

## Appendix A | Stream Habitat Assessment

---

Habitat Inventory Survey: *August 1st – September 1st, 2024*

White River RM 0 - RM 16.17

Napeequa River RM 0 – RM 2.20

Panther Creek RM 0 – RM 0.80

## Table of Contents

<b>1</b>	<b>Introduction &amp; Background</b> .....	<b>1</b>
1.1	Comparison to Previous Salmon Habitat Assessments .....	1
<b>2</b>	<b>Methods</b> .....	<b>3</b>
<b>3</b>	<b>Summary of Results</b> .....	<b>4</b>
3.1	Channel Morphology .....	5
3.2	Habitat Unit Composition .....	7
3.3	Side Channel Habitat.....	9
3.4	Large Woody Material .....	10
3.5	Substrate & Fine Sediment .....	12
3.6	Bank Instability.....	13
3.7	Fish Passage Barriers.....	14
3.8	Riparian Corridor.....	15
<b>4</b>	<b>Stream Habitat Reach Reports</b> .....	<b>19</b>
4.1	Reach 1.....	19
4.1.1	Habitat Unit Composition .....	19
4.1.2	Pools.....	22
4.1.3	Side Channel Habitat.....	22
4.1.4	Large Woody Material .....	22
4.1.5	Substrate & Fine Sediment .....	23
4.1.6	Riparian Corridor .....	25
4.2	Reach 2.....	27
4.2.1	Habitat Unit Composition .....	27
4.2.2	Pools.....	29
4.2.3	Side Channel Habitat.....	29
4.2.4	Large Woody Material .....	29
4.2.5	Substrate & Fine Sediment .....	29
4.2.6	Riparian Corridor .....	31
4.3	Reach 3.....	33
4.3.1	Habitat Unit Composition .....	33
4.3.2	Pools.....	35
4.3.3	Side Channel Habitat.....	35
4.3.4	Large Woody Material .....	35
4.3.5	Substrate & Fine Sediment .....	36
4.3.6	Riparian Corridor .....	37
4.4	Reach 4.....	39
4.4.1	Habitat Unit Composition .....	39
4.4.2	Pools.....	41
4.4.3	Side Channel Habitat.....	41
4.4.4	Large Woody Material .....	41

4.4.5	Substrate & Fine Sediment .....	41
4.4.6	Riparian Corridor .....	43
4.5	Reach 5.....	45
4.5.1	Habitat Unit Composition .....	45
4.5.2	Pools.....	47
4.5.3	Side Channel Habitat.....	47
4.5.4	Large Woody Material .....	47
4.5.5	Substrate & Fine Sediment .....	48
4.5.6	Riparian Corridor .....	50
4.6	Reach 6.....	52
4.6.1	Habitat Unit Composition .....	52
4.6.2	Pools.....	54
4.6.3	Side Channel Habitat.....	54
4.6.4	Large Woody Material .....	54
4.6.5	Substrate & Fine Sediment .....	55
4.6.6	Riparian Corridor .....	57
4.7	Reach 7.....	59
4.7.1	Habitat Unit Composition .....	59
4.7.2	Pools.....	61
4.7.3	Side Channel Habitat.....	61
4.7.4	Large Woody Material .....	61
4.7.5	Substrate & Fine Sediment .....	62
4.7.6	Riparian Corridor .....	64
4.8	Reach 8.....	66
4.8.1	Habitat Unit Composition .....	66
4.8.2	Pools.....	68
4.8.3	Side Channel Habitat.....	68
4.8.4	Large Woody Material .....	68
4.8.5	Substrate & Fine Sediment .....	69
4.8.6	Riparian Corridor .....	72
4.9	Reach 9.....	74
4.9.1	Habitat Unit Composition .....	74
4.9.2	Pools.....	76
4.9.3	Side Channel Habitat.....	76
4.9.4	Large Woody Material .....	76
4.9.5	Substrate & Fine Sediment .....	77
4.9.6	Riparian Corridor .....	79
4.10	Reach 10.....	81
4.10.1	Habitat Unit Composition .....	81
4.10.2	Pools.....	84
4.10.3	Side Channel Habitat.....	84
4.10.4	Large Woody Material .....	84

4.10.5	Substrate & Fine Sediment .....	84
4.10.6	Riparian Corridor .....	86
4.11	Napeequa River Reach 1 .....	88
4.11.1	Habitat Unit Composition .....	88
4.11.2	Pools.....	90
4.11.3	Side Channel Habitat.....	90
4.11.4	Large Woody Material .....	90
4.11.5	Substrate & Fine Sediment .....	91
4.11.6	Riparian Corridor .....	93
4.12	Napeequa River Reach 2 .....	95
4.12.1	Habitat Unit Composition .....	95
4.12.2	Pools.....	97
4.12.3	Side Channel Habitat.....	97
4.12.4	Large Woody Material .....	97
4.12.5	Substrate & Fine Sediment .....	98
4.12.6	Riparian Corridor .....	98
4.13	Panther Creek Reach 1.....	100
4.13.1	Habitat Unit Composition .....	100
4.13.2	Pools.....	103
4.13.3	Side Channel Habitat.....	103
4.13.4	Large Woody Material .....	103
4.13.5	Substrate & Fine Sediment .....	103
4.13.6	Riparian Corridor .....	105
4.14	Summary Data.....	106
<b>5</b>	<b>References .....</b>	<b>111</b>

# 1 Introduction & Background

The White River is located on the eastern side of the Central Cascade Mountains in central Washington, flowing southeast for nearly 30 miles before entering Lake Wenatchee (Carlson et al., 2004). This White River Habitat Assessment study area summarizes existing aquatic habitat and watershed conditions in the Lower White River, between River Mile (RM) 0 and 16.17. Two major tributaries to the White River were also assessed, including the lower 0.8 miles of Panther Creek, and the lower 2.20 miles of the Napeequa River. Study area RMs were determined from WA Department of Ecology datasets and updated to reflect current channel alignments by Inter-Fluve.

Reach breaks used for the Lower White River habitat assessment were from the Upper Columbia Salmon Recovery Board (*Upper Columbia Spatial Framework*, 2021). Field surveys followed the US Forest Service Stream Inventory Handbook: Level I & II, Pacific Northwest Region (USFS, 2020) protocols. Inter-Fluve staff conducted the habitat survey between August 1<sup>st</sup> and September 1<sup>st</sup>, 2024, beginning at RM 0 (mouth of the White River) and walking upstream to RM 16.17 (the lower waterfall at White River Falls). A White River discharge measurement was collected on August 7<sup>th</sup> approximately 1.5 miles downstream from the Sears Creek Bridge and approximately 5.5 miles upstream from the mouth of the White River. The field-measured discharge was recorded as 265 cfs. The Washington Department of Ecology (DOE) stream gage #45K090 recorded a discharge value of 316 cfs on August 7<sup>th</sup>. Significant precipitation was received twice throughout the survey period; the first on August 18<sup>th</sup> while staff were in the field and again on August 24<sup>th</sup>, which coincided with an off day for the field crew. Stream gage data from the Washington DOE gage #45K090 measured the peak stream flows of those precipitation events at 458 and 468 cfs, respectively (“Freshwater DataStream - Station 45K090,”). Stream flow was not otherwise measured as part of this survey.

This reach assessment was completed on behalf of the Yakama Nation as part of their efforts to assess and improve Threatened and Endangered salmon and trout habitat within the Columbia River Basin. The objective of the Habitat Assessment is to characterize the habitat quantity and quality for salmonid species native to the White River by quantifying in-channel morphologic features, characterizing riparian conditions, and identifying anthropogenic features influencing aquatic habitat. This information is used to inform potential restoration and conservation actions and will provide a baseline for evaluating future habitat trends and measuring the effectiveness of restoration efforts to improve the quantity and quality of available habitat within the study area.

## 1.1 COMPARISON TO PREVIOUS SALMON HABITAT ASSESSMENTS

A salmon habitat assessment of the full Lower White River study area (RM 0 – 16.17) is not known to exist. However, an assessment was conducted between RM 0 – 5.7 in 2013 (Herrera Environmental Consultants, 2014). The 2013 effort assessed many of the same metrics that support evaluations of channel and floodplain hydrology, geomorphology, habitat and vegetation, but did not explicitly follow all USFS Level II protocols (USFS, 2020) as in the 2024 field efforts. Therefore, direct comparisons between the results of the two surveys is more challenging. Where the datasets do overlap in content and spatial distribution, a discussion is provided below.

Locations of reach breaks were slightly different between the 2013 and 2024 surveys. The river miles used between the two surveys are comparable, but the Herrera survey used different locations for their reach breaks. Table 1 provides a summary and comparison of the reach breaks and river miles between 2013 and 2024 surveys.

**Table 1. Summary of reach boundaries and RMs for the two habitat surveys in 2013 and 2024 in the White River.**

	Reach 1 (RM)	Reach 2 (RM)	Reach 3 (RM)
<b>2013</b>	0-1.7 (weir)	1.7-3.5	3.5-5.7
<b>2024</b>	0-2.0 (bridge)	2.0-4.13	4.13-5.44

Metrics related to channel geomorphology and form that were collected in both surveys include bankfull width and depth and floodprone width. Bankfull width and depth measurement methods varied slightly, with 2013 survey crews recording bankfull width and depth at the thalweg, and 2024 survey crews measuring bankfull width and 10 evenly-spaced bankfull depth measurements, including the thalweg bankfull depth. Since no bankfull was recorded in Reach 1 during the IFI survey, only the bankfull and floodprone width measurements of Reaches 2 and 3 can be compared between the two surveys.

Maximum bankfull depths were almost identical among both datasets, with an average of 0.15-feet of difference among the bankfull depths for Reaches 2 and 3. Bankfull widths for Reaches 2 and 3 were also similar, ranging from 135-137 feet in the 2013 dataset and 120-140 feet in the 2024 dataset. Methods for determining floodprone widths varied among the 2013 and 2024 assessments. Visual field estimates or desktop-based GIS and HEC-RAS hydraulic model results informed the floodprone widths for the 2013 assessment, which ranged from 2,500 ft to 3,500 ft. The 2024 floodprone widths were determined using updated HEC-RAS 2D hydraulic modeling results, and ranged from 464 ft to 3,751 ft. The largest difference among the datasets is in Reach 3.

Channel and riparian conditions were also assessed in both 2013 and 2024 through habitat unit mapping, counts of large wood, observation of channel substrates, documentation of vegetation species, and bank erosion. Pools were the dominant habitat unit type observed in 2024, while the 2013 dataset recorded alternating pool and glide units through all three reaches. Surveyor subjectivity, and potentially differing water levels at the time of the survey, likely contribute to the difference in habitat unit type composition. Large wood counts recorded in the two assessments differed, but showed a consistent trend of a decreasing wood count downstream of the bridge at RM 2. On average, the IFI survey found 77 more pieces of medium and large wood (pieces with >1 foot diameter and >35 feet of length) per mile than the Herrera report. The 2013 survey relied on aerial photos from 2011 to estimate the number of pieces and confirmed the estimate in the field, but noted that submerged wood was not included in that count due to the turbidity of the water. The 2024 survey counted all wood that was visible and met the appropriate size class. Both counts included wood in jams, but in the 2013 survey the presence of root wads on large wood pieces was recorded, which was not noted during 2024 surveys.

In the 2013 surveys, substrate in the lower three reaches on the White were dominated by sand or fines, based on ocular observations. The 2024 survey relied on pebble counts conducted at representative riffle

crests, with gravels found as the dominant substrate in all three reaches. This difference can be attributed to a difference in protocol. Vegetation species recorded within the riparian corridor were essentially the same among both assessments and primarily included cottonwood and western red cedar. Locations of bank erosion were recorded in 2013 and 2024. A greater proportion of the banks were noted as eroding in 2013. However, all observable bank erosion was recorded by the 2013 survey crews, while the 2024 survey recorded locations of bank erosion that were specifically induced by anthropogenic causes. This difference is likely why the amount of bank erosion in the 2013 assessment is higher than that found in the 2024 survey.

## 2 Methods

The White River study area was subdivided into 13 distinct channel reaches covering the mainstem White River and two of its tributaries, the Napeequa River and Panther Creek. On the White River, there were 10 mainstem covering RM 0-16.17. There were two Napeequa River reaches (RM 0 – 2.20) and one Panther Creek reach (RM 0 – 0.8). On the mainstem White River, the habitat survey stopped just short of the study area upstream extent due to the presence of the lower White River Falls, located at approximately RM 16.09. On Panther Creek, surveyor access became unsafe near RM 0.7 and the habitat assessment was terminated before the end of the reach. A third tributary, Sears Creek, was originally proposed for survey, but was removed from further analysis after field reconnaissance indicated Sears Creek was considerably disconnected from the mainstem White River. These 13 reach delineations are used for both the habitat assessment as well as the geomorphic assessment and restoration strategy, as documented in Section 3 of the main report and Appendix C.

The habitat assessment employed the methods outlined in the US Forest Service Stream Inventory Handbook: Level I & II, Pacific Northwest Region. Version 2.20 (USFS, 2020). The “Eastside Forest Option” protocol was used. All protocols were followed when safe and most of the suggested forest inventory options were applied in the survey. Adaptions to the USFS Eastside protocol were made for this survey. Those adaptations include:

- All reach and habitat unit lengths were measured in GIS from GPS data recorded in the field. Habitat units were delineated by survey points collected with a Juniper System GNS2 Geode unit (sub-foot accuracy).
- Floodprone width calculated using LiDAR data and 2D hydraulic modeling results
- Bankfull measurements collected in slow water units when fast water units were not present
- Field data was collected digitally, using an iPad and ESRI Field Maps software.

At all channel units, surveyors performed an ocular estimate of wetted width and at nth units performed a measured wetted width using a laser rangefinder to calibrate their ocular estimate. A bankfull measurement was performed at the first three fast water channel units (riffle or glide) per reach, and then at every n<sup>th</sup> unit after. The n<sup>th</sup> channel unit (riffle, pool, glide) measurement frequency applied in the field for data collection was 20%, or every 5<sup>th</sup> unit, for both fast- and slow-water channel unit types. If fewer than three fast-water units were encountered in a reach, bankfull measurements were collected at slow water units instead. The length of anthropogenically-induced unstable banks was recorded for both the left and right channel banks in all units. Water depths for all habitat units was measured using a

graduated stadia rod carried by the observer, or estimated if depths or velocities exceeded the wading ability of the observer.

For the riparian vegetation measurements, the riparian corridor can be defined as either a single 100-ft wide zone or two adjacent riparian zones (inner and outer zones) totaling 100 feet in width (USFS, 2020). For this assessment, one single 100-ft wide riparian zone was designated for the White River study area. Survey methods dictate defining a dominant size class of vegetation type within the riparian corridor (e.g. small trees, shrubs), then defining the dominant species observed in the overstory and understory. Survey protocol differed from USFS protocol by collecting a dominant overstory size class and species, and a dominant understory species within the 100-ft wide riparian zone in addition to size class (2020).

Gravel counts were performed as part of the geomorphic survey to characterize the size distribution of bedload sediment. In total, 23 gravel counts were completed. Two gravel counts were completed in each of the Reaches 1-10 of the mainstem White River. Two gravel counts were collected in Napeequa River Reach 1, and no gravel counts were taken in Napeequa River Reach 2. Only one gravel count was collected in Panther Creek Reach 1. Gravel count locations were selected as representative of the general character of the reach.

For this habitat survey, side channels were defined as naturally-wetted flow paths connected to the mainstem channel at their upstream and downstream ends at low flow. Side channel units were identified when the main channel split to form a stable island with soil or fine sediment accumulations and with established vegetation older than 2 to 3 years. Each side channel was determined to be predominately a fast-water or slow-water unit type. The average width of the side channel was recorded based on field observations. Total length of the side channels were recorded using GPS following the same protocols used for main channel unit delineation. If the entire side channel was not wet at the time of survey, the length of the wetted portion of the side channel was estimated. This report provides data based on total side channel lengths, unless otherwise noted.

Large woody material (LWM) was counted in the mainstem and side channels following the size class characterizations for “Eastside” forests. Tallies of small (> 6 in. diameter, >20 ft long), medium (>12 in. diameter, > 35 ft long) and large (>20 in. diameter, >35 ft long) pieces of LWM were completed for each reach. A log jam was classified as a group of three or more pieces of qualifying size (meets the size requirements above) in contact with one another and with at least one piece within bankfull. For the log jam count in the habitat survey, both a within bankfull count (number of pieces within bankfull) and total count was performed (number of pieces within and outside of bankfull). The within bankfull count was used for this report.

### 3 Summary of Results

This section summarizes the results of the 13 mainstem and tributary reaches within the study area, including from RM 0 (mouth of the White) to RM 16.17 (White River Falls) on the mainstem of the White River, from RM 0 to RM 2.20 on the Napeequa River, and from RM 0 to RM 0.7 on Panther Creek. Detailed descriptions of the results on an individual reach-scale basis are included in Section 4 of this Appendix.

### 3.1 CHANNEL MORPHOLOGY

The channel morphology of the lower mainstem White River undergoes a dramatic change from the mouth at Lake Wenatchee up to White River Falls. In the upper portion of the study area, the channel is single-threaded and relatively straight, alternating between confined and partially-confined by bedrock and floodplain terraces. This degree of confinement, combined with a relatively steep slope, creates a high-energy system in which LWM and sediment are readily transported through the upper reaches and downstream into the lower portion of the study area. Beneath the Panther Creek confluence, the channel is generally unconfined with evidence of active historical lateral migration. Although the channel remains primarily single-threaded, large wood frequently creates split-flow conditions. Channel slope decreases considerably between the Panther Creek confluence (RM 15) and the Napeequa River confluence (RM 12.45), and then again downstream of the Sears Creek Road bridge crossing the White River near RM 7. The main channel remains straight to slightly meandering in the section between Panther Creek and Sears Creek (RM 8.55). Below Sears Creek, the sinuosity of the mainstem White River increases significantly until it reaches Lake Wenatchee.

The Napeequa River undergoes a considerable change in slope and confinement as it flows from the upstream boundary of the assessment area to its confluence with the White River. In the upper portion of the assessment area, the channel is steep and confined by adjacent hillslopes and bedrock outcrops. Sinuosity is low, and the channel is multi-threaded, with split flow around long vegetated islands. LWM and sediment are readily transported through the upper reach, although LWM wedged between boulders and bedrock outcrops results in local sediment sorting and creation of isolated step-pool sequences. Downstream of the falls at RM 1.7, the valley floor widens, slope decreases considerably, and the channel transitions to a primarily single-thread planform. The channel is unconfined by natural features, although riprap limits lateral processes in the downstream portion of the lower reach.

Panther Creek is steep, single threaded and has low sinuosity. Upstream of RM 0.4 it is confined by bedrock canyon. Downstream of RM 0.4 the channel is flowing across the Panther Creek alluvial fan. There is a network of seasonally active distributary channels that convey stream flow, coarse sediments, and LWM.

The Napeequa River is the largest of the tributaries to the White River, contributing an estimated 27% of the White's 2-year discharge. Lateral migration of the Napeequa is limited by bank hardening for a bridge near Tall Timber Ranch. Panther Creek contributes an estimated 14% of the White's 2-year discharge. See Table 2 for a summary of bankfull and floodprone widths. If zero or one measurement was performed, the table shows "n=0" or "n=1", respectively.

**Table 2. Bankfull and floodprone width results for the entire study area.**

Bankfull Widths (feet)													
	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10	Napeequa River 1	Napeequa River 2	Panther Creek
<b>Min</b>	n=0	120	140	130	120	150	160	75	110	80	54	40	40
<b>Max</b>	n=0	120	140	150	165	230	180	230	125	110	80	40	64
<b>Mean</b>	n=0	120	140	140	145	188	173	131	119	92	66	40	51
<b>St Dev</b>	n=0	n=1	n=1	14	18	39	12	57	8	14	13	n=1	11
Floodprone Widths													
	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10	Napeequa River 1	Napeequa River 2	Panther Creek
<b>Min</b>	n=0	3751	464	555	352	396	799	237	111	81	79	58	40
<b>Max</b>	n=0	3751	464	568	2948	1259	890	492	135	117	162	58	47
<b>Mean</b>	n=0	3751	464	562	1096	682	860	338	121	97	123	58	42
<b>St Dev</b>	n=0	n=1	n=1	10	1137	393	53	88	12	15	30	n=1	4
Bankfull Depths (feet)													
	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10	Napeequa River 1	Napeequa River 2	Panther Creek
<b>Min</b>	n=0	10.6	4.2	1.8	1.8	1.7	0.6	1.2	3.0	0.9	1.3	1.4	0.2
<b>Max</b>	n=0	13.1	13.0	10.1	10.7	8.8	8.5	5.8	5.7	5.4	4.8	3.3	4.1
<b>Mean</b>	n=0	12.2	9.8	7.2	6.3	5.1	4.7	4.2	4.4	3.8	3.1	2.7	2.1
<b>St Dev</b>	n=0	0.9	2.5	2.2	2.1	1.4	1.8	1.2	0.7	0.9	0.7	0.6	0.9

*\*If no measurements were performed, "n=0" is shown. If only one measurement was performed, "n=1" is shown.*

### 3.2 HABITAT UNIT COMPOSITION

Within the entire study area, including tributaries, pools are the dominant habitat type, comprising 78% of the total habitat area. Riffles comprise 9% of the total area, and glides 10%. Side channels comprise 3% of the total. There were several units classified as “other” in the survey: a weir in Reach 1, a waterfall in Reach 10, a waterfall in Napeequa River Reach 1, and two cascades and one waterfall in Panther Creek Reach 1. Throughout the entire survey area, waterfalls made up 0.1% of the total area, and the weir and cascades made up a negligible percentage when rounded.

Out of the White River reaches, Reaches 1 and 2 maintained the highest percentage of pool habitat, with nearly 100% of the reach area defined as pool. Reach 10 had the lowest percentage of pool habitat, with less than 8% of the reach area recorded as pool habitat. In general, pool habitat decreases as riffle and glide habitat increases, moving upstream. The first side channel appeared in Reach 5, where side channel units comprised 1% of the reach area. Reaches 6 and 7 had similar percentages of side channel habitat, making up roughly 4% of the area in the reach. Reach 9 had the most side channel habitat of the mainstem units at 18% (Figure 1).

The Napeequa River Reach 1 is predominantly pool habitat (67%), while the Napeequa River Reach 2 had the lowest percentage of pool area of any reach in the entire study area, including the mainstem White River, at 5%. Reach 2 of the Napeequa is dominated by riffle habitat (50%). The Napeequa River Reach 1 had roughly 4% side channel habitat, while the Napeequa River Reach 2 had the most side channel habitat of all the units (including the mainstem) at 45% (Figure 1).

Panther Creek is dominated by riffle habitat (69%), with pool habitat making up 30%. There is a small percentage of cascade habitat, that makes up 1% of the reach area (Figure 1).

The mean residual pool depth for the White River reaches, ranged from 10.8 feet in Reach 1 to 2.6 feet in Reach 10. Reach 8 had the lowest individual residual depth recorded, at 0.4 feet and Reach 1 had the highest at 12.0 feet. Pool frequency was the highest in the White River in Reach 6, with eight pools per mile. Reach 1 had the lowest pool frequency, with only one pool per mile, however, this low frequency of pools is likely due to the backwater influence of Lake Wenatchee.

Mean residual depth for the Napeequa River Reach 1 was 3.4 feet and 3 feet in the Napeequa River Reach 2. The individual residual depth measurements for the Napeequa ranged from 1.8 feet to 4.7 feet, both of which were recorded in the first reach. The Napeequa River Reach 1 had a higher frequency of pools than Reach 2, at roughly 14 pools per mile.

Panther Creek had a mean residual pool depth of 3.3 feet, ranging from 0.7 to 7.1 feet deep, and a pool frequency of 20 pools per mile. This was the highest pool frequency of any reach, tributaries and mainstem included.

The mean residual pool depth across all the reaches (including tributaries) is 4.1 feet. See Figure 3.

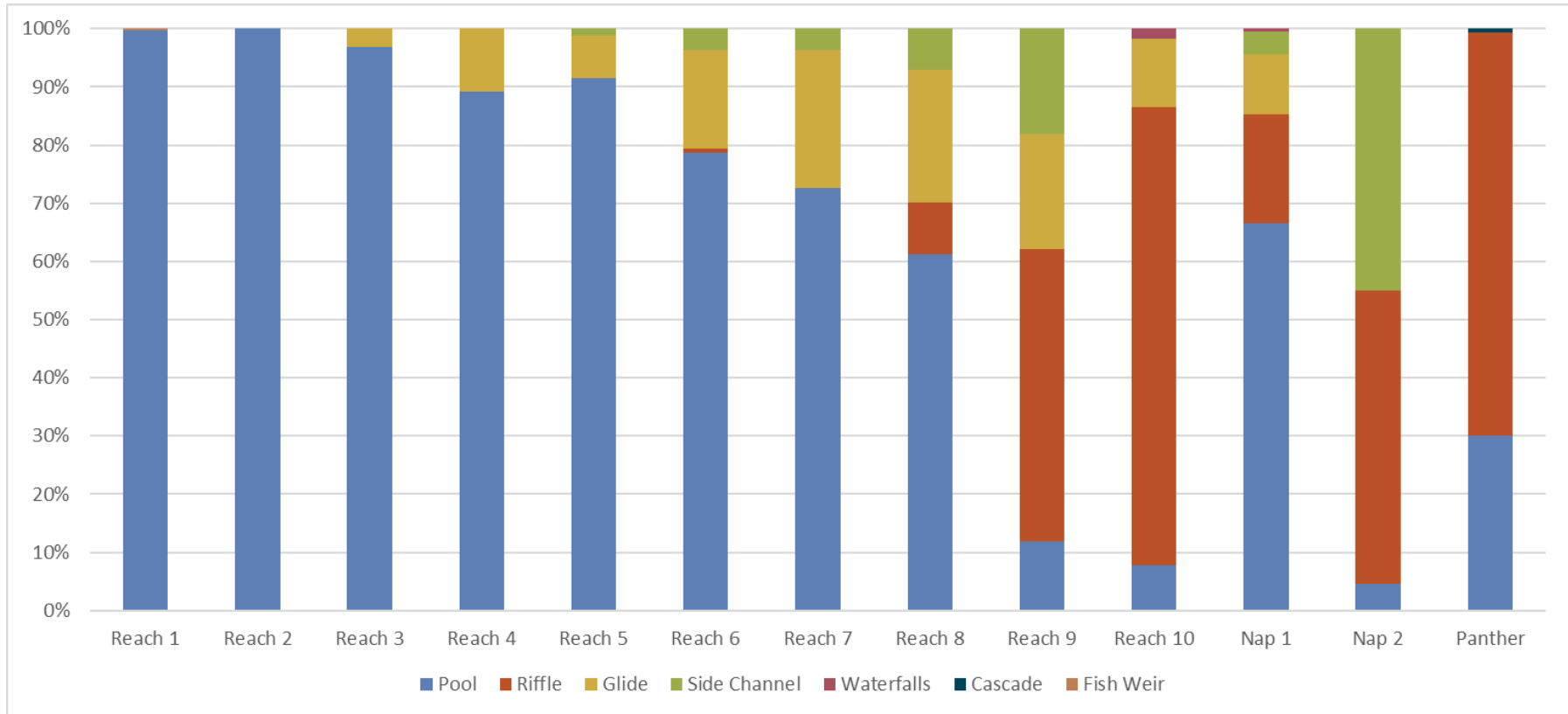
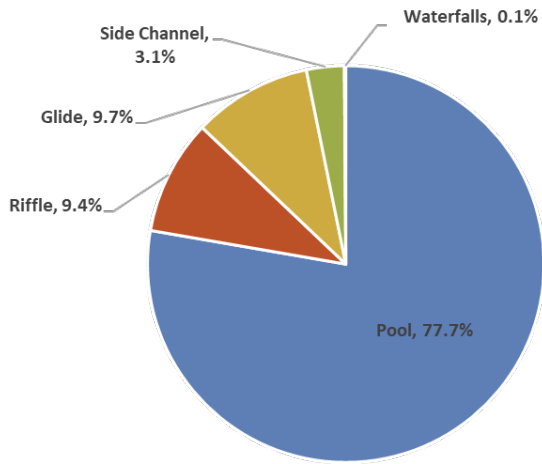
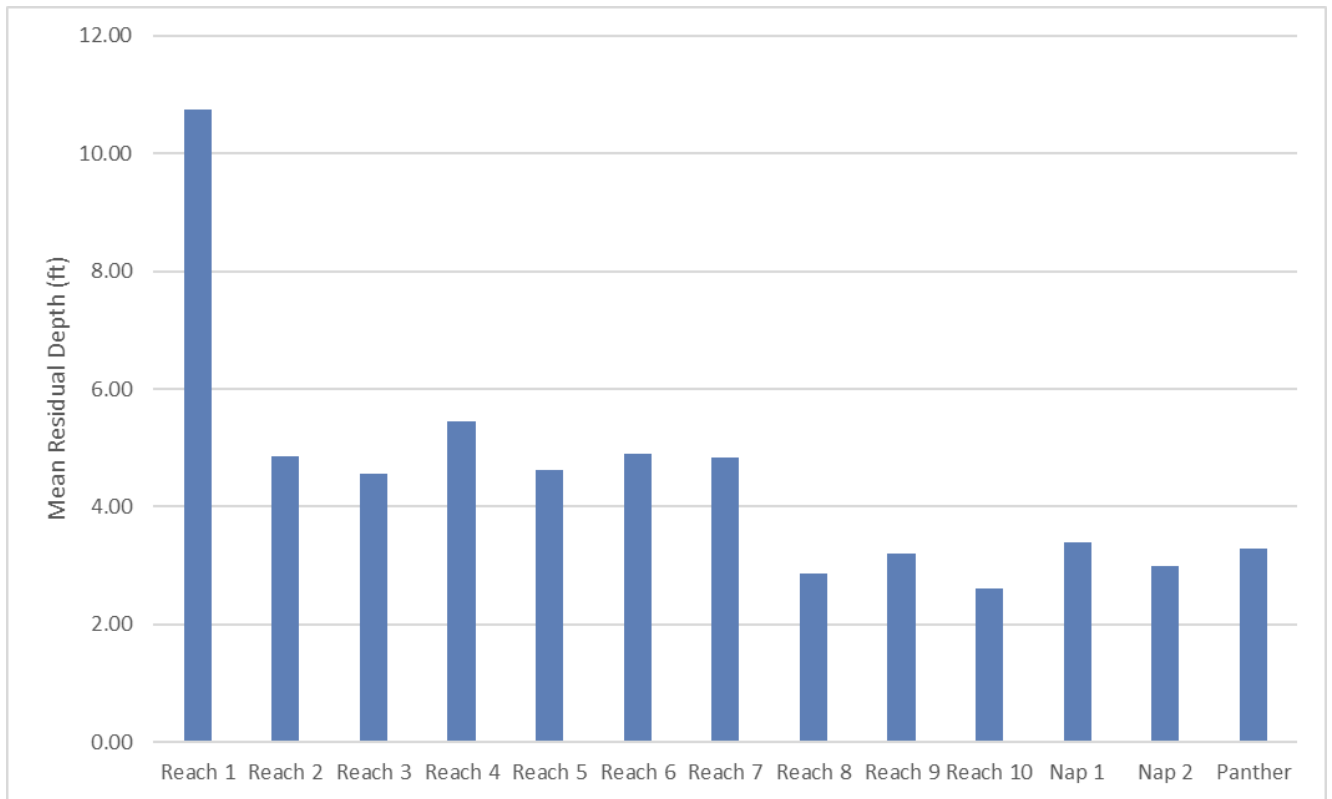


Figure 1. Figure illustrates the habitat unit composition (as a percent of total area) for each of the 13 surveyed reaches.



**Figure 2.** Figure illustrates the habitat unit composition for the entire study area, including tributaries. The pool area in Reaches 1-2 on the mainstem White River accounts for roughly 31% of the pool area for the entire study area.



**Figure 3.** Average residual pool depth per reach.

### 3.3 SIDE CHANNEL HABITAT

The side channel habitat area throughout the study area was relatively limited, accounting for just over 3% of the total habitat unit area. A total of 12 side channels were observed in the mainstem White River,

while nine side channels were recorded in the Napeequa River. No side channels were found in Panther Creek.



*Figure 4. One of the side channels in Reach 9, located downstream of the Panther Creek confluence.*

### 3.4 LARGE WOODY MATERIAL

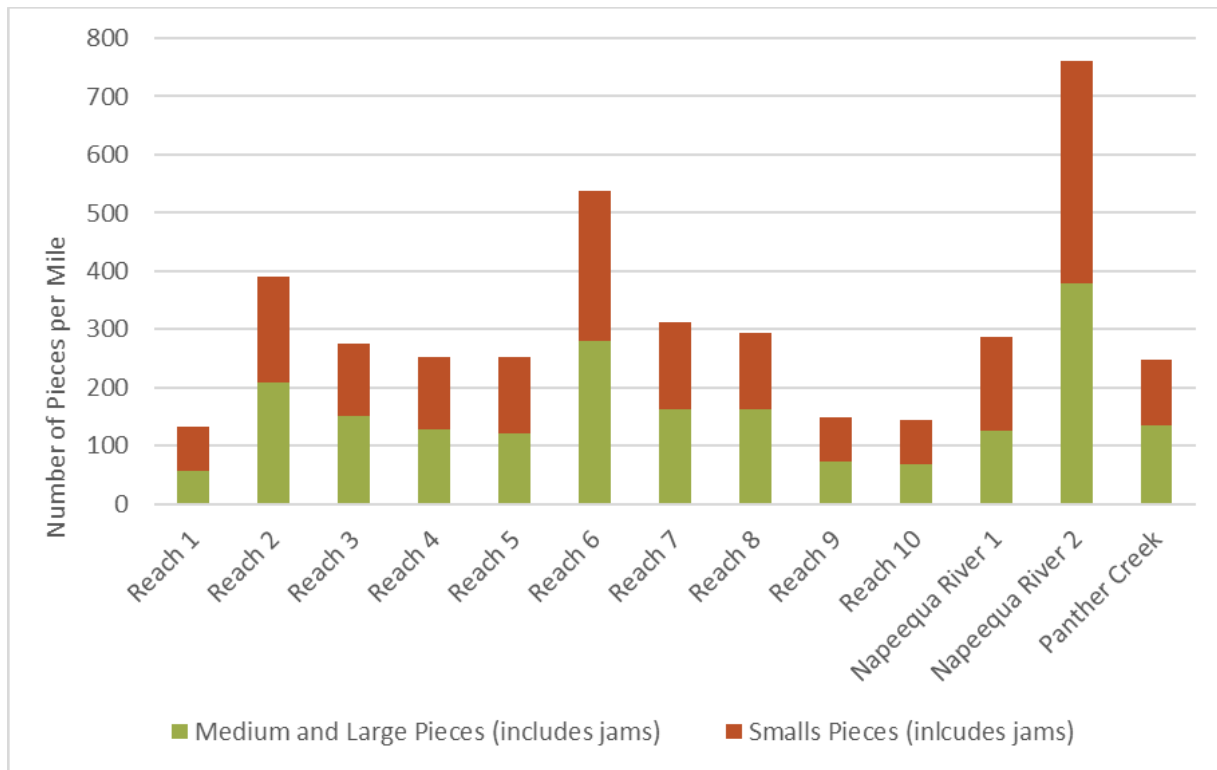
There were 5,709 pieces of LWM observed in the study area (including tributaries) averaging 301 pieces per mile and 154 medium and large (M+L) pieces per mile. This count includes individual pieces recorded as well as the number of pieces estimated in jams. LWM was counted in three size classes: small (diameter >6 inches and length >20 feet), medium (diameter >12 inches and length >35 feet), and large (diameter >20 inches and length >35 feet). Small LWM pieces made up nearly half of all wood recorded in the study area (49%). Of the remainder, 31% of LWM in the study area was in the medium size class while 20% was classified as large. Of all reaches in the study area, the Napeequa River Reach 2 maintained the most LWM in both number of quality pieces (medium and large) per mile (n=378) and total pieces per mile (n=760). The White River mainstem Reach 1 had the least number of LWM, with 57 quality pieces and 133 total pieces per mile (Figure 5).

Based on thresholds established by Fox and Bolton (Fox & Bolton, 2007) for Eastside forests, the “adequate” threshold for LWM is more than 67.45 pieces per mile of quality medium and large size class

wood (diameter >12 inches and length >35 feet), with additional woody debris available for short- and long-term recruitment. There is an average of 154 pieces of quality wood per mile across the whole study area. Reaches 3, 7, 9,10, the Napeequa River 2, and Panther Creek met the “adequate’ threshold; where they met the minimum number of pieces per mile and maintained strong recruitment potential for LWM based on riparian conditions.

During the survey, log jams were counted separately from individual LWM pieces and required three or more pieces of qualifying sized wood to be in contact with one another. At least one of the pieces had to fall within bankfull, and some jams had a portion of wood located outside of bankfull. In these cases, a “within bankfull” count was performed as well as a total count (including logs outside of bankfull). This habitat appendix will focus solely on the “within bankfull” count as that pertains to the habitat assessment. Over half of all the LWM observed in the study area was positioned in jams (56%), while 44% were recorded as individual pieces of LWM. A total of 245 jams (13 jams per mile) were counted in the study area.

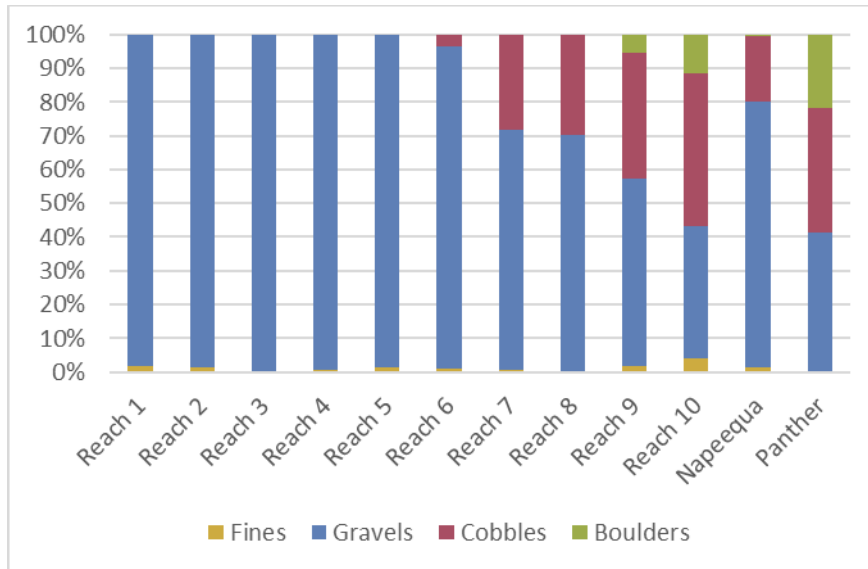
The geomorphic survey included an LWM assessment of key pieces for each reach. Key pieces were determined to large, stable pieces, that were effective in influencing and maintaining channel complexity. The geomorphic survey used visual estimates to determine the size qualifications for key pieces in each reach based on visual assessments of example key pieces found in the field. The wood count for key pieces in the geomorphic survey was separate from the wood count performed in the habitat survey, which followed USFS guidelines (2020).



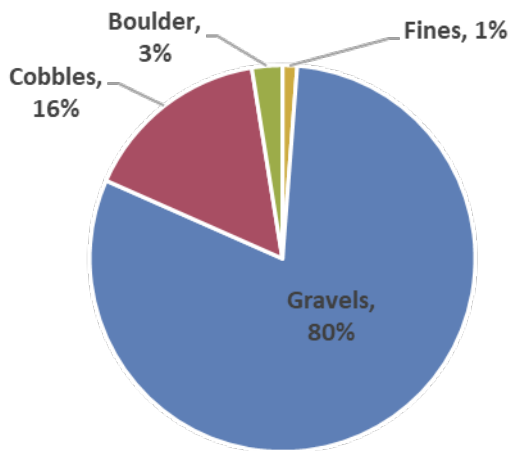
**Figure 5. Summary of the number of LWM pieces per mile, split into small and quality (medium and large) pieces.**

### 3.5 SUBSTRATE & FINE SEDIMENT

Substrate characterization is based on 23 gravel counts completed in the White River Reaches 1–10 and in the Napeequa and Panther tributaries. Gravel counts were performed at representative riffle crests or at representative bars. Two gravel counts were completed in each of the 10 mainstem reaches. Two gravel counts were completed in Napeequa River Reach 1, and one gravel count was completed in Panther Creek Reach 1. No gravel counts were performed in Napeequa River Reach 2 due to lack of available / suitable substrate. Sediment type is classified by the B-axis diameter of the clasts sampled according to the Wentworth grain size scale (fines = <2 mm, gravel = 2.1–64 mm, cobble = 64.1–256 mm, boulder = >256.1 mm). Based on the combined results of the two counts performed per reach, gravels (2–64 mm diameter) dominate White River Reaches 1–9, the Napeequa River Reach 1, and Panther Creek Reach 1, ranging from 41% to 100% gravels. In White River Reach 10, the most prevalent substrate is cobbles (64.1–256 mm diameter), making up 45% of the total available substrate. The percent of fines is low (0%–4%) across all reaches, with a study area average of 1%, indicating that fine sediments, which can be harmful to salmonid survival in high concentrations at spawning grounds, are likely readily transported out of the system and thus pose minimal risk to aquatic habitat quality in the surveyed area (Figure 6 and Figure 7). In the upper reaches, fines were observed at the interstices of boulder-cobble bars and in streambeds with slow or dry side channels. Fines became more prevalent in bars and associated with in-stream large wood from Reach 8 down. Ocular observations of substrate changes concur that substrate size increased moving upstream.



**Figure 6. Combined average gravel count size classification by reach for all reaches and tributaries based on two gravel counts performed for each reach. None were conducted in the Napeequa River Reach 2, and one was performed in Panther Creek Reach 1.**



**Figure 7. Gravel count size classification averaged for all reaches, including the tributaries. Gravel is the dominant classification that was observed.**

### 3.6 BANK INSTABILITY

Throughout the study area, human-caused bank instability was low, making up just 3% of the total bank length. The total bank length throughout the assessment area was calculated by doubling the length of the reach to account for unstable banks on both river left and river right. Surveyors recorded anthropogenically-caused bank instability, where human actions were leading to increased levels of erosion or where stability/reinforcement features were located. The primary causes of unstable banks were riprap along the banks near roads, protecting riverfront residential properties, or underneath

bridges (Figure 8). There were a few other instances of bank armoring with large boulders, sheet metal, or old cars, but those cases were minimal.

White River Reach 5 and the Napeequa River Reach 1 had the highest percentages of unstable banks, with 10% and 9% (respectively) of their total bank lengths having anthropogenically-caused bank instability. The river-left bank in White River Reach 5 abuts a privately-owned property with a large clear-cut parcel (RM 7.7-8.25), which field crews attributed to the localized erosion in that area, as well as residential building on river-right with rip rap protecting it (RM 9.4). The downstream end of Reach 5 is locked into place by the Sear Creek Road bridge near RM 7, which also had bank armoring. The downstream section (RM 0-0.9) of Napeequa River Reach 1 snaked through a neighborhood on the river-left side and Tall Timber Ranch, a privately owned retreat center, on river-right. Development and modification to the riparian area/channel banks, including access routes from neighborhoods into the channel, caused bank instability in the reach. Riprap was observed in some locations.



**Figure 8. Photo of riprap protecting the Sears Creek Bridge around RM 7 (at the break of Reach 4 and Reach 5) on the mainstem of the White River.**

### 3.7 FISH PASSAGE BARRIERS

No anthropogenic fish passage barriers were observed in the mainstem channel or in either of the tributaries. White River Falls at RM 16.17 on the mainstem is a fish passage barrier, but was outside the study area extent (the base of the falls formed the upstream boundary of the study area). The lower White River falls (near RM 16.09) is understood to be a natural partial fish passage impediment, but not a full

barrier for all upstream migrating salmonids (Figure 9). Between RM 0.5-0.7 in Panther Creek there were two cascades features, a waterfall (estimated 12-foot drop height), and a channel spanning log creating a plunge pool (estimated 3.5-foot drop) that all likely provide some level of fish passage impediment, though were not explicitly evaluated for passage as they are natural features in the channel. The upstream reach break for Napeequa River Reach 1 consists of a waterfall with two drops, heights estimated at 3 and 6 feet. Survey crews observed fish attempting to pass the waterfall. A side channel in Napeequa River Reach 2 (near RM 2.1) consisted of an estimated 700-foot-long mix of cascade habitat units and waterfalls, with an estimated 30-feet of elevation change throughout the stretch. One fish was witnessed attempting to jump one of the falls in the section. In the designated mainstem there was a similar, but shorter (estimated 120-foot-long with 15-feet of elevation change) cascade section, located at RM 2.1.



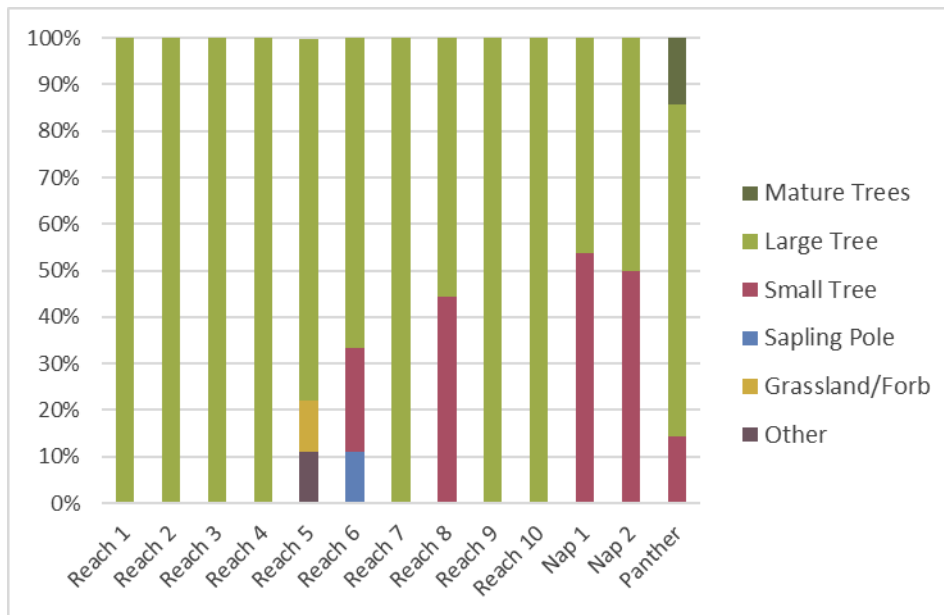
*Figure 9. An example of the natural fish passage impediments on the White River survey. This is the lower falls at White River falls, where the habitat survey stopped.*

### 3.8 RIPARIAN CORRIDOR

Foresters surveyed vegetation at select habitat units,  $n^{\text{th}}$  units and where a sudden change (compared to the previous habitat unit) in vegetation occurred. As per USFS guidelines,  $n^{\text{th}}$  channel units were units where additional measurements were taken, at a frequency of every fifth unit (20% of units), regardless of

unit type (2020). Vegetation surveys were included in the additional measurements performed at n<sup>th</sup> channel units. Of the 69 units measured (61 of which were n<sup>th</sup>) in the survey; the dominant (72%) overstory riparian vegetation size is large tree, that is trees with 21.0-31.9-inch diameter at breast height (dbh). Small trees (9.0-20.9-inch dbh) are the second most dominant with 22% of the total. Sapling/pole (5.0-8.9-inch dbh), grassland/forb, other, and mature trees (> 32-inch dbh) all make up 1% of the total overstory size class in the survey area (Figure 10). The dominant overstory species is cottonwood, which makes up 33% of the total overstory species surveyed. White/grand fir is the second most dominant with 22% of the total, followed by cedar, Douglas fir, and alder with 17%, 13%, and 9%, respectively (Figure 11).

Within the units measured, the dominant understory size class is shrub/seedling (1.0 -4.9-inch dbh), which makes up 83% of the understory size class for all the reaches. Grassland/forb is the second most prevalent size class with 13% of the total. Grassland/forb composition was dominated by reed canary grass in areas with high levels of current or past human disturbance, such as floodplain areas in the lower portion of the study area or areas affected by agricultural clearing. Less disturbed areas generally contained native Grassland/forb species. The least prevalent vegetation size classes were no vegetation and “other” with 3% and 1%, respectively (Figure 12). The dominant understory species is dogwood (39%), followed by alder and other/unknown, both of which make up 16% of the total understory species. Willow and vine/Douglas maple both make up 13% and cedar and quaking aspen both made up 1% of the total understory species (Figure 13).



**Figure 10. Percent composition of the dominant overstory size class for all units in which vegetation surveys were performed.**

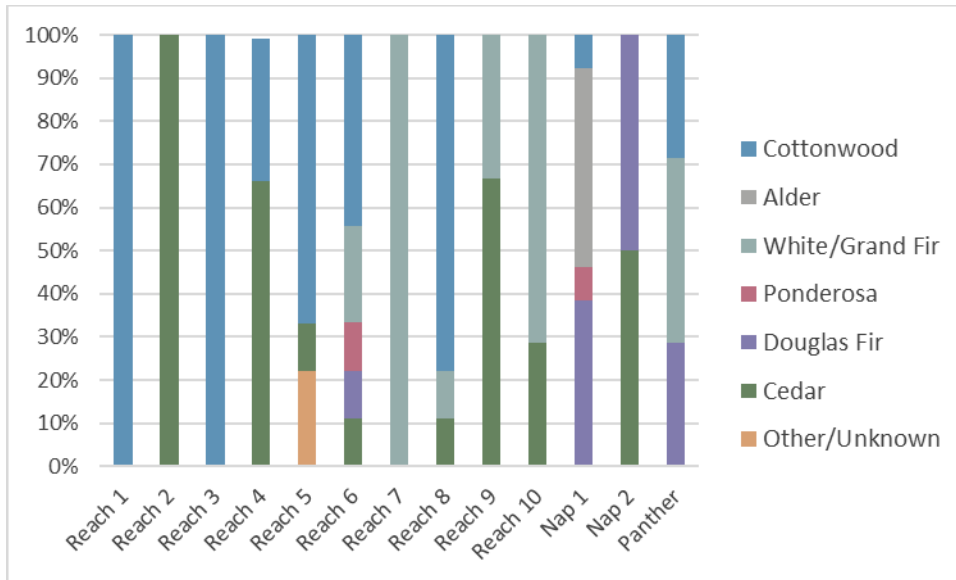


Figure 11. Percent composition of the dominant overstory species for all units in which vegetation surveys were performed.

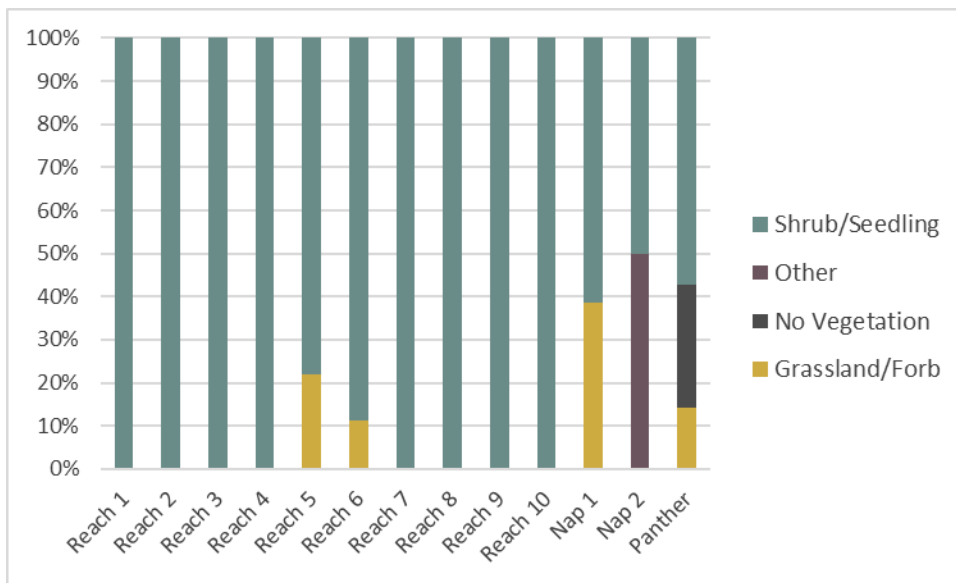
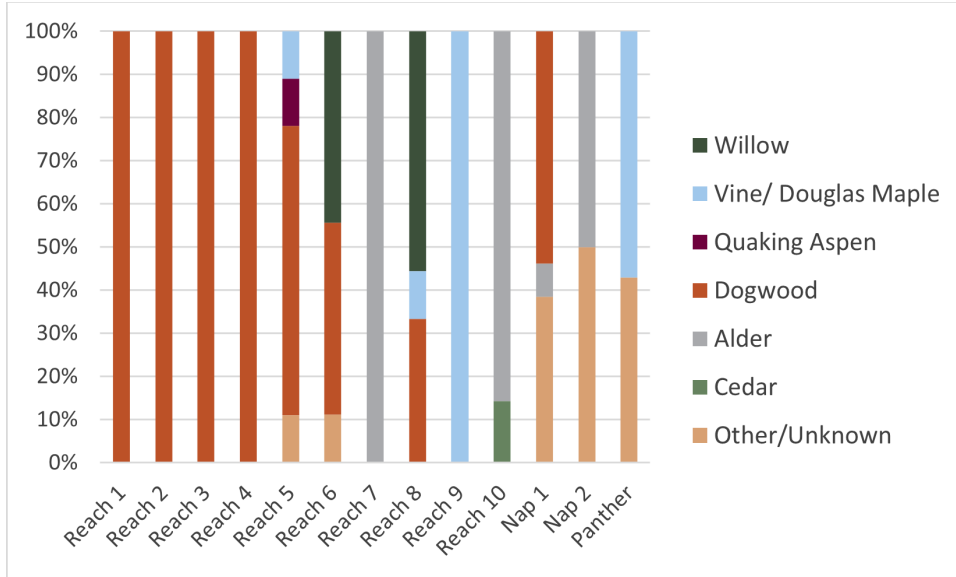


Figure 12. Percent composition of the dominant understory size class for all units in which vegetation surveys were performed.



**Figure 13. Percent composition of the dominant understory species for all units in which vegetation surveys were performed.**

## 4 Stream Habitat Reach Reports

### 4.1 REACH 1

**Location:** River mile 0 - 2.0

**Total length:** 2.0 miles

**Survey date:** August 1<sup>st</sup>, 2024



**Figure 14. Representative photo of Reach 1. Habitat units dominated by pools.**

#### 4.1.1 Habitat Unit Composition

Reach 1 is two miles long and is almost entirely (99.7%) pool habitat (Figure 17), largely due to the backwater effect of Lake Wenatchee in the reach. There is a channel spanning weir (Figure 15) located near RM 1.65 that makes up 0.3% of the reach habitat by area. The weir spans the entire width of the White River channel, and likely is not a full fish passage barrier except at very low flows, which may create a hydraulic drop at the structure that is difficult for smaller/juvenile fish to navigate. No side channels were present. There is a small amount of residential land use in the upstream river-left floodplain of the reach and the Little Wenatchee Road bridge crosses the White River at RM 2.0, coinciding with the end of the reach. The upstream portion of the channel in Reach 1 is incised, primarily from the Little Wenatchee Road bridge. Reach 1 has the lowest gradient of all the reaches at 0.02%.



***Figure 15. Channel spanning weir in Reach 1 near RM 1.65.***

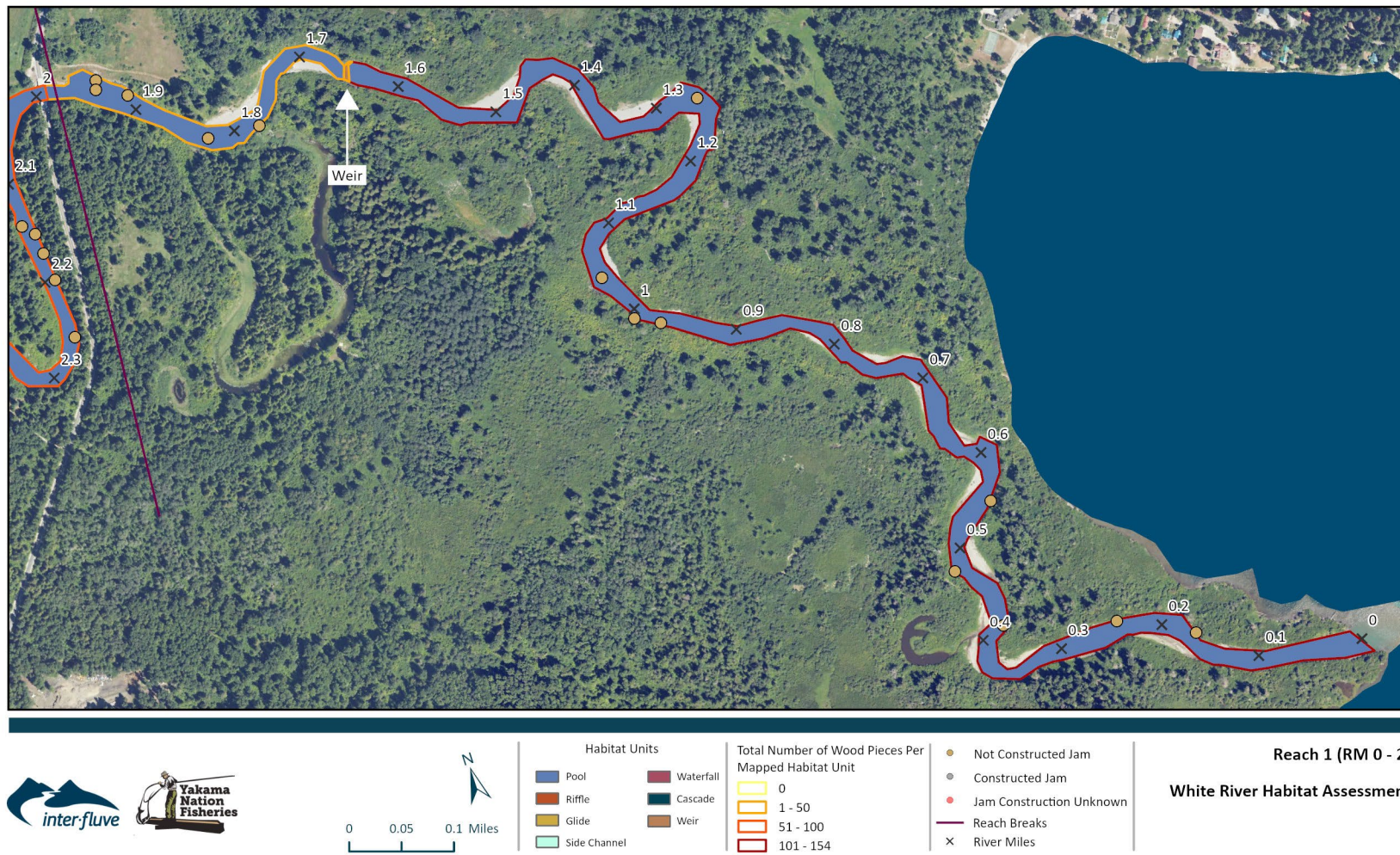
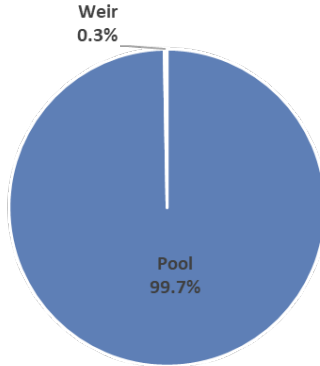


Figure 16. Map of the habitat unit composition and LWM in Reach 1 of the White River. LWM count does not include pieces in jams.



**Figure 17. Stream habitat unit area composition of Reach 1.**

#### **4.1.2 Pools**

Pool was the most prevalent habitat type in Reach 1, making up 99.7% of all the habitat area for the reach. Despite this, only two pool units were delineated, owing to the significant backwater effect from Lake Wenatchee in Reach 1. The two pool units were separated by a channel-spanning weir at RM 1.65. This is equivalent to 1 pool per mile, the lowest of any reach, although the backwater influence of Lake Wenatchee greatly affects the pool frequency. Mean pool spacing for the entire study area is 6 pools per mile. Both pools have a residual depth greater than or equal to six feet with an average of 10.8 feet, nearly seven feet deeper than the study area average of 4.1 feet. Reach 1 has one of the highest percentages of pool habitat by area, but the lowest number of pool units.

#### **4.1.3 Side Channel Habitat**

No connected side channels were observed in Reach 1. Throughout the study area there were historic and unconnected side channels, however, per USFS protocol they were not included in the habitat assessment (2020). See section 3.1.2 in the main report for details.

#### **4.1.4 Large Woody Material**

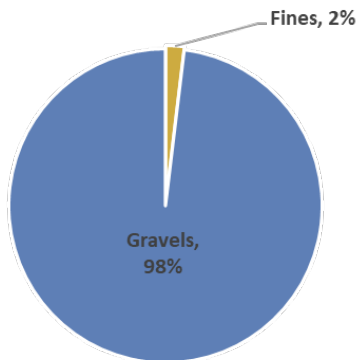
Reach 1 had one of the lowest quantities of LWM of all the reaches, with a combined (jams and individual pieces) total of 235 pieces – equating to 133 pieces per mile. There were 57 medium and large size class pieces per mile and 76 small pieces per mile. Fourteen jams were observed in Reach 1, amounting to 130 of those 235 total pieces of LWM in the reach (Table 3). The wood count for this reach is likely an undercount, as the high turbidity and depth made it difficult for the survey crew to view wood below the water surface.

**Table 3. Large woody material quantities in Reach 1.**

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of pieces	85	30	20	135
Number of pieces per mile	43	25		68
	Small (6 in x 20 ft)	Medium (12in x 35ft) and Large (20 in x 35 ft)		Total
Number of pieces per mile (including pieces in jams)	76	57		133
Number of jams	14			
Number of jams per mile	7			
Estimated Wood Count in Jams	130			

**4.1.5 Substrate & Fine Sediment**

Two gravel counts were performed in Reach 1, with a combined average of 98% gravel and 2% fines recorded (Figure 18). The first gravel count (GC01) was performed at a mid-channel bar in a transverse riffle crest near RM 1.63 and the second (GC02) was performed at a point bar near RM 1.83. The cumulative distribution curves and grain size class of the gravel counts completed in Reach 1 are provided below in Figure 19 - Figure 20 and Table 4.



**Figure 18. Combined percent sediment composition from the two gravel counts (GC01 and GC02) performed in Reach 1.**

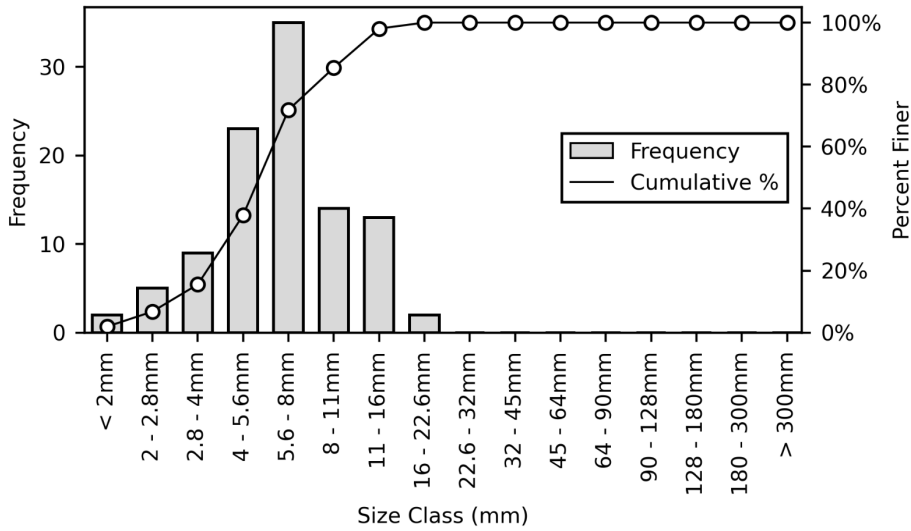


Figure 19. Cumulative distribution curve for GC01.

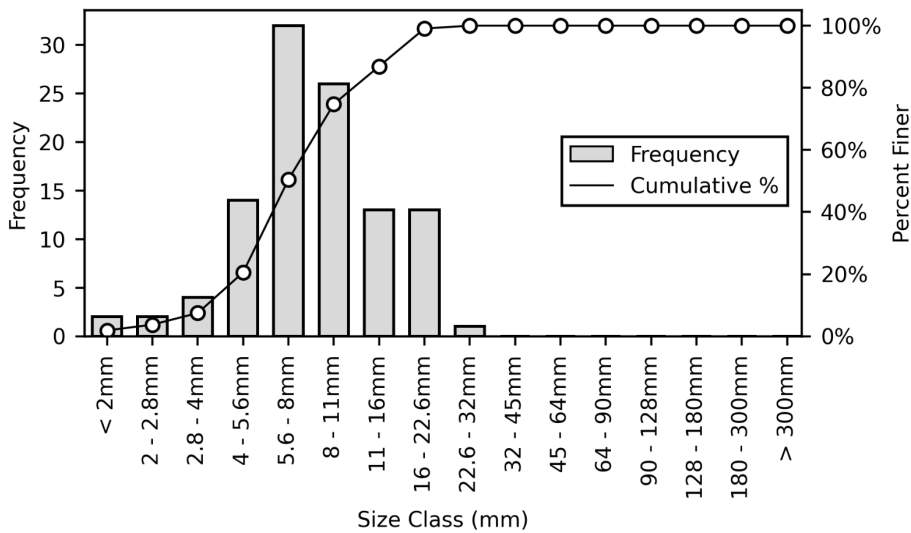


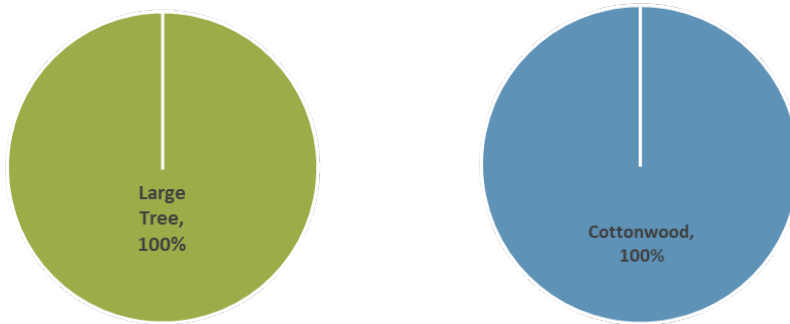
Figure 20. Cumulative distribution curve for GC02.

**Table 4. Grain size classes for GC01 and GC02 (assumed linear interpolation).**

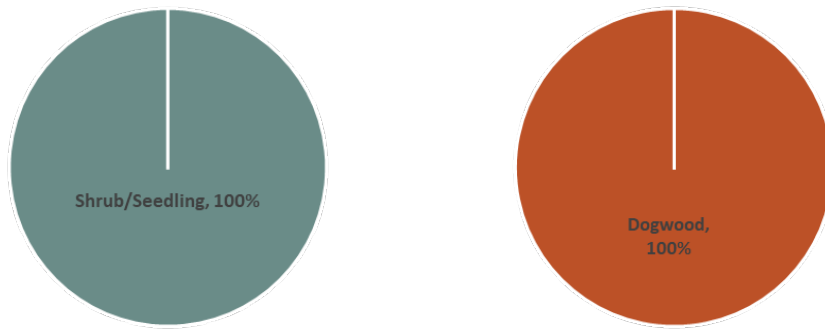
	<b>GC01</b>	<b>GC02</b>
<b>Size Class</b>	<i>Size percent finer than (mm)</i>	<i>Size percent finer than (mm)</i>
<b>D5</b>	2.1	3.2
<b>D16</b>	4.0	5.0
<b>D50</b>	6.5	8.0
<b>D84</b>	10.7	14.8
<b>D95</b>	14.8	20.4

#### 4.1.6 Riparian Corridor

Based on a single n<sup>th</sup> unit measurement taken in Reach 1, 100% of the overstory size class is large trees (21 - 31.9 inch diameter at breast height [dbh]). There were patches of large cottonwoods throughout the reach, but otherwise minimal overstory. The dominant (100%) overstory species is cottonwood (Figure 21). Dogwood makes up 100% of the understory species and shrub/seedling (1.0 - 4.9 inch dbh) is the dominant (100%) understory size class (Figure 22).



**Figure 21. Dominant overstory riparian vegetation class and species from one n<sup>th</sup> unit measurement based on ocular estimate.**



**Figure 22. Dominant understory riparian vegetation class and species from one  $n^{\text{th}}$  unit measurement based on ocular estimate.**

## 4.2 REACH 2

**Location:** River mile 2.0 - 4.13

**Total length:** 2.13

**Survey Date:** August 2<sup>nd</sup>, 2024



**Figure 23. Representative photo of Reach 2. Habitat is dominated by pool units.**

### 4.2.1 Habitat Unit Composition

Reach 2 is 2.13 miles long and consists of 100% pool units (Figure 25). Like Reach 1, there is some local incision on the downstream end from bank armoring of the Little Wenatchee River Road and the Little Wenatchee River Road bridge. With a gradient of 0.05%, Reach 2 has the second lowest gradient of all the reaches. This reach is also affected by the backwater influence of Lake Wenatchee.

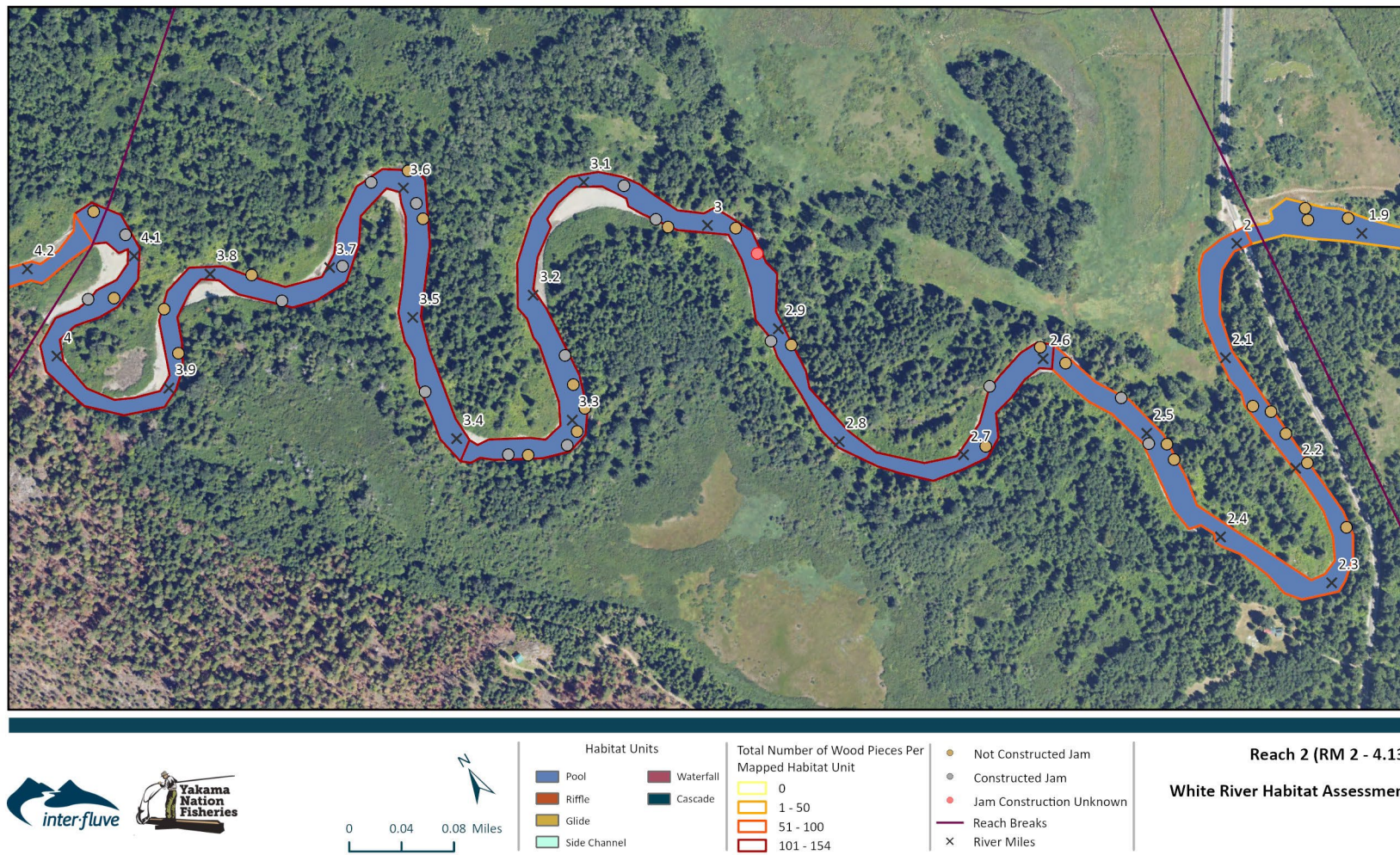
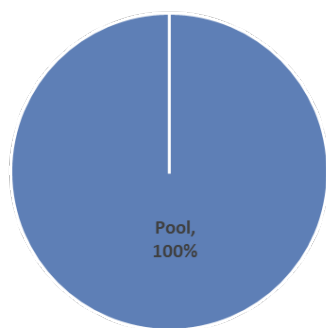


Figure 24. Map of the habitat unit composition and LWM in Reach 2 of the White River. LWM count does not include pieces in jams.



**Figure 25. Stream habitat unit area composition of Reach 2.**

**4.2.2 Pools**

Reach 2 consists entirely (100%) of pool habitat; however, only three pools were counted. One of the three pools has a residual depth greater than or equal to 6 feet, one has a residual depth between 3 and 6 feet, and one has a residual depth less than 3 feet. Residual depth ranges from 2.0 feet to 7.0 feet, with an average residual depth of 4.9 feet, compared to the study area average of 4.1 feet.

**4.2.3 Side Channel Habitat**

There were no side channels observed in Reach 2.

**4.2.4 Large Woody Material**

Reach 2 had 831 pieces of LWM total, equating to 390 pieces per mile. There were 208 medium and large LWM pieces (combined) per mile. Forty-one jams were observed in Reach 2, containing an estimated 468 pieces or 56% of the total number of LWM recorded in the reach (Table 5). As with Reach 1, this is likely an underestimate of the wood count due to lack of visibility beneath the water surface at the time of the survey.

**Table 5. Large woody material quantities in Reach 2.**

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of pieces	161	142	60	363
Number of pieces per mile	76	95		170
Number of pieces per mile (including pieces in jams)	182	208		390
Number of jams	41			
Number of jams per mile	19			
Estimated Wood Count in Jams	468			

**4.2.5 Substrate & Fine Sediment**

Two gravel counts were conducted in Reach 2. The combined average of the two counts shows the substrate is composed of 99% gravel and 1% fines. GC03 was performed at a riffle crest extending from a point bar near RM 3.13, and GC04 was conducted at a mid-channel gravel bar and riffle crest near RM

3.21. Both the cumulative distribution and grain size class can be found in Figure 27 - Figure 28 and Table 6.

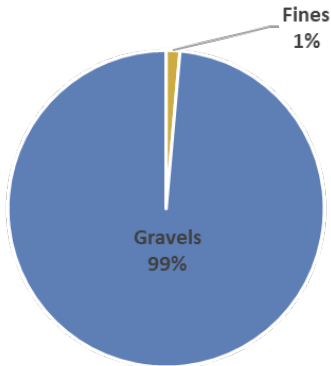


Figure 26. Combined percent sediment composition from the two gravel counts (GC03 and GC04) performed in Reach 2.

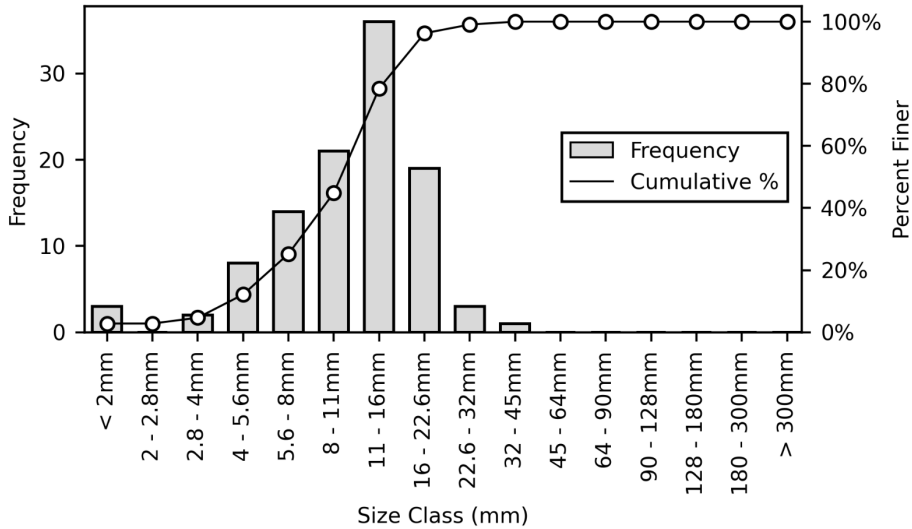


Figure 27. Cumulative distribution curve for GC03.

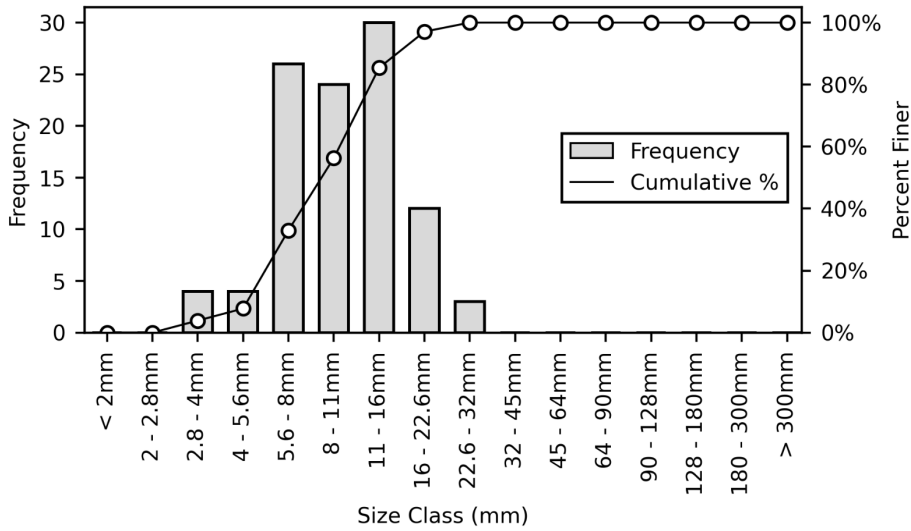


Figure 28. Cumulative distribution curve for GC04.

Table 6. Grain size class for GC03 and GC04 (assumed linear interpolation).

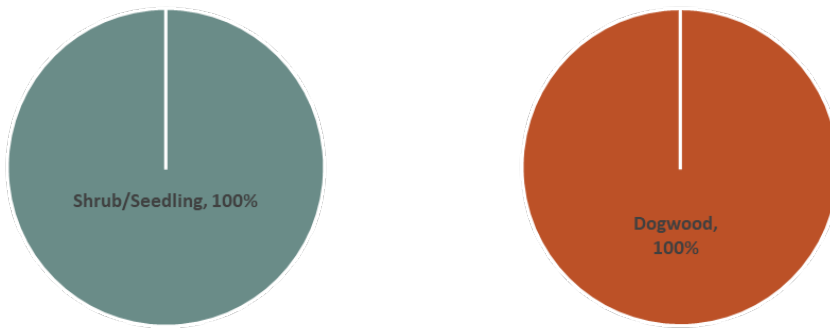
Size Class	GC03	GC04
	Size percent finer than (mm)	Size percent finer than (mm)
D5	4.1	4.5
D16	6.3	6.4
D50	11.8	10.2
D84	18.0	15.8
D95	22.1	21.4

#### 4.2.6 Riparian Corridor

Two n<sup>th</sup> unit measurements were recorded in Reach 2. The overstory size class in the riparian zone was entirely composed of large trees (21.0 - 31.9 inch dbh), which were all recorded as Western red cedar (Figure 29). The dominant (100%) understory size class was shrub/seedling (1.0 -4.9 inch dbh) and the dominant (100%) species was dogwood (Figure 30).



**Figure 29. Dominant overstory riparian vegetation class and species from two  $n^{\text{th}}$  unit measurements based on ocular estimate.**



**Figure 30. Dominant understory riparian vegetation class and species from two  $n^{\text{th}}$  unit measurements based on ocular estimate.**

### 4.3 REACH 3

**Location:** River mile 4.13 - 5.44

**Total length:** 1.31 miles

**Survey Date:** August 5<sup>th</sup>-6<sup>th</sup>, 2024



**Figure 31.** Representative photo of Reach 3. Habitat is dominated by pool units.

#### 4.3.1 Habitat Unit Composition

Reach 3 is 1.31 miles long and dominated by pool habitat (97%). Glide habitat made up the remaining 3%, with no riffles or side channels observed. The channel slope in Reach 3 remains relatively low at 0.07%, though is an increase in gradient compared to Reaches 1 and 2.

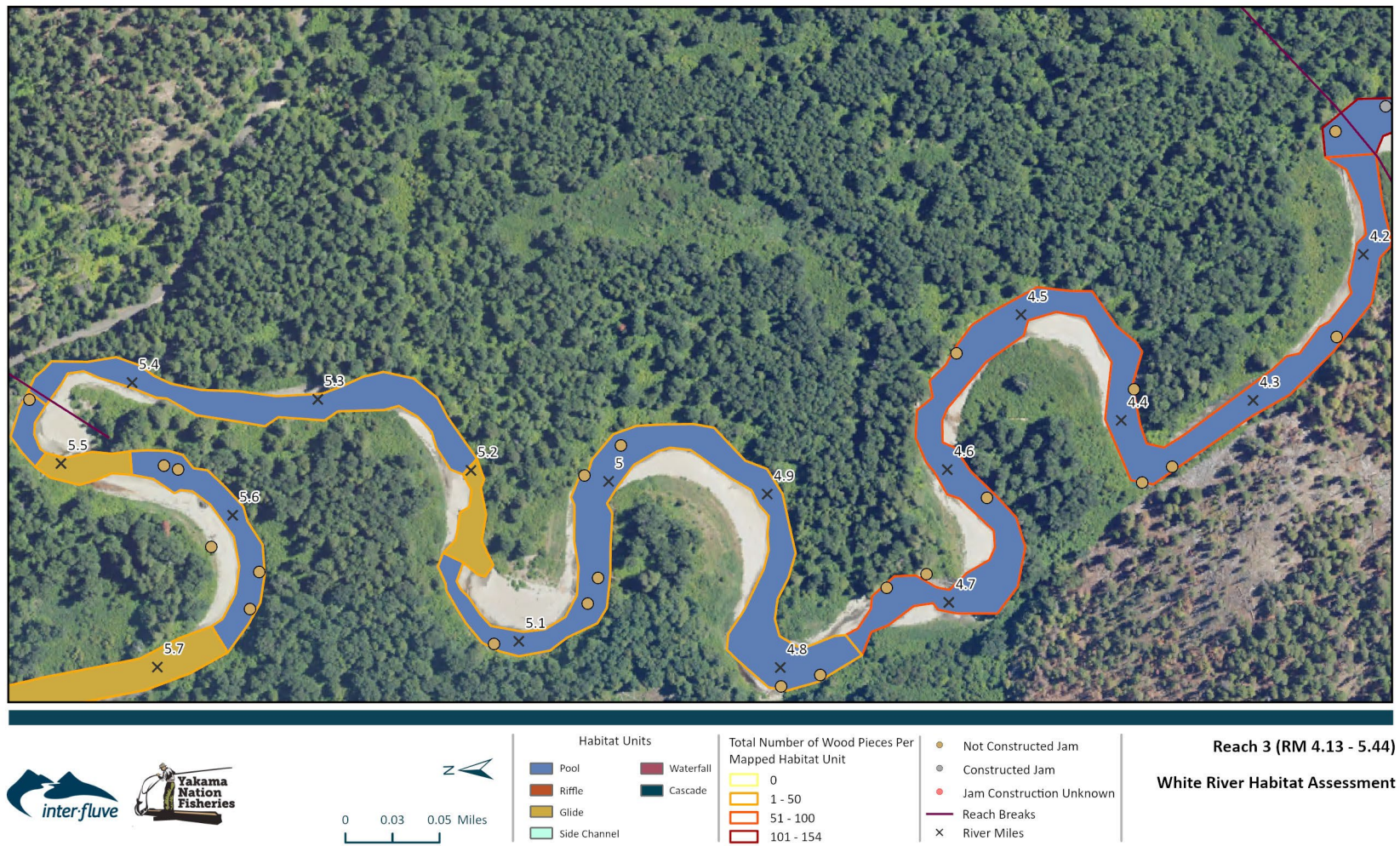
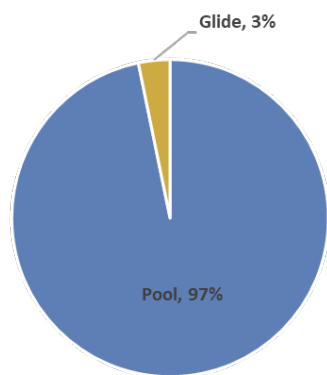


Figure 32. Map of the habitat unit composition and LWM in Reach 3 of the White River. LWM count does not include pieces in jams.



**Figure 33. Stream habitat unit area composition of Reach 3.**

### 4.3.2 Pools

A total of three pools were observed in Reach 3. This equates to two pools per mile, compared to the study area average of 6 pools per mile. Of the three pools counted, one (33%) has a residual depth greater than or equal to 6 feet, one (33%) has a residual depth between 3 and 6 feet, and one (33%) has a residual depth less than 3 feet. Residual depth for the reach ranges from 2.5 feet to 6.1 feet, with an average of 4.6 feet.

### 4.3.3 Side Channel Habitat

No side channels were observed in Reach 3.

### 4.3.4 Large Woody Material

Reach 3 had 360 total pieces of LWM, which amounts to 275 LWM pieces (jams and individual pieces combined) per mile. There were 151 combined medium and large pieces per mile. A total of 15 jams were recorded, containing an estimated 209 pieces (58%) of the LWM in Reach 3. Like Reaches 1 and 2, the wood count is likely an underestimate due to lack of visibility beneath the water surface during the survey.

**Table 7. Large woody material quantities in Reach 3.**

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of pieces	74	54	23	151
Number of pieces per mile	57	59		115
Number of pieces per mile (including pieces in jams)	124	151		275
Number of jams	15			
Number of jams per mile	12			
Estimated Wood Count in Jams	209			

### 4.3.5 Substrate & Fine Sediment

The two gravel counts performed in Reach 3 recorded 100% gravel. The first gravel count (GC05) was conducted at a riffle crest near RM 4.50 and the second (GC06) at a lateral bar near RM 5.20. Figure 35 - Figure 36 and Table 8 show the cumulative distribution and grain size class of both gravel counts.

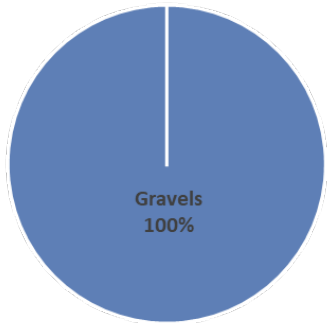


Figure 34. Combined percent sediment composition from the two gravel counts performed in Reach 3.

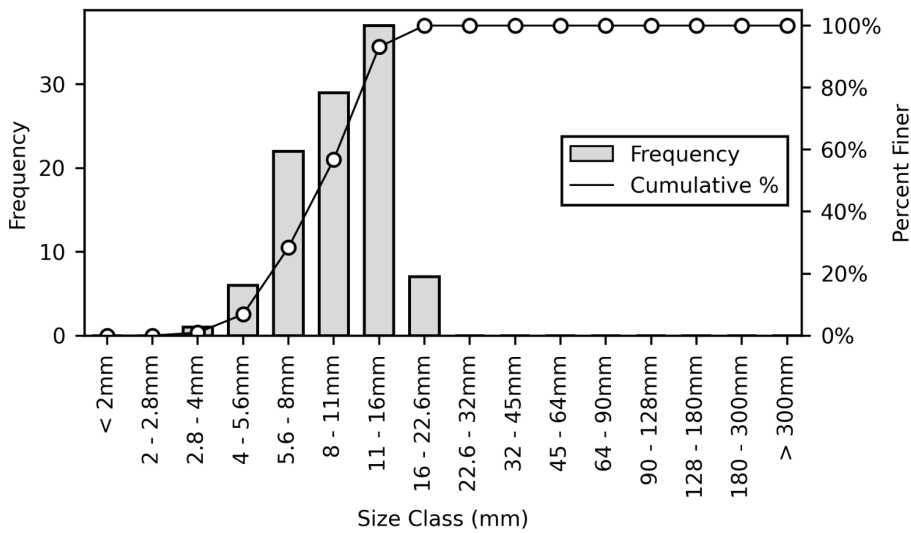


Figure 35. Cumulative distribution curve for GC05.

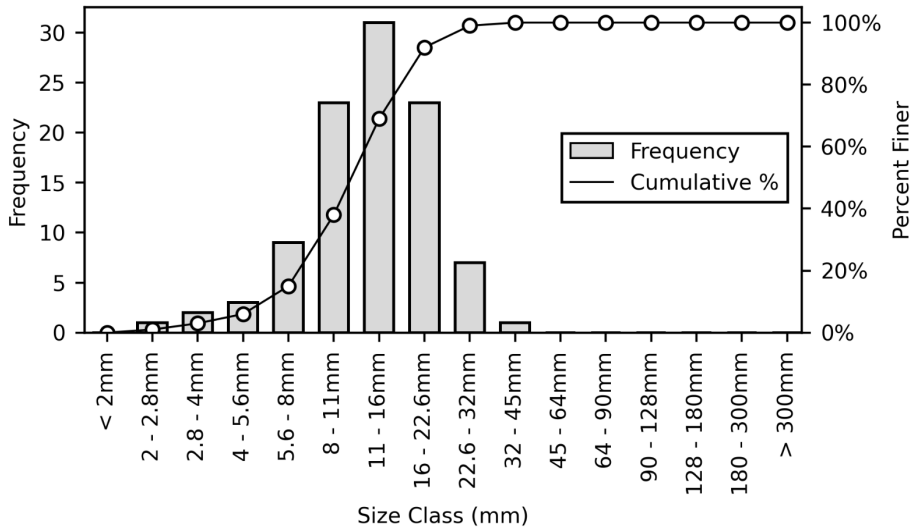


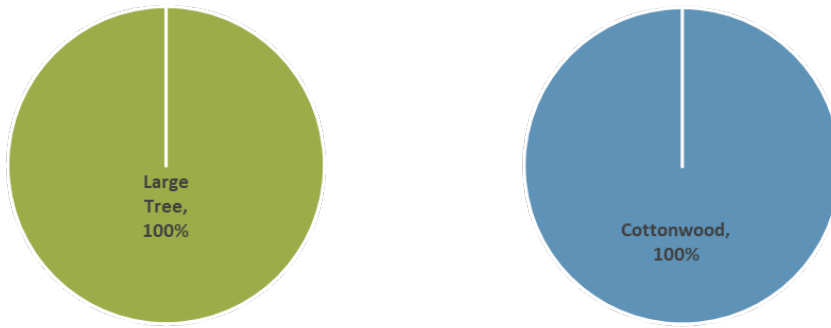
Figure 36. Cumulative distribution curve for GC06.

Table 8. Grain size class for GC05 and GC06 (assumed linear interpolation).

Size Class	GC05	GC06
	Size Percent Finer than (mm)	Size Percent Finer than (mm)
D5	5.1	5.1
D16	6.6	8.1
D50	10.3	12.9
D84	14.7	20.3
D95	17.8	26.6

#### 4.3.6 Riparian Corridor

A single n<sup>th</sup> unit measurement was taken in Reach 3, in which the overstory size class consisted of entirely large trees (21.0 - 31.9 inch dbh), see Figure 37. Cottonwood was recorded as the overstory species (Figure 37). The dominant (100%) understory size class is shrub/seedling (1.0 -4.9-inch dbh) and the dominant (100%) species is dogwood (Figure 38).



**Figure 37. Dominant overstory riparian vegetation class and species from one  $n^{\text{th}}$  unit measurement based on ocular estimate.**



**Figure 38. Dominant understory riparian vegetation class and species from one  $n^{\text{th}}$  unit measurement based on ocular estimate.**

## 4.4 REACH 4

**Location:** River mile 5.44-7.0

**Total length:** 1.56 miles

**Survey Date:** August 7<sup>th</sup>-8<sup>th</sup>, 2024



**Figure 39.** *Representative photo of Reach 4. Habitat is dominated by pool units.*

### 4.4.1 Habitat Unit Composition

Reach 4 is 1.56 miles long and dominated by pool habitat, with 89% of the total area recorded as pool. Glides make up the remaining 11% (Figure 41). No side channels or riffles were observed in Reach 4, and it has a gradient of 0.09%.

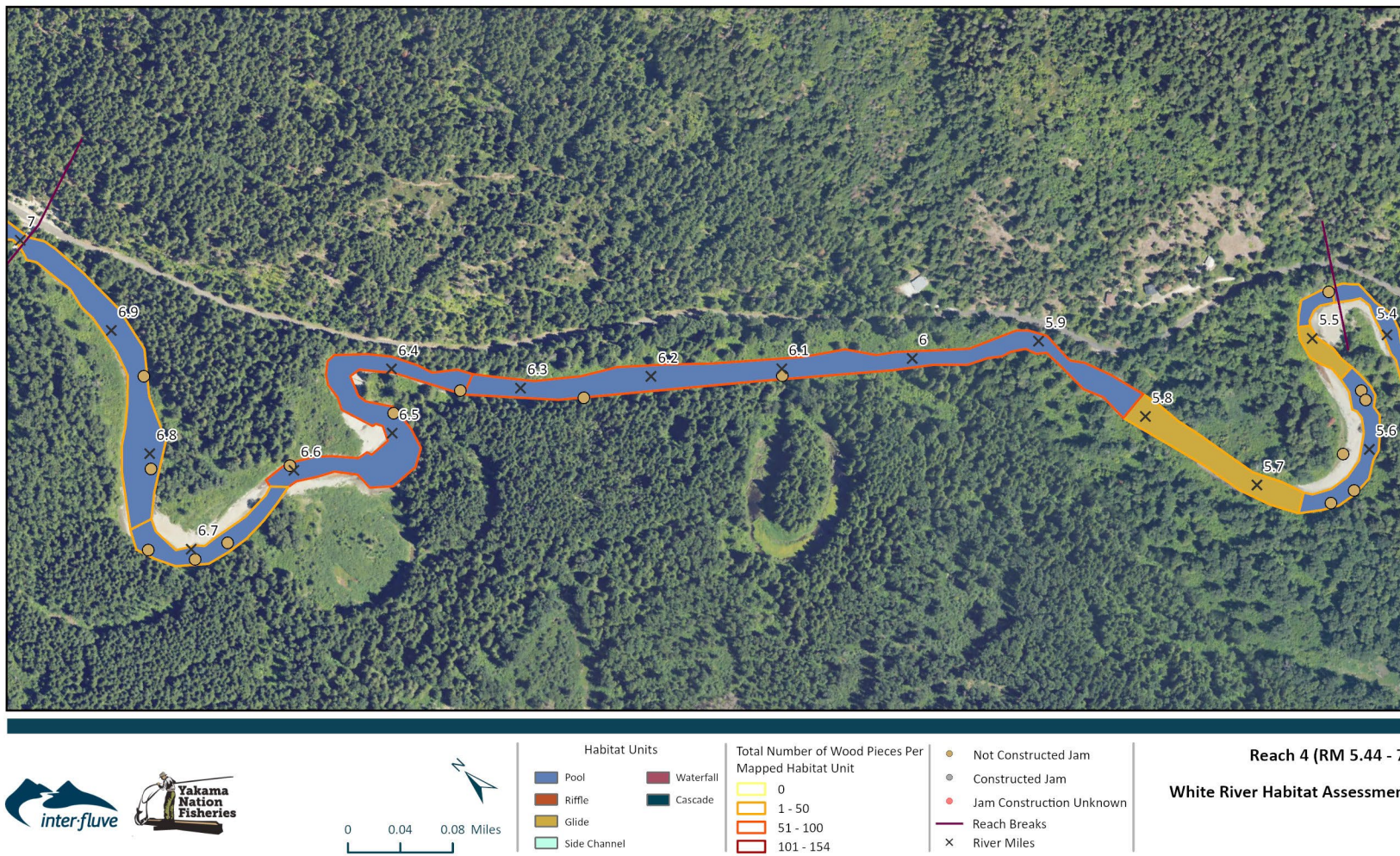
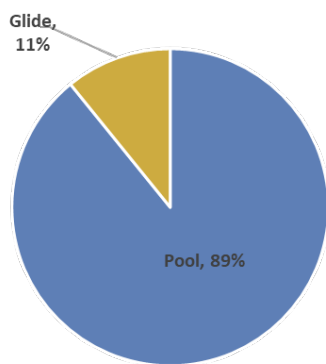


Figure 40. Map of the habitat unit composition and LWM in Reach 4 of the White River. LWM count does not include pieces in jams.



**Figure 41. Stream habitat unit area composition of Reach 4.**

#### 4.4.2 Pools

A total of six pool units were counted in Reach 4. Mean pool spacing for the reach was four pools per mile (compared to the study area average of six pools per mile). A third of the pools (33%) had a residual depth greater than or equal to 6 feet, and 67% had a residual depth between 3 and 6 feet. The average residual depth of the pools was 5.5 feet, ranging from 3.3 feet to 7.5 feet. The mean residual depth for the whole study area was 4.1 feet.

#### 4.4.3 Side Channel Habitat

No side channels were observed in Reach 4.

#### 4.4.4 Large Woody Material

A total of 395 pieces of LWM, equating to 253 pieces of LWM per mile, were observed in Reach 4. Sixteen jams were observed, containing 38% (n = 150) of the total LWM recorded. There were 129 medium and large pieces combined per mile (Table 9).

**Table 9. Large woody material quantities in Reach 4.**

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of pieces	134	71	40	245
Number of pieces per mile	86	46		157
Number of pieces per mile (including pieces in jams)	124	129		253
Number of jams	16			
Number of jams per mile	10			
Estimated Wood Count in Jams	150			

#### 4.4.5 Substrate & Fine Sediment

Two gravel counts (GC07 and GC08) were conducted in Reach 4, both at riffle crests near RM 5.81 (GC07) and RM 6.75 (GC08). The combined average of the two gravel counts reveals the substrate is 99.5% gravel and 0.5% fines. Figure 43 - Figure 44 and Table 10 show the cumulative distribution and grain size class of both gravel counts in Reach 4.

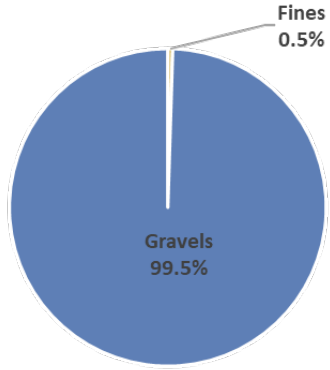


Figure 42. Combined percent sediment composition from the two gravel counts (GC07 and GC08) performed in Reach 4.

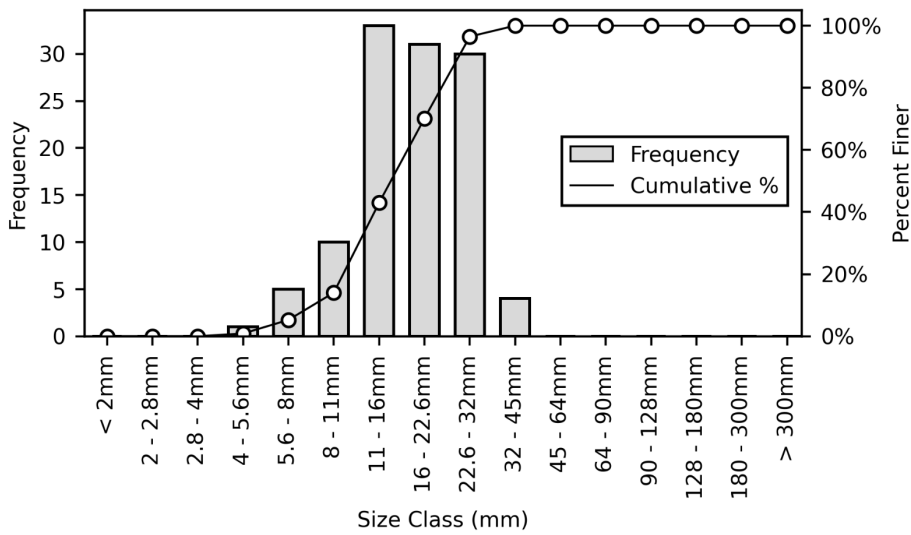


Figure 43. Cumulative distribution curve for GC07.

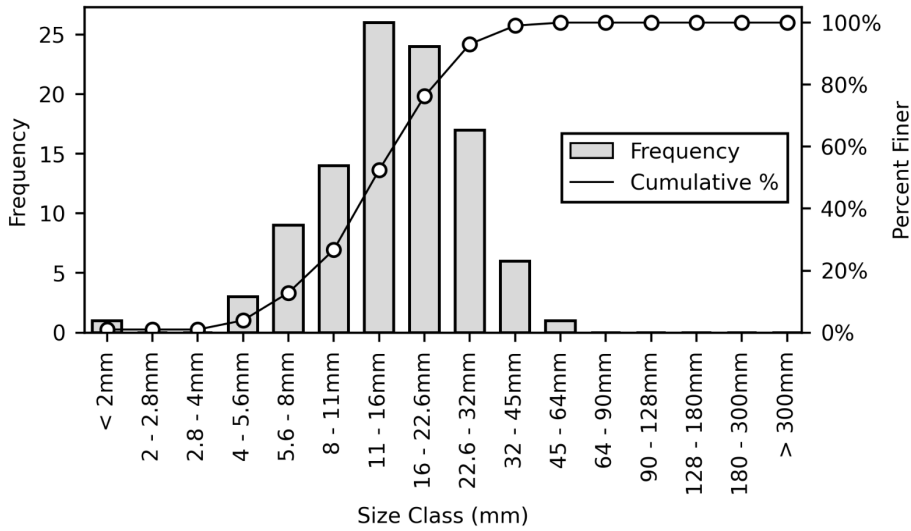


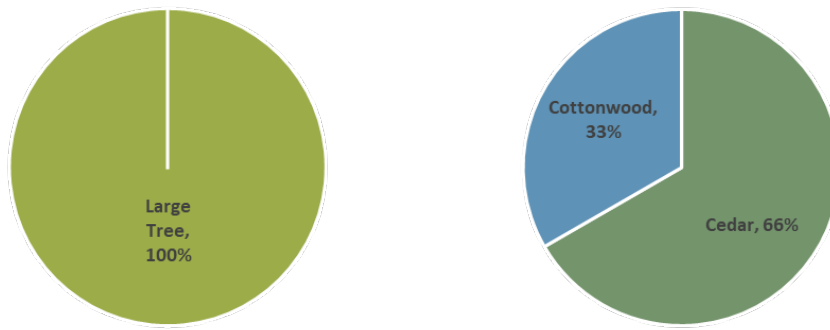
Figure 44. Cumulative distribution curve for GC08.

Table 10. Grain size class for GC07 and GC08 (assumed linear interpolation).

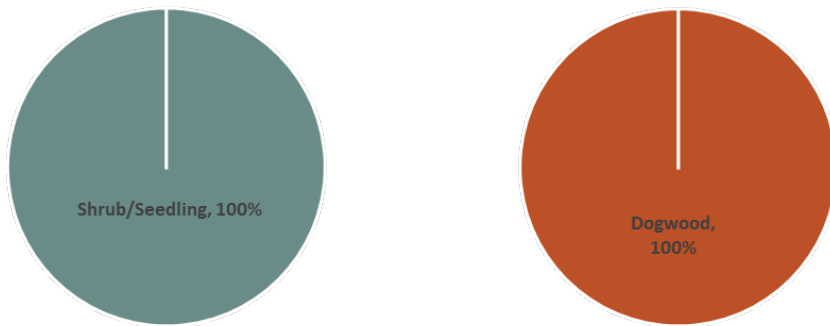
	GC07	GC08
Size Class	Size Percent Finer than (mm)	Size Percent Finer than (mm)
D5	7.9	5.9
D16	11.3	8.7
D50	17.7	15.5
D84	27.5	26.9
D95	31.5	36.2

#### 4.4.6 Riparian Corridor

Three n<sup>th</sup> unit measurements were recorded in Reach 4. The primary (100%) overstory size class was large trees (21.0 - 31.9 inch dbh). Western red cedar was the dominant overstory species (66%) surveyed with cottonwood recorded for the remaining 33% of units (Figure 45). As with Reaches 1 - 3, the dominant understory size class was shrub/seedling (1.0 - 4.9 inch dbh) and the dominant understory species (100%) was dogwood (Figure 46).



**Figure 45. Dominant overstory riparian vegetation class and species, based on three  $n^{\text{th}}$  unit surveys, within 100 feet of the White River by ocular estimate.**



**Figure 46. Dominant understory riparian vegetation class and species, based on three  $n^{\text{th}}$  unit surveys, within 100 feet of the White River by ocular estimate.**

## 4.5 REACH 5

**Location:** River mile 7.0 - 9.52

**Total length:** 2.52 miles

**Survey Date:** August 9<sup>th</sup> and August 13<sup>th</sup>, 2024



**Figure 47.** Representative photo of Reach 5. Habitat is dominated by pool units.

### 4.5.1 Habitat Unit Composition

Reach 5 is the longest reach in the lower White River study area at 2.52 miles. Channel gradient increases in Reach 5 compared to downstream reaches, with a slope of 0.18%. Aquatic habitat in Reach 5 is dominated by pool habitat, with 91.4% of the total area being pool habitat, followed by glides which make up 7.4%. Reach 5 is where the first side channel habitat was observed, which accounted for 1.2% of the total area (Figure 49).

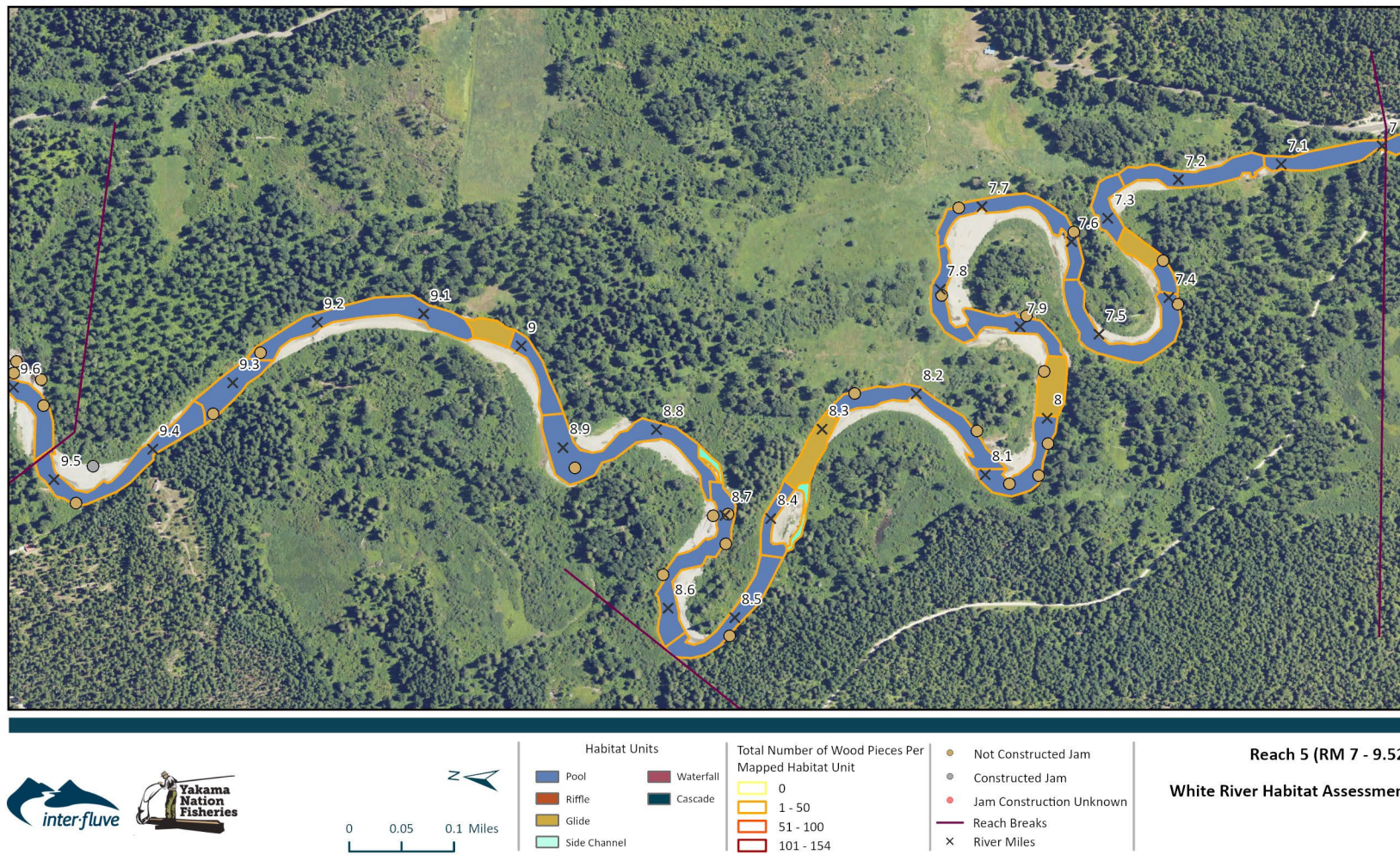
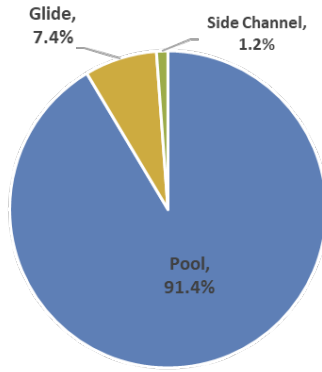


Figure 48. Map of the habitat unit composition and LWM in Reach 5 of the White River. LWM count does not include pieces in jams.



**Figure 49. Stream habitat unit area composition of Reach 5.**

**4.5.2 Pools**

Reach 5 has a total of 18 pools recorded. Mean pool spacing is seven pools per mile, higher than the six pools per mile average across the entire study area. Most of the pools (61%) have a residual depth between 3 and 6 feet, while 28% have a residual depth greater than or equal to 6 feet. Only 11% have a residual depth less than 3 feet. The average residual depth for Reach 5 is 4.6 feet, with a minimum of 1.5 feet and a maximum of 8.0 feet. The mean residual depth for the whole study area is 4.1 feet.

**4.5.3 Side Channel Habitat**

Two side channels were observed in Reach 5, with a total length of 572 feet. One side channel (Side 2) was predominantly fast water (e.g., riffles and glide habitat), and one side channel (Side 1) was mostly slow water (pool-type habitat) at the time of the survey. A total of 11 pieces of LWM were observed in the two side channels (Table 11).

**Table 11. Summary of the side channel habitat observed in Reach 5.**

Location	Length (ft)	Dominant unit type	Wood count	Jam Count	Wood Count in Jams
Side 1	365	Side Slow	9	0	0
Side 2	207	Side Fast	2	0	0
Total	572		11	0	0

**4.5.4 Large Woody Material**

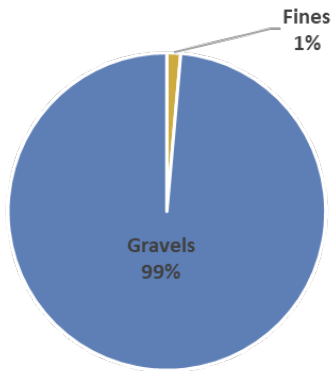
Reach 5 had 635 total pieces of LWM, including wood counted in jams, which equates to 252 pieces per mile. There were 121 (48%) pieces of medium and large wood (combined) per mile. Twenty-two jams were counted, containing 38% (n = 242) of the total number of LWM pieces observed in the reach (Table 12).

**Table 12. Large woody material quantities in Reach 5.**

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of pieces	222	111	60	393
Number of pieces per mile	88	68		156
Number of pieces per mile (including pieces in jams)	131	121		252
Number of jams	22			
Number of jams per mile	9			
Estimated Wood Count in Jams	242			

**4.5.5 Substrate & Fine Sediment**

The substrate in Reach 5 is dominated by gravel (99%), with a small percentage of fines (1%), based on two gravel counts (GC09 and GC10). Both gravel counts were performed at representative riffle crests near RM 7.96 and RM 8.74. The cumulative distribution curves and grain size class can be found in Figure 51 - Figure 52 and Table 13 below.



**Figure 50. Sediment composition from the two gravel counts (GC09 and GC10) performed in Reach 5.**

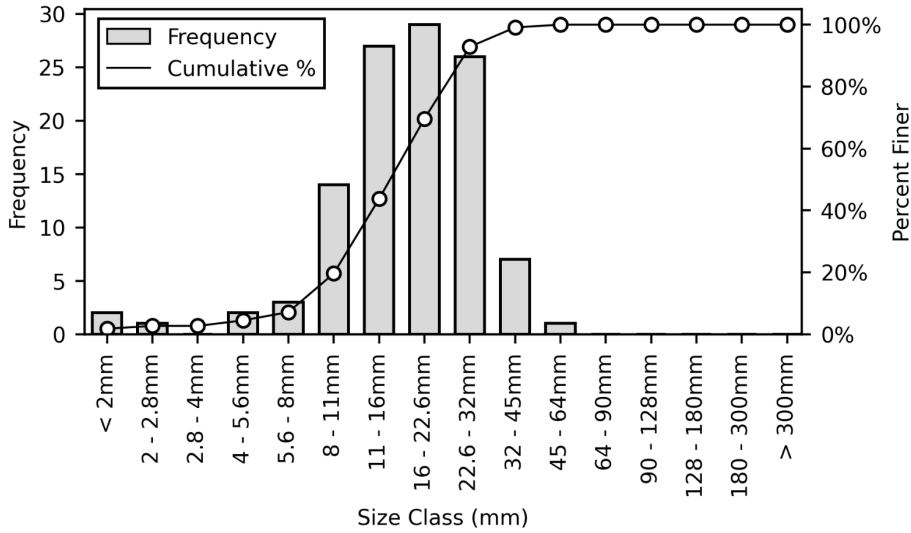


Figure 51. Cumulative distribution curve for GC09.

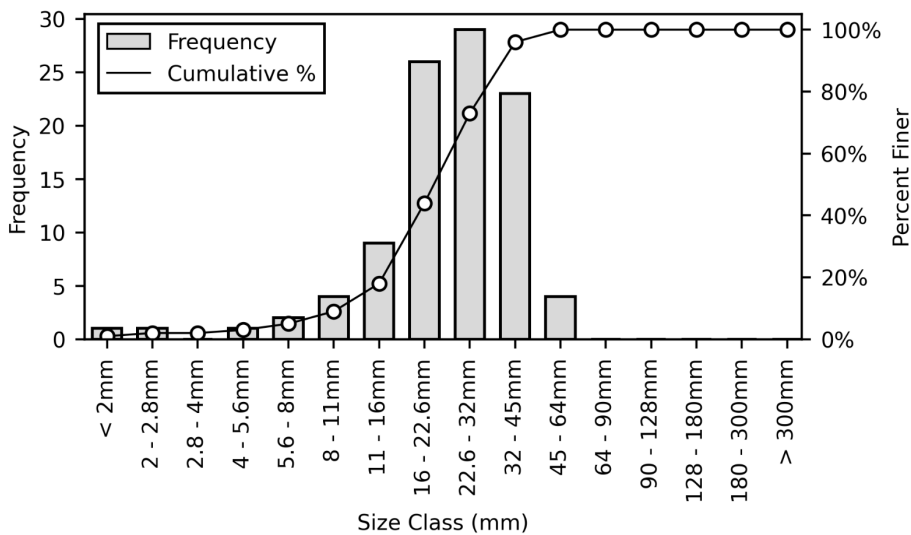


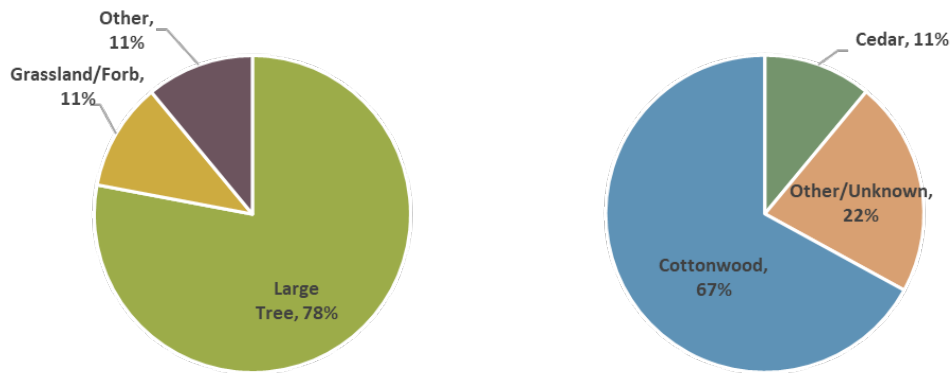
Figure 52. Cumulative distribution curve for GC10.

**Table 13. Grain size class for GC09 and GC10 (assumed linear interpolation).**

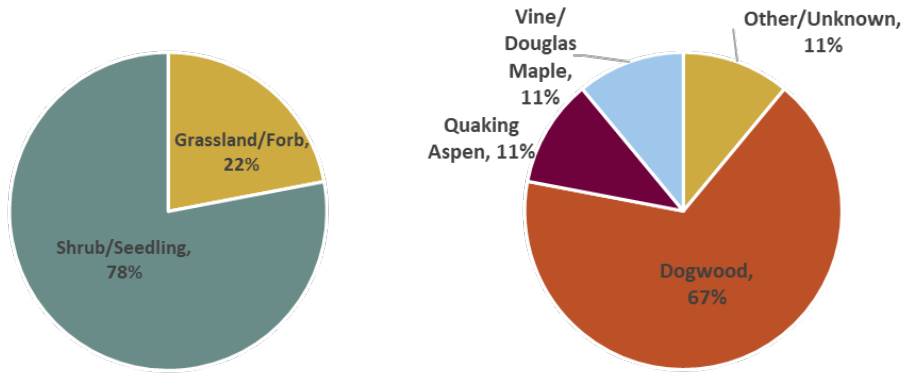
Size Class	GC09	GC10
	Size Percent Finer than (mm)	Size Percent Finer than (mm)
D5	6.08	8.00
D16	10.13	14.89
D50	17.59	24.54
D84	28.41	38.22
D95	36.46	44.43

#### 4.5.6 Riparian Corridor

Nine of the channel units in Reach 5 included ocular assessments of riparian vegetation. In addition to documentation of vegetation as a part of n<sup>th</sup> units (n = 5), four additional units documented vegetation conditions within 100 feet of the White River due to major changes in vegetation conditions observed by the survey crews. The primary overstory size class was large trees (78%; 21.0 - 31.9 inch dbh), followed by grassland/forb (11%) and other (11%). Some overstory was designated as “Other” as it appeared to have been relatively recently clear-cut within the riparian zone. Cottonwood made up 67% of the dominant overstory species and other/unknown made up 22%, which described the overstory species in the clear-cut area. Cedar made up the remaining 11% of the overstory species (Figure 53). Shrub/seedling (1.0 - 4.9 inch dbh) was the primary understory size class (78%) and grassland/forb made up the remaining 22%. Dogwood was the dominant understory species in 67% of the units surveyed, with quaking aspen (11%), vine/Douglas maple (11%), and other/unknown (11%) making up the remainder (Figure 54).



**Figure 53. Dominant overstory riparian vegetation class and species, based on nine units surveyed, within 100 feet of the White River by ocular estimate.**



**Figure 54. Dominant understory riparian vegetation class and species, based on nine units surveyed, within 100 feet of the White River by ocular estimate.**

## 4.6 REACH 6

**Location:** River mile 9.52 - 11.65

**Total length:** 2.13 miles

**Survey Date:** August 14<sup>th</sup> - 15<sup>th</sup>, 2024



**Figure 55. Representative photo of Reach 6. Habitat is dominated by pool units. The outlet of a documented side channel (Side 6) is shown photo right.**

### 4.6.1 Habitat Unit Composition

Reach 6 spans 2.13 miles. Pools were the dominant habitat type in Reach 6, consisting of 79% of the total reach area. This is followed by glides (17%), then side channels (4%), and riffles (1%; Figure 57). This reach had the highest density of LWM per mile of all the White River reaches, with a total of 538 pieces per mile. Reach 6 had a stream gradient of 0.18%, same as Reach 5.

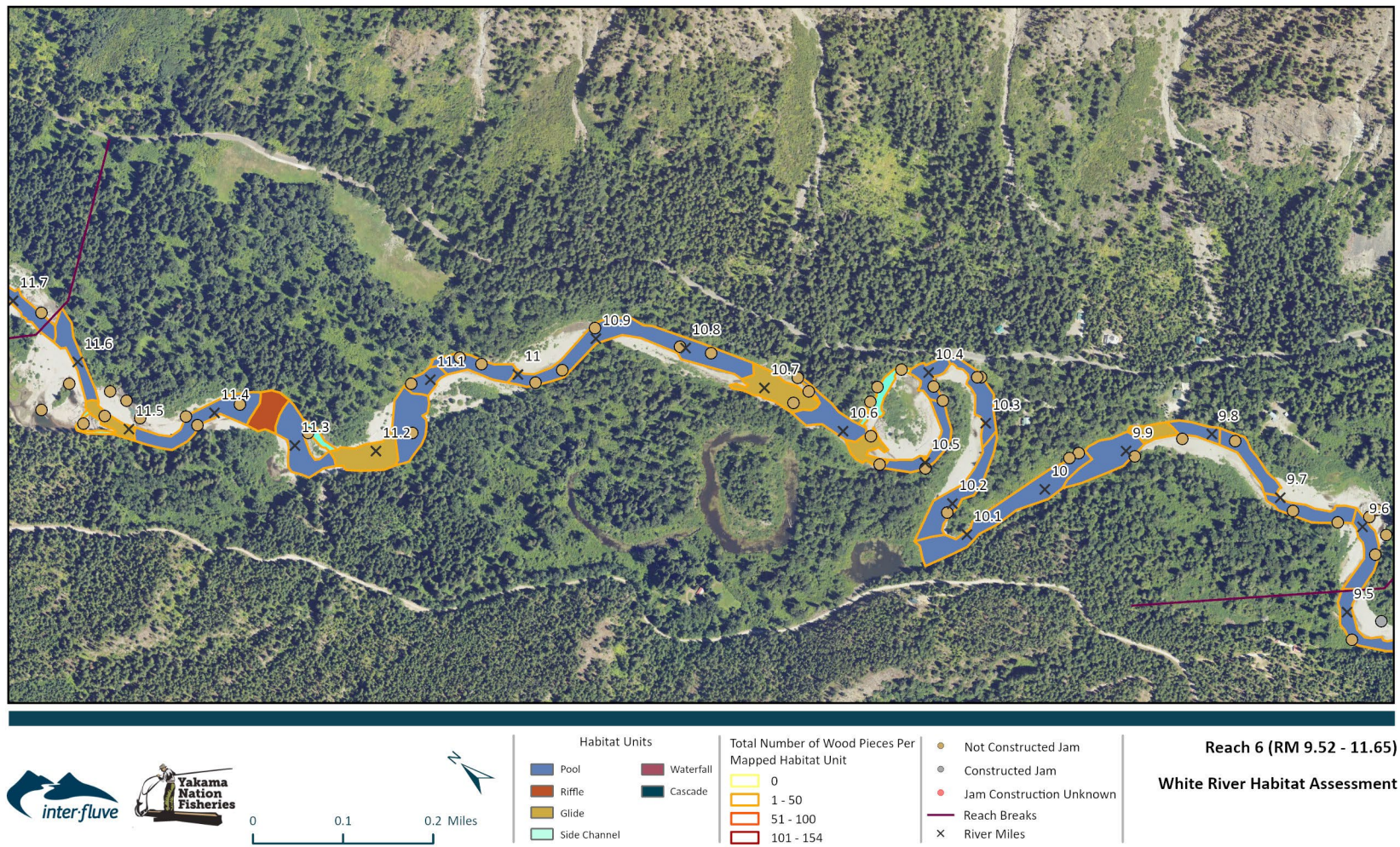
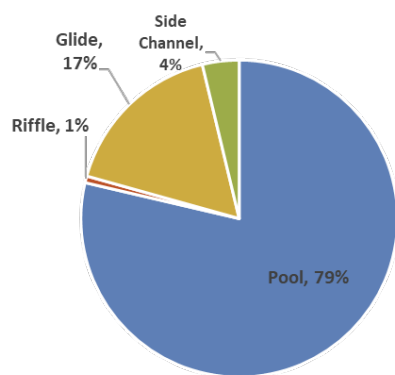


Figure 56. Map of the habitat unit composition and LWM in Reach 6 of the White River. LWM count does not include pieces in jams.



**Figure 57. Stream habitat unit area composition of Reach 6.**

#### 4.6.2 Pools

Reach 6 had a total pool count of 18, with five (28%) of those pools having a residual depth greater than or equal to 6 feet. Fifty-six percent had a residual depth between 3 and 6 feet, while the remaining 17% had less than 3 feet of residual depth. Residual depth in Reach 6 ranged from 2.7 to 8.1 feet, with an average of 6.5 feet (compared to 4.1 feet for the study area average). The mean pool spacing for this reach was eight pools per mile, higher than the study area average of six pools per mile.

#### 4.6.3 Side Channel Habitat

Three side channels were observed in Reach 6, with an total combined length of 1028 feet. One side channel was predominantly fast water, while the other two were predominantly slow water at the time of the survey. A total of 16 individual pieces of LWM and four jams with an estimated 67 pieces of LWM were observed in the three side channels (Table 14).

**Table 14. Summary of the side channel habitat observed in Reach 6.**

Location	Length (ft)	Dominant unit type	Wood count	Jam Count	Wood Count in Jams
Side 3	473	Side Fast	12	3	67
Side 4	217	Side Slow	3	0	0
Side 5	338	Side Slow	1	0	0
Total	1028		16	3	67

#### 4.6.4 Large Woody Material

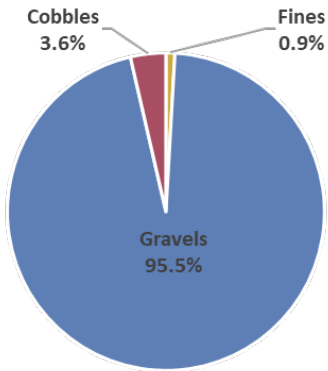
Reach 6 had the highest quantity of LWM of any mainstem White River reach. A total of 1,151 pieces of wood were observed, with a substantial majority (76%) of that LWM recorded within the documented wood jams. Reach 6 also had the most jams of any mainstem reach: 45 total, or roughly 21 jams per mile. There were 538 pieces of LWM per mile, with 257 of those pieces per mile being size small and 281 being size medium and large combined (Table 15).

**Table 15. Large woody material quantities in Reach 6.**

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of pieces	159	58	64	281
Number of pieces per mile	75	57		132
Number of pieces per mile (including pieces in jams)	257	281		538
Number of jams	45			
Number of jams per mile	21			
Estimated Wood Count in Jams	870			

**4.6.5 Substrate & Fine Sediment**

Two gravel counts were performed in Reach 6. Results from GC11 and GC12 are 95.5% gravel, 3.6% cobble, and 0.9% fines. One of the gravel counts (GC11) was performed at a riffle crest near RM 10.66 and the other (GC 12) was conducted at a riffle crest and mid-channel bar near RM 11.35. Figure 59 - Figure 60 and Table 16 show the cumulative distribution curves and grain size class of the two gravel counts in Reach 6.



**Figure 58. Combined percent sediment composition from the two gravel counts (GC11 and GC12) performed in Reach 6.**

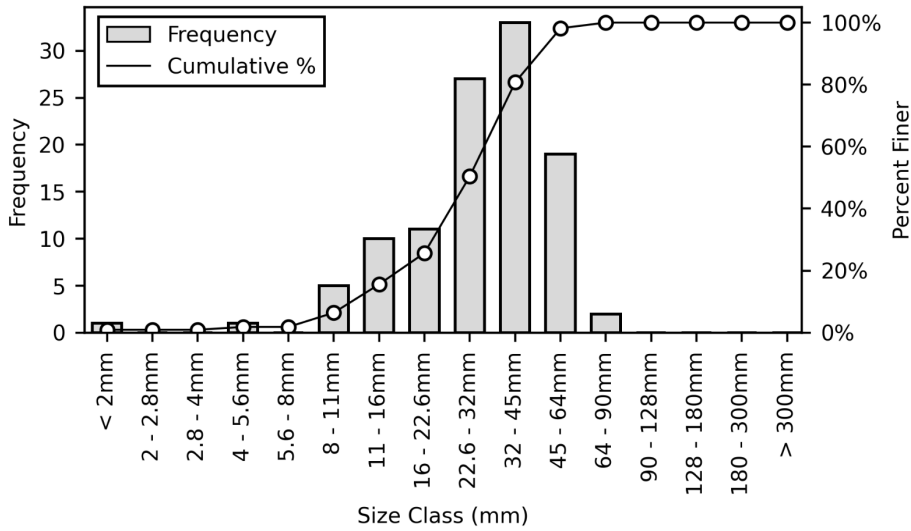


Figure 59. Cumulative distribution curve for GC11.

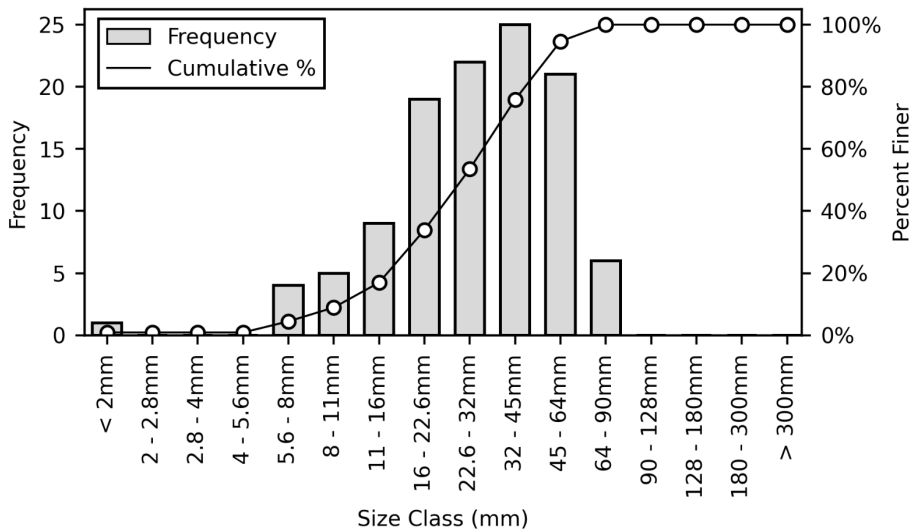


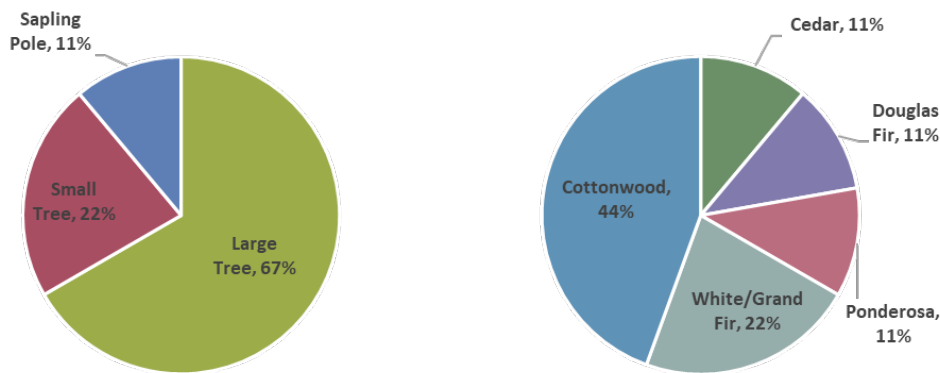
Figure 60. Cumulative distribution curve for GC12.

**Table 16. Grain size class for GC11 and GC12 (assumed linear interpolation).**

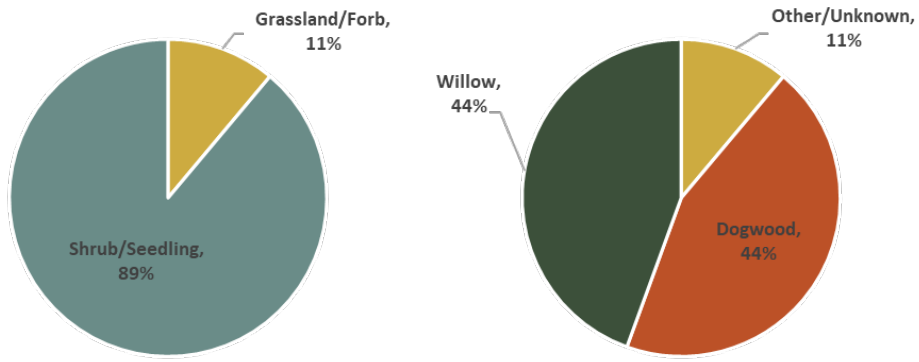
	<b>GC11</b>	<b>GC12</b>
<b>Size Class</b>	<i>Size Percent Finer than (mm)</i>	<i>Size Percent Finer than (mm)</i>
<b>D5</b>	10.1	8.4
<b>D16</b>	16.3	15.4
<b>D50</b>	31.8	30.3
<b>D84</b>	48.6	53.2
<b>D95</b>	60.6	65.7

#### 4.6.6 Riparian Corridor

Nine of the channel units in Reach 6 included ocular assessments of riparian vegetation. In addition to documentation of vegetation as a part of n<sup>th</sup> units (n = 8), one additional unit documented vegetation conditions within 100 feet of the White River due to major changes in vegetation conditions observed by the survey crew, in this case it was someone’s yard. Large trees (21.0 - 31.9 inch dbh) were the dominant overstory size class ( 67%), followed by small trees (22%; 9.0 - 20.9 inch dbh) and sapling/pole (11%; 5.0 - 8.9-inch dbh). The dominant overstory species was cottonwood (44%), followed by white/grand fir (22%), and ponderosa pine, Douglas fir and Western red cedar each with 11% (**Figure 61**). The understory size class was dominated by the shrub/seedling size class (89%; 1.0 - 4.9 inch dbh) and grassland/forb (11%). Dogwood and willow dominated the understory species, both in 44% of the units. Other/unknown was the dominant species for the remaining 11% (Figure 62), which surveyors assigned to the ornamental grasses and shrubs found in the yard that prompted a vegetation survey (mentioned above).



**Figure 61. Dominant overstory riparian vegetation class and species, based on nine surveyed units, within 100 feet of the White River by ocular estimate.**



**Figure 62. Dominant understory riparian vegetation class and species, based on nine surveyed units, within 100 feet of the White River by ocular estimate.**

## 4.7 REACH 7

**Location:** River mile 11.65 - 12.43

**Total length:** 0.78 miles

**Survey Date:** August 16<sup>th</sup>, 2024



**Figure 63.** *Representative photo of Reach 7. Habitat type is mainly pool units.*

### 4.7.1 Habitat Unit Composition

Reach 7 channel habitat consists of 73% pool habitat units, 25% glides, and 4% side channel habitat (Figure 65). At the upstream end of the reach, at the break between Reaches 7 and 8, the Napeequa River tributary enters the White River on the river left side. It brings in increased silt and suspended sediment, resulting in increased turbidity in Reach 7 and below. The White River's flow significantly increases as well in Reach 7, from the input of the Napeequa, and the tributary's input also acts as a source of coarse sediment. The reach is 0.78 miles long and has a stream gradient of 0.15%.

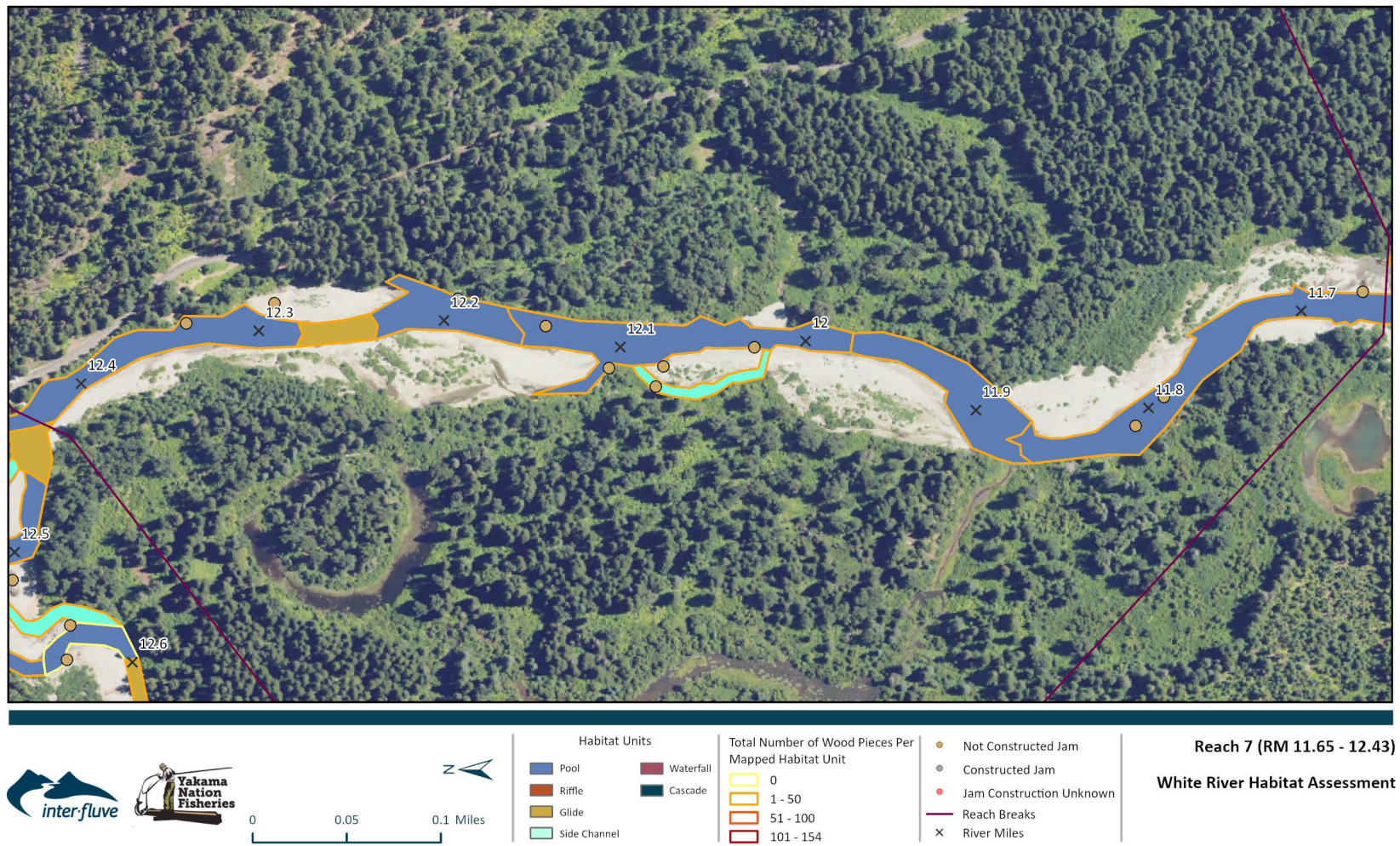
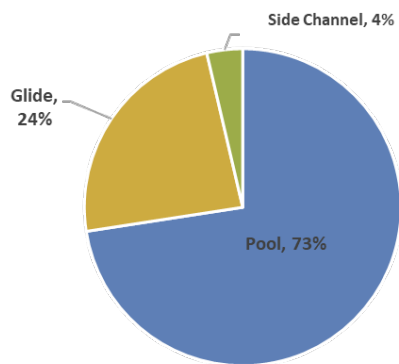


Figure 64. Map of the habitat unit composition and LWM in Reach 7 of the White River. LWM count does not include pieces in jams.



**Figure 65. Stream habitat unit area composition of Reach 7.**

#### 4.7.2 Pools

Only four pools were observed in Reach 7, though they covered a majority of the habitat area in the reach as noted above. Seventy-five percent of the pools have a residual depth between 3 and 6 feet, while the remaining 25% have a residual depth greater than or equal to 6 feet. Residual depths range from 4.0 feet to 6.3 feet, with an average of 4.8 feet. This is slightly higher than the study area average residual depth of 4.1 feet. Due to the relatively short length of this reach (0.78 miles), the pool frequency is approximately five pools per mile, less than the study area average of six pools per mile.

#### 4.7.3 Side Channel Habitat

One 449-foot-long side channel was observed in Reach 7. It was predominantly slow water and contained 12 pieces of LWM and one jam with an estimated 13 pieces of LWM (Table 17).

**Table 17. Summary of the side channel habitat observed in Reach 7.**

Location	Length (ft)	Dominant unit type	Wood count	Jam Count	Wood Count in Jams
Side 6	449	Side Slow	12	1	13
Total	449		12	1	13

#### 4.7.4 Large Woody Material

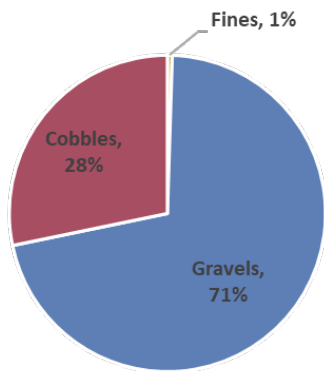
A total of 243 pieces, equating to 312 pieces per mile, were found in Reach 7. This count includes both individually-recorded pieces of LWM as well as the wood found in jams. The 11 jams in Reach 7 contained 48% of the wood. There were 163 medium and large pieces of wood combined per mile in Reach 7 (Table 18).

**Table 18. Large woody material quantities in Reach 7.**

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of pieces	66	32	29	127
Number of pieces per mile	85	78		163
Number of pieces per mile (including pieces in jams)	149	163		312
Number of jams	11			
Number of jams per mile	14			
Estimated Wood Count in Jams	116			

**4.7.5 Substrate & Fine Sediment**

Two gravel counts were conducted in Reach 7 at representative riffle crests near RM 11.90 (GC13) and RM 12.29 (GC14). Substrate was documented as primarily gravels (71%), followed by cobbles (28%), and fines (1%). Figure 67 - Figure 68 and Table 19 show the cumulative distribution and grain size class of both gravel counts conducted in Reach 7.



**Figure 66. Combined percent sediment composition from the two gravel counts (GC13 and GC 14) performed in Reach 7.**

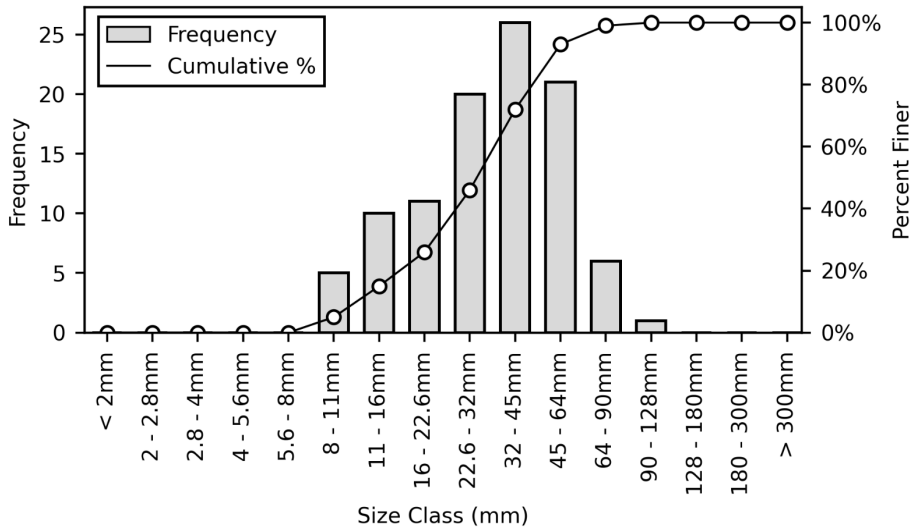


Figure 67. Cumulative distribution curve for GC13.

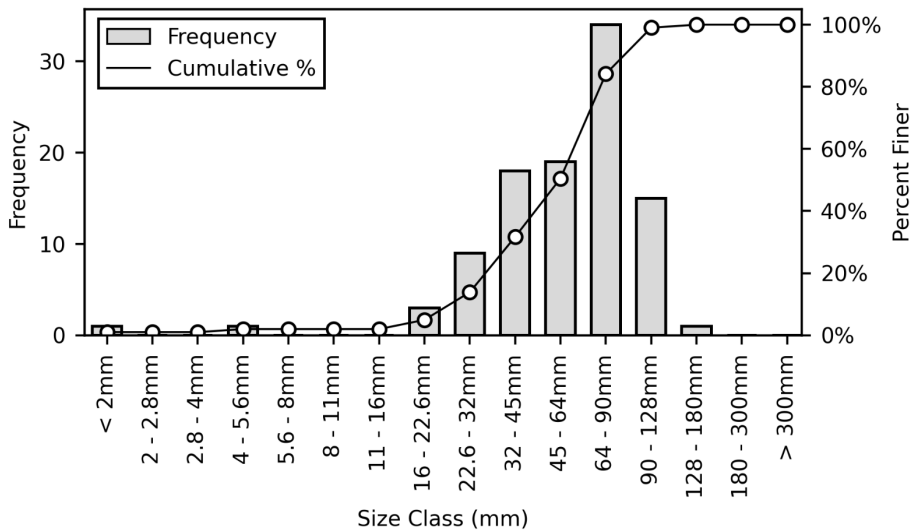


Figure 68. Cumulative distribution curve for GC14.

**Table 19. Grain size class for GC13 and GC014 (assumed linear interpolation).**

	<b>GC13</b>	<b>GC14</b>
<b>Size Class</b>	<i>Size Percent Finer than (mm)</i>	<i>Size Percent Finer than (mm)</i>
<b>D5</b>	11.0	22.7
<b>D16</b>	16.6	33.6
<b>D50</b>	34.0	63.5
<b>D84</b>	55.9	89.9
<b>D95</b>	72.7	117.7

**4.7.6 Riparian Corridor**

Based on the three n<sup>th</sup> units recorded in Reach 7, the overstory was dominated (100%) by large trees (21.0 - 31.9 inch dbh), all of which were documented as white/grand fir (Figure 69). The understory was dominated (100%) by alder in the shrub/seedling (1.0 - 4.9 inch dbh) size class (Figure 70).



**Figure 69. Dominant overstory riparian vegetation class and species, based on three n<sup>th</sup> units surveyed, within 100 feet of the White River by ocular estimate.**



**Figure 70. Dominant understory riparian vegetation class and species, based on three  $n^{\text{th}}$  units surveyed, within 100 feet of the White River by ocular estimate.**

## 4.8 REACH 8

**Location:** River mile 12.43 - 14.35

**Total length:** 1.92 miles

**Survey Date:** August 17<sup>th</sup> - 18<sup>th</sup>, 2024



**Figure 71. Representative photo of Reach 8. The primary habitat type was pool, with increased amount of fast water compared to downstream reaches.**

### 4.8.1 Habitat Unit Composition

The White River in Reach 8 was composed of a greater percentage of fast-water unit types than in downstream reaches, though pool habitat was still dominant at 61% pool habitat, followed by 23% glide habitat, 9% riffle habitat, and 7% side channel habitat (Figure 73). The stream gradient in this reach is 0.42%.

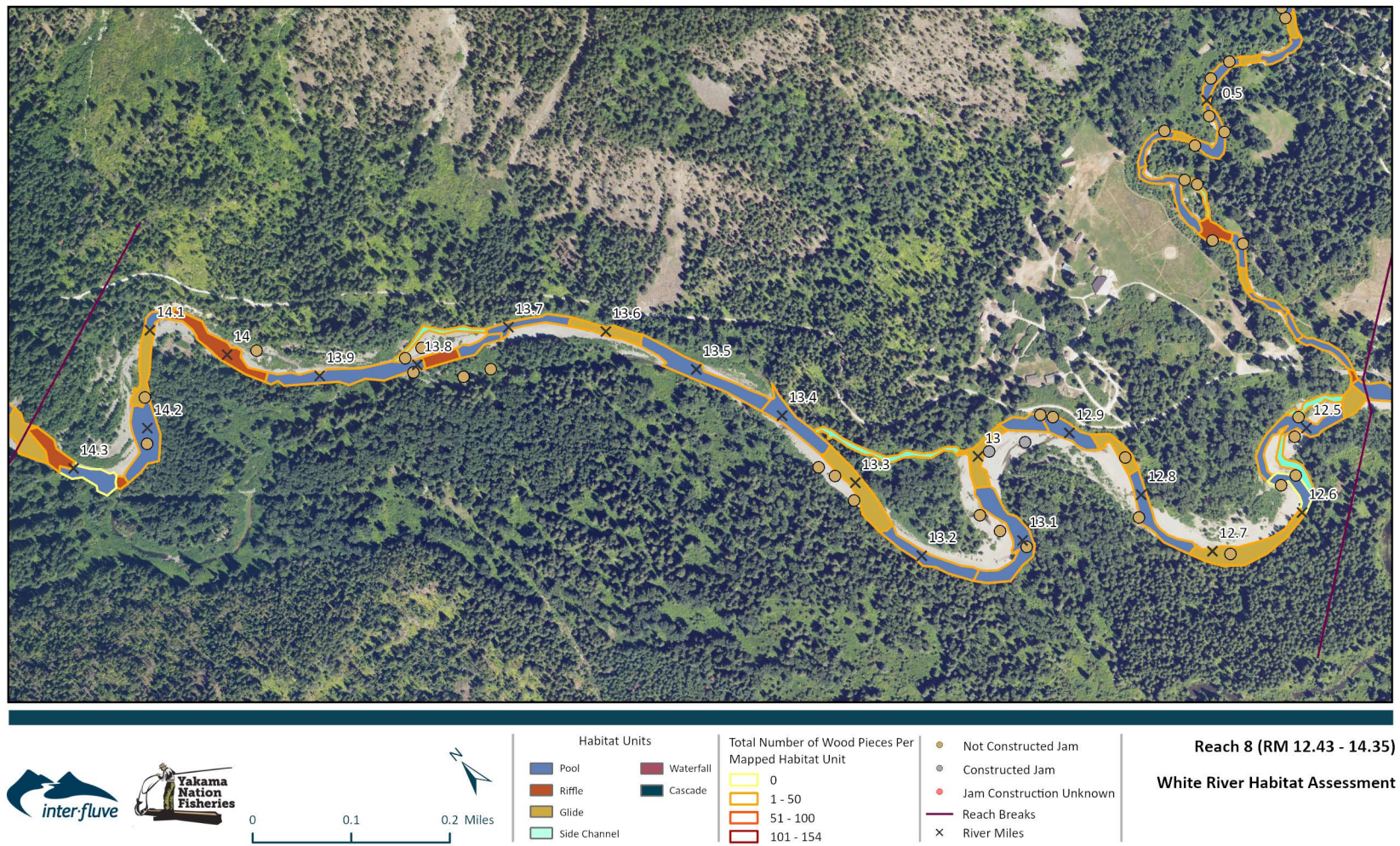
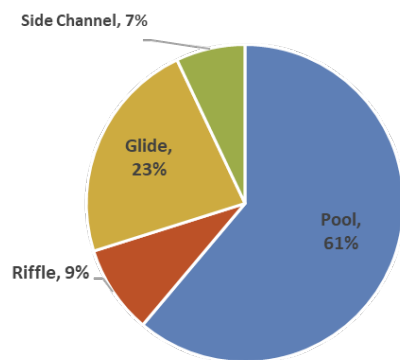


Figure 72. Map of the habitat unit composition and LWM in Reach 8 of the White River. LWM count does not include pieces in jams.



**Figure 73. Stream habitat unit area composition of Reach 8.**

#### 4.8.2 Pools

Fifteen pool units were observed in Reach 8. Of those 15 pools, six (40%) had a residual depth between 3 and 6 feet, and nine (60%) had a residual depth of less than 3 feet. None had a residual depth greater than 6 feet. Reach 8 had one of the lowest average residual pool depths at 2.9 feet (ranging from 0.7 to 5.2 feet), contrasting with the mean residual pool depth for the whole study area of 4.1 feet. Mean pool spacing in Reach 8 was eight pools per mile, higher than the study average of six pools per mile.

#### 4.8.3 Side Channel Habitat

Four side channels were counted in Reach 8, all of which were dominated by slow water. The total length of all side channels in Reach 8 is 2038 feet. A total of 30 pieces of LWM were found in the four side channels. No jams were observed (Table 20).

**Table 20. Summary of the side channel habitat observed in Reach 8.**

Location	Length (ft)	Dominant unit type	Wood count	Jam Count	Wood Count in Jams
Side 7	281	Side Slow	5	0	0
Side 8	364	Side Slow	2	0	0
Side 9	825	Side Slow	18	0	0
Side 10	569	Side Slow	5	0	0
Total	2038		30	0	0

#### 4.8.4 Large Woody Material

Reach 8 had 562 total pieces of LWM, with 65% (n = 366) of those pieces recorded within jams. This equates to 293 pieces per mile, and 162 medium and large pieces combined per mile. There were 23 jams observed in this reach (Table 21).

**Table 21. Large woody material quantities in Reach 8.**

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of pieces	102	54	40	196
Number of pieces per mile	53	49		102
Number of pieces per mile (including pieces in jams)	131	162		293
Number of jams	23			
Number of jams per mile	12			
Estimated Wood Count in Jams	366			

#### **4.8.5 Substrate & Fine Sediment**

There were two gravel counts performed in Reach 8 (GC15 and GC16), averaging 70% gravels and 30% cobbles. GC15 was performed at a riffle crest near RM 12.76 and GC16 was near a transverse riffle crest near RM 13.70. Figure 75 - Figure 76 and

Table 22 show the cumulative distribution and grain size class of both gravel counts conducted in Reach 8.

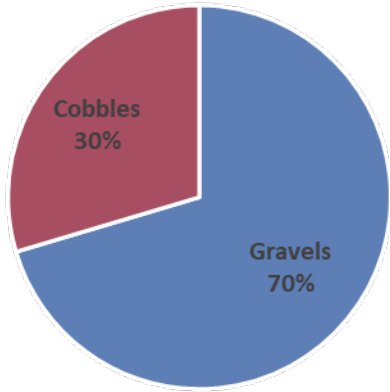


Figure 74. Combined percent sediment composition from the two gravel counts (GC15 and GC16) performed in Reach 8.

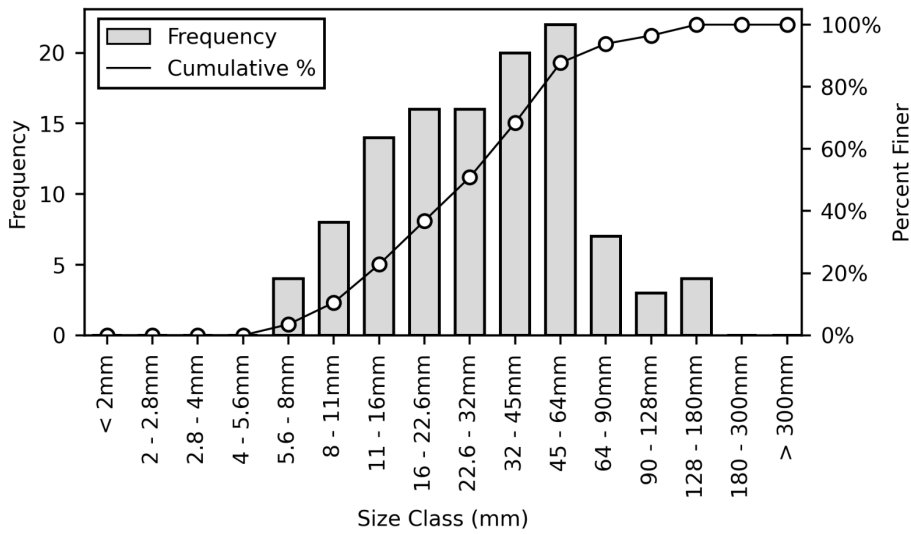


Figure 75. Cumulative distribution curve for GC15.

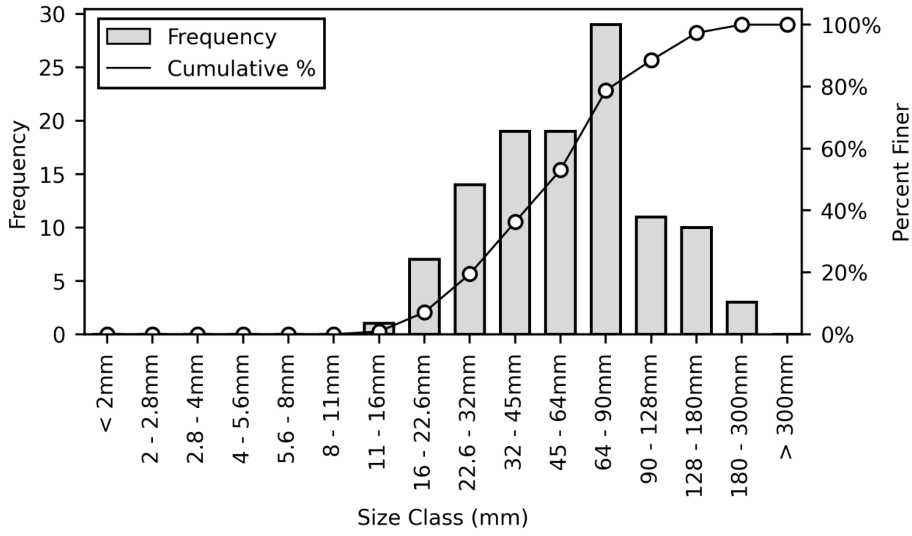


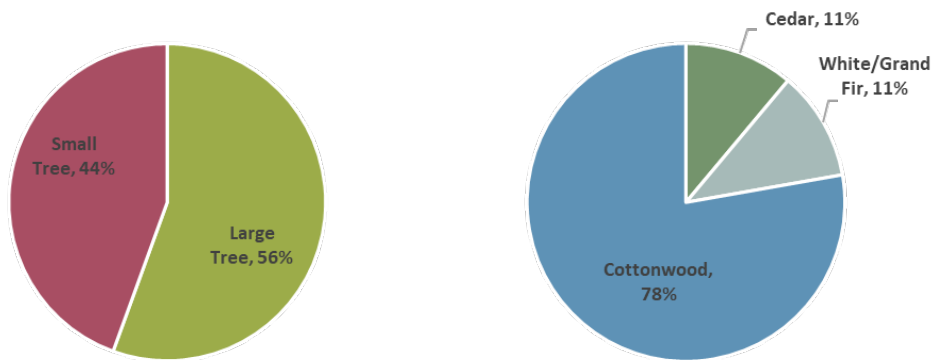
Figure 76. Cumulative distribution curve for GC16.

**Table 22. Grain size class for GC15 and GC16 (assumed linear interpolation).**

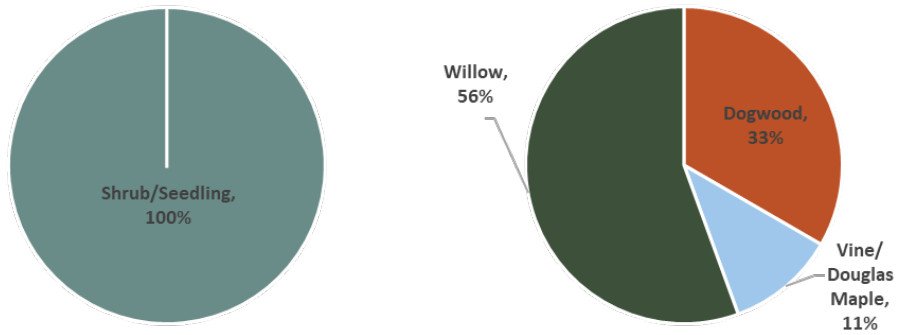
	<b>GC15</b>	<b>GC16</b>
<b>Size Class</b>	<i>Size Percent Finer than (mm)</i>	<i>Size Percent Finer than (mm)</i>
<b>D5</b>	8.6	20.4
<b>D16</b>	13.2	29.4
<b>D50</b>	31.4	60.5
<b>D84</b>	60.3	110.5
<b>D95</b>	106.5	166.2

#### 4.8.6 Riparian Corridor

Based on the nine n<sup>th</sup> units recording vegetation in Reach 8, the overstory size class was split between large trees (56%; 21 - 31.9-inch dbh) and small tree with (44%; 9.0 - 20.9-inch dbh). Cottonwood was the dominant overstory species (78%), while Western red cedar and white/grand fir were each recorded in 11% of measured units (Figure 77). The understory size class was recorded as entirely shrub/seedling (1.0 - 4.9-inch dbh), with willow as the dominant understory species (56%), followed by dogwood (33%) and vine/Douglas maple (11%). Figure 78 shows the understory size and species composition.



**Figure 77. Dominant overstory riparian vegetation class and species, based on nine n<sup>th</sup> units surveyed, within 100 feet of the White River by ocular estimate.**



**Figure 78. Dominant understory riparian vegetation class and species, based on nine  $n^{\text{th}}$  units surveyed, within 100 feet of the White River by ocular estimate.**

## 4.9 REACH 9

**Location:** River mile 14.35 - 15.01

**Total length:** 0.66 miles

**Survey Date:** August 27<sup>th</sup>, 2024



**Figure 79.** Representative photo of Reach 9. Riffles made up the majority of the channel units in Reach 9.

### 4.9.1 Habitat Unit Composition

Reach 9 was the shortest reach on the mainstem of the White River within the study area, covering 0.66 river miles. The channel gradient continues to increase moving upstream, with an average gradient in Reach 9 of 1.05% and a corresponding increase in fast-water habitat unit types. The dominant habitat type was riffle, making up 50% of the total area. Glide was the second most common habitat type (20%) in the reach, followed by side channel and pool habitat (18% and 12%, respectively; Figure 81). Reach 9 had the highest percentage of side channel habitat of all the mainstem White River reaches.

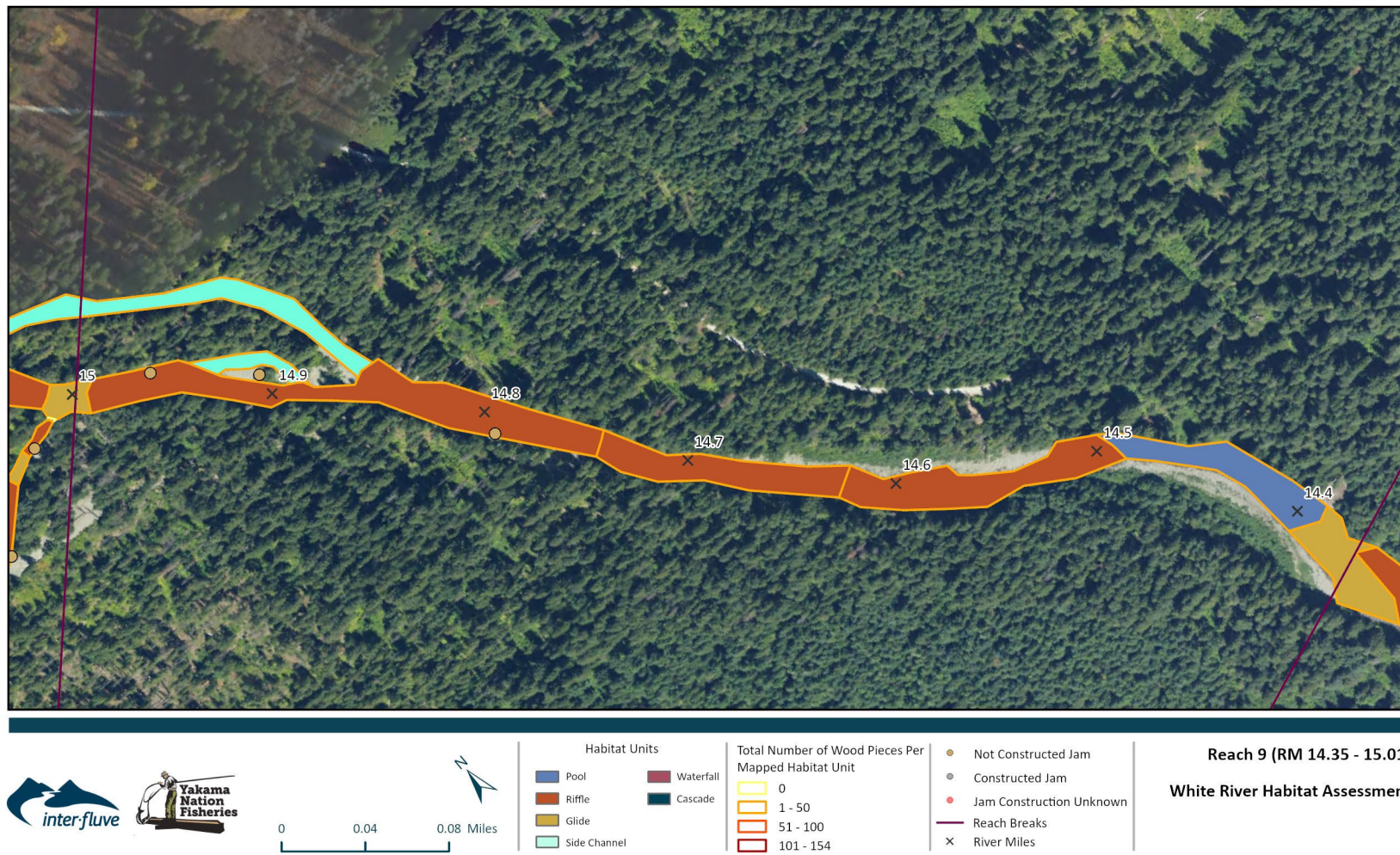
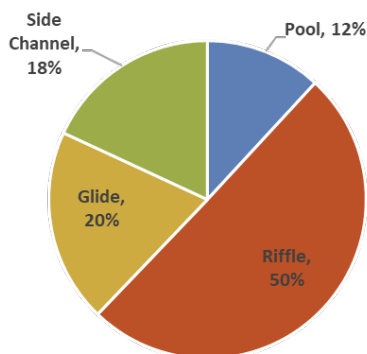


Figure 80. Map of the habitat unit composition and LWM in Reach 9 of the White River. LWM count does not include pieces in jams.



**Figure 81. Stream habitat unit area composition of Reach 9.**

### 4.9.2 Pools

Reach 9 had the fewest pool units recorded (n = 1) of all reaches. Mean pool spacing for this reach was two pools per mile, compared to the study area average pool spacing of six pools per mile. The one pool in this reach had a residual depth of 3.2 feet, shallower than the study area average of 4.1 feet.

### 4.9.3 Side Channel Habitat

Reach 9 had two side channel units, both recorded as primarily fast water (e.g., riffle & glide habitat within the side channels). The total combined length of the side channels in Reach 9 was 1365 feet. There were 28 pieces of LWM in the side channels, but no jams were observed (Table 23).

**Table 23. Summary of the side channel habitat observed in Reach 9.**

Location	Length (ft)	Dominant unit type	Wood count	Jam Count	Wood Count in Jams
Side 11	1102	Side Fast	25	0	0
Side 12	263	Side Fast	3	0	0
Total	1365		28	0	0

### 4.9.4 Large Woody Material

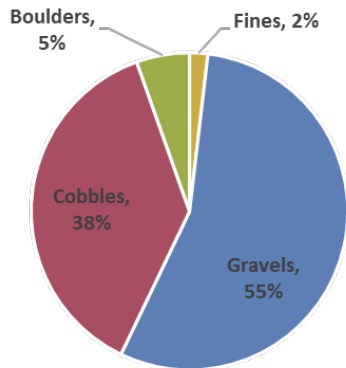
A total of 99 pieces of LWM pieces were recorded in Reach 9. This equates to 150 LWM pieces per mile, and roughly 73 medium and large pieces per mile. There were only three jams in this reach, the lowest number of any reach, which contained an estimated 36 pieces or 36% of the total pieces (Table 24).

**Table 24. Large woody material quantities in Reach 9.**

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of pieces	28	23	12	63
Number of pieces per mile	42	53		96
Number of pieces per mile (including pieces in jams)	77	73		150
Number of jams	3			
Number of jams per mile	5			
Estimated Wood Count in Jams	36			

**4.9.5 Substrate & Fine Sediment**

Two gravel counts were performed in Reach 9. GC17 was performed at a mid-channel bar near RM 14.47 and GC18 was performed at a lateral bar near RM 14.66. The combined average of the two gravel counts shows the substrate primarily gravels (55%), followed by cobbles (38%), boulders (5%), and fines (2%). The cumulative distribution for both gravel counts and the grain size class can be found in Figure 83 - Figure 84 and Table 25.



**Figure 82. Combined percent sediment composition from the two gravel counts (GC17 and GC18) performed in Reach 9.**

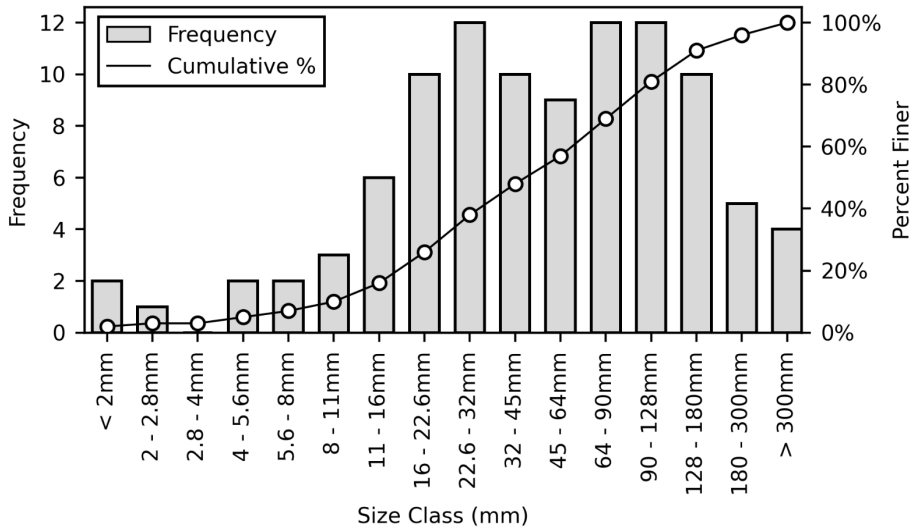


Figure 83. Cumulative distribution curve for GC17.

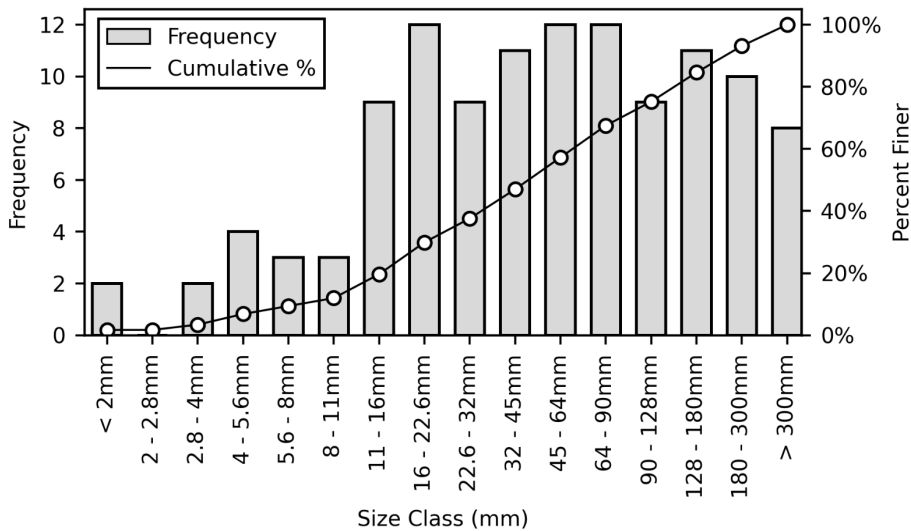


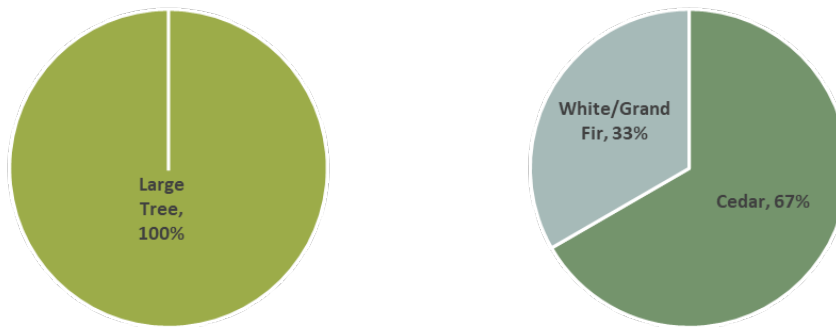
Figure 84. Cumulative distribution curve for GC18.

**Table 25. Grain size class for GC17 and GC18 (assumed linear interpolation).**

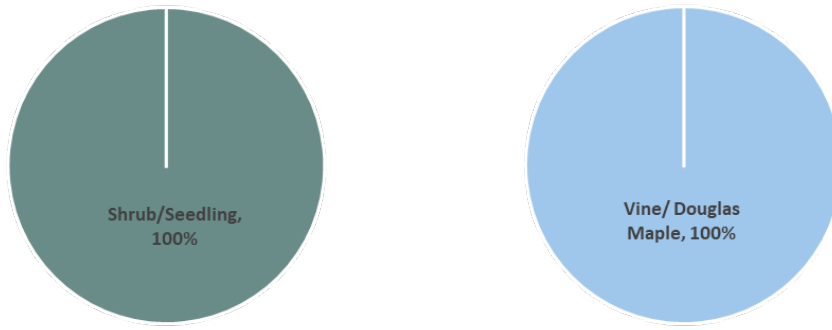
Size Class	GC17	GC18
	Size Percent Finer than (mm)	Size Percent Finer than (mm)
D5	5.6	4.7
D16	16.0	13.6
D50	49.2	50.5
D84	143.6	176.6
D95	276.0	300.3

#### 4.9.6 Riparian Corridor

Of the three n<sup>th</sup> unit vegetation surveys performed in Reach 9, large trees (21.0 - 31.9 inch dbh) were the dominant overstory size class in 100% of the measured units. Western red cedar was the dominant overstory species in 67% of units and white/grand fir in the other 33% (Figure 85). Vine/Douglas maple in the shrub/seedling (1.0 - 4.9 inch dbh) size class was the dominant understory in all the units (Figure 86).



**Figure 85. Dominant overstory riparian vegetation class and species, based on three n<sup>th</sup> units surveyed, within 100 feet of the White River by ocular estimate.**



**Figure 86. Dominant understory riparian vegetation class and species, based on three  $n^{\text{th}}$  units surveyed, within 100 feet of the White River by ocular estimate.**

## 4.10 REACH 10

**Location:** River mile 15.01 - 16.09 (habitat surveys terminated at RM 16.09, Reach 10 end is RM 16.17)

**Total length:** 1.08 miles (total reach length 1.16 miles)

**Survey Date:** August 28<sup>th</sup>, 2024



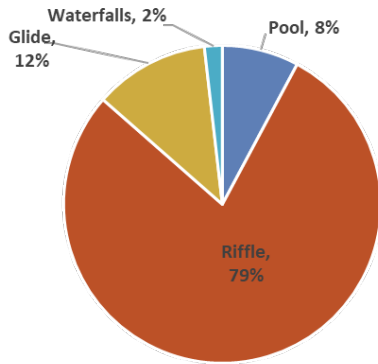
**Figure 87. Representative photo of Reach 10. The primary habitat type is riffle.**

### 4.10.1 Habitat Unit Composition

Reach 10 of the White River extends upstream to RM 16.17, however, the field habitat survey terminated at RM 16.09 where the lower falls of the White River Falls begins due to safety and access concerns. The Lower White River Falls was included in the delineated habitat units for Reach 10, but upstream of the Lower Falls was not assessed. All subsequent data reported for Reach 10 is based on the portion of Reach 10 that was assessed from RM 15.01 – 16.09.

Habitat units in Reach 10 were composed of predominately (79%) riffle habitat. Glides accounted for 12%, pool units for 8%, and lower White River Falls accounted for 2% of the total area surveyed by the habitat

crew (up to RM 16.09; Figure 89). No side channel units were observed in Reach 10. With a stream gradient of 2.40%, Reach 10 has the highest gradient of all the mainstem reaches.



**Figure 88. Stream habitat unit area composition of Reach 10.**

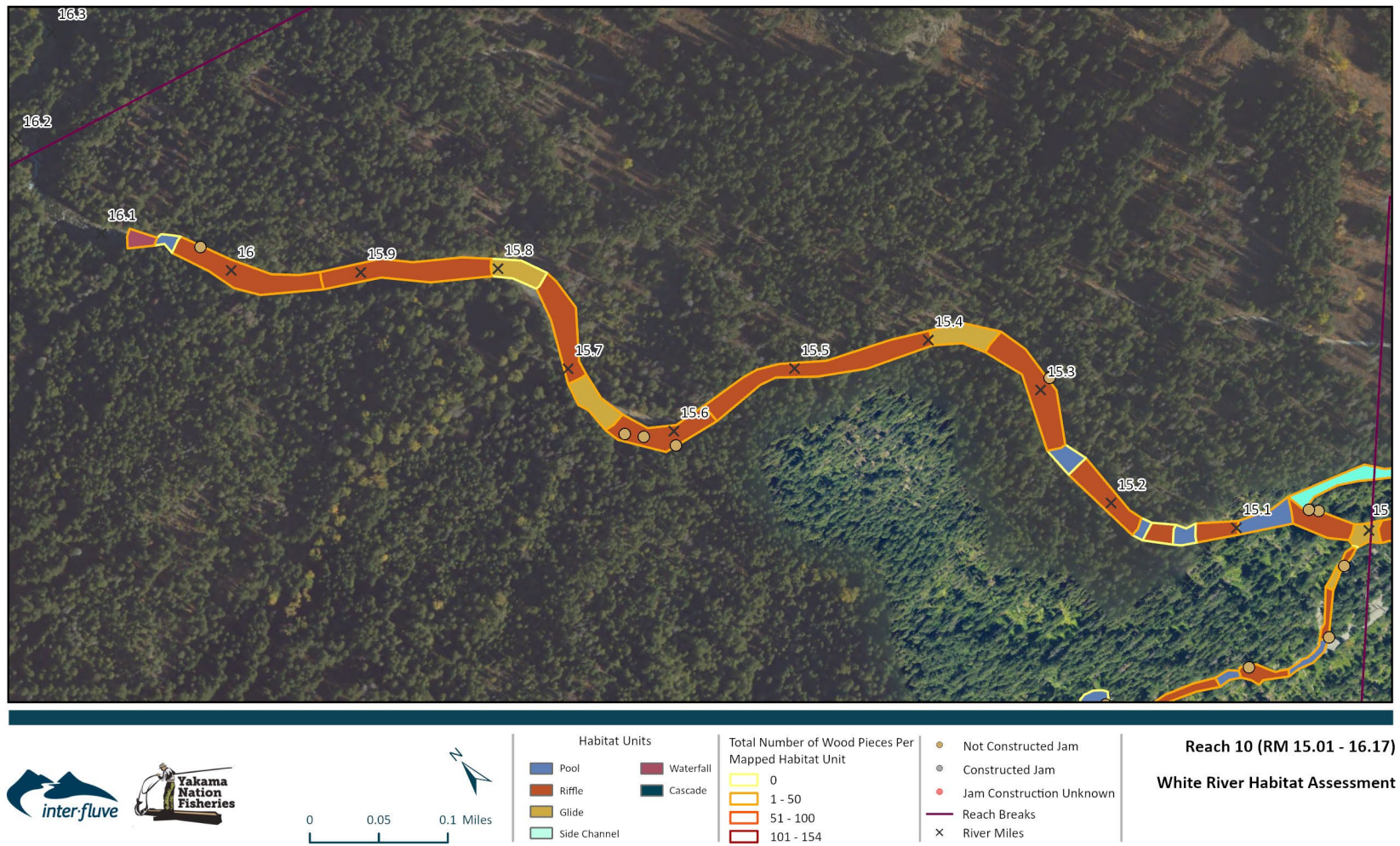


Figure 89. Map of the habitat unit composition and LWM in Reach 10 of the White River. LWM count does not include pieces in jams.

#### 4.10.2 Pools

Five pools were observed in Reach 10. Forty percent of the pools had a residual pool depth between 3 and 6 feet, and 60% had a residual pool depth of less than 3 feet. The average residual pool depth for Reach 10 was 2.60 feet, ranging from 1.2 feet to 5.2 feet. The mean residual depth for the whole study area was 4.1 feet. Pool frequency was approximately 5 pools per mile, compared to the study area average of six pools per mile.

#### 4.10.3 Side Channel Habitat

No side channels were recorded in Reach 10.

#### 4.10.4 Large Woody Material

Reach 10 had a total of 156 pieces of LWM, or roughly 144 LWM pieces per mile. There were 69 medium and large pieces combined per mile. A total of 7 jams were counted in this reach, containing one-third (33%) of all recorded pieces of LWM in the reach (Table 26).

**Table 26. Large woody material quantities in Reach 10.**

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of pieces	53	34	17	104
Number of pieces per mile	49	47		96
Number of pieces per mile (including pieces in jams)	76	69		144
Number of jams	7			
Number of jams per mile	7			
Estimated Wood Count in Jams	52			

#### 4.10.5 Substrate & Fine Sediment

Two gravel counts performed in Reach 10 (GC19 and GC20) show a composition of 45% cobbles, 39% gravels, 12% boulders, and 4% fines. Both gravel counts were performed at representative lateral bars near RM 15.25 (GC19) and RM 15.93 (GC20). The cumulative distribution curves and grain size class of both gravel counts can be found below in Figure 91 - Figure 92 and Table 27.

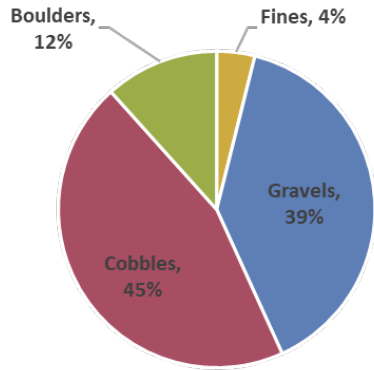


Figure 90. Combined percent sediment composition from the two gravel counts (GC19 and GC20) performed in Reach 10.

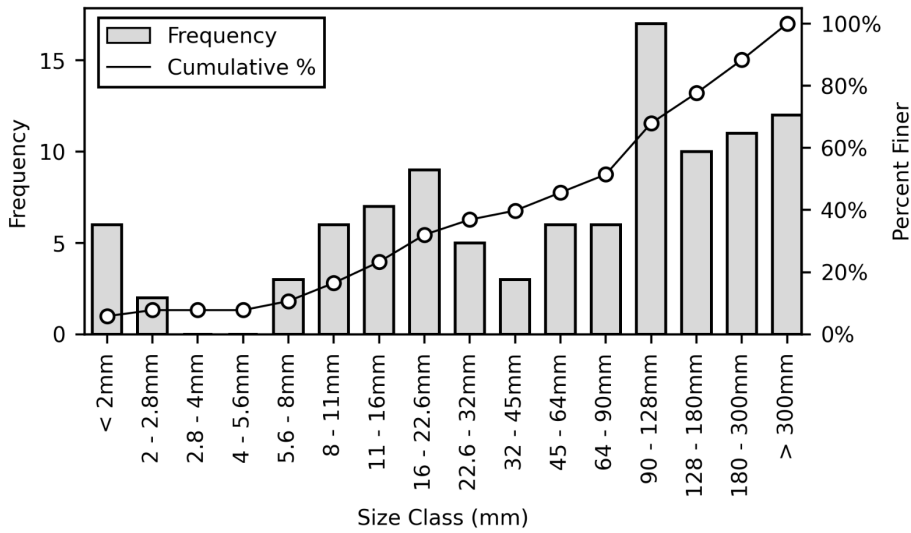


Figure 91. Cumulative distribution curve for GC19.

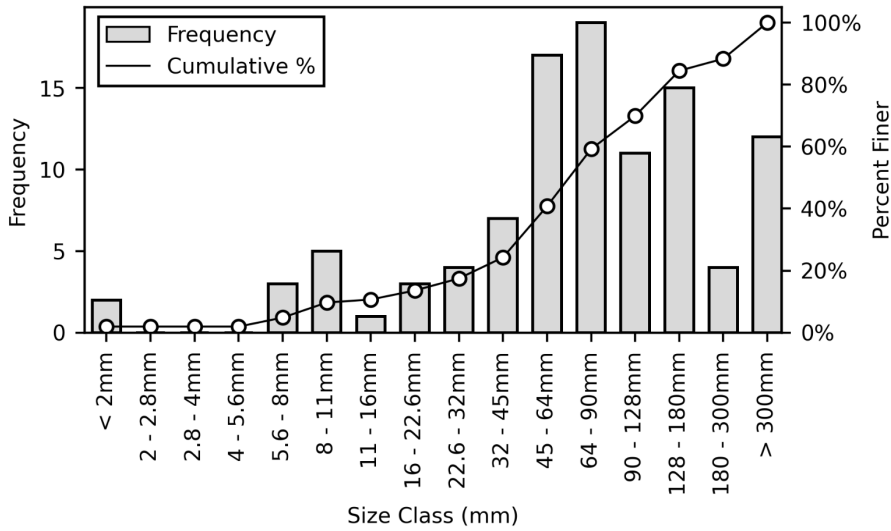


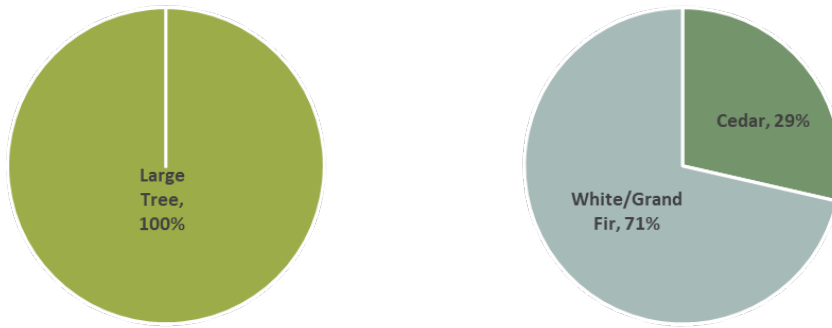
Figure 92. Cumulative distribution curve for GC20.

Table 27. Grain size class for GC19 and GC20 (assumed linear interpolation).

Size Class	GC19	GC20
	Size Percent Finer than (mm)	Size Percent Finer than (mm)
D5	1.0	8.1
D16	10.7	28.4
D50	83.5	77.0
D84	251.1	178.3
D95	300.6	300.6

#### 4.10.6 Riparian Corridor

Seven of the channel units in Reach 10 included ocular assessments of riparian vegetation. In addition to documentation of vegetation as a part of n<sup>th</sup> units (n = 6), one additional unit documented vegetation conditions within 100 feet of the White River due to major changes in vegetation conditions observed by the survey crew. The overstory in all seven of the units was dominated (100%) by large trees (21.0 - 31.9 inch dbh). Dominant overstory species included white/grand fir (71%) and Western red cedar (29%; Figure 93). Shrub/seedling (1.0 - 4.9 inch dbh) was the dominant size class (100%) for the understory in Reach 10. In 86% of the measured units the dominant understory species was alder, followed by cedar (14%; Figure 94).



**Figure 93. Dominant overstory riparian vegetation class and species, based on seven units surveyed, within 100 feet of the White River by ocular estimate**



**Figure 94. Dominant understory riparian vegetation class and species, based on seven units surveyed, within 100 feet of the White River by ocular estimate.**

#### 4.11 NAPEEQUA RIVER REACH 1

**Location:** Napeequa River, river mile 0 - 1.70

**Total length:** 1.70 miles

**Survey Date:** August 29<sup>th</sup> - 30<sup>th</sup>, 2024



**Figure 95. Representative photo of the Napeequa River Reach 1. The habitat type is dominated by pool units, with an increasing amount of fast water units moving upstream.**

##### 4.11.1 Habitat Unit Composition

The Napeequa River Reach 1 included 1.7 river miles, extending upstream from the confluence of the Napeequa and White Rivers. The Napeequa River Reach 1 is dominated by pool habitat units (66.6%), followed by riffles (18.6%), glides (10.3%), side channels (4%), and one waterfall at the end of the reach (which accounted 0.5% of the area; Figure 97).

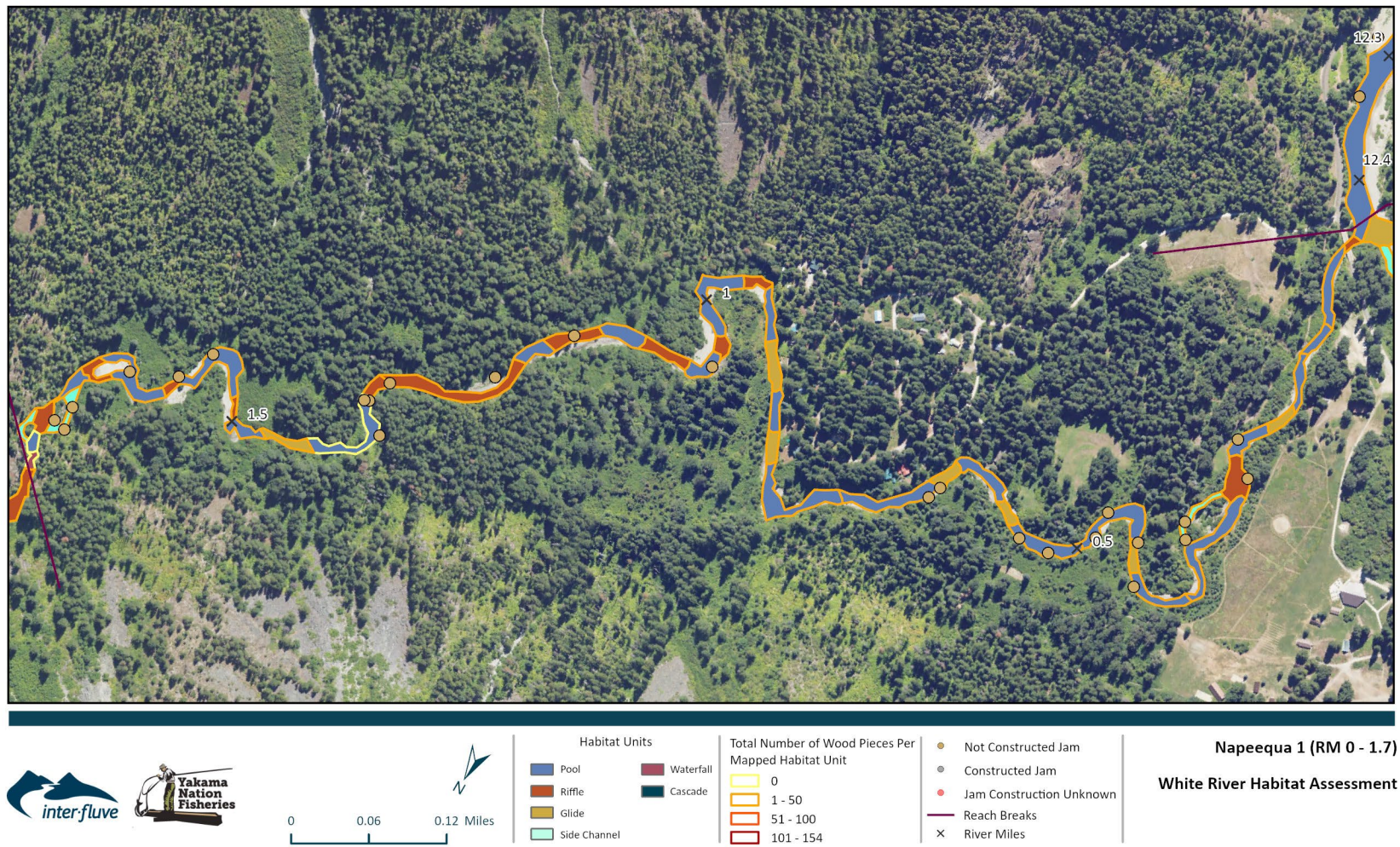
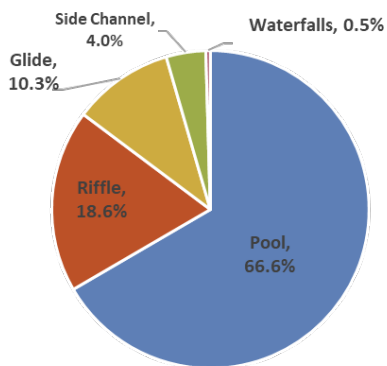


Figure 96. Map of the habitat unit composition and LWM in the Napeequa River Reach 1. LWM count does not include pieces in jams.



**Figure 97. Stream habitat unit area composition of the Napeequa River Reach 1.**

#### 4.11.2 Pools

The Napeequa River Reach 1 had the most pools of any reach in the study area, with 23 pool units observed. The residual depth of these pools ranged from 1.8 feet to 4.7 feet, with an average of 3.4 feet (compared to the study area average of 4.1 feet). Of the 23 pools, 65% had a residual pool depth between 3 and 6 feet, while 35% had less than 3 feet of residual pool depth. Pools are spaced at roughly 14 pools per mile (average study area spacing is six pools per mile).

#### 4.11.3 Side Channel Habitat

Three side channels were recorded in Napeequa River Reach 1, totaling 626 feet in length. Two of the three side channels provided largely fast water habitat, while one was predominantly slow water habitat. There were 13 pieces of LWM and four jams observed across the three side channels. An estimated 36 pieces of LWM were recorded in the four jams (Table 28).

**Table 28. Summary of the side channel habitat observed in the Napeequa River Reach 1.**

Location	Length (ft)	Dominant unit type	Wood count	Jam Count	Wood Count in Jams
Side 1	294	Side Slow	7	2	26
Side 2	222	Side Fast	4	2	10
Side 3	111	Side Fast	2	0	0
Total	626		13	4	36

#### 4.11.4 Large Woody Material

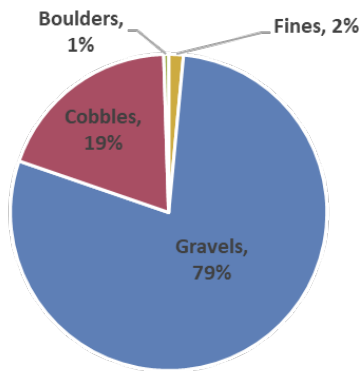
Napeequa River Reach 1 had a total of 484 pieces of LWM, or approximately 285 pieces of LWM per mile. There were 127 medium and large pieces of LWM combined per mile. Nearly half (47%) of the LWM was contained with the 25 jams counted in this reach (Table 29).

**Table 29. Large woody material quantities in Napeequa River Reach 1.**

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of pieces	158	67	33	258
Number of pieces per mile	93	59		152
Number of pieces per mile (including pieces in jams)	161	127		288
Number of jams	25			
Number of jams per mile	15			
Estimated Wood Count in Jams	226			

**4.11.5 Substrate & Fine Sediment**

Two gravel counts were performed in the Napeequa River Reach 1. Both were performed at riffle crests near RM 0.57 (GC21) and RM 1.11 (GC22). However, at the second gravel count location (GC22), only a portion of the channel cross-section was surveyed to avoid Sockeye Salmon actively spawning. Gravels comprised 79% of the substrate in the reach, while the remainder was cobbles (19%), fines (2%), and boulders (1%). The cumulative distribution curves and grain size class of both gravel counts can be found below in Figure 99 - Figure 100 and Table 30.



**Figure 98. Combined percent sediment composition from the two gravel counts (GC21 and GC22) performed in the Napeequa River Reach 1.**

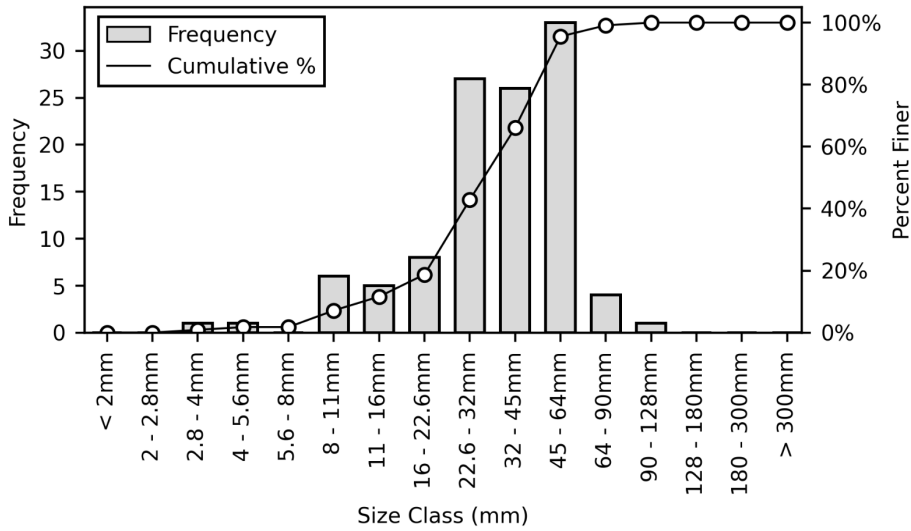


Figure 99. Cumulative distribution curve for GC21.

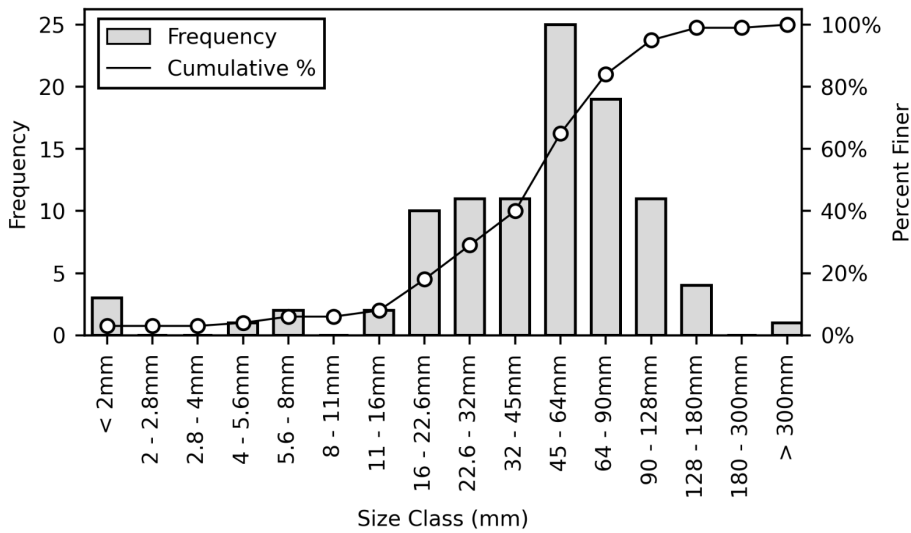


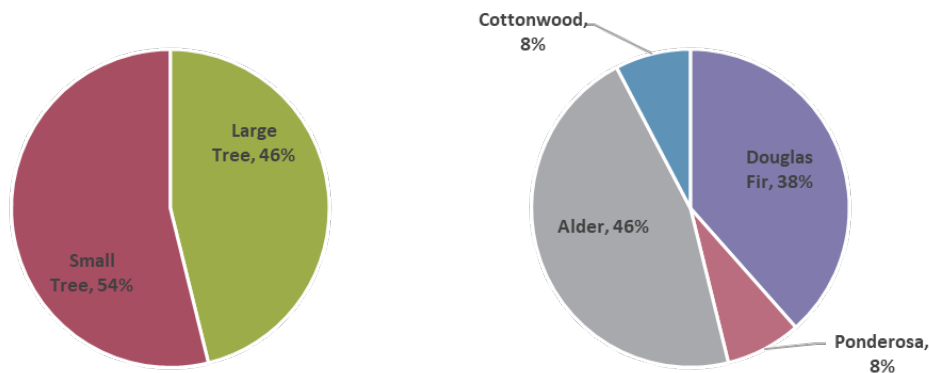
Figure 100. Cumulative distribution curve for GC22.

**Table 30. Grain size class for GC22 and GC22 (assumed linear interpolation).**

Size Class	GC21	GC22
	Size Percent Finer than (mm)	Size Percent Finer than (mm)
D5	9.8	6.8
D16	20.1	21.3
D50	36.0	52.6
D84	56.6	90.0
D95	63.7	128.0

**4.11.6 Riparian Corridor**

Thirteen of the channel units in Reach 1 of the Napeequa River included ocular assessments of riparian vegetation. In addition to documentation of vegetation as a part of n<sup>th</sup> units (n = 8), five additional units documented vegetation conditions within 100 feet of the White River due to major changes in vegetation conditions observed by the survey crew. Vegetation changes that prompted survey crews to record change of conditions largely related to human land uses within the 100-foot riparian zone of the Napeequa River channel, such as mowed residential yards or planted vegetation. A majority of Napeequa River Reach 1 is adjacent to privately-owned land. The overstory size class was divided between small trees (54%; 9.0 - 20.9 inch dbh) and large trees (46%; 21.0 - 31.9 inch dbh). The primary overstory species was alder (46%), followed closely by Douglas fir (38%), and ponderosa pine and cottonwood (both 8%; Figure 101). The primary understory size class was recorded as 62% shrub/seedlings (1.0 - 4.9 inch dbh) and 38% grassland/forb. The relatively high percentage of grassland/forb vegetation in the riparian zone compared to elsewhere in the study area is likely due to the mowed/landscaped manicured yards that abutted the channel banks in Reach 1 of the Napeequa. Dogwood was the primary understory species observed (54%), followed by other/unknown at 38% (for the ornamental species found in riverside properties), and alder (8%; Figure 102).



**Figure 101. Dominant overstory riparian vegetation class and species, based on 13 surveyed units, within 100 feet of the Napeequa River by ocular estimate.**



**Figure 102. Dominant understory riparian vegetation class and species, based on thirteen surveyed units, within 100 feet of the Napeequa River by ocular estimate.**

## 4.12 NAPEEQUA RIVER REACH 2

**Location:** Napeequa River, river mile 1.70 - 2.20

**Total length:** 0.50 miles

**Survey Date:** August 31<sup>st</sup>, 2024



**Figure 103.** Representative photo of the Napeequa River Reach 2. The habitat was dominated by riffle. This photo shows the cascade section in Side 8.

### 4.12.1 Habitat Unit Composition

Reach 2 of the Napeequa River was the shortest of all the reaches in the study area, covering only 0.5 miles. The reach primarily consisted of riffle units, which accounted for 50% of the habitat area recorded. Side channel habitat was the second most prevalent, accounting for 45% of the reach area. Pool habitat only accounted for 5% of the total reach area (Figure 105). Napeequa River Reach 2 had the highest percentage of side channel habitat, largely due to one long side channel in the upstream portion of the reach.

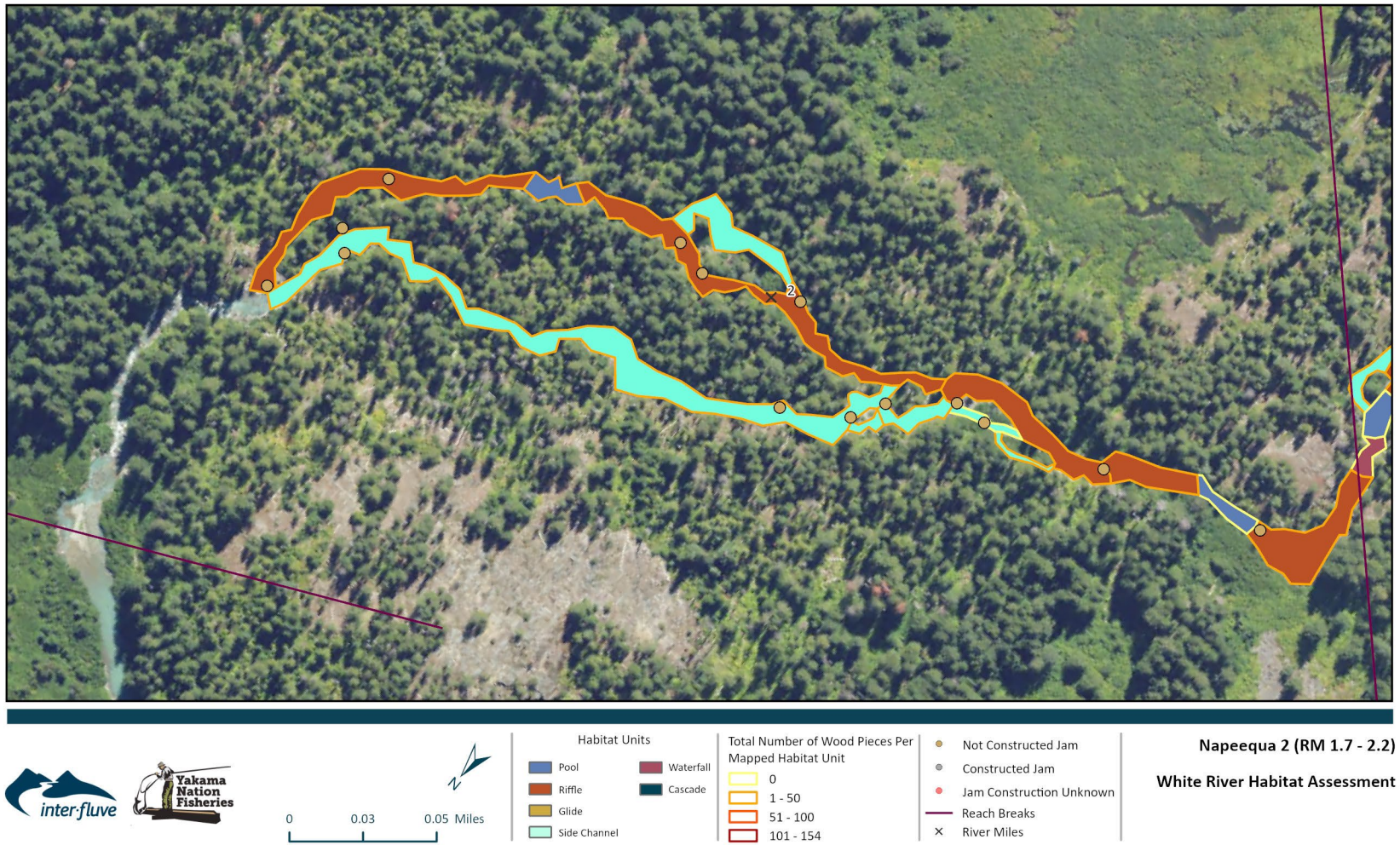
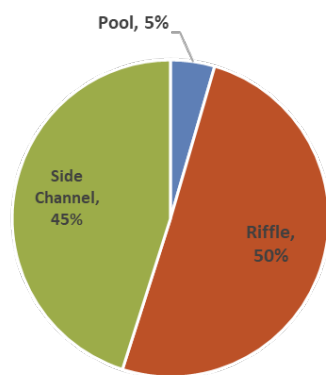


Figure 104. Map of the habitat unit composition and LWM in the Napeequa River Reach 2. LWM count does not include pieces in jams.



**Figure 105. Stream habitat unit area composition of Napeequa River Reach 2.**

#### 4.12.2 Pools

Only two pools were observed in Napeequa River Reach 2, both of which had a residual pool depth of 3 feet. Pool spacing frequency was roughly four pools per mile for this reach.

#### 4.12.3 Side Channel Habitat

Napeequa River Reach 2 had six side channels recorded, the most of any reach in the study area, including the White River. The total combined length of side channels in the Reach was 2079 feet. Only one side channel provided mainly slow water habitat, otherwise a majority of the side channels consistent of fast water habitat. There was a total of 51 pieces of LWM and eight jams observed within the six side channels. The jams contained an estimated 99 pieces of LWM (Table 31).

**Table 31. Summary of the side channel habitat observed in the Napeequa River Reach 2.**

Location	Length (ft)	Dominant unit type	Wood count	Jam Count	Wood Count in Jams
Side 4	134	Side Slow	1	0	0
Side 5	131	Side Fast	0	1	10
Side 6	62	Side Fast	1	2	58
Side 7	143	Side Fast	1	0	0
Side 8	1318	Side Fast	40	5	31
Side 9	292	Side Fast	8	0	0
Total	2079		51	8	99

#### 4.12.4 Large Woody Material

Napeequa River Reach 2 had the highest quantity of LWM per mile than any reach out of the entire study area (including the White River), with 730 LWM pieces per mile (corresponding to 365 pieces of LWM in total that were recorded in the reach). There were 382 small LWM pieces per mile and 378 medium and large LWM pieces combined per mile. Fourteen jams were observed in this reach, which contained 65% of the total pieces of LWM recorded (Table 32).

**Table 32. Large woody material quantities in the Napeequa River Reach 2.**

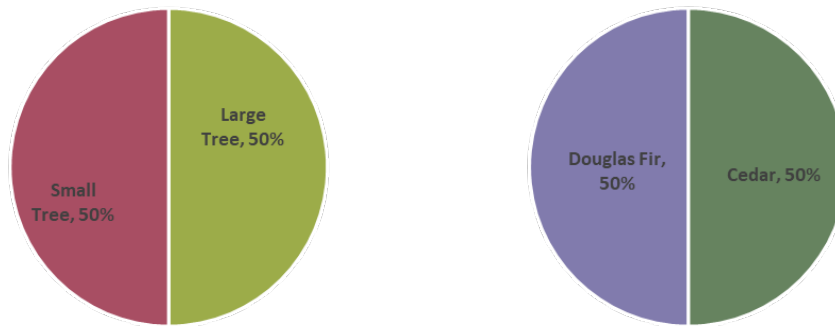
	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of pieces	63	48	17	128
Number of pieces per mile	126	130		156
Number of pieces per mile (including pieces in jams)	382	378		730
Number of jams	14			
Number of jams per mile	28			
Estimated Wood Count in Jams	237			

**4.12.5 Substrate & Fine Sediment**

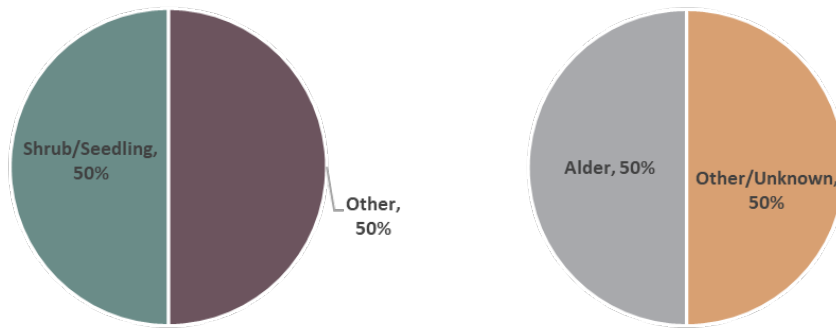
No gravel counts were performed in the Napeequa River Reach 2.

**4.12.6 Riparian Corridor**

Based on two <sup>n</sup><sup>th</sup> units in Reach 2 of the Napeequa River Reach 2, the primary overstory size class was large tree (50%; 21.0 - 31.9 inch dbh) and small tree (50%; 9.0 - 20.9 inch dbh). Overstory species were recorded as Douglas fir and cedar (both 50%). Figure 106 shows the overstory size and species composition. Size classes of the understory included shrub/seedlings (1.0 - 4.9 inch dbh) and other (both 50%). Species in the understory was mostly alder and other/unknown (both 50% of the total measured units). Units with “other” selected for the understory size class and species were largely comprised of little or no vegetation in the understory based on field notes. Figure 107 shows the understory size and species composition.



**Figure 106. Dominant overstory riparian vegetation class and species, based on two <sup>n</sup><sup>th</sup> units surveyed, within 100 feet of the Napeequa River by ocular estimate.**



**Figure 107. Dominant understory riparian vegetation class and species, based on two  $n^{\text{th}}$  units surveyed, within 100 feet of the Napeequa River by ocular estimate.**

### 4.13 PANTHER CREEK REACH 1

**Location:** Panther River, river mile 0 - 0.70 (habitat surveys terminated at RM 0.70, Panther Creek Reach 1 end is RM 0.80)

**Total length:** 0.7 miles (total reach length is 0.80 miles)

**Survey Date:** September 1<sup>st</sup>, 2024

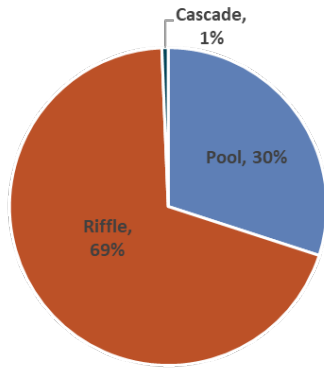


**Figure 108.** Representative photo of the Panther Creek Reach. The primary habitat type recorded was riffle. This photo shows the steep narrow gorge in which Panther Creek flows out of as well as the channel spanning log forming a plunge pool.

#### 4.13.1 Habitat Unit Composition

Reach 1 of Panther Creek extends upstream from its confluence with the White River to RM 0.80 in Panther Creek, however, the field habitat survey terminated at RM 0.70 due to safety and access concerns. Upstream of approximately RM 0.50, Panther Creek is within a relatively narrow and steep bedrock gorge. All subsequent data reported for Panther Creek Reach 1 is based on the portion of Reach 1 that was assessed by field crews from RM 0 – 0.70.

Panther Creek Reach 1 consisted of 69% riffle habitat and 30% pool habitat (Figure 109). There were multiple cascade units recorded, accounting for the remaining nearly 1% of the reach habitat area, as well as one waterfall unit at RM0.56 that totaled 0.3% of the reach area. No active side channels were observed in the reach, although there were multiple dry secondary channels at the mouth of Panther Creek that are likely activated at higher flows.



**Figure 109. Stream habitat unit area composition of the Panther Creek Reach.**

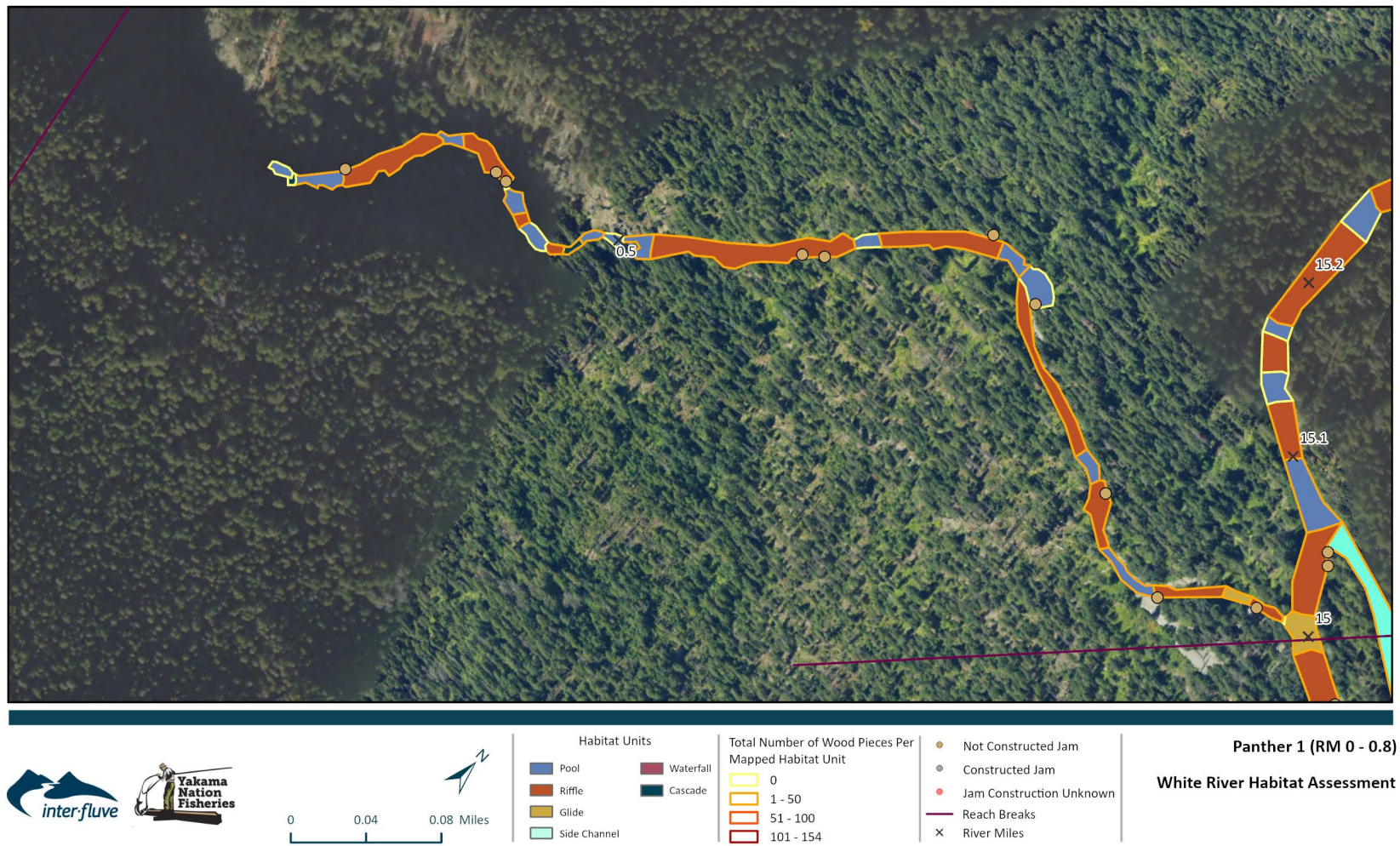


Figure 110. Map of the habitat unit composition and LWM in the Panther Creek Reach. LWM count does not include pieces in jams.

#### 4.13.2 Pools

Fourteen pools were observed in Panther Creek Reach 1, which corresponds to 20 pools per mile. Over half (57%) of the pools have residual pool depths less than 3 feet, 29% have a residual depth between 3 and 6 feet, and only 14% of the pools had a residual pool depth greater than or equal to 6 feet. Residual pool depths ranged from a low of 0.7 feet to a high of 7.1 feet, with an average of 4.0 feet (almost the same as the study area average of 4.1 feet). This large range of residual depths is because the Panther Creek channel within Reach 1 was relatively small and shallow with multiple waterfall units that created deep pools.

#### 4.13.3 Side Channel Habitat

No actively flowing side channels were observed in Panther Creek Reach 1.

#### 4.13.4 Large Woody Material

A total of 168 pieces of LWM were recorded within Reach 1 of Panther Creek, which corresponds to 240 pieces per mile. There were 111 small LWM pieces per mile and 136 medium and large LWM pieces combined per mile. There were 10 jams observed in Panther Creek Reach 1, which contained an estimated 105 pieces of LWM (63% of the reach totals) (Table 33).

**Table 33. Large woody material quantities in the Panther Creek Reach.**

	Small (6 in x 20 ft)	Medium (12 in x 35 ft)	Large (20 in x 35 ft)	Total
Number of pieces	23	27	13	63
Number of pieces per mile	33	57		90
Number of pieces per mile (including pieces in jams)	111	136		240
Number of jams	10			
Number of jams per mile	14			
Estimated Wood Count in Jams	105			

#### 4.13.5 Substrate & Fine Sediment

Only one gravel count (GC23) was performed in Panther Creek Reach 1, at a mid-channel bar near RM 0.30. The results of GC23 indicate channel substrate is 41% gravel, 37% cobbles, and 22% boulders. The cumulative distribution curve and size class of the gravel count completed in Panther Creek are provided in Figure 112 and Table 34 below.

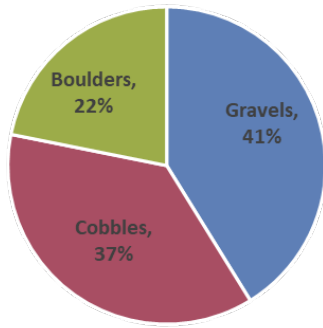


Figure 111. Percent sediment composition from one gravel count (GC23) performed in Panther Creek Reach 1.

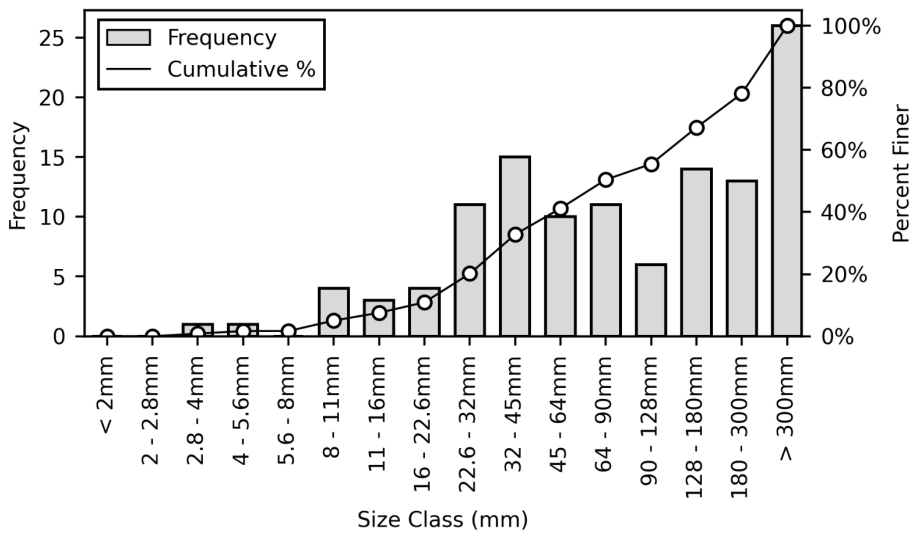


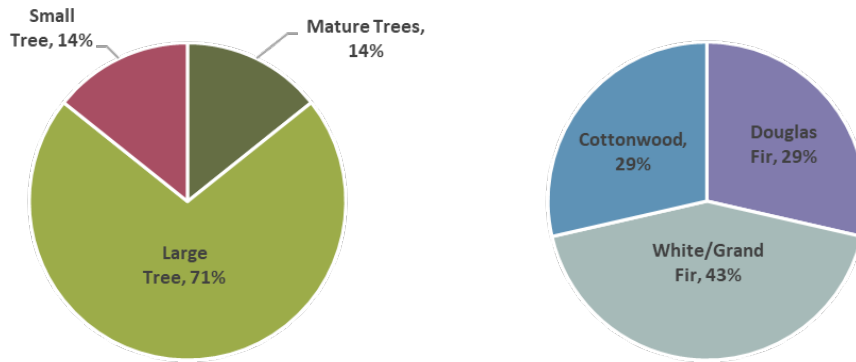
Figure 112. Cumulative distribution curve for GC23.

Table 34. Grain size class for GC23 (assumed linear interpolation).

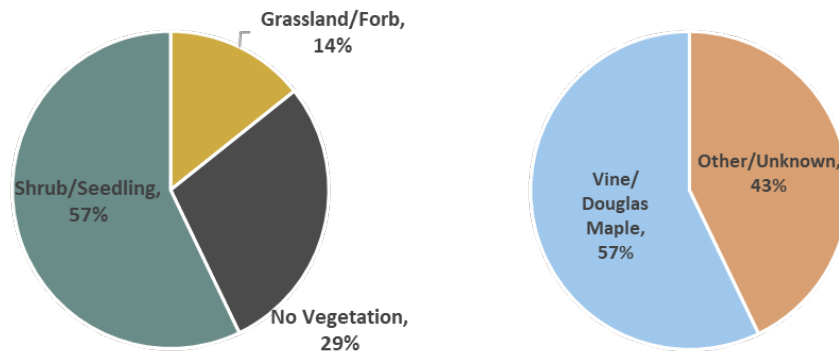
Size Class	GC23
	Size Percent Finer than (mm)
D5	11.0
D16	27.8
D50	88.8
D84	300.3
D95	300.8

### 4.13.6 Riparian Corridor

Eight vegetation surveys were conducted in the Panther Creek reach as a part of n<sup>th</sup> units. The dominant overstory size class recorded was large trees (71%; 21.0 - 31.9 inch dbh), then small trees (14%; 9.0 - 20.9 inch dbh) and mature trees (14%; > 32 inch dbh). White/grand fir is the most common dominant overstory species (in 43% of surveyed units), followed by cottonwood and Douglas fir (29% each; Figure 113). In 57% of units, shrub/seedling (1.0 -4.9-inch dbh) was the dominant understory size class, followed by no vegetation in 29% and grassland/forb in 14% of units. Vine/Douglas maple was observed as the primary understory species in a majority (57%) of the units. Unknown/Other species were recorded for the understory canopy in the remaining 43% of units (Figure 114).



**Figure 113. Dominant overstory riparian vegetation class and species, based on eight n<sup>th</sup> units surveyed, within 100 feet of Panther Creek by ocular estimate.**



**Figure 114. Dominant understory riparian vegetation class and species, based on eight n<sup>th</sup> units surveyed, within 100 feet of Panther Creek by ocular estimate.**

4.14 SUMMARY DATA

Table 35. Summary table of all the data collected in the 2024 Habitat Assessment for all the mainstem reaches and tributaries in the White River study area.

	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10	Napeequa River 1	Napeequa River 2	Panther Creek	All Reaches
<b>River Miles Surveyed</b>	2.00	2.13	1.31	1.56	2.52	2.13	0.78	1.92	0.66	1.08	1.70	0.50	0.70	18.99
<b>Stream Gradient</b>	0.02%	0.05%	0.07%	0.09%	0.18%	0.18%	0.15%	0.42%	1.05%	2.40%	0.76%	5.95%	5.73%	1.31%
<b>Average Wetted Width</b>														
<b>Pool</b>														
Mean	90	87	80	101	90	89	88	72	75	58	43	28	23	71
Median	90	80	80	90	90	85	80	75	75	55	45	28	23	80
St. Dev.	14	12	0	34	15	24	22	18	n=1	12	9	4	8	25
<b>Glide</b>														
Mean	0	0	70	90	81	106	75	66	180	58	39	0	15	71
Median	0	0	70	90	80	120	75	60	180	55	40	0	15	60
St. Dev.	0	0	n=1	14	6	25	7	15	n=1	17	5	0	n=1	29
<b>Riffle</b>														
Mean	0	0	0	0	0	45	0	66	66	75	35	32	25	46
Median	0	0	0	0	0	45	0	65	70	75	35	30	25	45
St. Dev.	0	0	0	0	0	n=1	0	19	14	12	5	5	6	26
<b>Side Channel</b>														
Mean	0	0	0	0	17	23	15	18	33	0	22	21	0	21
Median	0	0	0	0	17	30	15	15	33	0	20	23	0	20
St. Dev.	0	0	0	0	2	13	n=1	12	18	0	8	13	0	11
<b>Water Depth (ft)</b>														
<b>Pool Maximum Depth</b>														
Mean	14	11	8	8	7	6	6	4	5	5	5	4	4	6
Median	14	11	8	8	7	6	6	4	5	4	5	4	4	5
St. Dev.	0	2	0	1	2	2	1	1	n=1	1	1	0	2	2
<b>Pool Residual Depth</b>														
Mean	11	5	5	5	5	5	5	3	3	3	3	3	3	4

	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10	Napeequa River 1	Napeequa River 2	Panther Creek	All Reaches
Median	11	6	5	5	4	5	4	3	3	2	3	3	3	4
St. Dev.	2	3	2	2	2	2	1	1	n=1	2	1	0	2	2
<b>Riffle/Glide Average Depth</b>														
Mean	0	0	4	2	2	2	2	1	1	2	1	2	1	2
Median	0	0	4	2	2	2	2	1	1	2	1	2	1	2
St. Dev.	0	0	0	1	1	1	0	0	0	0	0	0	0	1
<b>Bankfull Characteristics</b>														
<b>Width (ft)</b>														
Mean	n=0	120	140	140	145	188	173	131	119	92	66	40	51	116
Median	n=0	120	140	140	140	185	180	125	122	86	60	40	49	120
St. Dev.	n=0	n=1	n=1	14	18	39	12	57	8	14	13	n=1	11	52
<b>Depth (ft)</b>														
Maximum Depth (ft)	n=0	13.1	13.0	10.1	10.7	8.8	8.5	5.8	5.7	5.4	4.8	3.3	4.1	13.1
Minimum Depth (ft)	n=0	10.6	4.2	1.8	1.8	1.7	0.6	1.2	3.0	0.9	1.3	1.4	0.2	0.2
Mean Depth (ft)	n=0	12.2	9.8	7.2	6.3	5.1	4.7	4.2	4.4	3.8	3.1	2.7	2.1	4.6
Median	n=0	12.5	10.3	6.7	6.0	5.3	5.1	4.5	4.5	4.0	3.1	2.9	1.9	4.3
St. Dev.	n=0	0.9	2.5	2.2	2.1	1.4	1.8	1.2	0.7	0.9	0.7	0.6	0.9	2.4
<b>Width:Depth Ratio</b>														
Mean	n=0	10	14	20	23	36	37	31	27	24	21	15	24	25
<b>Floodprone Width</b>														
Mean	n=0	3751	464	562	1096	682	860	338	121	97	123	58	42	495
Median	n=0	3751	464	562	378	537	890	336	117	96	129	58	41	300
St. Dev.	n=0	n=1	n=1	10	1137	393	53	88	12	15	30	n=1	4	747
<b>Habitat Area (%)</b>														
Pool	100%	100%	97%	89%	91%	79%	92%	61%	12%	8%	67%	5%	30%	78%
Riffle	0%	0%	0%	0%	0%	1%	0%	9%	50%	79%	19%	50%	69%	9%
Glide	0%	0%	3%	11%	7%	17%	5%	23%	20%	12%	10%	0%	0%	9%
Side Channel	0%	0%	0%	0%	1%	4%	4%	7%	18%	0%	4%	45%	0%	3%
Other	0.3%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0.5%	0%	0.6%	3%

	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10	Napeequa River 1	Napeequa River 2	Panther Creek	All Reaches
<b>Pools</b>														
<b>Pools per Mile</b>	1	1	2	4	7	8	5	8	2	5	14	4	20	6
<b>Residual Depth (% of Pools)</b>														
% of pools D<3 ft	0%	33%	33%	0%	11%	17%	0%	60%	0%	60%	35%	0%	57%	31%
% of pools 3ft≤D<6ft	0%	33%	33%	67%	61%	56%	75%	40%	100%	40%	65%	100%	29%	53%
% of pools ≥6ft	100%	33%	33%	33%	28%	28%	25%	0%	0%	0%	0%	0%	14%	17%
<b>Riffle: Pool Ratio</b>	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.27	3.00	2.00	0.52	2.50	0.71	0.39
<b>Mean Pool Spacing (bankfull channel widths per pool)</b>	n=0	31	16	10	5	3	6	5	29	13	6	33	5	8
<b>Wood</b>														
<b>Total Number of Pieces (not including pieces in jams)</b>														
Small	85	161	74	134	222	159	66	102	28	53	158	63	23	1328
Medium	30	142	54	71	111	58	32	54	23	34	67	48	27	751
Large	20	60	23	40	60	64	29	40	12	17	33	17	13	428
Medium and Large (Quality LW)	50	202	77	111	171	122	61	94	35	51	100	65	40	1179
<b>Total</b>	135	363	151	245	393	281	127	196	63	104	258	128	63	2507
<b>Number of Pieces/Mile (not including pieces in jams)</b>														
Small	43	76	56	86	88	75	85	53	42	49	93	126	33	70
Medium	15	67	41	46	44	27	41	28	35	31	39	96	39	40
Large	10	28	18	26	24	30	37	21	18	16	19	34	19	23
Medium and Large	<b>25</b>	<b>95</b>	<b>59</b>	<b>71</b>	<b>68</b>	<b>57</b>	<b>78</b>	<b>49</b>	<b>53</b>	<b>47</b>	<b>59</b>	<b>130</b>	<b>57</b>	<b>62</b>
<b>Total</b>	68	170	115	157	156	132	163	102	95	96	152	256	90	132
<b>Jams</b>														
<b>Total Jams</b>	14	41	15	16	22	44	11	23	3	7	25	14	10	245
<b>Jams Per Mile</b>	7	19	12	10	9	21	14	12	5	6	15	28	14	13
BF Small in Jams	67	227	88	60	109	389	50	149	23	28	110	113	50	1463
BF Medium in Jams	41	167	72	43	68	262	32	129	8	16	70	80	32	1020
BF Large in Jams	22	74	49	47	65	214	34	88	5	8	46	44	23	719
<b>Total BF Wood in Jams</b>	130	468	209	150	242	865	116	366	36	52	226	237	105	3202

	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10	Napeequa River 1	Napeequa River 2	Panther Creek	All Reaches
<b>Unstable Banks</b>														
<b>Percent Reach Length (both banks)</b>	5.4%	1.6%	0.0%	1.2%	10.2%	0.8%	3.6%	0.2%	0.0%	0.0%	9.4%	0.0%	0.0%	3.3%
<b>Substrate</b>														
<b>Gravel Counts Performed</b>	2	2	2	2	2	2	2	2	2	2	2	0	1	23
% Fines	2%	1%	0%	0.5%	1%	0.9%	1%	0%	2%	4%	2%	n=0	0%	1%
% Gravels	98%	99%	100%	99.5%	99%	95.5%	71%	70%	55%	39%	79%	n=0	41%	80%
% Cobbles	0%	0%	0%	0%	0%	3.6%	28%	30%	37%	45%	19%	n=0	37%	16%
% Boulders	0%	0%	0%	0%	0%	0%	0%	0%	5%	12%	1%	n=0	22%	3%
<b>Vegetation - Percent of System</b>														
<b>Dominant Overstory Size Class</b>														
Mature Trees	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	14%	1%
Large Tree	100%	100%	100%	100%	78%	67%	100%	56%	100%	100%	46%	50%	71%	71%
Small Tree	0%	0%	0%	0%	0%	22%	0%	44%	0%	0%	54%	50%	14%	22%
Sapling Pole	0%	0%	0%	0%	0%	11%	0%	0%	0%	0%	0%	0%	0%	1%
Grassland/Forb	0%	0%	0%	0%	11%	0%	0%	0%	0%	0%	0%	0%	0%	3%
No Vegetation	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Other	0%	0%	0%	0%	11%	0%	0%	0%	0%	0%	0%	0%	0%	1%
<b>Dominant Overstory Species Composition</b>														
Cedar	0%	100%	0%	66%	11%	11%	0%	11%	67%	29%	0%	50%	0%	17%
Douglas Fir	0%	0%	0%	0%	0%	11%	0%	0%	0%	0%	38%	50%	29%	13%
Ponderosa	0%	0%	0%	0%	0%	11%	0%	0%	0%	0%	8%	0%	0%	3%
White/Grand Fir	0%	0%	0%	0%	0%	22%	100%	11%	33%	71%	0%	0%	43%	22%
Other/Unknown	0%	0%	0%	0%	22%	0%	0%	0%	0%	0%	0%	0%	0%	3%
Alder	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	46%	0%	0%	9%
Cottonwood	100%	0%	100%	33%	67%	44%	0%	78%	0%	0%	8%	0%	29%	33%
<b>Dominant Understory Size Class</b>														
Grassland/Forb	0%	0%	0%	0%	22%	11%	0%	0%	0%	0%	38%	0%	14%	13%
No Vegetation	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	29%	3%

	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10	Napeequa River 1	Napeequa River 2	Panther Creek	All Reaches
Other	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	50%	0%	1%
Shrub/Seedling	100%	100%	100%	100%	78%	89%	100%	100%	100%	100%	62%	50%	57%	83%
<b>Dominant Understory Species Composition</b>														
Cedar	0%	0%	0%	0%	0%	0%	0%	0%	0%	14%	0%	0%	0%	1%
Other/Unknown	0%	0%	0%	0%	11%	11%	0%	0%	0%	0%	38%	50%	43%	16%
Alder	0%	0%	0%	0%	0%	0%	100%	0%	0%	86%	8%	50%	0%	16%
Dogwood	100%	100%	100%	100%	67%	44%	0%	33%	0%	0%	54%	0%	0%	39%
Quaking Aspen	0%	0%	0%	0%	11%	0%	0%	0%	0%	0%	0%	0%	0%	1%
Vine/Douglas maple	0%	0%	0%	0%	11%	0%	0%	11%	100%	0%	0%	0%	57%	13%
Willow	0%	0%	0%	0%	0%	44%	0%	56%	0%	0%	0%	0%	0%	13%

## 5 References

- Carlson, L., Rose, B., Kaputa, M., & Jerabeck, J. (2004). *Wenatchee Subbasin Plan*. [https://www.nwcouncil.org/sites/default/files/WenatcheePlan\\_screen.pdf](https://www.nwcouncil.org/sites/default/files/WenatcheePlan_screen.pdf)
- Chelan County, & Yakama Nation. (2004). *Wenatchee Subbasin Plan*.
- Fox, M., & Bolton, S. (2007). A regional and geomorphic reference for quantities and volumes of instream wood in unmanaged forested basins of Washington State. *North American Journal of Fisheries Management*, 27(1), 342–359. <https://doi.org/10.1577/M05-024.1>
- Freshwater DataStream - Station 45K090. (n.d.). In *Washington State Department of Ecology*. Retrieved January 27, 2025, from <https://apps.ecology.wa.gov/continuousflowandwq/StationDetails?sta=45K090>
- Herrera Environmental Consultants. (2014). *Reach Assessment: Channel and Floodplain Hydrology, Geomorphology, Habitat, and Vegetation*.
- Upper Columbia Spatial Framework. (2021, January 8). Upper Columbia Salmon Recovery Board. <https://ucsrp.maps.arcgis.com/apps/webappviewer/index.html?id=af7b5caa1d4241eb99895883970cf393>
- USFS. (2020). *Stream Inventory Handbook: Level I and Level II. Version 2.20. Pacific Northwest Region*. United States Department of Agriculture, United States Forest Service.

## Appendix B | Reach-Based Ecosystem Indicators (REI)

---

White River RM 0 - RM 16.17

Napeequa River RM 0 – RM 2.20

Panther Creek RM 0 – RM 0.80

# Contents

<b>1</b>	<b>Introduction .....</b>	<b>1</b>
1.1	Background .....	1
1.2	Summary of Results .....	1
<b>2</b>	<b>Metrics &amp; Indicators .....</b>	<b>4</b>
2.1	Watershed-Scale Metrics .....	4
2.2	Reach-Scale Metrics .....	5
<b>3</b>	<b>REI Ratings .....</b>	<b>8</b>
3.1	Watershed-Scale Ratings .....	8
3.2	Reach-Scale Ratings – Mainstem White River Reaches .....	9
3.3	Reach-Scale Ratings – Tributary Reaches .....	18
<b>4</b>	<b>References &amp; Sources .....</b>	<b>21</b>

# 1 Introduction

## 1.1 BACKGROUND

The Reach-based Ecosystem Indicators (REI) provide a consistent means of evaluating biological and physical conditions of a watershed in relation to regional standards and known habitat requirements for aquatic biota. These indicators, along with other scientific evaluations, describe the current quality of stream biophysical conditions and can help inform restoration targets and actions. The REI indicators used in this assessment are adaptations from previous efforts including the NMFS matrix of pathways and indicators (1996) and the USFWS (1998).

The REI evaluation for White River was conducted using field data, observations, previous studies, and available data for the study area. In particular, the rankings were developed based on: 1) quantitative inventory information from the Habitat Assessment performed as part of the Reach Assessment using USFS (2020) protocols, 2) assessment of geomorphic patterns and processes and how they have deviated, if at all, from historical conditions, and 3) analysis of existing watershed assessments and data (e.g. available ArcMap layers and shapefiles). Functional ratings include Adequate, At Risk, or Unacceptable. The REI analysis helps to summarize habitat impairments and to distill the impairments down to a consistent value that can be compared among reaches.

## 1.2 SUMMARY OF RESULTS

At the watershed scale, REI ratings for the White River ranged from Adequate to Unacceptable. Watershed-scale impairments are primarily related to historical or ongoing anthropogenic disturbance to the watershed. Reach-scale metrics similarly ranged from Adequate to Unacceptable. Across all reaches, the most impaired indicators occurred in the Habitat Quality and Riparian Vegetation categories. The mainstem White River does not have any full fish passage barriers and suitable spawning-sized substrates are present throughout the study area. However, off-channel habitats accessible to fish throughout the year and high-quality riparian conditions, such as mature, old-growth trees, channel shading, and undisturbed riparian zones were limited or completely lacking across nearly all mainstem White River reaches. The lower portion of the Napeequa River near the confluence with the White River has some residential development that has impaired many of the pathways and indicators assessed in the REI, including habitat quality, riparian vegetation, and channel dynamics. Panther Creek appears to be functioning relatively well, with a number of adequate ratings, though habitat quality could be improved by increasing the number and quality of pools and off-channel habitats.

Table 1. Summary ratings for the White River reach assessment study area. Ratings are color-coded, with green shading for Adequate condition, yellow for At Risk condition, and red for Unacceptable condition.

Pathway	General Indicators	Specific Indicators	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10
Habitat Access	Physical Barriers	Main Channel Barriers	At Risk	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate
Habitat Quality	Substrate	Dominant Substrate/ Fine Sediment	At Risk	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	At Risk
	LWM	Pieces per Mile at Bankfull	Unacceptable	At Risk	Adequate*	At Risk	At Risk	At Risk	Adequate*	At Risk	Adequate*	Adequate*
	Pools	Pool Frequency and Quality, Presence of Large Pools	Adequate	Adequate	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	Unacceptable
	Off-Channel Habitat	Connectivity with Main Channel	Unacceptable	Unacceptable	Unacceptable	Unacceptable	Unacceptable	At Risk	At Risk	Adequate	At Risk	Adequate
Riparian Vegetation	Condition	Structure	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	Adequate
		Disturbance (Human)	At Risk	At Risk	At Risk	At Risk	Adequate	At Risk	At Risk	At Risk	At Risk	Adequate
		Canopy Cover	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	Adequate	Adequate
Channel	Dynamics	Floodplain Connectivity	Adequate	At Risk	Adequate	Unacceptable	At Risk	Adequate	Adequate	Adequate	Unacceptable	Adequate
		Bank Stability/ Channel Migration	At Risk	Adequate	Adequate	Unacceptable	At Risk	Adequate	At Risk	At Risk	Unacceptable	Adequate
		Vertical Channel Stability	Adequate	Adequate	Adequate	At Risk	Adequate	Adequate	Adequate	Adequate	Unacceptable	Adequate

\*Although the LWM maybe be adequate from a habitat/cover perspective, this indicator does not consider the geomorphic function of LWM. An asterisk is indicated in the LWM reach rating where the rating would potentially be lowered if geomorphic function of LWM was taken into account.

**Table 2. Summary ratings for the Napeequa River and Panther Creek tributaries. Ratings are color-coded, with green shading for Adequate condition, yellow for At Risk condition, and red for Unacceptable.**

Specific Indicators	Napeequa River 1 Reach	Napeequa River 2 Reach	Panther Creek
Main Channel Barriers	Adequate	Adequate	Adequate
Dominant Substrate/ Fine Sediment	Adequate	Adequate	At Risk
Pieces per Mile at Bankfull	At Risk	Adequate*	Adequate*
Pool Frequency and Quality, Presence of Large Pools	At Risk	At Risk	At Risk
Connectivity with Main Channel	At Risk	Adequate	At Risk
Structure	At Risk	At Risk	Adequate
Disturbance (Human)	At Risk	Adequate	Adequate
Canopy Cover	At Risk	Adequate	Adequate
Floodplain Connectivity	At Risk	Adequate	Adequate
Bank Stability/ Channel Migration	At Risk	Adequate	Adequate
Vertical Channel Stability	At Risk	Adequate	Adequate

*\*Although the LWM maybe be adequate from a habitat/cover perspective, this does not consider the geomorphic function of the LWM, which may be lacking.*

## 2 Metrics & Indicators

### 2.1 WATERSHED-SCALE METRICS

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
<b>Watershed Scale</b>					
Watershed Condition	Drainage Network and Hydrologically Impaired Surfaces	Increase in Drainage Network/ Hydrologically Impaired Surfaces	Zero or minimal increases in the drainage network that is correlated with human caused disturbances. Hydrologically impaired surfaces in watershed total <8%. Road density <1 mile/miles <sup>2</sup> .	Low to moderate increase in the drainage network correlated with human caused disturbances. Hydrologically impaired surfaces in watershed total between 8 and 14.9%. Road density 1-2.4 miles/miles <sup>2</sup> .	Substantial increase in the drainage network correlated with human caused disturbances. Hydrologically impaired surfaces in watershed total >15%. Road density ≥2.5 miles/miles <sup>2</sup> .
	Disturbance Regime	Natural/Human Caused	Environmental disturbance is short-lived; predictable hydrograph, high-quality habitat and watershed complexity providing refuge and rearing space for all life stages or multiple life-history forms. Natural processes are stable.	Localized events of hillslope contributions, avulsion, lateral migrations, minor bed incision, or wildfires. Resiliency of habitat to recover from environmental disturbances is moderate.	Frequent flood or drought producing highly variable and unpredictable flows, hillslope contributions, avulsion, lateral migrations, minor to major bed incision (head cuts), or wildfires throughout a majority of the watershed. The channel is simplified, providing little hydraulic complexity in the form of pools or side channels. Natural processes are unstable.
Flow/Hydrology	Streamflow	Alterations to Peak/Base Flows	Magnitude, timing, duration, and frequency of peak flows within a watershed are not altered relative to natural conditions of an undisturbed watershed of similar size, geology, and geography.	Some evidence of altered magnitude, timing, duration and/or frequency of peak flows relative to natural conditions of an undisturbed watershed of similar size, geology, and geography.	Pronounced changes in magnitude, timing, duration and/or frequency of peak flows relative to natural conditions of an undisturbed watershed of similar size, geology, and geography.
Water Quality	Temperature	7-day average maximum temperatures	<p><b>Bull Trout:</b></p> <p>incubation            2 - 5°C</p> <p>rearing                4 - 12°C</p> <p>spawning             4 - 9°C</p> <p><b>Other salmonids:</b></p> <p>spawning             &lt;13°C</p> <p>rearing                &lt;15°C</p> <p>holding &amp; migration &lt;15°C</p> <p>And, temperatures do not exceed 15°C in areas used by adults during migration (no thermal barriers)</p>	<p><b>Bull Trout:</b></p> <p>incubation            &lt;2 or 6°C</p> <p>rearing                &lt;4 or 13 - 15°C</p> <p>spawning             &lt;4 or 10°C</p> <p><b>Other salmonids:</b></p> <p>spawning             14-15.5°C</p> <p>rearing                &lt;14 – 17.5°C</p> <p>holding &amp; migration &lt;14 – 17.5°C</p> <p>And, temperatures in areas used by adults during migration sometimes exceed 15°C</p>	<p><b>Bull Trout:</b></p> <p>incubation            &lt;1 or &gt;6°C</p> <p>rearing                &gt;15°C</p> <p>spawning             &lt;4 or &gt;10°C</p> <p><b>Other salmonids:</b></p> <p>spawning             &gt;15.5°C</p> <p>rearing                &gt;17.5°C</p> <p>holding &amp; migration &gt;17.5°C</p> <p>And, temperatures in areas used by adults during migration regularly exceed 15°C (thermal barriers present)</p>

2.2 REACH-SCALE METRICS

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
<b>Reach Scale</b>					
Habitat Access	Physical Barriers	Main Channel Barriers	No man-made barriers present in the mainstem that limit upstream or downstream migration at any flow.	Man-made barriers are present in the mainstem that have the potential to prevent or inhibit upstream or downstream migration at a subset of flows.	Man-made barriers present in the mainstem that prevent upstream or downstream migration at multiple or all flows.
Habitat Quality	Substrate	Dominant Substrate/Fine Sediment	Gravels or small cobbles make up >50% of the bed materials in spawning areas. ≤12% of substrates <6 mm in spawning gravel.	Gravels or small cobbles make up 30-50% of the bed materials in spawning areas. 12-20% of substrates <6 mm in spawning gravel.	Gravels or small cobbles make up <30% of the bed materials in spawning areas. >20% of substrates <6 mm in spawning gravel.
	LWM	Pieces per Mile at Bankfull	<p>Based on Fox and Bolton (2007) metrics for Eastern Washington, at least 67.45 pieces/mile of “Medium” and “Large” size large woody material (LWM) are present in the reach, based on USFS (2020) size classifications. USFS Stream Inventory protocol (2020) large woody material criteria, under the Eastside Forests criteria:</p> <p>Medium = diameter &gt; 12 in, length &gt; 35 ft</p> <p>Large = diameter &gt; 20 in, length &gt; 35 ft</p> <p>In addition to a minimum of 67.45 pieces of medium or large wood/mile, an adequate rating also indicates the LWM are well-distributed throughout the reach and there are sources of woody debris available for both long- and short-term recruitment within the reach.</p>	Current levels are able to maintain the minimum requirements for an "adequate" rating, but potential sources for long-term woody debris recruitment, as determined by the Riparian Structure reach metrics, are lacking in order to maintain these current levels or wood is not well-distributed throughout the reach.	Current levels are not meeting the minimum requirements for an “adequate” rating, and potential source of woody debris for short- and/or long-term recruitment are lacking or wood is not well-distributed throughout the reach.

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition																											
	Pools	Pool Frequency and Quality; presence of large pools.	<p>Pool frequency: Number of pools/mile for a given bankfull width (BFW) equal or exceed NMFS (1996) criteria (below). For channels with bankfull &gt;100 ft, minimum number of pools/mile were extrapolated based on relationship between BFW and pools/mile in NMFS (1996) criteria.</p> <p>Bankfull width:</p> <table border="1"> <tr><td>25-50</td><td>26</td><td>pools/mile</td></tr> <tr><td>51-75</td><td>23</td><td>pools/mile</td></tr> <tr><td>76-100</td><td>18</td><td>pools/mile</td></tr> <tr><td>101-130</td><td>15</td><td>pools/mile</td></tr> <tr><td>131-140</td><td>14</td><td>pools/mile</td></tr> <tr><td>141-150</td><td>13</td><td>pools/mile</td></tr> <tr><td>151-170</td><td>12</td><td>pools/mile</td></tr> <tr><td>171-180</td><td>11</td><td>pools/mile</td></tr> <tr><td>181-190</td><td>10</td><td>pools/mile</td></tr> </table> <p>In addition, at least 50% of the total pools must be large pools with &gt;1 m (3 ft) of residual depth and good fish cover.</p>	25-50	26	pools/mile	51-75	23	pools/mile	76-100	18	pools/mile	101-130	15	pools/mile	131-140	14	pools/mile	141-150	13	pools/mile	151-170	12	pools/mile	171-180	11	pools/mile	181-190	10	pools/mile	Pool frequency meets or almost meets the values for the "adequate" rating, but pools have inadequate cover/temperature and/or there has been a moderate reduction of pool volume by fine sediment. Reaches have between 20-50% large pools present with good fish cover.	Pool frequency does not meet the pools/mile metric given in the "adequate" rating. Reaches have <20% large pools (>1 m deep). Pools also have inadequate cover/temperature and/or there has been a major reduction of pool volume by fine sediment.
	25-50	26	pools/mile																													
51-75	23	pools/mile																														
76-100	18	pools/mile																														
101-130	15	pools/mile																														
131-140	14	pools/mile																														
141-150	13	pools/mile																														
151-170	12	pools/mile																														
171-180	11	pools/mile																														
181-190	10	pools/mile																														
	Off-Channel Habitat and Refugia	Connectivity with Main Channel	Reach has side channels and/or groundwater fed tributaries. Aquatic refugia such as backwaters, alcoves, large boulder eddies exist within the reach. Well-vegetated floodplains with healthy riparian community are inundated on a 1-2-year recurrence frequency. No man-made barriers that prevent access to off-channel areas.	Reach provides some aquatic off-channel and refugia features but access varies or is at risk of disconnection due to human impacts or man-made barriers. Floodplains along the off-channel habitat are well-vegetated with inundation recurrence of 2-5-years.	Reach provides no or only minimal off-channel refugia. Floodplains are disconnected and riparian vegetation has been altered.																											
Riparian Vegetation	Condition	Structure	>80% large trees (>21" DBH; USFS, 2020) in the riparian zone (defined as a 100ft buffer along each bank) based on habitat assessment data, as well as no visual evidence of human impacts on vegetations (e.g. logging or residential/agricultural clearing) in the floodplain.	50-80% large trees (>21" DBH; USFS, 2020) in the riparian zone (defined as a 100ft buffer along each bank) based on habitat assessment data, as well as a moderate amount of visual evidence of human impacts on vegetation (e.g. logging or residential/agricultural clearing) in the floodplain.	<50% large trees (>21" DBH; USFS, 2020) in the riparian zone (defined as a 100ft buffer along each bank) based on habitat assessment data, as well as moderate-high visual evidence of human impacts on vegetation (e.g. logging or residential/agricultural clearing) in the floodplain.																											
		Disturbance (Human)	<20% disturbance (e.g. agriculture and grazing, residential, roads, etc.) and <2 mile/miles <sup>2</sup> road density in the 200-foot channel buffer.	20-50% disturbance (e.g. agriculture and grazing, residential, roads, etc.) and 2-3 miles/miles <sup>2</sup> road density in the 200-foot channel buffer zone.	>50% disturbance (e.g. agriculture and grazing, residential, roads, etc.) and >3 miles/miles <sup>2</sup> road density in the in the 200-foot channel buffer zone.																											

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
		Canopy Cover	Canopy cover provides high level of channel shading, based on the number of shaded daylight hours on the summer solstice according to publicly-available map tool Shademap ( <a href="https://shademap.app/">https://shademap.app/</a> ). In addition, a high proportion of large trees (height > 100 feet) and little or no anthropogenic clearing or disturbance are present within 100-feet of the channel bank.	Canopy cover provides moderate level of channel shading, based on the number of shaded daylight hours on the summer solstice. In addition, a moderate proportion of large trees (height > 100 feet) and some anthropogenic clearing or disturbance is present within 100-feet of the channel bank.	Canopy cover provides low level of channel shading, based on the number of shaded daylight hours on the summer solstice. In addition, a small proportion of large trees (height > 100 feet) and substantial anthropogenic clearing or disturbance are present within 100-feet of the channel bank.
Channel	Dynamics	Floodplain Connectivity	Floodplain areas are hydrologically linked to main channel within the context of the local process domain; overbank flows occur and maintain wetland functions, and riparian vegetation. Naturally confined channels are considered adequate.	Reduced linkage of floodplains and riparian areas to main channel in reaches with historically strong connectivity; overbank flows are reduced relative to historic frequency, as evidenced by moderate degradation of floodplain soil accumulations and riparian vegetation/succession.	Severe reduction in hydrologic connectivity between off-channel, floodplain, and riparian areas relative to historical connectivity; riparian vegetation/succession is altered significantly.
		Bank Stability/Channel Migration	Channel is migrating at or near natural rates within the geomorphic construct of the reach.	Channel migration is occurring at a faster or slower rate relative to natural rates, but significant change in channel width or planform is not detectable; large woody debris is still being recruited.	Little or no channel migration is occurring because of human actions preventing reworking of the floodplain and large woody debris recruitment; or channel migration is occurring at an accelerated rate such that channel width has at least doubled, possibly resulting in a channel planform change, and sediment supply has noticeably increased from bank erosion.
		Vertical Channel Stability	No measurable trend of aggradation or incision beyond the natural geomorphic processes of the reach.	Measurable trend of aggradation or incision that has the potential to, but has not yet caused, disconnection of the floodplain or a visible change in channel planform (e.g. single thread to braided.)	Enough incision or human infrastructure has occurred that the floodplain and off-channel habitat areas have been disconnected from the main channel; or enough aggradation has occurred to create a visible change in channel planform (e.g. single thread to braided.)

### 3 REI Ratings

This section discusses the results for each indicator, rated at either the reach-scale or watershed-scale for all four reaches.

#### 3.1 WATERSHED-SCALE RATINGS

General Characteristics	General Indicators	Specific Indicators	Rating	Discussion
<b>Watershed Scale</b>				
Watershed Condition	Drainage Network and Hydrologically Impaired Surfaces	Increase in Drainage Network/ Hydrologically Impaired Surfaces	Adequate	Hydrologically impaired surfaces (roads, parking lots, and buildings) in the watershed were calculated using the 2010 Statewide Landuse GIS dataset (“2010 Statewide Landuse,” 2010). Parcels were classified as “hydrologically impaired” or “Not hydrologically impaired” for the watershed based on landuse codes in the dataset. Hydrologically impaired parcel polygon areas were summed and compared to the total watershed area, as determined using the StreamStats online mapper application (U.S. Geological Survey, 2024). The average percentage of hydrologically impaired surfaces for the entire contributing watershed was 0.6%. Road density was calculated using a Washington Department of Natural Resources state roads GIS dataset. Total length of roads in the White River watershed was calculated and compared to the total watershed area. The watershed road density is 0.3 miles of road per square mile of watershed. The White River watershed is relatively undeveloped, with most of the impaired surfaces in the valley bottom and in the downstream portion of the study area (Reach 6 and below). Some development is also present near the mouth of the Napeequa River. In some cases, the roads and structures are immediately adjacent to the river. Overall, road density and percentage of impaired surfaces is low, therefore this indicator receives an Adequate condition.
	Disturbance Regime	Natural/Human Caused	At Risk	This disturbance history rating reflects historical accounts of riparian and hillslope timber harvest, fire suppression, beaver trapping, grazing, agriculture and roads and residential development. These human-caused disturbances have historical and on-going impacts on the watershed and have altered the natural disturbance cycles. Instead of frequent, low intensity fires, fire suppression efforts have led to a denser, less fire-tolerant forest that is more prone to high-intensity fires (USFS, 1999, 2003; Mayfield et al., 2022). Two large fires have occurred in the watershed in recent years, the Alpine Lake Fire in 2023 (6956 acres) and the White River-Irving Peak Fire in 2022 (11, 110 acres) ( <i>Washington Large Fires 1973-2023</i> ). The removal of old growth conifers for timber harvest in the hillslopes and valley bottom has resulted in a lack of LWM that has significant influence on channel processes and morphology, as well as diminished amount of shade, nutrient contribution, and floodplain moisture retention. The loss of beaver and development within the floodplain has detrimentally affected floodplain dynamics within the watershed (Andonaegui, 2001; Plummer, 1902). Although human-related alterations to the disturbance regime exist within the watershed, the amount of disturbance is relatively low. Most of the development occurs in the lower portion of the White River or near the mouth of the Napeequa River. Logging occurred, but the basin has had comparably minimal logging overall (USFS, 2003) and enough time has passed that large trees are prevalent within the riparian zone. Most of the watershed is undeveloped and is either Okanogan-Wenatchee National Forest land or part of the protected Glacier Peak Wilderness. In consideration of these factors, the watershed receives an At Risk rating for disturbance.
Flow/Hydrology	Streamflow	Alterations to Peak/Base Flows	At Risk	The hydrology of the White River watershed is driven by snowmelt and precipitation. Peak flows occur in the spring from snowmelt runoff, with a secondary peak in the late fall from precipitation. Recent data exists from a Washington Dept of Ecology gage (Gage #45K090, data from 2002-present) and historical data exists from a USGS gage (1955-1983) for the same location. In a comparison of the two datasets, the 2002-present data show earlier timing of peak flow events, higher discharge events in the late fall/winter from precipitation falling as rain instead of snow, and lower discharges in the spring driven by snowmelt runoff. This aligns with predictions from regional climate change models, which estimated and increased proportion of the precipitation occurring as rain rather than snow, and that the timing and magnitude of peak flow will change, but not the mean annual flows. The two gage datasets support this, with very similar mean annual discharge values (810 cfs for 1955-1983 vs 808 cfs for 2002-present). This observed change in magnitude and timing of the peak flows is related to global/regional effects of climate change, and not watershed- or reach-scale disturbances. Therefore, the watershed receives an At Risk rating.
Water Quality	Temperature	Daily maximum and 7-day mean daily maximum temperatures	Unacceptable	Recent water temperature data exists from a Washington Dept of Ecology gage (Gage #45K090, data from 2003-present). Temperature data was evaluated for the period 2003-2024. Over the course of the 21-year period, the 7-DADMax exceeded 15°C 11 out of the 21 years. Between 2003-2013, the 7-DADMax was exceeded roughly every third year on average. Between 2014-2024, the 7-DADMax was more frequently exceeded – averaging every other year. Water temperatures over 15 °C most regularly occurred in August. The duration of water temperatures over 15 °C typically lasted for a week or longer. For these reasons, this indicator receives an Unacceptable rating.

3.2 REACH-SCALE RATINGS – MAINSTEM WHITE RIVER REACHES

Pathway	General Indicators	Specific Indicators	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10
Habitat Access	Physical Barriers	Main Channel Barriers	At Risk	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate
			There were no anthropogenic barriers in the main channel. There is a channel-spanning weir which has the potential to be a fish passage impediment at lower flows.	There were no anthropogenic barriers in the main channel.	There were no anthropogenic barriers in the main channel.	There were no anthropogenic barriers in the main channel.	There were no anthropogenic barriers in the main channel.	There were no anthropogenic barriers in the main channel.	There were no anthropogenic barriers in the main channel.	There were no anthropogenic barriers in the main channel.	There were no anthropogenic barriers in the main channel.	There were no anthropogenic barriers in the main channel.
Habitat Quality	Substrate	Dominant Substrate/ Fine Sediment	At Risk	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	At Risk
			Based on two gravel counts, gravels (2.1-64mm; 98%) dominate the substrate, followed by fines (<2mm; 2%). The combined average between the two gravel counts showed 29% of substrates are <5.6 mm.	Based on two gravel counts, gravels (2.1-64mm; 99%) dominate the substrate, followed by fines (<2mm; 1%). The combined average between the two gravel counts showed 10% of substrates are <5.6 mm.	Based on two gravel counts, gravels (2.1-64mm; 100%) dominate the substrate. The combined average between the two gravel counts showed 6% of substrates are <5.6 mm.	Based on two gravel counts, gravels (2.1-64mm; 95.5%) dominate the substrate, followed by fines (<2mm; 0.5%). The combined average between the two gravel counts showed 2.4% of substrates are <5.6 mm.	Based on two gravel counts, gravels (2.1-64mm; 99%) dominate the substrate, followed by fines (<2mm; 1%). The combined average between the two gravel counts showed 3.7% of substrates are <5.6 mm.	Based on two gravel counts, gravels (2.1-64mm; 95.5%) dominate the substrate, followed by cobbles (64.1-256 mm; 3.6%) and fines (<2mm; 0.9%). The combined average between the two gravel counts showed 1% of substrates are <5.6 mm.	Based on two gravel counts, gravels (2.1-64mm; 71%) dominate the substrate, followed by cobbles (64.1-256 mm; 28%) and fines (<2mm; 1%). The combined average between the two gravel counts showed 1% of substrates are <5.6 mm.	Based on two gravel counts, gravels (2.1-64mm; 70%) dominate the substrate, followed by cobbles (64.1-256 mm; 30%). The combined average between the two gravel counts showed 0% of substrates are <5.6 mm.	Based on two gravel counts, gravels (2.1-64mm; 55%) dominate the substrate, followed by cobbles (64.1-256 mm; 38%), boulders (>256 mm; 5%), and fines (<2mm; 2%). The combined average between the two gravel counts showed 6% of substrates are <5.6 mm.	Based on two gravel counts, cobbles (64.1-256 mm; 45%) dominate the substrate, followed by gravels (2.1-64mm; 39%), boulders (>256 mm; 12%) and fines (<2mm; 4%). The combined average between the two gravel counts showed 5% of substrates are <5.6 mm.

Pathway	General Indicators	Specific Indicators	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10
Habitat Quality	LWM	Pieces per Mile at Bankfull	Unacceptable	At Risk	Adequate*	At Risk	At Risk	At Risk	Adequate*	At Risk	Adequate*	Adequate*
			<p>M+L pieces/mi = 57</p> <p>Percent in Jams = 55%</p> <p>Distribution of Jams = Uneven</p> <p>Does not meet the minimum criteria of 67.45 pieces of M+L wood per mile. Most (&gt;50%) of the wood is within jams and potential sources for long-term woody debris recruitment are somewhat limited.</p>	<p>M+L pieces/mi = 208</p> <p>Percent in Jams = 56%</p> <p>Distribution of Jams = Even</p> <p>Meets the minimum criteria of 67.45 pieces of M+L wood per mile. Most (&gt;50%) of the wood is within jams, and potential sources for long-term woody debris recruitment are somewhat limited.</p>	<p>M+L pieces/mi = 151</p> <p>Percent in Jams = 58%</p> <p>Distribution of Jams = Uneven</p> <p>Meets the minimum criteria of 67.45 pieces of M+L wood per mile. Most (&gt;50%) of the wood is within jams and there are some sources of woody debris available for both long- and short-term recruitment within the reach.</p>	<p>M+L pieces/mi = 129</p> <p>Percent in Jams = 38%</p> <p>Distribution of Jams = Uneven</p> <p>Meets the minimum criteria of 67.45 pieces of M+L wood per mile. Less than 50% of the wood is within jams and potential sources for long-term woody debris recruitment are somewhat limited.</p>	<p>M+L pieces/mi = 121</p> <p>Percent in Jams = 38%</p> <p>Distribution of Jams = Uneven</p> <p>Meets the minimum criteria of 67.45 pieces of M+L wood per mile. Less than 50% of the wood is within jams and potential sources for long-term woody debris recruitment are somewhat limited.</p>	<p>M+L pieces/mi = 281</p> <p>Percent in Jams = 76%</p> <p>Distribution of Jams = Even</p> <p>Meets the minimum criteria of 67.45 pieces of M+L wood per mile. Most (&gt;50%) of the wood is within jams, and potential sources for long-term woody debris recruitment are somewhat limited.</p>	<p>M+L pieces/mi = 163</p> <p>Percent in Jams = 48%</p> <p>Distribution of Jams = Even</p> <p>Meets the minimum criteria of 67.45 pieces of M+L wood per mile. Less than 50% of the wood is within jams and there are some sources of woody debris available for both long- and short-term recruitment within the reach.</p>	<p>M+L pieces/mi = 162</p> <p>Percent in Jams = 65%</p> <p>Distribution of Jams = Uneven</p> <p>Meets the minimum criteria of 67.45 pieces of M+L wood per mile. Most (&gt;50%) of the wood is within jams, and potential sources for long-term woody debris recruitment are somewhat limited.</p>	<p>M+L pieces/mi = 73</p> <p>Percent in Jams = 36%</p> <p>Distribution of Jams = Uneven</p> <p>Meets the minimum criteria of 67.45 pieces of M+L wood per mile. Less than 50% of the wood is within jams and there are some sources of woody debris available for both long- and short-term recruitment within the reach.</p>	<p>M+L pieces/mi = 69</p> <p>Percent in Jams = 33%%</p> <p>Distribution of Jams = Uneven</p> <p>Meets the minimum criteria of 67.45 pieces of M+L wood per mile. Less than 50% of the wood is within jams and there are some sources of woody debris available for both long- and short-term recruitment within the reach.</p>

Pathway	General Indicators	Specific Indicators	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10
Habitat Quality	Pools	Pool Frequency and Quality; Presence of large pools.	Adequate	Adequate	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	Unacceptable	At Risk
			Total Pools = 2 Pools/mi = 1 Pools ≥ 3 ft = 0 (0%) Pools ≥ 6 ft = 2 (100%) Avg residual pool depth: 10.8 ft Cover: low Reach is significantly affected by the backwater effect of Lake Wenatchee, and is almost entirely pool habitat. Pools are large and deep. Overhanging cover for the pools is relatively low, though there is LWM present.	Total Pools = 3 Pools/mi = 1 Pools ≥ 3 ft = 1 (33%) Pools ≥ 6 ft = 1 (33%) Avg residual pool depth: 4.9 ft Cover: moderate Reach is significantly affected by the backwater effect of Lake Wenatchee, and is almost entirely pool habitat. Pools are large and deep. Overhanging cover for the pools is relatively low, though there is LWM present.	Total Pools = 3 Pools/mi = 2 Pools ≥ 3 ft = 1 (33%) Pools ≥ 6 ft = 1 (33%) Avg residual pool depth: 4.6 ft Cover: low Does not meet the pool frequency criteria for bankfull width (average BFW = 140, requires 14 pools/mile), however, this reach is not lacking in pool habitat, but rather in the heterogeneity of habitat units. Most of the pools are large, but cover is low, with only moderate amounts of LWM and cover.	Total Pools = 6 Pools/mi = 4 Pools ≥ 3 ft = 4 (67%) Pools ≥ 6 ft = 2 (33%) Avg residual pool depth: 5.5 ft Cover: moderate Does not meet the pool frequency criteria for bankfull width (average BFW = 140, requires 14 pools/mile), however, this reach is not lacking in pool habitat, but rather in the heterogeneity of habitat units. Most of the pools are large, with LWM and cover relatively available.	Total Pools = 18 Pools/mi = 7 Pools ≥ 3 ft = 11 (61%) Pools ≥ 6 ft = 5 (33%) Avg residual pool depth: 4.6 ft Cover: moderate Does not meet the pool frequency criteria for bankfull width (average BFW = 145, requires 13 pools/mile), however, this reach is not lacking in pool habitat, but rather in the heterogeneity of habitat units. Most of the pools are large, with LWM and cover relatively available.	Total Pools = 18 Pools/mi = 8 Pools ≥ 3 ft = 10 (56%) Pools ≥ 6 ft = 5 (28%) Avg residual pool depth: 4.9 ft Cover: moderate - high Does not meet the pool frequency criteria for bankfull width (average BFW = 188, requires 10 pools/mile) and pools are large. Cover and LWM is relatively high, offering high-quality pool habitat availability.	Total Pools = 4 Pools/mi = 5 Pools ≥ 3 ft = 3 (75%) Pools ≥ 6 ft = 1 (25%) Avg residual pool depth: 4.8 ft Cover: moderate Does not meet the pool frequency criteria for bankfull width (average BFW = 173, requires 11 pools/mile) however, this reach is not lacking in pool habitat, but rather in the heterogeneity of habitat units. Most of the pools are large, with LWM and cover relatively available.	Total Pools = 15 Pools/mi = 8 Pools ≥ 3 ft = 6 (40%) Pools ≥ 6 ft = 0 (0%) Avg residual pool depth: 2.9 ft Cover: moderate Does not meet the pool frequency criteria for bankfull width (average BFW = 131, requires 14 pools/mile). Pools residual depths are relatively low, though LWM and cover are relatively available.	Total Pools = 1 Pools/mi = 2 Pools ≥ 3 ft = 1 (100%) Pools ≥ 6 ft = 0 (0%) Avg residual pool depth: 3.2 ft Cover: low Does not meet the pool frequency criteria for bankfull width (average BFW = 119, requires 15 pools/mile). Availability of cover in the pool is low.	Total Pools = 5 Pools/mi = 5 Pools ≥ 3 ft = 2 (40%) Pools ≥ 6 ft = 0 (0%) Avg residual pool depth: 2.6 ft Cover: moderate Does not meet the pool frequency criteria for bankfull width (average BFW = 92, requires 18 pools/mile). Pools residual depths are relatively low, though LWM and cover are relatively available.

Pathway	General Indicators	Specific Indicators	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10
Habitat Quality	Off-Channel Habitat and Refugia	Connectivity with Main Channel	Unacceptable	Unacceptable	Unacceptable	Unacceptable	Unacceptable	At Risk	At Risk	Adequate	At Risk	Adequate
			<p>Total SC = 0</p> <p>Reach is lacking off-channel habitats that are connected at a high range of flows.</p> <p>Floodplains are disconnected by high levels of incision and some human structures, as determined by field observations and hydraulic modeling.</p>	<p>Total SC = 0</p> <p>Reach is lacking off-channel habitats that are connected at a high range of flows.</p> <p>Floodplains are disconnected by high levels of incision and some human structures, as determined by field observations and hydraulic modeling.</p>	<p>Total SC = 0</p> <p>Reach is lacking off-channel habitats that are connected at a higher range of flows.</p> <p>Floodplains are disconnected by high levels of incision and some human structures, as determined by field observations and hydraulic modeling.</p>	<p>Total SC = 0</p> <p>Reach is lacking off-channel habitats that are connected at a higher range of flows.</p> <p>Floodplains are hydraulically connected at a slightly greater range of flows, but constricted by the bridge and elevated road prism on the upstream end of the reach.</p>	<p>Total SC = 2</p> <p>Fast water = 1</p> <p>Slow water = 1</p> <p>Some off-channel habitat exists that is connected at a variety of flows.</p> <p>Floodplains are hydraulically connected at a slightly greater range of flows, but constricted by the bridge and elevated road prism on the downstream end of the reach.</p>	<p>Total SC = 3</p> <p>Fast water = 1</p> <p>Slow water = 2</p> <p>Some off-channel habitat exists that is connected at a variety of flows.</p> <p>Floodplains are hydraulically connected at a greater range of flows than other reaches, though some confinement still occurs from human impacts.</p>	<p>Total SC = 1</p> <p>Fast water = 0</p> <p>Slow water = 1</p> <p>Very little off-channel habitat exists.</p> <p>Floodplains are hydraulically connected at a greater range of flows than other reaches, though some confinement still occurs from human impacts.</p>	<p>Total SC = 4</p> <p>Fast water = 0</p> <p>Slow water = 4</p> <p>A moderate amount of off-channel habitat exists within the reach, and floodplains are hydraulically well connected to the channel.</p>	<p>Total SC = 2</p> <p>Fast water = 2</p> <p>Slow water = 0</p> <p>Some off-channel habitat exists that is connected at a variety of flows, but there was likely historical anthropogenic straightening as well as natural confinement that limits the potential for off-channel habitats.</p> <p>Available floodplains are hydraulically well connected to the channel.</p>	<p>Total SC = 0</p> <p>Fast water = 0</p> <p>Slow water = 0</p> <p>Minimal off channel habitat exists; however, natural conditions (steep slope and bedrock confinement) limit the potential for off-channel habitat forming. Minimal constriction from human impacts are present in the reach.</p>

Pathway	General Indicators	Specific Indicators	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10
Riparian Vegetation	Condition	Structure	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	Adequate
			<p>The riparian canopy overstory composition within the 100-foot riparian buffer was recorded as 100% large tree.</p> <p>Reach has some visual evidence of human disturbance that has reduced the width of the riparian buffer and impacted stand age and structural complexity in many areas of this reach as determined by field estimates, tree height data, or aerial photographs.</p>	<p>The riparian canopy overstory composition within the 100-foot riparian buffer was recorded as 100% large tree.</p> <p>Reach has some visual evidence of human disturbance that has reduced the width of the riparian buffer and impacted stand age and structural complexity in many areas of this reach as determined by field estimates, tree height data, or aerial photographs.</p>	<p>The riparian canopy overstory composition within the 100-foot riparian buffer was recorded as 100% large tree.</p> <p>Reach has some visual evidence of human disturbance that has reduced the width of the riparian buffer and impacted stand age and structural complexity in many areas of this reach as determined by field estimates, tree height data, or aerial photographs.</p>	<p>The riparian canopy overstory composition within the 100-foot riparian buffer was recorded as 100% large tree.</p> <p>Reach has some visual evidence of human disturbance that has reduced the width of the riparian buffer and impacted stand age and structural complexity in many areas of this reach, as determined by field estimates, tree height data, or aerial photographs.</p>	<p>The riparian canopy overstory composition within the 100-foot riparian buffer was recorded as 78% large tree, 11% grassland/forb, and 11% other.</p> <p>Reach has visual evidence of human disturbance that has reduced the width of the riparian buffer and impacted stand age and structural complexity in many areas of this reach, as determined by field estimates, tree height data, or aerial photographs.</p>	<p>The riparian canopy overstory composition within the 100-foot riparian buffer was recorded as 67% large tree, 22% small tree, and 11% sapling/pole.</p> <p>Reach has some visual evidence of human disturbance that has reduced the width of the riparian buffer and impacted stand age and structural complexity in many areas of this reach, as determined by field estimates, tree height data, or aerial photographs.</p>	<p>The riparian canopy overstory composition within the 100-foot riparian buffer was recorded as 56% large tree and 44% small tree.</p> <p>Reach has some human disturbance that has reduced the width of the riparian buffer and impacted stand age and structural complexity in many areas of this reach, as determined by field estimates, tree height data, or aerial photographs.</p>	<p>The riparian canopy overstory composition within the 100-foot riparian buffer was recorded as 100% large tree.</p> <p>Reach has some visual evidence of human disturbance that has reduced the width of the riparian buffer and impacted stand age and structural complexity in many areas of this reach, as determined by field estimates, tree height data, or aerial photographs.</p>	<p>The riparian canopy overstory composition within the 100-foot riparian buffer was recorded as 100% large tree.</p> <p>Reach has no visual evidence of human disturbance that impacted the riparian buffer as determined by field estimates, tree height data, or aerial photographs.</p>	
		Disturbance (Human)	At Risk	At Risk	At Risk	At Risk	Adequate	At Risk	At Risk	At Risk	At Risk	At Risk
<p>0.7% disturbance in the 200-foot buffer zone (e.g. residential, roads, etc.) and 2.1 miles/miles<sup>2</sup> road density in the 200-foot riparian buffer zone.</p>	<p>4.1% disturbance in the 200-foot buffer zone (e.g. residential, roads, etc.) and 9.7 miles/miles<sup>2</sup> road density in the 200-foot riparian buffer zone.</p>	<p>1.2% disturbance in the 200-foot buffer zone (e.g. residential, roads, etc.) and 3.0 miles/miles<sup>2</sup> road density in the 200-foot riparian buffer zone.</p>	<p>4.9% disturbance in the 200-foot buffer zone (e.g. residential, roads, etc.) and 9.3 miles/miles<sup>2</sup> road density in the 200-foot riparian buffer zone.</p>	<p>0.3% disturbance in the 200-foot buffer zone (e.g. residential, roads, etc.) and 0.6 miles/miles<sup>2</sup> road density in the 200-foot riparian buffer zone.</p>	<p>1.2% disturbance in the 200-foot buffer zone (e.g. residential, roads, etc.) and 2.4 miles/miles<sup>2</sup> road density in the 200-foot riparian buffer zone.</p>	<p>2.2% disturbance in the 200-foot buffer zone (e.g. residential, roads, etc.) and 4.0 miles/miles<sup>2</sup> road density in the 200-foot riparian buffer zone.</p>	<p>3.1% disturbance in the 200-foot buffer zone (e.g. residential, roads, etc.) and 7.9 miles/miles<sup>2</sup> road density in the 200-foot riparian buffer zone.</p>	<p>0.8% disturbance in the 200-foot buffer zone (e.g. residential, roads, etc.) and 2.2 miles/miles<sup>2</sup> road density in the 200-foot riparian buffer zone.</p>	<p>0.0% disturbance in the 200-foot buffer zone (e.g. residential, roads, etc.) and 0.0 miles/miles<sup>2</sup> road density in the 200-foot riparian buffer zone.</p>			

Pathway	General Indicators	Specific Indicators	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10
Riparian Vegetation	Condition	Canopy Cover	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	Adequate	Adequate
			<p>Reach average of 3.2 hours shaded during daylight hours on the summer solstice, determined from the weighted average of raster data from the shademap tool for each reach.</p> <p>Low amounts of tall trees (height&gt; 100 feet) within the 100-foot riparian buffer were found using visual estimates of GIS tree height data. Moderate levels of disturbance or clearing within the 100-foot buffer were determined through visual estimates of aerial photos.</p>	<p>Reach average of 7.1 hours shaded during daylight hours on the summer solstice, determined from the weighted average of raster data from the shademap tool for each reach.</p> <p>Low amounts of tall trees (height&gt; 100 feet) within the 100-foot riparian buffer were found using visual estimates of GIS tree height data. Moderate levels of disturbance or clearing within the 100-foot buffer were determined through visual estimates of aerial photos.</p>	<p>Reach average of 6.3 hours shaded during daylight hours on the summer solstice, determined from the weighted average of raster data from the shademap tool for each reach.</p> <p>Moderate amounts of tall trees (height&gt; 100 feet) within the 100-foot riparian buffer were found using visual estimates of GIS tree height data. Moderate levels of disturbance or clearing within the 100-foot buffer were determined through visual estimates of aerial photos.</p>	<p>Reach average of 6.2 hours shaded during daylight hours on the summer solstice, determined from the weighted average of raster data from the shademap tool for each reach.</p> <p>High amounts of tall trees (height&gt; 100 feet) within the 100-foot riparian buffer were found using visual estimates of GIS tree height data. High levels of disturbance or clearing within the 100-foot buffer were determined through visual estimates of aerial photos.</p>	<p>Reach average of 5.5 hours shaded during daylight hours on the summer solstice, determined from the weighted average of raster data from the shademap tool for each reach.</p> <p>Low amounts of tall trees (height&gt; 100 feet) within the 100-foot riparian buffer were found using visual estimates of GIS tree height data. Moderate levels of disturbance or clearing within the 100-foot buffer were determined through visual estimates of aerial photos.</p>	<p>Reach average of 6.0 hours shaded during daylight hours on the summer solstice, determined from the weighted average of raster data from the shademap tool for each reach.</p> <p>Moderate amounts of tall trees (height&gt; 100 feet) within the 100-foot riparian buffer were found using visual estimates of GIS tree height data. Moderate levels of disturbance or clearing within the 100-foot buffer were determined through visual estimates of aerial photos.</p>	<p>Reach average of 6.8 hours shaded during daylight hours on the summer solstice, determined from the weighted average of raster data from the shademap tool for each reach.</p> <p>Low amounts of tall trees (height&gt; 100 feet) within the 100-foot riparian buffer were found using visual estimates of GIS tree height data. Moderate levels of disturbance or clearing within the 100-foot buffer were determined through visual estimates of aerial photos.</p>	<p>Reach average of 7.1 hours shaded during daylight hours on the summer solstice, determined from the weighted average of raster data from the shademap tool for each reach.</p> <p>Moderate amounts of tall trees (height&gt; 100 feet) within the 100-foot riparian buffer were found using visual estimates of GIS tree height data. Moderate levels of disturbance or clearing within the 100-foot buffer were determined through visual estimates of aerial photos.</p>	<p>Reach average of 10.0 hours shaded during daylight hours on the summer solstice, determined from the weighted average of raster data from the shademap tool for each reach.</p> <p>High amounts of tall trees (height&gt; 100 feet) within the 100-foot riparian buffer were found using visual estimates of GIS tree height data. Low levels of disturbance were determined through visual estimates of aerial photos.</p>	<p>Reach average of 9.9 hours shaded during daylight hours on the summer solstice, determined from the weighted average of raster data from the shademap tool for each reach.</p> <p>High amounts of tall trees (height&gt; 100 feet) within the 100-foot riparian buffer were found using visual estimates of GIS tree height data. Low levels of disturbance were determined through visual estimates of aerial photos.</p>

Pathway	General Indicators	Specific Indicators	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10
Channel	Dynamics	Floodplain Connectivity	Adequate	At Risk	Adequate	Unacceptable	At Risk	Adequate	Adequate	Adequate	Unacceptable	Adequate
			<p>Vegetated floodplains exist throughout the valley floor in the reach. Connectivity to the existing modern floodplains is adequate with the exception of an anthropogenically disconnected surface at the upstream boundary of the reach associated with the Little Wenatchee Road bridge. As long as the disconnection remains local, floodplain connectivity is adequate for the reach.</p>	<p>Vegetated floodplains exist throughout the valley floor in the reach, although entrenchment associated with the Little Wenatchee Road bridge has anthropogenically disconnected multiple floodplain surfaces and low floodplain surfaces are sparsely distributed in the lower portion. Disconnection is likely to continue unless channel complexity is introduced to the reach. Natural levees line the channel in the reach and may exacerbate floodplain disconnection as they grow.</p>	<p>Where valley width allows, vegetated floodplains exist throughout the valley floor. Connectivity to the existing modern floodplain is adequate. Natural levees line the channel in the reach and may put the reach At Risk for floodplain connectivity if levees continue to grow.</p>	<p>The channel is entrenched in this reach due to channel straightening and confinement at the Sears Creek Road bridge. Although vegetated floodplains exist throughout the valley floor, connectivity to the existing modern floodplain is significantly reduced compared to presumed historical conditions. Natural levees line the channel in the reach and may exacerbate floodplain disconnection as they grow.</p>	<p>Where valley width allows, vegetated floodplains exist below historical floodplain terraces. The lower portion of the reach is entrenched due to channel straightening and confinement at the Sears Creek Road bridge. Connectivity to the existing modern floodplains is adequate in the middle and upper portion of the reach, and reduced in the lower portion of the reach. Entrenchment is likely to continue to grow leading to floodplain disconnection in the lower portion of the reach unless channel complexity is introduced to the reach.</p>	<p>Where valley width allows, vegetated floodplains exist below historical floodplain terraces. Connectivity to the existing modern floodplain is adequate.</p>	<p>Where valley width allows, vegetated floodplains exist below historical floodplain terraces. Connectivity to the existing modern floodplain is adequate.</p>	<p>The channel is entrenched and straightened in most of this reach. The channel was likely anthropogenically forced to the river left side of the valley and straightened in the past, disconnecting the former channel and much of its historical floodplain. Floodplain disconnection is likely to continue to increase unless channel complexity is introduced to the reach.</p>	<p>The channel is naturally confined by a series of terraces and bedrock outcrops in this reach. Where Valley width allows, vegetated floodplains exist below terrace surfaces. Connectivity to the existing modern floodplain is adequate.</p>	

Pathway	General Indicators	Specific Indicators	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10
Channel	Dynamics	Bank Stability/ Channel Migration	At Risk	Adequate	Adequate	Unacceptable	At Risk	Adequate	At Risk	At Risk	Unacceptable	Adequate
			Lateral migration processes in this reach are reduced compared to historical rates (assumed based on historic meander scars). Large wood removal, reduced wood load, and lateral confinement at the Little Wenatchee Road bridge have likely contributed to reduced lateral migration in the reach. Unless channel complexity increases lateral channel migration is unlikely to improve.	Where valley-width and channel complexity allow, lateral processes are occurring throughout the majority of the reach. In the lower portion of the reach, bank protection associated with Little Wenatchee Road and the Little Wenatchee Road bridge place constraints on natural lateral processes. Unless channel complexity increases, local lateral channel migration is unlikely to improve.	Where valley-width and channel complexity allow, lateral processes are occurring.	Human-imposed channel straightening, confinement, and entrenchment, have eliminated lateral migration in the middle portion, and only marginal channel migration is occurring in the upper and lower portions. Unless channel complexity increases, local lateral channel migration is unlikely to improve.	Human-imposed channel straightening, confinement, and entrenchment have eliminated lateral migration in the lower portion, whereas lateral processes are actively occurring in the middle and upper portion of the reach. Unless channel complexity increases in the lower portion, local lateral channel migration is unlikely to improve.	Where valley-width and channel complexity allow, lateral processes are occurring.	A meander cutoff in the middle of the reach resulted in channel straightening, and lateral confinement associated with White River Road limits lateral migration in the upper portion of the reach. Lateral migration is actively occurring in the downstream portion of the reach. Unless channel complexity increases where channel straightening has occurred, local lateral channel migration is unlikely to improve.	Historical channel straightening and bank protection have reduced lateral migration processes in this reach, although lateral migration is actively occurring in the upstream and downstream portions of the reach. Unless channel complexity increases where channel straightening and bank protection have been imposed, local lateral channel migration is unlikely to improve.	Due to human-imposed channel straightening, the channel is entrenched and little to no channel migration is occurring. Unless channel complexity increases, local lateral channel migration is unlikely to improve.	Where valley-width and channel complexity allow, lateral processes are occurring.

Pathway	General Indicators	Specific Indicators	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9	Reach 10
Channel	Dynamics	Vertical Channel Stability	Adequate	Adequate	Adequate	At Risk	Adequate	Adequate	Adequate	Adequate	Unacceptable	Adequate
			Localized incision associated with the Little Wenatchee Road bridge confinement has resulted in disconnection of floodplain surfaces. Without increased channel complexity, this process is expected to continue. Elsewhere in the reach, no measurable trend in incision or aggradation beyond natural geomorphic processes was observed.	Localized incision associated with the Little Wenatchee Road bridge confinement has resulted in disconnection of floodplain surfaces. Without increased channel complexity, this process is expected to continue. Elsewhere in the reach, no measurable trend in incision or aggradation beyond natural geomorphic processes was observed.	No measurable trend in incision or aggradation beyond natural geomorphic processes was observed in the reach.	Channel straightening and the Sears Creek Road bridge confinement have resulted in incision throughout much of the reach. Without increased channel complexity, this process is expected to continue. Floodplain surfaces are connected, but less frequently than prior to channel straightening.	Localized incision associated with the Sears Creek Road bridge has reduced floodplain connectivity. Without increased channel complexity this process is expected to continue. Associated floodplain surfaces are still connected at flows exceeding the 5-year recurrence interval. Elsewhere in the reach, no measurable trend in incision or aggradation beyond natural geomorphic processes was observed.	No measurable trend in incision or aggradation beyond natural geomorphic processes was observed in the reach.	No measurable trend in incision or aggradation beyond natural geomorphic processes was observed. Channel straightening, confinement by White River Road, and reduced LW inputs to the reach may have instigated incision in the past.	The channel is entrenched due to human impacts. Coarse bedload within the reach may limit the rate of incision, although incision may continue without increased channel complexity.	No measurable trend in incision or aggradation beyond natural geomorphic processes was observed in the reach.	

*\*Although the LWM maybe be adequate from a habitat/cover perspective, this does not consider the geomorphic function of the LWM, which may be lacking.*

3.3 REACH-SCALE RATINGS – TRIBUTARY REACHES

Pathway	General Indicators	Specific Indicators	Napeequa River Reach 1	Napeequa River Reach 2	Panther Creek Reach 1
Habitat Access	Physical Barriers	Main Channel Barriers	Adequate	Adequate	Adequate
			There were no anthropogenic barriers in the main channel. A natural waterfall at RM 1.7 is present in the reach.	There were no anthropogenic barriers in the main channel. A series of naturally-occurring waterfalls/cascades occur at RM 2.0 in this reach.	There were no anthropogenic barriers in the main channel. Multiple naturally-occurring waterfalls/ cascades exist in this reach starting at RM 0.4.
Habitat Quality	Substrate	Dominant Substrate/ Fine Sediment	Adequate	Adequate	At Risk
			Based on two gravel counts, gravels (2.1-64mm; 79%) dominate the substrate, followed by cobbles (64.1-256 mm; 19%), fines (<2mm; 2%) and boulders (>256 mm; 1%). The combined average between the two gravel counts showed 3% of substrates are <5.6 mm.	No gravel counts were performed in the Napeequa River Reach 2 because there was no representative riffle or bar surfaces on which to conduct the gravel count. The substrate is predominantly boulder or cobbles, with some gravels dispersed near LWM or boulders, as determined by review of field photos. The large substrate appears to be a result of naturally occurring geomorphic function for a high gradient reach.	Based on one gravel count, gravels (2.1-64mm; 41%) dominate the substrate, followed by cobbles (64.1-256 mm; 37%), and boulders (>256 mm; 22%). The combined average between the two gravel counts showed 2% of substrates are <5.6 mm.
	LWM	Pieces per Mile at Bankfull	At Risk	Adequate*	Adequate*
			M+L pieces/mi = 127 Percent in Jams = 47% Distribution of Jams: Uneven Meets the minimum criteria of 67.45 pieces of M+L wood per mile. Less than half of the wood is within jams, and potential sources for long-term woody debris recruitment are somewhat limited, particularly in the lower portion of the reach.	M+L pieces/mi = 378 Percent in Jams = 65% Distribution of Jams: Even Meets the minimum criteria of 67.45 pieces of M+L wood per mile. Most (>50%) of the wood is within jams and there are some sources of woody debris available for both long- and short-term recruitment within the reach.	M+L pieces/mi = 136 Percent in Jams = 63% Distribution of Jams: Even Meets the minimum criteria of 67.45 pieces of M+L wood per mile. Most (>50%) of the wood is within jams and there are some sources of woody debris available for both long- and short-term recruitment within the reach.
	Pools	Pool Frequency and Quality; presence of large pools.	At Risk	At Risk	At Risk
			Total Pools = 23 Pools/mi = 14 Pools ≥ 3 ft = 15 (65%) Pools ≥ 6 ft = 0 (0%) Avg residual pool depth: 3.4 ft Cover: high Does not meet the pool frequency criteria for bankfull width (average BFW = 66, requires 23 pools/mile), but pools are large and cover a majority of the reach. LWM and cover relatively available.	Total Pools = 2 Pools/mi = 4 Pools ≥ 3 ft = 2 (100%) Pools ≥ 6 ft = 0 (0%) Avg residual pool depth: 3.0 ft Cover: high Does not meet the pool frequency criteria for bankfull width (average BFW = 40, requires 26 pools/mile). Pool residual depths are relatively low, though LWM and cover good.	Total Pools = 14 Pools/mi = 20 Pools ≥ 3 ft = 4 (29%) Pools ≥ 6 ft = 2 (14%) Avg residual pool depth: 3.3 ft Cover: moderate Almost meets the pool frequency criteria for bankfull width (average BFW = 51, requires 23 pools/mile), and LWM/cover is moderate.
	Off-Channel Habitat and Refugia	Connectivity with Main Channel	At Risk	Adequate	At Risk
			Total SC = 3 Fast water = 2 Slow water = 1 Minimal off-channel habitat exists, and floodplains are disconnected from riverfront properties along lower the portion and the bridge on the downstream end, as determined by field observations and hydraulic modeling.	Total SC = 6 Fast water = 5 Slow water = 1 Off-channel habitat connected at a wide range of flows is present within the reach. Floodplain receives inundation with minimal constriction from human impacts, as determined by field observations and hydraulic modeling.	Total SC = 0 Reach is lacking off-channel habitats that are connected at a high range of flows. Some channels may be connected at higher flows near the mouth of Panther. Floodplain receives inundation with minimal constriction from human impacts, as determined by field observations and hydraulic modeling.

Pathway	General Indicators	Specific Indicators	Napeequa River Reach 1	Napeequa River Reach 2	Panther Creek Reach 1
Riparian Vegetation	Condition	Structure	At Risk	Adequate	Adequate
			The riparian canopy overstory composition within the 100-foot riparian buffer was recorded as 54% small tree and 46% large tree. Reach has some visual evidence of human disturbance that has reduced the width of the riparian buffer and impacted stand age and structural complexity in many areas of this reach as determined by field estimates, tree height data, or aerial photographs.	The riparian canopy overstory composition within the 100-foot riparian buffer was recorded as 50% small tree and 50% large tree. Reach is within a protected Wilderness Area had no visual evidence of human disturbance that impacted the riparian buffer as determined by field estimates, tree height data, or aerial photographs.	The riparian canopy overstory composition within the 100-foot riparian buffer was recorded as 71% large tree, followed by small trees (14%) and mature trees (14%). Reach had no visual evidence of human disturbance that impacted the riparian buffer as determined by field estimates, tree height data, or aerial photographs.
		Disturbance (Human)	At Risk	Adequate	Adequate
			9.5% disturbance in the 200-foot buffer zone (e.g. residential, roads, etc.) and 6.1 miles/miles <sup>2</sup> road density in the 200-foot riparian buffer zone.	0.0% disturbance in the 200-foot buffer zone (e.g. residential, roads, etc.) and 0.0 miles/miles <sup>2</sup> road density in the 200-foot riparian buffer zone.	0.0% disturbance in the 200-foot buffer zone (e.g. residential, roads, etc.) and 0.0 miles/miles <sup>2</sup> road density in the 200-foot riparian buffer zone.
		Canopy Cover	At Risk	Adequate	Adequate
			Reach average of 9.2 hours of shade during daylight hours on the summer solstice, based on weighted average from the shademap tool. ( <i>ShadeMap</i> , n.d.) Moderate amounts of tall trees (height > 100 feet) within the 100-foot riparian buffer were found using visual estimates of GIS tree height data. High levels of disturbance or clearing within the 100-foot buffer were determined through visual estimates of aerial photos.	Reach average of 14.1 hours of shade during daylight hours on the summer solstice, determined from the weighted average of raster data from the shademap tool. Moderate amounts of tall trees (height > 100 feet) within the 100-foot riparian buffer were found using visual estimates of GIS tree height data. Low levels of disturbance or clearing within the 100-foot buffer were determined through visual estimates of aerial photos.	Reach average of 12.7 hours of shade during daylight hours on the summer solstice, determined from the weighted average of raster data from the shademap tool. Moderate amounts of tall trees (height > 100 feet) within the 100-foot riparian buffer were found using visual estimates of GIS tree height data. Low levels of disturbance or clearing within the 100-foot buffer were determined through visual estimates of aerial photos.
Channel	Dynamics	Floodplain Connectivity	At Risk	Adequate	Adequate
			The channel is entrenched and straightened in the lower portion of the reach. Although much of the historical floodplain is available to the channel at flood-flow, frequency of connectivity is limited. Narrow low floodplain surfaces are dispersed throughout the lower portion of the reach. Unless channel complexity increases, floodplain connectivity is unlikely to improve.	The channel is naturally confined throughout the reach. Where valley width allows, vegetated floodplains exist below terrace surfaces. Connectivity to the existing modern floodplain is adequate	The channel is naturally confined throughout the reach. Where valley width allows, vegetated floodplains exist. Connectivity to the existing modern floodplain is adequate.
		Bank Stability/ Channel Migration	At Risk	Adequate	Adequate
			Lateral channel migration is limited in the lower portion of the reach due to abundant bank protection (riprap). In the upper portion, the channel is not artificially constrained and is able to migrate laterally. Unless channel complexity increases, lateral channel migration in the lower portion is unlikely to improve.	Lateral processes are limited by natural confinement, however, where valley-width and channel complexity allow, lateral processes are occurring.	Lateral processes are limited by natural confinement, however lateral migration across the Panther Creek alluvial fan appears to periodically occur.

Pathway	General Indicators	Specific Indicators	Napeequa River Reach 1	Napeequa River Reach 2	Panther Creek Reach 1
Channel	Dynamics	Vertical Channel Stability	At Risk	Adequate	Adequate
			Local incision has occurred in the lower portion of the reach, where bank protection on both sides of the channel limit overbank flow. In these sections, incision may increase if channel complexity is not increased.	No measurable trend in incision or aggradation beyond natural geomorphic processes was observed in the reach. Inputs from hillslopes provide sediment pulses that periodically force changes in channel form.	No measurable trend in incision or aggradation beyond natural geomorphic processes was observed in the reach. Inputs from hillslopes provide sediment pulses that periodically force changes in channel form.

Table 3. *\*Although the LWM maybe be adequate from a habitat/cover perspective, this does not consider the geomorphic function of the LWM, which may be lacking.*

## 4 References & Sources

- 2010 Statewide Landuse. (2010). In *Washington State Department of Ecology, GIS Technical Services*. Washington State Department of Ecology. <https://ecology.wa.gov/Research-Data/Data-resources/Geographic-Information-Systems-GIS/Data>
- Andonaegui, C. (2001). *Salmon, Steelhead, and Bull Trout Habitat Limiting Factors For the Wenatchee Subbasin (Water Resource Inventory Area 45) and Portions of WRIA 40 within Chelan County (Squilchuck, Stemilt and Colockum drainages)*. [https://www2.clark.wa.gov/files/dept/community-planning/shoreline-master-program/proposal-comments-received/futurewise-cd-1/fish-&-wildlife-habitat/salmon-limiting-factors-summaries/wria40\\_45.pdf](https://www2.clark.wa.gov/files/dept/community-planning/shoreline-master-program/proposal-comments-received/futurewise-cd-1/fish-&-wildlife-habitat/salmon-limiting-factors-summaries/wria40_45.pdf)
- Fox, M., & Bolton, S. (2007). A Regional and Geomorphic Reference for Quantities and Volumes of Instream Wood in Unmanaged Forested Basins of Washington State. *North American Journal of Fisheries Management*, 27(1), 342–359. <https://doi.org/10.1577/m05-024.1>
- Plummer, F. G. (1902). Forest conditions in the Cascade Range, Washington, between the Washington and Mount Rainier forest reserves. In *Professional Paper*. <https://doi.org/10.3133/pp6>
- ShadeMap. (n.d.). ShadeMap, MapLibre, Protomaps, OpenStreetMap. Retrieved January 26, 2025, from <https://shademap.app/@47.91255,-120.90288,11.24709z,1736796715983t,0b,0p,1m!1687349140214!1687406815846,qdGVsbWEsIHdh!47.84411!-120.81766>
- The National Marine Fisheries Service (Environmental and Technical Services Division Habitat Conservation Branch). (1996). *Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale*. [https://www.oregon.gov/ODOT/GeoEnvironmental/Documents/Biology\\_NMFS\\_Endangered-Species-Determination.pdf](https://www.oregon.gov/ODOT/GeoEnvironmental/Documents/Biology_NMFS_Endangered-Species-Determination.pdf)
- U.S. Fish and Wildlife Service. (1998). *Matrix of Physical/Environmental Pathways and Indicators for East-Side Streams*.
- US Forest Service (USFS). (1999). *Mainstem Wenatchee River Watershed Assessment*.
- US Forest Service (USFS). (2003). *Okanogan and Wenatchee National Forests Road Analysis: Wenatchee Sub-Basin*.
- U.S. Geological Survey. (2024). *StreamStats*. <https://streamstats.usgs.gov/ss/>
- USFS. (2020). *Stream Inventory Handbook: Level I and Level II. Version 2.20. Pacific Northwest Region*. United States Department of Agriculture, United States Forest Service.
- Washington Large Fires 1973-2023*. (n.d.). Washington State Department of Natural Resources. Retrieved January 26, 2025, from <https://geo.wa.gov/datasets/wadnr::washington-large-fires-1973-2023/explore?location=47.855104%2C-121.003971%2C11.38>

## Appendix C | Restoration Strategy

---

*September 2025*

## Table of Contents

<b>1</b>	<b>Restoration Strategy .....</b>	<b>1</b>
1.1	Introduction .....	1
1.2	Restoration Objectives.....	1
1.3	Action Types.....	1
1.4	Reach-Scale Restoration Strategies .....	5
1.4.1	Reach 1 Restoration Strategy.....	6
1.4.2	Reach 2 Restoration Strategy.....	8
1.4.3	Reach 3 Restoration Strategy.....	10
1.4.4	Reach 4 Restoration Strategy.....	12
1.4.5	Reach 5 Restoration Strategy.....	14
1.4.6	Reach 6 Restoration Strategy.....	16
1.4.7	Reach 7 Restoration Strategy.....	18
1.4.8	Reach 8 Restoration Strategy.....	20
1.4.9	Reach 9 Restoration Strategy.....	22
1.4.10	Reach 10 Restoration Strategy.....	24
1.4.11	Napeequa River Reach 1 Restoration Strategy .....	26
1.4.12	Napeequa River Reach 2 Restoration Strategy .....	28
1.4.13	Panther Creek Reach 1 Restoration Strategy.....	30
<b>2</b>	<b>Project Opportunities.....</b>	<b>32</b>
2.1	Project Identification and Evaluation Approach .....	32
2.2	Project Opportunities Overview .....	32
2.3	Project Descriptions .....	35
2.4	Project Maps .....	49
<b>3</b>	<b>Project Prioritization and Ranking .....</b>	<b>69</b>
3.1	Prioritization Matrix.....	69
3.3	Project Ranking Methods.....	72

# 1 Restoration Strategy

## 1.1 INTRODUCTION

The Restoration Strategy uses field surveys, inventories, and analyses performed in the Reach Assessment and accompanying appendices (Habitat Assessment and Reach-based Eco-system Indicators), as the technical basis for identifying and prioritizing restoration actions. This framework of developing a restoration strategy provides a direct linkage between the technical analyses, identified limiting factors, and the actions that are moved forward towards implementation. The restoration objectives (targets) are used to guide the development of appropriate restoration action types for the assessment area. The Reach-Scale Restoration Strategies (Section 1.4) present the summarized and compiled information in table format for each reach. Conceptual maps and descriptions of the project opportunities are presented in Section 2. Project ranking in Section 2.4, lays out the targets, benefits, and costs scoring involved in prioritizing project opportunities for the restoration strategies.

## 1.2 RESTORATION OBJECTIVES

Restoration objectives were developed for multiple ecological attributes, including habitat, geomorphic, and riparian. These objectives are presented as restoration targets. They are made to be as quantifiable as possible at this stage of analysis. These target conditions are compared to existing conditions from the Reach Assessment. This highlights habitat deficiencies and the “gap” that needs to be filled to recover habitat.

Target conditions were developed using the Reach-based Ecosystem Indicators (REI) targets (see Appendix B) as well as reference to site conditions and inference from local and regional studies. See Section 2.6 of the Assessment Report and Appendix B for more information on the REI analysis.

## 1.3 ACTION TYPES

Recommended actions are categorized here into five action types. There are 4 restoration action types plus a conservation action. We use the term ‘restoration’ as a broad catch-all when we refer actions; however, we acknowledge that many of the actions are not restoration in the true sense of the word and would be more appropriately labeled as “enhancement” or “creation.” We consider true restoration actions to be those that address root causes of impairments that aim to return the system close to its naturally functioning state. This is often not achievable due to past changes to the underlying processes or to process impairments that are unlikely to change due to infrastructure. An example of a true restoration project would be a project that fully removes a levee, returns the channel to its historical form, and replants the valley floor to restore natural floodplain inundation patterns. Enhancement measures are those that improve or rehabilitate habitat to the extent possible given existing impaired processes and anthropogenic constraints. Placement of large wood in an existing pool to provide cover is an example of habitat enhancement. Creation projects are those that create new habitat that is currently lacking or that will not be created on its own in a reasonable timeframe given existing impairment. Excavation of a new side-channel where one did not exist

already is an example of a creation project. Action types are often combined, and each project typically incorporates numerous action types. The five action types are described below.

### **1. Riparian Restoration**

Riparian restoration projects are recommended in areas where native riparian vegetation communities have been impacted by historic or current anthropogenic activities such that riparian function and connection with the stream are compromised. In the White River assessment area, large sections of the floodplain vegetation were logged in the past and the forests are still recovering. Near some private property, campgrounds, and infrastructure, riparian vegetation has been cleared or impacted for homes/buildings, agricultural purposes, roads and trails, or crossings. Restoration actions are focused on restoring native riparian vegetation communities to reestablish natural stream stability (including supporting beaver), stream shading, nutrient exchange, ecologic diversity, and long-term large wood recruitment. Riparian restoration may also include the development or enhancement of wetlands or riparian function along off-channel features. Even though it is not always explicitly stated, riparian restoration is a recommended component of most restoration actions, particularly within the disturbance limits of the action.

*Examples:*

- ▶ Replanting a riparian buffer area with native vegetation.
- ▶ Thinning second-growth forests to stimulate old-growth forest development and generate woody material for restoration actions.
- ▶ Fencing out grazing animals along a riparian area that is being restored to minimize impacts on naturally regenerated and/or planted vegetation.
- ▶ Placing willow or cottonwood baffles on bars to encourage vegetated island development.

### **2. Enhance Channel Complexity**

Channel complexity enhancement actions are aimed at increasing quantity or improving the quality of existing channel habitat and geomorphology. This type of action is designed to improve the geomorphic complexity of the system, which in turn supports instream aquatic habitat conditions and builds system resiliency. Sections of the White River assessment area lack geomorphic and habitat complexity as a result of historical logging, floodplain grading, channel straightening, and channel clearing practices. Due to the removal of old-growth trees, most of the floodplain forests lack sufficiently sized trees to act as “key-logs” capable of influencing and maintaining channel complexity. Where sufficient large wood jams do occur, geomorphic complexity and habitat function are notably increased. The Enhance Channel Complexity strategy includes a broad range of large wood installation types of varied sizes and purposes. It may also require grading to reactivate or reconnect abandoned channel meanders or flow routes, especially those resulting from anthropogenically forced channel straightening. Enhance Channel Complexity is recommended in the mainstem channel, side channels, off-channel habitat, and primary tributaries included in the assessment. The recommended treatments include identified treatment areas as well as site-specific

action. For instance, log placement may be recommended in a field-identified existing pool to provide salmonid hiding cover. In contrast, several feet of the channel may be identified as appropriate for large wood loading by helicopter. The structural elements included in these actions are placed in areas where they would naturally accumulate and be maintained by stream hydrology and geomorphology. This action type is generally considered enhancement measures, as they do not fully restore the root cause of the problem but provides and maintains increased complexity to support continued system recovery and resilience development the riparian and floodplain forests mature, sediment retention and distributions is normalized, floodplains increase in connectivity, and anthropogenic constraints are managed.

*Examples:*

- ▶ Helicopter large wood loading in areas with difficult ground access to increase quantity of effective in-channel large wood to promote log jam development, instigate bed-load retention, and increase available in-channel habitat.
- ▶ Installation of individual large wood pieces or jams for cover, pool scour, sediment sorting, and hydraulic complexity (e.g., high flow refuge for rearing juvenile fish).
- ▶ Installation of apex jam to promote scour, sediment retention, and split-flow conditions to support mid-channel bar/island development or side-channel initiation.

### **3. Side and Off-Channel Habitat Creation or Enhancement**

Off-channel habitat creation or enhancement projects are located in areas where there is the potential to increase the quantity, quality, or connectivity of off-channel habitat (i.e. alcoves, side channels, floodplain wetlands). Off-channel habitat features provide important rearing and refugia areas for juvenile salmonids, including high flow refugia, temperature refugia, and highly productive feeding areas. These projects may include the activation of existing habitat areas that have been disconnected via channel incision or floodplain alterations. In other cases, off-channel areas can be created via excavation and construction of features such as side channels or alcoves. Off-Channel Habitat Creation or Enhancement is often paired with Enhance Channel Complexity actions. These actions generally include the enhancement or creation of habitat, rather than the full restoration of root causes of the lack of off-channel habitat.

*Examples:*

- ▶ Increase the degree of connectivity (i.e. for surface flow and fish passage) of an existing off-channel area such as a floodplain oxbow wetland for juvenile feeding, flood refuge, or thermal refuge.
- ▶ Create new connected side-channel or off-channel habitat via excavation.
- ▶ Enhance conditions in new or created off-channel habitat.

#### 4. Floodplain and Channel Migration Zone Reconnection

Floodplain and CMZ connectivity actions are those that increase the frequency, duration, or extent of hydrologic connection between the mainstem channel and the floodplain or that re-establish natural channel migration functions. Floodplain and CMZ connectivity projects are located in areas where there is the potential to increase the quantity or quality of floodplain habitats and are typically located in areas where floodplains have been disconnected via channel incision/straightening, anthropogenic confinement such as undersized bridges, or floodplain modifications that inhibit connectivity such as road prisms or hardened banks. This strategy includes a broad range of potential project types, including floodplain grading to create valley-wide hydraulic connectivity, inset floodplains, or wetlands, as well as removal of constructed levees that in turn reengage existing floodplain surfaces or oxbows.

*Examples:*

- ▶ Remove or modify levees, bank armor, roads, or bridges to reestablish natural floodplain inundation and channel migration processes.
- ▶ Create inset floodplain to increase floodplain/channel connectivity.
- ▶ Raise or promote aggradation of an incised channel.
- ▶ Create multi-threaded channel corridor with valley-wide hydraulic connectivity.

#### 5. Conservation

Conservation actions include such things as land acquisitions, easements, or other measures that provide enduring protection to channels, riparian zones, and floodplains. They are only identified where they would complement restoration actions or where there is believed to be specific future risk of impairment. Much of the White River study area is already protected, lying within National Forest, Washington Department of Fish & Wildlife managed lands, or in conservation holdings (Chelan Douglas Land Trust). Approximately 20% of the valley bottom within the assessment area lies within private, non-conservation lands. Private parcels are located within the floodplain and periodically about the channel. Because they lie within the floodplain and/or channel migration zone of the river, portions of nearly all of these private lands could be considered targets for conservation. However, existing county-level shorelines, critical areas, and floodplain regulations would apply to many of these parcels and in theory would provide important protections. This assessment does not, however, include any type of land-use analysis such as looking at zoning patterns or the adequacy of local regulations. Due to these uncertainties, conservation actions are not identified broadly for the private lands. Instead, this assessment identifies conservation actions in the following situations: 1) private lands with high restoration value, where long-term protection of the land would complement restoration actions, and 2) where site or other observations indicate there are impending encroachments or development potential, such as land clearing, road building, land subdivision, or undeveloped properties advertised for sale.

#### **1.4 REACH-SCALE RESTORATION STRATEGIES**

Restoration strategies for each reach are provided below. The reach-scale restoration strategies identify existing ecologic/geomorphic conditions, project objectives and recovery potential, a list of projects, and recommended restoration action types. The ecological function (Low, Moderate, or High) of each reach is characterized by the ratings that resulted from the REI (see Appendix B). The trajectory (decline, same, improve) is determined by evaluation of the modern geomorphic trends, related existing habitat conditions, and continued limitations such as infrastructure and land-use (see Section 3 of the Reach Assessment Report and Habitat Assessment Appendix A). The recovery potential (Low, Moderate, and High) is based on the potential for the site to recover functioning habitat and processes with implementation of restoration actions. To do so, the potential for the REI indicator ratings to improve via restoration actions is considered. The recovery potential rating considers known limitations to recovery that are unlikely to be eliminated as part of implementation of this restoration strategy, such as the presence of transportation and residential infrastructure.

**1.4.1 Reach 1 Restoration Strategy**

<b>Overall ecological function</b>	<b>Low</b> <i>Rating is based on the Reach Assessment evaluations of habitat, geomorphology, hydrology, hydraulics, and vegetation. Eight of 11 REI metrics are at risk or unacceptable. Significant impairment of channel and riparian function due to riparian vegetation clearing, minimal habitat complexity, lack of large wood in the channel, and limited off-channel habitat.</i>
<b>Trajectory if no action taken</b>	<b>Decline</b> <i>Continued degradation due to persistent anthropogenic impacts to floodplain, channel incision, riparian, and large wood processes. Possible long-term recovery of riparian condition as mostly National Forest and land trust ownership.</i>
<b>Recovery potential</b>	<b>Low - Moderate</b> <i>Projects address lack of large in-channel structure but have limited impact on recovery of root causes due to effects of reach-wide incision related to floodplain and CMZ constrictions that are assumed to remain.</i>
<b>Restoration objectives</b>	<b>Target conditions in Table 1</b> <i>Bring existing conditions to target conditions (multiple habitat and geomorphic attributes), where possible, for the metrics identified in Table 1 below. To the extent possible at this stage of planning, the targets are presented as measurable quantities.</i>
<b>Action Types</b>	<b>Riparian Restoration Enhance Channel Complexity Side and Off-Channel Habitat Creation or Enhancement Floodplain and CMZ Connectivity</b> <i>Actions include enhancement/improvement of channel complexity via large wood placements. Modification of anthropogenic features, such as bank riprap or road/bridge crossings, would improve channel condition and floodplain connectivity. Excavation of side channel or oxbow inlets would increase available, accessible off-channel habitat areas. Revegetation of open field areas and willow/cottonwood trenches on open in-channel bars would improve long-term riparian conditions.</i>
<b>Project Areas &amp; Prioritization</b>	<b>Little Wenatchee Road Lake Reach</b> <i>The potential to improve the quantity and quality of available habitat in the downstream portion of Reach 1 is low-moderate, and focused primarily on LW addition throughout Reach 1 and some targeted side channel inlet excavation. At the upstream end of the reach, the Little Wenatchee Road project would provide some improvement to floodplain inundation/connectivity through increased conveyance at the culverts under the road and replacement of the riprap and sheetpile with bank buried jams. It is recognized that existing buildings and infrastructure limit recovery potential in Reach 1. Both Reach 1 project areas are complimentary to each other but would provide habitat and function benefits if completed independently.</i>

**Table 1. Reach 1 Restoration Objectives, Action Types, and Projects.**

<b>Attribute</b>	<b>Existing Condition (from assessment)</b>	<b>Target Condition [REI – Adequate Rating]</b>	<b>Action Type</b>	<b>Project</b>
Habitat Quality	Gravels present but presence of fine sediments is also high. 57 pieces of medium or large LW per mile. Pool habitat is extensive and pools are deep but have limited cover/complexity. No side-channels.	Gravels or small cobbles make up >50% of the bed materials in spawning areas and ≤12% fines/sand (<6 mm) in spawning gravel. At least 67.45 pieces/mile of large wood and sources for LW recruitment. Due to backwater from Lake Wenatchee, pool frequency is not considered in Target Conditions. Pools should be deep and have good fish cover and cool water. Contains side or off-channel refugia.	Side and Off-Channel Habitat Creation or Enhancement  Enhance Channel Complexity	Little Wenatchee Road  Lake Reach
Riparian Condition	Where riparian trees are present they are 100% large trees; 0.7% of the riparian zone is disturbed; Only 3.2 hours of shade during summer solstice (low thermal shading); and 2.1 mile/miles <sup>2</sup> road density within 200-ft riparian buffer.	At least a 200-ft riparian buffer with: > 80% large trees, or consistent with potential native community < 20% riparian disturbance (human); high proportion of daylight hours with thermal shading over channel; and <2 mile/miles <sup>2</sup> road density	Riparian Restoration	Little Wenatchee Road
Channel Dynamics	Well-vegetated floodplains in reach with localized floodplain disconnection. Lateral migration processes in this reach are reduced compared to historical rates.	Floodplain areas are hydrologically linked to main channel within the context of the local process domain. Channel is migrating at or near natural rates within the geomorphic construct of the reach. No measurable trend of aggradation or incision beyond the natural geomorphic processes of the reach	Riparian Restoration  Floodplain and CMZ Connectivity  Enhance Channel Complexity	Little Wenatchee Road

**1.4.2 Reach 2 Restoration Strategy**

<b>Overall ecological function</b>	<b>Low</b> <i>Rating is based on the Reach Assessment evaluations of habitat, geomorphology, hydrology, hydraulics, and vegetation. 6 of 11 REI metrics are at risk or unacceptable. Impairment of channel and riparian function due to road/levees, riparian vegetation clearing and disturbance, minimal habitat complexity, lack of large wood in the channel, and no off-channel habitat.</i>
<b>Trajectory if no action taken</b>	<b>Decline</b> <i>Continued degradation due to persistent anthropogenic impacts to floodplain, channel incision, riparian, and large wood processes. Possible long-term recovery of riparian condition as mostly National Forest and land trust ownership.</i>
<b>Recovery potential</b>	<b>Moderate</b> <i>Projects address lack of large in-channel structure but have limited impact on recovery of root causes due to effects of reach-wide incision related to floodplain and CMZ constrictions that are assumed to remain.</i>
<b>Restoration objectives</b>	<b>Target conditions in Table 2</b> <i>Bring existing conditions to target conditions (multiple habitat and geomorphic attributes), where possible, for the metrics identified in Table 1 below. To the extent possible at this stage of planning, the targets are presented as measurable quantities.</i>
<b>Action Types</b>	<b>Riparian Restoration Enhance Channel Complexity Floodplain and CMZ Connectivity Conservation</b> <i>Actions include enhancement/improvement of channel complexity via large wood placements. Modification of anthropogenic features, such as bank riprap or road/bridge crossings, would improve channel condition and floodplain connectivity. Revegetation of open field areas and willow/cottonwood trenches on open in-channel bars would improve long-term riparian conditions.</i>
<b>Project Areas &amp; Prioritization</b>	<b>Little Wenatchee Road Dirtyface</b> <i>The potential to improve the quantity and quality of available habitat in Reach 2 is moderate, and focused primarily on LW addition. At the downstream end of the reach, the Little Wenatchee Road project would provide some improvement to floodplain inundation/connectivity through increased conveyance at the culverts under the road. Riparian revegetation within the large open fields would improve long-term riparian and large wood processes. It is recognized that existing buildings and infrastructure limit recovery potential in Reach 2. Both Reach 2 project areas are complimentary to each other but would provide habitat and function benefits if completed independently.</i>

**Table 2. Reach 2 Restoration Objectives, Action Types, and Projects.**

<b>Attribute</b>	<b>Existing Condition (from assessment)</b>	<b>Target Condition [REI – Adequate Rating]</b>	<b>Action Type</b>	<b>Project</b>
Habitat Quality	Gravels present with relatively limited amounts of fines. 208 pieces of medium or large LW per mile. Pool habitat is extensive and pools are deep but have limited cover/complexity. No side-channels.	Gravels or small cobbles make up >50% of the bed materials in spawning areas and ≤12%fines/sand (<6 mm) in spawning gravel. At least 67.45 pieces/mile of large wood and sources for LW recruitment. Due to backwater from Lake Wenatchee, pool frequency is not considered in Target Conditions for this reach. Pools should be deep and have good fish cover and cool water. Contains side or off-channel refugia.	Enhance Channel Complexity  Floodplain and CMZ Connectivity	Dirtyface Little Wenatchee Road
Riparian Condition	Where riparian trees are present they are 100% large trees; 4.1% of the riparian zone is disturbed; 7.1 hours of shade during summer solstice (moderate thermal shading); and 9.7 mile/miles <sup>2</sup> road density within 200-ft riparian buffer.	At least a 200-ft riparian buffer with: > 80% large trees, or consistent with potential native community < 20% riparian disturbance (human); high proportion of daylight hours with thermal shading over channel; and <2 mile/miles <sup>2</sup> road density	Riparian Restoration  Floodplain and CMZ Connectivity	Dirtyface Little Wenatchee Road
Channel Dynamics	Low floodplain surfaces are sparsely distributed in the lower portion of reach with localized floodplain disconnection associated with roads/bridge. Where valley-width and channel complexity allow, lateral processes are occurring throughout the majority.	Floodplain areas are hydrologically linked to main channel within the context of the local process domain. Channel is migrating at or near natural rates within the geomorphic construct of the reach. No measurable trend of aggradation or incision beyond the natural geomorphic processes of the reach	Riparian Restoration  Floodplain and CMZ Connectivity  Enhance Channel Complexity	Little Wenatchee Road

**1.4.3 Reach 3 Restoration Strategy**

<b>Overall ecological function</b>	<b>Moderate</b> <i>Rating is based on the Reach Assessment evaluations of habitat, geomorphology, hydrology, hydraulics, and vegetation. Five of 11 REI metrics are at risk or unacceptable. Some disturbance to riparian vegetation disturbance, and loss of habitat complexity with no off-channel habitat.</i>
<b>Trajectory if no action taken</b>	<b>Maintain</b> <i>Effects of historical and ongoing degradation will remain due to anthropogenic impacts that have resulted in channel incision and altered riparian and large wood processes. Possible long-term natural recovery of riparian condition due to mix of land trust, private, and federally-owned land.</i>
<b>Recovery potential</b>	<b>Moderate</b> <i>Project addresses lack of large in-channel structure but has limited impact on recovery of root causes due to effects of reach-wide incision related to floodplain and CMZ constrictions that are assumed to remain.</i>
<b>Restoration objectives</b>	<b>Target conditions in Table 3</b> <i>Bring existing conditions to target conditions (multiple habitat and geomorphic attributes), where possible, for the metrics identified in Table 1 below. To the extent possible at this stage of planning, the targets are presented as measurable quantities.</i>
<b>Action Types</b>	<b>Riparian Restoration Enhance Channel Complexity Floodplain and CMZ Connectivity</b> <i>Actions include enhancement/improvement of channel complexity via large wood placements. Excavation of oxbow connections would increase available, accessible floodplain wetland habitat areas. Installation of willow/cottonwood trenches on open in-channel bars would improve long-term riparian conditions.</i>
<b>Project Areas &amp; Prioritization</b>	<b>Fivemile</b> <i>The potential to improve the quantity and quality of available habitat in Reach 3 is moderate. Large wood and off-channel reconnection actions could improve in-channel aquatic habitat conditions, but may not improve long-term geomorphic or riparian processes.</i>

**Table 3. Reach 3 Restoration Objectives, Action Types, and Projects.**

<b>Attribute</b>	<b>Existing Condition (from assessment)</b>	<b>Target Condition [REI – Adequate Rating]</b>	<b>Action Type</b>	<b>Project</b>
Habitat Quality	Gravels present with little fines. 151 pieces of medium or large LW per mile. 2 pools per mile with 66% pools > 1m (3ft) and low pool shade/cover. No side-channels.	Gravels or small cobbles make up >50% of the bed materials in spawning areas and ≤12%fines/sand (<6 mm) in spawning gravel. At least 67.45 pieces/mile of large wood; adequate sources for LW recruitment; and wood is providing geomorphic function. Pool frequency of 17/mile with ≥50% of pools ≥1m (3ft) deep and good fish cover and cool water. Contains side or off-channel refugia.	Enhance Channel Complexity  Floodplain and CMZ Connectivity	Fivemile
Riparian Condition	Riparian overstory consists of 100% large trees; 1.2% of the riparian zone is disturbed; 6.3 hours of shade during summer solstice (moderate thermal shading); and 3.0 mile/miles <sup>2</sup> road density within 200-ft riparian buffer.	At least a 200-ft riparian buffer with: > 80% large trees, or consistent with potential native community < 20% riparian disturbance (human); high proportion of daylight hours with thermal shading over channel; and <2 mile/miles <sup>2</sup> road density	Riparian Restoration  Floodplain and CMZ Connectivity	Fivemile
Channel Dynamics	Where valley width allows, vegetated floodplains exist throughout the valley floor. Connectivity to the existing modern floodplain is adequate, limited by natural levees along the channel.	Floodplain areas are hydrologically linked to main channel within the context of the local process domain. Channel is migrating at or near natural rates within the geomorphic construct of the reach. No measurable trend of aggradation or incision beyond the natural geomorphic processes of the reach	Riparian Restoration  Floodplain and CMZ Connectivity  Enhance Channel Complexity	Fivemile

**1.4.4 Reach 4 Restoration Strategy**

<b>Overall ecological function</b>	<b>Low</b> <i>Rating is based on the Reach Assessment evaluations of habitat, geomorphology, hydrology, hydraulics, and vegetation. 9 of 11 REI metrics are at risk or unacceptable. Significant impairment of channel and floodplain function due to channel entrenchment and straightening, riparian vegetation clearing, minimal habitat complexity, lack of large wood in the channel, and no off-channel habitat.</i>
<b>Trajectory if no action taken</b>	<b>Decline</b> <i>Continued degradation due to persistent anthropogenic impacts to floodplain/channel migration zone, channel incision, riparian, and large wood processes. Possible long-term recovery of riparian condition due to land trust and federal land ownership.</i>
<b>Recovery potential</b>	<b>Low - Moderate</b> <i>Low-to-mod potential for recovery, assuming Sears Creek Road bridge and road remain on the landscape and continue to contribute to floodplain/channel constriction and incision. Proposed restoration actions can only address habitat limitations and not the root causes, though a full mainstem channel re-route would improve the achievable recovery potential.</i>
<b>Restoration objectives</b>	<b>Target conditions in Table 4</b> <i>Bring existing conditions to target conditions (multiple habitat and geomorphic attributes), where possible, for the metrics identified in Table 1 below. To the extent possible at this stage of planning, the targets are presented as measurable quantities.</i>
<b>Action Types</b>	<b>Riparian Restoration</b> <b>Enhance Channel Complexity</b> <b>Side and Off-Channel Habitat Creation or Enhancement</b> <b>Floodplain and CMZ Connectivity</b> <b>Conservation</b> <i>Actions include enhancement/improvement of channel complexity via large wood placements. Modification of anthropogenic features, such as road/bridge crossing, would improve natural channel dynamics. Excavation of side channel or oxbow inlets would increase available, accessible off-channel habitat and floodplain wetland areas. Revegetation of open field areas and willow/cottonwood trenches on open in-channel bars would improve long-term riparian conditions.</i>
<b>Project Areas &amp; Prioritization</b>	<b>Straightaway</b> <b>Sears Creek Road</b> <i>The potential to improve the quantity and quality of available habitat in Reach 4 is low-moderate. If all channel and floodplain treatment actions are implemented jointly, notable improvements are possible. However, existing buildings and infrastructure limit recovery potential in Reach 4. Both Reach 4 project areas are complimentary to each other but would provide habitat and function benefits if completed independently.</i>

**Table 4. Reach 4 Restoration Objectives, Action Types, and Projects.**

<b>Attribute</b>	<b>Existing Condition (from assessment)</b>	<b>Target Condition [REI – Adequate Rating]</b>	<b>Action Type</b>	<b>Project</b>
Habitat Quality	Gravels present with little fines. 129 pieces of medium or large LW per mile. 4 pools per mile with 100% pools > 1m (3ft) and moderate pool shade/cover. No side-channels.	Gravels or small cobbles make up >50% of the bed materials in spawning areas and ≤12% fines/sand (<6 mm) in spawning gravel. At least 67.45 pieces/mile of large wood and sources for LW recruitment. Pool frequency of 14/mile with ≥50% of pools ≥1m (3ft) deep and good fish cover and cool water. Contains side or off-channel refugia.	Enhance Channel Complexity  Side and Off-Channel Habitat Creation or Enhancement  Floodplain and CMZ Connectivity	Straightaway Sears Creek Road
Riparian Condition	Riparian overstory consists of 100% large trees; 4.9% of the riparian zone is disturbed; 6.2 hours of shade during summer solstice (moderate thermal shading); and 9.3 mile/miles <sup>2</sup> road density within 200-ft riparian buffer.	At least a 200-ft riparian buffer with: > 80% large trees, or consistent with potential native community < 20% riparian disturbance (human); high proportion of daylight hours with thermal shading over channel; and <2 mile/miles <sup>2</sup> road density	Riparian Restoration	Sears Creek Road
Channel Dynamics	Channel is entrenched due to channel straightening and confinement at the Sears Creek Road bridge. Connectivity to the existing modern floodplain is significantly reduced. Lateral migration processes are significantly impaired, and incision has occurred throughout much of the reach.	Floodplain areas are hydrologically linked to main channel within the context of the local process domain. Channel is migrating at or near natural rates within the geomorphic construct of the reach. No measurable trend of aggradation or incision beyond the natural geomorphic processes of the reach	Riparian Restoration  Floodplain and CMZ Connectivity  Enhance Channel Complexity	Straightaway Sears Creek Road

**1.4.5 Reach 5 Restoration Strategy**

<b>Overall ecological function</b>	<b>Low</b> <i>Rating is based on the Reach Assessment evaluations of habitat, geomorphology, hydrology, hydraulics, and vegetation. 7 of 11 REI metrics are at risk or unacceptable. Significant impairment of channel and floodplain function due to channel entrenchment and straightening, riparian vegetation clearing, minimal habitat complexity, and limited off-channel habitat.</i>
<b>Trajectory if no action taken</b>	<b>Decline</b> <i>Continued degradation due to persistent anthropogenic impacts to floodplain disconnection, channel incision, and altered riparian and large wood processes. Possible long-term recovery of riparian condition.</i>
<b>Recovery potential</b>	<b>Low - Moderate</b> <i>Large wood addition and reconnection of off-channel habitats would increase habitat complexity, but is limited by privately-owned land, road and bridge infrastructure, and chronic channel incision that is hard to restore.</i>
<b>Restoration objectives</b>	<b>Target conditions in Table 5</b> <i>Bring existing conditions to target conditions (multiple habitat and geomorphic attributes), where possible, for the metrics identified in Table 1 below. To the extent possible at this stage of planning, the targets are presented as measurable quantities.</i>
<b>Action Types</b>	<b>Riparian Restoration Enhance Channel Complexity Side and Off-Channel Habitat Creation or Enhancement Conservation</b> <i>Actions include enhancement/improvement of channel complexity via large wood placements. Excavation of side channel inlets or full side channel alignments would increase available, accessible off-channel habitat. Revegetation of open field areas and willow/cottonwood trenches on open in-channel bars would improve long-term riparian conditions.</i>
<b>Project Areas &amp; Prioritization</b>	<b>Sears Road Bridge Sears</b> <i>The potential to improve the quantity and quality of available habitat in Reach 5 is low-moderate. If all channel and floodplain treatment actions are implemented jointly, notable improvements are possible. However, existing buildings and infrastructure limit recovery potential in Reach 5. Both Reach 5 project areas are complimentary to each other but would provide habitat and function benefits if completed independently. Projects should avoid actions that may accelerate meander cutoff processes.</i>

**Table 5. Reach 5 Restoration Objectives, Action Types, and Projects.**

<b>Attribute</b>	<b>Existing Condition (from assessment)</b>	<b>Target Condition [REI – Adequate Rating]</b>	<b>Action Type</b>	<b>Project</b>
Habitat Quality	Gravels present with little fines. 121 pieces of medium or large LW per mile. 7 pools per mile with 94% pools > 1m (3ft) and moderate pool shade/cover. Two side-channels.	Gravels or small cobbles make up >50% of the bed materials in spawning areas and ≤12%fines/sand (<6 mm) in spawning gravel. At least 67.45 pieces/mile of large wood and sources for LW recruitment. Pool frequency of 13/mile with ≥50% of pools ≥1m (3ft) deep and good fish cover and cool water. Contains side or off-channel refugia.	Riparian Restoration  Enhance Channel Complexity  Side and Off-Channel Habitat Creation or Enhancement	Sears Creek Road Sears
Riparian Condition	Riparian overstory consists of 78% large trees; 0.3% of the riparian zone is disturbed; 5.5 hours of shade during summer solstice (moderate thermal shading); and 0.6 mile/miles <sup>2</sup> road density within 200-ft riparian buffer.	At least a 200-ft riparian buffer with: > 80% large trees, or consistent with potential native community < 20% riparian disturbance (human); high proportion of daylight hours with thermal shading over channel; and <2 mile/miles <sup>2</sup> road density	Riparian Restoration  Floodplain and CMZ Connectivity	Sears Creek Road Sears
Channel Dynamics	Channel entrenchment and connectivity to the existing modern floodplains is adequate in the middle and upper portion of the reach, and reduced in the lower portion of the reach due to Sears Creek Road/Bridge. Channel is entrenched due to channel straightening and confinement at the Sears Creek Road bridge. Connectivity to the existing modern floodplain is significantly reduced. Lateral migration processes are significantly impaired in the lower portion of the reach.	Floodplain areas are hydrologically linked to main channel within the context of the local process domain. Channel is migrating at or near natural rates within the geomorphic construct of the reach. No measurable trend of aggradation or incision beyond the natural geomorphic processes of the reach	Enhance Channel Complexity  Side and Off-Channel Habitat Creation or Enhancement  Floodplain and CMZ Connectivity	Sears Creek Road Sears

**1.4.6 Reach 6 Restoration Strategy**

<b>Overall ecological function</b>	<b>Moderate</b> <i>Rating is based on the Reach Assessment evaluations of habitat, geomorphology, hydrology, hydraulics, and vegetation. 5 of 11 REI metrics are at risk, but none were rated unacceptable. Impairment of channel habitat complexity, limited off-channel habitat, and disturbance to riparian vegetation.</i>
<b>Trajectory if no action taken</b>	<b>Maintain</b> <i>Effects of degradation due to anthropogenic impacts to floodplain, channel migration and incision, riparian, and large wood processes continue, but recovery over the long term may be possible due to responsive channel type despite challenge of addressing incision. Possible long-term recovery of riparian condition.</i>
<b>Recovery potential</b>	<b>Moderate - High</b> <i>Significant available opportunities for improving aquatic habitat conditions via large wood addition and off-channel habitat reconnection. Projects address lack of large in-channel structure but not the processes that create and maintain it long-term.</i>
<b>Restoration objectives</b>	<b>Target conditions in Table 6</b> <i>Bring existing conditions to target conditions (multiple habitat and geomorphic attributes), where possible, for the metrics identified in Table 1 below. To the extent possible at this stage of planning, the targets are presented as measurable quantities.</i>
<b>Action Types</b>	<b>Riparian Restoration</b> <b>Enhance Channel Complexity</b> <b>Side and Off-Channel Habitat Creation or Enhancement</b> <b>Floodplain and CMZ Connectivity</b> <b>Conservation</b> <i>Actions include enhancement/improvement of channel complexity via large wood placements. Modification of anthropogenic features, such as large wood replacing or added to bank riprap, would improve aquatic habitat condition. Excavation of side channel or oxbow inlets would increase available, accessible off-channel habitat or floodplain wetland areas. Revegetation of open field areas and willow/cottonwood trenches on open in-channel bars would improve long-term riparian conditions.</i>
<b>Project Areas &amp; Prioritization</b>	<b>Tenmile</b> <b>Double O</b> <b>Canyon Confluence</b> <i>The potential to improve the quantity and quality of available habitat in Reach 6 is moderate-high. If all channel and floodplain treatment actions are implemented, substantial improvements are possible. It is recognized that existing buildings and infrastructure adjacent to the channel and floodplains may limit recovery potential. All Reach 6 project areas are complimentary to each other but would provide habitat and function benefits if completed independently.</i>

**Table 6. Reach 6 Restoration Objectives, Action Types, and Projects.**

<b>Attribute</b>	<b>Existing Condition (from assessment)</b>	<b>Target Condition [REI – Adequate Rating]</b>	<b>Action Type</b>	<b>Project</b>
Habitat Quality	Gravels present with little fines. 281 pieces of medium or large LW per mile. 8 pools per mile with 84% pools > 1m (3ft) and moderate-high pool shade/cover. Three side-channels.	Gravels or small cobbles make up >50% of the bed materials in spawning areas and ≤12% fines/sand (<6 mm) in spawning gravel. At least 67.45 pieces/mile of large wood and sources for LW recruitment. Pool frequency of 10/mile with ≥50% of pools ≥1m (3ft) deep and good fish cover and cool water. Contains side or off-channel refugia.	Enhance Channel Complexity  Side and Off-Channel Habitat Creation or Enhancement	Tenmile Double O Canyon Confluence
Riparian Condition	Riparian overstory consists of 67% large trees; 1.2% of the riparian zone is disturbed; 6.0 hours of shade during summer solstice (moderate thermal shading); and 2.4 mile/miles <sup>2</sup> road density within 200-ft riparian buffer.	At least a 200-ft riparian buffer with: > 80% large trees, or consistent with potential native community < 20% riparian disturbance (human); high proportion of daylight hours with thermal shading over channel; and <2 mile/miles <sup>2</sup> road density	Riparian Restoration  Floodplain and CMZ Connectivity	Tenmile Double O Canyon Confluence
Channel Dynamics	Where valley width allows, vegetated floodplains exist throughout the valley floor. Connectivity to the existing modern floodplain is adequate, limited by natural levees along the channel.	Floodplain areas are hydrologically linked to main channel within the context of the local process domain. Channel is migrating at or near natural rates within the geomorphic construct of the reach. No measurable trend of aggradation or incision beyond the natural geomorphic processes of the reach	Riparian Restoration  Floodplain and CMZ Connectivity  Enhance Channel Complexity  Side and Off-Channel Habitat Creation or Enhancement	Tenmile Double O Canyon Confluence

**1.4.7 Reach 7 Restoration Strategy**

<b>Overall ecological function</b>	<b>Moderate</b> <i>Rating is based on the Reach Assessment evaluations of habitat, geomorphology, hydrology, hydraulics, and vegetation. 6 of 11 REI metrics are at risk, but none were rated unacceptable. Some impairment of channel and, riparian condition from disturbance within the riparian buffer, minimal habitat complexity, and limited off-channel habitat.</i>
<b>Trajectory if no action taken</b>	<b>Maintain</b> <i>Effects of degradation due to anthropogenic impacts to floodplain, channel migration and incision, riparian, and large wood processes continue, but recovery over the long term may be possible due to responsive channel type despite challenge of addressing incision. Possible long-term recovery of riparian condition.</i>
<b>Recovery potential</b>	<b>High</b> <i>Significant available opportunities for improving aquatic habitat conditions. Project area is all National Forest, and road is only adjacent to a small section of the channel at upstream end of the reach. High potential for recovery over the long-term. Proposed restoration actions can have large effect due to the responsive channel type. However, project actions largely address lack of large in-channel structure rather than the processes that create and maintain it long-term.</i>
<b>Restoration objectives</b>	<b>Target conditions in Table 7</b> <i>Bring existing conditions to target conditions (multiple habitat and geomorphic attributes), where possible, for the metrics identified in Table 1 below. To the extent possible at this stage of planning, the targets are presented as measurable quantities.</i>
<b>Action Types</b>	<b>Riparian Restoration</b> <b>Enhance Channel Complexity</b> <b>Side and Off-Channel Habitat Creation or Enhancement</b> <b>Floodplain and CMZ Connectivity</b> <i>Actions include enhancement/improvement of channel complexity via large wood placements. Modification of anthropogenic features, such as large wood added to bank riprap along the road, would improve aquatic habitat condition. Excavation of side channel or oxbow inlets would increase available, accessible off-channel habitat or floodplain wetland areas. Revegetation of open field areas and willow/cottonwood trenches on open in-channel bars would improve long-term riparian conditions.</i>
<b>Project Areas &amp; Prioritization</b>	<b>Napeequa Crossing</b> <i>The potential to improve the quantity and quality of available habitat in Reach 7 is high. If all channel and floodplain treatment actions are implemented, substantial improvements are possible. It is recognized that existing road infrastructure adjacent to the channel and floodplains may limit recovery potential.</i>

**Table 7. Reach 7 Restoration Objectives, Action Types, and Projects.**

Attribute	Existing Condition (from assessment)	Target Condition [REI – Adequate Rating]	Action Type	Project
Habitat Quality	Gravels present with little fines. 163 pieces of medium or large LW per mile. 5 pools per mile with 100% pools > 1m (3ft) and moderate pool shade/cover. One side-channel.	Gravels or small cobbles make up >50% of the bed materials in spawning areas and ≤12%fines/sand (<6 mm) in spawning gravel. At least 67.45 pieces/mile of large wood; adequate sources for LW recruitment; and wood is providing geomorphic function. Pool frequency of 11/mile with ≥50% of pools ≥1m (3ft) deep and good fish cover and cool water. Contains side or off-channel refugia.	Enhance Channel Complexity  Side and Off-Channel Habitat Creation or Enhancement	Napeequa Crossing
Riparian Condition	Riparian overstory consists of 100% large trees; 2.2% of the riparian zone is disturbed; 6.8 hours of shade during summer solstice (moderate thermal shading); and 4.0 mile/miles <sup>2</sup> road density within 200-ft riparian buffer.	At least a 200-ft riparian buffer with: > 80% large trees, or consistent with potential native community < 20% riparian disturbance (human); high proportion of daylight hours with thermal shading over channel; and <2 mile/miles <sup>2</sup> road density	Riparian Restoration  Floodplain and CMZ Connectivity	Napeequa Crossing
Channel Dynamics	Where valley width allows, vegetated floodplains exist throughout the valley floor. Channel straightening and lateral confinement from White River Road limits lateral migration in the upper portion of the reach, but is occurring at natural rates elsewhere. Connectivity to the existing modern floodplain is adequate.	Floodplain areas are hydrologically linked to main channel within the context of the local process domain. Channel is migrating at or near natural rates within the geomorphic construct of the reach. No measurable trend of aggradation or incision beyond the natural geomorphic processes of the reach	Riparian Restoration  Floodplain and CMZ Connectivity  Enhance Channel Complexity  Side and Off-Channel Habitat Creation or Enhancement	Napeequa Crossing

**1.4.8 Reach 8 Restoration Strategy**

<b>Overall ecological function</b>	<b>Low</b> <i>Rating is based on the Reach Assessment evaluations of habitat, geomorphology, hydrology, hydraulics, and vegetation. 6 of 11 REI metrics are at risk, but none were rated unacceptable. Some impairment of channel and, riparian condition from disturbance within the riparian buffer, minimal habitat complexity, and limited off-channel habitat.</i>
<b>Trajectory if no action taken</b>	<b>Decline</b> <i>Continued degradation due to persistent anthropogenic impacts to floodplain, channel migration and incision, and riparian and large wood processes. Possible long-term recovery of riparian condition.</i>
<b>Recovery potential</b>	<b>Moderate - High</b> <i>Significant available opportunities for improving aquatic habitat conditions. Proposed restoration actions can have large effect due to the responsive channel type. Much of the reach is National Forest, but some private landownership and the proximity of roads and buildings to the channel and floodplain may limit full recovery potential.</i>
<b>Restoration objectives</b>	<b>Target conditions in Table 8</b> <i>Bring existing conditions to target conditions (multiple habitat and geomorphic attributes), where possible, for the metrics identified in Table 1 below. To the extent possible at this stage of planning, the targets are presented as measurable quantities.</i>
<b>Action Types</b>	<b>Riparian Restoration</b> <b>Enhance Channel Complexity</b> <b>Side and Off-Channel Habitat Creation or Enhancement</b> <b>Conservation</b> <i>Actions include enhancement/improvement of channel complexity via large wood placements. Modification of anthropogenic features, such as road setback or riprap replaced by large wood, would improve aquatic habitat condition. Excavation of side channel inlets would increase available, accessible off-channel habitat or floodplain wetland areas. Revegetation on open channel banks and willow/cottonwood trenches on open in-channel bars would improve long-term riparian conditions.</i>
<b>Project Areas &amp; Prioritization</b>	<b>Napeequa Confluence</b> <b>Above Napeequa</b> <i>The potential to improve the quantity and quality of available habitat in Reach 8 is moderate - high. If all channel and floodplain treatment actions are implemented, substantial improvements are possible. It is recognized that existing road infrastructure adjacent to the channel and floodplains may limit recovery potential. Both Reach 8 project areas are complimentary to each other but would provide habitat and function benefits if completed independently.</i>

**Table 8. Reach 8 Restoration Objectives, Action Types, and Projects.**

Attribute	Existing Condition (from assessment)	Target Condition [REI – Adequate Rating]	Action Type	Project
Habitat Quality	Gravels present with little fines. 162 pieces of medium or large LW per mile. 8 pools per mile with 40% pools > 1m (3ft) and moderate pool shade/cover. Four side-channels.	Gravels or small cobbles make up >50% of the bed materials in spawning areas and ≤12% fines/sand (<6 mm) in spawning gravel. At least 67.45 pieces/mile of large wood and sources for LW recruitment. Pool frequency of 14/mile with ≥50% of pools ≥1m (3ft) deep and good fish cover and cool water. Contains side or off-channel refugia.	Enhance Channel Complexity  Side and Off-Channel Habitat Creation or Enhancement	Napeequa Crossing Above Napeequa
Riparian Condition	Riparian overstory consists of 56% large trees; 3.1% of the riparian zone is disturbed; 7.1 hours of shade during summer solstice (moderate thermal shading); and 7.9 mile/miles <sup>2</sup> road density within 200-ft riparian buffer.	At least a 200-ft riparian buffer with: > 80% large trees, or consistent with potential native community < 20% riparian disturbance (human); high proportion of daylight hours with thermal shading over channel; and <2 mile/miles <sup>2</sup> road density	Riparian Restoration  Side and Off-Channel Habitat Creation or Enhancement	Napeequa Crossing Above Napeequa
Channel Dynamics	Historical channel straightening and bank protection have reduced lateral migration processes in this reach, although lateral migration is actively occurring in the upstream and downstream portions. Where valley width allows, vegetated floodplains exist throughout the valley floor. No measurable trend in incision or aggradation beyond natural geomorphic processes is occurring..	Floodplain areas are hydrologically linked to main channel within the context of the local process domain. Channel is migrating at or near natural rates within the geomorphic construct of the reach. No measurable trend of aggradation or incision beyond the natural geomorphic processes of the reach	Riparian Restoration  Enhance Channel Complexity	Napeequa Crossing Above Napeequa

**1.4.9 Reach 9 Restoration Strategy**

<b>Overall ecological function</b>	<b>Low</b> <i>Rating is based on the Reach Assessment evaluations of habitat, geomorphology, hydrology, hydraulics, and vegetation. 7 of 11 REI metrics are at risk or unacceptable. Significant impairment of channel and floodplain function due to channel entrenchment and straightening, riparian vegetation clearing, minimal habitat complexity, relatively low quantities large wood in the channel compared to other reaches, and limited off-channel habitat.</i>
<b>Trajectory if no action taken</b>	<b>Decline/Maintain</b> <i>Some continued degradation due to persistent anthropogenic impacts to floodplain, channel migration and incision, and riparian and large wood processes. Possible long-term recovery of riparian condition.</i>
<b>Recovery potential</b>	<b>Moderate - High</b> <i>Significant available opportunities for improving aquatic habitat conditions. Proposed restoration actions can have large effect due to the responsive channel type. Proposed project actions are on National Forest, but the proximity of roads to the channel and floodplain may limit full recovery potential.</i>
<b>Restoration objectives</b>	<b>Target conditions in Table 9</b> <i>Bring existing conditions to target conditions (multiple habitat and geomorphic attributes), where possible, for the metrics identified in Table 1 below. To the extent possible at this stage of planning, the targets are presented as measurable quantities.</i>
<b>Action Types</b>	<b>Enhance Channel Complexity Side and Off-Channel Habitat Creation or Enhancement Floodplain and CMZ Connectivity</b> <i>Actions include enhancement/improvement of channel complexity via large wood placements. Excavation of side channel inlets would increase available, accessible off-channel habitat or floodplain wetland /beaver complex areas.</i>
<b>Project Areas &amp; Prioritization</b>	<b>Below Panther Grasshopper</b> <i>The potential to improve the quantity and quality of available habitat in Reach 9 is moderate - high. If channel and floodplain treatment actions are implemented, notable improvements are possible. Existing roads, some within close proximity to the channel, and recreational use areas may limit recovery potential, however. Both Reach 9 project areas are complimentary to each other but would provide habitat and function benefits if completed independently.</i>

**Table 9. Reach 9 Restoration Objectives, Action Types, and Projects.**

Attribute	Existing Condition (from assessment)	Target Condition [REI – Adequate Rating]	Action Type	Project
Habitat Quality	Channel has high proportion of larger cobbles and boulders, but gravels are present with minimal fines exist. 73 pieces of medium or large LW per mile. 2 pools per mile with 100% (n=1) pools > 1m (3ft) and low pool shade/cover. Two side-channels.	Gravels or small cobbles make up >50% of the bed materials in spawning areas and ≤12%fines/sand (<6 mm) in spawning gravel. At least 67.45 pieces/mile of large wood; adequate sources for LW recruitment; and wood is providing geomorphic function. Pool frequency of 15/mile with ≥50% of pools ≥1m (3ft) deep and good fish cover and cool water. Contains side or off-channel refugia.	Enhance Channel Complexity  Side and Off-Channel Habitat Creation or Enhancement  Floodplain and CMZ Connectivity	Below Panther Grasshopper
Riparian Condition	Riparian overstory consists of 100% large trees; 0.8% of the riparian zone is disturbed; 10.0 hours of shade during summer solstice (moderate thermal shading); and 2.2 mile/miles <sup>2</sup> road density within 200-ft riparian buffer.	At least a 200-ft riparian buffer with: > 80% large trees, or consistent with potential native community < 20% riparian disturbance (human); high proportion of daylight hours with thermal shading over channel; and <2 mile/miles <sup>2</sup> road density		
Channel Dynamics	Due to human-imposed channel straightening, the channel is entrenched and little to no channel migration is occurring. As a result, floodplains have been disconnected from the channel.	Floodplain areas are hydrologically linked to main channel within the context of the local process domain. Channel is migrating at or near natural rates within the geomorphic construct of the reach. No measurable trend of aggradation or incision beyond the natural geomorphic processes of the reach	Enhance Channel Complexity  Floodplain and CMZ Connectivity	Below Panther

**1.4.10 Reach 10 Restoration Strategy**

<b>Overall ecological function</b>	<b>Moderate-High</b> <i>Rating is based on the Reach Assessment evaluations of habitat, geomorphology, hydrology, hydraulics, and vegetation. 3 of 11 REI metrics are at risk, but none were rated as unacceptable. Some loss of habitat quality and complexity is present, and limited off-channel habitat is available due to natural confinement of the reach.</i>
<b>Trajectory if no action taken</b>	<b>Improve</b> <i>Degradation from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest will persist, but passive recovery is likely due to location within National Forest.</i>
<b>Recovery potential</b>	<b>High</b> <i>Significant available opportunities for improving aquatic habitat conditions. High potential for recovery over the long-term, but mainly due to passive recovery. Proposed restoration actions may have limited benefit due to high-energy, large channel in which a response may be hard to initiate.</i>
<b>Restoration objectives</b>	<b>Target conditions in Table 10</b> <i>Bring existing conditions to target conditions (multiple habitat and geomorphic attributes), where possible, for the metrics identified in Table 1 below. To the extent possible at this stage of planning, the targets are presented as measurable quantities.</i>
<b>Action Types</b>	<b>Enhance Channel Complexity Side and Off-Channel Habitat Creation or Enhancement</b> <i>Actions include enhancement/improvement of channel complexity via large wood placements. Large wood structures would likely increase the frequency of hydraulic connection of existing low swales and floodplain surfaces.</i>
<b>Project Areas &amp; Prioritization</b>	<b>Falls Reach</b> <i>The potential to improve the quantity and quality of available habitat in the downstream portion of Reach 1 is high, though that may be more a result of long-term passive recovery than project treatments.</i>

**Table 10. Reach 10 Restoration Objectives, Action Types, and Projects.**

Attribute	Existing Condition (from assessment)	Target Condition [REI – Adequate Rating]	Action Type	Project
Habitat Quality	Channel is dominated by larger cobbles and boulders, with only 39% gravels and minimal fines. 69 pieces of medium or large LW per mile. 5 pools per mile with 40% pools > 1m (3ft) and moderate pool shade/cover. No side-channels.	Gravels or small cobbles make up >50% of the bed materials in spawning areas and ≤12%fines/sand (<6 mm) in spawning gravel. At least 67.45 pieces/mile of large wood; adequate sources for LW recruitment; and wood is providing geomorphic function. Pool frequency of 18/mile with ≥50% of pools ≥1m (3ft) deep and good fish cover and cool water. Contains side or off-channel refugia.	Enhance Channel Complexity  Side and Off-Channel Habitat Creation or Enhancement	Falls Reach
Riparian Condition	Riparian overstory consists of 100% large trees; 0.0% of the riparian zone is disturbed; 9.9 hours of shade during summer solstice (moderate thermal shading); and 0.0 mile/miles <sup>2</sup> road density within 200-ft riparian buffer.	At least a 200-ft riparian buffer with: > 80% large trees, or consistent with potential native community < 20% riparian disturbance (human); high proportion of daylight hours with thermal shading over channel; and <2 mile/miles <sup>2</sup> road density		
Channel Dynamics	The channel is naturally confined, but where valley width allows, connectivity to the existing modern floodplain is adequate and no measurable trend in incision or aggradation beyond natural geomorphic processes was observed.	Floodplain areas are hydrologically linked to main channel within the context of the local process domain. Channel is migrating at or near natural rates within the geomorphic construct of the reach. No measurable trend of aggradation or incision beyond the natural geomorphic processes of the reach	Enhance Channel Complexity  Side and Off-Channel Habitat Creation or Enhancement	Falls Reach

**1.4.11 Napeequa River Reach 1 Restoration Strategy**

<b>Overall ecological function</b>	<b>Low-Moderate</b> <i>Rating is based on the Reach Assessment evaluations of habitat, geomorphology, hydrology, hydraulics, and vegetation. 9 of 11 REI metrics are at risk, but none are rated as unacceptable. Significant impairment of channel and floodplain function due to channel entrenchment and straightening, as well as bank armoring and riparian vegetation clearing. These result in decreased aquatic habitat quality and complexity and limited off-channel habitat.</i>
<b>Trajectory if no action taken</b>	<b>Decline/Maintain</b> <i>Continued impairment and possibly additional degradation due to persistent anthropogenic impacts to floodplain, channel migration and entrenchment, riparian, and large wood processes. Possible long-term recovery of riparian condition.</i>
<b>Recovery potential</b>	<b>Moderate - High</b> <i>Significant instream, side-channel, and riparian treatments are possible, but full recovery is challenged by continued development on the private parcels on the lower river.</i>
<b>Restoration objectives</b>	<b>Target conditions in Table 11</b> <i>Bring existing conditions to target conditions (multiple habitat and geomorphic attributes), where possible, for the metrics identified in Table 1 below. To the extent possible at this stage of planning, the targets are presented as measurable quantities.</i>
<b>Action Types</b>	<b>Riparian Restoration</b> <b>Enhance Channel Complexity</b> <b>Side and Off-Channel Habitat Creation or Enhancement</b> <b>Floodplain and CMZ Connectivity</b> <b>Conservation</b> <i>Actions include enhancement/improvement of channel complexity and aquatic habitat, side-channel reconnections, as well as removing anthropogenic features from the floodplain to restore function. Full restoration is limited by downstream private land ownership.</i>
<b>Project Areas &amp; Prioritization</b>	<b>Napeequa 1</b> <b>Napeequa 2</b> <i>Napeequa 2 is functioning moderately well already and treatment may have some limits to their benefits. Napeequa 1 has some significant impairments due to the existing land use, and assuming the land use stays the same, full recovery potential is limited.</i>

**Table 11. Napeequa Reach 1 Restoration Objectives, Action Types, and Projects.**

Attribute	Existing Condition (from assessment)	Target Condition [REI – Adequate Rating]	Action Type	Project
Habitat Quality	Gravels present with little fines. 127 pieces of medium or large LW per mile. 14 pools per mile with 65% pools > 1m (3ft) and good pool shade/cover. Three side-channels.	Gravels or small cobbles make up >50% of the bed materials in spawning areas and ≤12%fines/sand (<6 mm) in spawning gravel. At least 67.45 pieces/mile of large wood and sources for LW recruitment. Pool frequency of 23/mile with ≥50% of pools ≥1m (3ft) deep and good fish cover and cool water. Contains side or off-channel refugia.	Enhance Channel Complexity  Side and Off-Channel Habitat Creation or Enhancement	Napeequa 1 Napeequa 2
Riparian Condition	Riparian overstory consists of 46% large trees; 9.5% of the riparian zone is disturbed; 9.2 hours of shade during summer solstice (moderate thermal shading); and 6.1 mile/miles <sup>2</sup> road density within 200-ft riparian buffer.	At least a 200-ft riparian buffer with: > 80% large trees, or consistent with potential native community < 20% riparian disturbance (human); high proportion of daylight hours with thermal shading over channel; and <2 mile/miles <sup>2</sup> road density	Riparian Restoration  Floodplain and CMZ Connectivity  Side and Off-Channel Habitat Creation or Enhancement	Napeequa 1
Channel Dynamics	The channel is entrenched and straightened in the lower portion of the reach. Although much of the historical floodplain is available to the channel at flood-flow, frequency of connectivity is limited. Lateral channel migration is limited and local incision has occurred in the lower portion of the reach due to abundant bank protection (riprap). In the upper portion, the channel is not artificially constrained and is able to migrate laterally.	Floodplain areas are hydrologically linked to main channel within the context of the local process domain. Channel is migrating at or near natural rates within the geomorphic construct of the reach. No measurable trend of aggradation or incision beyond the natural geomorphic processes of the reach	Floodplain and CMZ Connectivity  Enhance Channel Complexity  Side and Off-Channel Habitat Creation or Enhancement	Napeequa 1 Napeequa 2

**1.4.12 Napeequa River Reach 2 Restoration Strategy**

<b>Overall ecological function</b>	<b>Moderate-High</b> <i>Rating is based on the Reach Assessment evaluations of habitat, geomorphology, hydrology, hydraulics, and vegetation. 2 of 11 REI metrics are at risk or unacceptable. Natural channel confinement results in some loss of aquatic habitat and riparian quality/complexity.</i>
<b>Trajectory if no action taken</b>	<b>Improve</b> <i>Degradation from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest will persist, but passive recovery is likely due to location within Wilderness.</i>
<b>Recovery potential</b>	<b>High</b> <i>In-channel aquatic habitat will improve in quality and complexity from treatment actions. Degraded from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest. But project area is all within a federal Wilderness Area, away from road or other human access. High potential for recovery over the long-term.</i>
<b>Restoration objectives</b>	<b>Target conditions in Table 12</b> <i>Bring existing conditions to target conditions (multiple habitat and geomorphic attributes), where possible, for the metrics identified in Table 1 below. To the extent possible at this stage of planning, the targets are presented as measurable quantities.</i>
<b>Action Types</b>	<b>Enhance Channel Complexity</b> <i>Actions include enhancement/improvement of channel complexity via large wood additions.</i>
<b>Project Areas &amp; Prioritization</b>	<b>Napeequa Twin Lakes</b> <i>Moderate priority (Tier 2) due to challenging access, already high functioning conditions, and limitations in the ability of restoration treatments to bring about large changes (mainly will require long-term passive restoration of riparian forests).</i>

**Table 12. Napeequa River Reach 2 Restoration Objectives, Action Types, and Projects.**

<b>Attribute</b>	<b>Existing Condition (from assessment)</b>	<b>Target Condition [REI – Adequate Rating]</b>	<b>Action Type</b>	<b>Project</b>
Habitat Quality	Gravel counts were not conducted; but ocular observations suggest large cobble and boulder substrates dominate. 378 pieces of medium or large LW per mile. 4 pools per mile with 100% pools > 1m (3ft) and good pool shade/cover. Six side-channels.	Gravels or small cobbles make up >50% of the bed materials in spawning areas and ≤12% fines/sand (<6 mm) in spawning gravel. At least 67.45 pieces/mile of large wood; adequate sources for LW recruitment; and wood is providing geomorphic function. Pool frequency of 23/mile with ≥50% of pools ≥1m (3ft) deep and good fish cover and cool water. Contains side or off-channel refugia.	Enhance Channel Complexity	Napeequa Twin Lakes
Riparian Condition	Riparian overstory consists of 50% large trees; 0.0% of the riparian zone is disturbed; 14.1 hours of shade during summer solstice (moderate thermal shading); and 0.0 mile/miles <sup>2</sup> road density within 200-ft riparian buffer.	At least a 200-ft riparian buffer with: > 80% large trees, or consistent with potential native community < 20% riparian disturbance (human); high proportion of daylight hours with thermal shading over channel; and <2 mile/miles <sup>2</sup> road density		
Channel Dynamics	The channel is naturally confined throughout the reach. Where valley width allows, connectivity to the existing modern floodplain is adequate and lateral processes are occurring. No measurable trend in incision or aggradation is occurring.	Floodplain areas are hydrologically linked to main channel within the context of the local process domain. Channel is migrating at or near natural rates within the geomorphic construct of the reach. No measurable trend of aggradation or incision beyond the natural geomorphic processes of the reach	Enhance Channel Complexity	Napeequa Twin Lakes

**1.4.13 Panther Creek Reach 1 Restoration Strategy**

<b>Overall ecological function</b>	<b>Moderate-High</b> <i>Rating is based on the Reach Assessment evaluations of habitat, geomorphology, hydrology, hydraulics, and vegetation. 3 of 11 REI metrics are at risk, but none were rated as unacceptable. Natural channel confinement results in some loss of habitat quality/complexity and off-channel habitat.</i>
<b>Trajectory if no action taken</b>	<b>Maintain – Improve</b> <i>Degradation from past timber harvest and loss of in-channel jams and loss of large tree riparian and floodplain forest will persist, but passive recovery is likely due to location within National Forest.</i>
<b>Recovery potential</b>	<b>High</b> <i>Opportunities are available for improving aquatic habitat conditions and addressing loss of large in-channel jams in Panther Creek Reach 1. Proposed restoration actions can have large effect due to size of channel.</i>
<b>Restoration objectives</b>	<b>Target conditions in Table 13</b> <i>Bring existing conditions to target conditions (multiple habitat and geomorphic attributes), where possible, for the metrics identified in Table 1 below. To the extent possible at this stage of planning, the targets are presented as measurable quantities.</i>
<b>Action Types</b>	<b>Enhance Channel Complexity Side and Off-Channel Habitat Creation or Enhancement</b> <i>Actions include enhancement/improvement of channel complexity via large wood placements. Large wood structures could increase activation of distributary channels in Panther alluvial fan.</i>
<b>Project Areas &amp; Prioritization</b>	<b>Panther</b> <i>The potential to improve the quantity and quality of available habitat in Panther Creek Reach 1 is high. Construction access is a challenge, but may be possible via helicopter and targeted ground-based access.</i>

**Table 13. Panther Creek Reach 1 Restoration Objectives, Action Types, and Projects.**

Attribute	Existing Condition (from assessment)	Target Condition [REI – Adequate Rating]	Action Type	Project
Habitat Quality	Channel is dominated by larger cobbles and boulders, with only 41% gravels and minimal fines. 136 pieces of medium or large LW per mile. 20 pools per mile with 43% pools > 1m (3ft) and moderate pool shade/cover. No side-channels.	Gravels or small cobbles make up >50% of the bed materials in spawning areas and ≤12% fines/sand (<6 mm) in spawning gravel. At least 67.45 pieces/mile of large wood; adequate sources for LW recruitment; and wood is providing geomorphic function. Pool frequency of 23/mile with ≥50% of pools ≥1m (3ft) deep and good fish cover and cool water. Contains side or off-channel refugia.	Enhance Channel Complexity  Side and Off-Channel Habitat Creation or Enhancement	Panther
Riparian Condition	Riparian overstory consists of 71% large trees and 14% mature trees; 0.0% of the riparian zone is disturbed; 12.7 hours of shade during summer solstice (moderate thermal shading); and 0.0 mile/miles <sup>2</sup> road density within 200-ft riparian buffer.	At least a 200-ft riparian buffer with: > 80% large trees, or consistent with potential native community < 20% riparian disturbance (human); high proportion of daylight hours with thermal shading over channel; and <2 mile/miles <sup>2</sup> road density		
Channel Dynamics	The channel is naturally confined throughout the reach. Where valley width allows, connectivity to the existing modern floodplain is adequate and lateral processes are occurring. No measurable trend in incision or aggradation is occurring.	Floodplain areas are hydrologically linked to main channel within the context of the local process domain. Channel is migrating at or near natural rates within the geomorphic construct of the reach. No measurable trend of aggradation or incision beyond the natural geomorphic processes of the reach	Enhance Channel Complexity	Panther

## 2 Project Opportunities

### 2.1 PROJECT IDENTIFICATION AND EVALUATION APPROACH

Projects were identified through field surveys and analysis performed in the Reach Assessment. A map of the project areas is provided in Figure 1. Project elements were identified that are believed to best achieve target conditions and address fish habitat limiting factors. The projects represent an initial first step; it is expected that projects will be modified once project-specific surveys, analysis, and stakeholder coordination are performed. Project descriptions and maps are provided below. Project prioritization was performed to rank the projects into three priority tiers. Prioritization occurred by subjecting the projects to a set of scoring criteria. These criteria are based on several factors, including how well projects address the “gap” between existing and target conditions, species use/potential use of the area, and whether or not projects address root causes of impairments. Projects are also given a relative cost score estimate and feasibility designation in order to provide a relative cost perspective in project selection and planning. A description of the scoring methods and guidance is provided at the end of this document (Section 3.2).

### 2.2 PROJECT OPPORTUNITIES OVERVIEW

A total of 20 project areas were identified. An effort was made to identify project boundaries that group similar actions or that address similar reach-scale conditions; however, in many cases the selection of boundaries was qualitative, but a necessary means to divide up the study area into distinct projects that can be evaluated and ranked. Actual project extents for projects that are brought forward for implementation are likely to change depending on factors such as funding, landowner cooperation, schedule, phasing, etc.

A summary of the prioritization results is included in Table 14. There are some overarching themes and patterns when it comes to project opportunities in the White River Reach Assessment area. The projects that stand out as highest priority (Tier 1) are those in the upper middle portion of the mainstem from approximately RM 11.5 to 15 and comprise the projects Below Panther, Above Napeequa, Napeequa Confluence, and Napeequa Crossing. These reaches are moderate-to-low gradient, with high fish use, and with impairments to instream wood and side-channel availability. Significant improvements can be made by the proposed actions and the channel will likely be responsive to the treatments. The landownership is largely National Forest and access is generally good. The next priority (Tier 2) are projects that are either steeper, less accessible, and/or are expected to be less responsive to treatment. These include projects in the upper mainstem, Panther, and upper Napeequa. Tier 2 projects also include the lower Napeequa (Napeequa 1) and the middle lower mainstem where the channel type is transitioning from the high priority areas upstream to the lower gradient, highly incised channels downstream. Landownership is a mix of public, private, and land trust. The third tier include the downstream mainstem projects where the fish use is less, the channels are highly incised, construction methods are more challenging, channels are less responsive, and there are fundamental human

constraints that are causing significant chronic impairment and are unlikely to change (e.g. roads and bridges).

**Table 14. Summary results of project prioritization. The full matrix is presented in Section 3.1.**

Project Area						Total Benefit Score	Cost Score	Benefit-to-Cost Score	Feasibility Designation
Tiers	Project Name	Reach	Down-stream RM	Up-stream RM	Total Length (mi)				
<b>Tier 1</b>	Below Panther	9	14.30	14.80	0.50	7	2	3.5	High
	Above Napeequa	8	13.30	14.30	1.00	7	2	3.5	High
	Napeequa Confluence	8	12.45	13.30	0.85	7	2	3.5	High
	Napeequa Crossing	7	11.65	12.45	0.80	7	2	3.5	High
<b>Tier 2</b>	Canyon Confluence	6	10.90	11.65	0.75	6.5	2.5	2.6	High
	Double O	6	10.05	10.90	0.85	6.5	2.5	2.6	High
	Napeequa 1	Napeequa 1	0.00	0.95	0.95	6.5	2.5	2.6	Low-Moderate
	Grasshopper	9	14.80	15.05	0.25	5	2	2.5	High
	Panther	Panther 1	0.00	0.40	0.40	5.5	2.5	2.2	High
	Falls Reach	10	15.10	16.00	0.90	5	2.5	2.0	High
	Tenmile	6	9.40	10.05	0.65	6	3	2.0	Moderate
	Napeequa Twin Lakes	Napeequa 2	1.70	2.20	0.50	5	2.5	2.0	Moderate-High
Napeequa 2	Napeequa 1	0.95	1.70	0.75	5	2.5	2.0	Moderate-High	
<b>Tier 3</b>	Dirtyface	2	2.55	4.15	1.60	4	2.5	1.6	Moderate
	Sears	5	7.50	9.40	1.90	4	3	1.3	Moderate
	Fivemile	3	4.15	5.75	1.60	4	3	1.3	Moderate
	Straightaway	4	5.75	6.65	0.90	4.5	3.5	1.3	Low-Moderate
	Lake Reach	1	0.00	1.80	1.80	3.5	3	1.2	Moderate
	Sears Creek Rd Bridge	4/5	6.65	7.50	0.85	3.5	3.5	1.0	Moderate (Low)
	Little Wenatchee Rd	1/2	1.80	2.55	0.75	3.5	3.5	1.0	Moderate (Low)

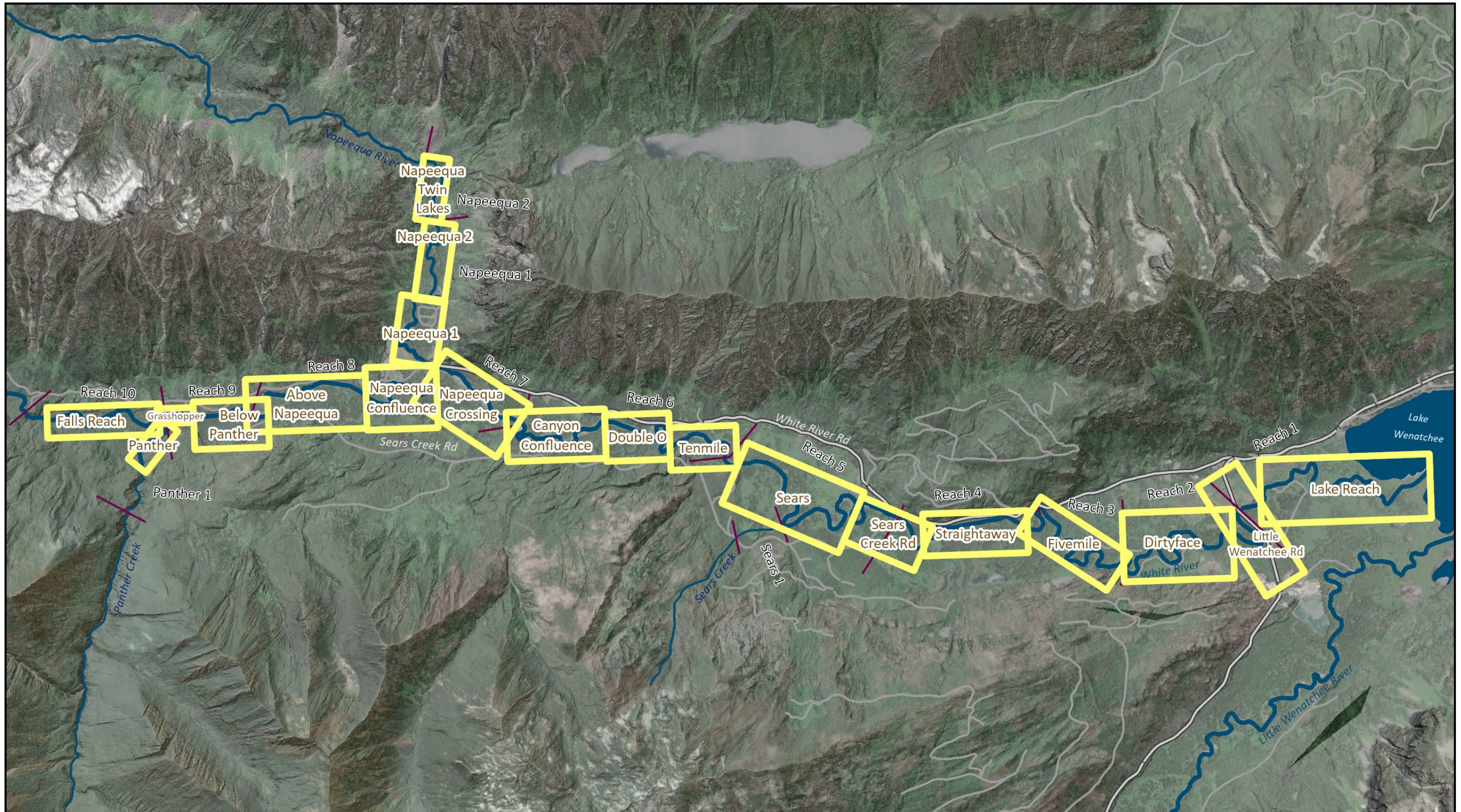


Figure 1. Overview of project locations.

**2.3 PROJECT DESCRIPTIONS**

This table describes project opportunities by project area within the White River Assessment area. Concept maps of the project opportunities are included below the table.

Reach	River Miles	Project Name	Project Description	Considerations
<b>1</b>	0 – 1.8	<i>Lake Reach</i>	<p><b>Narrative:</b>                      The Lake Reach comprises nearly 2 miles of stream extending from the White River mouth at Lake Wenatchee. The channel is incised and straightened compared to likely historical conditions, and sections of the river-left floodplain vegetation has been clear-cut allowing for establishment of reed canary grass. There are two channel scars on the river-right floodplain at RM 1.5 and RM 1.8 that could be re-connected through pilot channel excavation and could act as side-channels, or a re-routed, more sinuous main channel. An additional pilot channel could be excavated on the outside of the meander upstream of RM 1 to create a side channel around a vegetated island. The river-left floodplain could be re-vegetated to combat the growth of reed canary grass and to provide a long-term source of large wood and partial stream shading to the reach. There is an oxbow wetland that is connected to the main channel at RM 0.4 that is lacking cover. Large wood could be placed in the main channel and oxbow wetland to enhance connectivity and habitat condition. Large wood is generally lacking from the White River channel within the Lake Reach, and lateral processes are limited. A series of pile-supported structures containing abundant racked wood and spanning a significant portion of the channel could be installed throughout the reach. These structures would be paired with upstream jams intended to promote lateral processes and would be designed to capture transported wood and bedload, and address incision in addition to increasing habitat complexity. Willow and cottonwood trenching on bars in the upstream portion of the Lake Reach could promote cottonwood establishment and combat reed canary grass.</p> <p><b>Project Elements:</b></p> <ul style="list-style-type: none"> <li>• RM 1.3-1.8: Cottonwood/willow trenching on point bars.</li> <li>• RM 1-1.8: Multiple opportunities to excavate pilot channels to activate historic channel scars and create side-channels or re-route main channel. Place apex jams below excavated channels to encourage inundation.</li> <li>• RM 0.9-1.8: Revegetate clear-cut floodplain surfaces on river-left</li> <li>• RM 0.4: Encourage connectivity and cover in existing oxbow wetland</li> <li>• RM 0-1.8: Encourage large wood trapping and retention throughout the project area by installing a series of piling structures with abundant racked large wood. Place apex structures on existing bars.</li> </ul>	<p>An abandoned road cuts across the river-right floodplain from Little Wenatchee Road to RM 1.5. This road provides access for machinery. Downstream of this road there are no established access routes.</p> <p>It may be necessary to work with private landowners for completion of certain actions.</p>

Reach	River Miles	Project Name	Project Description	Considerations
1/2	1.8 – 2.55	<i>Little Wenatchee Rd</i>	<p><b>Narrative:</b>                      The Little Wenatchee Rd project area includes the Little Wenatchee Road bridge crossing at RM 2. The bridge and road prism are impediments to channel migration and floodplain connectivity, and modification of the existing structures could improve conditions and long-term processes within the project area. The river-left floodplain surface has been cleared and is now dominated by reed canary grass. Revegetation of floodplain surfaces would improve long-term wood recruitment and provide partial shading to the channel. A network of floodplain ditches cuts across the cleared floodplain on river-left. These ditches could be selectively filled and recontoured to limit floodplain draining and provide additional off-channel floodplain habitat at high flows. Riprap and sheet piling limit lateral migration of the channel from RM 1.9-2.0. These structures could be removed to allow for lateral processes to occur, or if bank hardening is deemed necessary, they could be removed and replaced with bank-buried jams to improve habitat conditions. Barbs for bank erosion on the outside of the meander at RM 2.3 could be replaced with habitat-providing bank-buried jams. A series of pile-supported structures containing abundant racked wood and spanning a significant portion of the channel could be installed throughout the reach. These structures would be paired with upstream jams intended to promote lateral processes and would be designed to capture transported wood and bedload, and address incision in addition to increasing habitat complexity.</p> <p>Conservation actions are worth consideration in this project area, where there is private property and floodplain clearing. Pursuing conservation easements or other protections (if they don't exist already) may help to facilitate restoration actions and would also help prevent future potential development that could impair channel, riparian, and floodplain processes.</p> <p><b>Project Elements:</b></p> <ul style="list-style-type: none"> <li>• RM 2.3: Remove barbs and replace with bank-buried jams</li> <li>• RM 2.0: Consider modifications of Little Wenatchee Road bridge to improve channel migration and floodplain connectivity</li> <li>• RM 2.0: Increase floodplain conveyance at Little Wenatchee Road crossings.</li> <li>• RM 1.9-2.0: Evaluate if bank hardening is required. If so, remove riprap and sheet pile and replace with bank-buried jams.</li> <li>• RM 1.8-2.55: Re-vegetation of clear-cut floodplain surfaces.</li> <li>• RM 0-1.8: Install a series of pile-supported structures with abundant racked large wood and paired upstream jams to promote lateral processes, address incision, capture upstream recruited wood, and improve habitat conditions.</li> </ul>	<p>Little Wenatchee Road provides a route for machinery access to the White River channel.</p> <p>It may be necessary to work with private landowners for completion of actions downstream of the Little Wenatchee Road bridge.</p>

Reach	River Miles	Project Name	Project Description	Considerations
2	2.55 – 4.15	<i>Dirtyface</i>	<p><b>Narrative:</b>                      This 1.6 mile reach is located upstream of the Little Wenatchee Road crossing of the river and floodplain. The channel is very flat, incised, and has adjusted very little in the past 30 years. There is some wood, including past pile-supported structures installed ~10 years ago intended to catch fluvially-transported wood, but most of these structures have little to no wood and are likely not aggressive and channel-spanning enough to be effective. Landownership is mostly state and land trust, with some private lands further afield in the floodplain. There is clearing and a floodplain ditch network in the river-left floodplain that is assumed to drain the floodplain water table during lower flow periods, but that also may provide some off-channel habitat to fish where ditches to connect to the river. There may be opportunities to selectively fill interior ditches to reduce the drainage effect, and/or to enhance (via recontouring and wood additions) lower portions of ditches near where they connect to the river to provide good off-channel habitat. The pros/cons of actions to address the ditches warrants further investigation. Addressing the channel incision is challenging. Wood can be added to help promote lateral adjustment to speed channel evolution, and also to provide additional cover and complexity. A series of pile-supported structures containing abundant racked wood and spanning a significant portion of the channel could be installed throughout the reach, similar to previous projects but more channel-spanning and with more wood directly added. These structures would be paired with upstream jams intended to promote lateral processes and would be designed to capture transported wood and bedload, and address incision in addition to increasing habitat complexity.</p> <p>Conservation actions are worth consideration in this project area, where there is private property and floodplain clearing. Pursuing conservation easements or other protections (if they don't exist already) may help to facilitate restoration actions and would also help prevent future potential development that could impair channel, riparian, and floodplain processes.</p> <p><b>Project Elements:</b></p> <ul style="list-style-type: none"> <li>• RM 2.55 – 3: Restoration of floodplain forest vegetation in river-left floodplain.</li> <li>• RM 2.6 – 4.1: Bar apex jams for split flows and to force lateral erosion at bends. Cover wood in alcoves and intermittent along banks</li> <li>• RM 2.6 – 4.1: Install a series of pile-supported structures with abundant racked large wood and paired upstream jams to promote lateral processes, address incision, capture upstream recruited wood, and improve habitat conditions.</li> <li>• RM 3.1: Willow and/or cottonwood planted in bundles/trenches on large point bars being dominated by reed canary grass, to help establish cottonwoods and to help force lateral erosion of opposite bank.</li> </ul>	<p>Machine access can be obtained from river-left floodplain from properties off of White River Road and Little Wenatchee Road. Access to the river-right floodplain can be obtained from an old road bed from Little Wenatchee Road.</p>

Reach	River Miles	Project Name	Project Description	Considerations
3	4.15 – 5.75	Fivemile	<p><b>Narrative:</b> The fivemile project is one of the longest projects at 1.6 miles long. Most of the land is National Forest or land trust. The channel is incised and is very low gradient, mostly slow deep pool habitat. The channel has changed very little for at least the past 30 years, despite what would be expected to be an active scrolling meandering channel. Incision and loss of large jams has likely contributed. The objective here would be to promote the lateral dynamics to the extent possible, using apex jams to force lateral erosion, especially into a few areas where there are larger trees for recruitment. The channel is wide, deep, and incised, meaning that fairly aggressive approaches are required to induce change. A recommended treatment that begins in this reach is to use pile-supported structures not totally unlike what has been attempted here in the past, but being more aggressive, spanning more of the channel, and incorporating more wood into the jams during construction. These jams would be designed to capture bedload to address incision, capture fluvially transported wood, and would provide high habitat complexity. In some cases, these jams would be located downstream of jams meant to promote lateral erosion, placed to capture recruited trees.</p> <p><b>Project Elements:</b></p> <ul style="list-style-type: none"> <li>• RM 4.2 – 4.8: Install a series of pile-supported structures with abundant racked large wood and paired upstream jams to promote lateral processes, address incision, capture upstream recruited wood, and improve habitat conditions</li> <li>• RM 4.7 – 5.7: Bar apex jams for split flows and to force lateral erosion at bends. Cover wood in alcoves and intermittent along banks.</li> <li>• RM 4.8 – 5.1: Potential to excavate side-channel inlet and outlet to connect oxbow in river-right floodplain.</li> <li>• RM 5.1: Willow and/or cottonwood planted in bundles/trenches on large point bars being dominated by reed canary grass, to help establish cottonwoods and to help force lateral erosion of opposite bank.</li> </ul>	<p>Machine access from White River Road on river-left, though will require establishing access road through floodplain forest. River-right access may be challenging, requiring river crossing or possibly access from old road bed that is present up-valley.</p>
4	5.75 – 6.65	Straightaway	<p><b>Narrative:</b> The Straightaway Project is nearly one-mile long and comprises the straight section of channel from RM 5.9 to 6.4. This section of channel was likely straightened in the past, but the specific history is unknown. The channel currently appears to be held against the river left hillslope toe, and may be somewhat locked in this location due to incision that may be exacerbated from scour along the hillslope. The White River Road is located close on river-left and there is riprap armoring at the upstream end along the roadway. Most of the area is National Forest, with some private and land trust land at the downstream end. Due to the degree of incision, there are limited opportunities for significant restoration using the typical log jam and side-channel reconnections. The recommended actions therefore are mainly focused on increasing cover and complexity in this very simplified channel. Some attempt could be made to bounce the channel back and forth in an effort to induce lateral bank erosion and bar development, and the configuration of the wood in the concept plan reflects this. There are also a few places where excavation (potentially deep digs) could connect up abandoned oxbows as side-channel and off-channel habitat. However, more aggressive measures may need to be taken to induce significant changes. One potential option is to plug the upstream end, and potentially other portions of the straight channel section, and selectively excavate to route flow into the river-right floodplain. This could have significant short-term impacts and may be cost-prohibitive, but is nevertheless worth consideration.</p> <p><b>Project Elements:</b></p> <ul style="list-style-type: none"> <li>• RM 5.8 – 6.3: log complexes in alternating bank locations to induce bank erosion and bar development to increase channel hydraulic complexity, pool scour, and cover.</li> <li>• RM 5.8, RM 6.6: Apex jams to split flow and help promote mid-channel vegetated island development.</li> <li>• RM 5.95, 5.1, 6.35, 6.67: potential connection points to connect up abandoned oxbows for side-channel and off-channel habitat. Would potentially require some deep excavations.</li> </ul>	<p>Access can be obtained via White River Road on river-left and potentially from river-right from an abandoned road grade in the floodplain.</p>

Reach	River Miles	Project Name	Project Description	Considerations
4/5	6.65 – 7.5	Sears Creek Rd	<p><b>Narrative:</b>                      The Sears Creek Rd project mainly focusses on the area of the bridge and road crossing of the floodplain and associated straightened channel segment (~0.4 miles). This section of stream suffers from severe disconnection of channel migration and floodplain inundation processes due to the bridge locking the channel in place along the river-left hillslope toe and the Sears Creek road prism bisecting the river-right floodplain. The channel is incised. The White River Road is located close by on river-left, with channel and riparian impacts. There is private land in the river-right floodplain, but also public land through most of the project area. The primary opportunity is to look for options for addressing the CMZ and floodplain disconnections, which are challenging if the road remains in place. A longer bridge span, and more and larger culvert crossings under the road in the floodplain would help, but may be too expensive for the benefit. Removing the road, and relying on another access point from the Little Wenatchee Road is worth consideration, but may be untenable given the topography and distance. With or without these potential larger improvements, there are opportunities for in-channel large wood work to add complexity and also some side-channel connection opportunities.</p> <p>Conservation actions are worth consideration in this project area where there is private property. Pursuing conservation easements or other protections (if they don't exist already) may help to facilitate restoration actions and would also help prevent future potential development that could impair channel, riparian, and floodplain processes.</p> <p><b>Project Elements:</b></p> <ul style="list-style-type: none"> <li>• RM 6.75 – 7.3: Use wood jams to add cover and complexity in this very simplified channel. Not much opportunity for wood to promote significant channel dynamics and split flow given the straightened and confined reach; except for some limited opportunity for an apex jam and split flow at the downstream end near RM 6.8.</li> <li>• RM 7: Look for opportunities to address confinement at bridge and from road that bisects river-right floodplain (see discussion in narrative above).</li> <li>• RM 7.35: Evaluate potential to excavate a connection into a long river-right floodplain side-channel that would connect existing floodplain swales and could have multiple re-entry points to the channel downstream as far as RM 6.7. Would require an improved/new crossing under Sears Creek Rd.</li> </ul>	<p>Easy access from White River Road and Sears Creek Road. Some work and access routes may require willing landowner at private parcel river-right floodplain.</p> <p>Long-term gage is located at bridge. Significant modification to bridge or road could potentially affect the gage station.</p>

Reach	River Miles	Project Name	Project Description	Considerations
5	7.5 – 9.4	Sears	<p><b>Narrative:</b> Sears is the longest project in the study area at 1.9 miles. Most of river-left, and some of river-right through the project area is private lands. There has been past clearing of riparian and floodplain vegetation at the downstream end, which has not recovered and where re-establishment of forested conditions is recommended. Incision related to the downstream bridge and road fill (and other various impacts) begins to significantly manifest in this reach, posing some challenges for floodplain re-connections. Project opportunities include in-channel apex jams, bank structures along cutbanks with cleared vegetation, and some side channel reconnections. Sears Creek enters this reach on river-right without a surface flow connection at low flows. Once Sears enters the White River floodplain, it enters a complex of floodplain wetlands and beaver ponds in abandoned oxbows. Creating a low-flow connection of Sears Creek with the White is worth consideration, although further evaluation is warranted as to the fish benefits of a low flow connection, versus keeping it as a high flow flood refuge and rearing area.</p> <p>Conservation actions are worth consideration in this project area, particularly at the downstream end where there is private property and floodplain clearing. Pursuing conservation easements or other protections (if they don't exist already) may help to facilitate restoration actions and would also help prevent future potential development that could impair channel, riparian, and floodplain processes.</p> <p><b>Project Elements:</b></p> <ul style="list-style-type: none"> <li>• RM 7.5 – 9.35: numerous opportunities to enhance large wood in-channel structure using jams to stabilize mid-channel islands and to increase overall cover and complexity.</li> <li>• RM 8.07 – 9.3: there are a few opportunities for side channel reconnections. A couple of back-bar channels that would likely require excavation due to height of bars, and two potential deeper digs to connect floodplain swales for longer side-channel connections. These warrant further evaluation of cost-benefit.</li> <li>• RM 7.65 – 7.85, RM 8.2: Replanting to recover riparian and floodplain forest vegetation. Construct meander bend jams along bank to reduce rapid erosion of bare cut-banks until vegetation can re-establish and provide long term stability and other functions. Need to consider pros/cons of working in these mature meander bends at the downstream end that are likely to cut off in coming years and could abandon instream wood work.</li> <li>• RM 8.4 – 8.7 bend: Recommend avoiding work through here as there is likely to be a meander cutoff in the next 5-10 years, which could jeopardize the benefits of restoration treatments.</li> <li>• RM 8.6: Sears Creek likely enters main channel somewhere near here, but not at low flows. Evaluate potential benefits, and feasibility, of reconnecting Sears Creek to mainstem at low flows.</li> </ul>	<p>Access can be obtained from river-left through private properties in floodplain, if willing landowners. There are likely access options river-right from Sears Creek Road.</p>

Reach	River Miles	Project Name	Project Description	Considerations
6	9.4 – 10.05	Tenmile	<p><b>Narrative:</b> This project area extends a little over a half-mile. There are private lands and cabins along river-left. The river here is very low gradient with riffles becoming shallower and shorter with longer pools compared to upstream reaches. There is a lack of large wood structure except for one large jam near RM 9.6. Project opportunities include in channel large wood structures, addressing bank armoring at a private residence (plus plantings), and some side-channel connections.</p> <p>Conservation is also a recommendation for this project area. There are private lands along river-left and within the active floodplain. Pursuing conservation easements or other protections (if they don't exist already) may help to facilitate restoration actions and would help prevent future potential development that could impair channel, riparian, and floodplain processes.</p> <p><b>Project Elements:</b></p> <ul style="list-style-type: none"> <li>• RM 9.5 – 10.2: a few opportunities to enhance large wood in-channel structure using jams to stabilize mid-channel islands and to increase overall cover and complexity</li> <li>• RM 9.6 – 10: There are a few opportunities for side channel connections, including a couple in the river-left floodplain that would likely require excavation to connect existing floodplain channel scars as side-channel habitat.</li> <li>• RM 9.85: There is existing armoring and clearing at a private cabin. Replace the armoring with bank-buried jams to enhance margin complexity. Replant cleared riparian with native riparian forest vegetation.</li> </ul>	<p>The road is close on river-left and there are private cabins near the river. This would provide potential access routes, pending willing landowners.</p>
6	10.05 – 10.9	Double O	<p><b>Narrative:</b> This nearly one-mile project includes two prominent cutoff oxbows in the river-right floodplain and one pending neck cutoff at the downstream end. The road abuts the channel on river-left at the downstream end but is mostly out of the floodplain on a terrace on river-right. The project area includes one significant opportunity for a long side-channel connection through the two “double O” oxbows on river-left. There is considerable existing in-channel complexity between RM 10.4 and 10.6 in the river-right channel (flow split), and so recommendations are included to push flow into that channel. This action, combined with roughening a low spot at the isthmus where the bend would cutoff, would dissuade cutoff potential. However, a cutoff may be challenging to prevent overall. A cutoff would shorten and straighten the channel. A “controlled” cutoff could be considered on river-right upstream of the bend, which would create an alignment with greater sinuosity than would result from the cutoff. The feasibility and pros/cons of this would require further evaluation.</p> <p>Conservation actions are worth consideration in this project area, particularly at the bend at the downstream end where there is private property and a structure that could be affected if the bend continues to laterally migrate. Pursuing conservation easements or other protections (if they don't exist already) may help to facilitate restoration actions and would also help prevent future potential development that could impair channel, riparian, and floodplain processes.</p> <p><b>Project Elements:</b></p> <ul style="list-style-type: none"> <li>• RM 10.15: add wood cover to existing alcove on river-right</li> <li>• RM 10.4: add large wood cover to existing riprap armor along roadway</li> <li>• RM 10.5: Place roughness wood on isthmus where cutoff would occur, and along bend, to dissuade cutoff potential</li> <li>• RM 10.57: Consider controlled cutoff alignment. Will require modeling and evaluation of pros and cons.</li> <li>• RM 10.6: add large jams to push flow into river-left channel with high existing complexity, and to take energy off of pending cutoff bend.</li> <li>• RM 10.65 – 10.9: numerous opportunities to enhance large wood in-channel structure using jams to stabilize mid-channel islands and to increase overall cover and complexity.</li> <li>• RM 11: This is the potential inlet point for creation of a long side-channel river-right that would connect the two “Double O” oxbows.</li> </ul>	<p>Access can be gained on river-left from the road, which abuts the channel at the downstream end. River-right access could be obtained off of Sears Creek Rd, and potentially via a private residence in the river-right floodplain.</p>

Reach	River Miles	Project Name	Project Description	Considerations
6	10.9 – 11.65	<i>Canyon Confluence</i>	<p><b>Narrative:</b>                      This nearly 1 mile project area begins to see a significant transition to lower gradient, with shallower riffles. The river has changed course over the past 5 years, with an avulsion (neck cutoff) that occurred between RM 11.5 and 11.6 sometime in 2022-3. There is relatively abundant in-channel wood and jams, likely at least partially due to the avulsion and subsequent channel adjustment. For this reason, there are some areas where instream wood treatments are not warranted. There are, nevertheless, opportunities in some areas to construct larger apex jams to remain stable and help promote forested island development. There are also some off-channel, connected alcove areas where wood cover and complexity could be enhanced. There are also some side-channel reconnection opportunities, including potentially a long side-channel through the river-left floodplain. Some older floodplain forests provide opportunities to promote lateral erosion and recruitment. Further afield in the river-left floodplain a cleared parcel could benefit from restoration of native floodplain forest vegetation.</p> <p><b>Project Elements:</b></p> <ul style="list-style-type: none"> <li>• RM 10.9 – 11.75: numerous opportunities to enhance large wood in-channel structure using jams to stabilize mid-channel islands, promote lateral erosion into mature forests for recruitment, and to increase overall cover and complexity.</li> <li>• RM 11.3 and RM 11.6: there are two connected river-right alcoves (former oxbows the channel has laterally connected into) that are relatively devoid of large wood cover. Cover could be enhanced for juvenile rearing and refuge habitat.</li> <li>• RM 11 – 11.4: There are a few opportunities for side channel connections, likely requiring excavation to connect abandoned oxbows as side-channel habitat.</li> <li>• RM 11.7: Evaluate potential to connect into long river-left side-channel, which would re-enter nearly a mile downstream.</li> </ul>	<p>Access can be obtained from White River Road on river-left and Sears Creek Road on river-left.</p> <p>Some dynamic channel adjustment is still occurring in response to 2022-3 avulsion. Need to take into consideration trends in channel position when planning restoration.</p>
7	11.65 – 12.45	<i>Napeequa Crossing</i>	<p><b>Narrative:</b>                      This half-mile project is located immediately downstream of the Napeequa confluence. The Napeequa Crossing camping area is located near the upstream end. The road directly abuts the channel at the upstream end river-left where there is a riprap bank. The road then arcs away from the channel with relatively little human disturbance for the remainder of the project area. There are multiple opportunities for in channel large wood structure and side-channel connections through the river-left and river-right floodplains, requiring various degrees of excavation to connect abandoned oxbows and other floodplain swales. The riparian forest is relatively young.</p> <p><b>Project Elements:</b></p> <ul style="list-style-type: none"> <li>• RM 11.7 – 12.3: numerous opportunities to enhance large wood in-channel structure using jams to stabilize mid-channel islands and to increase overall cover and complexity.</li> <li>• RM 11.7 – 12.3: numerous opportunities to use select excavation and log jams to connect side-channel features. Modeling and grading analysis will be required to determine the necessary amount of excavation to connect features.</li> <li>• RM 12.4: Add large wood cover to existing riprap bank along road.</li> </ul>	<p>Access can be obtained from White River Road, which lies close to the channel at the upstream end river-left. River-right work may require a channel crossing, or possibly access from Sears Creek Road further in the river-right floodplain, but could be significant vegetation and wetland impacts to establish access from that side.</p>

Reach	River Miles	Project Name	Project Description	Considerations
8	12.45 – 13.3	<i>Napeequa Confluence</i>	<p><b>Narrative:</b>                      The Napeequa Confluence project comprises just under 1 mile of stream immediately upstream from the confluence with the Napeequa River. Much of the land on river-left is part of the Tall Timbers retreat center. There is some good existing complexity through this reach and some older timber stands offering good large wood recruitment into the river. There are nevertheless impairments due to a reduction in former wood loading and related reduced connections to off-channel habitats and floodplains. Development at the Tall Timbers retreat center and the proximity of the White River Road create impacts to channel, riparian, and floodplain processes. Recommended actions include a consideration for a re-route of the road to set it back from the river. The current road directly abuts the river near RM 12.9, where there are old and failing log and boulder bank revetments that may be further compromised in coming years. Road set-back would require coordination with the retreat center. Other potential actions include apex jams in the channel to promote forested island development and select excavation to connect longer side-channels through the river-right floodplain to help promote anastomosing conditions. There may be good opportunity for enhancement/creation of a groundwater-fed channel in the river left floodplain; pump tests would help confirm.</p> <p>Conservation is critical for this project area, particularly privately-held lands along the river and within the active floodplain. Pursuing conservation easements or other protections (if they don't exist already) may help to facilitate restoration actions and would help prevent future potential development that could impair channel, riparian, and floodplain processes.</p> <p><b>Project Elements:</b></p> <ul style="list-style-type: none"> <li>• RM 12.5 – 13.3: Numerous locations for apex jams to help stabilize bars and form mid-channel forested islands</li> <li>• RM 12.6 – 12.7: Mid-channel jams to encourage lateral erosion river-right to recruit large timber from older stand</li> <li>• RM 12.6: Consider set-back of White River Road. Remove boulders and any armoring from along roadway and replace with bank-buried large wood structures. Riparian plantings.</li> <li>• RM 13.1: Enhance cover and complexity using large wood in existing side-channel that begins here and re-enters near RM 12.75</li> <li>• RM 13.1 – 13.2: Consider select excavation to activate side-channel complex through river-right floodplain to create anastomosing conditions. Will require further evaluation with model and examination of grades.</li> <li>• RM 13.3: There is an existing connected high flow side channel with beaver activity that cuts across the point bar at the upstream end of the project area that lies within private lands and is an important functioning feature to protect for off-channel juvenile rearing and refuge habitat.</li> </ul>	<p>It may be necessary to work with private landowners, including the Tall Timber retreat center, for completion of certain actions.</p> <p>Access will need to be obtained to river-right for some actions, which will require a temporary bridge or wet crossing, which would be possible during base flow conditions.</p>
8	13.3 – 14.3	<i>Above Napeequa</i>	<p><b>Narrative:</b>                      This 1-mile project area includes multiple mainstem complexity opportunities and multiple off-channel and floodplain reconnection opportunities. The off-channel and floodplain work is located in two primary areas, one is on river-left across the point bar at the upstream end and the other is through a series of floodplain channel scars on river-right in the upstream half of the project area. At the upstream river-left area, apex jams and potentially some select excavation could be used to increase the activation of a series of high flow channels across the point bar. These channels would also include large wood placements that are not shown on the concept drawing. On river-right, a connection could be made to activate the prominent oxbow, connecting up to a network of channel scars that all reenter the mainstem by RM 13.6. If a significant connection point is made at the upstream end, this could help to create the forest island anastomosing channel pattern that likely existed here historically. Large wood jams could be used, possibly with select excavation to increase the activation of multiple back bar channels and other side-channels closer to the active channel. There is already good complexity and abundant jams in portions of this reach, primarily at the bend at RM 14.2.</p> <p><b>Project Elements:</b></p> <ul style="list-style-type: none"> <li>• RM 14.1 – 14.4: Apex jams and select excavation to increase the activation of a series of high flow channels across point bar</li> <li>• RM 14.3: Excavate to enhance connectivity of floodplain oxbow and side-channel network.</li> <li>• RM 13.4 – 14: Multiple opportunities to use apex jams and other structures to increase activation of side-channels and back-bar channels and to increase overall complexity and cover.</li> </ul>	<p>Access can be obtained either from the White River Road or from the remnant 6404 Road bed that still partially exists in the river-right floodplain, but would take some clearing and re-creation of channel crossings.</p>

Reach	River Miles	Project Name	Project Description	Considerations
9	14.3 – 14.8	<i>Below Panther</i>	<p><b>Narrative:</b> This 0.5 mile project area is the most upstream of the reaches in the core project opportunity area between Panther and the Napeequa confluences. The valley widens after passing through the steeper upstream reach that traverses the Panther Fan. There is a relative well-connected floodplain surface on valley-right with a prominent channel scar that could be reconnected as a side-channel or even co-dominant channel. Excavation would be needed at the upstream end plus an apex jam and other jams and wood loading in the main channel to initiate channel activation. There may also be the potential for a groundwater-fed channel in this floodplain that connects into the side-channel. More investigation (pump test) is warranted to understand if there is adequate groundwater flow. There are multiple opportunities to enhance complexity and to increase activation of back-bar channels within the active channel corridor. There are also opportunities for felling in selective large riparian conifers.</p> <p><b>Project Elements:</b></p> <ul style="list-style-type: none"> <li>• RM 14.75: Excavate entrance to former channel scar to create side-channel or co-dominant main channel. This would increase channel sinuosity compared to the current mainstem alignment. Add apex jams and other jams in the mainstem to divert flow.</li> <li>• RM 14.3 – 14.7: Place apex jams at heads of lateral bars to increase activation of back-bar channels and to support development of forested bars/islands.</li> <li>• RM 14.3 – 14.8 (full length): Selectively fell mature streamside conifers where available.</li> </ul>	<p>Access is close from White River Road. Channel crossing would be required using temporary bridge or in-water crossing.</p> <p>Pump tests required to investigate groundwater-fed channel potential in river-right floodplain. Would require machinery access across river. Creation of groundwater-fed channel could have significant vegetation impacts to mature floodplain forest; however, existing swale is mostly smaller trees and shrubs.</p>
9/10	14.8 – 15.05	<i>Grasshopper</i>	<p><b>Narrative:</b> This is a short project that extends from RM 14.8 to 15.07. It spans the split flow section around a large forested island, one of the few split flow sections in the entire study area. Although this reach is still steep and has less floodplain and side-channel connection opportunities, the split flow condition offers a unique opportunity for using channel-spanning jams secured along the bed to capture bedload and create forced step-pool channel conditions. This would mainly occur in the smaller river-left channel around the island. Spanning or partially-spanning logs would be placed as tight to the bed as possible, with additional wood added in the channel and extending from the banks for ballast. Use of slash would assist with ‘sealing’ of the jams to the bed to maximize bedload capture. Selective large trees could be felled from the mature riparian forest. The river-right channel is larger; treatments here could include similar approaches but may have to rely more on trees extending out from the banks to provide more localized scour and bedload capture as opposed to channel-spanning structures that may be challenging to maintain in this larger channel.</p> <p><b>Project Elements:</b></p> <ul style="list-style-type: none"> <li>• RM 14.87 – 15.5 River-left channel: Channel-spanning structures tight to bed to capture bedload and to create forced step-pool conditions</li> <li>• RM 14.87 – 15.5 River-right channel: Extend partially-spanning structures from bank, and fell riparian trees, to create localized scour, cover, and bedload capture</li> </ul>	<p>Access via machines from Grasshopper Campground. River crossings likely easiest at low water at island. Possibly use temporary bridge or logs for temporary crossings.</p>

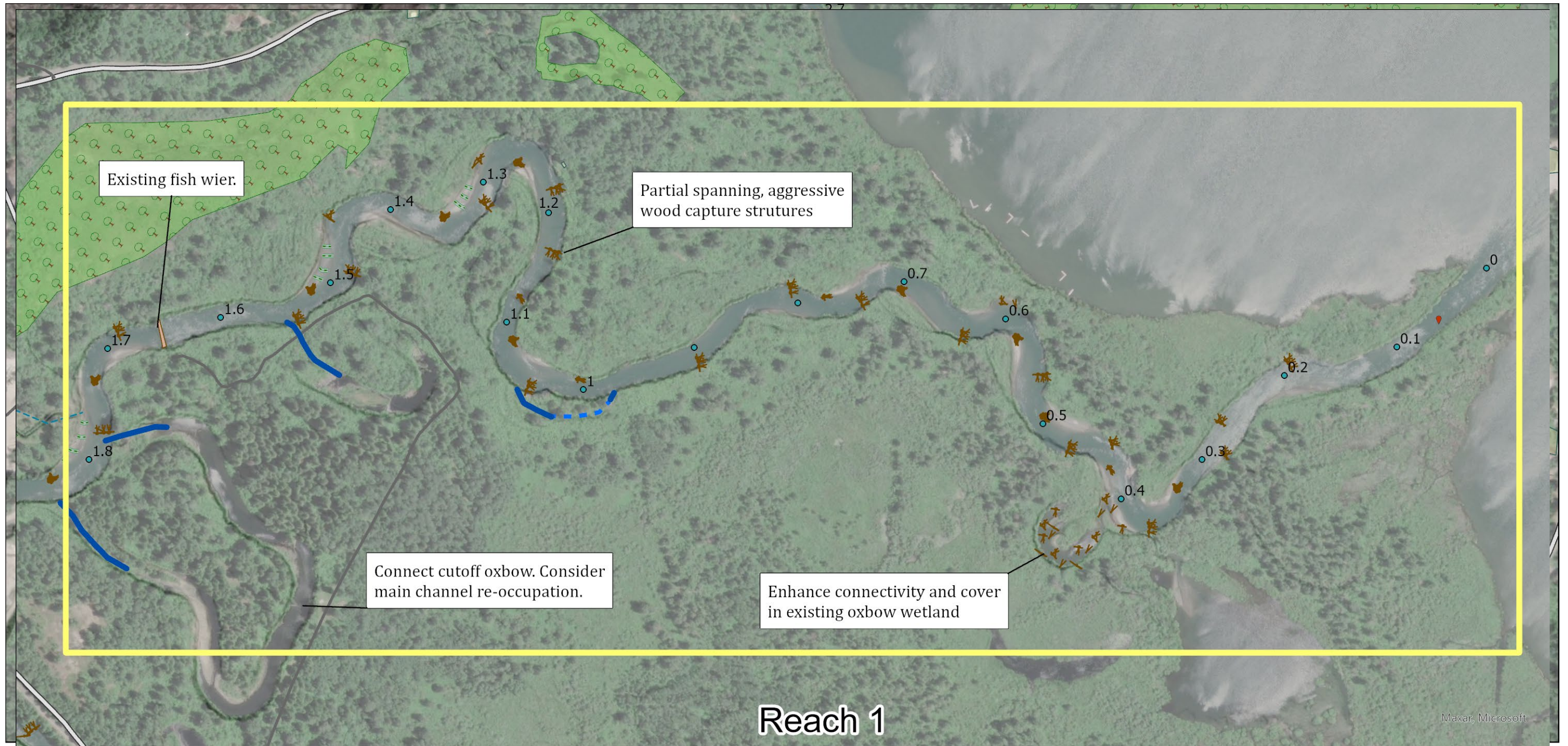
Reach	River Miles	Project Name	Project Description	Considerations
10	15.1 - 16	<i>Falls Reach</i>	<p><b>Narrative:</b>                      This project area extends from approximately 0.2 miles downstream of White River Falls at RM 15.9 to just upstream of the Panther Creek confluence at RM 15.1. This area has no straightforward construction access via machines so is primarily focused on helicopter wood placements and felling of large streamside trees, except for one area identified for machine digging for a side-channel connection at the lower end. This reach is more confined and steeper than downstream areas and so the potential for activating floodplains and side-channels is less than in other project areas. There are, however, a few high flow side channels where it is believed that helicopter wood placements could increase the degree of activation of the channels via flow diversion, scour at the inlet areas, and in some cases combined with channel wood loading to increase bedload capture and roughness</p> <p><b>Project Elements:</b></p> <ul style="list-style-type: none"> <li>• RM 15.1 – 15.95: helicopter wood loading and felling of large streamside trees. Focus on greater activation of high flow side channel entrances at RM 15.7 and 15.8.</li> <li>• RM 15.17: Machine-based excavation to open up a side-channel inlet on river-right, combined with apex log jam construction. Other elements through here could also be performed or aided by machine.</li> </ul>	<p>Machine access is challenging due to road located up on hillslope and dense forest vegetation.</p> <p>For the machine-access portion near RM 15.17, access would occur from the vicinity of Grasshopper Campground located downstream near RM 14.9. Channel would likely be easiest crossed at island near campground. Ideally, logs would be delivered by helicopter to reduce the amount of required stream crossings.</p>

Reach	River Miles	Project Name	Project Description	Considerations
<b>Napeequa Reach 1</b>	0 – 0.95	<i>Napeequa 1</i>	<p><b>Narrative:</b>                      The Napeequa 1 project area extends from the mouth of the Napeequa River to RM 0.95, and is located on Tall Timber retreat center property. The channel contains riprap bank hardening throughout much of the area to protect built structures on the valley floor. The channel was likely straightened, and vegetation was cleared from floodplain surfaces. Anthropogenic features limit channel and habitat complexity and disrupt geomorphic and habitat processes. Riprap on both banks could be replaced or enhanced with large wood to improve existing habitat conditions and encourage lateral migration into the opposite banks while maintaining bank protections for existing built structures. The river-left floodplain contains several prominent channel scars that could be re-connected as side-channels or re-activated as the main channel. Several back bar channels on river-right could be activated through large wood placement and pilot channel excavation. Clear-cut floodplain surfaces could be re-planted to improve bank stability and provide a long-term source of wood recruitment and partial shading to the channel. Apex jams could be placed on mid-channel and lateral gravel-cobble bars throughout the project area to promote and sustain split flow conditions. The bridge crossing the mouth of the Napeequa River could be lengthened to allow for expanded floodplain width at the outlet of the Napeequa River.</p> <p>Conservation actions are worth consideration in this project area, where there is private property and development of riparian and floodplain areas. Pursuing conservation easements or other protections (if they don't exist already) may help to facilitate restoration actions and would also help prevent future potential development that could impair channel, riparian, and floodplain processes.</p> <p><b>Project Elements:</b></p> <ul style="list-style-type: none"> <li>• RM 0.75– 0.87: Excavate river-right side channels and place large wood jams to direct flow into excavated channels and promote scour.</li> <li>• RM 0.53 – 0.58 and RM 0.29 – 0.39: Excavate pilot channel and place apex jam at inlet to promote side-channel flow and scour.</li> <li>• RM 0.45 – 0.55: Excavate pilot channel and place apex jam to direct flow into existing historical oxbow on river-left. Place large wood jam at oxbow outlet to promote pool scour.</li> <li>• RM 0.1 – 0.58: Re-plant clear-cut floodplain surfaces</li> <li>• RM 0.15 – 0.65: Place apex large wood jams on existing gravel-cobble bars to enhance split flow conditions and existing habitat conditions</li> <li>• RM 0.1 – 0.2: Remove existing rock barb and place apex jam to direct flow into existing historical oxbow on river-left. Remove historical channel plug, culvert and old utility crossing at outlet to mainstem channel.</li> <li>• RM 0 – 0.95 (full length): Remove portions of riprap from river-left and river-right banks and replace or enhance with large wood to provide bank protection and improved habitat, and encourage lateral migration to other side of channel while maintaining bank protection for existing built structures.</li> <li>• RM 0: Increase bridge length and expand floodplain width underneath bridge at outlet of Napeequa River.</li> </ul>	<p>Machine access can be obtained from the unimproved road on river-right that extends from White River Road, or from the network of unimproved roads on the Tall Timber property. Machine access would require clearing forest vegetation.</p> <p>It will be necessary to work with private landowners, including the Tall Timber retreat center, for completion of most actions.</p>

Reach	River Miles	Project Name	Project Description	Considerations
<b>Napeequa Reach 1</b>	0.95 – 1.7	<i>Napeequa 2</i>	<p><b>Narrative:</b> The Napeequa 2 project area extends from the eastern edge of the Tall Timber property on the Napeequa River near RM 0.95 to the falls at RM 1.7. The valley floor widens and gradient flattens considerably as the Napeequa River exits a narrow canyon downstream of the falls. The Napeequa River channel in the project area is sinuous but lacks sufficient large wood. Large wood could be placed to improve habitat conditions. Apex jams could be installed on existing bars to promote and/or sustain split-flow conditions and encourage scour pool development. Bank-attached large wood jams could be placed on channel margins to enhance habitat conditions and provide additional cover, and to encourage continued lateral migration within the project area. Existing access routes are lacking in the upstream portion of the reach. Therefore, helicopter wood placements and/or felling of existing trees would be required. Downstream, an unimproved road extending from White River Road through the Tall Timber property could be used for construction machine access, although some forest vegetation clearing would be required to access the river.</p> <p><b>Project Elements:</b></p> <ul style="list-style-type: none"> <li>• RM 1.5 – 1.7: Helicopter placements of apex and bank-attached jams to promote split flow conditions and pool scour, and to enhance existing habitat complexity and cover.</li> <li>• RM 0.95 – 1.2: Helicopter and machine-based placements of apex, bank-attached, and side-channel outlet jams to promote split flow conditions and enhance existing habitat complexity and cover.</li> </ul>	<p>Helicopter wood placements and some tree felling are assumed for the upper portion of the project area due to lack of access roads and dense forest vegetation.</p> <p>Machine access to the lower portion of the project area can be obtained from the unimproved road on river-right that extends from White River Road to approximately RM 1.3, but would require clearing forest vegetation.</p> <p>It may be necessary to work with private landowners, including the Tall Timber retreat center, for completion of most actions.</p>
<b>Napeequa Reach 2</b>	1.7 – 2.3	<i>Napeequa Twin Lakes</i>	<p><b>Narrative:</b> This project area extends from the falls at RM 1.7 to RM 2.3 on the Napeequa River. The Napeequa River in this area is steep, and laterally confined within a narrow canyon. The area has no existing construction access, and projects include helicopter wood placements to promote and enhance split flow conditions, and increase activation of narrow floodplain surfaces on vegetated islands. Given the high stream energy in this project area, large wood would be placed between existing boulders to maximize large wood stability.</p> <p><b>Project Elements:</b></p> <ul style="list-style-type: none"> <li>• RM 2.27 – 2.3: Helicopter wood loading onto existing boulders to promote split flow and increase floodplain activation.</li> <li>• RM 2.1 – 2.2: River-right channel: Helicopter wood loading upstream of existing boulders to promote split flow.</li> </ul>	<p>Helicopter wood placements and some tree felling are assumed. Machine access is challenging due to lack of access road, dense forest vegetation, and steep terrain.</p> <p>The project area is located within the Glacier Peak Wilderness therefore any tree felling must be accomplished through non-mechanized means.</p>

Reach	River Miles	Project Name	Project Description	Considerations
<b>Panther Reach 1</b>	0 – 0.4	<i>Panther</i>	<p><b>Narrative:</b>                      Lower Panther Creek is currently incised into its fan, a condition likely exacerbated due to historical land use. The channel makes a very direct path to the White River and is lacking large wood to force complexity, process, and habitat. This project has two primary components:</p> <p>1) Helicopter wood additions to the main channel from where the creek exits the canyon near RM 0.4 to the major river-right distributary channel that branches off at RM 0.1. This work would address incision into the fan that has likely been exacerbated by past logging that has resulted in a modern lack of large wood structure in the channel. Placements could also incorporate felling smaller riparian trees into the channel, and/or adding slash via helicopter, to “seal” structures to the bed to maximize gravel capture to raise the bed and create complexity in pools (plunge pools, chutes) and with cover. Also includes heli-delivered wood in upper river-right distributary channel path for roughness to account for potentially more flow.</p> <p>2) Increase the activation of the prominent distributary channel that branches off of the main channel near RM 0.1. This channel is not active at lower flows. Compared to the existing straight and simplified channel, the distributary channel has greater length, multi-thread channels, and abundant large wood complexity. The project would use machines to construct a large spanning/blocker jam at the junction to block the existing flow path and activate the distributary channel. Large wood roughness would be added to the lower portion of the existing channel to further dissuade it returning to become the dominant channel.</p> <p><b>Project Elements:</b></p> <ul style="list-style-type: none"> <li>• RM 0.1 – 0.4: Helicopter loading to capture bedload and create forced step-pool morphology. Heli roughness wood added to upper distributary path.</li> <li>• RM 0 – 1: Block existing active channel and route main flow path into river-right distributary channel. Roughen existing channel below with large wood. Machine-based work.</li> </ul>	<p>Helicopter wood placements and some tree felling are assumed for the upstream work, but could also be performed by machines if reasonable access can be found.</p> <p>The lower work, with the channel blocking jam, would require accessing with machines from existing access points across the White River. This should be possible at low flows, but may require a temporary bridge or log crossing depending on number of trips and permitting requirements.</p>

## **2.4 PROJECT MAPS**



## Reach 1

### White River Reach Assessment Project Opportunities Lake Reach

Project Elements		Built Features	
Log & log with rootwad	SC Excavation	Trailheads	Bank Hardening
2, 3, & 4 log structures	SC Activation	Previously Constructed Large Wood	Paved Road
Small & large whole tree	Revegetation	Screw Trap	Unmaintained Road
Small & large apex jams	Remove armoring	Culverts	Campgrounds and Picnic Areas
Sm, med & lrg bank jams	Willow/Ctwd trenching	Drainage Ditches	Bridges
			Structures

Note: These are preliminary concepts intended to describe the type of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.





**White River Reach Assessment**  
*Project Opportunities*  
**Dirtyface**

**Project Elements**

- Log & log with rootwad
- 2, 3, & 4 log structures
- Small & large whole tree
- Small & large apex jams
- Sm, med & lrg bank jams

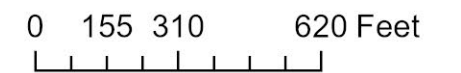
- SC Excavation
- SC Activation
- Revegetation
- Remove armoring
- Willow/Ctwd trenching

- Trailheads
- Previously Constructed Large Wood
- Screw Trap
- Culverts
- Drainage Ditches

**Built Features**

- Bank Hardening
- Paved Road
- Unmaintained Road
- Grade Control
- Campgrounds and Picnic Areas
- Bridges
- Structures

Note: These are preliminary concepts intended to describe the type of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.

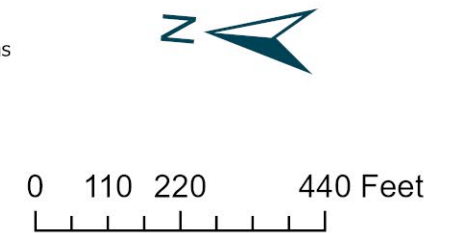


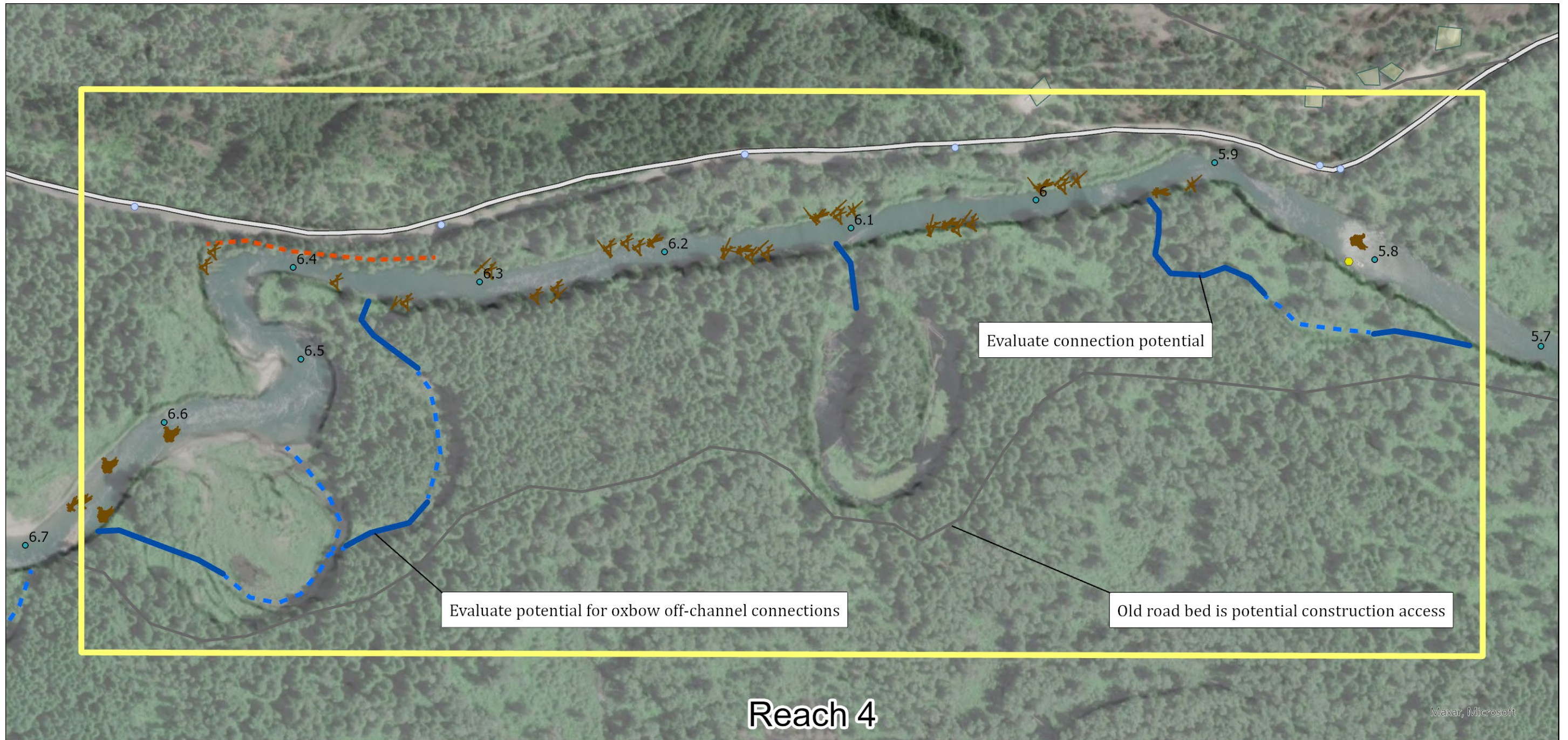


**White River Reach Assessment**  
*Project Opportunities*  
**Fivemile**

Project Elements		Built Features	
Log & log with rootwad	SC Excavation	Trailheads	Bank Hardening
2, 3, & 4 log structures	SC Activation	Previously Constructed Large Wood	Paved Road
Small & large whole tree	Revegetation	Screw Trap	Unmaintained Road
Small & large apex jams	Remove armoring	Culverts	Grade Control
Sm, med & lrg bank jams	Willow/Ctwd trenching	Drainage Ditches	Campgrounds and Picnic Areas

Note: These are preliminary concepts intended to describe the type of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.





**White River Reach Assessment**  
*Project Opportunities*  
**Straightaway**

**Project Elements**

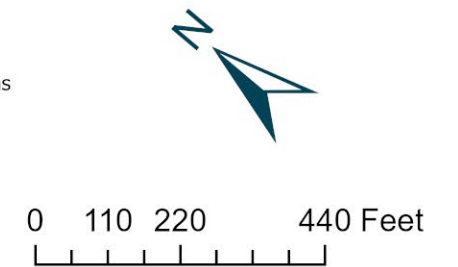
- Log & log with rootwad
- 2, 3, & 4 log structures
- Small & large whole tree
- Small & large apex jams
- Sm, med & lrg bank jams
- SC Excavation
- SC Activation
- Revegetation
- Remove armoring
- Willow/Ctwd trenching

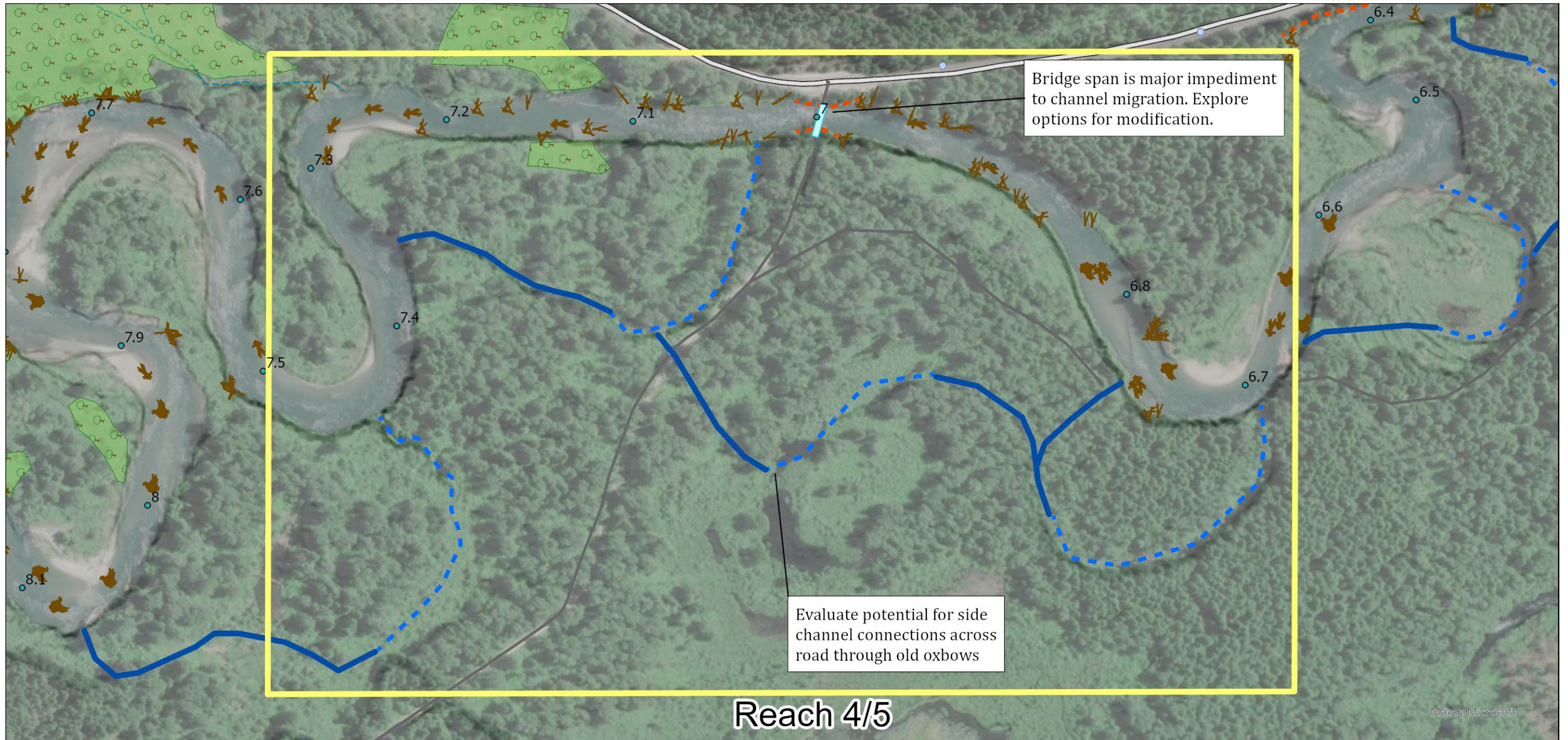
- Trailheads
- Previously Constructed Large Wood
- Screw Trap
- Culverts
- Drainage Ditches

**Built Features**

- Bank Hardening
- Paved Road
- Unmaintained Road
- Grade Control
- Campgrounds and Picnic Areas
- Bridges
- Structures

Note: These are preliminary concepts intended to describe the type of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.





**White River Reach Assessment**  
*Project Opportunities*  
**Sears Creek Rd**

**Project Elements**

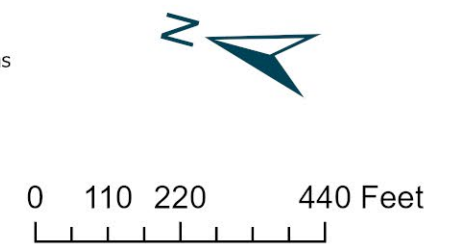
- Log & log with rootwad
- 2, 3, & 4 log structures
- Small & large whole tree
- Small & large apex jams
- Sm, med & lrg bank jams
- SC Excavation
- SC Activation
- Revegetation
- Remove armoring
- Willow/Ctwd trenching

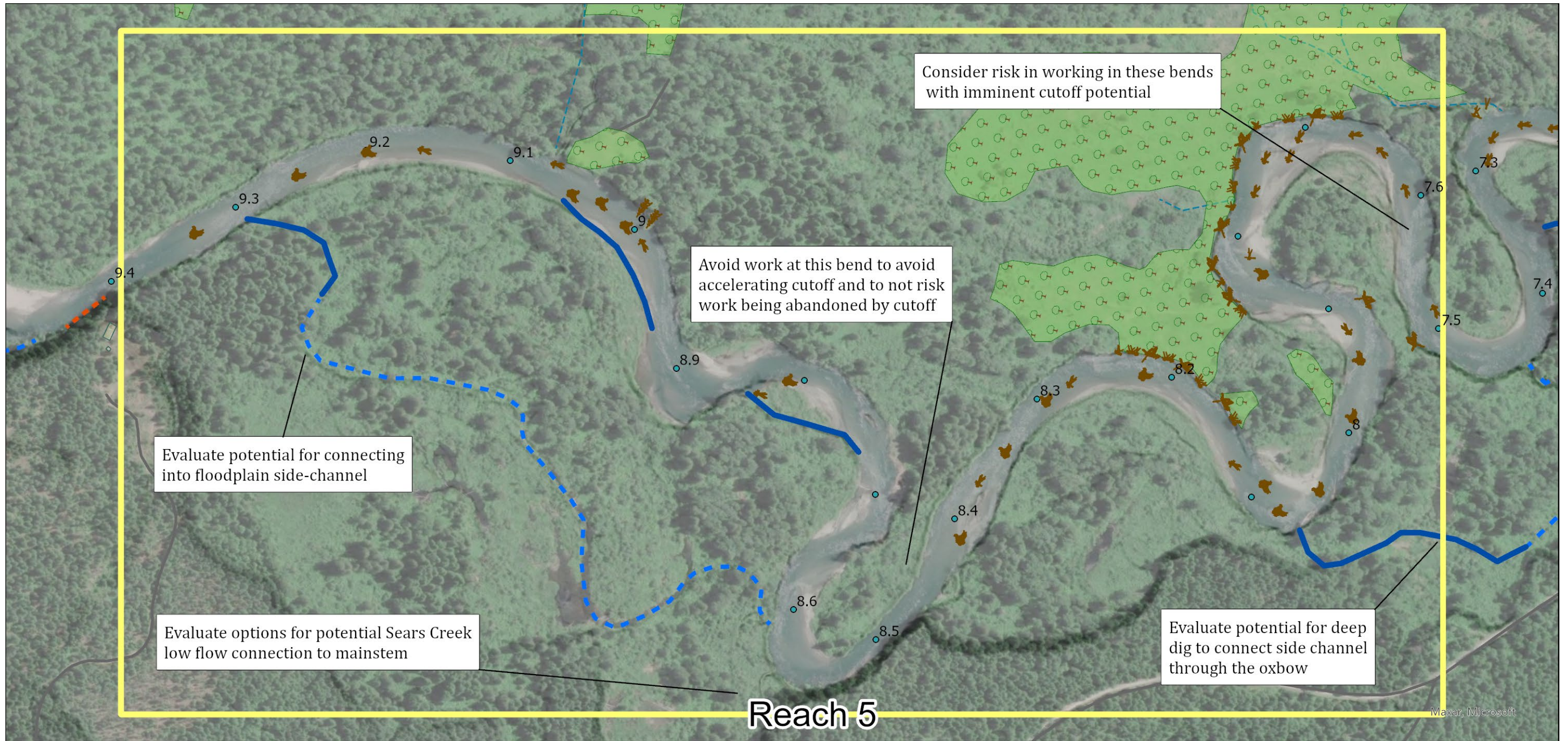
- Trailheads
- Previously Constructed Large Wood
- Screw Trap
- Culverts
- Drainage Ditches

**Built Features**

- Bank Hardening
- Paved Road
- Unmaintained Road
- Grade Control
- Campgrounds and Picnic Areas
- Bridges
- Structures

Note: These are preliminary concepts intended to describe the type of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.

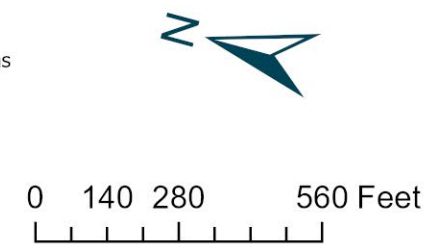


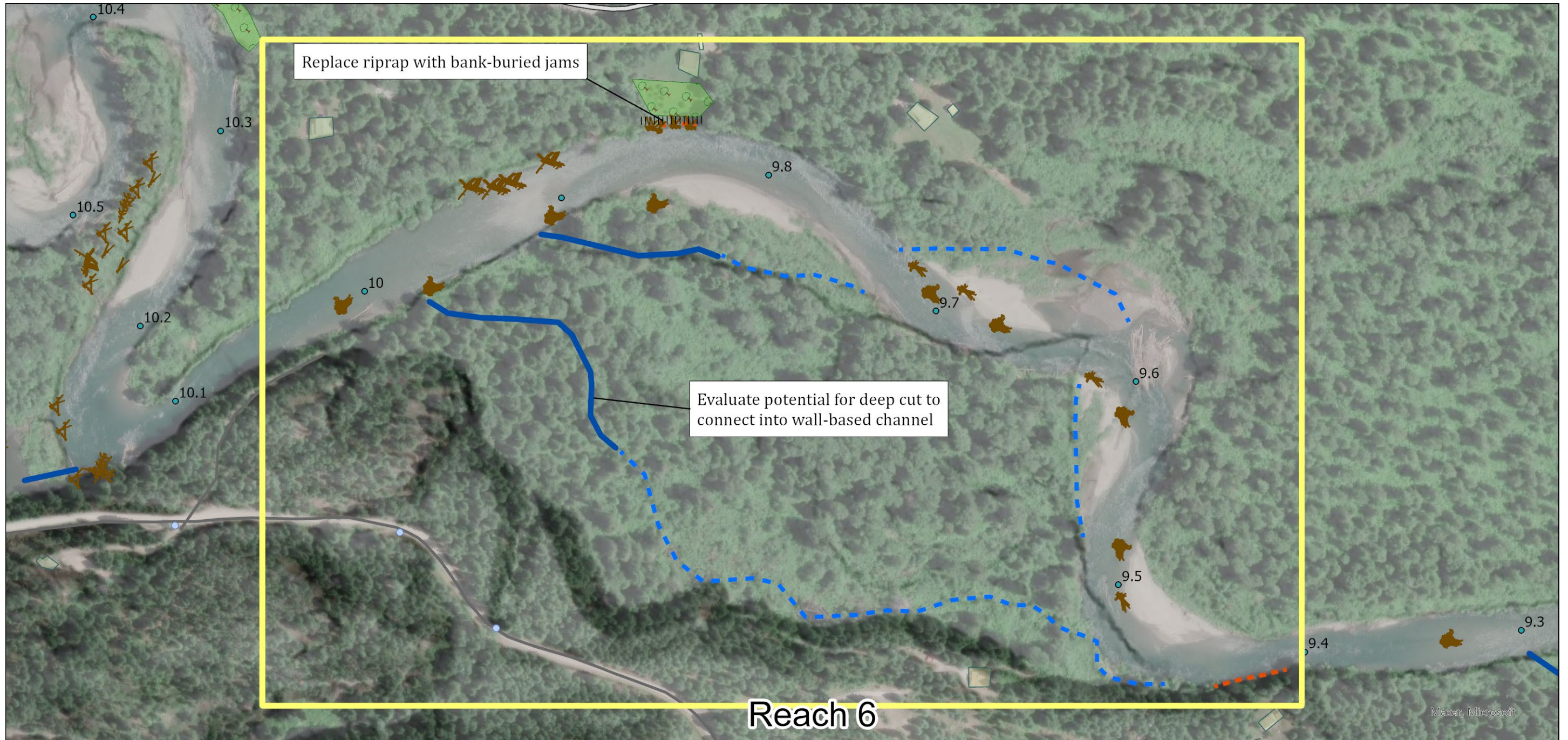


**White River Reach Assessment**  
*Project Opportunities*  
**Sears**

Project Elements		Built Features	
Log & log with rootwad	SC Excavation	Trailheads	Bank Hardening
2, 3, & 4 log structures	SC Activation	Previously Constructed Large Wood	Paved Road
Small & large whole tree	Revegetation	Screw Trap	Unmaintained Road
Small & large apex jams	Remove armoring	Culverts	Grade Control
Sm, med & lrg bank jams	Willow/Ctwd trenching	Drainage Ditches	Campgrounds and Picnic Areas
			Bridges
			Structures

Note: These are preliminary concepts intended to describe the type of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.





**White River Reach Assessment**  
*Project Opportunities*  
**Tenmile**

**Project Elements**

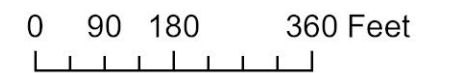
- Log & log with rootwad
- 2, 3, & 4 log structures
- Small & large whole tree
- Small & large apex jams
- Sm, med & lrg bank jams
- SC Excavation
- SC Activation
- Revegetation
- Remove armoring
- Willow/Ctwd trenching

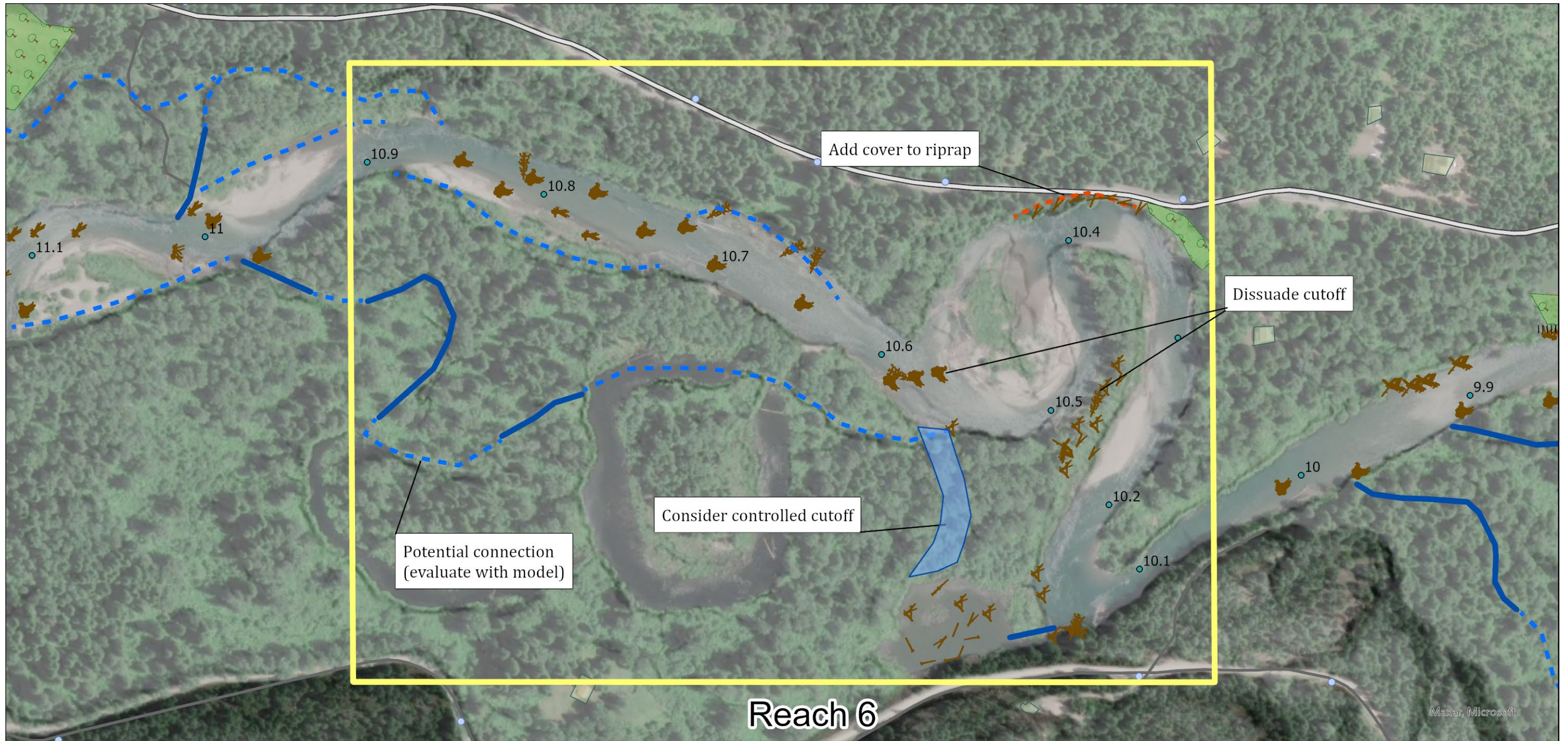
- Trailheads
- Previously Constructed Large Wood
- Screw Trap
- Culverts
- Drainage Ditches

**Built Features**

- Bank Hardening
- Paved Road
- Unmaintained Road
- Grade Control
- Campgrounds and Picnic Areas
- Bridges
- Structures

Note: These are preliminary concepts intended to describe the type of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.





**White River Reach Assessment**  
*Project Opportunities*  
**Double O**

**Project Elements**

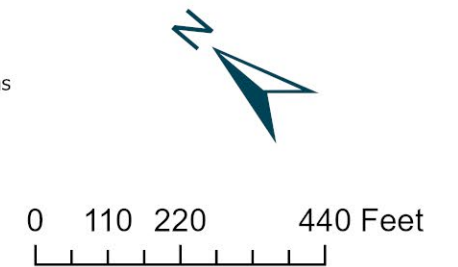
- Log & log with rootwad
- 2, 3, & 4 log structures
- Small & large whole tree
- Small & large apex jams
- Sm, med & lrg bank jams
- SC Excavation
- SC Activation
- Revegetation
- Remove armoring
- Willow/Ctwd trenching

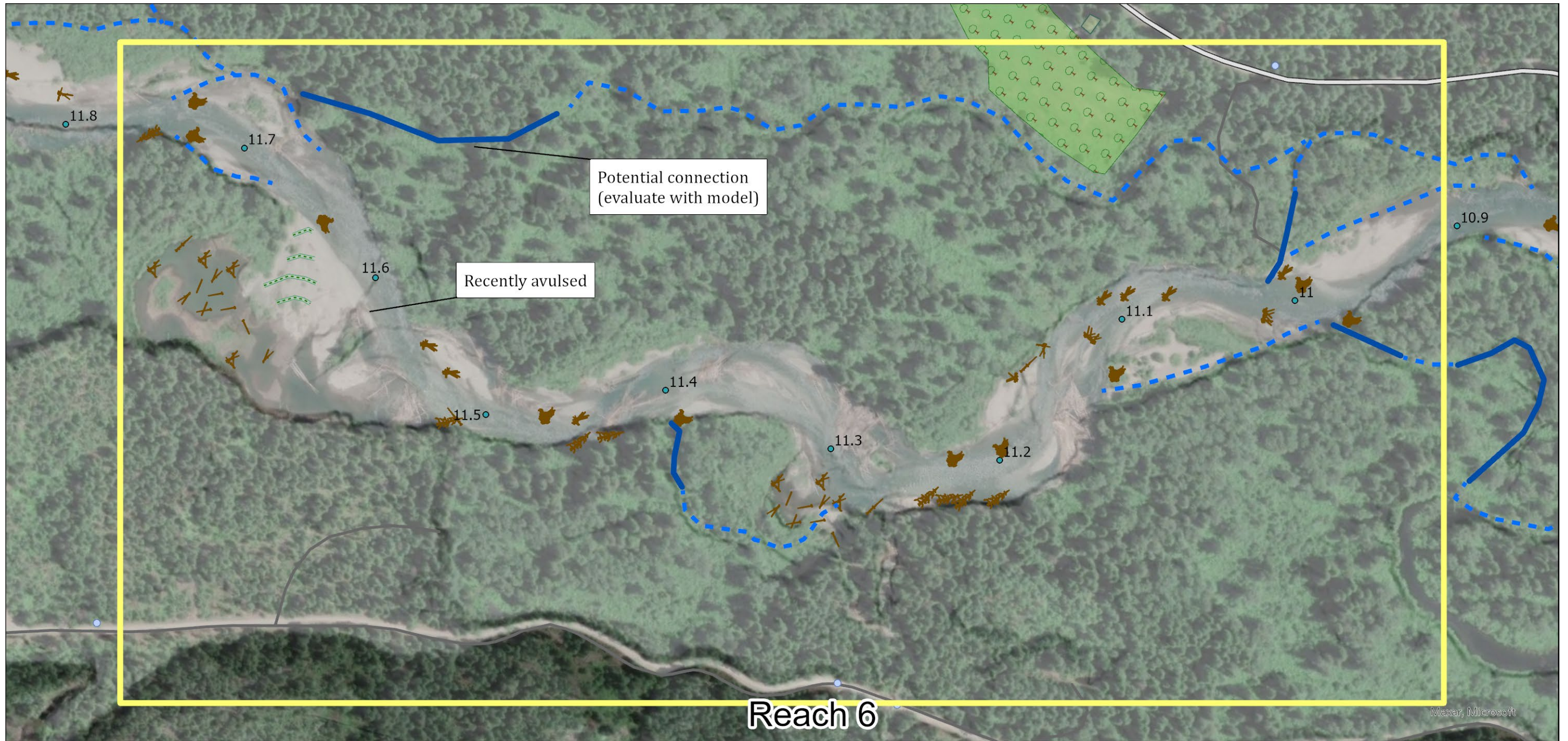
- Trailheads
- Previously Constructed Large Wood
- Screw Trap
- Culverts
- Drainage Ditches

**Built Features**

- Bank Hardening
- Paved Road
- Unmaintained Road
- Grade Control
- Campgrounds and Picnic Areas
- Bridges
- Structures

Note: These are preliminary concepts intended to describe the type of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.

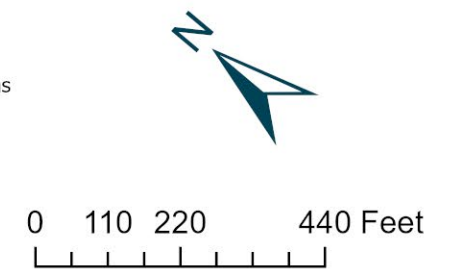


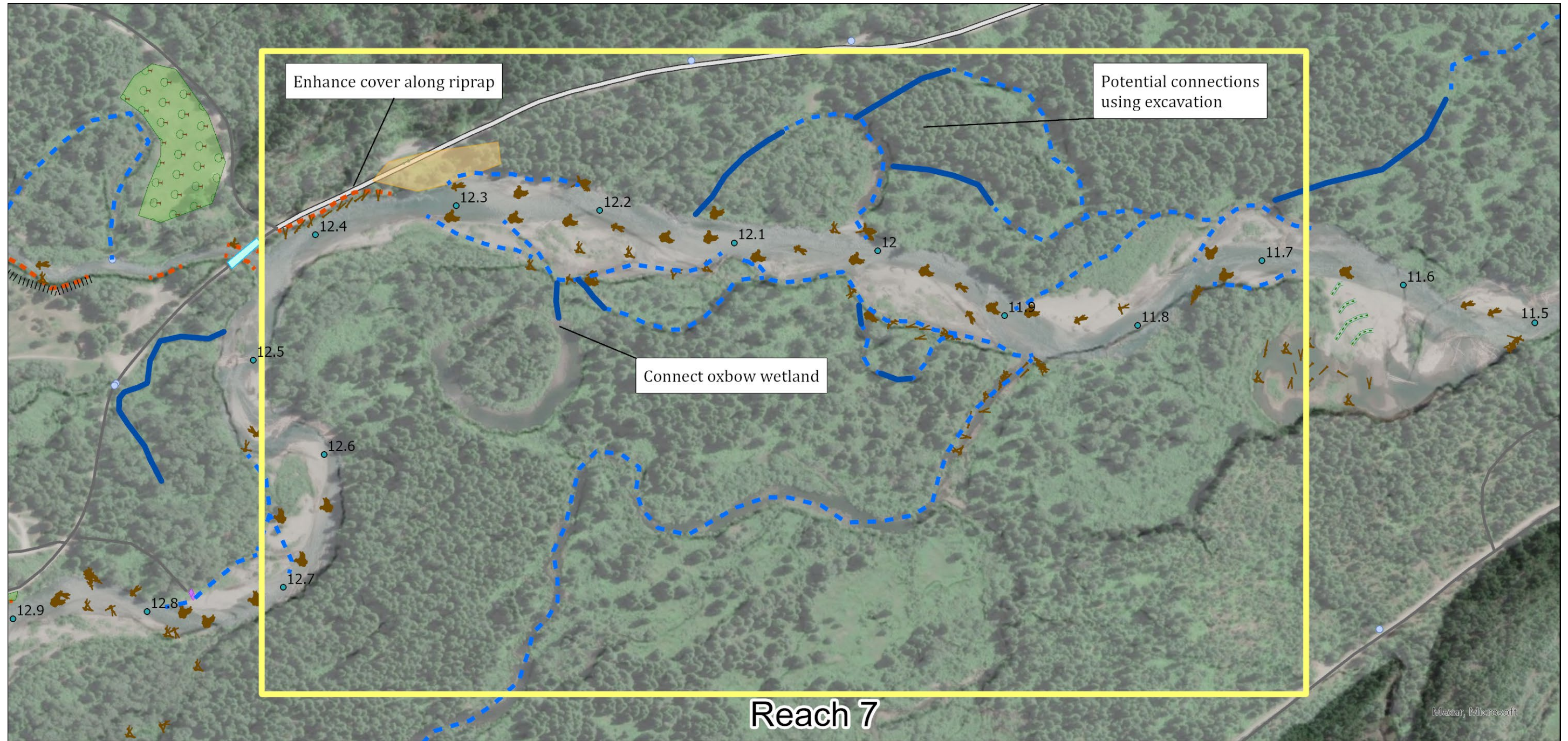


**White River Reach Assessment**  
*Project Opportunities*  
**Canyon Confluence**

Project Elements		Built Features		
Log & log with rootwad	SC Excavation	Trailheads	Bank Hardening	Grade Control
2, 3, & 4 log structures	SC Activation	Previously Constructed Large Wood	Paved Road	Campgrounds and Picnic Areas
Small & large whole tree	Revegetation	Screw Trap	Unmaintained Road	Bridges
Small & large apex jams	Remove armoring	Culverts	Drainage Ditches	Structures
Sm, med & lrg bank jams	Willow/Ctwd trenching			

Note: These are preliminary concepts intended to describe the type of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.

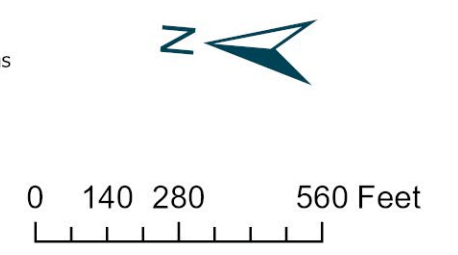


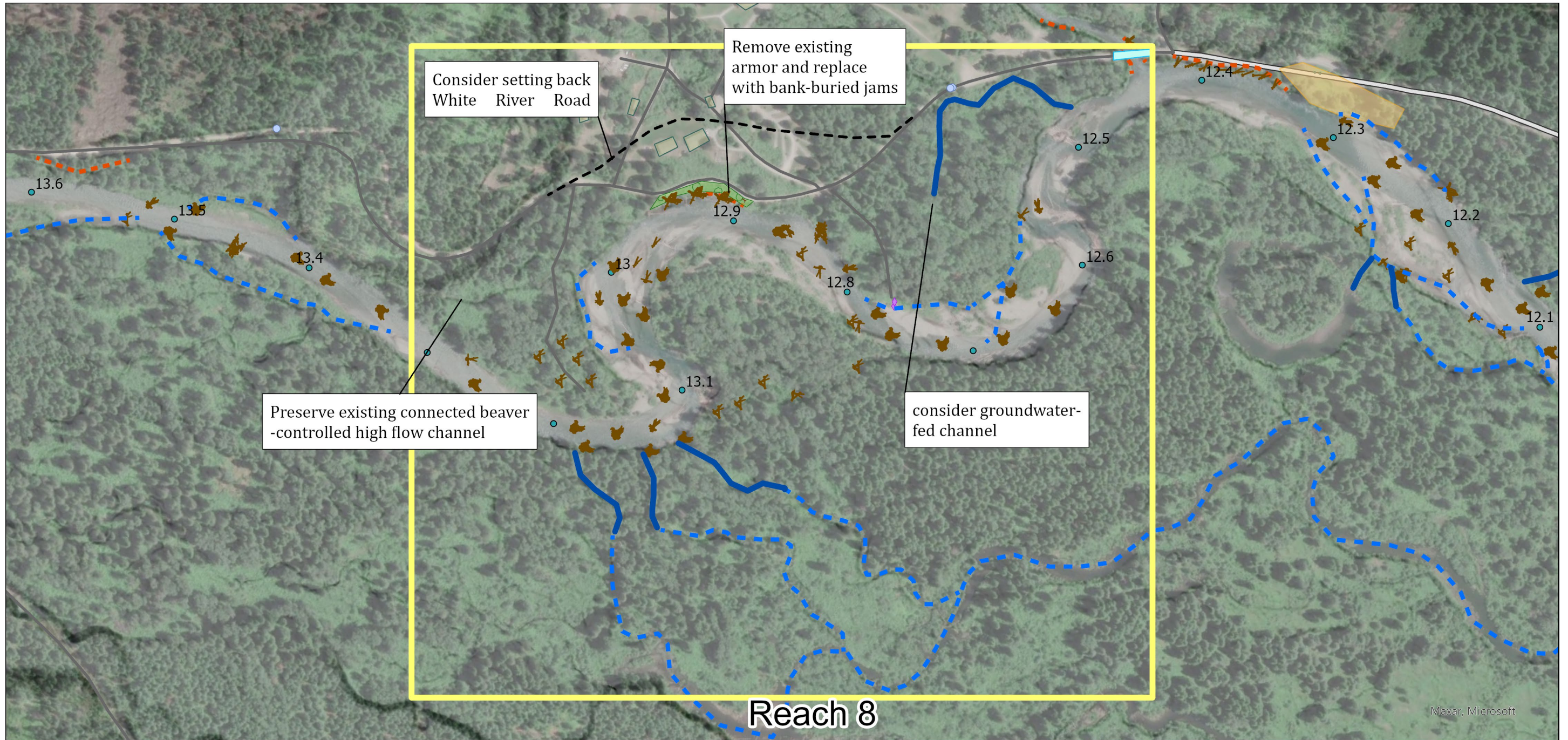


**White River Reach Assessment**  
*Project Opportunities*  
**Napeequa Crossing**

Project Elements		Built Features	
Log & log with rootwad	SC Excavation	Trailheads	Bank Hardening
2, 3, & 4 log structures	SC Activation	Previously Constructed Large Wood	Paved Road
Small & large whole tree	Revegetation	Screw Trap	Unmaintained Road
Small & large apex jams	Remove armoring	Culverts	Grade Control
Sm, med & lrg bank jams	Willow/Ctwd trenching	Drainage Ditches	Campgrounds and Picnic Areas
			Bridges
			Structures

Note: These are preliminary concepts intended to describe the type of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.





**White River Reach Assessment**  
*Project Opportunities*  
**Napeequa Confluence**

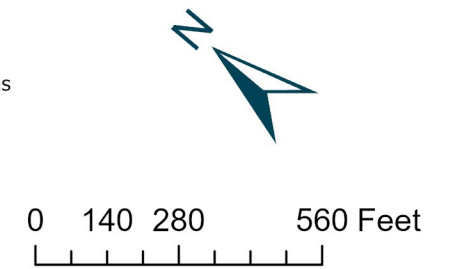
**Project Elements**

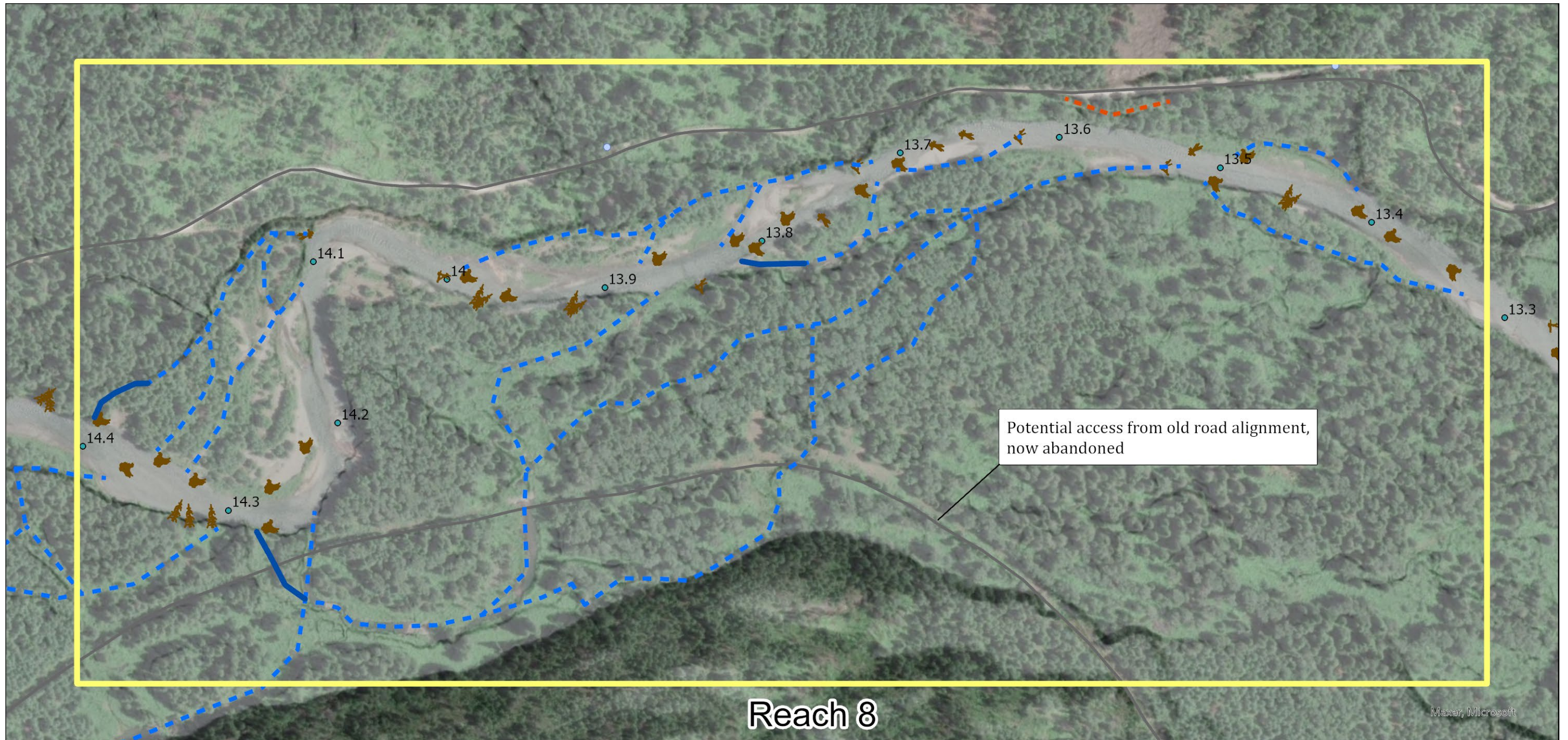
- Log & log with rootwad
- 2, 3, & 4 log structures
- Small & large whole tree
- Small & large apex jams
- Sm, med & lrg bank jams
- SC Excavation
- SC Activation
- Revegetation
- Remove armoring
- Willow/Ctwd trenching

**Built Features**

- Trailheads
- Previously Constructed Large Wood
- Screw Trap
- Culverts
- Drainage Ditches
- Bank Hardening
- Paved Road
- Unmaintained Road
- Grade Control
- Campgrounds and Picnic Areas
- Bridges
- Structures

Note: These are preliminary concepts intended to describe the type of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.





**White River Reach Assessment**  
*Project Opportunities*  
**Above Napeequa**

**Project Elements**

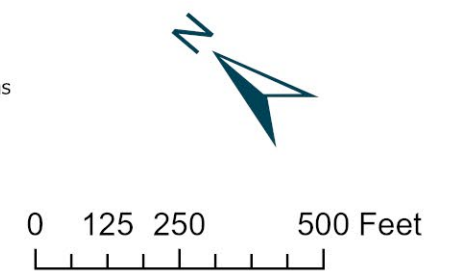
- Log & log with rootwad
- 2, 3, & 4 log structures
- Small & large whole tree
- Small & large apex jams
- Sm, med & lrg bank jams
- SC Excavation
- SC Activation
- Revegetation
- Remove armoring
- Willow/Ctwd trenching

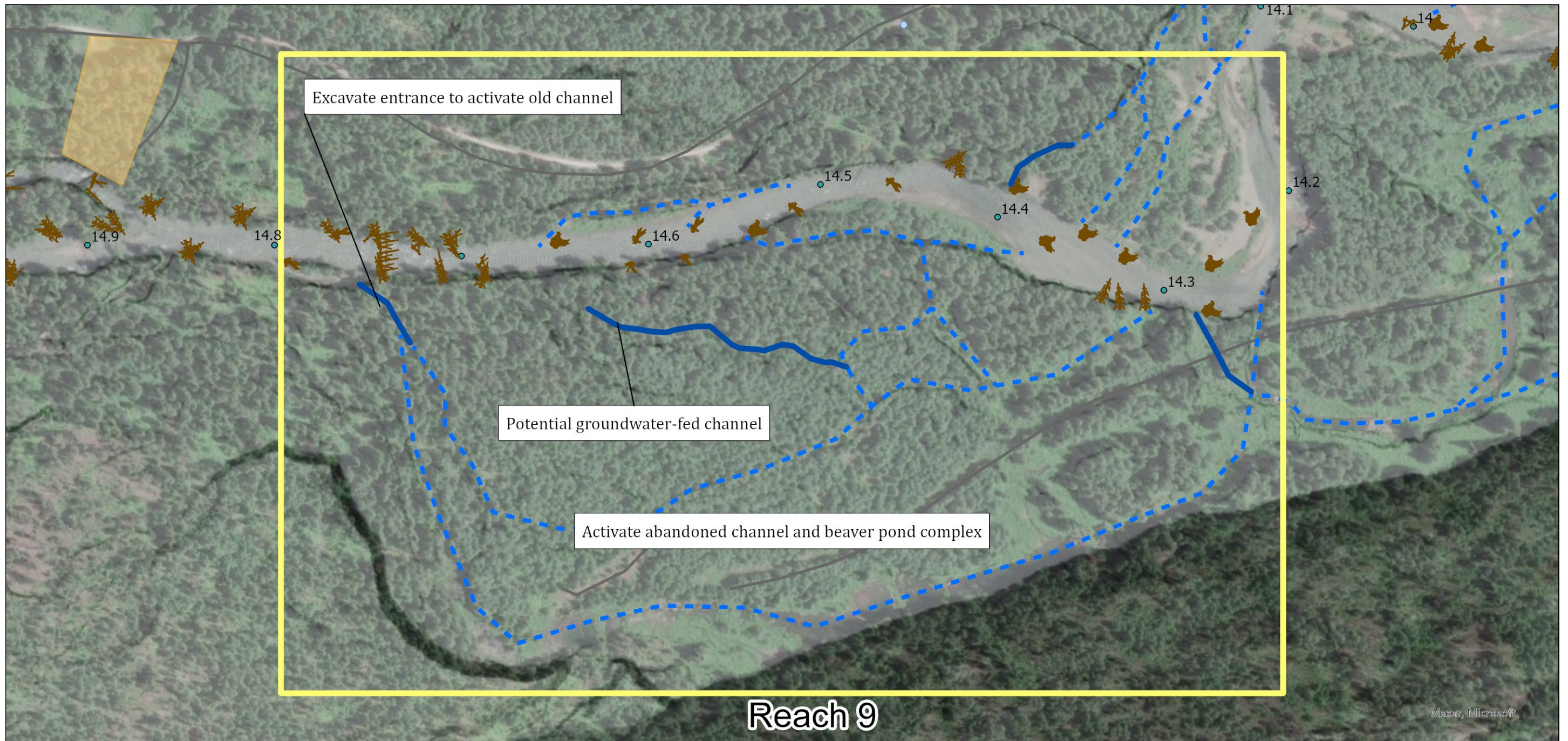
- Trailheads
- Previously Constructed Large Wood
- Screw Trap
- Culverts
- Drainage Ditches

**Built Features**

- Bank Hardening
- Paved Road
- Unmaintained Road
- Grade Control
- Campgrounds and Picnic Areas
- Bridges
- Structures

Note: These are preliminary concepts intended to describe the type of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.



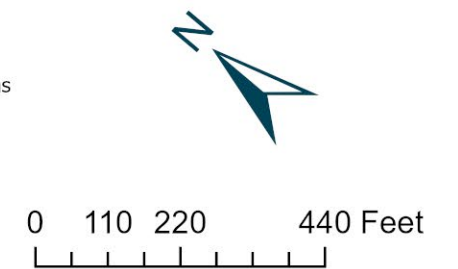


### Reach 9

## White River Reach Assessment Project Opportunities Below Panther

Project Elements		Built Features		
Log & log with rootwad	SC Excavation	Trailheads	Bank Hardening	Grade Control
2, 3, & 4 log structures	SC Activation	Previously Constructed Large Wood	Paved Road	Campgrounds and Picnic Areas
Small & large whole tree	Revegetation	Screw Trap	Unmaintained Road	Bridges
Small & large apex jams	Remove armoring	Culverts	Willow/Ctwd trenching	Structures
Sm, med & lrg bank jams	Drainage Ditches			

Note: These are preliminary concepts intended to describe the type of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.





**White River Reach Assessment**  
*Project Opportunities*  
**Grasshopper**

**Project Elements**

- Log & log with rootwad
- 2, 3, & 4 log structures
- Small & large whole tree
- Small & large apex jams
- Sm, med & lrg bank jams

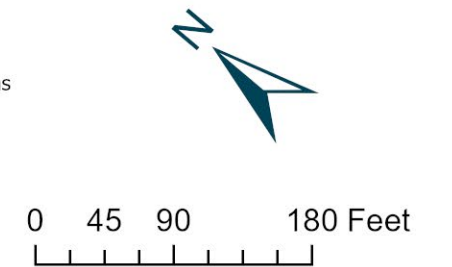
- SC Excavation
- SC Activation
- Revegetation
- Remove armoring
- Willow/Ctwd trenching

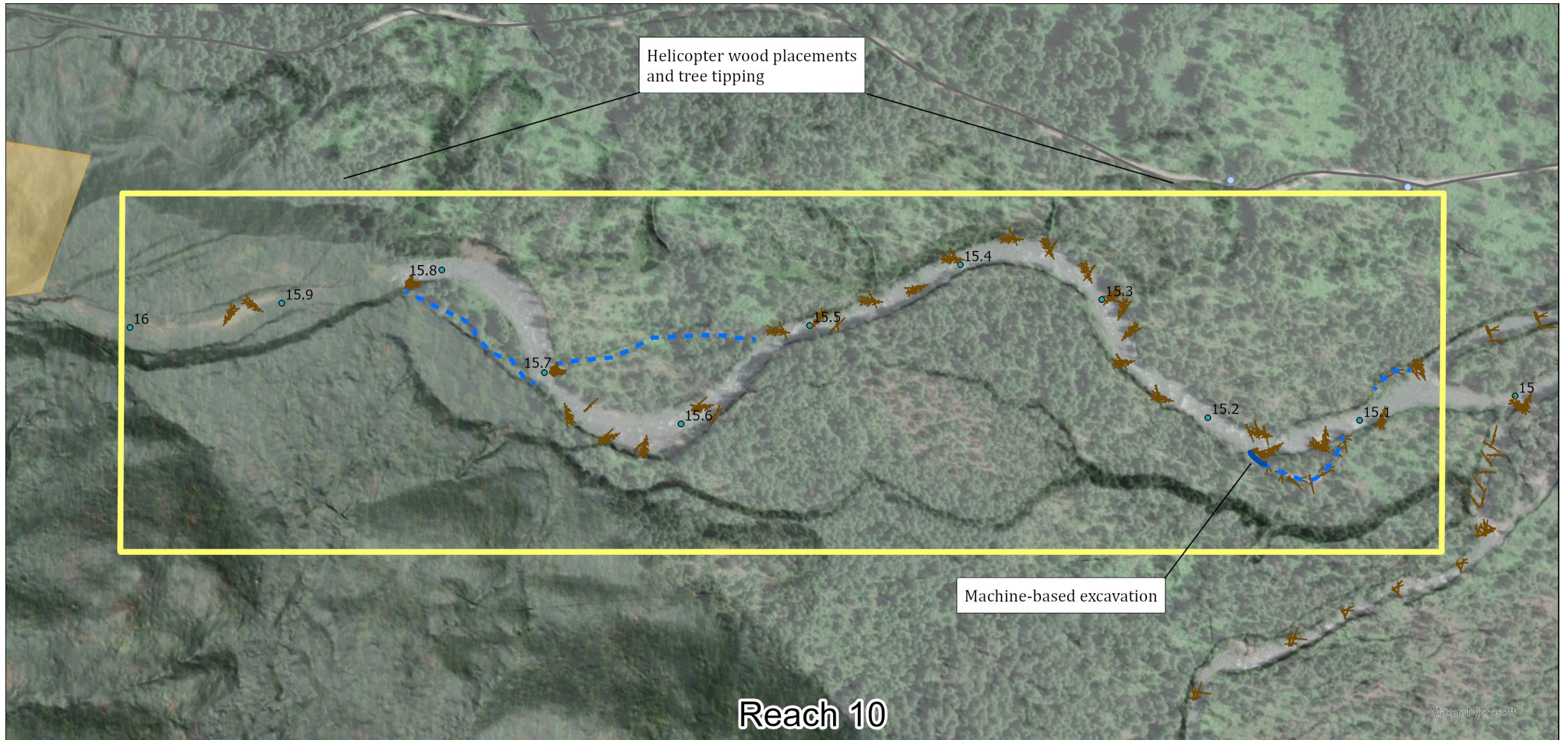
- Trailheads
- Previously Constructed Large Wood
- Screw Trap
- Culverts
- Drainage Ditches

**Built Features**

- Bank Hardening
- Paved Road
- Unmaintained Road
- Grade Control
- Campgrounds and Picnic Areas
- Bridges
- Structures

Note: These are preliminary concepts intended to describe the type of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.





**White River Reach Assessment**  
*Project Opportunities*  
**Falls Reach**

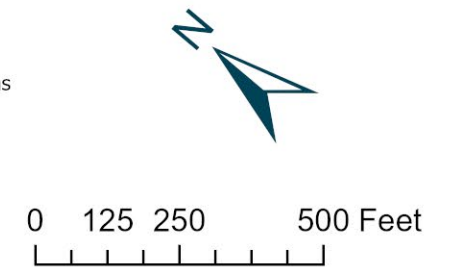
**Project Elements**

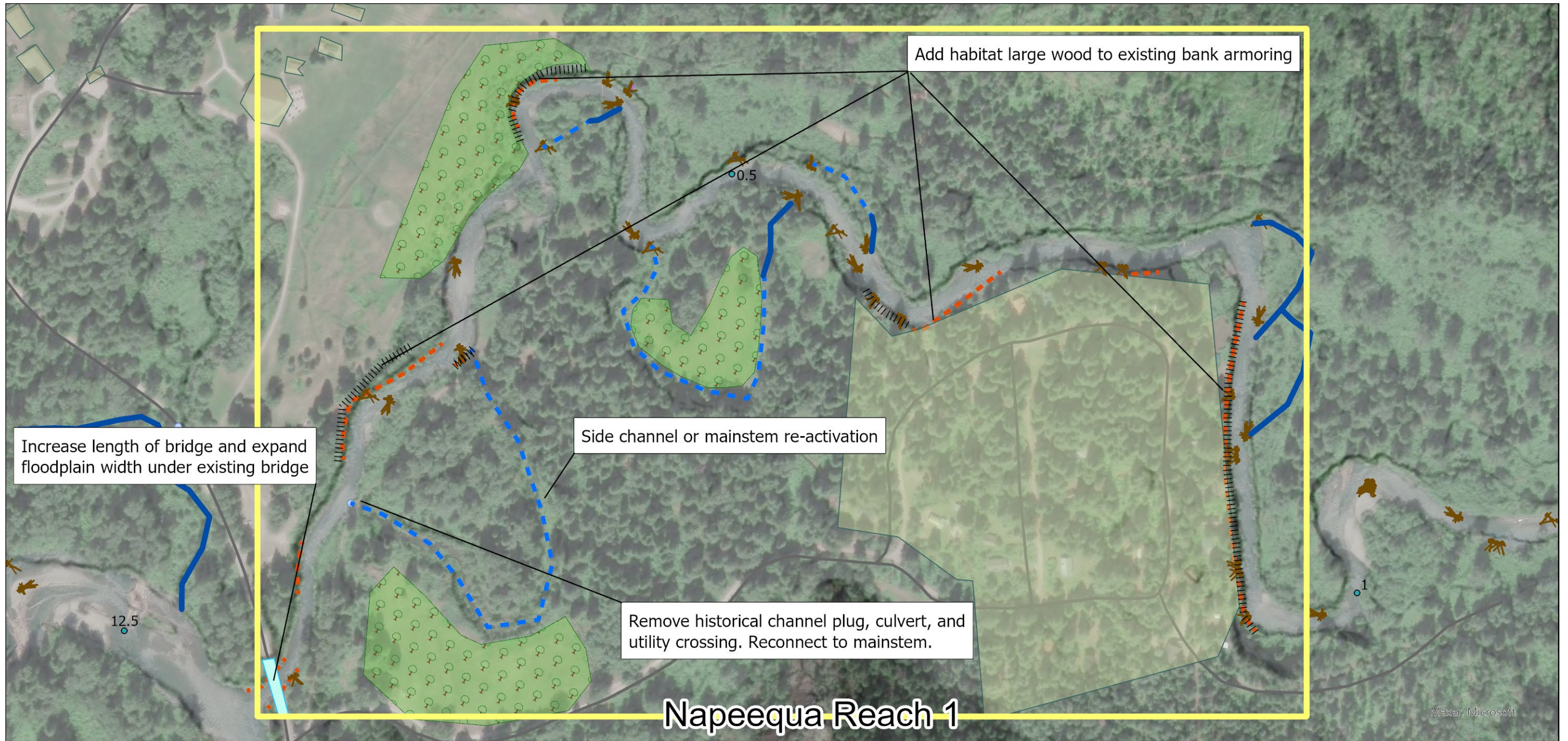
- Log & log with rootwad
- 2, 3, & 4 log structures
- Small & large whole tree
- Small & large apex jams
- Sm, med & lrg bank jams
- SC Excavation
- SC Activation
- Revegetation
- Remove armoring
- Willow/Ctwd trenching

**Built Features**

- Trailheads
- Previously Constructed Large Wood
- Screw Trap
- Culverts
- Drainage Ditches
- Bank Hardening
- Paved Road
- Unmaintained Road
- Grade Control
- Campgrounds and Picnic Areas
- Bridges
- Structures

Note: These are preliminary concepts intended to describe the type of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.





**White River Reach Assessment**  
*Project Opportunities*  
**Napeequa 1**

**Project Elements**

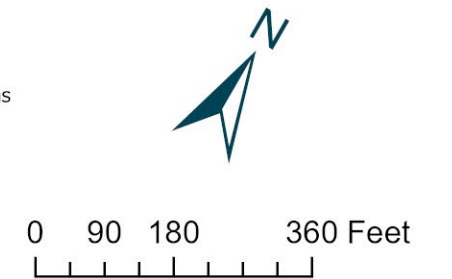
- Log & log with rootwad
- 2, 3, & 4 log structures
- Small & large whole tree
- Small & large apex jams
- Sm, med & lrg bank jams
- SC Excavation
- SC Activation
- Revegetation
- Remove armoring
- Willow/Ctwd trenching

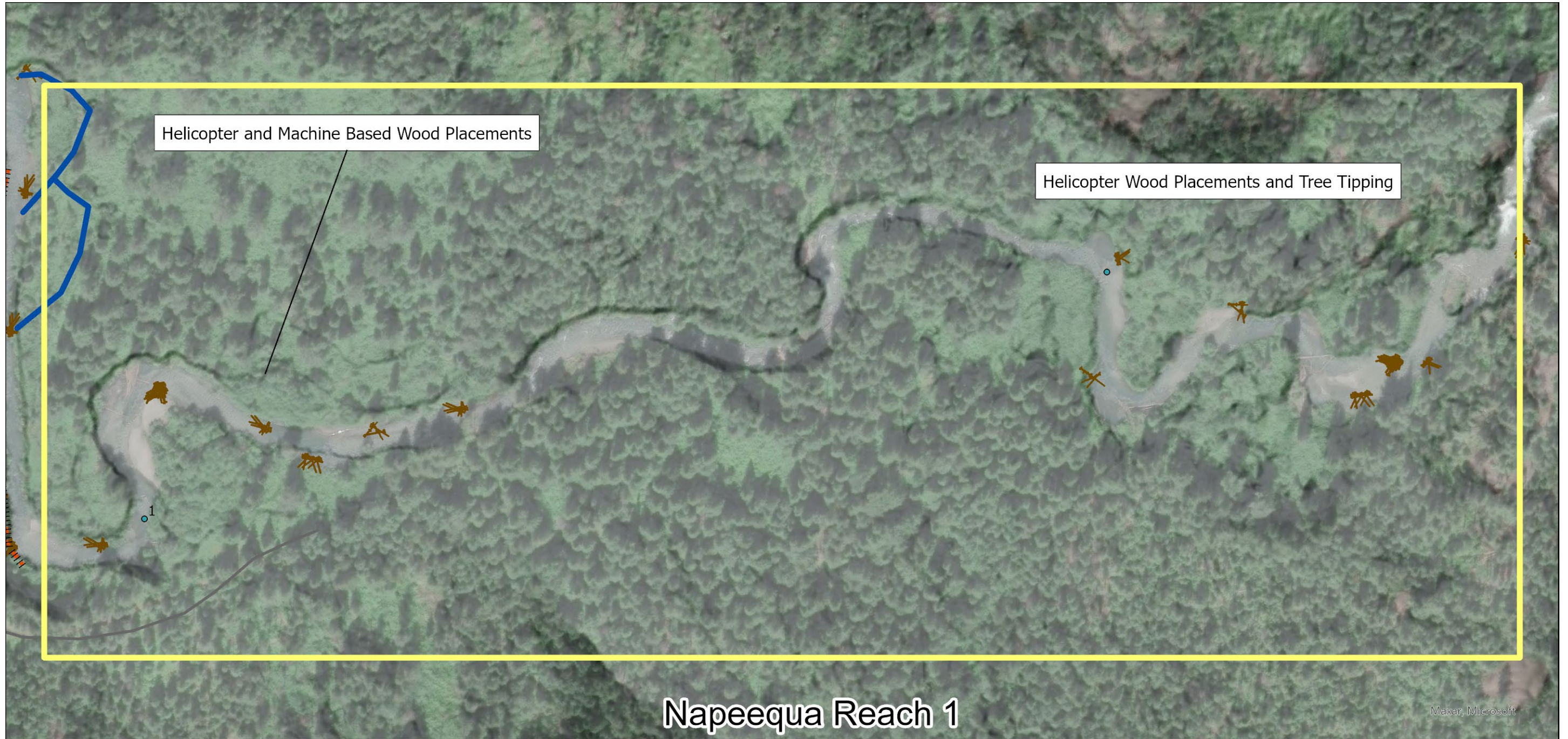
- Trailheads
- Previously Constructed Large Wood
- Screw Trap
- Culverts
- Drainage Ditches

**Built Features**

- Bank Hardening
- Paved Road
- Unmaintained Road
- Grade Control
- Campgrounds and Picnic Areas
- Bridges
- Structures

Note: These are preliminary concepts intended to describe the type of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.















## Napeequa Reach 1

Maxar, Microsoft

### White River Reach Assessment Project Opportunities Napeequa 2

#### Project Elements

-  Log & log with rootwad
-  2, 3, & 4 log structures
-  Small & large whole tree
-  Small & large apex jams
-  Sm, med & lrg bank jams

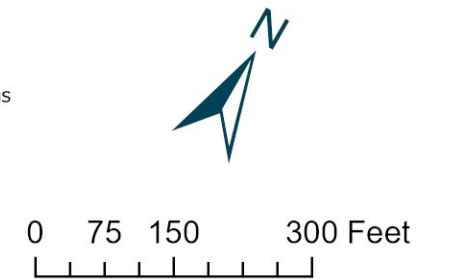
-  SC Excavation
-  SC Activation
-  Revegetation
-  Remove armoring
-  Willow/Ctwd trenching

-  Trailheads
-  Previously Constructed Large Wood
-  Screw Trap
-  Culverts
-  Drainage Ditches

#### Built Features

-  Bank Hardening
-  Paved Road
-  Unmaintained Road
-  Grade Control
-  Campgrounds and Picnic Areas
-  Bridges
-  Structures

Note: These are preliminary concepts intended to describe the type of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.





**White River Reach Assessment**  
*Project Opportunities*  
**Napeequa Twin Lakes**

**Project Elements**

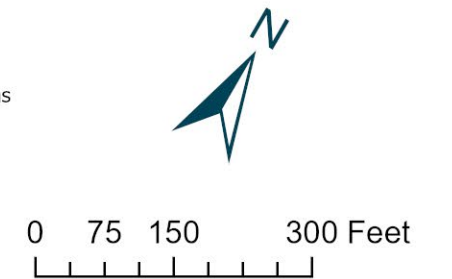
- Log & log with rootwad
- 2, 3, & 4 log structures
- Small & large whole tree
- Small & large apex jams
- Sm, med & lrg bank jams

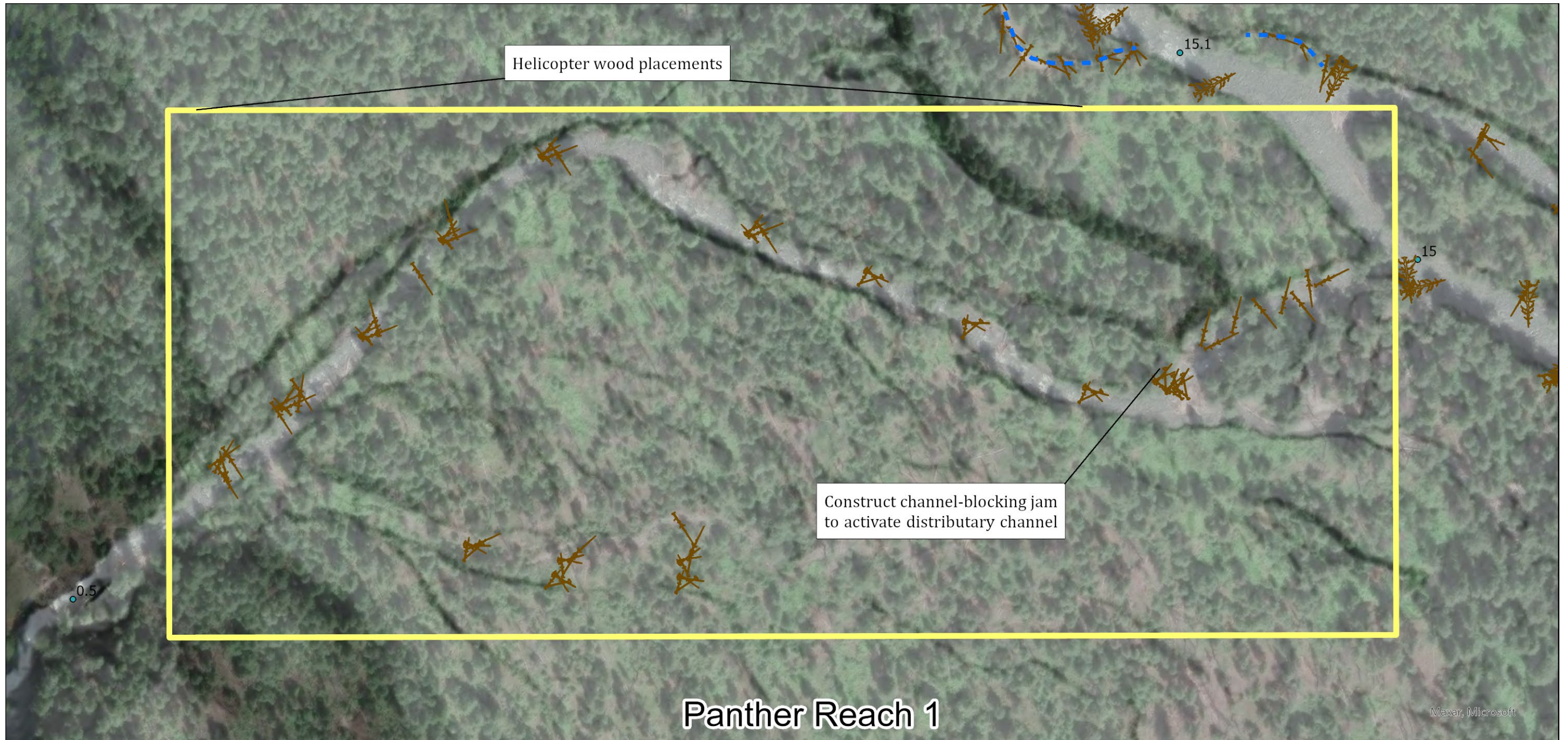
- SC Excavation
- SC Activation
- Revegetation
- Remove armoring
- Willow/Ctwd trenching

**Built Features**

- Trailheads
- Previously Constructed Large Wood
- Screw Trap
- Culverts
- Drainage Ditches
- Bank Hardening
- Paved Road
- Unmaintained Road
- Grade Control
- Campgrounds and Picnic Areas
- Bridges
- Structures

Note: These are preliminary concepts intended to describe the type of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.





White River Reach Assessment  
 Project Opportunities  
**Panther**

**Project Elements**

- Log & log with rootwad
- 2, 3, & 4 log structures
- Small & large whole tree
- Small & large apex jams
- Sm, med & lrg bank jams

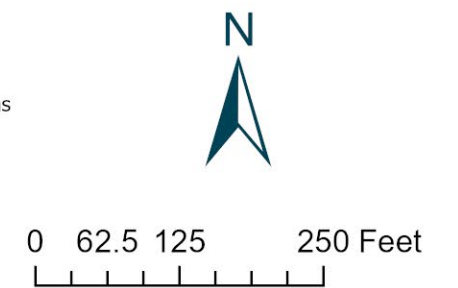
- SC Excavation
- SC Activation
- Revegetation
- Remove armoring
- Willow/Ctwd trenching

- Trailheads
- Previously Constructed Large Wood
- Screw Trap
- Culverts
- Drainage Ditches

**Built Features**

- Bank Hardening
- Paved Road
- Unmaintained Road
- Grade Control
- Campgrounds and Picnic Areas
- Bridges
- Structures

Note: These are preliminary concepts intended to describe the type of potential restoration work that could be performed. Additional site investigations and analysis will be necessary to determine specific treatment types and locations.



### 3 Project Prioritization and Ranking

#### 3.1 PRIORITIZATION MATRIX

Project Area						Benefit Score								Cost Score		Cost Benefit	Feasibility Designation		
Tiers	Project Name	Reach	Downstream RM	Upstream RM	Total Length (mi)	Restoration Gap Analysis				Existing and Potential Fish Use		Root Causes		Total Benefit Score	Cost Score (1-4)	Rationale/ assumption	Benefit-to-Cost Score	Feasibility Designation	Rationale/ assumption
						Existing Condition (1-7)	Achievable Target (1-7)	Final Gap Score (Target - Existing) (0-6)	Rationale/ assumption	Score (1-3)	Rationale/ assumption	Score (1-3)	Rationale/ assumption						
Tier 1	Below Panther	9	14.30	14.80	0.50	4.5	6.5	2	Degraded from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest. Has led to disconnection of former floodplain and side-channel habitat. But project area is all within National Forest. Road is close. High potential for recovery over the long-term. Proposed restoration actions can have large effect; responsive channel type.	3	Reach is highly used for spawning and the project would increase quality of in-channel aquatic habitat as well as expand quantity / access to off-channel habitat.	2	Addresses lack of large in-channel structure but does not address the processes that create and maintain it over the long-term.	7	2	Good access. No major constraints	3.5	High	No major constraints. National Forest
	Above Napeequa	8	13.30	14.30	1.00	4.5	6.5	2	Degraded from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest. Has led to disconnection of former floodplain and side-channel habitat. But project area is all within National Forest. Road is close. High potential for recovery over the long-term. Proposed restoration actions can have large effect; responsive channel type.	3	Reach is highly used and the project would increase quality of in-channel aquatic habitat as well as expand quantity / access to off-channel habitat.	2	Addresses lack of large in-channel structure but does not address the processes that create and maintain it over the long-term.	7	2	Good access. No major constraints	3.5	High	No major constraints. National Forest
	Napeequa Confluence	8	12.45	13.30	0.85	4	6	2	Degraded from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest. Has led to disconnection of former floodplain and side-channel habitat. Project area is National Forest on one side but private and developed on the other. Road is very close. Mod-high potential for recovery over the long-term. Proposed restoration actions can have large effect; responsive channel type.	3	Reach is highly used for spawning and the project would increase quality of in-channel aquatic habitat as well as expand quantity / access to off-channel habitat.	2	Addresses lack of large in-channel structure but does not address the processes that create and maintain it over the long-term.	7	2	Good access. No major constraints	3.5	High	No major constraints. National Forest
	Napeequa Crossing	7	11.65	12.45	0.80	4.5	6.5	2	Degraded from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest. Has led to disconnection of former floodplain and side-channel habitat. Project area is all National Forest. Road is very close for only a small section at upstream end, then far. High potential for recovery over the long-term. Proposed restoration actions can have large effect; responsive channel type.	3	Reach has moderate use for spawning but the project would increase quality of in-channel aquatic habitat as well as expand quantity / access to off-channel habitat for rearing.	2	Addresses lack of large in-channel structure but does not address the processes that create and maintain it over the long-term.	7	2	Good access. No major constraints	3.5	High	No major constraints. National Forest

Project Area						Benefit Score							Cost Score		Cost Benefit	Feasibility Designation			
Tiers	Project Name	Reach	Downstream RM	Upstream RM	Total Length (mi)	Restoration Gap Analysis				Existing and Potential Fish Use		Root Causes		Total Benefit Score	Cost Score (1-4)	Rationale/ assumption	Benefit-to-Cost Score	Feasibility Designation	Rationale/ assumption
						Existing Condition (1-7)	Achievable Target (1-7)	Final Gap Score (Target - Existing) (0-6)	Rationale/ assumption	Score (1-3)	Rationale/ assumption	Score (1-3)	Rationale/ assumption						
Tier 2	Canyon Confluence	6	10.90	11.65	0.75	4	5.5	1.5	Degraded from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest. Has led to disconnection of former floodplain and side-channel habitat. Project area is all National Forest. Road not close. Mod-High potential for recovery over the long-term. Proposed restoration actions can have mod-large effect but incision hard to restore; responsive channel type.	3	Reach has moderate use but the project would increase quality of in-channel aquatic habitat as well as expand quantity / access to off-channel habitat for rearing.	2	Addresses lack of large in-channel structure but does not address the processes that create and maintain it over the long-term.	6.5	2.5	Decent access. Some significant digs for off-channel connections.	2.6	High	No major constraints. National Forest
	Double O	6	10.05	10.90	0.85	4	5.5	1.5	Degraded from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest. Has led to disconnection of former floodplain and side-channel habitat. Project area is mostly National Forest, with some land trust and some private. Road close at downstream end. Mod-high potential for recovery over the long-term. Proposed restoration actions can have mod-large effect but incision hard to restore; responsive channel type.	3	Reach has moderate use for spawning but the project would increase quality of in-channel aquatic habitat as well as expand quantity / access to off-channel habitat for rearing.	2	Addresses lack of large in-channel structure but does not address the processes that create and maintain it over the long-term.	6.5	2.5	Decent access. Some significant digs for off-channel connections.	2.6	High	No major constraints. National Forest
	Napeequa 1	Napeequa 1	0.00	0.95	0.95	4	5.5	1.5	Degraded from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest. Has led to disconnection of former floodplain and side-channel habitat. Project area is mostly within the Tall Timbers retreat center property and other private lands. The retreat center impacts are significant in the downstream portion. Mod-high potential for recovery over the long-term, limited by retreat center. Proposed restoration actions can have significant effect; responsive channel type.	3	Reach is highly used for spawning and the project would increase quality of in-channel aquatic habitat as well as expand quantity / access to off-channel habitat.	2	Addresses lack of large in-channel structure but does not address the processes that create and maintain it over the long-term.	6.5	2.5	Good access. But private lands (more risk)	2.6	Low-Moderate	Private lands and nearby retreat infrastructure
	Grasshopper	9	14.80	15.05	0.25	5	6	1	Degraded from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest. Project area is all within National Forest, but is close to a campground and road, which lowers achievable target.	2	Reach is highly used for spawning and project increases cover and complexity of habitat, but may not dramatically increase potential fish use from current.	2	Addresses lack of large in-channel structure but does not address the processes that create and maintain it over the long-term.	5	2	Good access. No major constraints	2.5	High	No major constraints. National Forest
	Panther	Panther Reach 1	0.00	0.40	0.40	5	6.5	1.5	Degraded from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest. But project area is all within National Forest. Away from road. High potential for recovery over the long-term. Proposed restoration actions can have large effect due to size of channel.	2	Reach is highly used for spawning and project increases cover and complexity of habitat, but may not dramatically increase potential fish use from current.	2	Addresses lack of large in-channel structure but does not address the processes that create and maintain it over the long-term.	5.5	2.5	Challenging access. Heli work and some mod challenging machine access	2.2	High	No major constraints. National Forest
	Falls Reach	10	15.10	16.00	0.90	5	6	1	Degraded from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest. But project area is all within National Forest. Away from road. High potential for recovery over the long-term, but mainly due to passive recovery not the proposed restoration which has limited benefit due to high energy large channel that is hard to initiate a response.	2	Reach has moderate use but the high-energy channel with large substrate may limit potential.	2	Addresses lack of large in-channel structure but does not address the processes that create and maintain it over the long-term.	5	2.5	Challenging access. Heli work	2.0	High	No major constraints. National Forest
	Tenmile	6	9.40	10.05	0.65	4	5	1	Degraded from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest. Plus current residential riparian impacts. Past land use has led to disconnection of former floodplain and side-channel habitat. Project area is nearly all private, some with some land trust. Cabins close to left bank. Mod-high potential for recovery over the long-term but limited by private lands. Proposed restoration actions can have mod-large effect but incision hard to restore; responsive channel type.	3	Reach has moderate use for spawning but the project would increase quality of in-channel aquatic habitat as well as expand quantity / access to off-channel habitat for rearing.	2	Addresses lack of large in-channel structure but does not address the processes that create and maintain it over the long-term.	6	3	Decent access. Some significant digs for off-channel connections. Bigger channel, some nearby private parcels (risk)	2.0	Moderate	Nearby private lands and cabins
	Napeequa Twin Lakes	Napeequa 2	1.70	2.20	0.50	5.5	6.5	1	Degraded from past timber harvest and loss of large in-channel jams but relatively good condition. In Wilderness, so high potential for recovery, but mostly will be due to passive recovery over the long-term as forests continue to mature.	2	Reach has moderate use but the high-energy channel with large substrate may limit potential.	2	Addresses lack of large in-channel structure but does not address the processes that create and maintain it over the long-term.	5	2.5	Challenging access. Heli work	2.0	Moderate-High	No major constraints except potential limitations associated with Wilderness
	Napeequa 2	Napeequa 1	0.95	1.70	0.75	5.5	6.5	1	Degraded from past timber harvest and loss of large in-channel jams but relatively good condition. Partly in Wilderness, so high potential for recovery, but mostly will be due to passive recovery over the long-term as forests continue to mature.	2	Reach has moderate use but the high-energy channel with large substrate may limit potential.	2	Addresses lack of large in-channel structure but does not address the processes that create and maintain it over the long-term.	5	2.5	Challenging access. Heli work	2.0	Moderate-High	No major constraints except potential limitations associated with Wilderness

Project Area						Benefit Score					Cost Score		Cost Benefit	Feasibility Designation					
Tiers	Project Name	Reach	Downstream RM	Upstream RM	Total Length (mi)	Restoration Gap Analysis				Existing and Potential Fish Use		Root Causes		Total Benefit Score	Cost Score (1-4)	Rationale/ assumption	Benefit-to-Cost Score	Feasibility Designation	Rationale/ assumption
						Existing Condition (1-7)	Achievable Target (1-7)	Final Gap Score (Target - Existing) (0-6)	Rationale/ assumption	Score (1-3)	Rationale/ assumption	Score (1-3)	Rationale/ assumption						
<b>Tier 3</b>	Dirtyface	2	2.55	4.15	1.60	3	4	1	Degraded from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest. Reach-wide channel incision from downstream bridge, past ag impacts. Project area is mostly state and land trust, some private. Mod potential for recovery given reach-wide incision. Proposed restoration actions can have mod effect.	2	Reach likely has moderate use by juveniles and the project would improve quality of in-channel aquatic habitat, but reach-scale incision may limit the potential use.	1	Addresses lack of large in-channel structure but limited impact due to effects of reach-wide incision related to floodplain and CMZ constrictions that are assumed to remain.	4	2.5	Good access. Bigger channel. Possible barge-mounted work.	1.6	Moderate	Large channel, somewhat challenging construction methods
	Sears	5	7.50	9.40	1.90	3.5	4.5	1	Degraded from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest. Some past floodplain veg clearing for ag. Impacts have led to disconnection of former floodplain and side-channel habitat. Possibly incision related to downstream bridge. Project area is combo of private, state, federal. Mod potential for recovery over the long-term, limited by private lands and chronic incision. Proposed restoration actions can have mod effect; incision hard to restore.	2	Reach has moderate use and the project would improve quality of in-channel aquatic habitat as well as expand quantity / access to off-channel habitat, primarily in lower portion of project area.	1	Addresses lack of large in-channel structure but limited impact due to effects of reach-wide incision related to floodplain and CMZ constrictions that are assumed to remain.	4	3	Decent access. Some significant digs for off-channel connections. Bigger channel, some nearby private parcels (risk)	1.3	Moderate	Private lands
	Fivemile	3	4.15	5.75	1.60	3	4	1	Degraded from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest. Reach-wide channel incision from downstream bridge, other impacts. Project area is combo land trust, private, and federal. Mod potential for recovery given reach-wide incision. Proposed restoration actions can have mod effect.	2	Reach likely has moderate use by juveniles and the project would improve quality of in-channel aquatic habitat, but reach-scale incision may limit the potential use.	1	Addresses lack of large in-channel structure but limited impact due to effects of reach-wide incision related to floodplain and CMZ constrictions that are assumed to remain.	4	3	Decent access. Some significant digs for off-channel connections. Bigger channel.	1.3	Moderate	Large channel, somewhat challenging construction methods
	Straightaway	4	5.75	6.65	0.90	2.5	4	1.5	Degraded from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest. Presumed past straightening, channel incision. Project area is mostly National Forest with some land trust. Mod potential for recovery given reach-wide incision. Proposed restoration actions can have mod effect, assuming full mainstem channel re-route does not occur (which would up the achievable target).	2	Reach has moderate use and the project would improve quality of in-channel aquatic habitat, but reach-scale incision may limit the potential use, unless a full mainstem channel re-route	1	Addresses lack of large in-channel structure but limited impact due to effects of reach-wide incision related to floodplain and CMZ constrictions that are assumed to remain.	4.5	3.5	Good access. Some significant digs for off-channel connections. Addressing straightened section could be	1.3	Low-Moderate	Addressing straightened channel and incision is challenging
	Lake Reach	1	0.00	1.80	1.80	3	3.5	0.5	Degraded from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest. Impact from bridge and road prism effects on CMZ and floodplain connectivity, channel incision. Ag impacts. Mostly National Forest and land trust, some private. Low-to-mod potential for recovery given reach-wide incision.	2	Reach likely has moderate use by juveniles and the project would improve quality of in-channel aquatic habitat, but reach-scale incision may limit the potential use.	1	Addresses lack of large in-channel structure but limited impact due to effects of reach-wide incision related to floodplain and CMZ constrictions that are assumed to remain.	3.5	3	Decent access. Some significant digs for off-channel connections. Bigger channel.	1.2	Moderate	Large channel, somewhat challenging construction methods
	Sears Creek Rd Bridge	4/5	6.65	7.50	0.85	2.5	3	0.5	Degraded from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest. Significant impact from bridge and road prism effects on CMZ and floodplain connectivity, channel incision. Project area is combo of private, state, federal. Low-to-mod potential for recovery assuming bridge and road stay. Proposed restoration actions can have low-mod effect due to bridge/rd limitations.	2	Reach has moderate use and the project would improve quality of in-channel aquatic habitat, but reach-scale incision may limit the potential use.	1	Addresses lack of large in-channel structure but limited impact due to effects of reach-wide incision related to floodplain and CMZ constrictions that are assumed to remain.	3.5	3.5	Good access. Some significant digs for off-channel connections. Addressing roadway and bridge impacts could be	1.0	Moderate (Low)	Addressing bridge and road issues is challenging. Other actions are moderate.
	Little Wenatchee Rd	1/2	1.80	2.55	0.75	2.5	3	0.5	Degraded from past timber harvest and loss of large in-channel jams and loss of large tree riparian and floodplain forest. Significant impact from bridge and road prism effects on CMZ and floodplain connectivity, channel incision. Ag impacts. Some bank armoring. Mostly private lands, some state. Low-to-mod potential for recovery assuming bridge and road stay. Proposed restoration actions can have low-mod effect due to bridge/rd limitations.	2	Reach likely has moderate use by juveniles and the project would improve quality of in-channel aquatic habitat, but reach-scale incision may limit the potential use.	1	Addresses lack of large in-channel structure but limited impact due to effects of reach-wide incision related to floodplain and CMZ constrictions that are assumed to remain.	3.5	3.5	Good access. Big channel (potential barge-based work). Addressing roadway and bridge impacts could be very expensive.	1.0	Moderate (Low)	Addressing bridge and road issues is challenging. Other actions are moderate.

### 3.3 PROJECT RANKING METHODS

- Step 1:** **Benefit Score:** Projects are scored according to 3 benefit categories, which include a “recovery gap” category and 2 additional categories. Scores for each category are summed to obtain the **Benefit Score**.
- Step 2:** **Cost Score:** Projects are given a **Cost Score**, which reflects the overall *relative cost* for the project based on techniques, access, and construction feasibility issues.
- Step 3:** **Benefit-to-Cost Score:** Total benefit score (sum of all 4 benefit scores) is divided by the cost score to obtain the **Benefit-to-Cost Score**.
- Step 4:** **Feasibility Designation:** Projects are given a **Feasibility Designation** based on the overall likely feasibility of being able to implement the project within a 10-year timeframe.

#### **Benefit Score**

The Benefit Score includes the summation of scores from 3 categories. These include the Recovery Gap score (0-6 points), the Fish Use score (1-3 points), and the Root Causes score (1-3 points). The guidelines for scoring are provided below.

##### **Recovery Gap**

Existing Condition Rating (1-7)

- 1 – Very low ecosystem function and habitat quality. Highly altered systems.
- 2 – Low ecosystem function and habitat quality.
- 3 – Low-to-moderate ecosystem function and habitat quality.
- 4 – Moderate ecosystem function and habitat quality.
- 5 – Moderate-to-high ecosystem function and habitat quality.
- 6 – High ecosystem function and habitat quality.
- 7 – Very high level of natural ecosystem function and habitat quality. Pristine, unaltered systems.

Achievable Condition Rating (1-7)

These ratings use the same categories as above but reflect the future potential recovery trajectory. This is a rating of what can realistically be achieved given past and on-going impacts and constraints of land use, infrastructure, social acceptance, and ownership. Ratings should reflect an “optimistic potential scenario” in order to not discount large potential changes.

Final Gap Score (0-6)

This is simply the achievable condition rating minus the existing condition rating. This represents the gap that can be filled between existing and target conditions through restoration measures.

##### **Fish Use**

- 3 – High existing or potential productivity area for spawning or rearing for multiple species
- 2 – Moderate existing or potential productivity area for one or more species
- 1 – Low existing or potential productivity area for one or two species

##### **Root Causes**

- 3 – Restoration of root causes and key physical processes that create and maintain habitat over time
- 2 – Partial restoration of root causes
- 1 – Primarily a structurally-focused restoration strategy that doesn’t significantly address underlying causes

#### **Cost Score**

The cost score reflects the relative cost for the project based on techniques, access, and feasibility issues. This is a relative cost, not an absolute cost, so the scale of the project is NOT factored into this score. The cost score ranges from 1 to 3, with 1 reflecting relatively lower cost projects. The following guidelines/examples can help to determine the cost score.

#### 4 – High relative cost

- Requires high-cost techniques or materials (e.g., highly engineered log jams, extensive channel shaping, water crossings or bridges)
- Deep excavation or long-distance hauling of spoils
- Entails construction of additional new flood control or bank erosion features (e.g. set-back levees or buried rip-rap)
- Intensive de-watering requirements
- Limited, difficult, or remote access

#### 2-3 – Moderate relative cost

- Uses moderate cost techniques (e.g. typical log jam structures)
- Moderate excavation and hauling distance of spoils
- Typical planting or invasive weed control
- Moderate access conditions
- Standard or no de-watering requirements

#### 1 – Low relative cost

- Uses low cost techniques (e.g. non-ballasted log placements)
- Minimal excavation and hauling distance of spoils
- Little to no planting or weed control
- Easy access conditions
- No de-watering required
- Availability of free materials or volunteer labor

### **Benefit-to-Cost Score**

The benefit-to-cost score is simply the benefit score divided by the cost score. This is a relative value used to compare project benefits.

### **Feasibility Designation**

The feasibility designation is the overall likely feasibility of being able to implement the project within a 10-year timeframe. This is based on landownership, as well as economic, regulatory, political, social, permitting, or other considerations that are known to impact the feasibility of conducting projects within a reasonable timeframe. The feasibility designation is not used as part of the project scoring because feasibility issues may change over time and it is desirable to evaluate project benefits independent of feasibility. The designations include the following:

#### High feasibility

- No known feasibility issues.
- One or two landowners; or landowner(s) has already indicated willingness

#### Moderate feasibility

- There are potential feasibility constraints that could affect the likelihood of project implementation within a 10-year timeframe
- Three to five landowners; or there is reason to believe landowner(s) would grant permission

#### Unlikely feasibility

- There are known feasibility constraints that would be expected to limit the ability to implement the project within a 10-year timeframe
- More than five landowners: or there is reason to believe landowner(s) would not grant permission

# Appendix D | Hydraulic Model

---

*September 2025*

## Table of Contents

<b>1</b>	<b>Introduction .....</b>	<b>2</b>
<b>2</b>	<b>Hydraulic Model Methodology.....</b>	<b>2</b>
2.1	Model Setup.....	2
2.1.1	Model Terrain .....	2
2.1.2	Model Domain and Geometry .....	2
2.1.3	Water Control Structures.....	3
2.2	Model Inputs.....	5
2.2.1	Model Roughness.....	5
2.2.2	Model Hydrology.....	7
2.2.3	Model Boundary Conditions .....	8
2.3	Model Calibration and Verification.....	9
<b>3</b>	<b>Summary of Hydraulic Model Results.....</b>	<b>11</b>
3.1	Modeled Velocity Results .....	11
3.2	Modeled Depth Results.....	19
<b>4</b>	<b>References .....</b>	<b>26</b>

## 1 Introduction

A hydraulic analysis of the lower White River was conducted as part of the reach assessment. This analysis includes a preliminary-level 2-dimensional (2-D) hydraulic model of Reaches 1 to 10 of the White River, Reaches 1 and 2 of the Napeequa River, Reach 1 of Panther Creek, and Reach 1 of Sears Creek. The hydraulic model is used to understand general hydraulic characteristics of the river at a range of high flows, including stream energy (e.g. velocity), floodplain inundation patterns, and the effects of human and natural features on streamflow patterns. Model results were used to support the geomorphological interpretations that are included in the main document and were also used to inform the sediment transport analysis that is presented in the main document.

## 2 Hydraulic Model Methodology

The hydraulic model was developed in the U.S. Army Corps of Engineers HEC-RAS 6.5 software (USACE, 2024), which can compute hydraulic properties related to the physical processes governing water flow through natural rivers and other channels. Characteristics of the White River, such as regions of high sinuosity and a wide and complex floodplain, make it a good candidate for a 2-D model, as such features are difficult to accurately model using a 1-dimensional model. The model was developed for existing conditions to assess the current channel and floodplain dynamics, as well as to assess the impacts of a range of flows on the landscape. This model only accounts for surface water flows and does not include groundwater fed features. This document describes parameterization, assumptions, and set up of the hydraulic model. Results are depicted and described in Section 3.

### 2.1 MODEL SETUP

#### 2.1.1 Model Terrain

A digital terrain model (DTM) was created using a combination of LiDAR data and manual adjustments informed by site observations and surveys. The available LiDAR datasets ranged from 2007 to 2020; we utilized the most recent and high-resolution data where available (PSRC, 2007; QSI, 2016, 2019; WGS, 2023). None of the LiDAR datasets captured ground elevations below water, leaving considerable data gaps of the bathymetry of the river channels, or any areas that were wetted during the LiDAR flights. Due to the depth of the channel in the lower section of the project area, the terrain of the channel was modified as part of the model calibration process to better represent the site. See Section 2.3 for more details. This resulted in model results that better matched site indicators of bankfull conditions and floodplain inundation frequencies; however, there is still considerable uncertainty with model outputs given the lack of comprehensive bathymetric data.

#### 2.1.2 Model Domain and Geometry

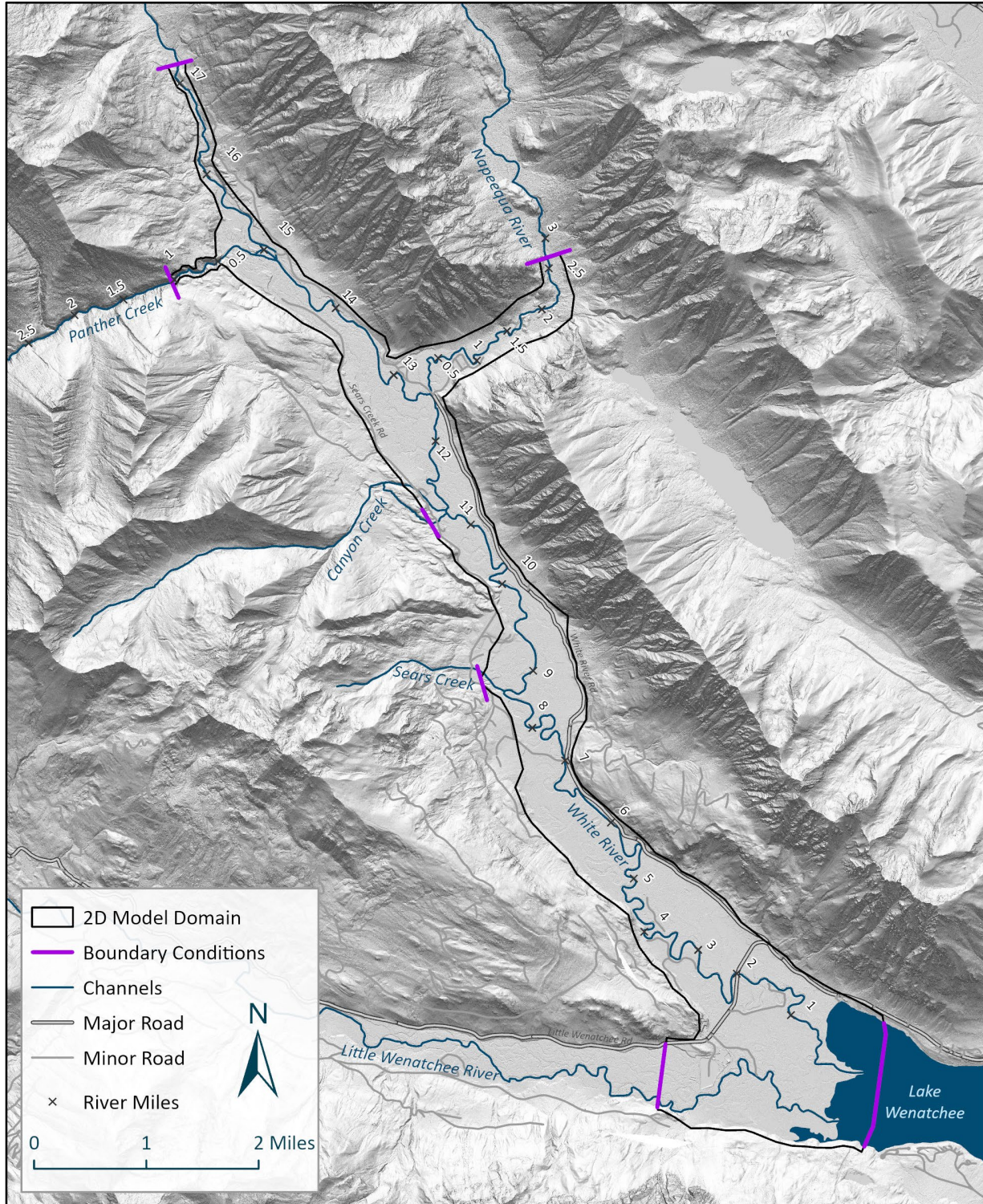
The model's domain extends from just upstream of the Northernmost end of the White River Forest Service 6400 Rd and the White River Trailhead to Lake Wenatchee at the downstream end (Figure 1). The computational mesh consists of grid cells ranging from 5-70 feet, with the smallest grid cells utilized to provide higher resolution results closer to the channel and terrain features of interest (Figure 2). To save hours to days of run time, channel cell size ranged between 8x8 and 20x20 ft, while much of the

floodplain is made up of 50x50 ft cells. Larger cells on the floodplain can sometimes result in overestimation of flow inundation if cells span across high ground areas that would in reality be a flow barrier. Breaklines were added along topographic high points to align cell faces along high ground to improve the representation of the underlying terrain and to limit this “leaking” effect, but there can still be some overestimation of floodplain inundation in some areas. Breaklines are also added along the channel to force cell alignment perpendicular to flow, improving efficiency and accuracy.

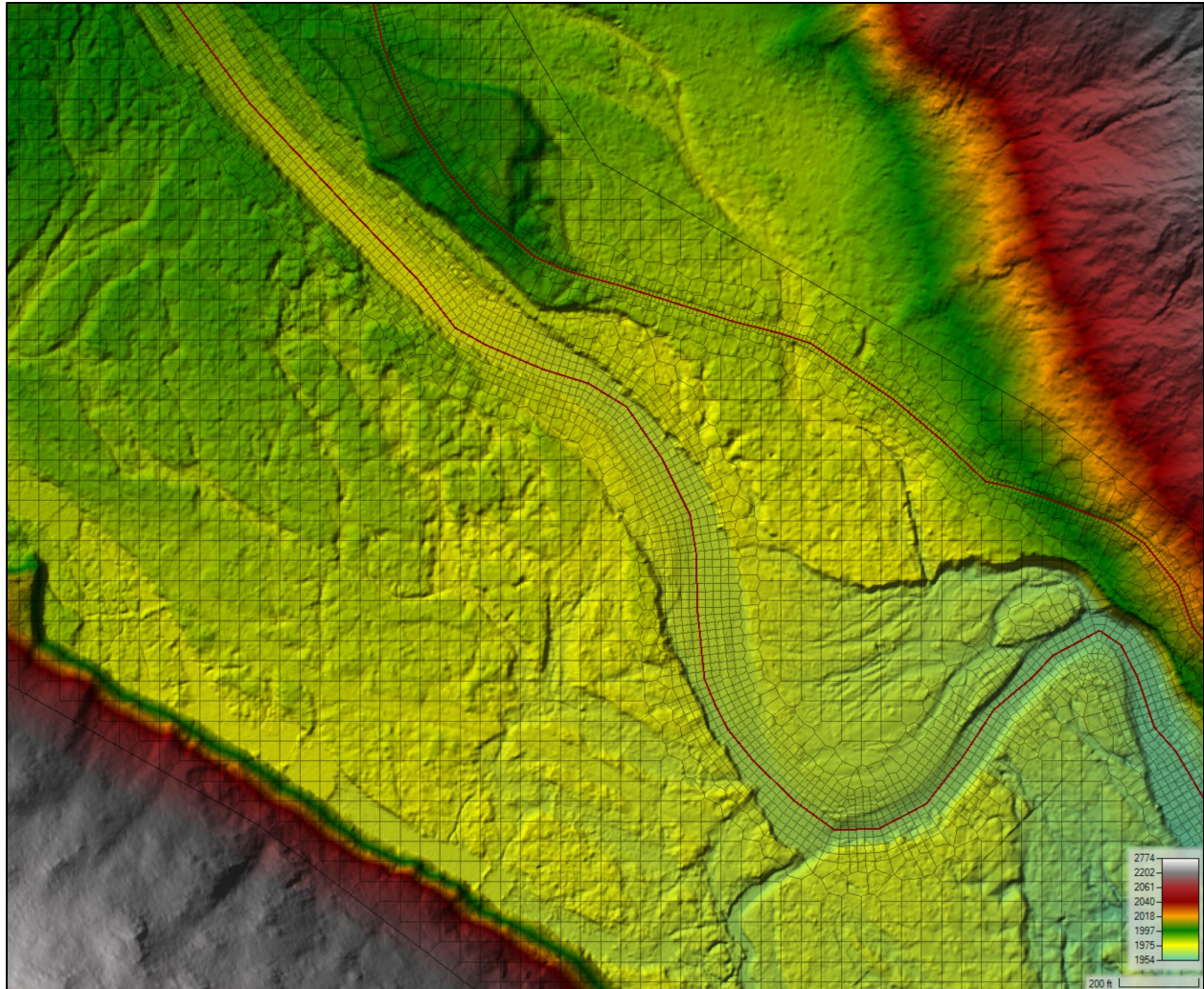
### **2.1.3 Water Control Structures**

Three corrugated metal culverts flow under Little Wenatchee Road, to the north of the bridge at RM 2. These culverts were added to the model as SA/2D connections, which routes flow through these structures to better represent existing conditions at the sites, as the floodplain becomes inundated at this site, and this is one of the routes that water can flow to the other side of the RM 2 road and bridge. The culverts were estimated to have diameters of 3 ft and lengths of 75 ft based on field observations, and entrance and exit loss coefficients of 0.9 and 1.0 respectively, as the culverts projected directly from the fill beneath the road at the site, with no head wall or wing walls. There are also four culverts on the river right at the RM 2 bridge that were not initially included in the model, as it was assumed that they are not regularly inundated. Upon reviewing preliminary model results, significant amounts of water accumulate behind the road at that location, so they were added to the model. And were assumed to have the same characteristics as the observed culverts at the site. The channel-spanning bridges at RM 2 and RM 7 were not included in this preliminary model, as there were no concerns about bridges being submerged.

A broad crested weir was observed near RM 1.7 of the White See (Appendix A Figure 15). It was described by field crews as being made of wooded boards spanning the entire width of the White River channel, and appears to be imposing some grade control for the human-straightened section of channel upstream, including under the bridge. Based on field observations, LiDAR, and aerial imagery, the weir elevation was estimated to be about 1873.3 ft above NAVD88, with a width of 15 ft and a weir coefficient of 2.6. Comparisons between the 2015 LiDAR Water Surface elevation and the model were used to check these values.



**Figure 1. 2D model domain for White River showing tributaries included in the model, roads, and model external boundary locations.**



**Figure 2.** Representative computational mesh near the upstream end of the model domain. Grid cells within the channel have a nominal size of 10-15 ft, while the outer floodplain cells are 50 ft. Breaklines (seen in red) are enforced along the channels and high ground features to align cell faces perpendicular to the prominent flow direction.

## 2.2 MODEL INPUTS

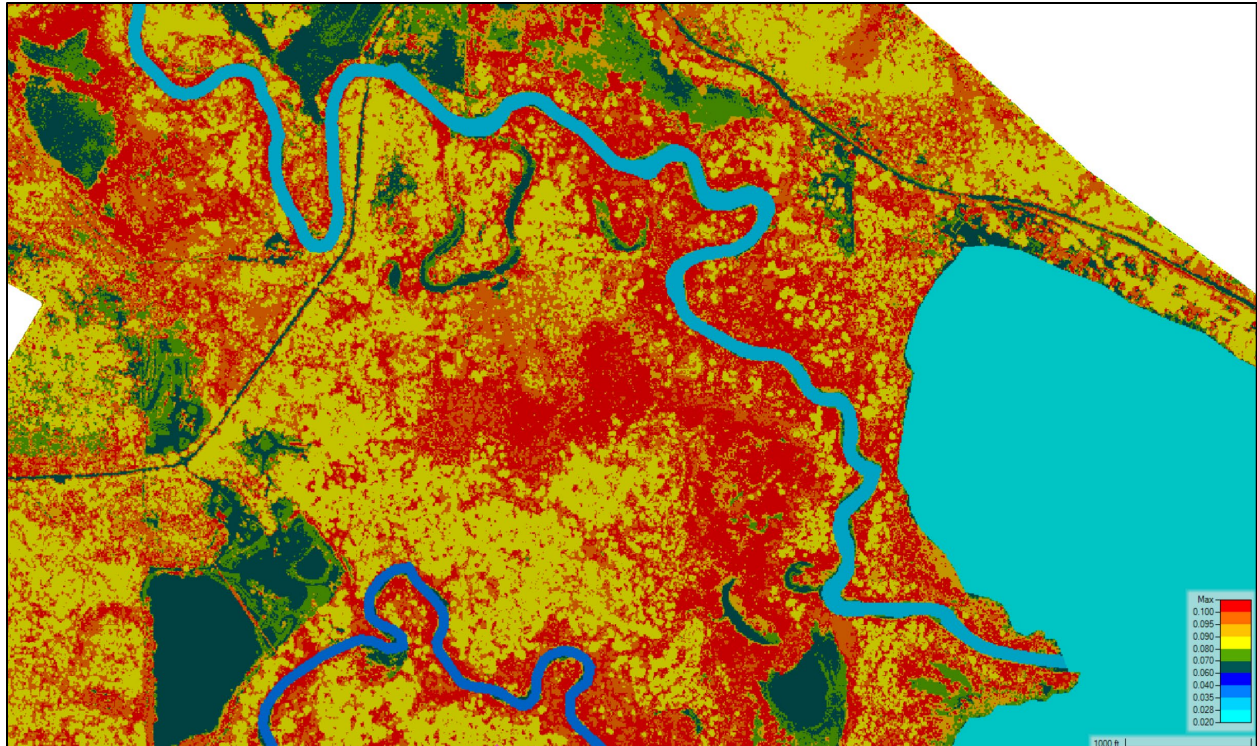
### 2.2.1 Model Roughness

A spatially varying Manning's  $n$  layer was developed using ArcGIS tools to represent hydraulic roughness throughout the model domain. The roughness layer was developed using a vegetation height layer created by subtracting the LiDAR bare ground layer (DTM) from the LiDAR first return layer (Digital Surface Model) and reclassifying these data to approximate vegetation densities that would represent different Manning's  $n$  values (Figure 3). These data were supplemented with hand-digitized polygons, representing more discrete features such as creek and river channels, and the lake at the downstream boundary of the model. Additional refinements were also made in certain areas based on field observations, such as forests with light understories. A table of Manning's  $n$  coefficients and their associated classifications is provided in Table 1. Assumed channel roughness coefficients range from

0.028 at the downstream, low gradient end where the bed has significant fines, to 0.045 where the channel is steeper and gravel-bedded. The lake is represented by a roughness of 0.02. Floodplain roughness coefficients range from 0.06 to 0.1.

**Table 1. Roughness coefficients (Manning's n values) utilized in the preliminary existing conditions modeling.**

<b>Area Description</b>	<b>Roughness Coefficient (Manning's n Value)</b>
Upper White River Channel	0.045
White River Channel	0.035
Lower White River Channel	0.028
Lake Wenatchee	0.02
Canyon Creek Channel	0.04
Sears Creek Channel	0.04
Upper Panther Creek Channel	0.08
Lower Panther Creek Channel	0.04
Upper Napeequa River Channel	0.08
Lower Napeequa River Channel	0.035
Little Wenatchee River Channel	0.035
Bare Ground (<0.5 ft)	0.06
Vegetation Height 0.5-4 ft	0.07
Vegetation Height 4-12 ft	0.09
Vegetation Height 12-25 ft	0.1
Vegetation Height 25-60 ft	0.095
Vegetation Height 60+ ft	0.085



**Figure 3. Representative depiction of roughness regions assigned to the existing conditions White River model.**

### 2.2.2 Model Hydrology

The hydrologic inputs for the White River model were calculated by performing a variety of hydrologic analyses using data from various sources. For the mainstem White River, a flood frequency analysis was performed using data from the Washington Department of Ecology gage on the White River near Plain (Station 45K090), which is situated by a bridge at RM 7 of the White River (WDOE, 2024). The WDOE gage has a period of record from September 2002 to 2024. Peak flows from water years 2003 to 2023 were used to complete a bulletin 17C peak flow analysis with the HEC-SSP software (USACE, 2023). The 17C analysis was conducted using a weighted skew, with a regional skew of -0.07 and a regional skew MSE of 0.18, as outlined by Mastin et al. (2017). This gage is situated in the middle of the project area. The peak flows from this analysis were scaled using the weighting equations for Region 2 in Mastin et al (2017) to obtain the flow input at the upstream boundary of the model as well as at the mouth of the White River to inform tributary input flows. Four tributaries to the White River were identified as additional flow inputs to the hydraulic model: the Napeequa River, Panther Creek, Canyon Creek, and Sears Creek. The drainage areas for each of these tributaries were used to scale the results of the White River flood frequency analysis, such that hydrologic inputs could be proportioned between the tributaries. Drainage areas for each tributary were calculated as the difference between the drainage area of the White River just above and just below the tributary confluence. Drainage areas were determined using StreamStats (USGS, 2022). The difference in peak flows between the top and bottom of the project area (described previously) was then distributed among the tributaries based on drainage area (Table 2). Little Wenatchee River flows, which are also included in the model, were obtained by scaling the peak flows from the White River WDOE gage to the drainage area of the Little Wenatchee at the flow input point.

**Table 2. Modeled flow events for the White River and tributaries used in hydraulic modeling.**

Flow Event	White River Upstream Discharge (cfs)	Panther Creek (cfs)	Napeequa River (cfs)	Canyon Creek (cfs)	Sears Creek (cfs)	Little Wenatchee River (cfs)	Lake Wenatchee Stage (ft NAVD88)
2 - year	2,950	900	1,700	350	320	2,750	1,876.8
5 - year	3,650	1,100	2,050	400	380	3,600	1,877.6
10 - year	4,100	1,200	2,250	440	420	4,600	1,878.2
20 - year	4500	1,300	2,450	475	450	5,900	1,878.9
50 - year	5,000	1,400	2,650	520	500	8,300	1,880
100 - year	5,400	1,500	2,800	550	525	11,000	1,881.2

The hydraulic model was used to evaluate existing conditions at flow events ranging from the 2-year to the 100-year flow event for the White River (Table 2). Multiple synthetic hydrographs containing inflows of interest were used as the model input hydrographs to simulate steady-state flow conditions for given peak flows, where the discharge of interest remains constant long enough to allow the model to reach a state of equilibrium. Allowing the model to reach a steady state during large flood events may overestimate flooding results, as floodplain storage areas throughout the model domain must reach capacity for the outflow of the model to reach steady-state conditions. In reality, this may not occur during short-duration events. However, it is a safe assumption for longer-duration events and is a more conservative (i.e., more likely to predict larger flooding extents) approach that was deemed appropriate for this preliminary-level model.

### 2.2.3 Model Boundary Conditions

The upstream boundary condition was set to the “White River Upstream Discharge” in Table 2, with an assumed Energy Grade Line slope of 0.017 based on the terrain at the location of the upstream boundary, which estimates the energy loss across the boundary condition. Each of the four tributaries, the Napeequa River, Panther Creek, Sears Creek, and Canyon Creek, were also added to the model as external boundary conditions with their own hydrograph and energy slopes estimated based on the channel bed slope from the LiDAR-based terrain, and with peak flow timings corresponding to the mainstem White River peak flows.

The downstream boundary of the model is Lake Wenatchee and water surface elevation in the lake was used as the downstream boundary condition. Lake Wenatchee stage was analyzed using USGS gage 12455000 (Wenatchee River below Wenatchee Lake)(USGS, 2024a). This gage is located above the upstream-most riffle on the Wenatchee River, and it is assumed that the stage recorded at the gage is equivalent to the lake stage. Low flow stages recorded on the gage align with the elevation of the first riffle crest (hydraulic control for the lake) on the Wenatchee River in the LiDAR dataset and the difference between peak flow and low flow stage measurements were added to the riffle crest elevation for the calculated peak lake stage. The influence and timing of Lake Wenatchee stage was incorporated into the hydraulic model by assuming that times of high flows in the White River coincide with times of high lake stage, and that events of the same return interval coincide. A HEC-SSP bulletin 17C peak flow analysis (USACE, 2023) was conducted using the peak flow period of record from 1932 to 1979. The

results of the peak flow analysis were translated to the lake stage by aligning the flows of interest (2-, 5-, 10-, 20-, 50-, and 100-year events) with the closest stage records in the period of record (Table 2). USGS gage 12455000 was recorded using NVGD29 as the datum, and all data have been translated to NAVD88 (USGS, 2024a).

Another major flow input to Lake Wenatchee is the Little Wenatchee River, which enters the lake just to the south of the White River mouth. The two rivers share a floodplain in their lowest reaches and so the flows interact at high flows. For this reason, the lower Little Wenatchee River flowing into the lake was incorporated into the model. The upstream boundary of the model on the Little Wenatchee was set at approximately RM 2.6 on the Little Wenatchee, upstream of where the two floodplains connect. It was assumed in the model that the timing of peak flows in the Little Wenatchee River corresponded to those modeled for the White River.

### **2.3 MODEL CALIBRATION AND VERIFICATION**

The effect of missing bathymetry data on the modeling was observed to be greatest in the lower reaches of the White River where the channel is deep and lacks the shallow riffles present in the upper reaches. Water depths exceeding 15 feet were measured during the habitat survey in the lower reaches. For this reason, the model terrain was modified in reaches 1-5 (RM 0-9) to provide a better representation of channel bathymetry through these deep-water areas. Channel depths taken as part of the habitat survey were used to inform the development of a modified channel geometry that was incorporated into the DTM for these reaches. This included lowering the LiDAR-derived channel bed elevation based on habitat survey measures of pool tail crest depths and riffle depths. This was believed to provide a reasonable approximation of channel bed elevation because the habitat surveys occurred at a similar discharge as when the LiDAR data were collected based on the information in the LiDAR data report (QSI, 2016). A 50 ft bottom width was used for the adjusted/lowered channel bed as this width appeared to be a reasonable “fit” within the existing channel by occupying most of the channel but not resulting in widening of the banks. Additional adjustments were made to the bed elevation where habitat survey data were sparse (primarily in Reach 2); this was performed as part of the calibration/verification process, which occurred via two approaches: 1) comparing the water surface elevation produced by the model when run with the flow observed at the site on the day the LiDAR was flown in 2015 (298 cfs) to the water surface elevation from the LiDAR flight along the channel centerline, and 2) comparing the model Q2, Q20, and Q100 water surface elevations at the RM 7 Bridge with a high-flow rating curve produced based on flows and gage heights recorded at the USGS gage for flows greater than 2,000 cfs. Model calibration occurred through an iterative process of adjusting channel roughness and bed elevation (where habitat data were lacking) to achieve water surface elevations that more closely matched the LiDAR flow, Q2, Q20, and Q100 flows, as well as site indicators of bankfull conditions and floodplain inundation frequencies. Despite these calibration and verification efforts, there remains considerable uncertainty with model outputs due to a lack of comprehensive bathymetry data and a lack of specific and reliable calibration data throughout the study area.

**Table 3. White River WSE comparison for final model at the old USGS gage station location at the RM 7 bridge.**

<b>Flow Event</b>	<b>Flow at RM 7 Bridge (cfs)</b>	<b>Rating Curve/ LiDAR WSE (ft NAVD88)</b>	<b>Model WSE (ft NAVD88)</b>
LiDAR	298	1888.7	1888.83
2 - year	6005	1899.34	1899.52
20 - year	7375	1900.55	1900.36
100 - year	7885	1900.95	1900.7

### 3 Summary of Hydraulic Model Results

The results of the White River model were used to assess existing condition channel hydraulics and floodplain dynamics. A wide range of flows were run in the model (2, 5, 10, 20, 50, and 100-year flood events); however, for simplicity, the 2-year, 20-year, and 100-year floods are displayed here as they well-represent the range of conditions in the study area over the range of flood flows.

#### 3.1 MODELED VELOCITY RESULTS

Modeled velocities for the 2-year, 20-year, and 100-year flood velocity results are displayed in Figures 4-9. The results indicate that in the downstream reaches of the project, Reaches 1 to 6, channel velocities generally remain between 2 and 6 ft/s, with occasional areas spiking to 8 ft/s during the 20-year and 100-year events (Figure 4, 6, and 8). Higher velocities (6-8 ft/s) were computed at the two channel-spanning bridges (located at RM 2 and RM 7), where flow is largely constricted to the channel. The bridge at RM 7, where the White River WDOE gage is located, appears to have significant floodplain flow routed around the bridge and over the road at the simulated 2-year flood, and floodplain flow increases at the 20-year and 100-year flow (see Table 3). Conversely, the RM 2 bridge shows flow confined to the channel or conveyed through the floodplain culverts for all the modeled flows.

**Table 4. White River flows in the channel and over the floodplain at the RM 7 bridge.**

Flow Event	Floodplain Discharge (cfs)	White River Channel Discharge (cfs)
2 - year	215	6005
20 - year	1810	7375
100 - year	2900	7885

Generally, floodplain velocities for the 2-year event are < 0.5 ft/s in these lower reaches, except for large portions of Reaches 1, 3, and 5 where velocities range from 0.5-2 ft/s on river left. As floodplain inundation increases with the 20-year and 100-year flows, so does the average floodplain velocity, especially in Reaches 5 and 6 where the valley bottom is narrower. Natural levees observed in Reaches 2, 3, and 4 can be seen in the model results, as many of them, especially those surrounding the channel from RM 3 to RM 4 and those on river right RM 6 to 6.5, are not fully submerged. However, the model shows flow routing around them from points upstream, resulting in much of the floodplain being fully inundated despite their presence. The natural levee in Reach 4 on river right from RM 6 to 6.5 appears to confine the river to a much straighter, fast-moving channel than in the surrounding reaches.

In Reaches 7 and 8, modeled channel velocities generally range from 4-8 ft/s for the 2-year flow, with isolated areas of 10 ft/s just downstream of the Napeequa River confluence near RM 12.5, as well as upstream of RM 14 (Figure 5, 7, and 9). Modeled velocities increase slightly with the 20-year and 100-year flows, with more of the main channel velocities in Reach 8 exceeding 8-10 ft/s. Floodplain inundation in Reaches 7 and 8 can be seen during the 2-year flow with velocities ranging from 0.5-2 ft/s, increasing to 1-

2 ft/s at higher flows. With increased inundation, an oxbow and other channel scars in the floodplain of Reach 7 are shown to be reconnected to the White River at the 20-year flow.

Reach 1 of the Napeequa River has velocities ranging from 2 to 10 ft/s in the main channel, with the highest velocities near RM 1.4. Overall, there are minimal velocity increases between the 2-year and 100-year flows, but the 20-year and 100-year events show greater floodplain inundation downstream of RM 0.5. Modeled velocities in Napeequa River Reach 2 are generally higher in the main channel relative to Reach 1, with typical values greater than 6 ft/s, and often exceeding 10 ft/s for the 20-year and 100-year flows. These relatively high velocities are expected of the steep and confined valley that the Napeequa River flows through.

Modeled velocities in the upstream-most portion of the study area, Reaches 9-10 of White River, and Panther Creek Reach 1, are relatively high compared to the rest of the study area, often exceeding 10ft/s in all of the modeled flows. High flows in this area are mostly confined to the main channel of the White River and Panther Creek, and gradients are much steeper.

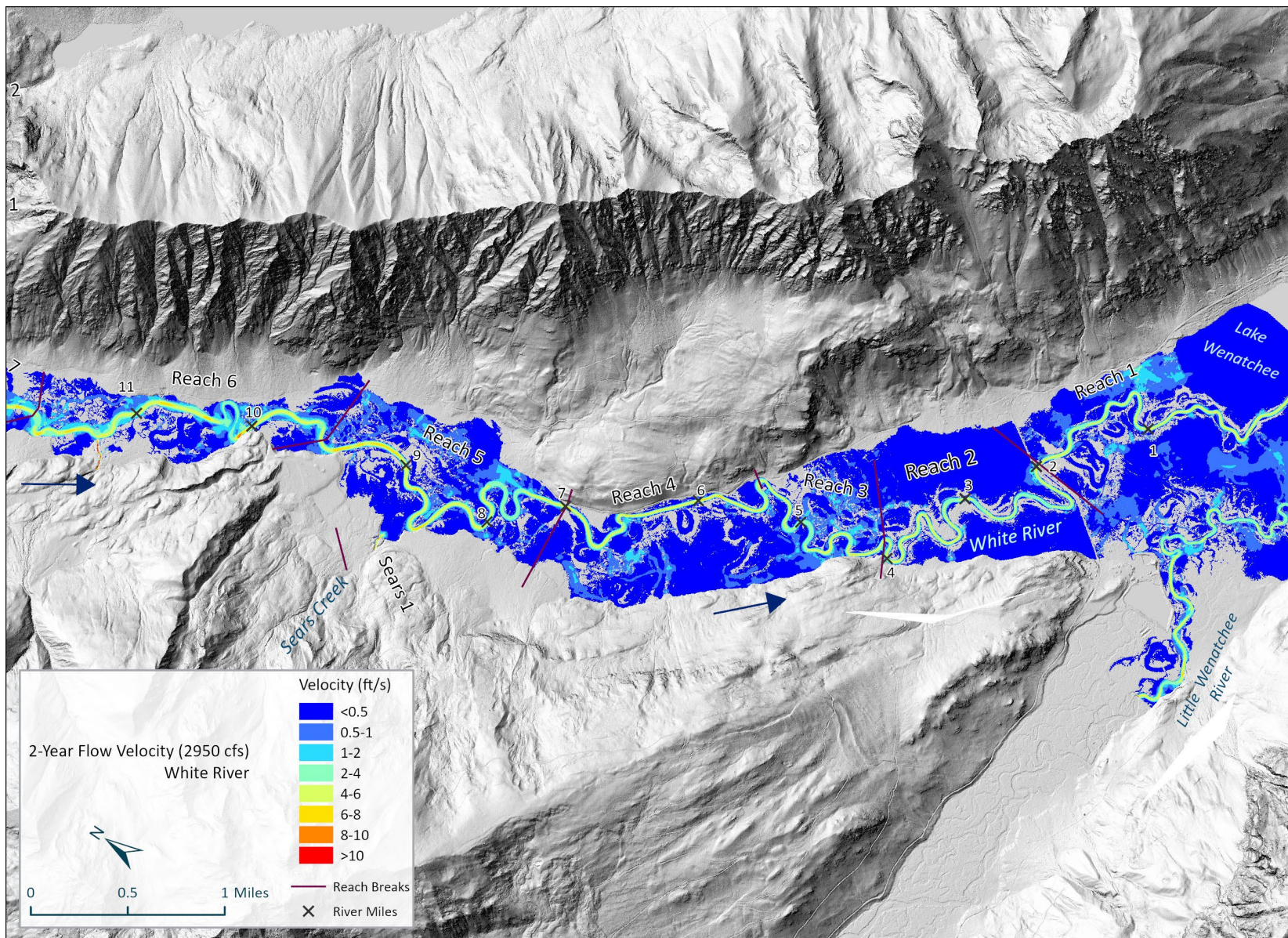


Figure 4. Modeled 2-year flood velocity for reaches 1 to 6.

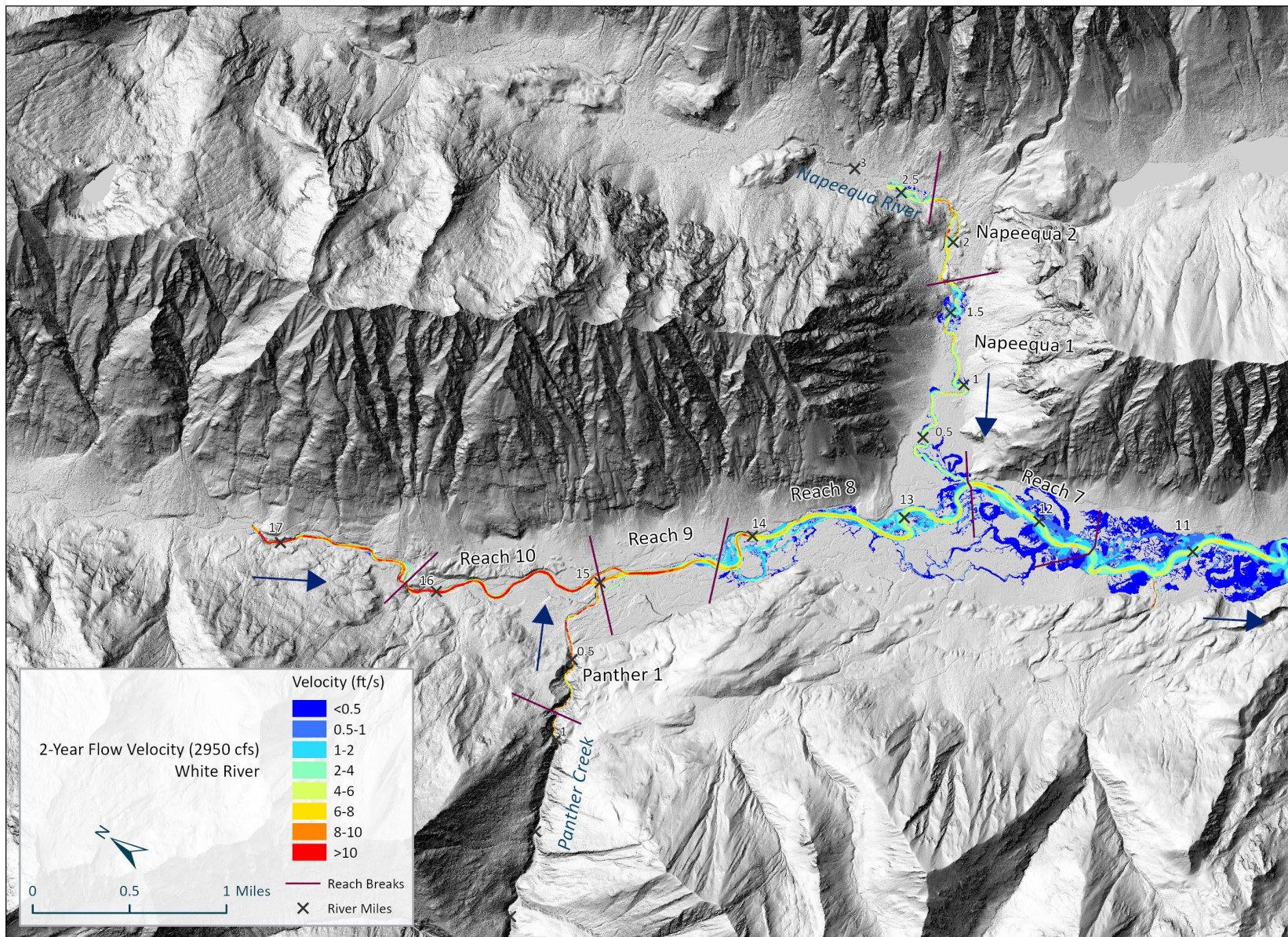


Figure 5. Modeled 2-year flood velocity for reaches 7 to 10.

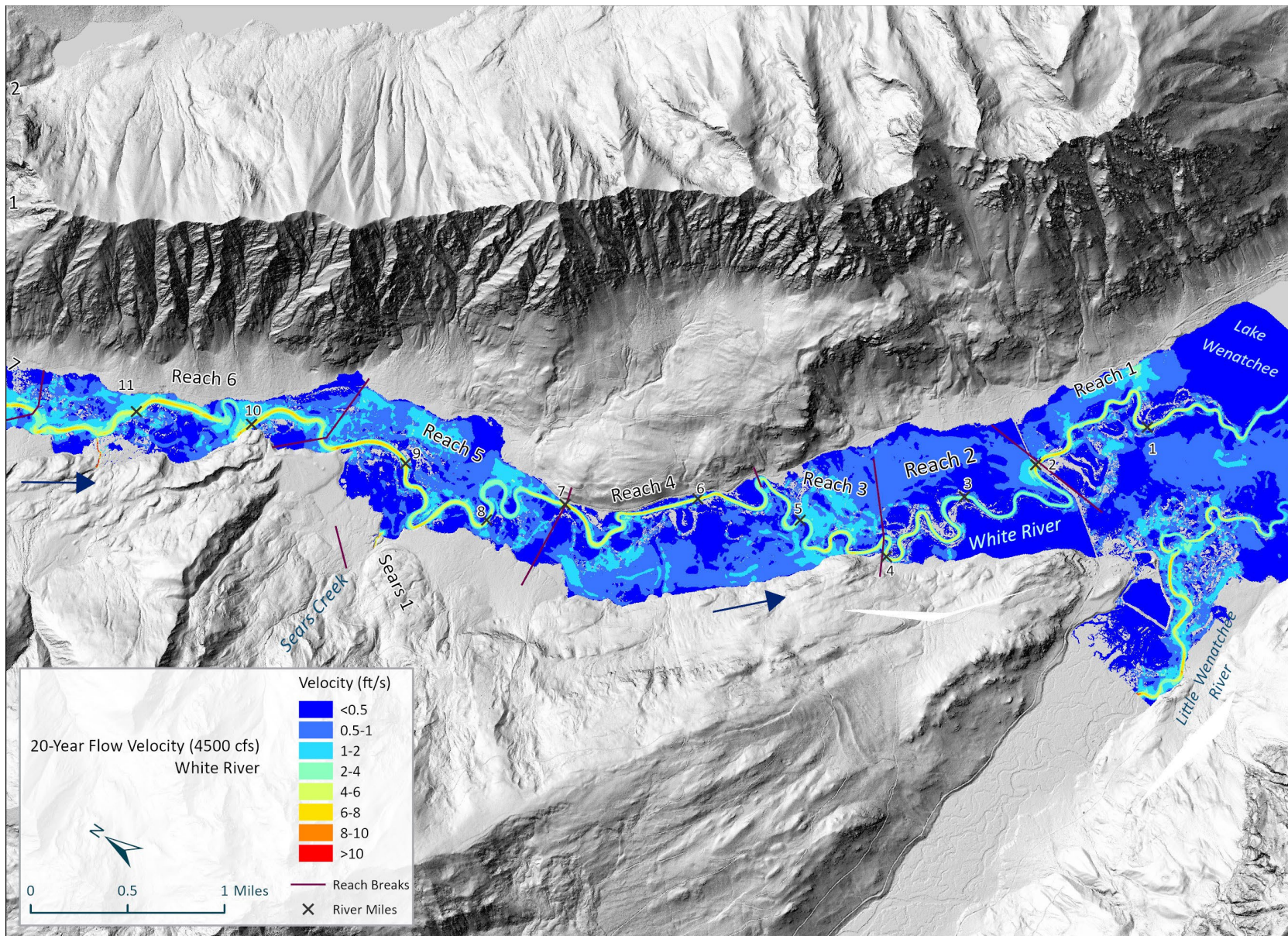


Figure 6. Modeled 20-year flood velocity for reaches 1 to 6.

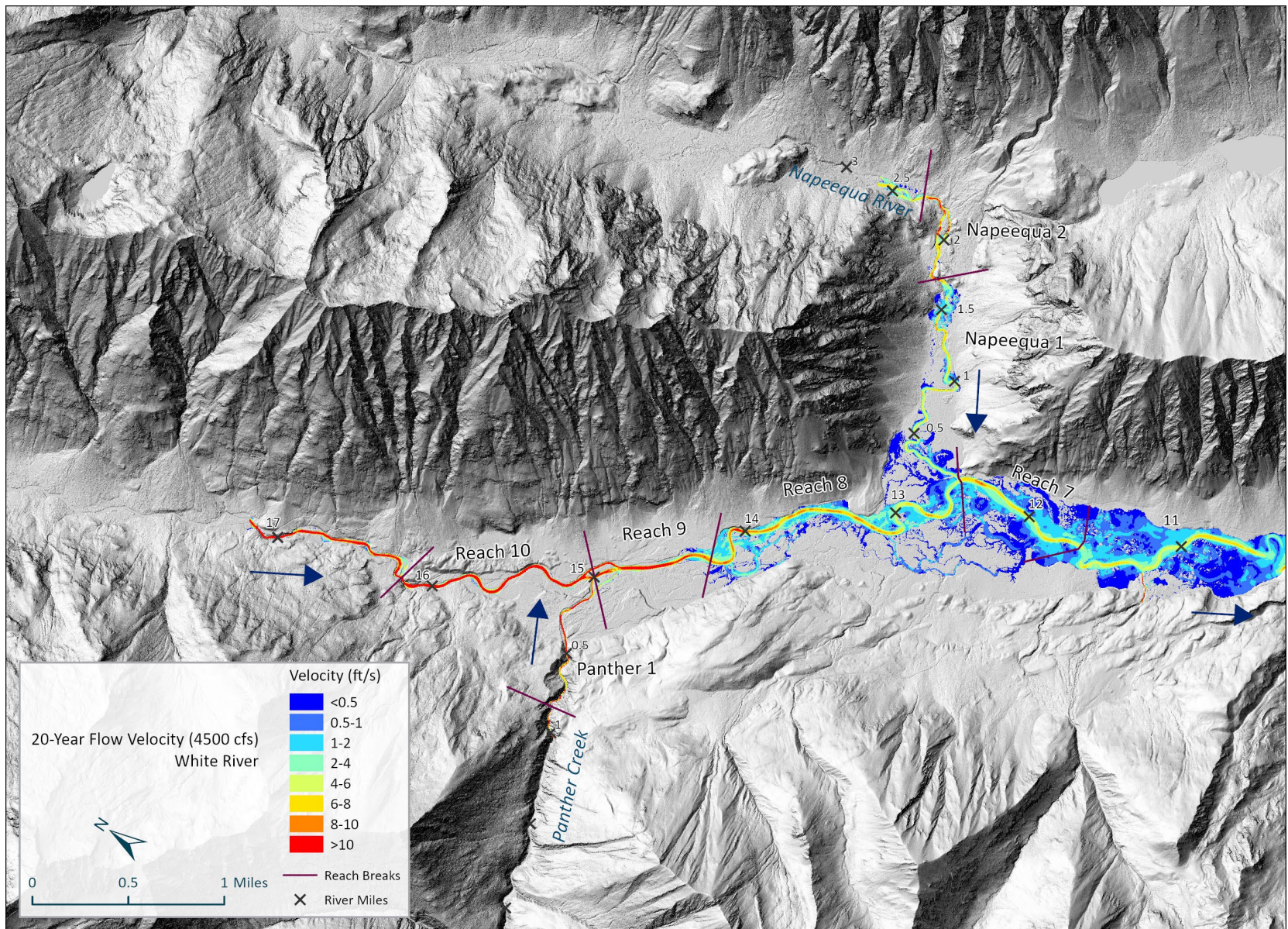


Figure 7. Modeled 20-year flood velocity for reaches 7 to 10.

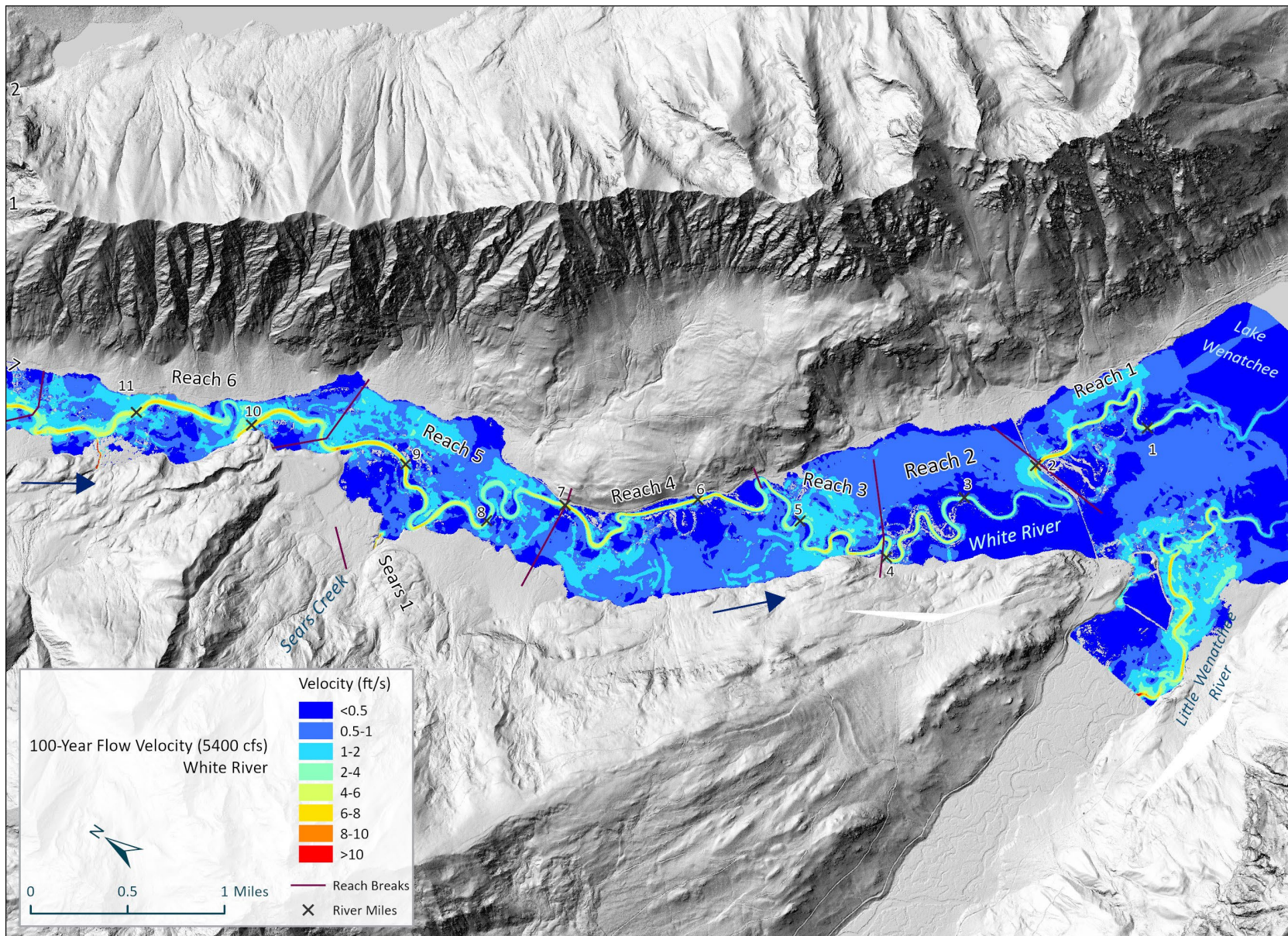


Figure 8. Modeled 100-year flood velocity for reaches 1 to 6.

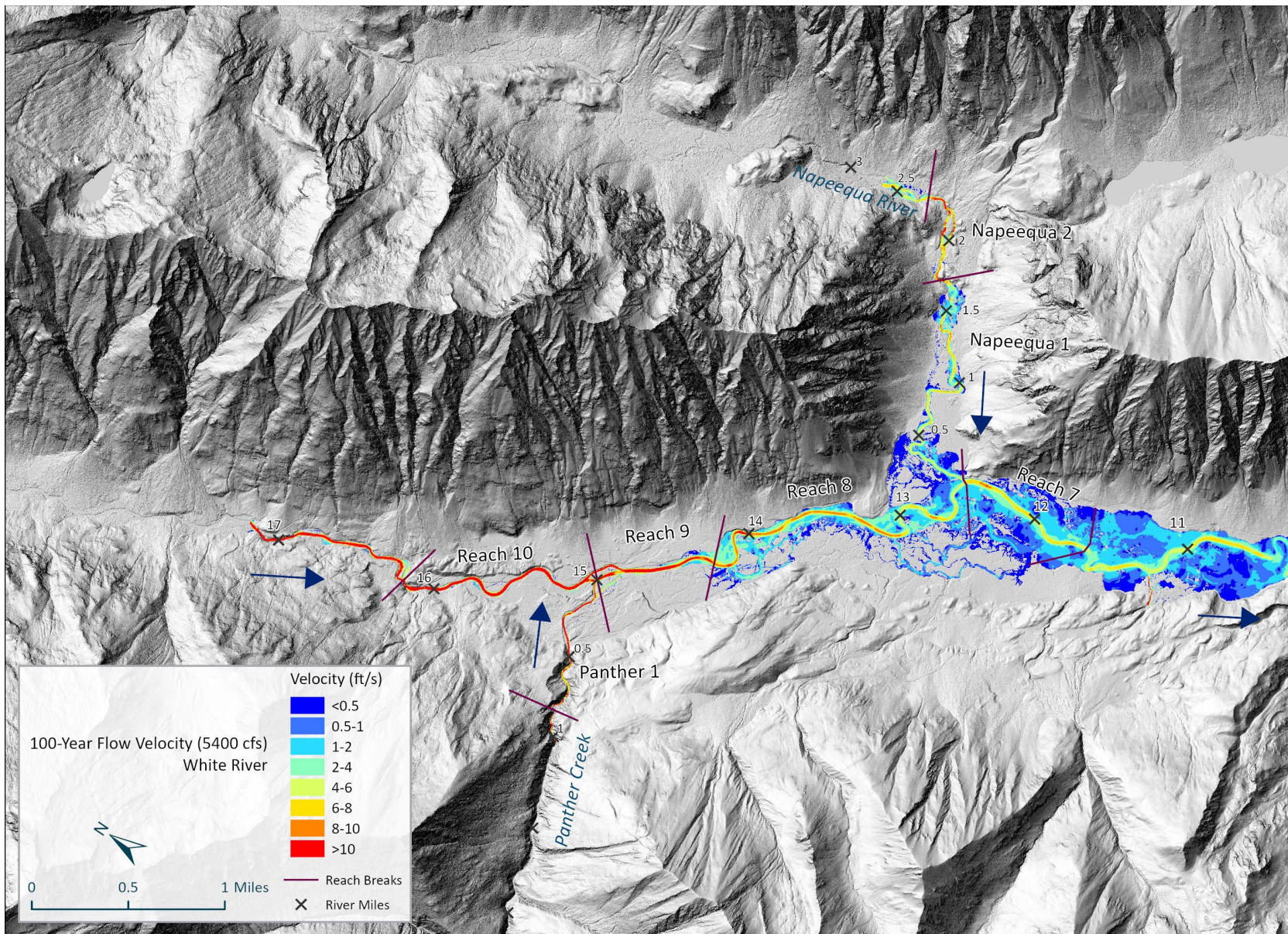


Figure 9. Modeled 100-year flood velocity for reaches 7 to 10.

### 3.2 MODELED DEPTH RESULTS

As previously mentioned, The LiDAR used in the model terrain does not include bathymetry, leading to uncertainty in the model's channel conveyance and depths. In the lower river, a channel was burned into the model terrain using available data from the habitat survey in an attempt to better represent actual conditions, as described previously in Section 2.3. Despite these limitations, the model nevertheless provides useful information on relative depths at a coarse scale, especially in the upstream reaches that have a shallower channel where the LiDAR data is more representative.

Modeled depths at the 2-year, 20-year, and 100-year recurrence interval events are displayed below in Figures 10-15. In the downstream portion of the project area, Reaches 1 to 4, modeled channel depths for the 2-, 20-, and 100-year flows exceed 10 feet on average (Figures 10, 12, and 14). At the 2-year flow, floodplain depths range from 0.5 to 4 feet, and are deepest alongside the road at Reach 2, which constricts flow to pass under the bridge or through culverts at that point. Depths in these locations increase to about 4-6 feet for the 20-year and 100-year flows, and most of the floodplain is inundated across the valley bottom, with only the natural levees in Reaches 2, 3, and 4 remaining above water. Modeled main channel depths in Reaches 5 and 6 range from 4 to 10+ feet during the 2-year flow event, with an average of 8-10 feet in Reach 5 and 6-8 feet in Reach 6. Channel depths in these reaches increase to 6 to 10+ feet during the 20-year and 100-year flows. Floodplain depths in Reach 5 are shallower than downstream, ranging from 0 to 2 feet at the 2-year flood, with most of the floodplain depth being less than 0.5 feet. Floodplain depths increase slightly in this reach, ranging from 0.5 to 4 feet. The valley is more confined in Reach 6, and floodplain inundation seems to be limited to old side channels and oxbows in the floodplain. Three prominent oxbows in Reach 6 become inundated at the 2-year flow (depths ranging from 2-6 feet), becoming deeper and more connected with surface water as the simulated flow increases. During the 2-year flow, it appears that backwatering from Lake Wenatchee reaches to about RM 0.2, increasing to RM 0.5 and RM 1.0 at the 20-year and 100-year flows.

During the 2-year flood, the model indicates very little floodplain inundation in the upstream section (Reaches 7 to 10), with flow rarely escaping the main channel until downstream of the confluence of the Napeequa River in Reach 7 (Figure 11). Main channel depths in Reach 7 range from 4 to 8 feet during the 2-year flood, increasing to 4 to 10 feet during the 20-year and 100-year floods (Figure 13 and Figure 15). Main channel depths in Reaches 8-10 of the White River are on average 4 to 6 feet, with 6-8 feet at lateral scour pools in the main channel. The results for the Napeequa River show channel depths between 2 and 6 feet during the 2-year flow, increasing to 4 to 8 feet during the 20-year and 100-year flows. The average depth of Panther Creek in the model is between 2 to 4 feet for all flows. While floodplain inundation remains limited within Reaches 9 and 10 of the White River, Reach 1 of Panther Creek, and Reach 2 of the Napeequa River at other modeled flows, Reach 1 of the Napeequa River and Reach 8 of the White River show increased activation of the floodplain and old side channels in the areas upstream of the Napeequa River confluence, with floodplain depths ranging from 0.5 to 4 feet.

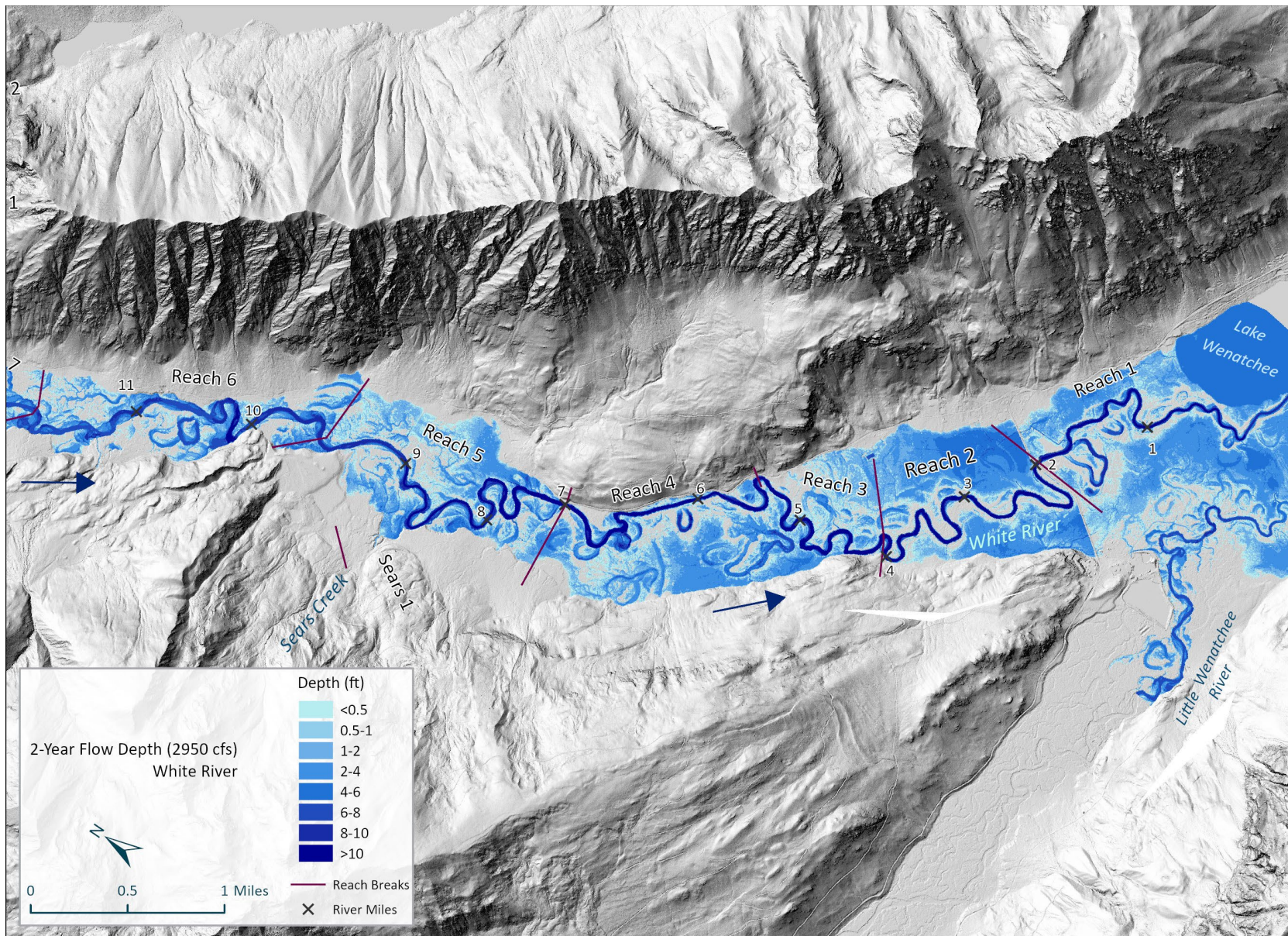


Figure 10. Modeled 2-year flood depth for reaches 1 to 6.

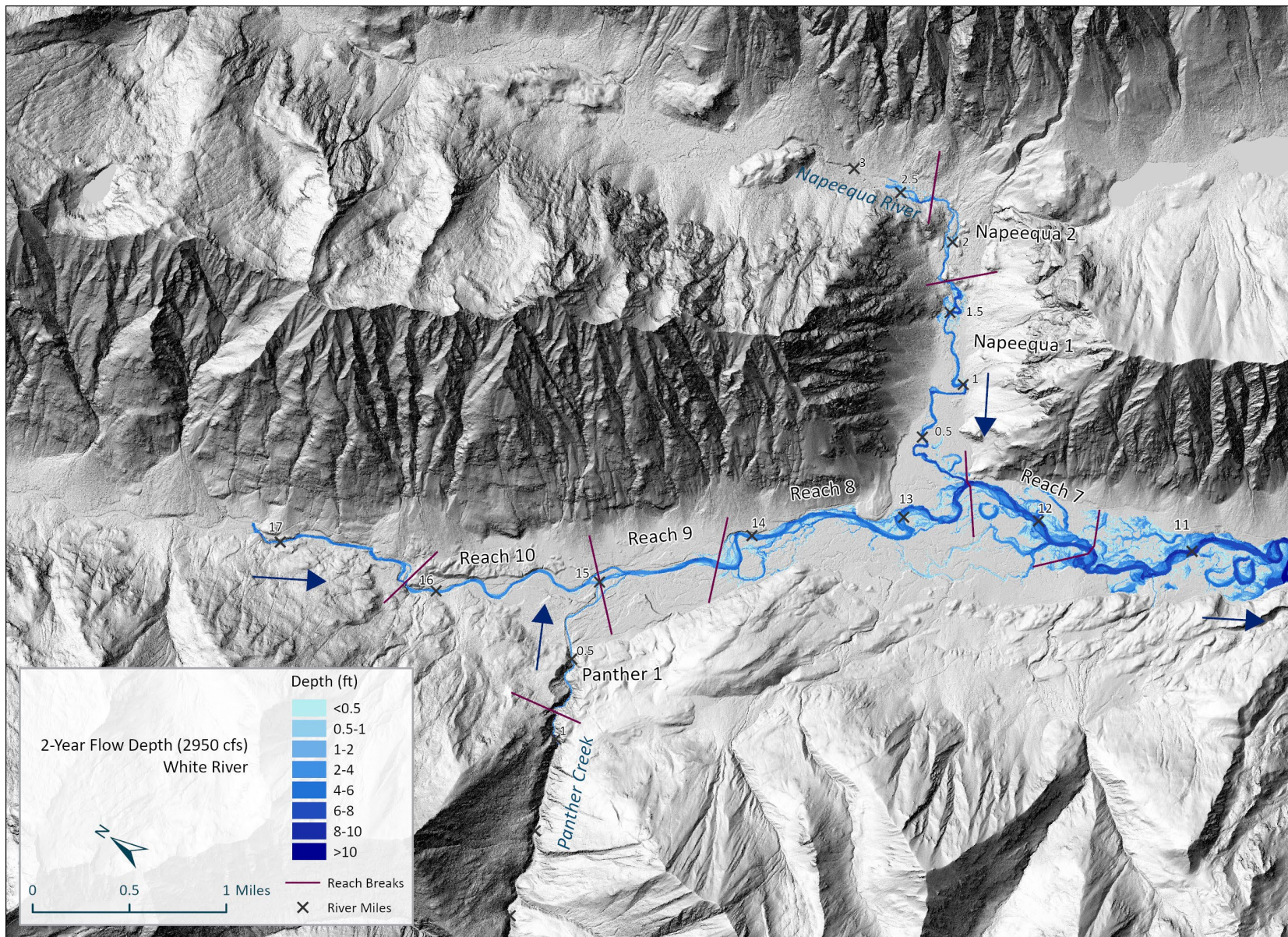


Figure 11. Modeled 2-year flood depth for reaches 7 to 10.

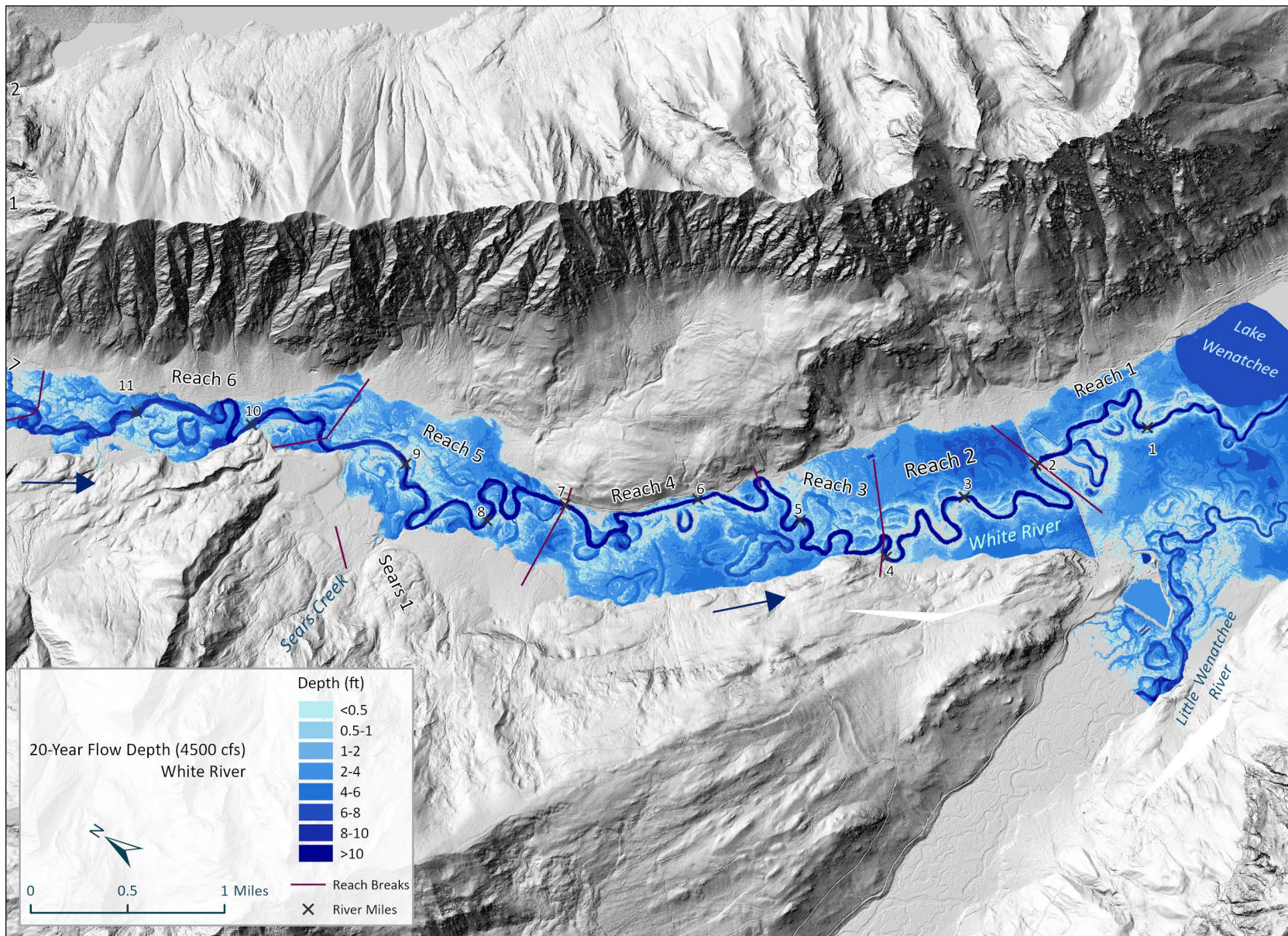


Figure 12. Modeled 20-year flood depth for reaches 1 to 6.

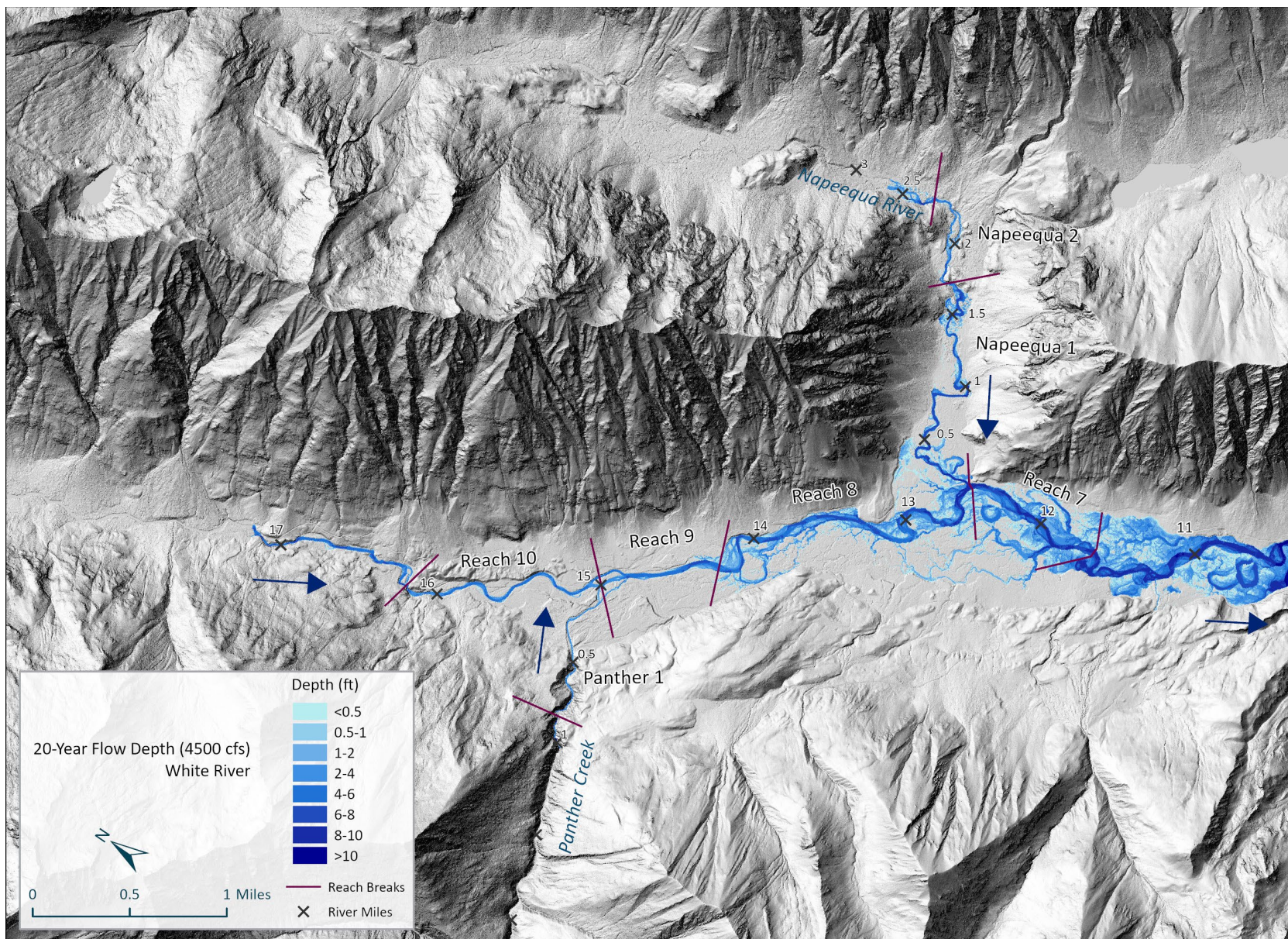


Figure 13. Modeled 20-year flood depth for reaches 7 to 10.

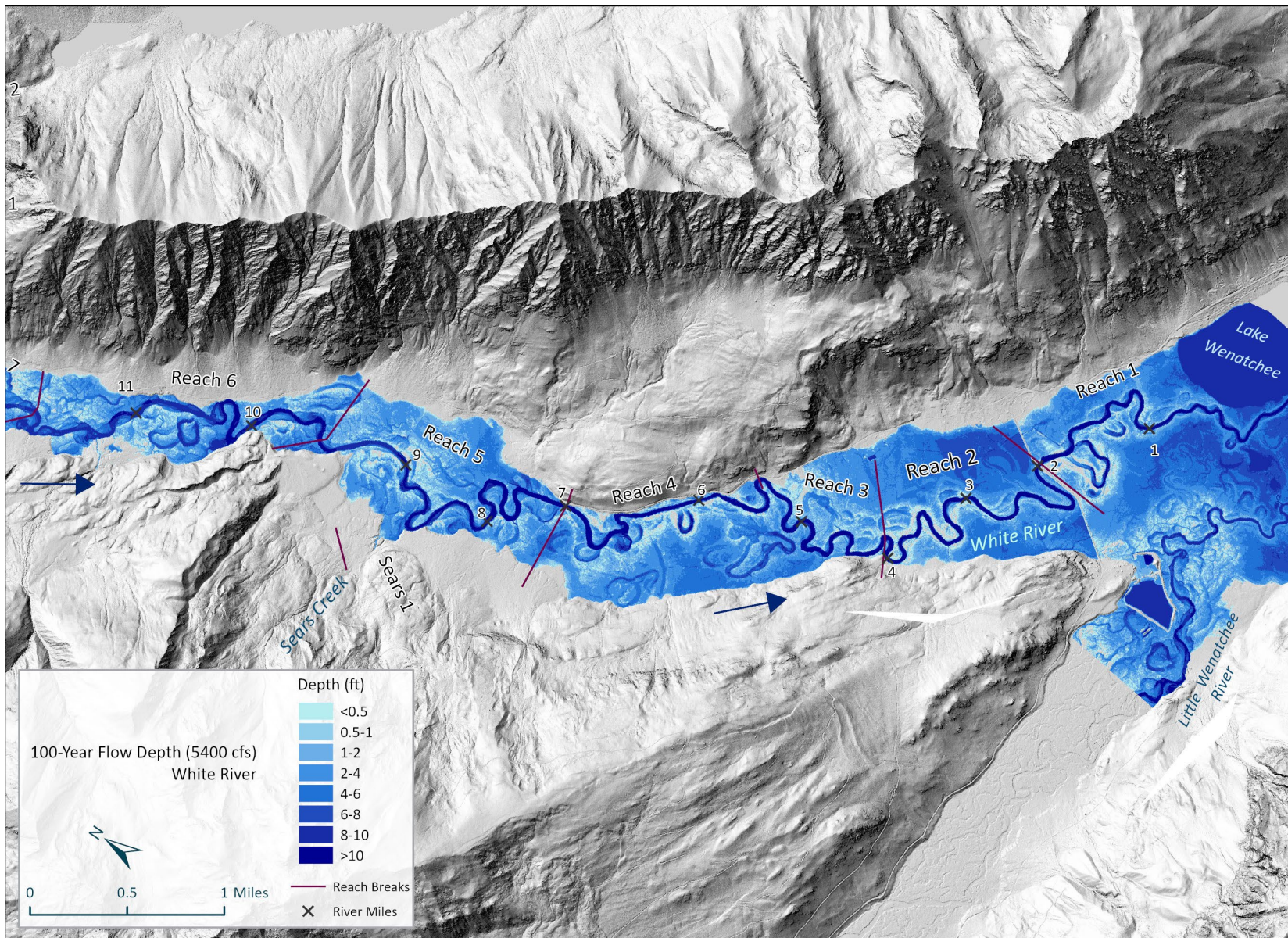


Figure 14. Modeled 100-year flood depth for reaches 1 to 6.

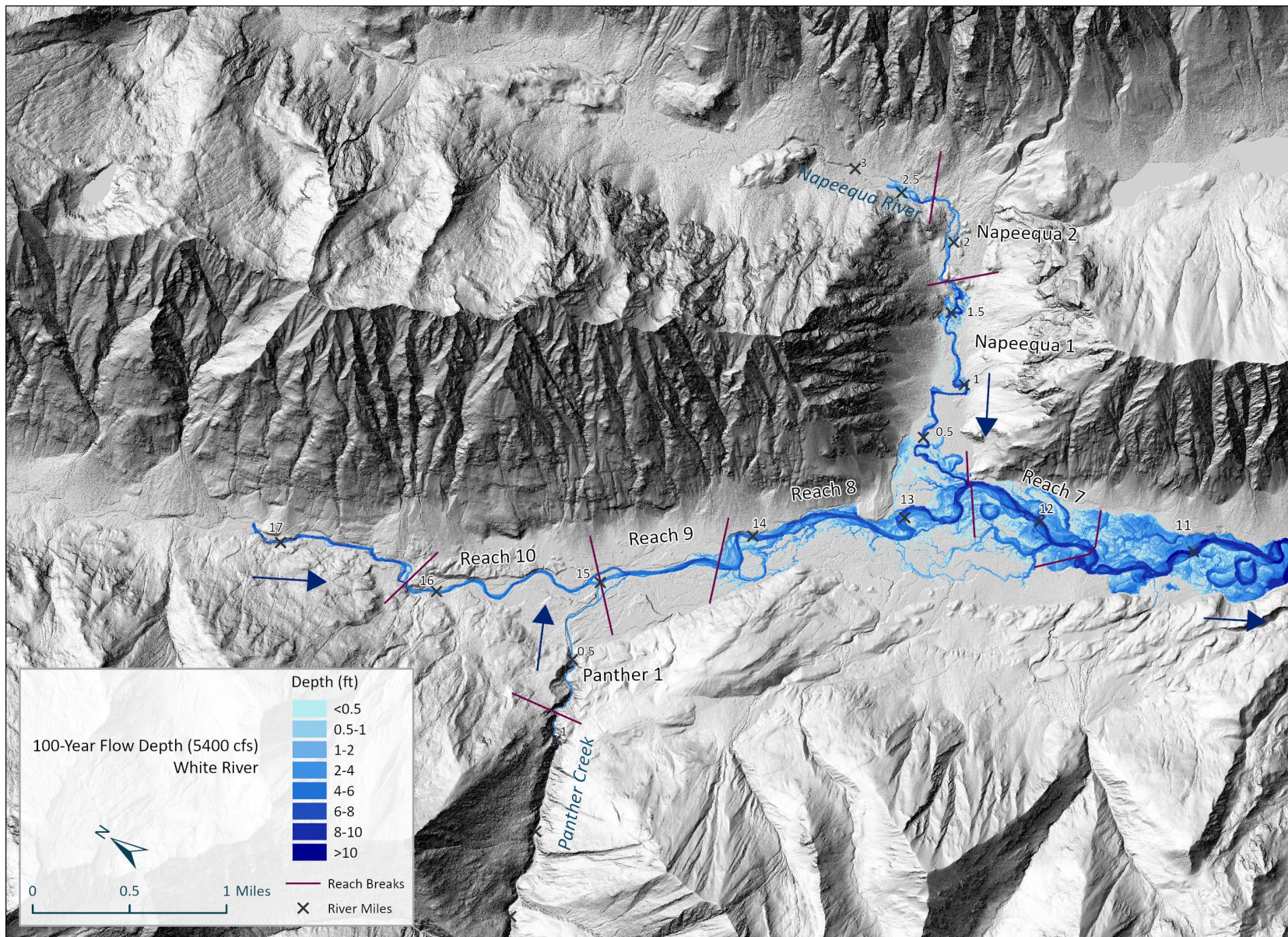


Figure 15. Modeled 100-year flood depth for reaches 7 to 10.

## 4 References

- Mastin, M. C., Konrad, C. P., Veilleux, A. G., & Tecca, A. E. (2017). Magnitude, Frequency, and Trends of Floods at Gaged and Ungaged Sites in Washington, Based on Data through Water Year 2014 (ver 1.2). *U.S. Geological Survey Scientific Investigations Report*, 2016–5118. <https://doi.org/http://dx.doi.org/10.3133/sir20165118>
- PSRC. (2007). *LiDAR Remote Sensing Data Collection: Upper & Lower Okanogan River, Methow River, Lake Roosevelt, Wenatchee River, and John Day River Study Areas*.
- QSI. (2016). *Oregon Lidar Consortium 2015 Chelan FEMA Study Report*.
- QSI. (2019). *Chelan, Washington LiDAR Technical Data Report*. [www.quantumspatial.com](http://www.quantumspatial.com)
- USACE. (2023). *Hydrologic Engineering Center Statistical Software Package (HEC-SSP 2.3) (2.3)*. U.S. Army Corps of Engineers Hydrologic Engineering Center.
- USACE. (2024). *Hydrologic Engineering Center River Analysis System (HEC-RAS), HEC-RAS version 6.5 (6.5)*. U.S. Army Corps of Engineers.
- USGS. (2022). *The StreamStats program*. U.S. Geological Survey. <https://streamstats.usgs.gov/ss/>
- USGS. (2024a). *USGS Surface-Water data for Washington*. USGS 12455000 WENATCHEE RIVER BELOW WENATCHEE LAKE, WA. [https://nwis.waterdata.usgs.gov/nwis/inventory/?site\\_no=12455000&agency\\_cd=USGS](https://nwis.waterdata.usgs.gov/nwis/inventory/?site_no=12455000&agency_cd=USGS)
- USGS. (2024b). *USGS Surface-Water data for Washington*. USGS 12454000 WHITE RIVER NEAR PLAIN, WA. [https://waterdata.usgs.gov/nwis/inventory/?site\\_no=12454000](https://waterdata.usgs.gov/nwis/inventory/?site_no=12454000)
- WDOE. (2024). *Freshwater DataStream Station Information White R. nr Plain (45K090)*. Washington Department of Ecology.
- WGS. (2023). *Lidar Project Quality Assurance Report, Project: East Cascades North 2020*.