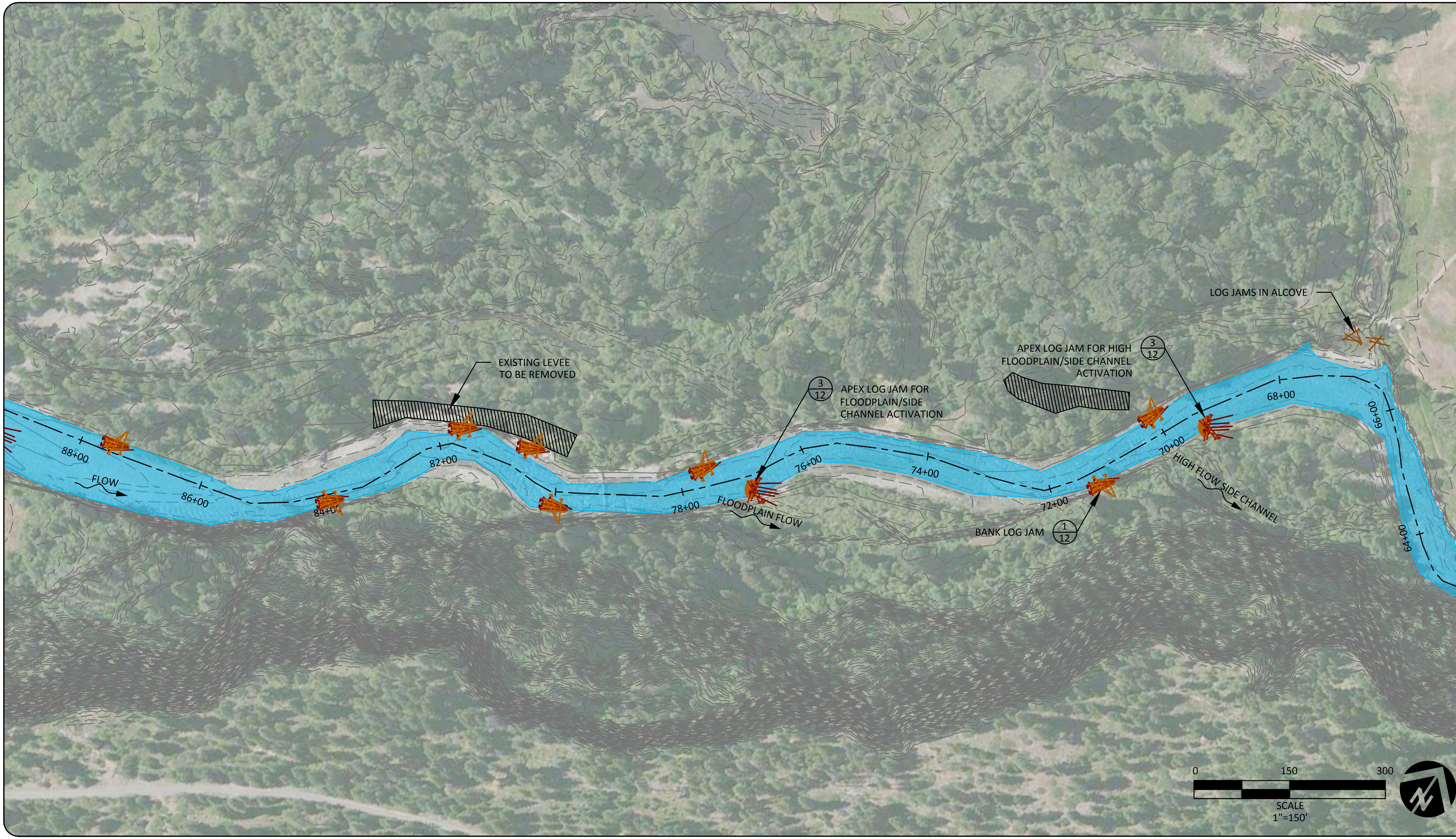
70+00

EXISTING MAIN CHANNEL

LOGS (LAYERS)

inter·fluve

Main Channels Log Jams 1



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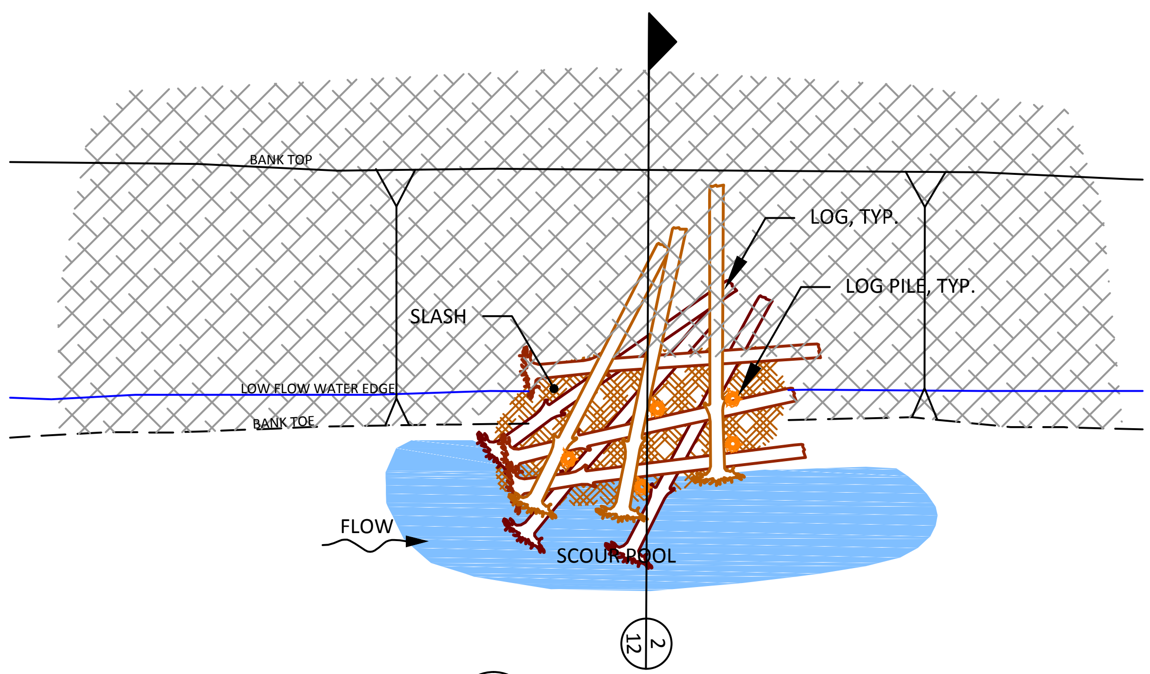
PLAN LEGEND

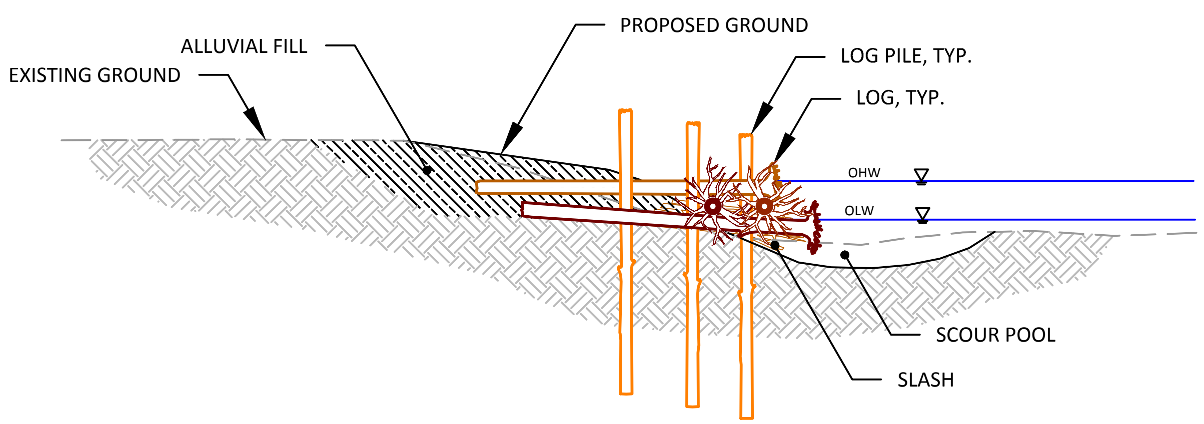
- EXISTING 1 FT CONTOURS
- 70+00 MAIN CHANNEL RIVER STATION
- EXISTING MAIN CHANNEL
- EXISTING LEVEE TO BE REMOVED
- LOGS (LAYERS)

inter·fluve

Main Channel Log Jams 2

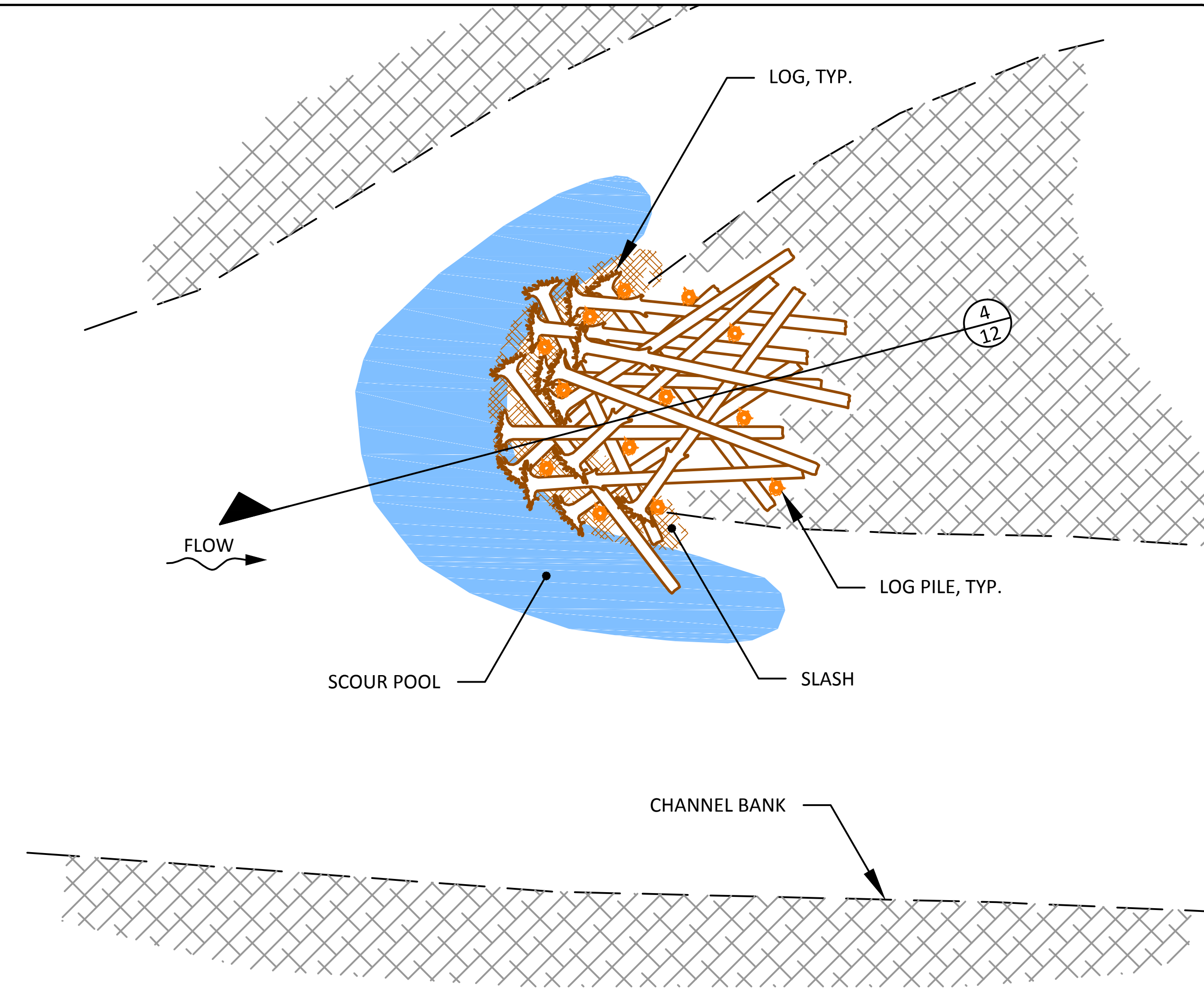


1 / 12 TYPICAL PLAN
BANK LOG JAM

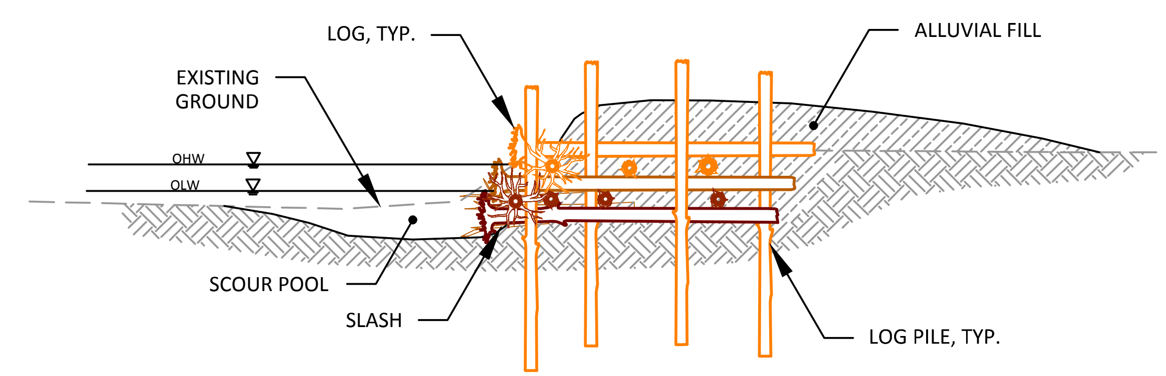


2 / 12 TYPICAL SECTION
BANK LOG JAM

NOTE: SPECIFIC BALLASTING METHODS TO BE DETERMINED



3 / 12 TYPICAL PLAN
APEX LOG JAM



4 / 12 TYPICAL SECTION
APEX LOG JAM

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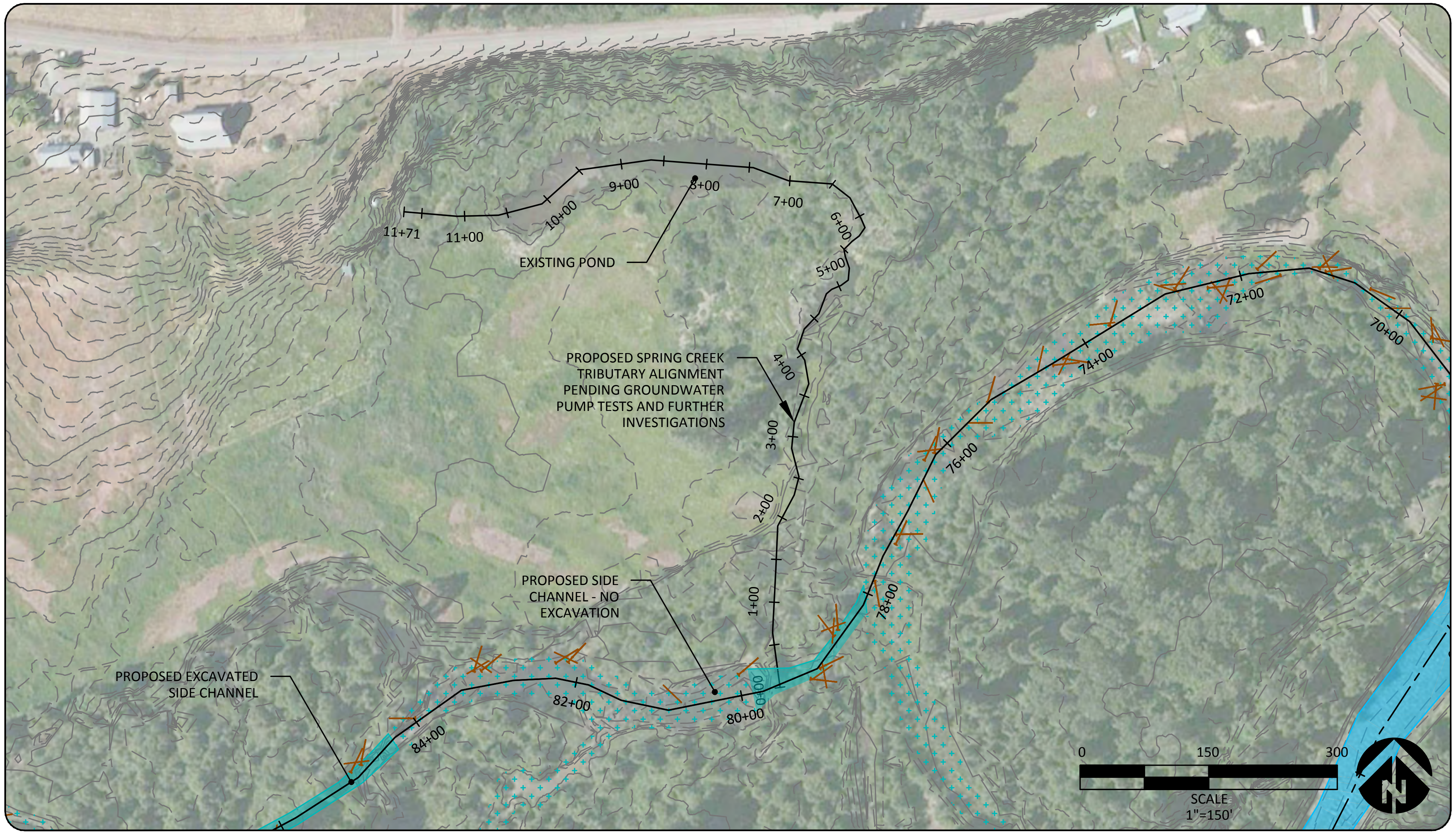
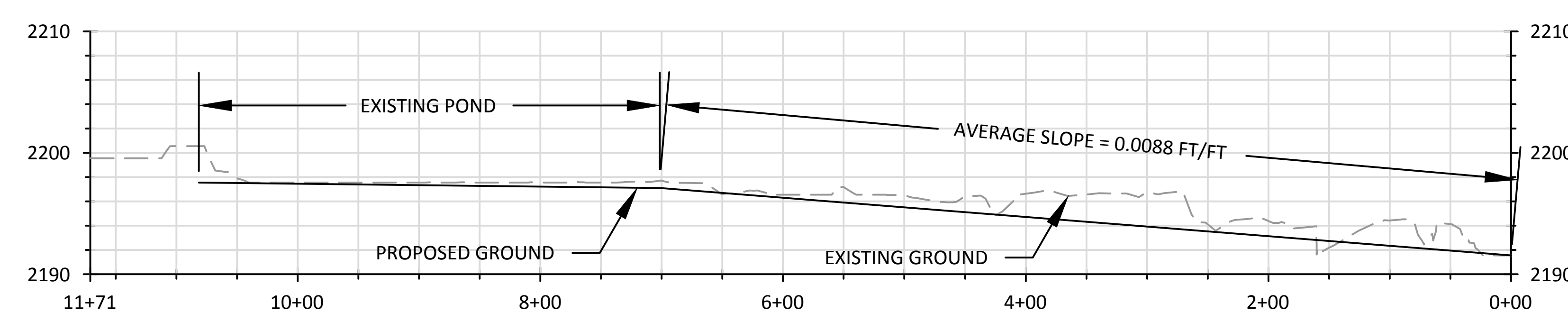
Typical Log Jam Details

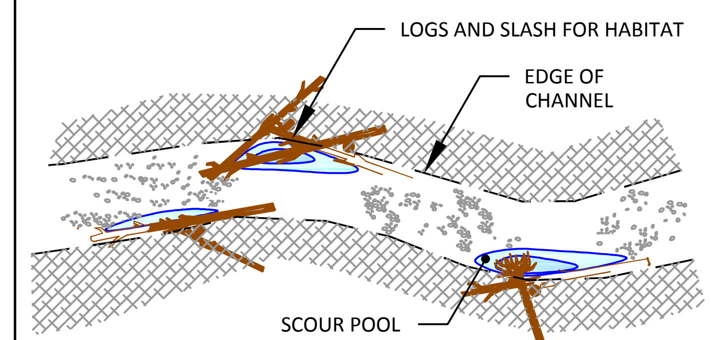
PLAN LEGEND

- EXISTING 1 FT CONTOURS
- 70+00 MAIN CHANNEL RIVER STATION
- 70+00 SIDE CHANNEL RIVER STATION
- EXISTING MAIN CHANNEL
- PROPOSED SIDE CHANNEL - EXCAVATED
- PROPOSED SIDE CHANNEL - NO EXCAVATION
- LOGS (LAYERS)





SPRING CREEK TRIBUTARY PROFILE



1/13 TYPICAL PLAN SIDE CHANNEL

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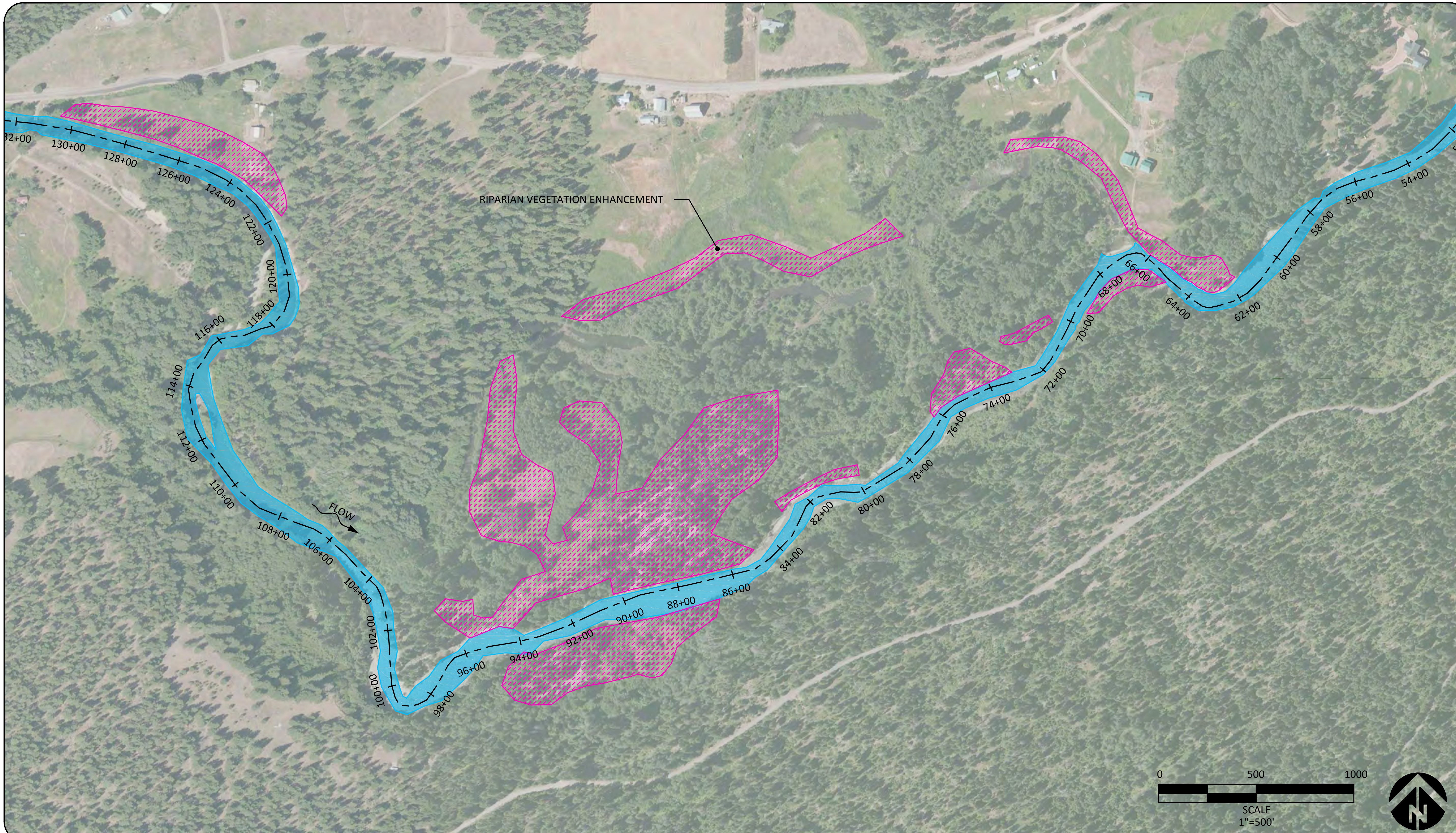
Spring Creek Tributary



PLAN LEGEND

	EXISTING 1 FT CONTOURS
70+00	MAIN CHANNEL RIVER STATION
	EXISTING MAIN CHANNEL
	RIPARIAN VEGETATION ENHANCEMENT

inter·fluve

Riparian Enhancement

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TITLE – BPA Project Number

Click here to enter a date.

HIP III

GENERAL PROJECT AND DATA SUMMARY REQUIREMENTS for RRT REVIEW

Version 2.0

Instructions: *The project sponsor shall provide the information requested in this form to initiate Restoration Review Team (RRT) review for a Habitat Improvement Program (HIP) III Endangered Species Act (ESA) consultation for* ***medium*** *and* ***high*** *risk restoration projects. If the project consists only of* ***low*** *risk activities the completion of this form is not required. Refer to page 66 of the HIP III Handbook (http://efw.bpa.gov/environmental_services/endangeredspecies.aspx)or contact your BPA Environmental Compliance Lead for additional information on risk determinations.*

Information should be provided as a short summary or reference the appropriate documents where the requirements have been addressed (e.g. see Basis of Design Report page 5. paragraph 2). All technical documents referred to in the GPDSR must be submitted to facilitate technical review. If the information being requested was not conducted provide rational on why the analysis is not necessary or how the design was informed. If the information requested is not applicable please write not applicable.

Include pictures or use bulleted lists, as necessary. Examples of completed applications are available upon request.

This information will be used to conduct a functional and technical review of the project for HIP III ESA consultation by the Restoration Review Team (RRT). The completion of this form is a regulatory requirement of the HIP III ESA consultation and failure to complete this form may result in delays in ESA consultation completion and therefore project implementation.

If you have questions regarding the completion of this form or the HIP III ESA consultation process, please contact your environmental compliance lead for the contract, or the RRT Team Lead, Dan Gambetta, 503-230-3493, or email dagambetta@bpa.gov

Table of Contents

1.0 General Data Requirements

Project Background

		Included in Designs	
1)	Names and title of sponsor, firms and individuals responsible for design.	Yes	☐
		No	☐
		NA	☐

Supporting information/document title/page numbers

Click here to enter text.

		Included in Designs	
2)	List of project elements that have been designed by a licensed Professional Engineer.	Yes	☐
		No	☐
		NA	☐

Supporting information/document title/page numbers

Click here to enter text.

		Included in Designs	
3)	Identification and description of risk to infrastructure or existing resources.	Yes	☐
		No	☐
		NA	☐

Supporting information/document title/page numbers

Click here to enter text.

		Included in Designs	
4)	Explanation and background on fisheries use (by life stage –period) and limiting factors addressed by project. Information detailing locations of ESA-listed salmonid spawning areas within the reach.	Yes	☐
		No	☐
		NA	☐

Supporting information/document title/page numbers

Click here to enter text.

		Included in Designs	
5)	List of primary project features including constructed or natural elements	Yes	☐
		No	☐
		NA	☐

Supporting information/document title/page numbers

Click here to enter text.

		Included in Designs	
6)	Brief description of disturbance including timing and areal extent and potential impacts associated with implementation of each element.	Yes	☐
		No	☐
		NA	☐

Supporting information/document title/page numbers

Click here to enter text.

Resource Inventory and Evaluation

		Included in Designs	
1)	In-stream flow management and constraints in project reach.	Yes	☐
		No	☐
		NA	☐

Supporting information/document title/page numbers

Click here to enter text.

		Included in Designs	
2)	Description of existing geomorphic conditions and constraints on physical processes.	Yes	☐
		No	☐
		NA	☐

Supporting information/document title/page numbers

Click here to enter text.

		Included in Designs	
3)	Description of existing riparian condition and historical riparian impacts.	Yes	☐
		No	☐
		NA	☐

Supporting information/document title/page numbers

Click here to enter text.

		Included in Designs	
4)	Description of lateral connectivity to floodplain and historical floodplain impacts.	Yes	☐
		No	☐
		NA	☐

Supporting information/document title/page numbers

Click here to enter text.

		Included in Designs	
5)	Tidal influence in project reach and influence of structural controls (dikes or gates).	Yes	☐
		No	☐
		NA	☐

Supporting information/document title/page numbers

Click here to enter text.

Technical Data

		Included in Designs	
1)	Stability analyses and computations for project elements, and comprehensive project plan.	Yes	☐
		No	☐
		NA	☐

Supporting information/document title/page numbers

Click here to enter text.

		Included in Designs	
2)	Summary of site information and measurements (survey, bed material, etc.) used to support assessment and design.	Yes	☐
		No	☐
		NA	☐

Supporting information/document title/page numbers	
Click here to enter text.	

	Included in Designs	
3) Summary of hydrologic modeling and analyses conducted, including data sources and period of record including a list of design discharge (Q) and return interval (RI) for each design element.	Yes	☐
	No	☐
	NA	☐

Supporting information/document title/page numbers
Click here to enter text.

	Included in Designs	
4) Summary of sediment supply and transport analyses conducted, including data sources including sediment size gradation used in streambed design.	Yes	☐
	No	☐
	NA	☐

Supporting information/document title/page numbers
Click here to enter text.

	Included in Designs	
5) Description of how preceding technical analysis has been incorporated into and integrated with the construction – contract documentation.	Yes	☐
	No	☐
	NA	☐

Supporting information/document title/page numbers
Click here to enter text.

Construction – Contract Documentation

The Design Plans must include the following items:	**Included**		**Location in planset (document and page no#)**
Site Access Staging and Sequencing Plan with description	Yes	☐	Click here to enter text.
	No	☐	
	NA	☐	
Work Area Isolation and Dewatering Plan with description of how aquatic organisms within the action area will be treated / protected. Confirm that work will be conducted in accordance with the Work Area Isolation and Fish Salvage General Conservation Measures.	Yes	☐	Click here to enter text.
	No	☐	
	NA	☐	
Erosion and Pollution Control Plan.	Yes	☐	Click here to enter text.
	No	☐	
	NA	☐	
Site Reclamation and Restoration Plan.	Yes	☐	Click here to enter text.
	No	☐	
	NA	☐	
List of proposed equipment and fuels management plan.	Yes	☐	Click here to enter text.

	No ☐ NA ☐		
Calendar schedule for construction/implementation procedures.	Yes ☐ No ☐ NA ☐	Click here to enter text.
Site or project specific monitoring to support pollution prevention and/or abatement.	Yes ☐ No ☐ NA ☐	Click here to enter text.
Confirm the incorporation of HIP III specific and general and Construction Conservation Measures into contractor/sub-contractor bid package. Identify any conservation measures that cannot be met.	Yes ☐ No ☐ NA ☐	Click here to enter text.
Identify any conservation measures that cannot be met due to design and implementation constraints.	Yes ☐ No ☐ NA ☐	Click here to enter text.

2.0 Activity Specific Data Requirements

Activity 1a: Dams, Water Control Structures, or Legacy Structures Removal

The Design Plans must include the following items:	Included	Location in planset (document and page no#)
A longitudinal profile of the stream channel thalweg for 20 channel widths upstream and downstream of the structure shall be used to determine the potential for channel degradation.	Yes ☐ No ☐ NA ☐	Click here to enter text.
A minimum of three cross-sections – one downstream of the structure, one through the reservoir area upstream of the structure, and one upstream of the reservoir area outside of the influence of the structure) to characterize the channel morphology and quantify the stored sediment.	Yes ☐ No ☐ NA ☐	Click here to enter text.
Sediment characterization to determine the proportion of coarse sediment (>2mm) in the reservoir area.	Yes ☐ No ☐ NA ☐	Click here to enter text.
A survey of any downstream spawning areas that may be affected by sediment released by removal of the water control structure or dam. Reservoirs with a d35 greater than 2 mm (i.e., 65% of the sediment by weight exceeds 2 mm in diameter) may be removed without excavation of stored material, if the sediment contains no contaminants; reservoirs with a d35 less than 2 mm (i.e., 65% of the sediment by weight is less than 2 mm in diameter) will require partial	Yes ☐ No ☐ NA ☐	Click here to enter text.

removal of the fine sediment to create a pilot channel, in conjunction with stabilization of the newly exposed streambanks with native vegetation.		
Sediment characterization to determine the presence and fate of organic or inorganic pollutants stored in the reservoir.	Yes ☐ No ☐ NA ☐	Click here to enter text.
Confirm the incorporation of HIP III specific Conservation Measures related to *Activity 1a: Dams, Water Control Structures, or Legacy Structures Removal* are into contractor/sub-contractor bid package.	Yes ☐ No ☐ NA ☐	Click here to enter text.

Activity 1b: Consolidate or Replace Existing Irrigation Diversions

The Design Plans must include the following items:	Included	Location in planset (document and page no#)
A longitudinal profile of the stream channel thalweg for 20 channel widths upstream and downstream of the structure shall be used to determine the potential for channel degradation.	Yes ☐ No ☐ NA ☐	Click here to enter text.
A minimum of three cross-sections – one downstream of the structure, one through the reservoir area upstream of the structure, and one upstream of the reservoir area outside of the influence of the structure) to characterize the channel morphology and quantify the stored sediment	Yes ☐ No ☐ NA ☐	Click here to enter text.
Confirm the incorporation of HIP III specific Conservation Measures related to *Activity 1b: Consolidate or Replace Existing Irrigation Diversions* are incorporated into contractor/sub-contractor bid package.	Yes ☐ No ☐ NA ☐	Click here to enter text.

Activity 1c: Headcut and Grade Stabilization

The Design Plans must include the following items:	Included	Location in planset (document and page no#)
A longitudinal profile of the stream channel thalweg for 20 channel widths upstream and downstream of the structure shall be used to determine the potential for channel degradation.	Yes ☐ No ☐ NA ☐	Click here to enter text.
A minimum of three cross-sections – one downstream of the structure, one through the reservoir area upstream of the structure, and one upstream of the reservoir area outside of the influence of the structure) to characterize the channel morphology and quantify the stored sediment	Yes ☐ No ☐ NA ☐	Click here to enter text.
Confirm the incorporation of HIP III specific Conservation	Yes ☐	Click here to enter text.

Measures related to *Activity 1c: Headcut and Grade Stabilization* are incorporated into contractor/sub-contractor bid package.	No ☐ NA ☐	

Activity 1f: Bridge and Culvert Removal or Replacement

The Design Plans must include the following items:	Included	Location in planset (document and page no#)
Designs shall include site sketches, drawings, aerial photographs, or other supporting specifications, calculations, or information that is commensurate with the scope of the action, that show the active channel, the 100-year floodplain, the functional floodplain, any artificial fill within the project area, the existing crossing to be replaced, and the proposed crossing.	Yes ☐ No ☐ NA ☐	Click here to enter text.
Confirm the incorporation of HIP III specific Conservation Measures related to *Activity 1f: Bridge and Culvert Removal or Replacement* are incorporated into contractor/sub-contractor bid package.	Yes ☐ No ☐ NA ☐	Click here to enter text.

Activity 1h: Installation of Fords

The Design Plans must include the following items:	Included	Location in planset (document and page no#)
Designs must demonstrate that the ford accommodate reasonably foreseeable flood risks, including associated bedload and debris, and to prevent the diversion of streamflow out of the channel and down the trail if the crossing fails.	Yes ☐ No ☐ NA ☐	Click here to enter text.
Information detailing locations of ESA listed salmon, steel head, and bull trout spawning areas within the reach.	Yes ☐ No ☐ NA ☐	Click here to enter text.
Confirm the incorporation of HIP III specific Conservation Measures related to *Activity 1h: Installation of Fords* are incorporated into contractor/sub-contractor bid package.	Yes ☐	Click here to enter text.

Activity 2a: Improve Secondary Channel and Wetland Habitats

The Design Plans must include the following items:	Included	Location in planset (document and page no#)
Evidence of historical channel location, such as land use	Yes ☐	Click here to enter text.

surveys, historical photographs, topographic maps, remote sensing information, or personal observation.	No ☐ NA ☐	
If new side channel habitat is proposed, designs must demonstrate sufficient hydrology and that the project will be self-sustaining over time. Self-sustaining means the restored or created habitat would not require major or periodic maintenance, but function naturally within the processes of the floodplain.	Yes ☐ No ☐ NA ☐	Click here to enter text.
Designs must demonstrate that the proposed action will mimic natural conditions for gradient, width, sinuosity and other hydraulic parameters.	Yes ☐ No ☐ NA ☐	Click here to enter text.
Designs must demonstrate that the proposed action will not result in the creation of fish passage issues or post construction stranding of juvenile or adult fish.	Yes ☐ No ☐ NA ☐	Click here to enter text.
Confirm the incorporation of HIP III specific Conservation Measures related to *Activity 2a: Improve Secondary Channel and Wetland Habitats* are incorporated into contractor/sub-contractor bid package.	Yes ☐ No ☐ NA ☐	Click here to enter text.

Activity 2d: Install Habitat-Forming Natural Material Instream Structures (Large Wood, Boulders, and Spawning Gravel)

The Design Plans must include the following items:	Included	Location in planset (document and page no#)
Large wood placements mimic natural accumulations of large wood in the channel, estuary, or marine environment and addresses basin defined limiting factors?	Yes ☐ No ☐ NA ☐	Click here to enter text.
Boulder placements are limited to stream reaches with an intact, well-vegetated riparian area, including trees and shrubs where those species would naturally occur, or that are part of riparian area restoration action; and a stream bed that consists predominantly of coarse gravel or larger sediments?	Yes ☐ No ☐ NA ☐	Click here to enter text.
Boulder sizing is appropriate for the size of the stream, maximum depth of flow, planform, entrenchment, and ice and debris loading?	Yes ☐ No ☐ NA ☐	Click here to enter text.
For systems where boulders were not historically a component of the project stream reach, is it demonstrated how this use of this technique will address limiting factors and provide the appropriate post restoration habitats?	Yes ☐ No ☐ NA ☐	Click here to enter text.
LW and boulder placements will not result in a fish passage barrier?	Yes ☐ No ☐ NA ☐	Click here to enter text.

Spawning gravel augmentation is limited to areas where the natural supply has been eliminated or significantly reduced through anthropogenic means?	Yes ☐ No ☐ NA ☐	Click here to enter text.
Confirm the incorporation of HIP III specific Conservation Measures related to *Activity 2d: Install Habitat-Forming Natural Material Instream Structures (Large Wood, Boulders, and Spawning Gravel)* are incorporated into contractor/sub-contractor bid package.	Yes ☐ No ☐ NA ☐	Click here to enter text.

Activity 2f: Channel Reconstruction

The Design Plans must include the following items:	Included	Location in planset (document and page no#)
Designs must demonstrate that channel reconstruction will identify, correct to the extent possible, and then account for in the project development process, the conditions that lead to the degraded condition.	Yes ☐ No ☐ NA ☐	Click here to enter text.
Designs must demonstrate that the proposed action will mimic natural conditions for gradient, width, sinuosity and other hydraulic parameters.	Yes ☐ No ☐ NA ☐	Click here to enter text.
Designs must demonstrate sufficient hydrology and that the project will be self-sustaining over time. Self-sustaining means the restored or created habitat would not require major or periodic maintenance, but function naturally within the processes of the floodplain.	Yes ☐ No ☐ NA ☐	Click here to enter text.
Designs must demonstrate that structural elements shall fit within the geomorphic context of the stream system.	Yes ☐ No ☐ NA ☐	Click here to enter text.
Designs must demonstrate that the proposed action will not result in the creation of fish passage issues or post construction stranding of juvenile or adult fish.	Yes ☐ No ☐ NA ☐	Click here to enter text.
Confirm the incorporation of HIP III specific Conservation Measures related to *Activity 2f: Channel Reconstruction* are incorporated into contractor/sub-contractor bid package in addition to the development of a *Monitoring and Adaptive Management Plan*, see below.	Yes ☐ No ☐ NA ☐	Click here to enter text.

Monitoring and Adaptive Management Plan

A Monitoring and Adaptive Management must be prepared for channel reconstruction projects that include a concise trigger table with design criteria summarized to inform when corrective action is necessary. A general outline is provided below and examples are available upon request.

1. Introduction
2. Existing Monitoring Protocols
3. Project Effectiveness Monitoring Plan
    a. Objective 1
    b. Objective 2
4. Project Review Team Triggers
5. Monitoring Frequency, Timing, and Duration
    a. Baseline Survey
    b. As-built Survey
    c. Monitoring Site Layout
    d. Post-Bankfull Event Survey
    e. Future Survey (related to flow event)
6. Monitoring Technique Protocols
    a. Photo Documentation and Visual Inspection
    b. Longitudinal Profile
    c. Habitat Survey
    d. Survival Plots
    e. Channel and Floodplain Cross-sections
    f. Fish Passage
    g. Other
7. Data Storage and Analysis
8. Monitoring Quality Assurance Plan
9. Literature Cited