RECLAMATION

Managing Water in the West

Kahler Reach Assessment

Nason Creek

Chelan County, Washington

U.S. Department of the Interior

Bureau of Reclamation
Pacific Northwest Region
Boise, Idaho

March 2009

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

The assessment teams overarching hypothesis on ecosystem processes are:

The proposed potential habitat actions presented in this reach assessment will provide a cumulative benefit that will improve ecosystem resilience at the reach scale; and the processes that naturally create and sustain habitat upon which the species of concern will be maintained or improved resulting in a net increase in abundance, productivity, spatial diversity and structure of the populations.

Cover Photograph – Cobble and boulder substrate near a unit channel of riffle in reach IZ-1, looking northeast downstream. Upper White Pine Reach; Subreach UWP IZ-2, Nason Creek - Wenatchee Subbasin, Washington. Bureau of Reclamation Photograph by D. Bennett; August 9, 2007.

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Acknowledgements

The Bureau of Reclamation (Reclamation) was fortunate to have the support and cooperation of multiple United States (U.S.) Forest Service staff who participated in the effort to produce the *Kahler Reach Assessment, Nason Creek, Chelan County, Washington*. In particular, Reclamation acknowledges the collaborative efforts and contributions of U.S. Forest Service employees Dave Hopkins, Cindy Raekes, and Cameron Thomas with the integration of the Reach-based Ecosystem Indicators (REI) that is the overarching strength of this reach assessment.

The following Reclamation employee is acknowledged for their peer review of this report: Geologist Terril Stevenson, Geology, Exploration & Instrumentation Group, Pacific Northwest Regional Office.

Table of Contents

List of Figures

List of Tables

Appendices

Appendix A – Reach-based Ecosystem Indicator Tables, is included at the end of this document on page 119.

Included on the CD on the back cover of this publication are this Reach Assessment report; **Appendix A** - Reach-based Ecosystem Indicator Tables; **Appendix B** – Initial Subreach Assessments; **Appendix C** – Habitat Assessment; **Appendix D** – Vegetation Report; **Appendix E** – UCRTT Biological Rank; and **Appendix F** – Hydraulic Engineering.

EXECUTIVE SUMMARY

Nason Creek is a tributary to the Wenatchee River which flows into the Columbia River in Chelan County, Washington (Figure 1). As part of the Columbia River Basin, Nason Creek contains salmon and steelhead habitat of the Columbia River fish species. Limiting factors identified in this report and in previous reports include riparian condition, streambank condition, channel function, flood plain connectivity, water quality, habitat diversity, and large woody debris (Andonaegui 2001; UCSRB 2007; UCRTT 2007). The species of concern found in Nason Creek include Upper Columbia River spring Chinook salmon (*Oncorhynchus tshawysha*), Upper Columbia River steelhead (*Oncorhynchus mykiss*), and Columbia River bull trout (*Salvelinus confluentus*) which are included in the Threatened and Endangered list under the Endangered Species Act (UCSRB 2007).

The Bureau of Reclamation produced this reach assessment to assist in meeting tributary habitat commitments contained in the 2008 Federal Columbia River Power System Biological Opinion (NMFS 2008). This report provides scientific information to Tribal, State, and local partners for identifying, prioritizing, and implementing sustainable field projects that improve survival and lead to the recovery of salmon and steelhead listed under the Endangered Species Act (NMFS 2008). Three reach assessments on Lower Nason Creek are being completed based on the 2008 field surveys and evaluations. These reach assessments evaluate condition of each reach, the impacts from human activities, and the sustainability of fish habitat within the reach.

Many authors have documented strategies that emphasize restoring processes that form, connect, and sustain habitats (Beechie et al. 1996; Kauffman et al. 1997; Beechie and Bolton 1999; Montgomery and Bolton 2003; UCRTT 2007). Habitat actions of this nature often occur at the site or reach scale. Roni et al. (2002) introduced a hierarchical implementation strategy that places site-specific actions within a watershed context. The Reclamation reach assessment and the previously mentioned objectives purposely feed into this strategy by further telescoping options through Roni's strategy as well as three additional filters of geomorphic potential, river conditions, and specific habitat actions in the *Upper Columbia Salmon Recovery Plan* (UCSRB 2007) at the reach scale. Geomorphic potential and synthesis of the results of the Reach-based Ecosystem Indicators (REI) serve as filters to identify potential habitat actions by subreach unit. In turn, several other layers of information are used to prioritize potential habitat actions within a geomorphic reach context based on results by beginning with protection and transitioning through several forms of active rehabilitation (Figure 2). This so-called stratified strategy is used throughout the Subreach Unit Profile section of the report to assist with the project selection process.

The Kahler reach is located between river miles 4.65 and 8.9 on Nason Creek, a 6th field Hydrologic Unit Code (HUC) watershed (Figure 1). In its natural state, Lower Nason Creek maintained dynamic equilibrium by actively migrating laterally across its floodplain within the Kahler reach. Typically, unconfined geomorphic reaches have flatter slopes and a

complex network of channels that result in a high degree of interaction between the active channel and the floodplain. This lateral channel migration helps the stream maintain a flatter channel profile as sediment is stored on the floodplain before being eroded and transported downstream. The natural ecosystem processes of the riparian, hydrologic, and geomorphic regimes create a healthy stream characterized by a dynamic cycle of conversion from stream to floodplain and vice versa, producing a constant renewal of fish habitat. If the interaction between these regimes is altered, it impacts the availability of fish habitat and threatens the continuation of the species within the basin.

Ecosystem processes in the Kahler reach are in a degraded state as a result of human-constructed constraints. The multiple functions associated with the three regimes have been impacted by the dissection of the floodplain by U.S. Highway 2, Highway 207, the hardening of the banks with riprap, and general development within the reach. These features have reduced the overall width of the available floodplain and length of the stream channel. Protection and rehabilitation strategies are recommended to prevent further degradation of the stream ecosystem.

Where restoration is the ultimate aim in many instances, it is realized that a more measured approach is sometimes necessary due to multiple human constraints, including the U.S. Highway 2 and Highway 207. Rehabilitation provides an approach that is consistent with restoration objectives to return critical stream ecosystem function to the best possible condition. In addition, rehabilitation is incremental and iterative in nature to accommodate the notion that complete restoration may not be possible due to anthropogenic structures and/or disturbance regimes. Key rehabilitation strategies include a combination of floodplain reconnection and riparian rehabilitation for promoting a return of natural ecosystem processes. Restoration strategies identified by the Upper Columbia Salmon Recovery Board (UCSRB), consisting of both potential protection and rehabilitation actions, are recommended to prevent further degradation of the stream ecosystem (UCSRB 2007).

Field surveys and evaluations were conducted in the Kahler reach during the summer and fall of 2008 to determine the condition of the riparian, hydrologic, and geomorphic regimes. The three reaches were delineated at the valley segment scale from the refinement of data from the tributary assessment in which two reaches were identified (Reclamation 2008). The three reaches were characterized into two general geomorphic reach types, confined and unconfined, based on natural channel constraints. The confined and unconfined reaches were ranked based on their coarse-scale geomorphic potential.

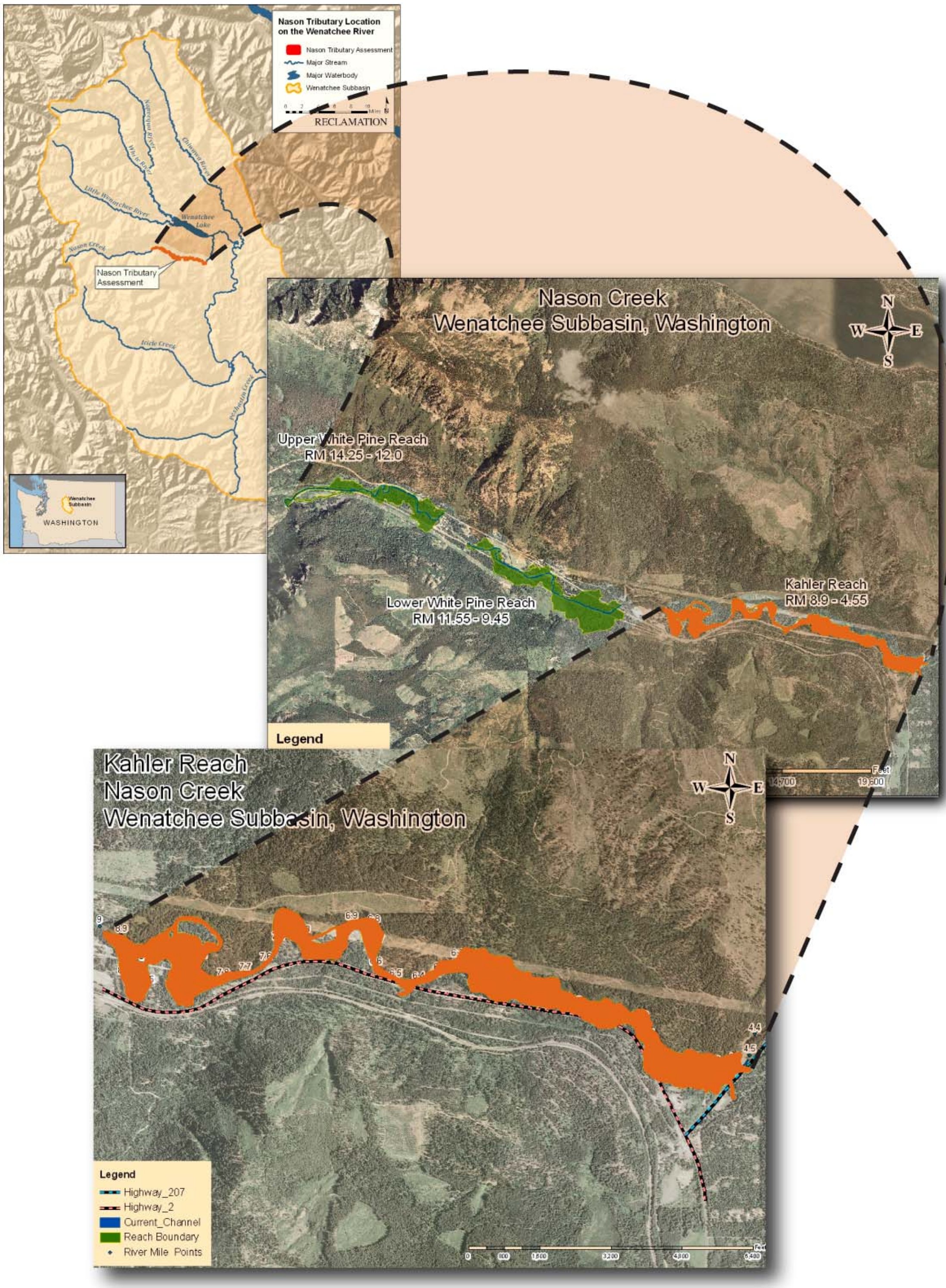

Figure 1 - Location map for the Kahler reach assessment demonstrating the nested geographic relationship of the Wenatchee watershed, Nason Creek tributary assessment area at the valley-segment scale and the Kahler reach assessment study area.

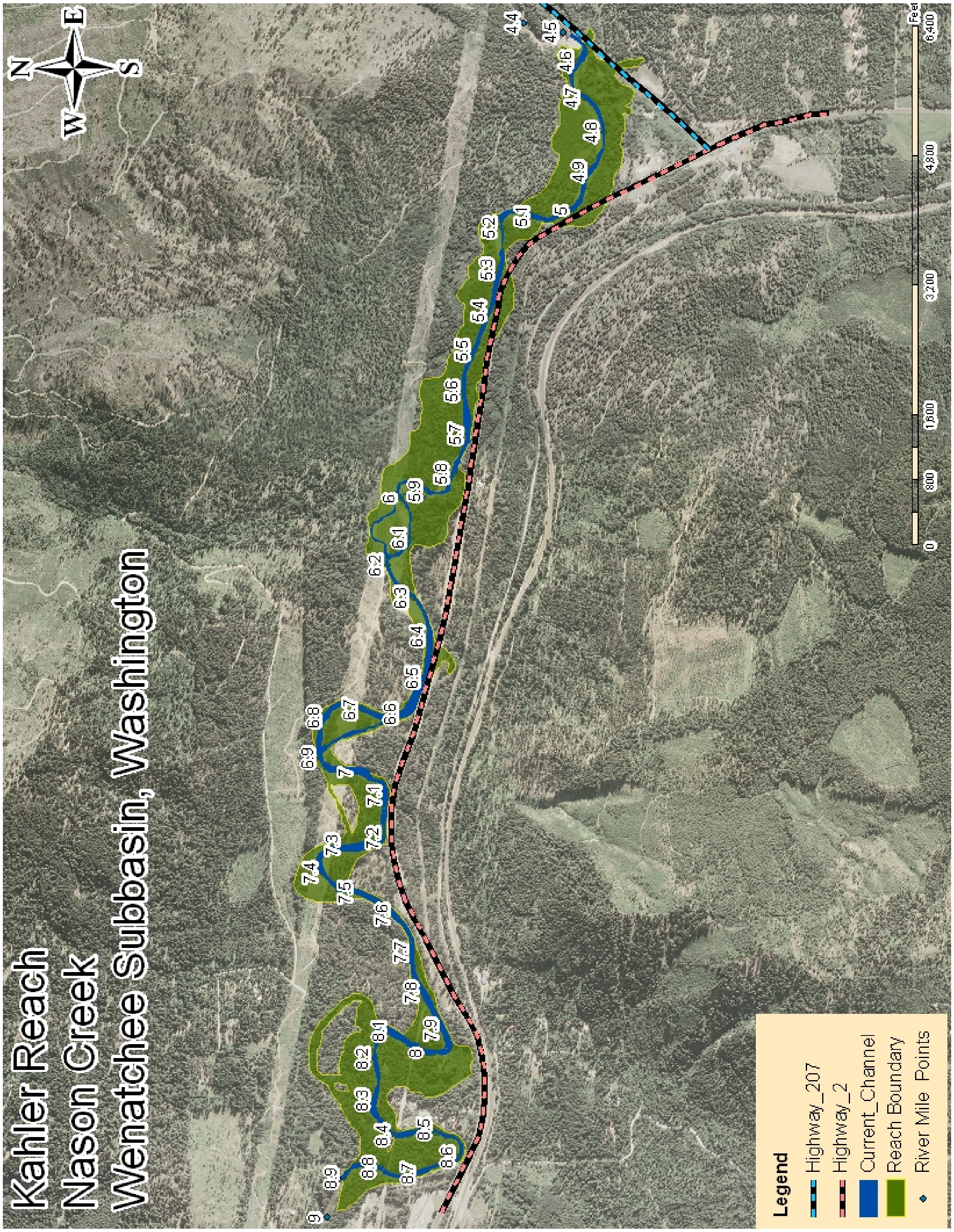

Figure 2 - Inner and Outer Zones of the Kahler Reach, Nason Creek, Wenatchee Subbasin, Washington.

Purpose of the assessment: Refine understanding of geomorphic potential within the Kahler reach and establish environmental baseline conditions to assist in the local selection, implementation, and monitoring of potential habitat actions that will address the limiting factors through the rehabilitation of habitat-forming processes.

Goal of the assessment: Provide sound integrative river science that will assist the local watershed action group in the development of an implementation strategy and aid in project selection. The reach assessment had these objectives:

1) Determine the functional arrangement of physical and biological components of the reach.
2) Establish an understanding of the predominant physical processes.
3) Interpret and document the problems.
4) Propose potential solutions.
5) Develop a recommended prioritization of the subreaches to be utilized by local watershed action groups when developing an implementation strategy and the selection of projects.

This reach assessment establishes environmental baseline conditions in Kahler reach by examining fluvial geomorphic forms and processes (i.e., those landforms and processes that are related to the movement of flowing water) and assessing their influences on forming and maintaining fish habitat at the reach scale. A reach is comprised of smaller scale components that include the active main channel, the floodplain, and off-channel areas which are called subreaches. Subreaches are delineated by lateral and vertical controls with respect to the presence or absence of inner or outer zones (Figure 2). An inner zone (IZ) is an area where ground-disturbing flows take place, such as the active main channel or related side channels (USFS 2008). An outer zone (OZ) is an area that may become inundated at higher flows, but does not experience a ground-disturbing flow. The outer zone, also known as the floodprone width, is typically a terrace that is generally coincidental with the historic channel migration zone except where the channel has been modified or incised, cutting the creek off from the historic floodplain.

The river condition describes the current state of fluvial processes and their relationship to habitat-forming processes. Human features can be analyzed to establish their impacts to the current river condition. Subsequently, the river condition provides a baseline for comparisons in future references. In the instance of the Kahler reach, the habitat-forming processes have been unfavorably impacted, with over 93 percent of the river condition indicators in a degraded condition (i.e., one of the indicators is at unacceptable risk and ten out of twelve are at risk as shown in Table 3). With the exception of habitat access, all other pathways have at least one river condition indicator functioning in an at-risk or unacceptable-risk condition.

This is indicative of impaired habitat-forming processes. Three indicators in particular, large woody debris, pool quality, and floodplain connectivity, are symptomatic of the larger issue of lost geomorphic potential. Reclamation defines geomorphic potential as the capability of adjustment or change in process/structural components of an ecosystem through the combined interaction of hydrologic, riparian, and geomorphic regimes to form, connect, and sustain fish habitat over time.

The geomorphic potential has been altered through the dissection of the floodplain by U.S. Highway 2, Highway 207, riprap associated with both highways, and general development within the reach. The result is a diminished capacity to dissipate stream power; a reduced ability to migrate in subreaches DIZ-1, DIZ-2, DOZ-1, DOZ-2, DOZ-3, DOZ-4, and DOZ-5; and very little off-channel habitat for fish rearing (Figure 3). At low flow, only about 1.5 percent of the habitat area consists of side channels and off-channel habitat. The inability to decrease stream power promotes incision of the channel bed; reduces heterogeneity of channel units; decreases large woody debris recruitment and retention; decreases deposition of spawning gravel; and reduces nutrient supply and storage in the connected inner zones. Impaired channel migration and the disconnection of the floodplain reduce the ability of the stream to rejuvenate ecosystem functions, such as riparian vegetation and substrate throughout the current main channel of the reach.

Over 5 percent of the Kahler reach does not contribute to habitat-forming processes through the interaction of hydrologic, riparian, and geomorphic regimes. Figure 3 shows a prioritization of each subreach unit for the Kahler reach. A dual focus approach would concentrate on both protection and rehabilitation goals necessary for reestablishment of geomorphic potential and healthy stream conditions (Table 3). The rehabilitation goals would address two types of subreaches. The first type addressed by rehabilitation actions are those subreaches that are currently disconnected by the highways or other human features. Subreaches of particular interest include DIZ-1 and DIZ-2, along with historic outer zone areas of DOZ-1, DOZ-2, DOZ-3, DOZ-4, and DOZ-5. The second type of subreach addressed by rehabilitation actions are the outer zones that have impacted habitat units and include subreaches OZ-1 through OZ-19. This cooperative effort could be executed in conjunction with the protection goals that will complement reconnection of the disconnected subreaches and the connected subreaches that lack habitat. Potential habitat actions are identified and prioritized based on several key parameters established in the reach assessment.

A dual focus approach is expected to run in parallel with a measured difference in timing for implementation. Protection goals are a series of potential habitat actions that will complement the reconnection of the disconnected subreaches. Potential protection actions necessary in the short term include land acquisition or lease and stream bank and wetland protection. The rehabilitation goals covering the disconnected subreaches is a long-term enterprise requiring the full cooperation of the State of Washington Department of

Transportation as well as local landowners. Potential rehabilitation actions should be considered as components of a comprehensive strategy to reinitiate habitat-forming processes and include relocation or modification of the highway and/or culverts; unimproved road relocations or removals; small bridge placements; culvert removals, modifications, or replacements; riparian plantings and noxious weed eradication; and instream structures.

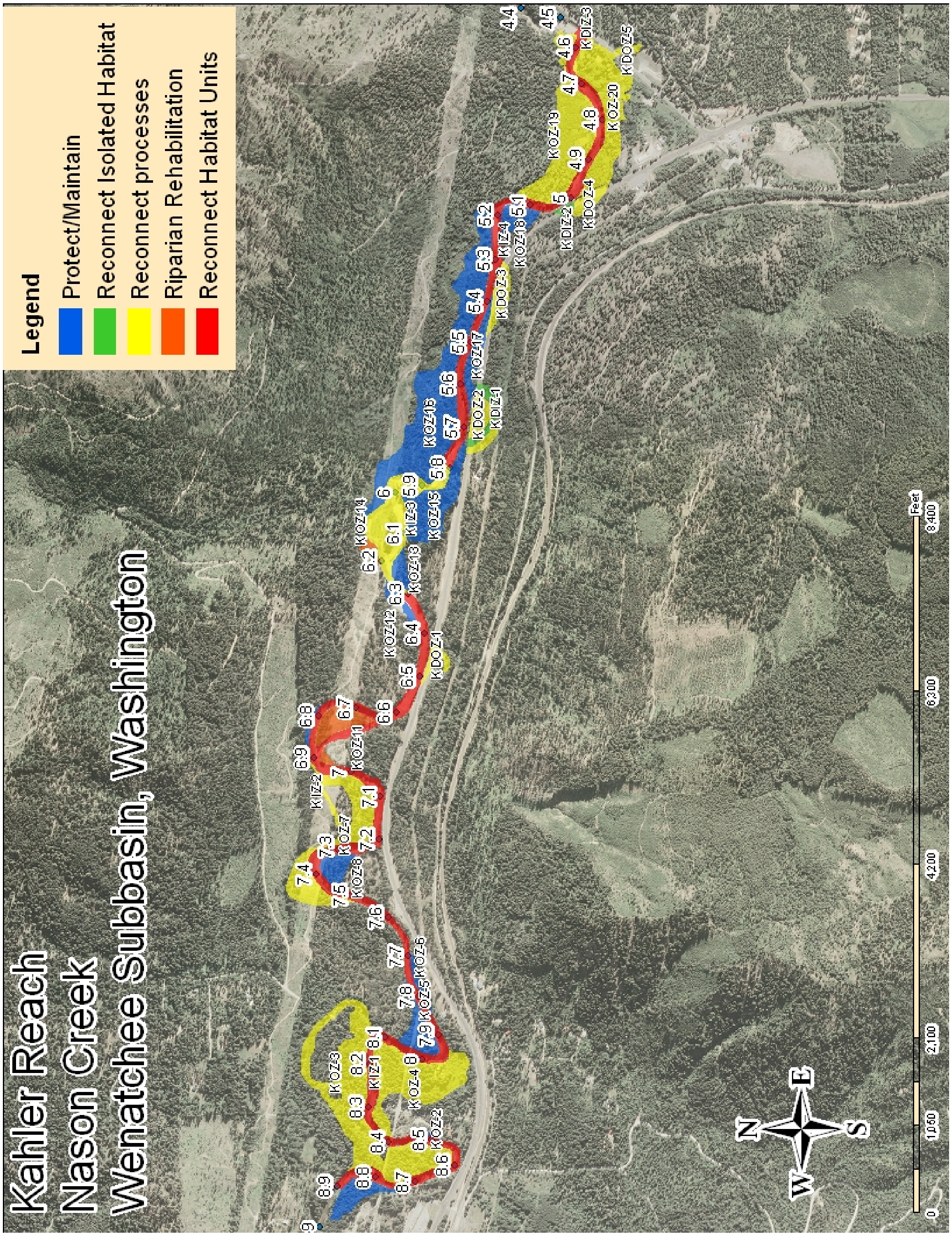

Figure 3 - A spatial representation of a prioritized rehabilitation approach for the Kahler reach by subreach unit.

OVERVIEW

Assessments are hierarchically nested to address the spatial and chronological scales of an ecosystem (Figure 4). Assessments telescope from the largest scale called a basin to a smaller scale called a reach from which habitat actions are implemented. This is called a top-down approach. After implementation of a habitat action, monitoring of the physical and biological variables telescope in reverse from the reach to the basin, called a bottom-up approach, from which intervention analysis or monitoring may be conducted on the status of the species of concern. This nesting approach enables development of an overall understanding of the ecosystem's current and historic conditions and how the species of concern and stream processes such as the creation and maintenance of aquatic habitat have been affected.

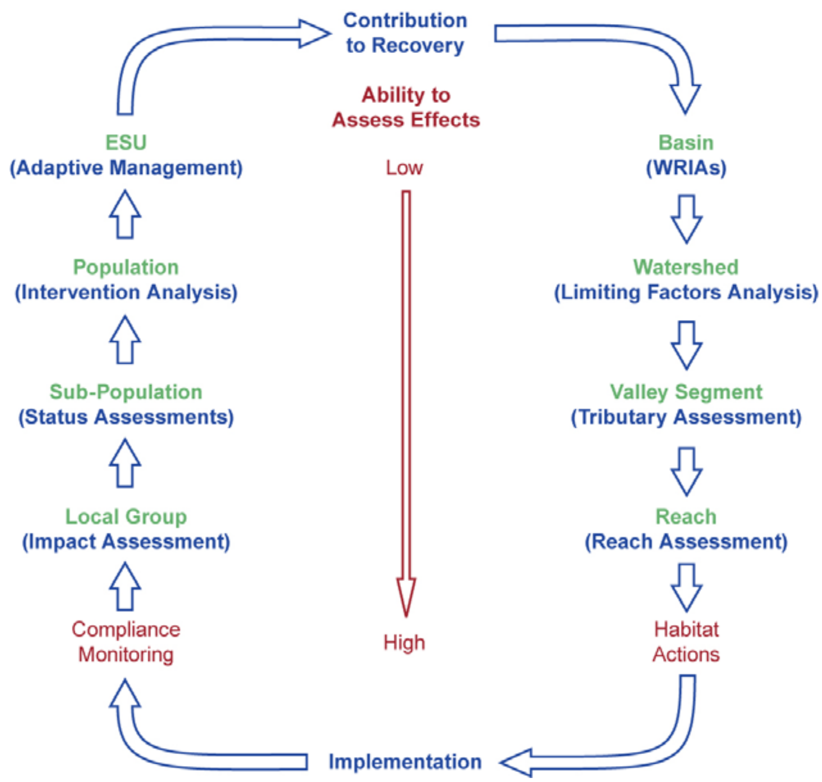

Figure 4 - Idealized model showing how assessments and monitoring are hierarchically nested and related. Clockwise from the top, Compiled from Hillman (2006), UCSRP (2007), and Stewart-Oaten and Bence (2001).

Tributary assessments can be conducted to further analyze impaired stream processes and their effects and to provide a prioritized list of geomorphic reaches based on floodplain or valley confinement (i.e., confined, moderately confined, and unconfined). Not all reaches require a reach assessment. For example, naturally confined reaches that are not severely degraded and pose little risk to property and infrastructure may not need a reach assessment. Reach assessments are generally recommended for moderately to unconfined geomorphic reaches where complex processes have been degraded and where the implementation of habitat actions may pose risks to property and infrastructure. Even in instances where a reach assessment is not conducted, some baseline data should be collected prior to implementing any habitat action so that the action can be monitored for effectiveness.

The purpose of a reach assessment is to refine understanding of the geomorphic potential within a reach and establish environmental baseline conditions at the reach-scale. The reach assessment evaluates the current condition of a group of indicators. The physical variables, which are quantifiable and have geospatial reference, are organized in a reach-based ecosystem indicator matrix (REI). Incorporating quantifiable biological variables into the REI is currently being done by the Bureau of Reclamation (Reclamation). The variables measured in the REI record the baseline environmental conditions and are hierarchical in nature in that they are used as information about the condition of higher-level indicators called pathways. The REI identifies deficiencies in the vegetation, geomorphic, and hydrologic regimes upon which habitat actions can be implemented using a cost effectiveness approach.

Following implementation of a habitat action or series of actions, the action is documented by including what was done, where it was done, and why it was done (i.e., compliance monitoring). After several habitat actions have been implemented in a reach, an impact assessment can be completed using a subset of the physical variables from the REI based on the overall intent of the actions (i.e., reconnect isolated habitats).

Status assessments that document changes to physical and biological variables can be used to evaluate how the ecosystem and the species of concern are responding to the habitat actions. This is known as an intervention analysis to determine if the overall response is positive. If the response is positive, then the actions were effective and there is no need for adjustments. If the response is flat or negative, the habitat actions may need to be adjusted within an adaptive management framework. These checks and balances are intended to improve the habitat of the species of concern and ultimately contribute to their recovery.

PURPOSE AND LOCATION

Reclamation produced this report to help meet tributary habitat commitments contained in the 2008 Federal Columbia River Power System Biological Opinion (NMFS 2008). This report provides scientific information to help identify, prioritize, and implement sustainable field projects in collaboration with Tribal, State, and local partners that improve survival and lead to the recovery of salmon and steelhead listed under the Endangered Species Act (NMFS 2008).

The goal of a reach assessment is to set up local stakeholder processes for project selection based on sound integrative river science, through the following objectives:

- *Determining the functional arrangement of physical and biological components of the response reach.* Establish the geomorphic potential of the river reach through a spatial framework and relevant scaling relationships for the assessment area. This is done through scaling down the response reach to individual subreaches and channel/geomorphic units, which are smaller scale structural components of the reach. Subreach units are comprised of the active main channel, floodplain, and off-channel areas. A local geomorphic regime has inherent constraints and capabilities for forming, connecting, and sustaining aquatic river habitat.
- *Establishing an understanding of the predominant physical processes.* Identify linkages between physical processes and anthropogenic impacts based on the understanding of the key physical processes operating in the reach or within and among the context of subreach units; and identify how these processes have been impacted by past and present human activities.
- *Interpreting and documenting the problems.* Diagnose river conditions at the reach-scale based on integrating physical, biological, and habitat information into an REI. The REI is a diagnostic tool for measuring baseline environmental baseline conditions and identifying deficiencies in three regimes: geomorphic, vegetation, and hydrologic.
- *Proposing potential solutions.* Identify and prioritize potential habitat actions at the subreach scale that support the greatest cumulative biological benefit based on a refined understanding of the geomorphic potential and environmental baseline conditions.
- *Developing a recommended prioritization.* Develop a recommended prioritization of the subreaches based on refined understanding of geomorphic potential and ecosystem conditions to be utilized by local watershed action groups when developing an implementation strategy and the selection of projects.
- *Presenting the results to the local group for project selection.* Use the proposed implementation strategy along with other local factors provided by local stakeholders and partners to discuss a synthesis of all available information and ultimately, an implementation time line.

Nason Creek is a tributary to the Wenatchee River, Chelan County, Washington (Figure 5). A total of three reach assessments on Lower Nason Creek are being completed sequentially based on summer and fall of 2008 field surveys and evaluations. Collectively, the three reach assessments will provide a foundation for a holistic, comprehensive strategy for rehabilitation and protection at the scale of the valley segment (Figure 6).

The Kahler reach is located between river miles (RM) 4.65 and 8.9 on Nason Creek, a 6th field Hydrologic Unit Code (HUC 170100100104) watershed within the Eastern Cascade Section of the Cascade Province (Hillman 2006). The species of concern found in Nason Creek include Upper Columbia River (UCR) spring Chinook salmon (*Oncorhynchus tshawysha*), UCR steelhead (*Oncorhynchus mykiss*), and Columbia River bull trout (*Salvelinus confluentus*) (UCSRB 2007).

Limiting factors at the watershed scale that are the result of various anthropogenic impacts include riparian condition, streambank condition, channel function, floodplain connectivity, water quality, habitat diversity, and large woody debris (Andonaegui 2001; UCSRB 2007; UCRTT 2007).

The Upper Columbia Spring Chinook Salmon, Steelhead, and Bull Trout Recovery Plan identified potential restoration strategies based on a combination of available data, aquatic ecosystem modeling, and professional judgment of a panel of scientists (UCSRB 2007). Further technical evaluation was recommended to refine the level of detail needed to implement projects and determine if the recommendations are sustainable and compatible with the geomorphic conditions of the river. Regarding physical processes, the Upper Columbia Salmon Recovery Board (UCSRB) recommends conducting additional research to identify priority locations for protection and rehabilitation and examining fluvial geomorphic processes to assess how these processes affect habitat creation and maintenance. This reach assessment is intended to address those recommendations.

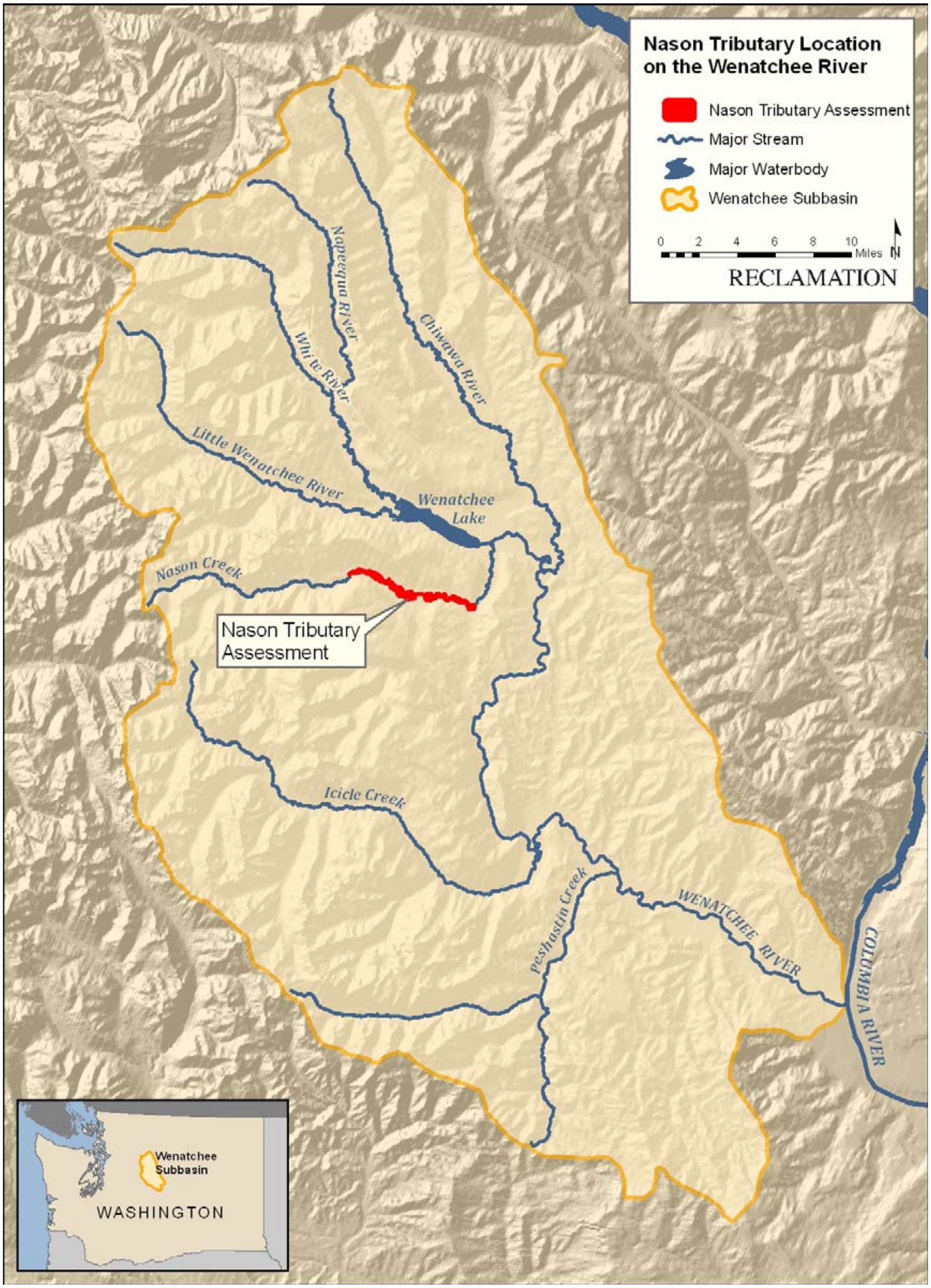

Figure 5 - Location map of Nason Creek within the Wenatchee subbasin. The section in red notes the valley segment that was examined in the tributary assessment.

Figure 6 - Location map with river miles for the three response reaches identified in the Nason Creek Tributary Assessment, Chelan County, WA.

TRIBUTARY ASSESSMENT

Previously identified watershed-scale limiting factors are typically the result of various anthropogenic impacts and include riparian condition, streambank condition, channel function, floodplain connectivity, water quality, habitat diversity, and large woody debris (Andonaegui 2001; UCSRB 2007; UCRTT 2007). The *Upper Columbia Spring Chinook Salmon, Steelhead, and Bull Trout Recovery Plan* (UCSRB 2007) has identified potential restoration strategies based on a combination of available data, aquatic ecosystem modeling, and the professional judgment of a panel of scientists. The Plan recommends refinement of existing data and/or the collection data at the appropriate scale that will allow habitat actions to be implemented.

The Nason Creek Tributary Assessment, *Chelan County*, *Washington* (Tributary Assessment) was completed by a multidisciplinary team of hydraulic engineers, geologists, hydrologists, biologists, and botanists (Reclamation 2008). The focus of the Tributary Assessment was to complete a comprehensive geomorphic analysis of the fluvial system along about 10 miles of Nason Creek located in the Wenatchee subbasin in Chelan County, Washington (Figure 5).

The objectives of the Tributary Assessment were to (1) delineate and characterize channel reaches on the basis of their geomorphic characteristics and biological opportunities and develop potential rehabilitation strategies organized on a reach-based approach; (2) provide technical ranking of the geomorphic reaches that can be used to prioritize the potential habitat protection and improvement areas within the assessment area based on linkage to primary limiting factors for salmon recovery; (3) identify the recurrence intervals of natural and human-induced disturbances and how they affect channel processes within the assessment area; and (4) evaluate the habitat-forming physical processes and disturbance regimes working at the subbasin and reach scales from both historical and contemporary context (Reclamation 2008).

At the tributary scale, three reaches were delineated and characterized into two general geomorphic reach types based on natural channel constraints, referred to as confined and unconfined geomorphic reaches (a third geomorphic reach type, moderately confined, was not encountered; see Table 1). The unconfined and confined reaches were ranked based on their geomorphic potential. The confined reach identified as Reach 2 in the Tributary Assessment was not assessed. The White Pine reach had the higher geomorphic potential and the largest impact from anthropogenic features within the low surface (i.e., more departed from a natural condition). The Lower White Pine and Upper White Pine reach assessments were completed in February and March 2009 respectively for the White Pine reach.

The White Pine reach was initially identified as geomorphic reach 3 in the Tributary Assessment. Refined mapping and analysis performed for this reach assessment further delineated this area into two response reaches, the Upper and Lower White Pine, that are separated by a confined reach (reach 4) located at river miles 11.55 to 12.0 (Table 1).

Table 1 - Geomorphic Reach and response reach location by river mile, reach type, and floodplain area for Upper Nason Creek between RM 4.5 and RM 14.3 (Reclamation 2008).

Geomorphic Reach Designation (Reclamation 2008)	Reach Assessment Name	River Miles	Reach Type	Total Floodplain Area (Approximate Acres)
Reach 1	Kahler	4.5 - 8.9	Unconfined	about 221
Reach 2	Reach 2	8.9 - 9.42	Confined	about 14
Reach 3	Lower White Pine	9.42 - 11.55	Unconfined	about 229
	Reach 4	11.55 - 12.0	Confined	
	Upper White Pine	12.0 - 14.25	Unconfined	about 135

Within the Kahler reach, there has been no large-scale change to the balance between incoming water and sediment loads that would indicate a potential for incision or aggradation (Reclamation 2008); however, several sections of the river within the reach have been artificially straightened and confined by bank hardening. Highway 2 disconnects Nason Creek from its tributaries. The absence of sediment that would have been provided indicates a potential for increased sediment transport capacity and possible incision.

The largest impact to physical processes and habitat is the Highway 2 realignment and widening in the 1960s. The impacts of these features include channel straightening and relocation, reduced channel migration, reduced floodplain connectivity, altered sediment and large woody debris delivery and retention, and disconnected tributaries and groundwater sources from the main channel. Bridges, small levees, and the power line corridor also impact physical processes, but to a more localized degree.

The Kahler reach assessment provides the recommended technical evaluation to refine the level of detail necessary for selecting and implementing potential habitat actions. The reach assessment establishes environmental baseline conditions tied into a geospatial reference. This is done through an in-field evaluation of fluvial geomorphic form and processes. In turn, this reach-based baseline can be used to assess the influence and feedback on habitat formation and maintenance over time.

REACH CHARACTERIZATION

The Kahler reach encompasses about 221 acres of floodplain and active channel of Nason Creek within an alluvial valley from RM 4.55 to 8.9. The current channel and active floodplain are located to the north of Highway 2 (Figure 7). The valley bottom is classified as a U-shaped trough with a valley bottom gradient of less than 1 percent and a slightly confined, moderately sinuous channel (Naiman et al. 1992). The stream type is C and F type (Rosgen 1996) showing evidence of slight to moderate incision with predominantly riffle and run bedform (Montgomery and Buffington 1993) and cobble as the dominant substrate. Landforms typically include alluvial and glacial deposits comprising terraces and alluvial fans (Hillman 2006). Alluvial fan and terrace deposits with large substrate provide lateral and vertical channel controls.

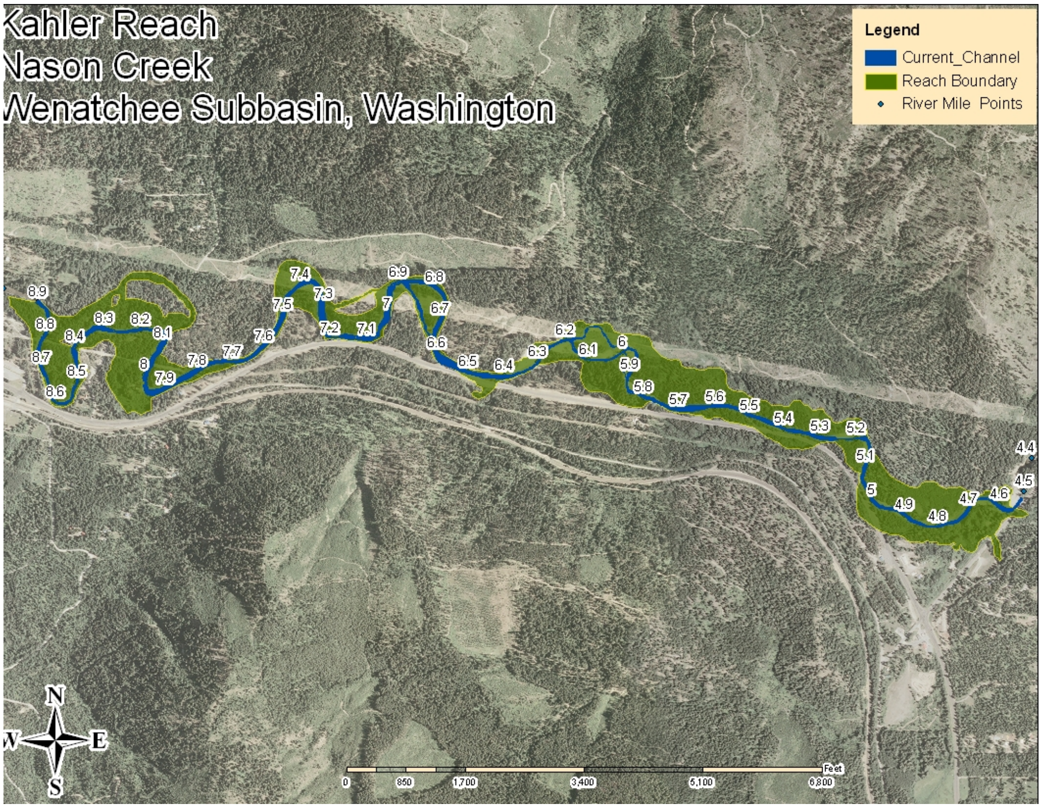

Figure 7 - Refined reach delineation and boundary conditions of the Kahler Reach.

Table 2 - Acres by zone type on the Kahler reach, Nason Creek, Wenatchee Subbasin, Washington.

Inner Zone	Connected Outer Zone	Disconnected Outer Zone	Disconnected Inner Zone
60 Acres	147 Acres	11 Acres	3 Acres

The reach is comprised of the active main channel, floodplain, and off-channel areas. The reach was further broken down into two types of morphologically distinct areas or subreach unit types to denote greater local control and variability. Called inner and outer zones, these subreach unit types essentially represent areas of existing and potential habitat formation and maintenance within the response reach. Subreaches are delineated by lateral and vertical controls based on the presence/absence of inner or outer zones processes (Figure 8). An inner zone (IZ) is characterized by the presence of primary and secondary side channels, a repetitious sequence of channel units, and relatively uniform physical attributes indicative of localized transport, transition, and deposition. It is generally associated with ground-disturbing flows with sufficient frequency that mature conifers are rare and a distinct hardwood zone is identifiable (USFS 2008). In the instance of the active main channel, it was further subdivided into six inner zones based on the mapping of channel units (Figure 9 and Figure 10).

In contrast, an outer zone (OZ) also known as the floodprone width, is typically a terrace tread and generally coincidental with the historic channel migration zone unless the channel has been modified or incised leading to the abandonment of the floodplain. This zone includes overflow channels, wetlands, and other off-channel habitat and is usually predominated by riparian vegetation and hillslope processes. An outer zone is further distinguished from an inner zone by the presence of flood deposits, a change in vegetation, and bounding geologic landforms such as an older terrace, bedrock or valley wall, alluvial fan, colluvium, or glacial deposits.

The highway disconnects sections of inner and outer zones from the active channel and floodplain that total about 3 percent of the total reach area. Table 2 summarizes the number of acres in the inner and outer zones.

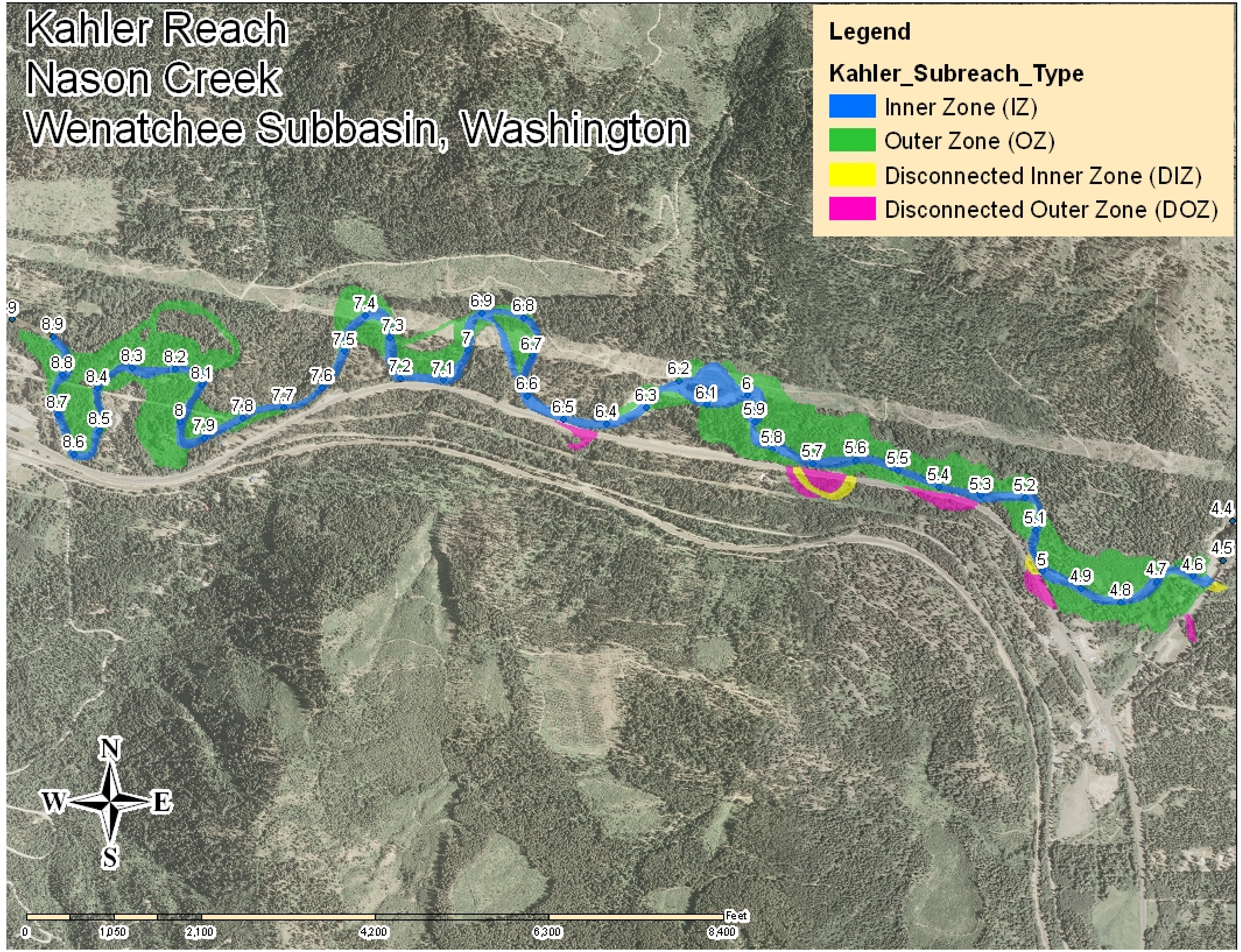

Figure 8 - Image showing Inner and Outer Zones of the Kahler Reach, Nason Creek, Wenatchee Subbasin, Washington.

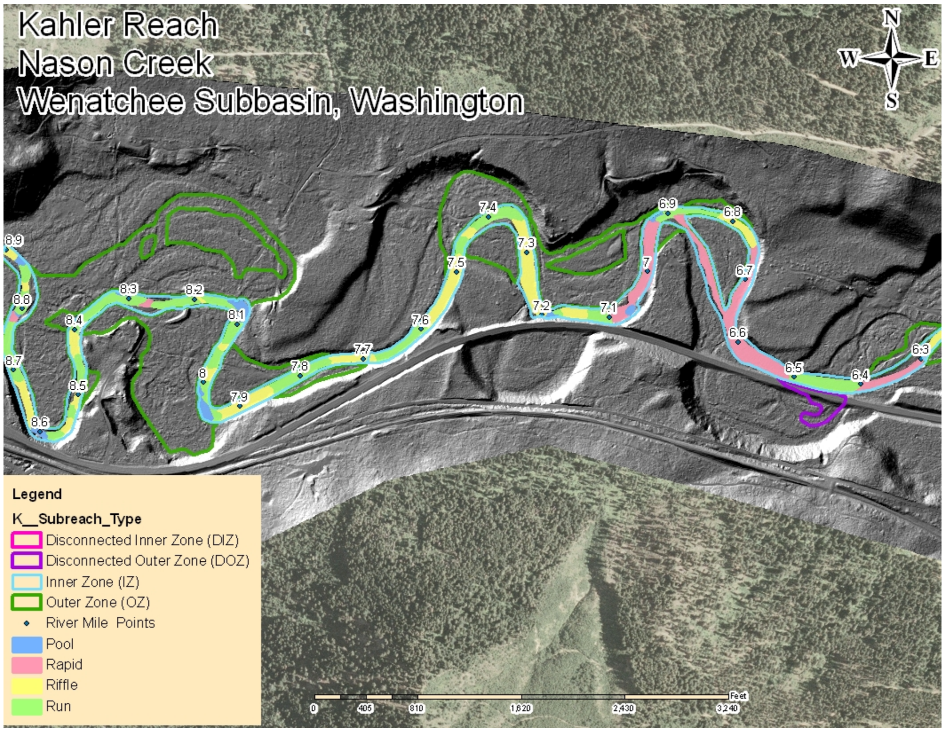

Figure 9 - Channel unit mapping of the upper portion of the Kahler Reach including subreach unit boundary conditions.

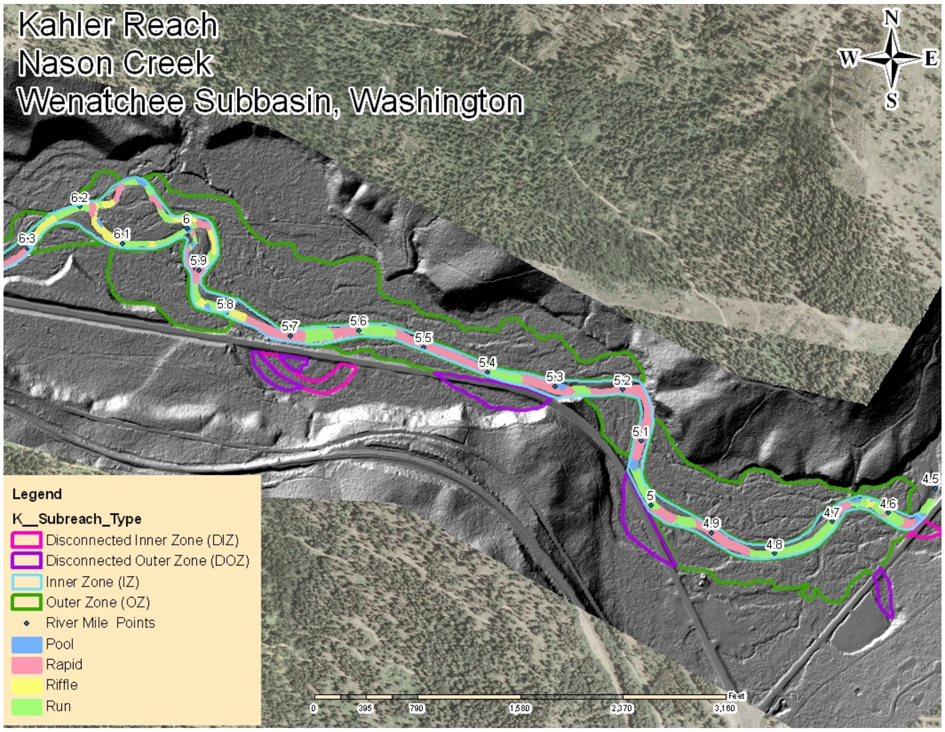

Figure 10 - Channel unit mapping of the lower portion of the Kahler Reach including subreach unit boundary conditions.

RIVER REACH CONDITION

The river reach condition is a combination of all information available at the time of the investigation. The REI matrix is a compilation of the information and data collection from multidisciplinary analyses that were conducted prior to or during this investigation (Appendix A). Specific data collected and documented within separate disciplinary analyses are the Initial Site Evaluations (Appendix B), Level 2 Habitat Assessment (Appendix C), and two-dimensional (2D) Hydraulics and Sediment Analysis (Appendix H, Reclamation 2008). The biological ranking of the subreaches was performed by the Upper Columbia Regional Technical Team (RTT) subcommittee (Appendix G).

River condition limiting factors are determined by measuring and synthesizing results from indicators within five pathways: water quality, habitat access, habitat quality, channel dynamics, and riparian vegetation. The indicators measured in the REI record baseline environmental conditions which are indicative of the condition of higher-level indicators such as pathways. The synthesis of the collected information provides a “snapshot” understanding of the combined condition of the geomorphic, riparian vegetation, and hydrologic regimes. In turn, this information is used to develop an overall interpretation of reach-based river conditions with respect to the primary limiting factors.

Based on the best available information and measurements from the field evaluation, each indicator was determined as functioning at one of three conditions: adequate, at risk, or unacceptable risk, based on criteria contained in the REI. Table 3 shows the results of the REI.

Table 3 - Summary results of the reach-based ecosystem indicators (REI) for the Kahler reach. Each indicator was interpreted to be in one of three conditions: *adequate*, *at risk*, or *unacceptable risk*.

Pathway	Reach-based Indicator (REI)	Condition
Water Quality	Temperature	Unacceptable Risk
	Turbidity	At Risk
	Chemical Contaminants/Nutrients	At Risk
Habitat Access	Physical Barriers	Adequate
Habitat Quality	Substrate	At Risk
	LWD	At Risk
	Pool Frequency and Quality	At Risk
	Connectivity w/ Main Channel	At Risk
Channel Condition and Dynamics	Floodplain connectivity	At Risk
	Bank Stability/Channel Migration	At Risk
	Vertical Channel Stability	At Risk
Riparian Vegetation	Structure	At Risk
	Disturbance	At Risk
	Canopy Cover	At Risk

The following are summary results of reach-based conditions:

- 1 of the 14 indicators is at unacceptable risk.
- 12 of the 14 indicators are at risk.
- 1 of the 14 indicators is adequate.

Limiting factor indicators should be monitored to gauge the response of the creek to the implemented actions. The assessment team suggests that monitoring these indicators may provide pro-active opportunities to maintain or improve the overall ecosystem resiliency of the Kahler response reach.

Following implementation of a habitat action or series of actions, the action is documented by including what was done, where it was done, and why it was done (i.e., compliance monitoring). After several habitat actions have been implemented in a river reach, an impact assessment can be completed using a subset of the physical variables from the REI based on the overall intent of the actions such as reconnection of isolated habitats.

At the reach scale, the ability to assess both the physical and biological effects of the actions is considered high (Hillman 2006). Improvements made to physical variables coupled with the biological variables (i.e., status and trend) can be used to evaluate the ecosystem's response and whether the species of concern are responding. If the response is positive, the actions were effective and there is no need for adjustment. If the response is flat or negative, adaptive management may be needed for implementation of additional habitat actions to achieve the desired effect. These checks and balances are intended to improve fish habitat upon which the species of concern depend for their recovery.

Water Quality

The condition of the water quality pathway throughout the reach is at risk based on indicators of temperature, turbidity, and chemical contaminants. Temperature is at unacceptable risk, due to the replacement of bank vegetation with riprap within the reach, along with upstream factors and contributions (Thomas 2007). Temperature surveys indicated the stream fluctuates from 18.4° C to 14.8° C upstream of the Kahler reach (Watershed Sciences 2003). Cooling was noted around the area of White Pine campground, but temperatures increased steadily downstream to the Wenatchee River (Watershed Sciences 2003). Turbidity issues stem from increased timber harvest roads and development (UCSRB 2007). The indicator of chemical contaminants and nutrients is interpreted to be at risk due to current water use or withdrawals upstream.

Although the water quality pathway and the associated indicators are an issue at the watershed scale, impacts to the indicators can be attributed to acute problems observed at the subreach scale within the Kahler reach. For example, by drawing a 10-meter buffer zone along the banks of the channel, the condition of canopy cover for shading can be quantified by looking at the seral stage and composition of the riparian vegetation. Subreaches OZ-7, OZ-9, OZ-11, and 0Z-14 with greater than 20 percent disturbed vegetation likely contribute to the temperature issue. Given the overall young seral stage, those subreaches likely contribute to the at-unacceptable-risk condition of temperature to varying degrees. Subreaches DIZ-1 impounds runoff and groundwater behind the highway. That impounded water will likely increase in temperature before it enters the main channel if inadequate shading exists along the perimeter of the wetlands. Upon entering the main channel, the impounded water contributes to the temperature condition of the reach.

Habitat Access

The condition of the habitat access pathway is adequate given that there are no barriers on the mainstem.

Habitat Quality

The habitat quality pathway is at risk due to the following conditions: (1) lack of large woody debris in the channel; (2) pool quality; and (3) culverts placed through the highway embankments to drain runoff water and base flow. The culverts do not provide adequate fish passage to isolated pockets of habitat.

Multiple subreaches contribute to an at-risk condition for habitat quality through the indicator of large woody debris in the channel. The connected inner zones IZ-1, IZ-2, IZ-3, and IZ-4 contribute through a low large woody debris count. Subreach inner zone IZ-3 was noted to have higher large woody debris counts, but it was concentrated in four complexes at RM 5.3, RM 7.0, and RM 6.2 where two were located (Appendix C). Disconnected subreaches DIZ-1, DIZ-2, DOZ-1, DOZ-2, DOZ-3, DOZ-4, and DOZ-5 cannot contribute large woody debris to the system. Low in-channel wood counts and diminished amounts of large wood available for recruitment from the subreaches listed above contribute directly to an at-risk pool frequency and quality condition within the inner zones. The indicator of connectivity with the main channel is impacted in the disconnected subreaches DIZ-1, DIZ-2, DOZ-1, DOZ-2, DOZ-3, DOZ-4, and, DOZ-5 where anthropogenic features including the highway disconnect existing habitat from the current channel and/or where culverts do not allow access to off-channel habitat at base flow.

Channel Dynamics

The channel condition and dynamics pathways are at risk. The impacts on floodplain connectivity of Highway 2 have been well documented (Andonaegui 2001; UCSRB 2007; UCRTT 2007). Bank stability and channel migration are affected by Highway 2, but are also impacted by bank hardening with riprap and clearing of riparian vegetation.

The current channel and floodplain are to the north of Highway 2. The highway disconnects fluvial processes in one inner and multiple outer zones of the active channel and floodplain that total about 3 percent of the reach. The disconnection of fluvial processes results in a reduction of lateral channel migration and floodplain connectivity. Subreaches that contribute to the at-risk condition of the floodplain connectivity indicator are the disconnected subreaches DIZ-1, DIZ-2, DOZ-1, DOZ-2, DOZ-3, DOZ-4, and DOZ-5. Subreach inner zones IZ-1, IZ-2, IZ-3, and IZ-4 contribute to an at-risk condition for the bank stability and channel migration indicators. Where the active channel is channelized, or banks of the inner zone are hardened with riprap, no lateral migration occurs. This increases the potential of vertical migration. Observations were made of accelerated channel migration at locations where riprap is not present and riparian vegetation is removed along banks.

Riparian Vegetation

The riparian vegetation pathway is at risk. Although the riparian composition at the floodplain width may have a high percentage of native species, the available large wood is only about 30 percent for the entire reach. The riparian disturbance indicator is at risk given that about 11 percent of floodplain vegetation has been disturbed by way of clearing and/or modification to some degree. The percentage of mature or late seral stage vegetation in the 30-meter buffer is acceptable only in one outer zone, thus large wood recruitment potential is impaired (USFS 2008).

The indicator of canopy cover is also at risk. About 12 percent of the vegetation in the 10-meter buffer zone is large diameter (Hillman 2006). The common factor with all three indicators is a low percent of large diameter trees (USFS 2008). Additionally, the disconnected inner and outer zone subreaches DIZ-1, DIZ-2, DOZ-1, DOZ-2, DOZ-3, DOZ-4, and DOZ-5 have disturbed vegetation that is greater than 20 percent of the total area of the subreach.

DISCUSSION

The river condition describes a baseline or current condition of fluvial processes and their relationship to habitat-forming processes. Human features can be placed within a context when using current river condition to establish their impacts. In the instance of the Kahler reach, the diagnosis is not favorable with over 93 percent of the indicators in either an at-risk or unacceptable-risk condition. With exception of habitat access, all other pathways possess at least one indicator with observed degraded condition of at risk or unacceptable risk. Three indicators in particular, large woody debris, pool quality, and floodplain connectivity, are symptomatic of a larger issue of lost geomorphic potential or the potential for geomorphic regime change. Geomorphic potential is essential in forming, connecting, and sustaining fish habitat because of the combined influence of hydrologic, riparian, and geomorphic regimes over time.

The multiple functions associated with all three regimes have been impacted through the dissection of the floodplain by Highway 2, hardening of the banks with riprap, and disturbance of vegetation. These features have reduced the overall width of the available floodplain, length of the stream channel, and fluvial-riparian interactions. The result is a diminished capacity to dissipate stream power and a reduced ability to migrate in the subreaches. The outcome is very little off-channel habitat exists for rearing fish. At low flow, only about 1.5 percent of the habitat area consists of side channels and off-channel habitat. An increase in stream power promotes incision, reduces the diversity of channel units, decreases large woody debris recruitment, decreases spawning gravel and large woody debris retention, and reduces nutrient supply and storage in the connected inner zones.

Impaired channel migration and the disconnection of the floodplain reduce the ability of the stream to rejuvenate ecosystem elements, such as riparian vegetation and substrate, throughout the current main channel of the reach.

Typically, unconfined geomorphic river reaches have flatter slopes and a complex network of channels and large woody debris that result in a high degree of interaction between the active channel and the floodplain. Prior to human impacts, Lower Nason Creek maintained dynamic equilibrium by actively migrating laterally across its floodplain within the Kahler reach. This lateral channel migration helped the river maintain a flatter channel profile as sediment was stored on the floodplain before being eroded and transported down gradient. The result was a dynamic cycle of conversion from river to floodplain and vice versa and with it, continual renewal of fish habitat.

In a properly functioning system, the average channel bed elevations within the reach do not change over time so that there is no net change in the total volume of sediment stored in the reach beyond a natural range of fluctuation (Reclamation 2008). Lateral channel migration and floodplain connectivity are especially critical in the Kahler reach to maintain the following at optimal levels that will create, maintain, and rejuvenate habitat:

- Riparian structure and composition
- Groundwater recharge
- Water temperature
- Stream power
- Large woody debris recruitment and retention
- Spawning gravel recruitment and retention
- Nutrient supply and storage

On Lower Nason Creek, impacts to the overall hydrologic regime have resulted in an increase in stream power that gives rise to transport as the dominant process, over-all similarity of channel units, and lack of channel complexity at the reach scale. At the subreach scale, subreaches where transition-to-deposition is the dominant process alternate between longer subreaches of transportation. Within the transport subreaches, the bed load is hypothesized to become mobile when flows are increasing and deposited when flows are decreasing with the ultimate result being plane-bed features. Conversely, it is hypothesized that the mobilized bed load from the transport reaches deposits in the smaller subreaches where transition-to-deposition is the dominant process during the increasing flows. As runoff flows decrease, the newly deposited bed material is then incised, resulting in tall bars and only moderate change of form.

The loss of riparian function within all subreaches at the floodplain width and within the 30-meter and 10-meter buffer zones has both direct and indirect impacts to multiple pathways. At the floodplain width, an overall young seral stage indicates a risk to ecosystem health. At the 30-meter buffer zone, high percentages of disturbed or removed vegetation and limited existing large diameter trees create a decreased large woody debris recruitment potential, thus a lack of large woody debris in the system. The same conditions within the 10-meter buffer zone reduce shading potential which ultimately promote elevated water temperatures. Another contributing factor to an increase in water temperature in the main channel is due to the impounding of surface water behind the highway in subreach DIZ-1.

Overall, ecosystem processes in the Kahler reach are in a degraded state as a result of human impacts. Rehabilitation activities, consisting of both potential protection and rehabilitation actions, are recommended to prevent further degradation of the river ecosystem. Where restoration is the ultimate aim in many instances, a more measured approach is sometimes necessary due to multiple natural and human-made constraints (Figure 11). Rehabilitation provides an approach that is consistent with restoration objectives to return critical river ecosystem function to a pristine condition (UCSRB 2007). In addition, rehabilitation is incremental and iterative in nature to accommodate the notion that complete restoration may not be possible due to structural limitations and disturbance regimes. Potential protection and rehabilitation actions specific to this river reach should be prioritized with the following objectives based on Table 5.9 in the *Upper Columbia Spring Chinook Salmon, Steelhead, and Bull Trout Recovery Plan* (UCSRB 2007).

Many authors have documented strategies that emphasize restoring processes that form, connect, and sustain habitats (Beechie et al. 1996; Kauffman et al. 1997; Beechie and Bolton 1999; Montgomery and Bolton 2003; UCRTT 2007). Habitat actions of this nature often occur at the site or reach scale. Roni et al. (2002) introduced a hierarchical strategy that places site-specific actions within a watershed context. The Reclamation reach assessment and previous objectives purposely feed into this strategy by further telescoping options through several additional filters or layers of consideration at the reach scale. This so-called stratified strategy can be used to prioritize potential habitat actions within a geomorphic reach context based on the *Upper Columbia Spring Chinook Salmon, Steelhead, and Bull Trout Recovery Plan* (UCSRB 2007) objectives and reach assessment results by beginning with protection and transitioning through several forms of active rehabilitation.

The hierarchical implementation strategy, which is illustrated in Figure 12, is tied to a corresponding gradational color scheme (Table 4) and used throughout the Subreach Unit Profile section to assist with correspondences throughout the project selection process. A subreach unit is recommended for protection actions where visual field evidence shows that

80 percent or more of the indicators are functioning adequately. A subreach unit is recommended for rehabilitation, where visual field evidence shows that less than 80 percent of the indicators are functioning adequately (i.e., the indicators are either at risk or are at unacceptable risk).

However, the stratified strategy does not consider landowner willingness, construction feasibility, costs, and other local considerations. There are alternative methods that can be used to sequence project selection (i.e., degree of departure, landowner willingness, and construction costs) that can be factored in along with the results of reach assessment.

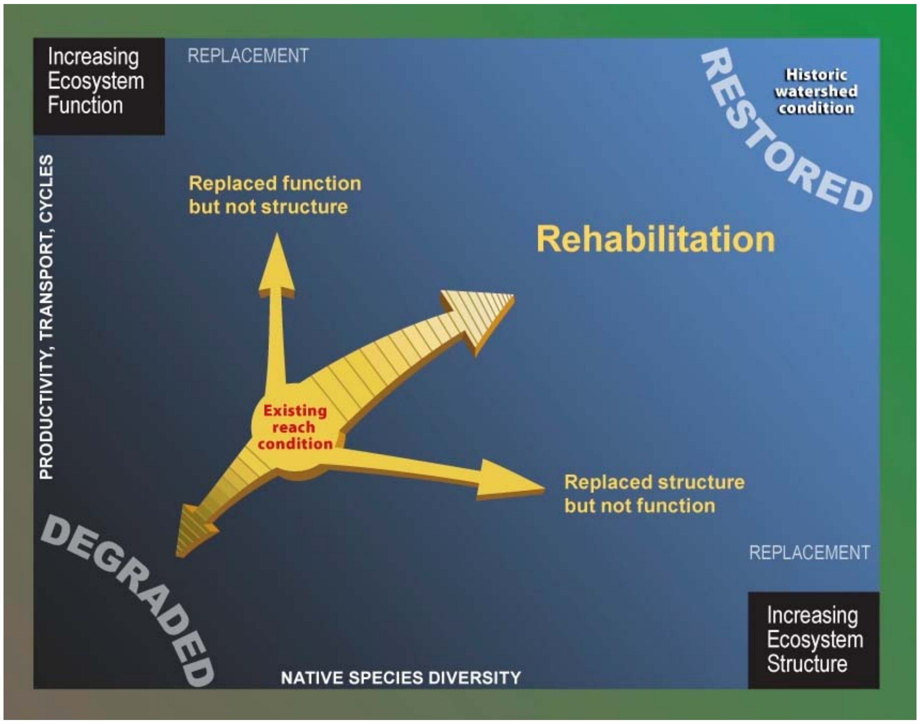

Figure 11 – Responses to Reach Assessment Actions. Through time, land development and management activities lead to altering natural flows that sustain balance and ultimately, the condition of an ecosystem. Healthy aquatic stream ecosystems by nature are resilient and able to cope with impacts through feedback and adjustment. Rehabilitation offers the opportunity to resurrect balance and redirect stream aquatic habitat on a resilient course once again.

Table 4 - Definitions for reach conditions, which are tied into the hierarchical implementation strategy in Figure 12. The stratified strategy is used to filter results of the reach assessment to illustrate the differential responses expected for potential habitat protection and rehabilitation actions. Note corresponding gradational color scheme.

Protect/Maintain Processes: off-channel and riparian areas such as wetland, channel network, side channel, and riparian buffers possessing "adequate" ecological conditions and a present high or a potential high biological benefit.
Protect/Reconnect Isolated Habtats: off-channel and riparian areas possessing "adequate" ecological condition, but are fagmented by anthropogenic disturbances.
Reconnect Processes (Long-term): through regaining of channel dynamics and riparian interactions for areas possessing "adequate" or "at risk" ecological conditions that have a present high or potential high biological benefit.
Reconnect Processes and Habitats: through the regaining of channel dynamics and riparian interactions for areas possessing "at risk" ecological conditions that have a moderate to low present or high potential biological benefit.
Reconnect Habitat Units (Short-Term): through in-channel replacement of wood and rock habitat features or structures.

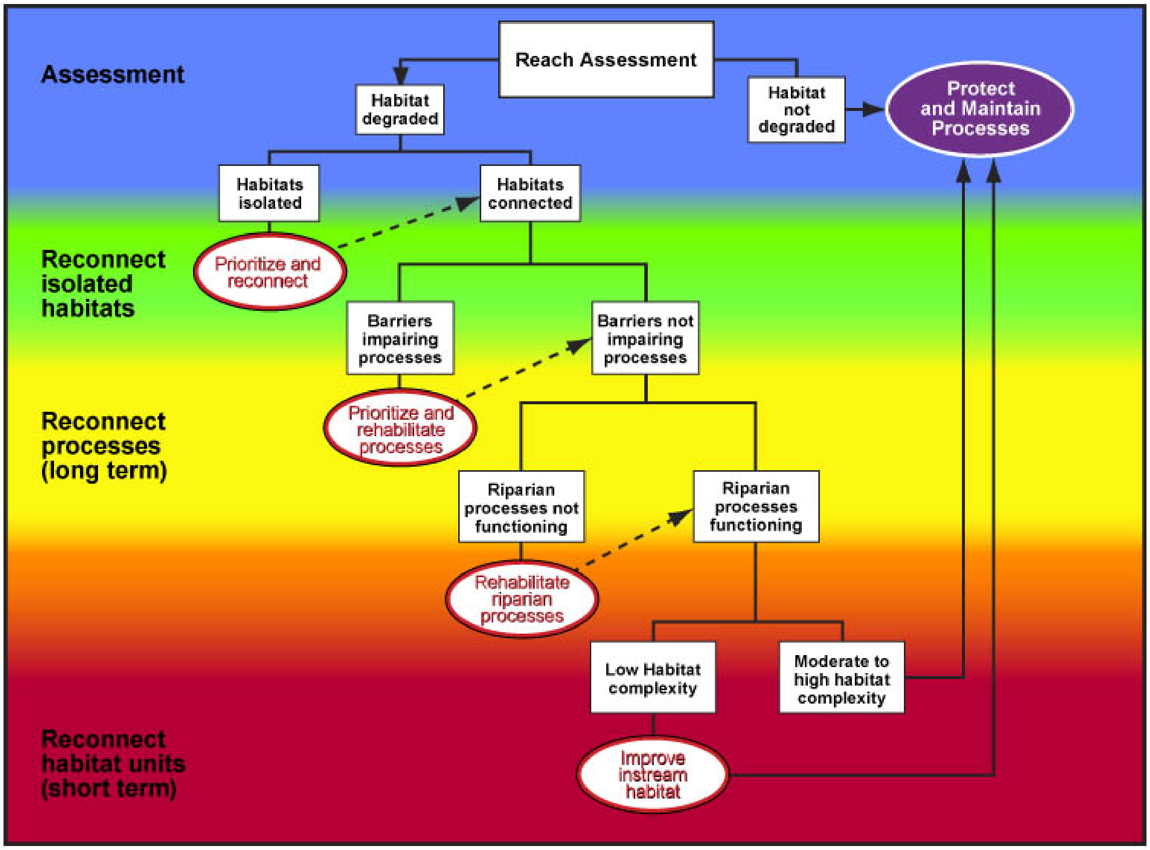

Figure 12 – Implementation strategy for prioritizing potential habitat actions from protection-to-rehabilitation at the reach scale. Individual ovals indicate decisions and their interconnectivity correspond to stratified interrelationships (adapted from Roni et al. 2005).

Geomorphic potential is essential for habitat-forming processes. Geomorphic potential is the combined influence of water, sediment, and large woody debris in forming, connecting, and sustaining fish habitat. Where 6 percent of the Kahler reach does not contribute to habitat-forming processes due to a disconnection of floodplain and riverine processes, a dual-track rehabilitation approach is necessary to reestablish geomorphic potential and with it healthy river conditions (Table 5). Figure 13 offers a spatial representation of a prioritized rehabilitation strategy for the Kahler reach. The dual focus approach would concentrate on both protection and rehabilitation goals necessary for reestablishment of geomorphic potential and healthy stream conditions (Table 3). Subreaches that are candidates for protection include OZ-1, OZ-2, OZ-5, OZ-6, OZ-8, OZ-10, OZ-12, OZ-13 and OZ-15 through OZ-18, all of which already offer form and connectivity. Rehabilitation goals would address two types of subreaches. First are those subreaches that are currently disconnected by the highway or other human features. Subreaches of particular interest include DIZ-1 and DIZ-2, along with adjacent historic outer zone areas of DOZ-1, DOZ-2, DOZ-3, DOZ-4, and DOZ-5. The second type of subreach addressed with rehabilitation goals is the reconnection proesses and of isolated habitat units within impacted inner zones. Specific subreaches of particular interest include OZ-3, OZ-4, OZ-7, OZ-20, IZ-1, IZ-2, IZ-3, and IZ-4. This cooperative effort could be executed in conjunction with the protection goals that will complement reconnection of the disconnected subreaches and the connected subreaches that lack habitat. Potential habitat actions are identified and prioritized based on several key parameters established in the reach assessment.

A dual focus approach is expected to run in parallel with a measured difference in timing for implementation. Protection goals are a series of potential short-term habitat actions that will complement the reconnection of the disconnected subreaches. Potential protection actions necessary in the short term include land acquisitions or lease and stream bank and wetland protection (UCRTT 2009). The rehabilitation goals covering the disconnected subreaches is a long-term enterprise requiring full cooperation of the State of Washington Department of Transportation as well as local land owners. Potential rehabilitation actions should be considered as a component to a comprehensive strategy to reinitiate habitat-forming processes and include culvert removals, modifications, or replacements; small bridge placements; riparian plantings and noxious weed eradication; and road relocations or removals.

Subreach	Acres	Restoration Strategy	Time Frame IT	Time Frame ET	Justification
K OZ-16	30	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-15	8	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-5	4	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-1	4	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-17	3	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-18	3	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-8	3	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-12	2	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-13	2	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-6	1	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-10	1	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K OZ-2	<1	Protect/Maintain Processes	ST	ST	Less than 20% Riparian disturbance, no disconnection.
K DIZ-1	2	Reconnect Isolated off-channel and riparian areas fragmented by anthropogenic disturbances.	LT	ST	Reconnect existing wetland to riverine system.
K DIZ-2	<1	Reconnect Isolated off-channel and riparian areas fragmented by anthropogenic disturbances.	LT	ST	Reconnect section of historic channel.
K DIZ-3	3+	Reconnect Isolated off-channel and riparian areas fragmented by anthropogenic disturbances.	LT	ST	Reconnect section of historic channel.
K OZ-3	25	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Remove disconnecting features within the subreach to improve floodplain processes.
K OZ-19	16	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Remove disconnecting features within the subreach to improve floodplain processes.
K OZ-4	14	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Remove disconnecting features within the subreach to improve floodplain processes.
K OZ-20	14	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Remove disconnecting features within the subreach to improve floodplain processes.
K OZ-7	13	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Remove disconnecting features within the subreach to improve floodplain processes.
K IZ-3	11	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Increase current bed elevations to restore fluvial/riparian interactions, combine with Riparian Rehabilitation with adjacent outer zone.
K DOZ-3	3	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Increase current bed elevations to restore fluvial/riparian interactions, combine with Riparian Rehabilitation with adjacent outer zone.
K DOZ-2	3	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Remove disconnecting features within the subreach to improve floodplain processes.
K DOZ-4	2	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Remove disconnecting features within the subreach to improve floodplain processes.
K DOZ-1	1	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Remove disconnecting features within the subreach to improve floodplain processes.
K DOZ-5	1	Reconnect Processes (Long-term) through the Rehabilitation of channel dynamics and riparian interactions	LT	LT	Remove disconnecting features within the subreach to improve floodplain processes.
K OZ-11	4	Reconnect Processes and Habitats: through the regaining of channel dynamics and riparian interactions	ST	LT	Utilize riparian plantings to address high levels of disturbed or removed vegetation
K OZ-14	1	Reconnect Processes and Habitats: through the regaining of channel dynamics and riparian interactions	ST	LT	Utilize riparian plantings to address high levels of disturbed or removed vegetation
K OZ-9	1	Reconnect Processes and Habitats: through the regaining of channel dynamics and riparian interactions	ST	LT	Utilize riparian plantings to address high levels of disturbed or removed vegetation
K IZ-2	19	Reconnect Habitats (Short Term): through in-channel placement or Rehabilitation of wood and rock habitat features or structures.	ST	ST	Place large wood as key members that will promote the retention of additional wood and spawning gravels to improve in-stream complexity.
K IZ-4	16	Reconnect Habitats (Short Term): through in-channel placement or Rehabilitation of wood and rock habitat features or structures.	ST	ST	Place large wood as key members that will promote the retention of additional wood and spawning gravels to improve in-stream complexity.
K IZ-1	14	Reconnect Habitats (Short Term): through in-channel placement or Rehabilitation of wood and rock habitat features or structures.	ST	ST	Place large wood as key members that will promote the retention of additional wood and spawning gravels to improve in-stream complexity.

Table 5 - Summary of subreaches prioritized by rehabilitation strategies. The time frame column represents both time to implement and time to see benefit. LT (long-term) can be greater than 20 years; ST (short-term) can be less than 1 year or up to 5 years

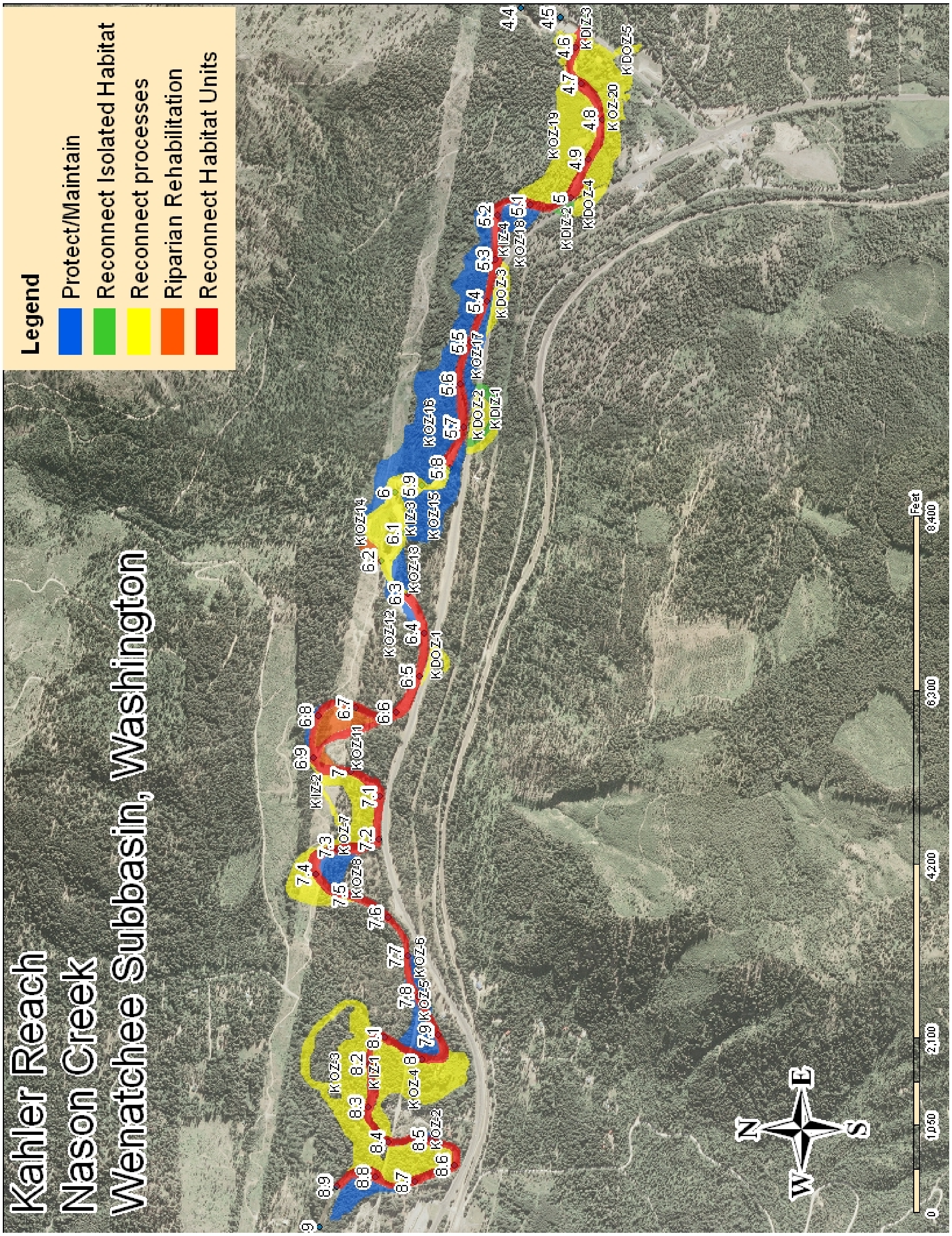

Figure 13 - Prioritized Rehabilitation strategy by subreach unit based on Table 6 for the Kahler reach.

SUBREACH UNIT PROFILES

Within this section, the anthropogenic features and resulting existing conditions of each subreach are discussed. Type, length, and number of human features, as well as areas of disturbed vegetation within the subreach are the result of graphical information system (GIS) analysis. The following descriptions of each subreach include a list of general restoration strategies/prioritized habitat actions, the four viable salmonid population (VSP) parameters that would be addressed by each action, and an estimate of the geomorphic potential of those actions. The subreaches are discussed in the sequential order of implementation that is represented in Table 5**.**

In the effort to reinitiate habitat forming processes, the major types of actions have been identified. The top priority of protection can be achieved through land acquisitions or protection easements. The next general category of reconnecting isolated habitat is generally thought to address some type of disconnecting feature, such as a road or railroad grade. The common recommendation associated with this action is removal or modification with a bridge to allow connection to existing wetland or other off-channel habitat. The third type of action is reconnecting processes. These address obstructions that disrupt floodplain processes. Specific actions include the removal or modification of roads and embankments. The fourth type of action is riparian rehabilitation, and specifically addresses the vegetation element of geomorphic potential. Actions include replanting areas that have been disturbed by human activities or those areas that are at risk of noxious week invasion. The last type of action is reconnecting isolated habitat units. This can be done through various actions.

When conducting rehabilitation efforts, various habitat actions from multiple habitat action classes may be implements. For example, the habitat actions of reconnecting wetlands and creating diverse channel patterns are listed under the habitat action class Floodplain Rehabilitation. The habitat action of slowing of water velocities is listed under the habitat action class of In-Stream Structures. The habitat action of adding large woody debris and engineered log jams is listed under the action class of Large Wood Rehabilitation. Floodplain Rehabilitation addresses all VSP parameters while Large Wood Rehabilitation and In-Stream Structures address two. The number of VSP parameters addressed in respect to reconnecting processes will depend on the action that is implemented.

K OZ-16

Subreach K OZ-16 is located in the mid-section of the Kahler reach in the left floodplain from RM 5.19 to 5.98 (Figure 15). The subreach is considered to be functioning at greater than 80 percent efficiency which makes the subreach protection-oriented. Riparian rehabilitation actions can be implemented in tandem with protection strategies to address the low percentage of disturbed vegetation associated with the power line.

The subreach is about 30 acres in size and contains about 4 acres of wetlands. Natural lateral controls for the subreach are terraces and alluvial fans. There are no anthropogenic features include that disconnect the subreach from the active channel. Human features are limited to 478 feet of power lines. The impacts to the riparian vegetation associated with the power lines are about 3 acres or 9 percent of the total subreach area.

The potential to increase the area of inundation in this subreach is low. When comparing 5,000 cubic feet per second (cfs) stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Rehabilitation options are listed in Table 7 and are prioritized to maximize the geomorphic potential of the subreach through the reconnection and re-establishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in adjacent subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

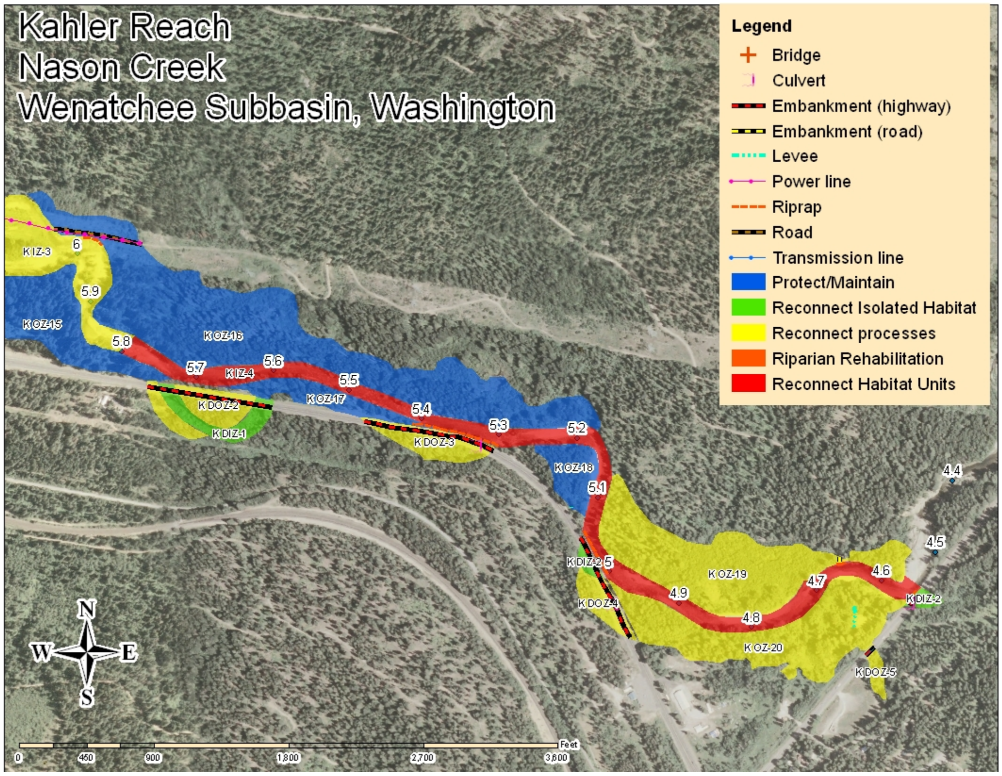

Figure 14 – K OZ-16 and adjacent subreaches in the Kahler reach.

Table 6 – Rehabilitation options for K OZ-16.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Protection	Protect and maintain current levels of geomorphic, hydrologic, and riparian function. Riparian Rehabilitation: Restore sections of riparian vegetation impacted by the power line by planting trees and shrubs to increase large wood recruitment potential within the current floodplain and reduce the amount of altered vegetation. Address noxious weeds through planting and education/prevention programs.	4; Productivity, Abundance, Diversity and Structure	High

K OZ-15

Subreach K OZ-15 is located in the mid-section of the Kahler reach in the right floodplain from RM 5.72 to 6.11 (Figure 15). The subreach is considered to be functioning at greater than 80 percent efficiency which makes the subreach protection-oriented.

The subreach is slightly over 8 acres in size. Natural lateral controls for the subreach are terraces and alluvial fans. There are no anthropogenic features include that disconnect the subreach from the active channel or disturbances to vegetation.

The potential to increase the area of inundation in this subreach is low. When comparing 5,000 cubic feet per second (cfs) stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Rehabilitation options are listed in Table 7 and are prioritized to maximize the geomorphic potential of the subreach through the reconnection and re-establishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in adjacent subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

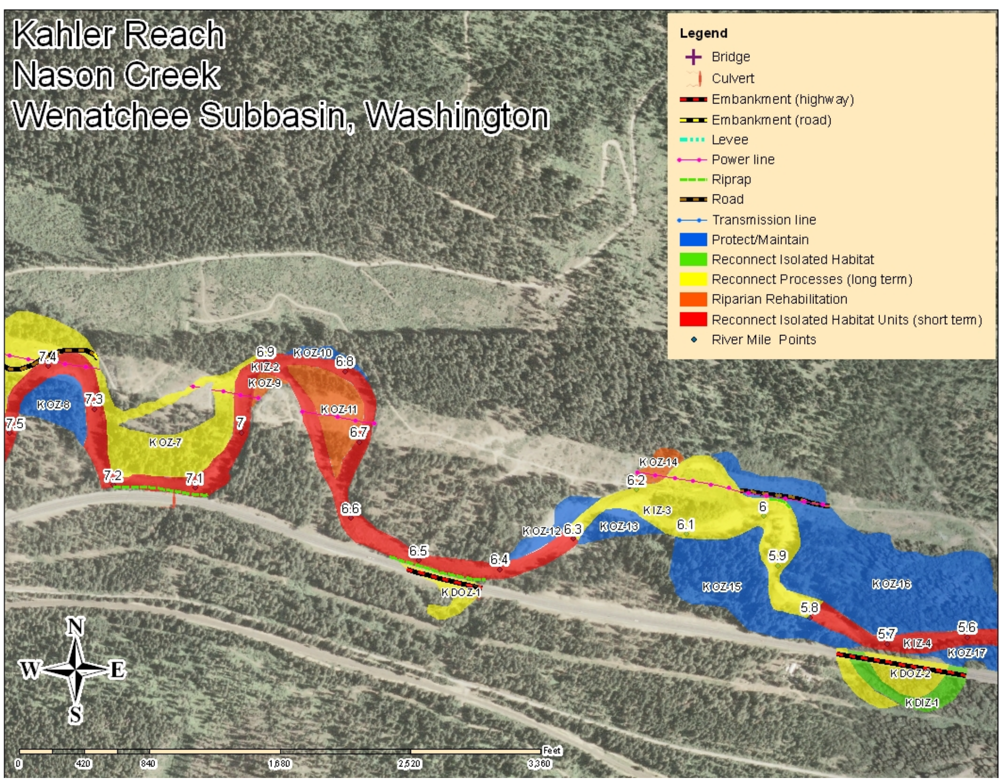

Figure 15 - K OZ-15 and adjacent subreaches in the Kahler reach.

Table 7 - Rehabilitation options for K OZ-15.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Protection	Protect and maintain current levels of geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity and Structure	High

K OZ-5

Subreach K OZ-5 is located in the upstream section of the Kahler reach in the left floodplain from RM 7.75 to 8.06 (Figure 16). The subreach is considered to be functioning at greater than 80 percent efficiency which makes the subreach protection-oriented. Riparian rehabilitation actions can be implemented in tandem with protection strategies to address the low percentage of disturbed vegetation.

The subreach is about 4 acres in size. Natural lateral controls for the subreach are terraces. There are no anthropogenic features that disconnect the subreach from the active channel. Disturbances to vegetation associated with the power line are about one-half of an acre or about 13 percent of the total area of the subreach.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 8 and are prioritized to maximize the geomorphic potential of the subreach through the reconnection and re-establishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other adjacent subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

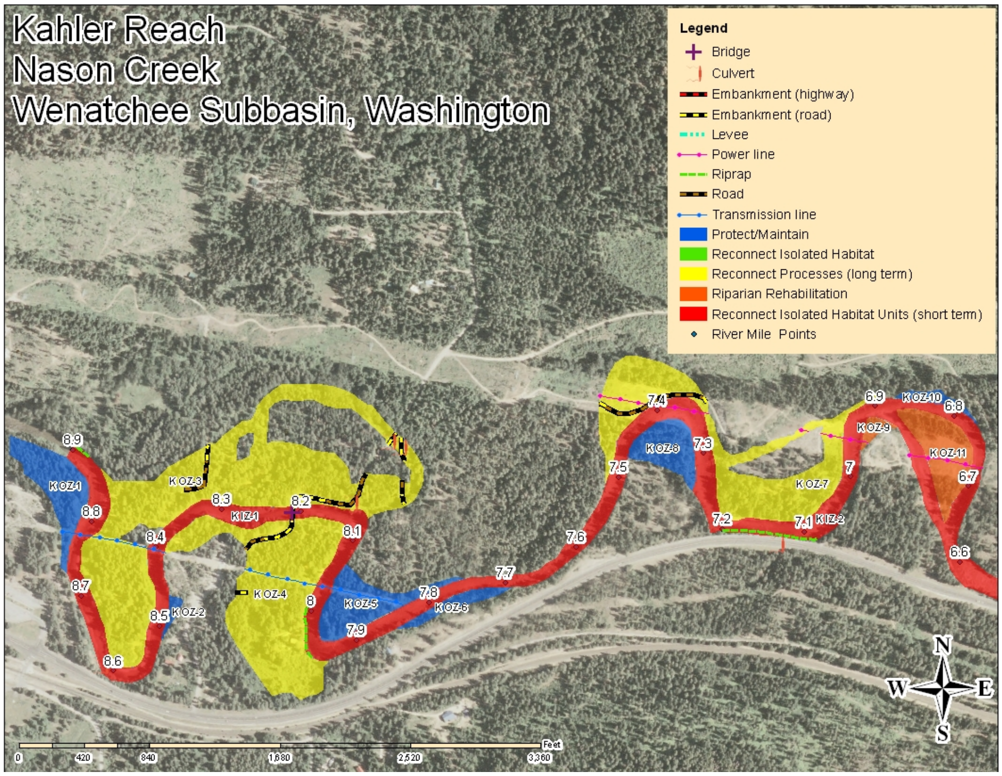

Figure 16 - K OZ-5 and adjacent subreaches in the Kahler reach.

Table 8 - Rehabilitation options for K OZ-5.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Protection	Protect and maintain current levels of geomorphic, hydrologic, and riparian function. Riparian Rehabilitation: Restore sections of riparian vegetation impacted by the power line by planting trees and shrubs to increase large wood recruitment potential within the current floodplain and reduce the amount of altered vegetation. Address noxious weeds through planting and education/prevention programs.	4; Productivity, Abundance, Diversity and Structure	High

K OZ-1

Subreach K OZ-1 is located in the upstream section of the Kahler reach in the right floodplain from RM 8.74 to 8.98 (Figure 17). The subreach is considered to be functioning at greater than 80 percent efficiency which makes the subreach protection-oriented. Riparian rehabilitation actions can be implemented in tandem with protection strategies to address the low percentage of disturbed vegetation.

The subreach is about 4 acres in size. Natural lateral controls for the subreach are alluvial fan material. There are no anthropogenic features that disconnect the subreach from the active channel. Disturbances to vegetation within this subreach are limited to one-tenth of an acre and are associated with the power line.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 9 and are prioritized to maximize the geomorphic potential of the subreach through the reconnection and re-establishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other adjacent subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

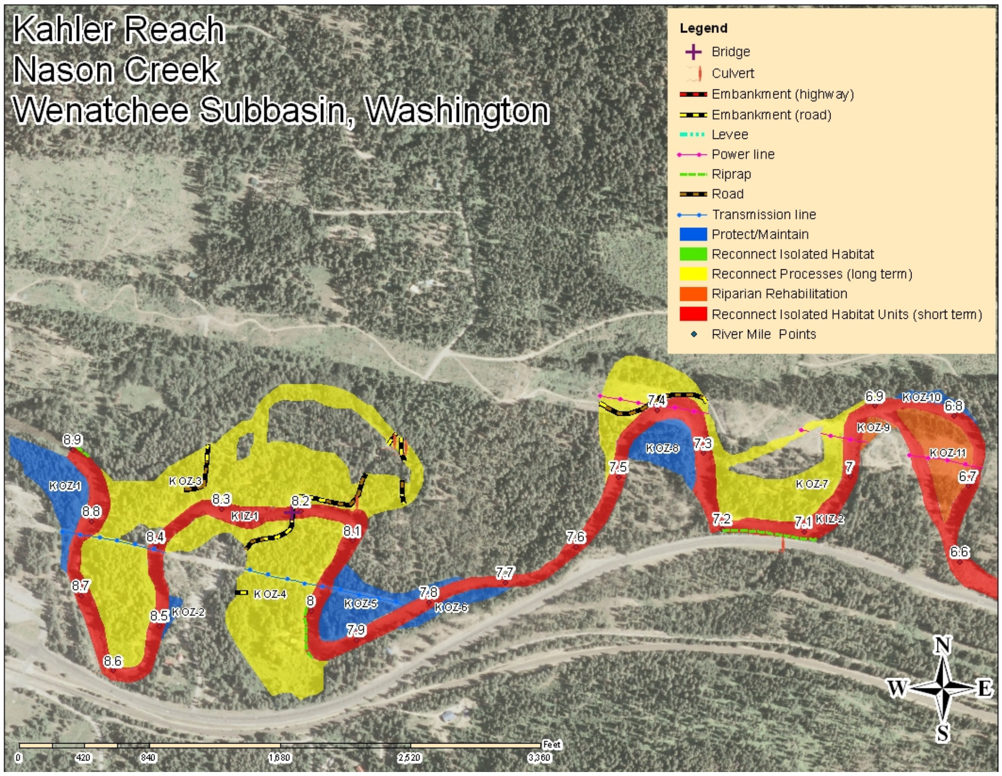

Figure 17 - K OZ-1 and adjacent subreaches in Kahler reach.

Table 9 - Rehabilitation options for K OZ-1.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Protection	Protect and maintain current levels of geomorphic, hydrologic, and riparian function. Riparian Rehabilitation: Restore sections of riparian vegetation impacted by the power line (less than 1 acre) by planting trees and shrubs to increase large wood recruitment potential within the current floodplain and reduce the amount of altered vegetation. Address noxious weeds through planting and education/prevention programs.	4; Productivity, Abundance, Diversity and Structure	High

K OZ-17

Subreach K OZ-17 is located in the downstream section of the Kahler reach in the right floodplain from RM 5.4 to 5.67 (Figure 18). The subreach is considered to be functioning at greater than 80 percent efficiency which makes the subreach protection-oriented.

The subreach is slightly less than 3 acres in size. Natural lateral controls for the subreach are terraces and alluvial fans. There are no anthropogenic features that disconnect the subreach from the active channel or disturbances to vegetation.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 10. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

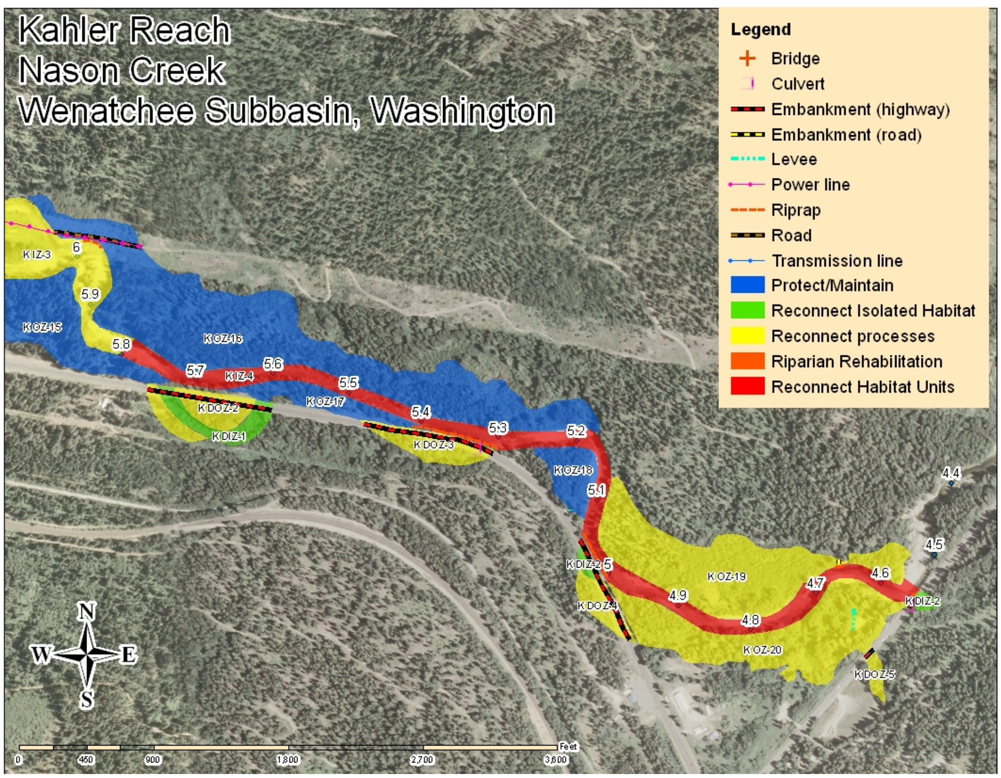

Figure 18 - K OZ-17 and adjacent subreaches in the Kahler reach.

Table 10 - Rehabilitation options for K OZ-17.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Protection	Protect and maintain current levels of geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity and Structure	High

K OZ-18

Subreach K OZ-18 is located in the downstream section of the Kahler reach in the right floodplain from RM 5.07 to 5.26 (Figure 19). The subreach is considered to be functioning at greater than 80 percent efficiency which makes the subreach protection-oriented.

The subreach is slightly less than 3 acres in size. Natural lateral controls for the subreach are terraces and alluvial fans. There are no anthropogenic features that disconnect the subreach from the active channel or disturbances to vegetation.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 11 and are prioritized to maximize the geomorphic potential of the subreach through the reconnection and re-establishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other adjacent subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

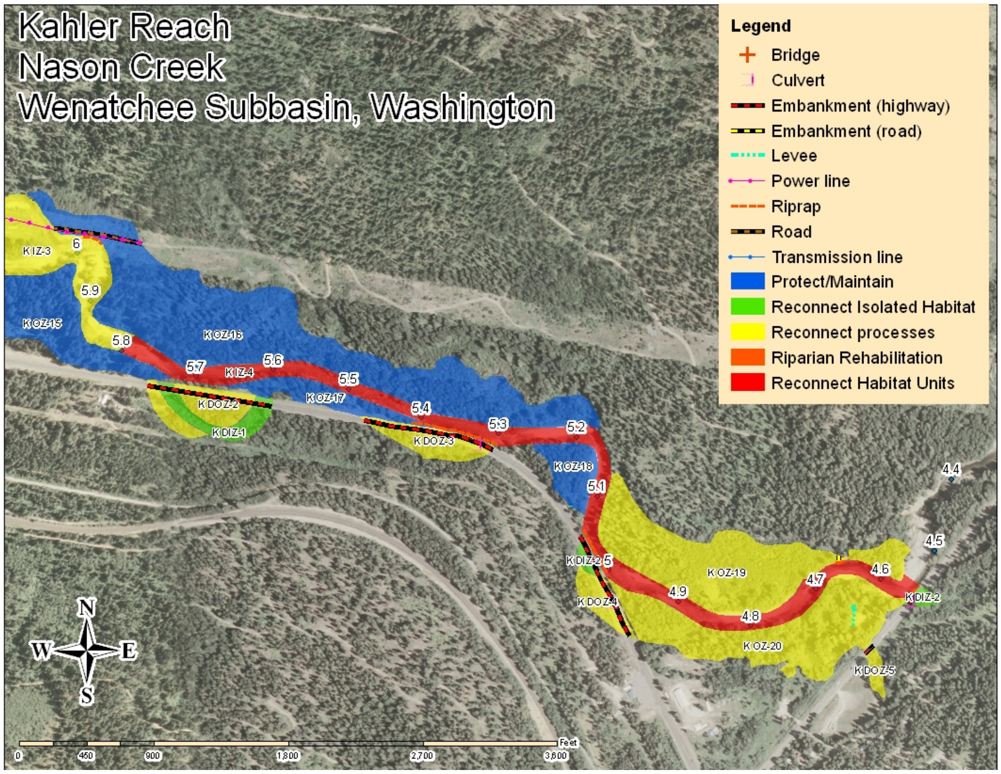

Figure 19 - K OZ-18 and adjacent subreaches in the Kahler reach.

Table 11 - Rehabilitation options for K OZ-18.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Protection	Protect and maintain current levels of geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity and Structure	High

K OZ-8

Subreach K OZ-8 is located in the upstream section of the Kahler reach in the right floodplain from RM 7.25 to 7.45 (Figure 20). The subreach is considered to be functioning at greater than 80 percent efficiency which makes the subreach protection-oriented. Riparian rehabilitation actions can be implemented in tandem with protection strategies to address the low percentage of disturbed vegetation.

The subreach is about 3 acres in size. Natural lateral controls for the subreach are terraces. There are no anthropogenic features that disconnect the subreach from the active channel. Disturbances to vegetation associated with the powerline total one-tenth of an acre or 3 percent of the total subreach.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 12. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

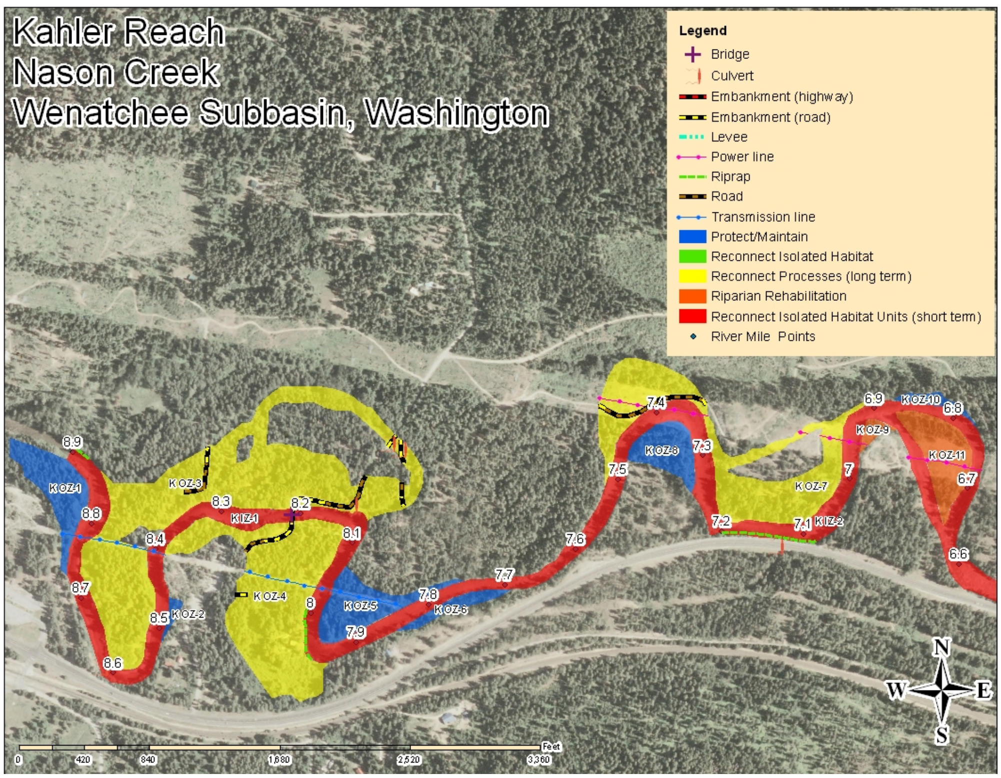

Figure 20 - K OZ-8 and adjacent subreaches in the Kahler reach.

Table 12 - Rehabilitation options for K OZ-8.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Protection	Protect and maintain current levels of geomorphic, hydrologic, and riparian function. Riparian Rehabilitation: Restore sections of riparian vegetation impacted by the power line by planting trees and shrubs to increase large wood recruitment potential within the current floodplain and reduce the amount of altered vegetation. Address noxious weeds through planting and education/prevention programs.	4; Productivity, Abundance, Diversity and Structure	High

K OZ-12

Subreach K OZ-12 is located in the mid-section of the Kahler reach in the left floodplain from RM 6.25 to 6.4 (Figure 21). The subreach is considered to be functioning at greater than 80 percent efficiency which makes the subreach protection-oriented. Riparian rehabilitation actions can be implemented in tandem with protection strategies to address the low percentage of disturbed vegetation and/or prevent the spread of noxious weeds.

The subreach is about 2 acres in size. Natural lateral controls are terraces and coarse substrate. There are no anthropogenic features that disconnect the subreach from the active channel. Although there are no human disturbances to vegetation proactive planting should be utilized to prevent noxious weed development.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 13. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

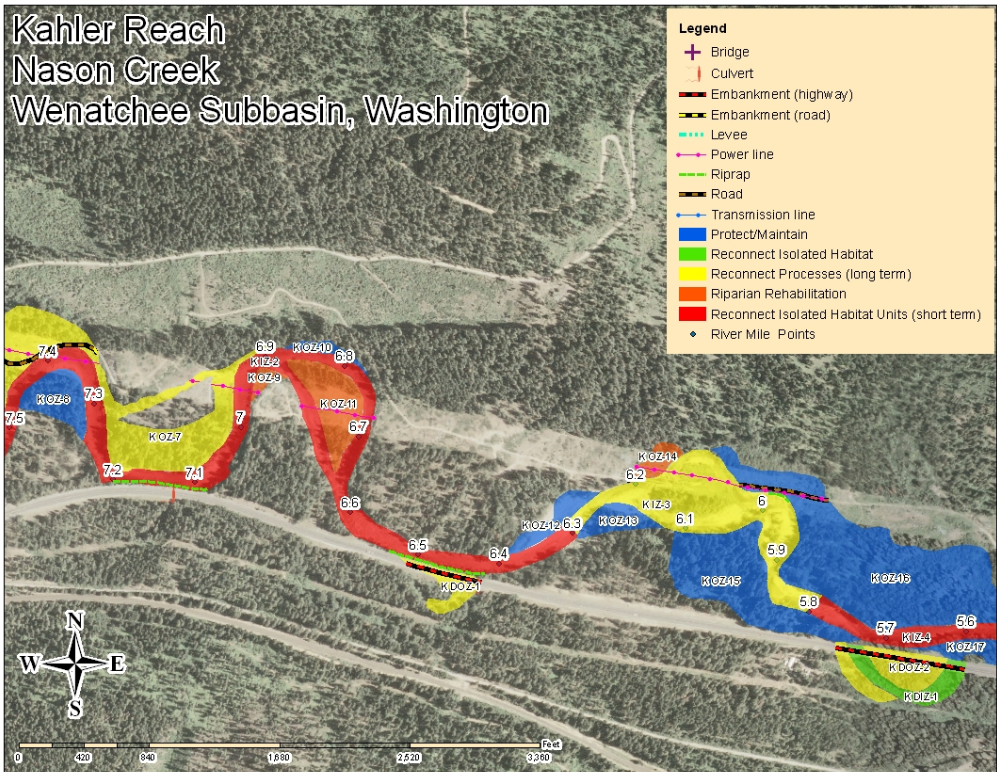

Figure 21 - K OZ-12 and adjacent subreaches in the Kahler reach.

Table 13 - Rehabilitation options for K OZ-12.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Protection	Protect and maintain current levels of geomorphic, hydrologic, and riparian function. Riparian Rehabilitation: Plant sections of riparian vegetation to increase large wood recruitment potential within the current floodplain and increase shading. Address noxious weeds through planting and education/prevention programs.	4; Productivity, Abundance, Diversity and Structure	High

K OZ-13

Subreach K OZ-13 is located in the mid-section of the Kahler reach in the right floodplain from RM 6.12 to 6.3 (Figure 22). The subreach is considered to be functioning at greater than 80 percent efficiency which makes the subreach protection-oriented.

The subreach is about 2 acres in size. Natural lateral controls for the subreach are terraces and alluvial fans. There are no anthropogenic features that disconnect the subreach from the active channel or disturbances to vegetation.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 14. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

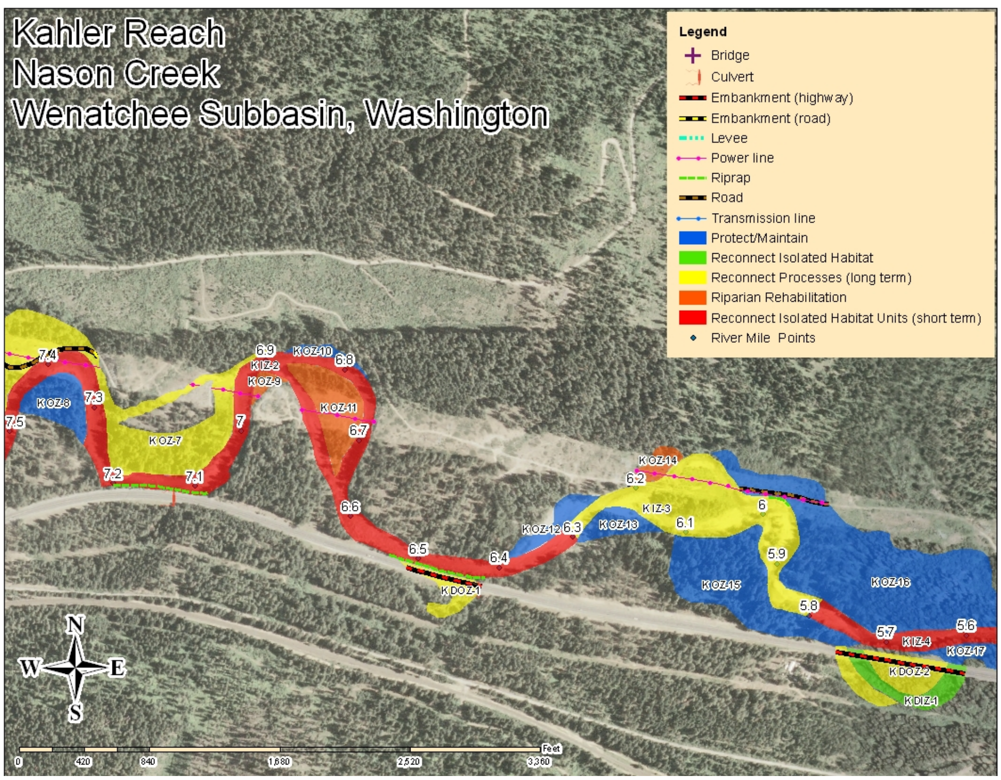

Figure 22 - K OZ-13 and adjacent subreaches in the Kahler reach.

Table 14 - Rehabilitation options for K OZ-13.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Protection	Protect and maintain current levels of geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity and Structure	High

K OZ-6

Subreach K OZ-6 is located in the upstream section of the Kahler reach in the right floodplain from RM 7.7 to 7.86 (Figure 23). The subreach is considered to be functioning at greater than 80 percent efficiency which makes the subreach protection-oriented.

The subreach is about 1 acre in size. Natural lateral controls for the subreach are terraces. There are no anthropogenic features that disconnect the subreach from the active channel or disturbances to vegetation.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 15. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

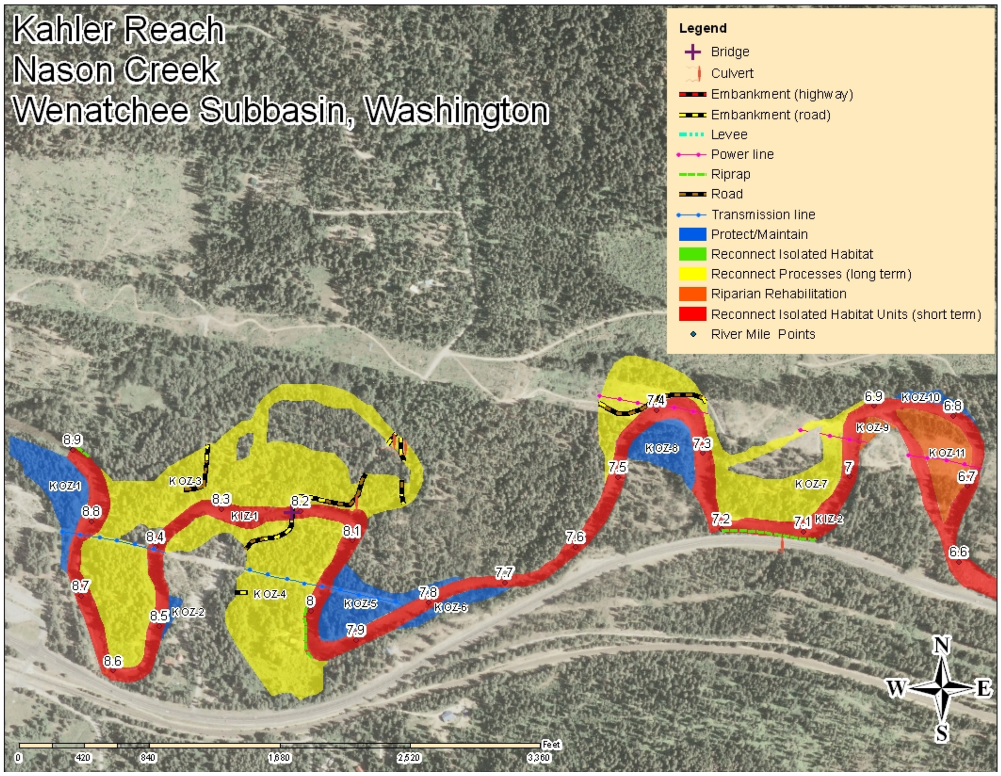

Figure 23 - K OZ-6 and adjacent subreaches in the Kahler reach.

Table 15 - Rehabilitation options for K OZ-6.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Protection	Protect and maintain current levels of geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity and Structure	High

K OZ-10

Subreach K OZ-10 is located in the mid-section of the Kahler reach in the left floodplain from RM 6.78 to 6.89 (Figure 24). The subreach is considered to be functioning at greater than 80 percent efficiency which makes the subreach protection-oriented.

The subreach is about 1 acre in size. Natural lateral controls for the subreach are terraces alluvial fans. There are no anthropogenic features that disconnect the subreach from the active channel or disturbances to vegetation.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 16. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

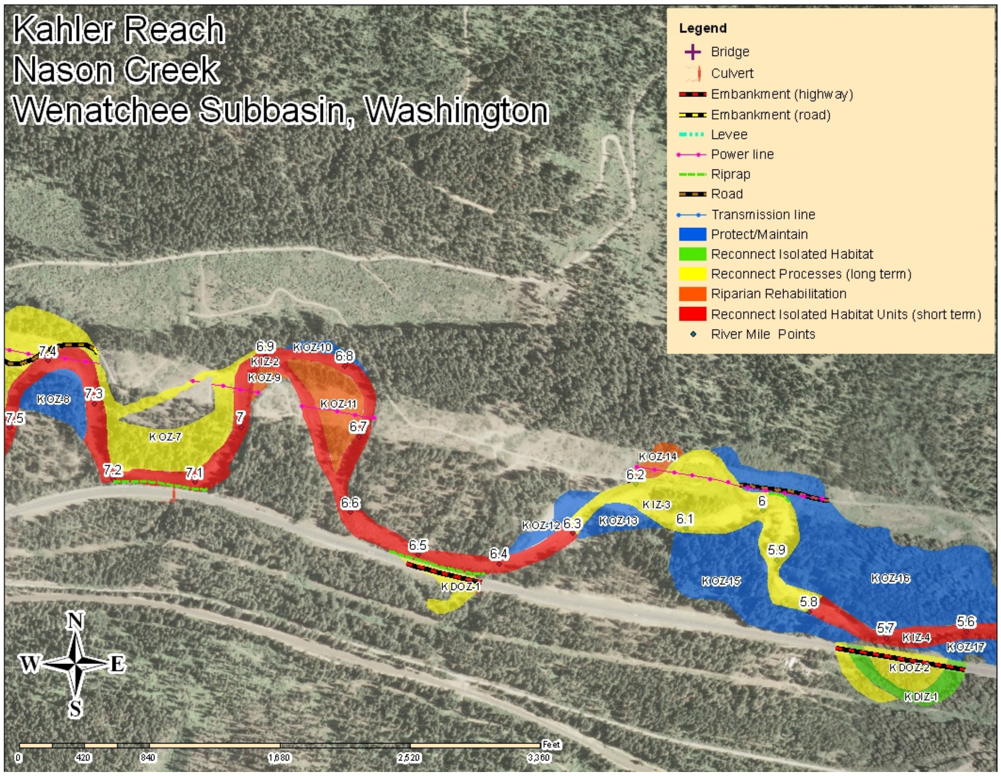

Figure 24 - K OZ-10 and adjacent subreaches in the Kahler reach.

Table 16 - Rehabilitation options for K OZ-10.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Protection	Protect and maintain current levels of geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity and Structure	High

K OZ-2

The subreach K OZ-2 is located in the right floodplain in theup-stream section of the Kahler reach at RM 8.5 (Figure 25). The subreach is considered to be functioning at greater than 80 percent efficiency which makes the subreach protection-oriented.

The subreach is slightly less than 1 acre in size. Natural lateral controls for the subreach are terraces and alluvial fans. There are no anthropogenic features that disconnect the subreach from the active channel.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 17. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

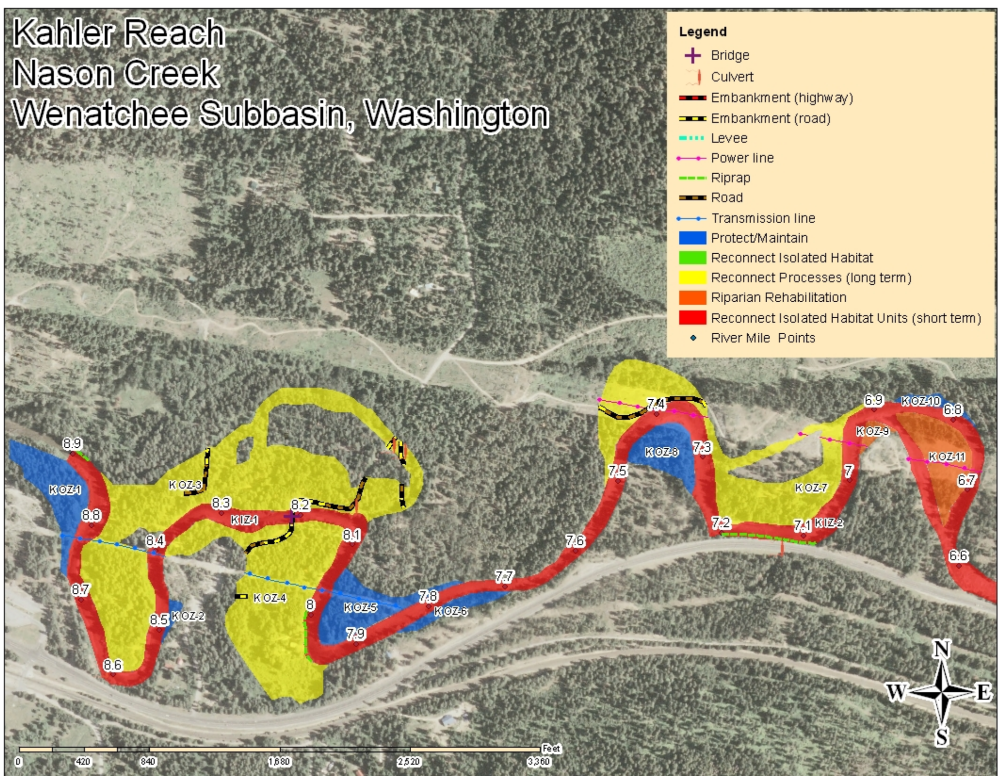

Figure 25 - K OZ-2 and adjacent subreaches in the Kahler reach.

Table 17 - Rehabilitation options for K OZ-2.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Protection	Protect and maintain current levels of geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity and Structure	High

K DIZ-1

Subreach K DIZ-1 is located in the mid-section of the Kahler reach to the south of Highway 2 at RM 5.7 (Figure 26). This subreach is rehabilitation oriented due to impacts to the riparian vegetation.

The subreach is just less than 2 acres in size and contains wetlands. Human features include about 250 feet of Highway 2 that disconnects the historic channel bed from the active channel and floodplain. Impacts to the vegetation associated with the highway total just over 1 acre or about 30 percent of the total area of the subreach.

The 2-D hydraulic model did not predict any inundation with the human features removed at 5,000 cfs and the wetlands may be inundated by ground water and/or a small seasonal tributary. However, by improving the connection at a minimum, a cold water source may be utilized. Rehabilitation options are listed in Table 18. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

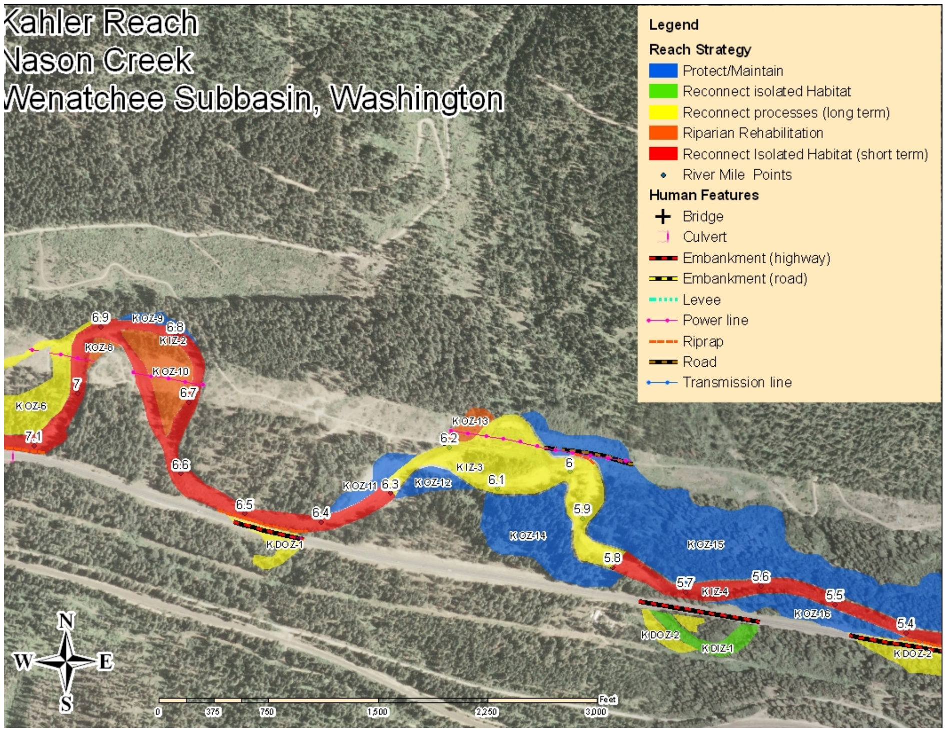

Figure 26 - K DIZ-1 and adjacent subreaches in the Kahler reach.

Table 18 - Rehabilitation options for K DIZ-1.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Isolated Habitat: Remove or modify Highway with bridges where appropriate to reconnect historic channel and reinitiate habitat-forming processes. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
2	Rehabilitation + Protection	Reconnect Processes: Remove or modify Highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity and Abundance	High
3	Rehabilitation + Protection	Riparian Rehabilitation: Riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity and Abundance	Medium
4	Rehabilitation	Reconnect Isolated Habitat: Remove or modify Highway with bridges where appropriate to reconnect floodplain and reinitiate habitat-forming processes. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	4; Productivity, Abundance, Diversity, and Structure	Medium
5	Rehabilitation	Reconnect Processes: Remove or modify Highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	2; Productivity, Abundance	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
6	Rehabilitation	Reconnect Isolated Habitat: Remove or modify Highway grade with bridges where appropriate to reconnect floodplain and reinitiate habitat-forming processes.	4; Productivity, Abundance, Diversity, and Structure	Low
7	Rehabilitation	Reconnect Processes: Remove or modify Highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat.	2; Productivity and Abundance	Low
8	Rehabilitation	Riparian Rehabilitation: Riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	2; Productivity and Abundance	Low
9	Protection	Protect existing wetlands and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K DIZ-2

Subreach K DIZ-2 is located in the downstream end of the Kahler reach to the east of Highway 2 at RM 5.0 (Figure 27). This subreach is rehabilitation oriented due to the disconnection of floodplain and riverine processes.

The subreach is about a half an acre in size. Human features include about 290 feet of Highway 2 that disconnects the historic channel from the current active channel. Culverts are present but were observed to not provide passage at base flow. Impacts to the vegetation associated with the highway total about 0.4 acres or about 87 percent of the subreach.

The 2-D hydraulic model did not predict any inundation with the human features removed at 5000 cfs and the wetlands may be inundated by ground water and/or a small seasonal tributary. However, by improving the connection at a minimum, a cold water source may be utilized. Rehabilitation options are listed in Table 19. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

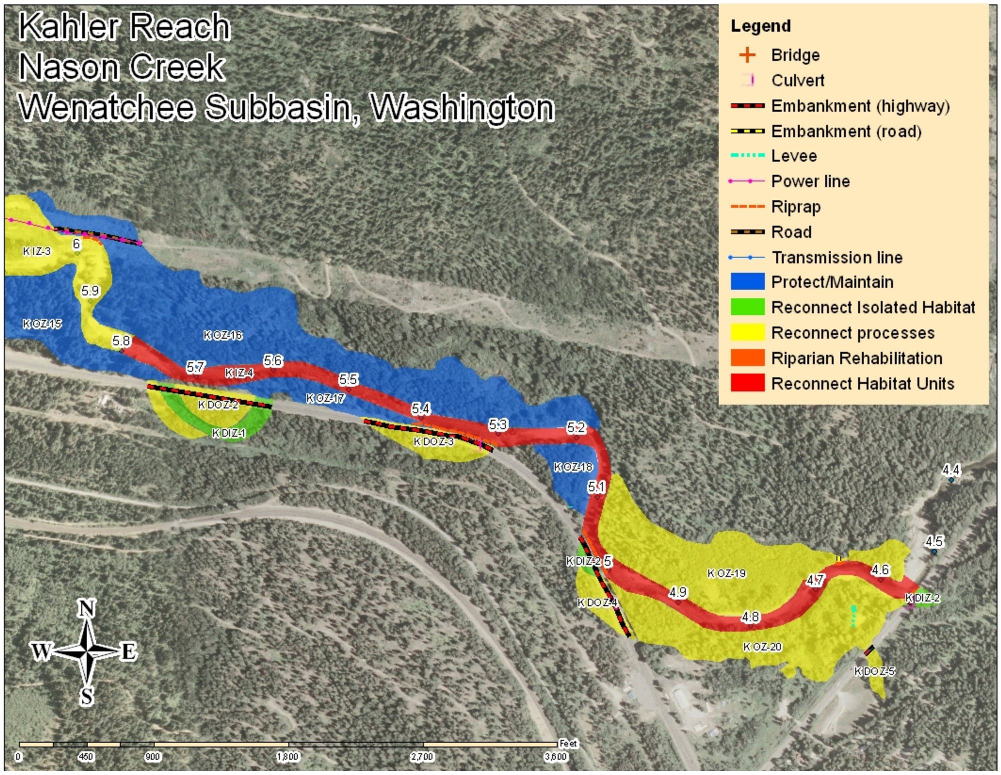

Figure 27 - K DIZ-2 and adjacent subreaches in the Kahler reach.

Table 19 - Rehabilitation options for K DIZ-2.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Isolated Habitat: Remove or modify Highway with bridges where appropriate to reconnect historic channel and reinitiate habitat-forming processes. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High
2	Rehabilitation + Protection	Reconnect Processes: Remove or modify Highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity and Abundance	High
3	Rehabilitation + Protection	Riparian Rehabilitation: Riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity and Abundance	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
4	Rehabilitation	Reconnect Isolated Habitat: Remove or modify Highway with bridges where appropriate to reconnect floodplain and reinitiate habitat-forming processes. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	4; Productivity, Abundance, Diversity, and Structure	Medium
5	Rehabilitation	Reconnect Processes: Remove or modify Highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	2; Productivity, Abundance	Medium
6	Rehabilitation	Reconnect Isolated Habitat: Remove or modify Highway grade with bridges where appropriate to reconnect floodplain and reinitiate habitat-forming processes.	4; Productivity, Abundance, Diversity, and Structure	Low
7	Rehabilitation	Reconnect Processes: Remove or modify Highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat.	2; Productivity and Abundance	Low
8	Rehabilitation	Riparian Rehabilitation: riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	2; Productivity and Abundance	Low
9	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K DIZ-3

Subreach K DIZ-3 is located is located at the downstream end of the Kahler reach to the west of Highway 207 at RM 4.55 (Figure 28). This subreach is rehabilitation-oriented due the impacts on the riparian vegetation.

The subreach, as mapped, is about a half of an acre in size; however this represents the agreed on end point of the reach assessment. The subreach is actually the upstream end of a disconnected inner and outer zone that is nearly 3 acres in size. The subreach is disconnected from the floodplain and active riverine system by a total of 1,232 feet of Highway 207.

The inundation potential is about 3 acres. Rehabilitation options are listed in Table 20. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

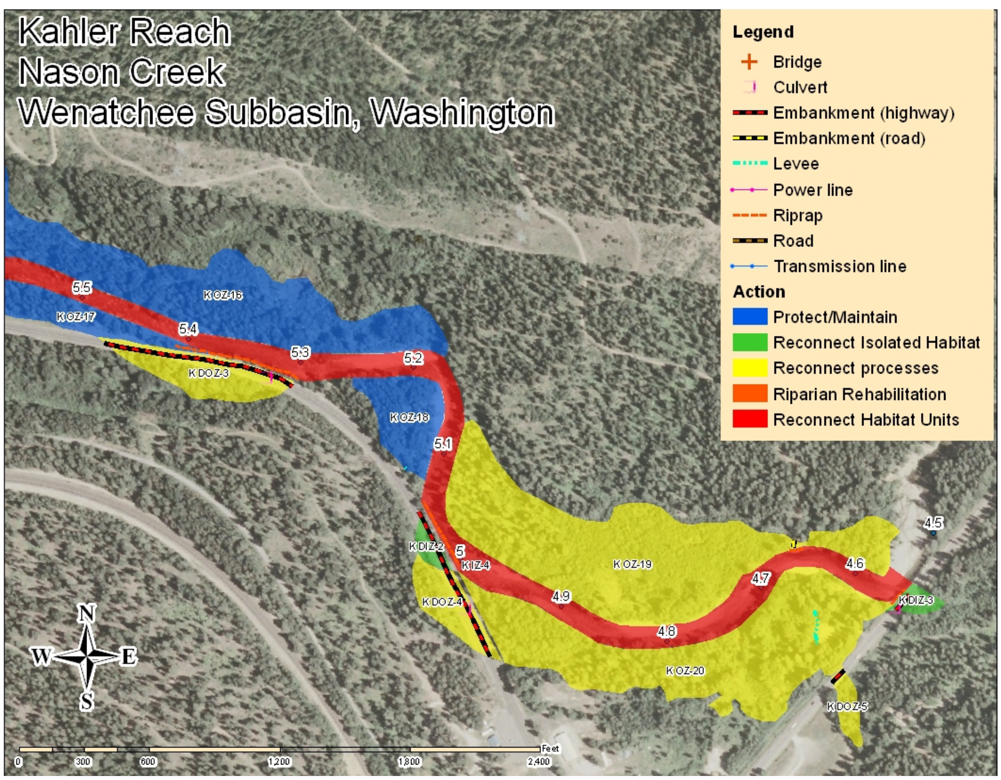

Figure 28 - K DIZ-3 and adjacent subreaches in the Kahler reach.

Table 20 - Rehabilitation options for K DIZ-3.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Isolated Habitat: Remove or modify Highway with bridges where appropriate to reconnect historic channel and reinitiate habitat-forming processes. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High
2	Rehabilitation + Protection	Reconnect Processes: Remove or modify Highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity and Abundance	High
3	Rehabilitation + Protection	Riparian Rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity and Abundance	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
4	Rehabilitation	Reconnect Isolated Habitat: Remove or modify Highway with bridges where appropriate to reconnect floodplain and reinitiate habitat-forming processes. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	4; Productivity, Abundance, Diversity, and Structure	Medium
5	Rehabilitation	Reconnect Processes: Remove or modify Highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	2; Productivity, Abundance	Medium
6	Rehabilitation	Reconnect Isolated Habitat: Remove or modify Highway grade with bridges where appropriate to reconnect floodplain and reinitiate habitat-forming processes.	4; Productivity, Abundance, Diversity, and Structure	Low
7	Rehabilitation	Reconnect Processes: Remove or modify Highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat.	2; Productivity and Abundance	Low
8	Rehabilitation	Riparian Rehabilitation riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	2; Productivity and Abundance	Low
9	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K OZ-3

Subreach K OZ-3 is located in the upstream section of the Kahler reach in the left floodplain from RM 8.87 – 8.11 (Figure 29). This subreach is rehabilitation-oriented due to disconnections within the floodplain.

The subreach is about 14 acres in size. Human features include 670 feet of road embankment and 770 feet of unimproved road. A bridge abutment is also present in the center of the reach at RM 8.2. Natural lateral controls are terraces and alluvial fans. Impacts to the vegetation associated with the unimproved road and bridge abutment are just over 1 acre, or about 9% of the total subreach.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 21. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

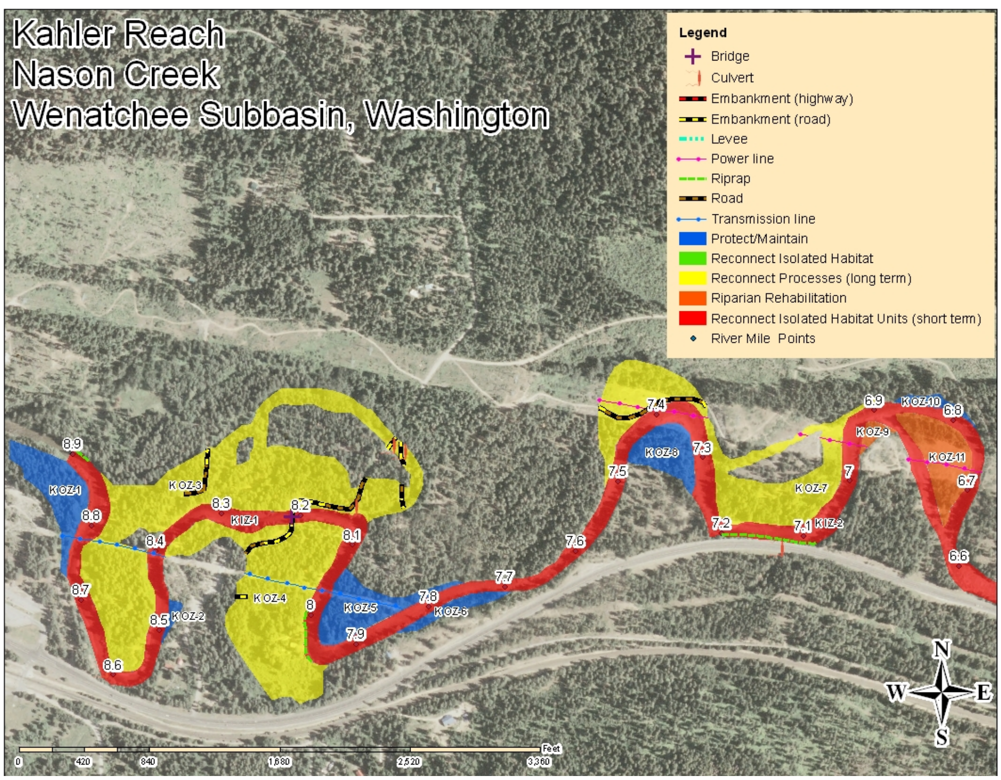

Figure 29 - K OZ-3 and adjacent subreaches in the Kahler reach.

Table 21 - Rehabilitation options for K OZ-3.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Processes: Remove or modify road embankments and bridge abutment to reconnect floodplain to riverine system. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover and large wood recruitment potential within the rehabilitated floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High
2	Rehabilitation + Protection	Reconnect Processes: Remove or modify road embankments with culverts where appropriate and bridge abutment to reconnect floodplain area to riverine system. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover and large wood recruitment potential within the rehabilitated floodplain. Address noxious weeds through planting and education/prevention programs.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Protection	Reconnect Processes: Remove or modify road embankments with culverts where appropriate and bridge abutment to reconnect floodplain area to riverine system. Protect and maintain current levels of hydrologic, riparian, and geomorphic function. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
4		Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity, Abundance,	Medium
5		Reconnect Processes: Remove or modify road embankments with culverts where appropriate and bridge abutment to reconnect floodplain area to riverine system.	2; Productivity, Abundance,	Medium
6		Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	2; Productivity, Abundance,	Medium
7		Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity, Abundance,	Maintain

K OZ-19

Subreach K OZ-19 is located in the downstream section of the Kahler reach in the left floodplain from RM 4.55 to 5.13 (Figure 30). This subreach is rehabilitation-oriented due to disconnections within the floodplain.

The subreach is about 16 acres in size and contains 3 acres of wetlands. Human features include 35 feet of unimproved road embankment and a bridge abutment that disconnect the downstream end of the subreach from the adjacent floodplain and active channel. Natural lateral controls are terraces and alluvial fans. Impacts to the vegetation associated with the unimproved road and bridge abutment are less than 1 acre.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 22 and are prioritized to maximize the geomorphic potential of the subreach through the reconnection and re-establishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other adjacent subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

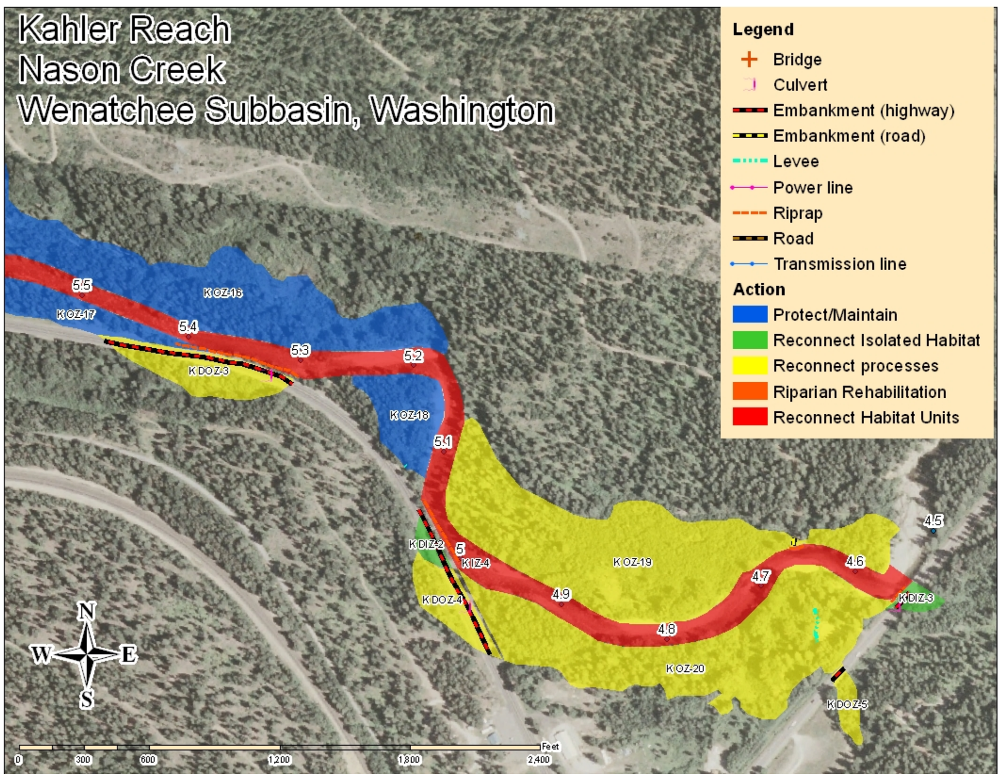

Figure 30 - K OZ-19 and adjacent subreaches in Kahler reach.

Table 22 - Rehabilitation options for K OZ-19.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Processes: Remove or modify embankments to reconnect floodplain area to riverine system. Protect existing wetlands and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High
2	Rehabilitation + Protection	Reconnect Processes: Remove or modify embankments to reconnect floodplain area to riverine system.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Protection	Protect existing wetlands and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K OZ-4

K OZ-4 is located in the up-stream section of the Kahler reach in the right floodplain from RM 7.94 to 8.4 (Figure 31). This subreach is rehabilitation-oriented due to disconnections within the floodplain.

The subreach is about 14 acres in size. Anthropogenic features include 337 feet of road embankment, 146 feet of unimproved road, and 384 feet of power lines. The subreach also includes developed areas. Natural lateral controls are terraces. Impacts of anthropogenic features to the vegetation total about 1 acre or about 7 percent of the subreach.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 23 and are prioritized to maximize the geomorphic potential of the subreach through the reconnection and re-establishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other adjacent subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

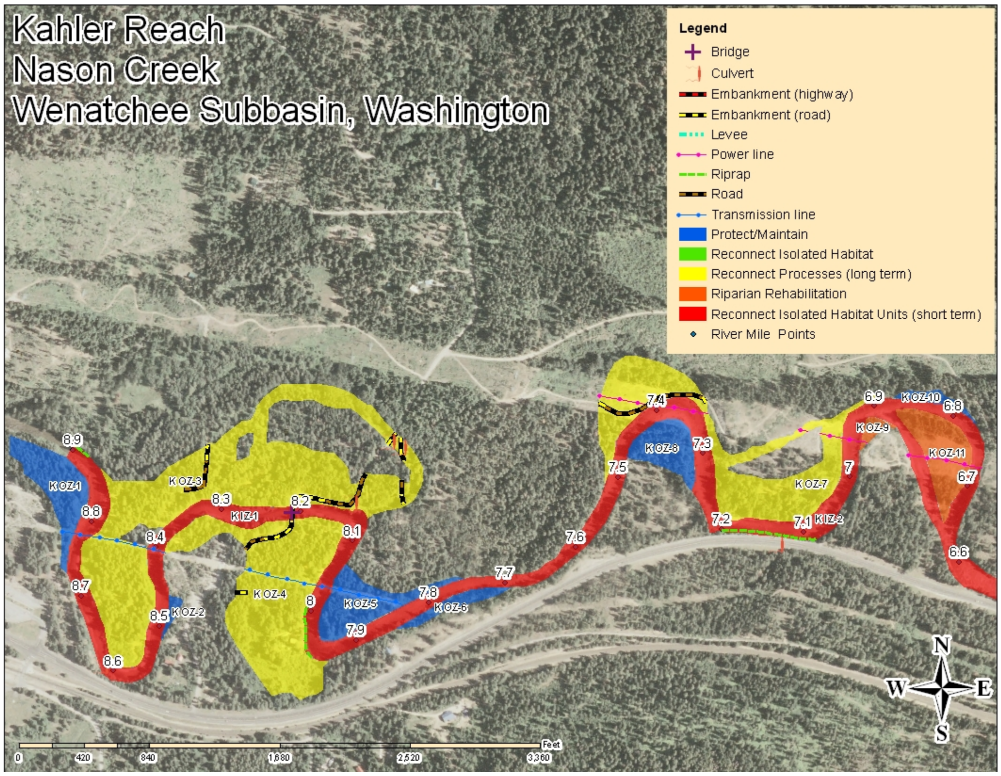

Figure 31 - K OZ-4 and adjacent subreaches in Kahler reach.

Table 23 - Rehabilitation options for K OZ-4.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Modify unimproved roads to control fine sediment input to the system. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover and large wood recruitment potential within the rehabilitated floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
2	Rehabilitation + Protection	Reconnect Processes: Modify road embankments with culverts where appropriate to reconnect existing wetland area to riverine system. Modify unimproved roads to control fine sediment input to the system. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Rehabilitation	Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
4	Rehabilitation	Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	2; Productivity and Abundance	Medium
5	Rehabilitation	Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Modify unimproved roads to control fine sediment input to the system	2; Productivity and Abundance	Low

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
6	Rehabilitation	Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	2; Productivity, and Abundance	Low
7	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K OZ-20

Subreach K OZ-20 is located in the downstream section of the Kahler reach in the right floodplain from RM 4.55 to 4.99 (Figure 32). This subreach is rehabilitation-oriented due to disconnections within the floodplain.

The subreach is about 14 acres in size and contains 6 acres of wetlands. Human features include 160 feet of levee that protects an elevated parking area and 20 feet of riprap. The riprap serves as bank protection and is addressed in the K IZ-4 profile. Impacts to the vegetation from the parking area and other disturbances total about a quarter of an acre or about 2 percent of the subreach.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 24. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other adjacent subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

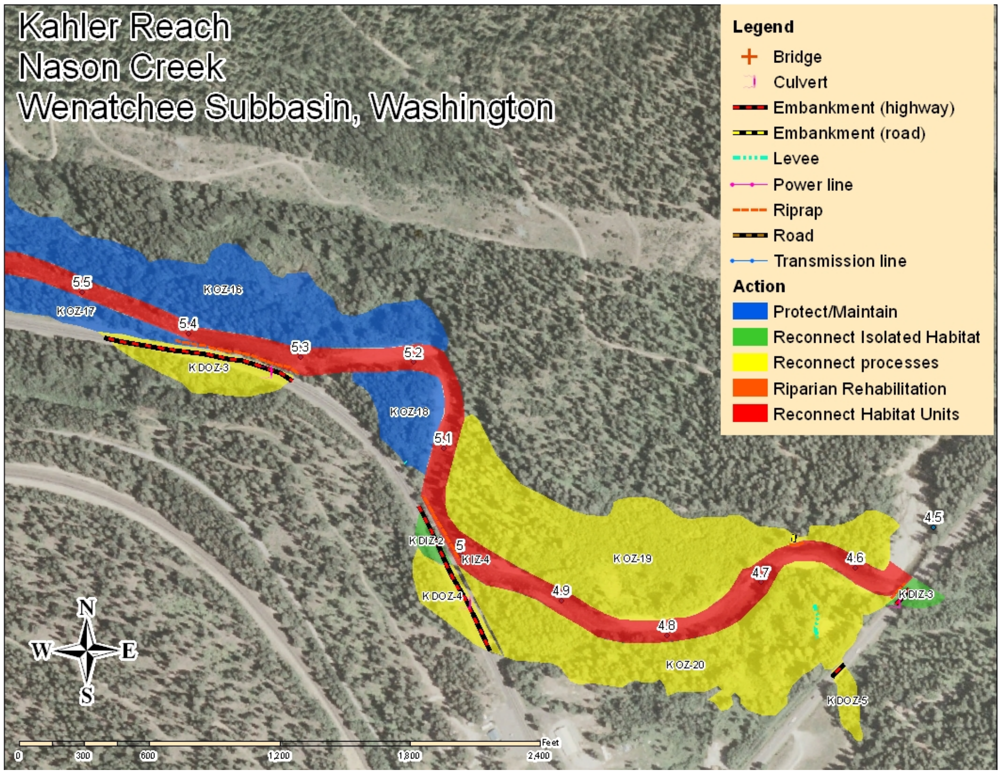

Figure 32 - K OZ-20 and adjacent subreaches in Kahler reach.

Table 24 - Rehabilitation options for K OZ-20.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Processes: Remove or modify embankments and levee to reconnect floodplain area to riverine system. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High
2	Rehabilitation + Protection	Reconnect Processes: Remove or modify embankments and levee to reconnect floodplain area to riverine system.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K OZ-7

Subreach K OZ-7 is located in the upstream section of the Kahler reach in the left floodplain at RM 6.9 to 7.5 (Figure 33). This subreach is rehabilitation-oriented due to the disconnection from the floodplain and riverine system.

The subreach is about 13 acres in size and contains 1 acre of wetlands. Anthropogenic features include 75 feet of road embankment, 680 feet of unimproved road, and 580 feet of powerline. Natural lateral controls are alluvial fans and terraces. Impacts to the vegetation total just over 3 acres or about 27 percent of the subreach.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 25. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

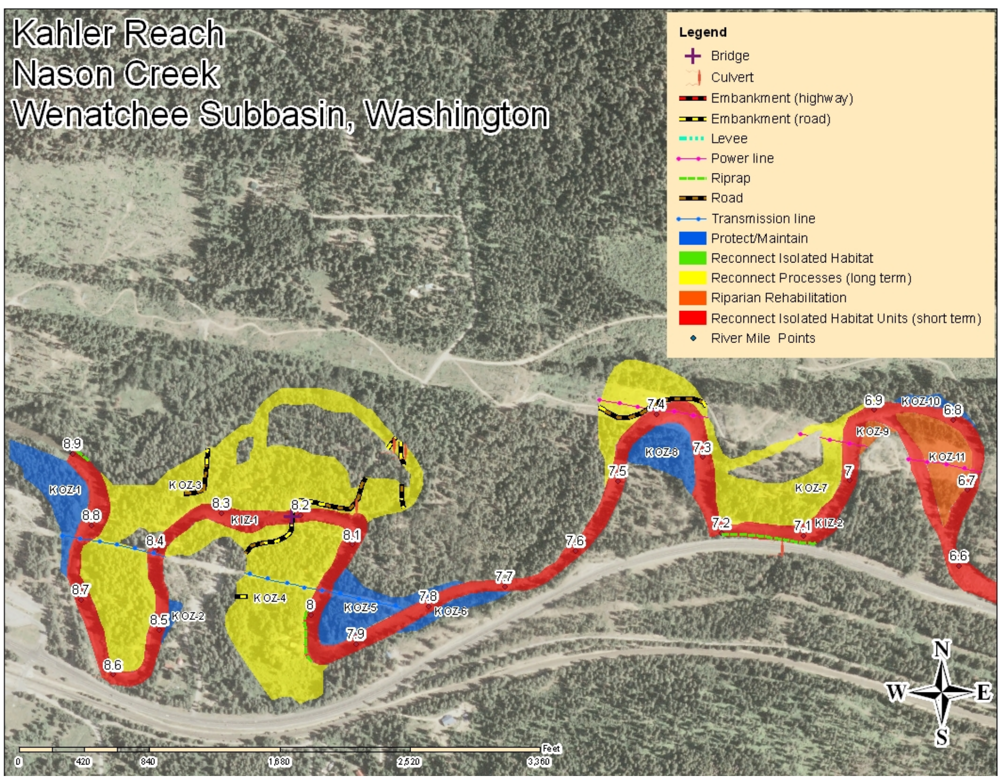

Figure 33 - K OZ-7 and adjacent subreaches in Kahler reach.

Table 25 - Rehabilitation options for K OZ-7.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Processes: Re-slope vertical banks where appropriate to reconnect floodplain and existing wetlands and reinitiate habitat-forming processes. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High
2		Reconnect Processes: Re-slope vertical banks where appropriate to reconnect floodplain and existing wetlands and reinitiate habitat-forming processes. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Abundance and Productivity	Medium
3		Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address the area impacted by the transmission line and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Abundance and Productivity	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
4	Rehabilitation	Reconnect Processes: Re-slope vertical banks where appropriate to reconnect floodplain and existing wetlands and reinitiate habitat-forming processes. Combine with riparian rehabilitation of sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address the area impacted by the highway and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	2; Abundance and Productivity	Medium
5	Rehabilitation	Reconnect Processes: Re-slope vertical banks where appropriate to reconnect floodplain and existing wetlands and reinitiate habitat-forming processes.	2; Productivity and Abundance	Medium
6	Rehabilitation	Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address the area impacted by the transmission line and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	2; Productivity and Abundance	Low
7	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K IZ-3

Subreach K IZ-3 is just over 11 acres and comprises a section of the current active channel from RM 5.8 to 6.3 in the Kahler reach (Figure 34). The dominant process is transition to deposition, as noted by the increase in sinuosity, gravel substrate and increase in the diversity of channel units. The subreach composition is 57 percent runs, 25 percent riffles, and 18 percent pools.

Anthropogenic features included one cabled log, one boulder cluster, and riprap. The biggest impact comes from two sections of riprap for a total of 390 linear feet along the left bank at the upstream and downstream boundaries of the subreach. Other anthropogenic impacts include two powerline crossings in the downstream end of the subreach.

Rehabilitation options are listed in Table 26. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

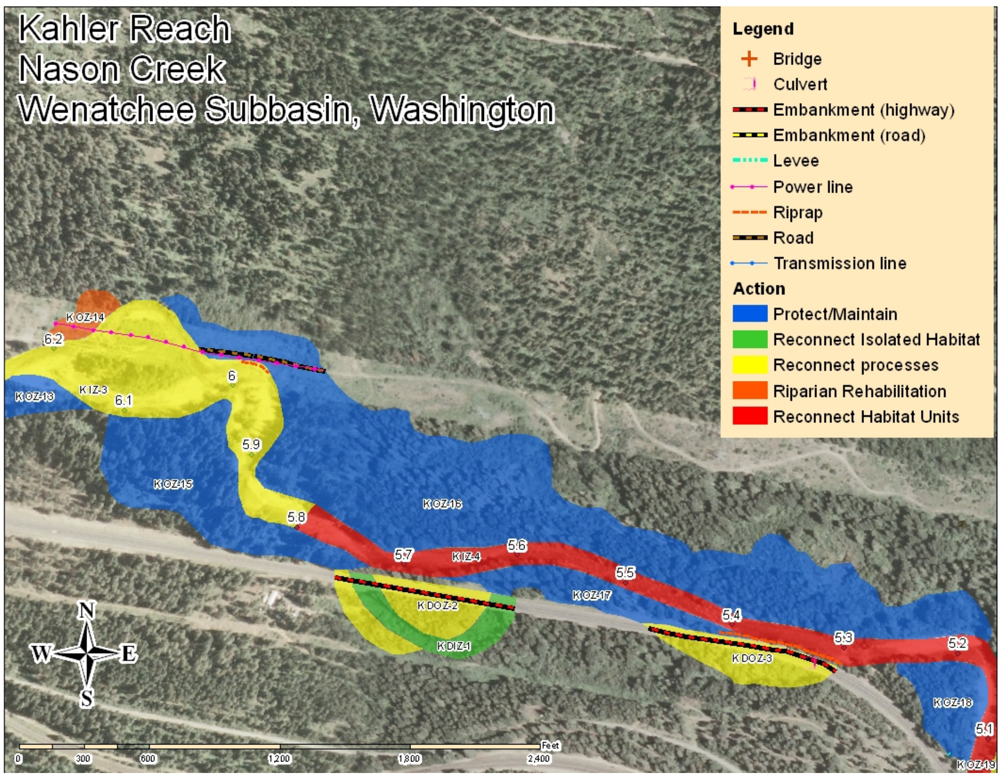

Figure 34 - K IZ-3 and adjacent subreaches in Kahler reach.

Table 26 - Rehabilitation options for K IZ-3.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Processes through the use of various habitat actions from multiple habitat action classes including in-stream structures, floodplain Rehabilitation and large wood Rehabilitation that will result in an increase in the current bed elevation. This will in turn allow fluvial processes to work within adjacent outer zones more frequently. Combine with Riparian rehabilitation: Apply efforts for a long-term approach that will result in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High
2	Rehabilitation + Protection	Reconnect Processes through the use of various habitat actions from multiple habitat action classes including in-stream structures, floodplain Rehabilitation and large wood Rehabilitation that will result in an increase in the current bed elevation. Combine with Riparian rehabilitation: Apply efforts for a long-term approach that will result in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Rehabilitation + Protection	Reconnect Processes through the use of various habitat actions from multiple habitat action classes including in-stream structures, floodplain Rehabilitation and large wood Rehabilitation that will result in an increase in the current bed elevation. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
4	Rehabilitation + Protection	Riparian rehabilitation: Apply efforts for a long-term approach that will result in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
5	Rehabilitation	Reconnect Processes through the use of various habitat actions from multiple habitat action classes including in-stream structures, floodplain Rehabilitation and large wood Rehabilitation that will result in an increase in the current bed elevation.	Ranges from 2 up to 4 depending on action and action class	Low
6	Rehabilitation	Riparian rehabilitation: Apply efforts for a long-term approach that will result in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality.	2; Productivity, and Abundance	Low
7	Protection	Protect and maintain current levels of geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K DOZ 3

K DOZ-3 is located in the downstream section of the Kahler reach in the right floodplain to the west of Highway 2 from RM 5.4 to 5.3 (Figure 35). This subreach is rehabilitation-oriented due to disconnections from the adjacent active floodplain and riverine system.

The subreach is just less than 3 acres in size. Human features include 884 feet of Highway 2. The highway disconnects the subreach from the adjacent floodplain and riverine system. There is a culvert at the downstream end, but it is believed to allow run-off water to enter the system rather than fish passage. Disturbance to the riparian vegetation associated with the highway totals just over 1 acre or about 44 percent of the subreach.

The inundation potential is about 1.4 acres or 1.4 percent of the inundation potential of the Kahler reach. Rehabilitation options are listed in Table 27 and are prioritized to maximize the geomorphic potential of the subreach through the reconnection and re-establishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other adjacent subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

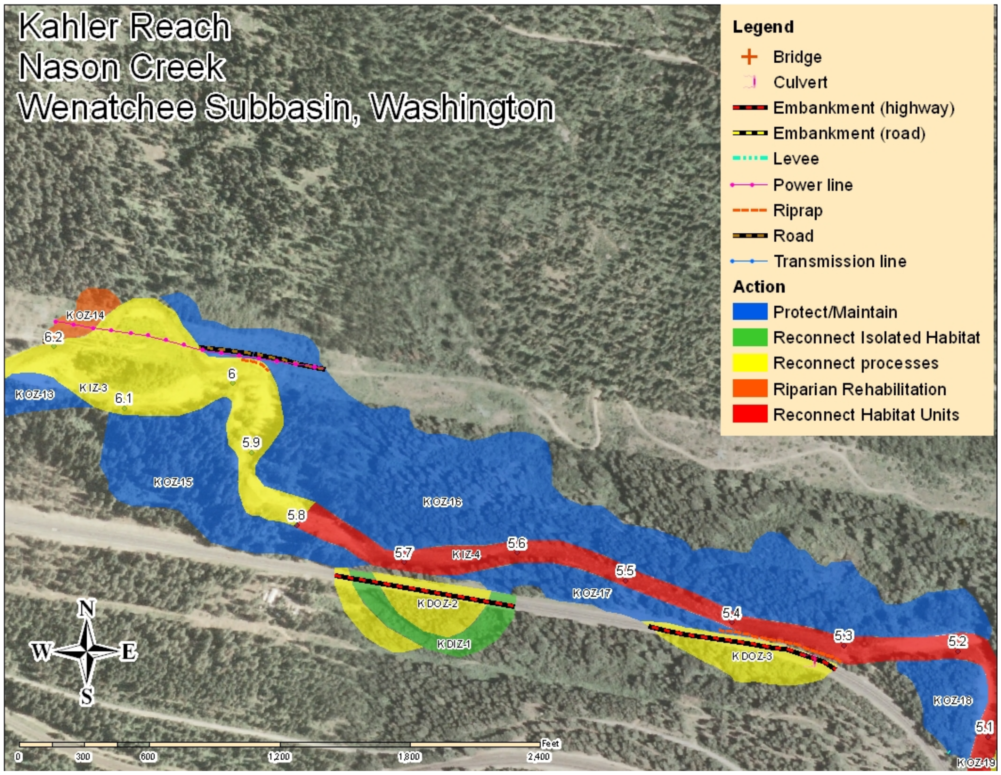

Figure 35 - K DOZ-3 and adjacent subreaches in Kahler reach.

Table 27 - Rehabilitation options for K DOZ-3.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Processes: Remove or modify Highway with bridges where appropriate to reconnect historic channel and reinitiate habitat-forming processes. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity and Abundance	High
2	Rehabilitation + Protection	Riparian Rehabilitation: Restore sections of riparian vegetation impacted by the highway by planting trees and shrubs to increase large wood recruitment potential within the current floodplain and reduce the amount of altered vegetation. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity and Abundance	Medium
3	Rehabilitation	Reconnect Isolated Habitat: Remove or modify Highway with bridges where appropriate to reconnect floodplain and reinitiate habitat-forming processes. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	4; Productivity, Abundance, Diversity, and Structure	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
4	Rehabilitation	Reconnect Processes: Remove or modify Highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	2; Productivity, Abundance	Medium
5	Rehabilitation	Reconnect Isolated Habitat: Remove or modify Highway grade with bridges where appropriate to reconnect floodplain and reinitiate habitat-forming processes.	4; Productivity, Abundance, Diversity, and Structure	Low
6	Rehabilitation	Reconnect Processes: Remove or modify Highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat.	2; Productivity and Abundance	Low
7	Rehabilitation	Riparian Rehabilitation: Restore sections of riparian vegetation impacted by the highway by planting trees and shrubs to increase large wood recruitment potential within the current floodplain and reduce the amount of altered vegetation. Address noxious weeds through planting and education/prevention programs.	2; Productivity and Abundance	Low
8	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K DOZ-2

The subreach K DOZ-2 is located in the mid-section of the Kahler reach to the south of Highway 2 at RM 5.7 (Figure 36). This subreach is rehabilitation-oriented due to the impacts on the riparian vegetation.

The subreach is about 3 acres in size and is the complimentary outer zone to DIZ-1. Human features include about 588 feet of Highway 2. Impacts to the vegetation associated with the highway total nearly 1 acre or about 30 percent of the subreach.

The 2-D hydraulic model did not predict any inundation with the human features removed at 5,000 cfs, although the wetlands may be inundated by ground water and/or a small seasonal tributary. By improving the connection as a minimum, a cold water source may be utilized. Rehabilitation options are listed in Table 28. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and re-establishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale

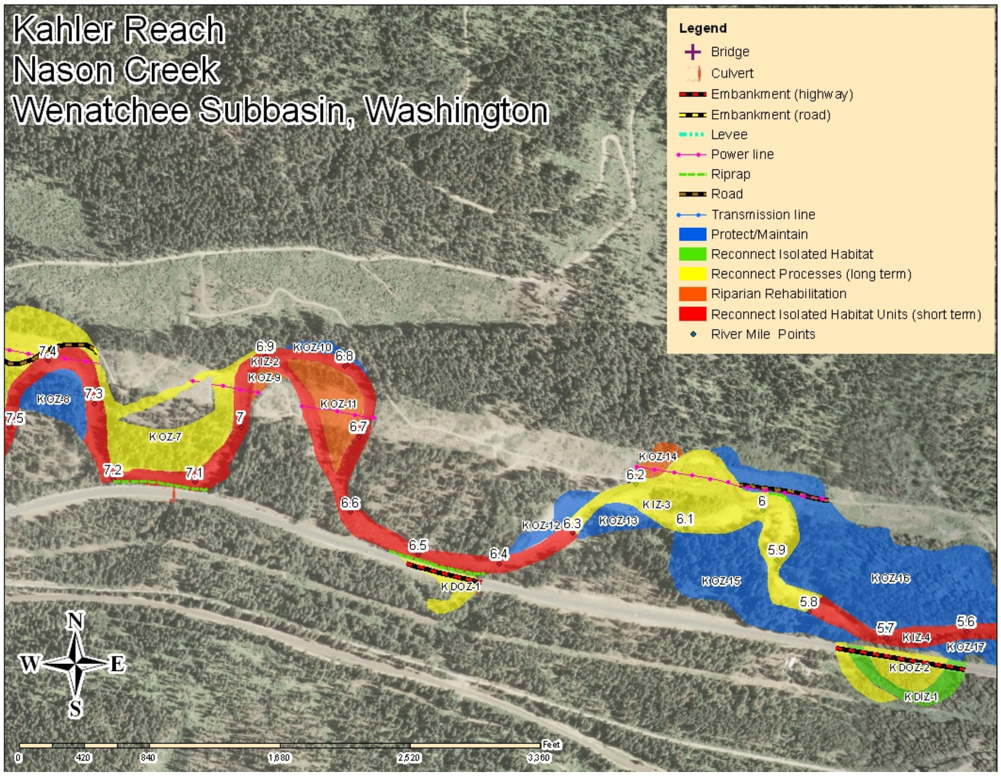

Figure 36 - K DOZ-2 and adjacent subreaches in Kahler reach.

Table 28 - Rehabilitation options for K DOZ-2.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect processes of fluvial and riparian interaction throught Riparian Rehabilitation: Restore sections of riparian vegetation impacted by highway by planting trees and shrubs to increase large wood recruitment potential within the current floodplain and reduce the amount of altered vegetation. Address noxious weeds through planting and education/prevention programs. Protect and maintain current levels of geomorphic, hydrologic, and rehabilitated levels of riparian function	4; Productivity, Abundance, Diversity, and Structure	High
2	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K DOZ-4

K DOZ-4 is located in the downstream section of the Kahler reach in the right floodplain to the west of Highway 2 at RM 5.0 (Figure 37). This subreach is rehabilitation-oriented due to disconnections from the adjacent active floodplain and riverine system.

The subreach is just less than 2 acres in size. Human features include 447 feet of Highway 2 that disconnects the subreach from the active channel and floodplain. The highway disconnects the subreach from the adjacent floodplain and riverine system. A culvert at the downstream end is believed to allow run-off water to enter the system but does not allow fish passage. Disturbance to the riparian vegetation associated with the highway totals about 1 acre or about 44 percent of the subreach.

The inundation potential is about 2.3 acres or 2.3 percent of the inundation potential of the Kahler reach. Rehabilitation options are listed in Table 29. The options are prioritized to maximize the geomorphic potential of the subreach through the reconnection and re-establishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other adjacent subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

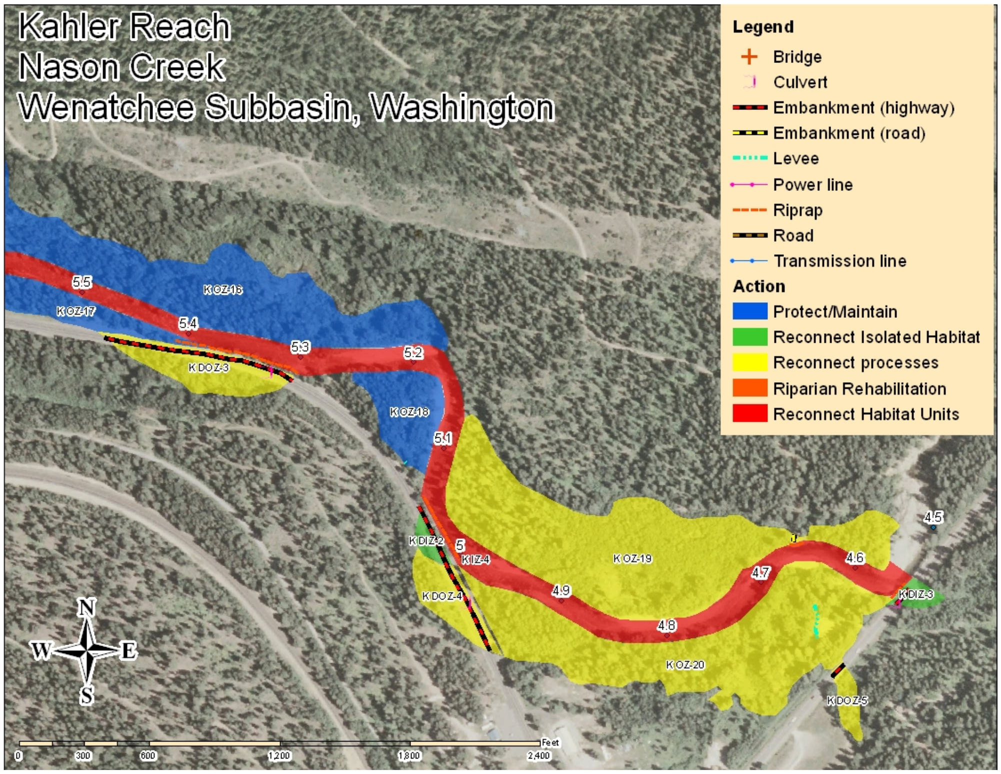

Figure 37 - KDOZ-4 and adjacent subreaches in Kahler reach.

Table 29 - Rehabilitation options for K DOZ-4.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Isolated Habitat: Remove or modify highway with bridges where appropriate to reconnect historic channel and reinitiate habitat-forming processes. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
2	Rehabilitation + Protection	Reconnect Processes: Remove or modify highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity and Abundance	High
3	Rehabilitation + Protection	Riparian Rehabilitation: Restore sections of riparian vegetation impacted by the highway by planting trees and shrubs to increase large wood recruitment potential within the current floodplain and reduce the amount of altered vegetation. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	2; Productivity and Abundance	Medium
4	Rehabilitation	Reconnect Isolated Habitat: Remove or modify highway with bridges where appropriate to reconnect floodplain and reinitiate habitat-forming processes. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	4; Productivity, Abundance, Diversity, and Structure	Medium
5	Rehabilitation	Reconnect Processes: Remove or modify highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover, and large wood recruitment potential within the rehabilitated floodplain.	2; Productivity, Abundance	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
6	Rehabilitation	Reconnect Isolated Habitat: Remove or modify highway grade with bridges where appropriate to reconnect floodplain and reinitiate habitat-forming processes.	4; Productivity, Abundance, Diversity, and Structure	Low
7	Rehabilitation	Reconnect Processes: Remove or modify highway with culverts where appropriate, or improve existing culverts to reconnect floodplain and provide access to off-channel habitat.	2; Productivity and Abundance	Low
8	Rehabilitation	Riparian Rehabilitation: Restore sections of riparian vegetation impacted by the power lines) by planting trees and shrubs to increase large wood recruitment potential within the current floodplain and reduce the amount of altered vegetation. Address noxious weeds through planting and education/prevention programs.	2; Productivity and Abundance	Low
9	Protection	Protect existing wetlands and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K DOZ-1

Subreach K DOZ-1 is located in the mid-section of Kahler reach to the south of the right floodplain and Highway 2 from RM 6.42 to 6.53 (Figure 38). This subreach is rehabilitation-oriented due to disconnections within the floodplain and active channel.

The subreach is about 2 acres in size. Anthropogenic features include 500 feet of highway embankment that disconnects the subreach from the adjacent floodplain and active channel. Natural lateral controls are terraces. Impacts to the vegetation associated with the highway total just less than 1 acre or about 30 percent of the subreach.

The inundation potential is about 1 acre, which is about 1 percent of the inundation potential for the entire Kahler reach. Rehabilitation options are listed in Table 30. The options are prioritized to maximize the geomorphic potential of the subreach through the reconnection and re-establishment of both long-term and short-term processes at the subreach scale.

Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other adjacent subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

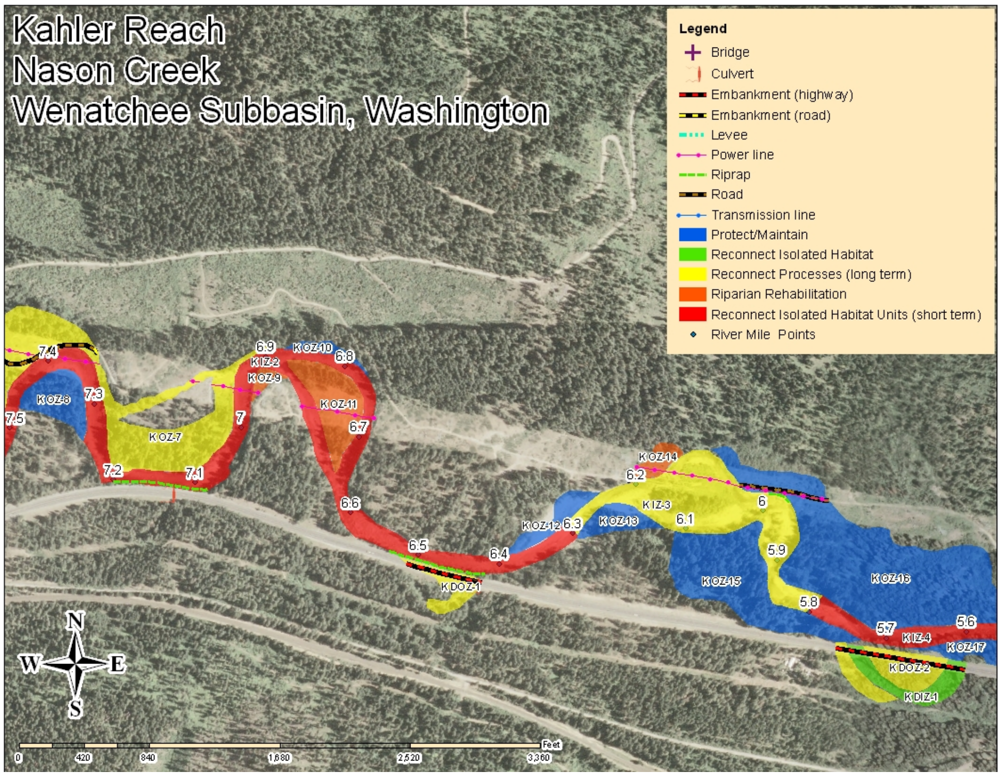

Figure 38 - K DOZ-1 and adjacent subreaches in Kahler reach.

Table 30 - Rehabilitation options for K DOZ-1.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Modify unimproved roads to control fine sediment input to the system. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover and large wood recruitment potential within the rehabilitated floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High
2	Rehabilitation + Protection	Reconnect Processes: Modify Highway 2 with culverts where appropriate to reconnect existing floodplain area to riverine system to reinitiate habitat forming processes. Combine with Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Rehabilitation + Protection	Reconnect Processes: Modify Highway 2 with culverts where appropriate to reconnect existing floodplain area to riverine system to reinitiate habitat forming processes. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
4	Rehabilitation + Protection	Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
5	Rehabilitation	Reconnect Processes: Modify Highway 2 with culverts where appropriate to reconnect existing floodplain area to riverine system to reinitiate habitat forming processes. Combine with Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	2; Productivity and Abundance	Medium
6	Rehabilitation	Reconnect Processes: Modify Highway 2 with culverts where appropriate to reconnect existing floodplain area to riverine system to reinitiate habitat forming processes.	2; Productivity and Abundance	Low
7	Rehabilitation	Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	2; Productivity and Abundance	Low

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
8	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K DOZ-5

Subreach K DOZ-5 is located in the downstream section of Kahler reach to the west of Washington State Highway 207 near RM 4.7 (Figure 39). This subreach is rehabilitation-oriented due to disconnections within the floodplain and active channel.

The subreach is less than 1 acre in size. Anthropogenic features include 78 feet of highway embankment that disconnects the subreach from the adjacent floodplain. Additional human impacts include the adding of fill material to the south. Natural lateral controls are terraces. Impacts to the vegetation associated with the highway total just less than 1 acre or about 30 percent of the subreach.

The inundation potential is about 1 acre, which is about 1 percent of the inundation potential for the entire Kahler reach. Rehabilitation options are listed in Table 31. The options are prioritized to maximize the geomorphic potential of the subreach through the reconnection and re-establishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other adjacent subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

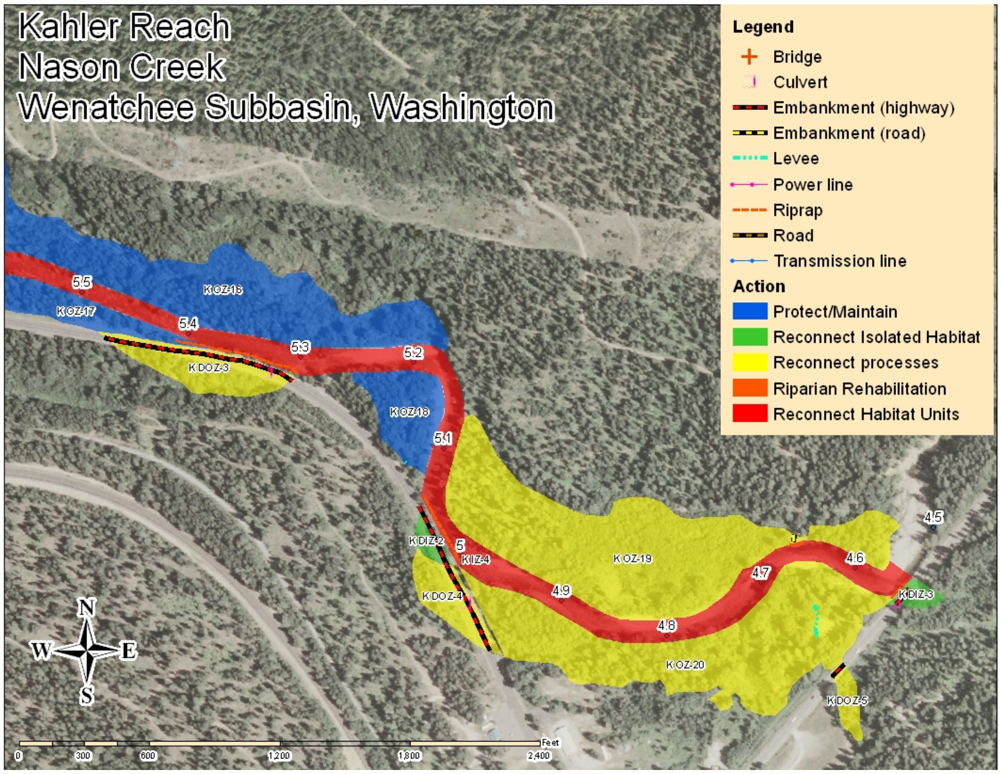

Figure 39 - K DOZ-5 and adjacent subreaches in Kahler reach.

Table 31 - Rehabilitation options for K DOZ-5.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Remove fill material to allow maximum floodplain inundation. Combine with riparian rehabilitation at 10-meter, 30-meter, and floodplain widths to provide adequate composition, canopy cover and large wood recruitment potential within the rehabilitated floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
2	Rehabilitation + Protection	Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Remove fill material to allow maximum floodplain inundation. Combine with Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Rehabilitation + Protection	Reconnect Processes: Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Remove fill material to allow maximum floodplain inundation. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
4	Rehabilitation + Protection	Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
5	Rehabilitation	Reconnect Processes: Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Remove fill material to allow maximum floodplain inundation. Combine with Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	2; Productivity and Abundance	Medium
6	Rehabilitation	Reconnect Processes: Reconnect Processes: Modify road embankments with bridges or culverts where appropriate to reconnect floodplain area to riverine system. Remove fill material to allow maximum floodplain inundation.	2; Productivity and Abundance	Low
7	Rehabilitation	Riparian Rehabilitation: Re-plant sections of riparian vegetation at 10-meter, 30-meter, and floodplain widths to address disturbed areas and to improve canopy cover, large wood recruitment potential, and riparian composition within the floodplain. Address noxious weeds through planting and education/prevention programs.	2; Productivity and Abundance	Low
8	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K OZ-11

Subreach K OZ-11 is located in the mid-section of the Kahler reach as a vegetated island at RM 6.85 to 6.95 (Figure 40). This subreach is rehabilitation-oriented due to impacts to the riparian vegetation.

The subreach is about 4 acres in size. Human features include about 300 feet of power lines. Impacts to the vegetation associated with the power line total about 2 acres or about 50 percent of the subreach.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 32. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

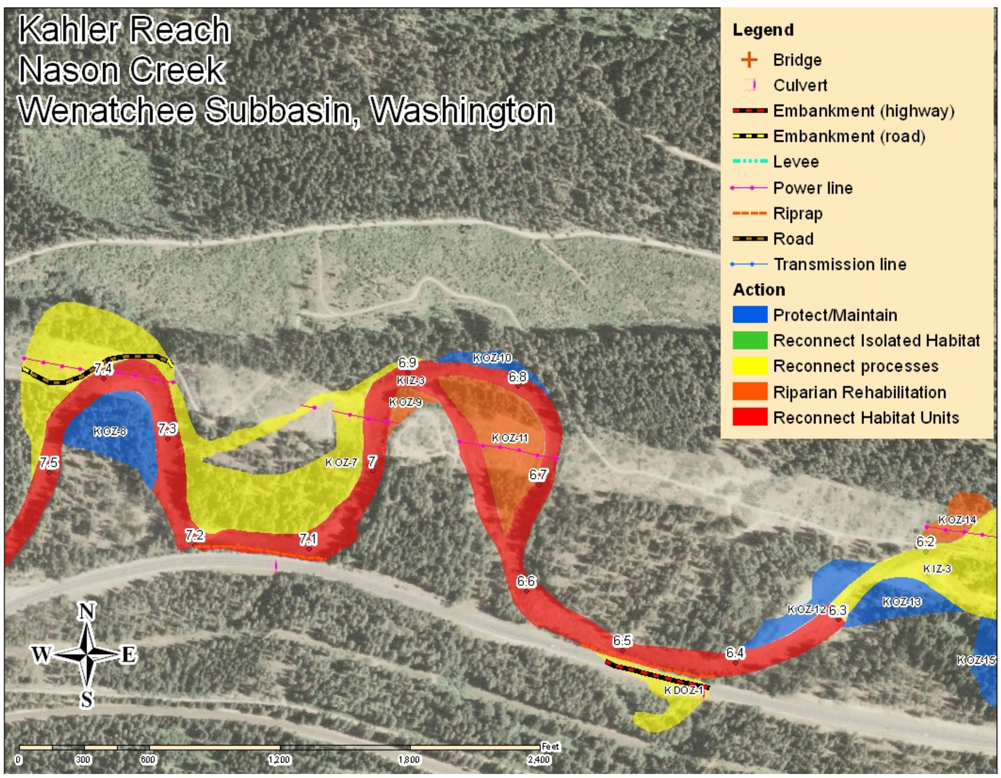

Figure 40 - K OZ-11 and adjacent subreaches in Kahler reach.

Table 32 - Rehabilitation options for K OZ-11.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Riparian Rehabilitation: Restore sections of riparian vegetation impacted by the power line by planting trees and shrubs to increase large wood recruitment potential within the current floodplain and reduce the amount of altered vegetation. Address noxious weeds through planting and education/prevention programs. Protect and maintain current levels of geomorphic, hydrologic, and rehabilitated levels of riparian function	4; Productivity, Abundance, Diversity, and Structure	High
2	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K OZ-14

The subreach K OZ-14 is located in the mid-section of the Kahler reach in the left floodplain at RM 6.2 (Figure 41). This subreach is rehabilitation-oriented due to the impacts on the riparian vegetation.

The subreach is about 1 acre in size. Human features include about 185 feet of power lines and about 20 feet of access road that is utilized for recreation. Impacts to the vegetation associated with the power line total just under 1 acre or about 72 percent of the subreach.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed Table 33. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

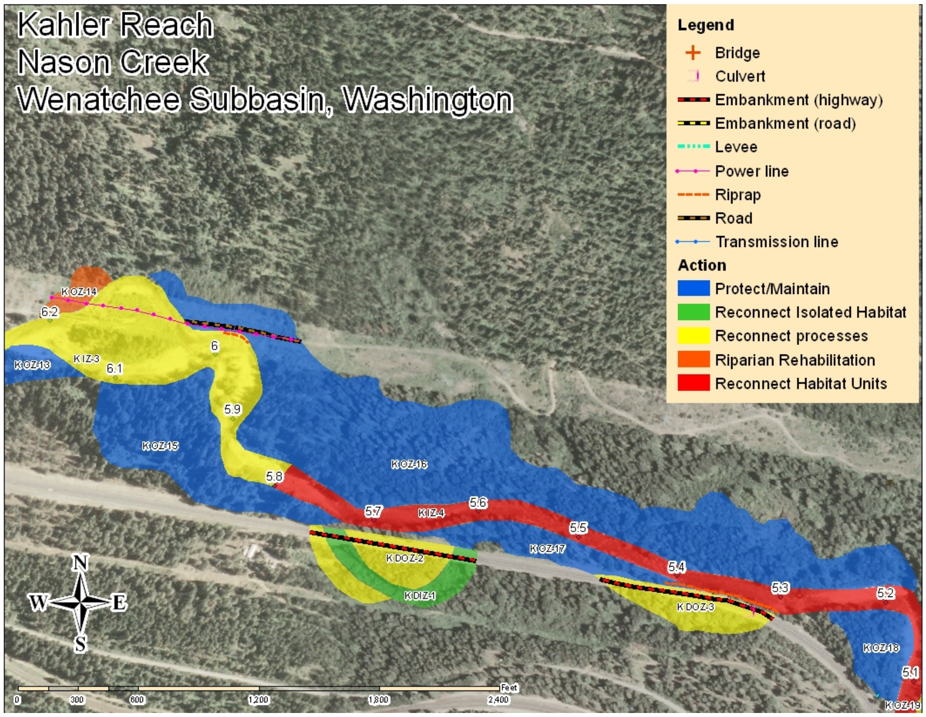

Figure 41 - K OZ-14 and adjacent subreaches in Kahler reach.

Table 33 - Rehabilitation options for K OZ-14.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Riparian Rehabilitation: Restore sections of riparian vegetation impacted by the power line by planting trees and shrubs to increase large wood recruitment potential within the current floodplain and reduce the amount of altered vegetation. Address noxious weeds through planting and education/prevention programs. Protect and maintain current levels of geomorphic, hydrologic, and rehabilitated levels of riparian function	4; Productivity, Abundance, Diversity, and Structure	High
2	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K OZ-9

Subreach K OZ-9 is located in the mid-section of the Kahler reach in the right floodplain at RM 6.85 to 6.95 (Figure 42). This subreach is rehabilitation-oriented due to the impacts on the riparian vegetation.

The subreach is about one half of an acre in size. Human features include about 44 feet of power lines. Impacts to the vegetation associated with the power lines total about two-tenths of an acre or about 40 percent of the subreach.

The potential to increase the area of inundation is low. When comparing 5,000 cfs stream flow for existing conditions versus potential conditions (i.e., with anthropogenic features removed), the 2D-hydraulic model results show little change in area of inundation. Most of the subreach is inundated at both modeled flows. Rehabilitation options are listed in Table 34. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

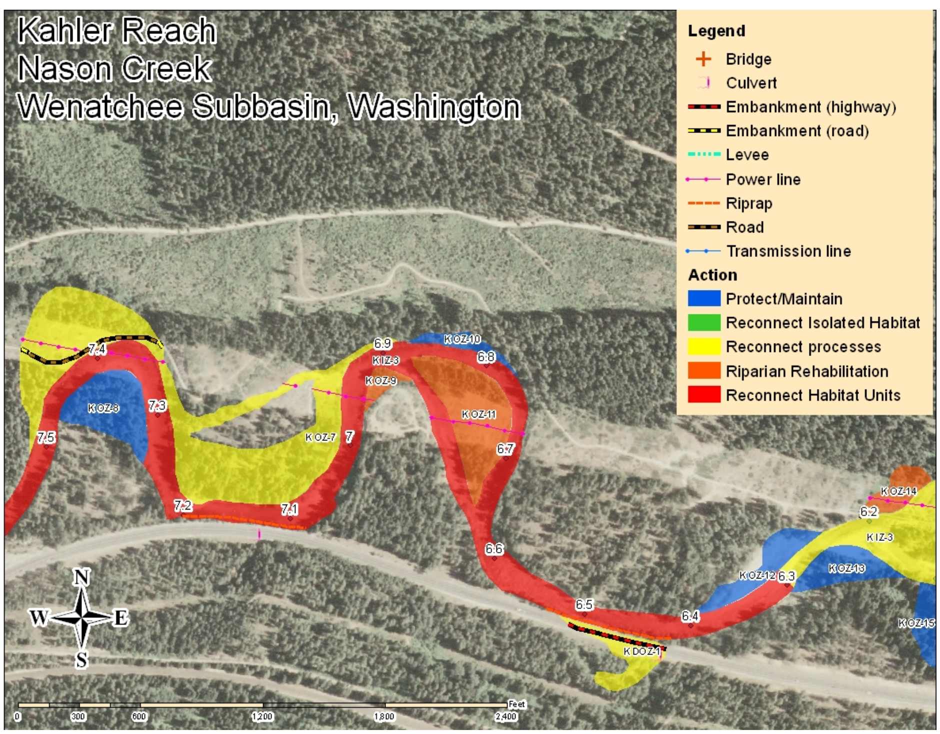

Figure 42 - K OZ-9 and adjacent subreaches in Kahler reach.

Table 34 - Rehabilitation options for K OZ-9.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Riparian Rehabilitation: Restore sections of riparian vegetation impacted by the power line by planting trees and shrubs to increase large wood recruitment potential within the current floodplain and reduce the amount of altered vegetation. Address noxious weeds through planting and education/prevention programs. Protect and maintain current levels of geomorphic, hydrologic, and rehabilitated levels of riparian function	4; Productivity, Abundance, Diversity, and Structure	High
2	Protection	Protect and maintain current levels of hydrologic, riparian, and geomorphic function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K IZ-2

Subreach K IZ-2 is about 19 acres in size and comprises a section of the current active channel and bars from RM 6.3 to 7.7 (Figure 43). The dominant process is transition-to-deposition. The dominant substrate is gravel and cobble. The subreach channel unit composition is 41 percent runs, 7 percent pools, 33 percent riffles, and 19 percent rapids. Due to the existing functioning conditions of his subreach, it is restoration-oriented.

Anthropogenic features in the subreach include about 1,250 feet of riprap that protects Highway 2 along the right bank at RM 7.15 and 6.5. There are also four power line crossings throughout the reach. Natural lateral control for the subreach is alluvial fan and terraces with coarse substrate. Large woody debris is concentrated in three large wood complexes at RM 7.0 and two complexes at RM 6.2.

Rehabilitation options are listed in Table 35. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

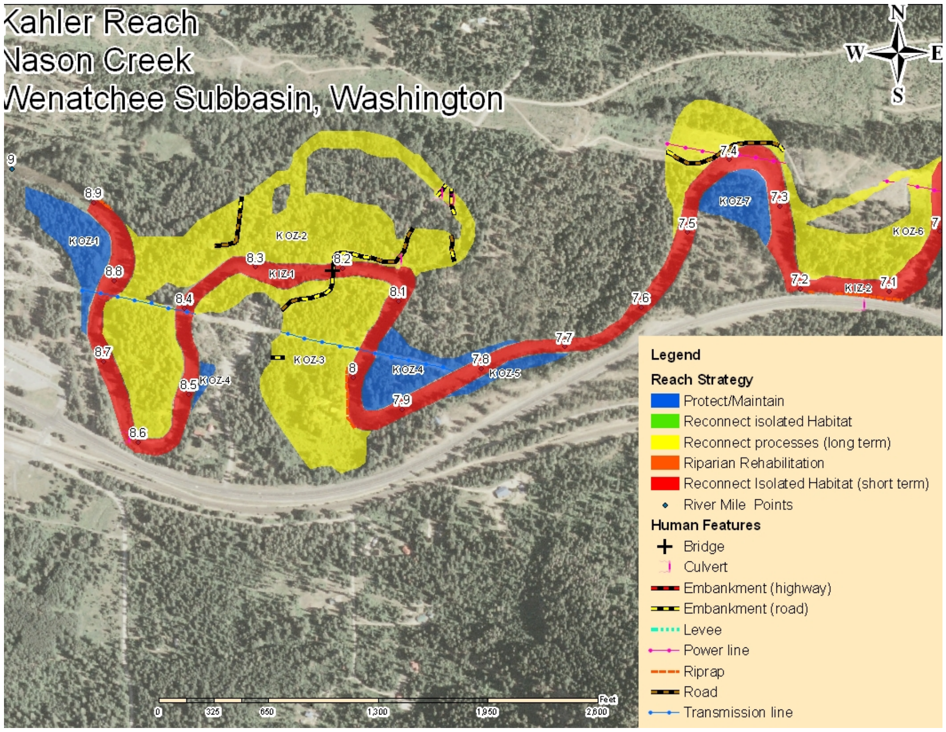

Figure 43 - K IZ-2 and adjacent subreaches in Kahler reach.

Table 35 - Rehabilitation options for K IZ-2.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007). This habitat action should be implemented in conjunction with Riparian rehabilitation: Apply efforts for a long-term approach that will result in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High
2	Rehabilitation + Protection	Riparian rehabilitation: Implement efforts for a long-term approach that results in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Rehabilitation + Protection	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007). Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
4	Rehabilitation	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass. Existing in-stream structures should be evaluated and potentially modified to improve the functionality of refugia and hiding cover, sorting and retention of spawning gravel, and large wood retention. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007). This habitat action should be implemented in conjunction with Riparian rehabilitation: Apply efforts for a long-term approach that will result in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality.	2; Productivity, and Abundance	Low
5	Rehabilitation	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass.	2; Productivity, and Abundance	Low
6	Rehabilitation	Riparian rehabilitation: Apply efforts for a long-term approach that results in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Existing in-stream structures should be evaluated and potentially modified to improve the functionality of refugia and hiding cover, sorting and retention of spawning gravel, and large wood retention. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007).	2; Productivity, and Abundance	Low
7	Protection	Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K IZ-4

Subreach K IZ-4 is about 16 acres in size and comprises a section of the current active channel and bars from RM 4.65 to 5.8 (Figure 44). The dominant process is transition-to-transport. The dominant substrate is gravel and cobble. The subreach channel unit composition is 38 percent runs, 4 percent pools, 3 percent riffles, and 55 percent rapids. Due to the existing functioning conditions of his subreach, it is restoration-oriented.

Anthropogenic features in the subreach include about 950 feet of riprap. The riprap protects Highway 2 and State Highway 207 along the right bank of the active channel. Natural lateral control for the subreach is alluvial fan, terraces with course substrate, and bedrock. Large woody debris is concentrated in a large wood complex at RM 5.3.

Rehabilitation options are listed in Table 36. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

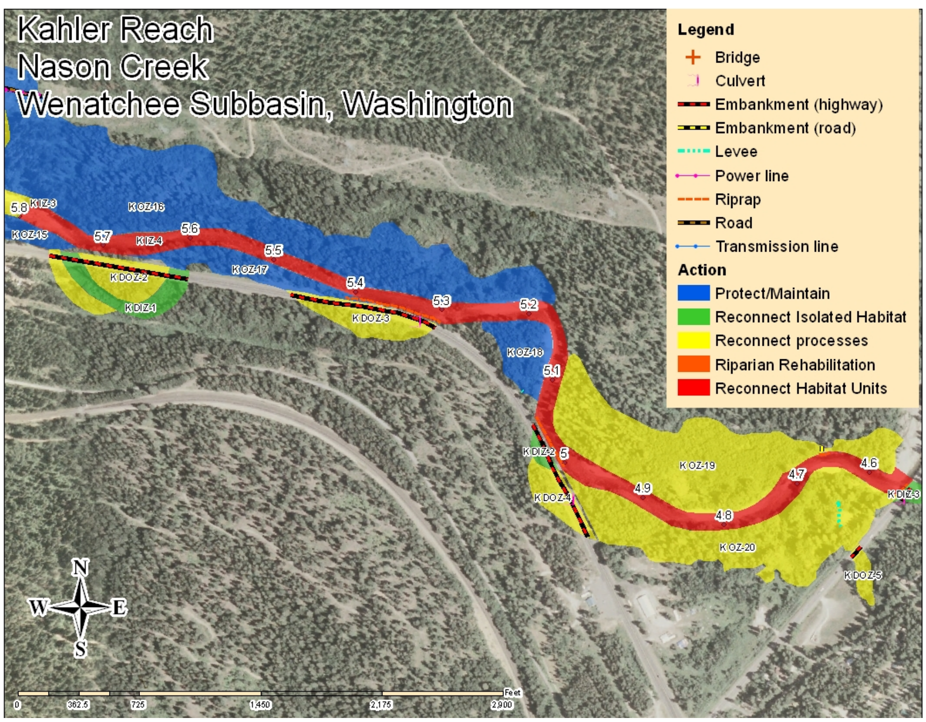

Figure 44 - K IZ-4 and adjacent subreaches in Kahler reach.

Table 36 - Rehabilitation options for K IZ-4.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007). This habitat action should be implemented in conjunction with Riparian rehabilitation: Apply efforts for a long-term approach that will result in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High
2	Rehabilitation + Protection	Riparian rehabilitation: Implement efforts for a long-term approach that results in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Rehabilitation + Protection	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007). Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
4	Rehabilitation	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass. Existing in-stream structures should be evaluated and potentially modified to improve the functionality of refugia and hiding cover, sorting and retention of spawning gravel, and large wood retention. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007). This habitat action should be implemented in conjunction with Riparian rehabilitation: Apply efforts for a long-term approach that will result in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality.	2; Productivity, and Abundance	Low
5	Rehabilitation	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass.	2; Productivity, and Abundance	Low
6	Rehabilitation	Riparian rehabilitation: Apply efforts for a long-term approach that results in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Existing in-stream structures should be evaluated and potentially modified to improve the functionality of refugia and hiding cover, sorting and retention of spawning gravel, and large wood retention. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007).	2; Productivity, and Abundance	Low
7	Protection	Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

K IZ-1

Subreach K IZ-1 is slightly less than 14 acres and comprises a section of the current active channel and bars in the Kahler reach from RM 7.7 to 8.9 (Figure 45). The dominant process is transition-to-deposition. The dominant substrate is gravel and cobble. The subreach channel unit composition is 58 percent runs, 10 percent pools, 30 percent riffles, and 2 percent rapids. Due to the existing functioning conditions of his subreach, it is restoration-oriented.

Anthropogenic features in the subreach include 490 feet of riprap along the left bank at the top of the subreach and near RM 8 along the right bank. A bridge is located just upstream of RM 8.2. Other impacts include four power line crossings throughout the reach and one culvert that allows run off water to enter from the right bank near RM 8.6.

Natural lateral controls for the subreach are higher terraces that confine this subreach to a moderate extent. The existence of riprap and the higher terraces reduce the amount of lateral migration. The result is a decrease in diversity of channel units and reduced instream habitat complexity. Large woody debris counts are low which hinders the creation of complexity at higher flows. It is hypothesized that material begins to deposit during low flow.

Rehabilitation options are listed in Table 37. Options are prioritized to maximize geomorphic potential of the subreach through the reconnection and reestablishment of both long-term and short-term processes at the subreach scale. Rehabilitation actions in this subreach should be considered collectively with rehabilitation actions recommended in other subreaches to achieve a holistic reconnection and reestablishment of processes at the reach scale.

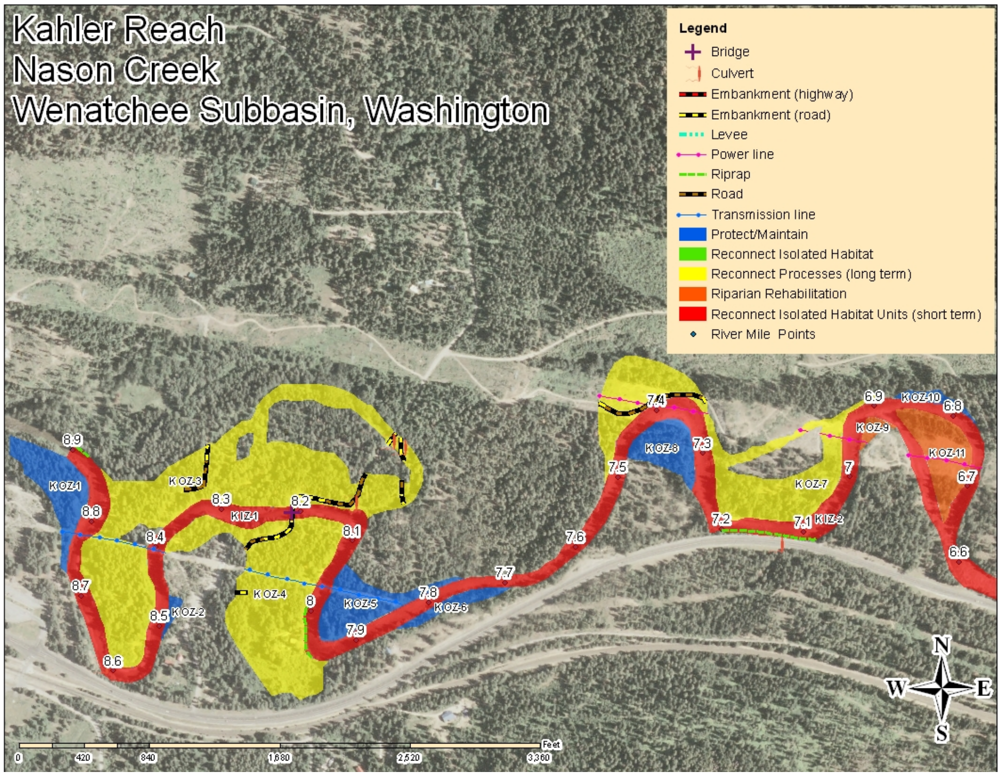

Figure 45 - K IZ-1 and adjacent subreaches in Kahler reach.

Table 37 - Rehabilitation options for K IZ-1.

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
1	Rehabilitation + Protection	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007). This habitat action should be implemented in conjunction with Riparian rehabilitation: Apply efforts for a long-term approach that will result in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	High

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
2	Rehabilitation + Protection	Riparian rehabilitation: Implement efforts for a long-term approach that results in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
3	Rehabilitation + Protection	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007). Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Medium
4	Rehabilitation	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass. Existing in-stream structures should be evaluated and potentially modified to improve the functionality of refugia and hiding cover, sorting and retention of spawning gravel, and large wood retention. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007). This habitat action should be implemented in conjunction with Riparian rehabilitation: Apply efforts for a long-term approach that will result in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality.	2; Productivity, and Abundance	Low
5	Rehabilitation	Reconnect Habitat: Modify riprap with and/or construct large wood complexes to increase retention of incorporated large wood, improve channel complexity, and provide cover and biomass.	2; Productivity, and Abundance	Low

Option	Habitat Action	Prioritized Habitat Actions	VSP Parameters Addressed	Geomorphic Potential
6	Rehabilitation	Riparian rehabilitation: Apply efforts for a long-term approach that results in increased large wood recruitment potential, increased sinuosity, sorting and retention of spawning gravels, increased number of complex pools, and water quality. Existing in-stream structures should be evaluated and potentially modified to improve the functionality of refugia and hiding cover, sorting and retention of spawning gravel, and large wood retention. This is listed as a Tier 1 habitat action in the Biological Strategy (RTT 2007).	2; Productivity, and Abundance	Low
7	Protection	Protect and maintain resulting levels of rehabilitated geomorphic, hydrologic, and riparian function.	4; Productivity, Abundance, Diversity, and Structure	Maintain

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GLOSSARY

Some terms in this glossary appear in this *Reach Assessment.*

TERM	DEFINITION
2D-hydraulic analysis	Information derived from a two-dimensional computer model that calculates the water surface profiles and features or processes (i.e., sediment, water velocity) that may affect stream flows.
adaptive management	A management process that applies the concept of experimentation to design and implementation of natural resource plans and policies.
alluvial fan	A low, outspread, relatively flat to gently sloping mass of loose rock material, shaped like an open fan or a segment of a cone, deposited by a stream at the place where it issues from a narrow mountain valley upon a plain or broad valley, or where a tributary stream is near or at its junction with the main stream, or wherever a constriction in a valley abruptly ceases or the gradient of the stream suddenly decreases; it is steepest near the mouth of the valley where its apex points upstream, and it slopes gently and convexly outward with a gradually decreasing gradient (Neuendorf et al. 2005).
alluvium	A general term for clay, silt, sand, gravel, or similar unconsolidated detrital material, deposited during comparatively recent geologic time by a stream, as a sorted or semi-sorted sediment on the river bed and floodplain (Neuendorf et al. 2005).
anadromous (fish)	A fish, such as the Pacific salmon, that spawns and spends its early life in freshwater but moves into the ocean where it attains sexual maturity and spends most of its life span (Owen & Chiras 1995).
anthropogenic	Caused by human activities.
bedload	The sediment that is transported intermittently along the bed of the river channel by creeping, rolling, sliding, or bouncing along the bed. Typically includes sizes of sediment ranging between coarse sand to boulders (the larger or heavier sediment).
bed-material	Sediment that is preserved along the channel bottom and in adjacent bars; it may originally have been material in the suspended load or in the bed load.
bedrock	A general term for the rock, usually solid, that underlies soil or other unconsolidated, superficial material (Neuendorf et al. 2005). The bedrock is generally resistant to fluvial erosion over a span of several decades, but may erode over longer time periods.

TERM	DEFINITION
canopy cover (of a stream)	Vegetation projecting over a stream, including crown cover (generally more than 1 meter (3.3 feet) above the water surface) and overhang cover (less than 1 meter (3.3 feet) above the water).
cfs	Cubic feet per second; a measure of water flows
channel morphology	The physical dimension, shape, form, pattern, profile, and structure of a stream channel.
channel planform	Characteristics of the river channel that determine its two-dimensional pattern as viewed on the ground surface, aerial photograph, or map.
channel sinuosity	The ratio of length of the channel or thalweg to down-valley distance. Channels with a sinuosity value of 1.5 or more are typically referenced as meandering channels (Neuendorf et al. 2005).
channel stability	The ability of a stream, over time and under the present climatic conditions, to transport the sediment and flows produced by its watershed in such a manner that the stream maintains its dimension, pattern, and profile without either raising or lowering the level of the streambed.
channelization	Alteration of a natural channel typically by straightening and deepening the stream channel to permit the water to move faster, to reduce flooding, or to drain wetlands.
constructed features	Human-made features that are constructed in the river and/or floodplain areas (e.g., levees, bridges, riprap). These features are referred to as human features in the *Map Atlas*.
controls	A feature that is highly resistant to erosion by flowing water and limits the ability of a river or stream to migrate across a valley in either the lateral (horizontal) or vertical direction or both. Geologic controls are naturally occuring features such as bedrock outcrops, landslides, or alluvial fans that erode slowly over long periods of time. Human-constructed features such as highways, railroads, bridge abutments, or riprap may also act as controls and limit the ability of a river to migrate.
degradation	Wearing down of the land surface through the processes of erosion and/or weathering
depositional areas (stream)	Local zones within a stream where the energy of flowing water is reduced and sediment settles out, accumulating on the streambed.
diversity	Genetic and phenotypic (life history traits, behavior, and morphology) variation within a population.
ecosystem	A unit in ecology consisting of the environment with its living elements, plus the non-living factors, that exist in and affect it (Neuendorf et al. 2005).

TERM	DEFINITION
floodplain	The surface or strip of relatively smooth land adjacent to a river channel constructed by the present river in its existing regimen and covered with water when the river overflows its banks. It is built on alluvium, carried by the river during floods and deposited in the sluggish water beyond the influence of the swiftest current. A river has one floodplain and may have one or more terraces representing abandoned floodplains (Neuendorf et al. 2005).
flow regime	The quantity, frequency, and seasonal nature of water flow.
fluvial process	Those processes related to the movement of flowing water that shape the surface of the earth through the erosion, transport, and deposition of sediment, soil particles, and organic debris.
geomorphic potential	The capability of adjustment or change in structural/process components of an ecosystem through the combined action of hydrologic, riparian, and geomorphic regimes to form, connect, and sustain fish habitat over time.
geomorphic province	A large area comprised of similar land forms that exhibit comparable hydrologic, erosional, and tectonic processes (Montgomery and Bolton 2003); any large area or region considered as a whole, all parts of which are characterized by similar features or by a history differing significantly from that of adjacent areas (Neuendorf et al 2005); also referred to as a basin.
geomorphic reach	An area containing the active channel and its floodplain bounded by vertical and/or lateral geologic controls, such as alluvial fans or bedrock outcrops, and frequently separated from other reaches by abrupt changes in channel slope and valley confinement. Within a geomorphic reach, similar fluvial processes govern channel planform and geometry through driving variables of flow and sediment. A geomorphic reach is comprised of a relatively consistent floodplain type and degree of valley confinement. Geomorphic reaches may vary in length from 100 meters in small, headwater streams to several miles in larger systems (Frissell et al. 1986).
geomorphology	The study of the classification, description, nature, origin, and development of present landforms and their relationships to underlying structures, and of the history of geologic changes caused by the actions of flowing water.
GIS	Geographical information system. An organized collection of computer hardware, software, and geographic data designed to capture, store, update, manipulate, analyze, and display all forms of geographically referenced information.

TERM	DEFINITION
habitat action	Proposed restoration or protection strategy to improve the potential for sustainable habitat upon which endangered species act (ESA) listed salmonids depend on. Examples of habitat actions include the removal or alteration of project features to restore floodplain connectivity to the channel, reconnection of historic side channels, placement of large woody debris, reforestation of the low surface, or implementation of management techniques.
habitat connectivity (stream)	Suitable stream conditions that allow fish and other aquatic organisms to access habitat areas needed to fulfill all life stages.
habitat unit	A morphologically distinct area within a geomorphic reach comprised of floodplain and channel areas; typically less than several channel widths in length (Montgomery and Bolton 2003). They generally correspond to different habitat types for aquatic species. Basic channel units may include pools, riffles, bars, steps, cascades, rapids, floodplain features, and transitional zones characterized by relatively homogeneous substrate, water depth, and cross-sectional averaged velocities. *Also known as channel or geomorphic units*.
indicator	A variable used to forecast the value or change in the value of another variable; for example, using temperature, turbidity, and chemical contaminents or nutrients to measure water quality.
inner zone (IZ)	Area where ground-disturbing flows take place; characterized by the presence of primary (perennial) and secondary (ephemeral) side channels, a repetitious sequence of channel units, and relatively uniform physical attributes indicative of localized transport, transition, and deposition.
intevention analysis	Consists of computer models and methods based on samples collected at an impact site before and after an intervention, such as a habitat action, so that effects of the intervention may be determined.
large woody debris (LWD)	Large downed trees that are transported by the river during high flows and are often deposited on gravel bars or at the heads of side channels as flow velocity decreases. The trees can be downed through river erosion, wind, fire, or human-induced activities. Generally refers to the woody material in the river channel and floodplain whose smallest diameter is at least 12 inches and has a length greater than 35 feet in eastern Cascade streams.
limiting factor	Any factor in the environment that limits a population from achieving complete viability with respect to any Viable Salmonid Population (VSP) parameter.
low-flow channel	A channel that carries streamflow during base flow conditions.
mass wasting	General term for the dislodgement and downslope transport of soil and rock under the influence of gravitational stress (mass movement). Often referred to as shallow-rapid landslide, deep-seated failure, or debris flow.

TERM	DEFINITION
overflow channel	A channel that is expressed by no or little vegetation through a vegetated area. There is no evidence for water at low stream discharges. The channel appears to have carried water recently during a flood event. The upstream and/or downstream ends of the overflow channel usually connect to the main channel.
outer zone (OZ)	Area that may become inundated at higher flows but does not experience a ground-disturbing flow; generally coincidental with the historic channel migration zone unless the channel has been modified or incised leading to the abandonment of the floodplain. (also knows as the floodprone zone)
pathways	Interpretation of one or more indicators (i.e., water quality) that is used to define or refine potential environmental deficiencies caused by natural or anthropogenic impacts that negatively affect a life stage(s) of the species of concern (i.e., limiting factor). Pathways are typically analyzed at the reach, valley segment, watershed, and basin scales.
peak flow	Greatest stream discharge recorded over a specified period of time, usually a year, but often a season.
planform	The shape of a feature, such as a channel alignment, as seen in two dimensions, horizontally, as on an aerial photograph or map.
reach-based ecosystem indicators (REI)	Measure of physical variables that are quantifiable and have geospatial reference.
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
response reach	A reach that is more responsive to change and often characterized by unconfined and moderately confined alluvial plains/channels that lack geologic controls which often define confined channels. A response reach can be further broken down to individual subreach units that comprise finer morphologically distinct areas providing geomorphic control and transitional habitat and biological potential.
riparian area	An area with distinctive soils and vegetation community/composition adjacent to a stream, wetland, or other body of water.
riprap	Large angular rocks that are placed along a river bank to prevent or slow erosion.
river mile (RM)	Miles from the mouth of a river or for upstream tributaries; miles from the point where the tributary joins the main river.
side channel	A channel that is not part of the main channel, but appears to have water during low-flow conditions and has evidence for recent higher flow (e.g., may include unvegetated areas (bars) adjacent to the channel). At least the upstream end of the channel connects to, or nearly connects to, the main channel. The downstream end may connect to the main channel or to an overflow channel. May also be referred to as a secondary channel.

TERM	DEFINITION
spawning and rearing habitat	Stream reaches and the associated watershed areas that provide all habitat components necessary for adult spawning and juvenile rearing for a local salmonid population. Spawning and rearing habitat generally supports multiple year classes of juveniles of resident and migratory fish, and may also support subadults and adults from local populations.
subbasin	A subbasin represents the drainage area upslope of any point along a channel network (Montgomery & Bolton 2003). Downstream boundaries of subbasins are typically defined in this assessment at the location of a confluence between a tributary and mainstem channel. An example would be the Twisp River Subbasin.
subreach units	Distinct areas are comprised of the floodplain and off-channel and active-channel areas. They are delineated by lateral and vertical controls with respect to position and elevation based on the presence/absence of inner or outer riparian zones.
terrace	A relatively stable, planar surface formed when the river abandons the floodplain that it had previously deposited. It often parallels the river channel, but is high enough above the channel that it rarely, if ever, is covered by water and sediment. The deposits underlying the terrace surface are alluvial, either channel or overbank deposits, or both. Because a terrace represents a former floodplain, it can be used to interpret the history of the river.
tributary	A stream feeding, joining, or flowing into a larger stream or lake (Neuendorf et al. 2005).
UCSRB	Upper Columbia Salmon Recovery Board
UCRTT	Upper Columbia Regional Technical Team
valley segment	An area of river within a watershed sometimes referred to as a subwatershed that is comprised of smaller geomorphic reaches. Within a valley segment, multiple floodplain types exist and may range between wide, highly complex floodplains with frequently accessed side channels to narrow and minimally complex floodplains with no side channels. Typical scales of a valley segment are on the order of a few to tens of miles in longitudinal length.
vertical migration	Movement of a stream channel in a vertical direction; the filling and raising or the removal or erosion of streambed material that changes the level of the stream channel.
viable salmonid population	An independent population of Pacific salmon or steelhead trout that has a negligible risk of extinction over a 100-year time frame. Viability at the independent population scale is evaluated based on the parameters of abundance, productivity, spatial structure, and diversity.

TERM	DEFINITION
watershed	The area of land from which rainfall (and/or snow melt) drains into a stream or other water body. Watersheds are also sometimes referred to as drainage basins. Ridges of higher ground form the boundaries between watersheds. At these boundaries, rain falling on one side flows toward the low point of one watershed, while rain falling on the other side of the boundary flows toward the low point of a different watershed.