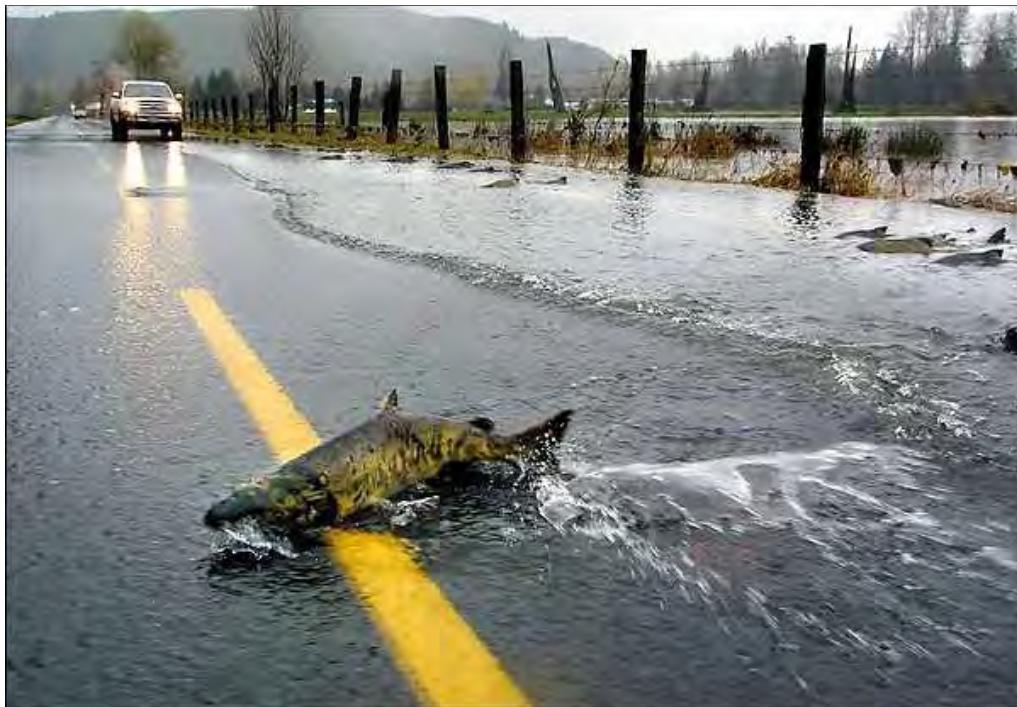


SKOKOMISH RIVER BASIN MASON COUNTY, WASHINGTON ECOSYSTEM RESTORATION



Integrated Feasibility Report and Environmental Impact Statement

April 2015



**US Army Corps
of Engineers®**
Seattle District

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RECORD OF DECISION

SKOKOMISH RIVER BASIN ECOSYSTEM RESTORATION STUDY MASON COUNTY, WASHINGTON

The Final Integrated Feasibility Report and Environmental Impact Statement (FR/EIS) dated April 2015, for the Skokomish River Basin Ecosystem Restoration, incorporated herein by reference, addresses ecosystem restoration opportunities and feasibility in the Skokomish River Basin, Mason County, Washington. The final recommendation is contained in the report of the Chief of Engineers, dated December 14, 2015. Based on these reports, the reviews by other Federal, State and local agencies, Tribes, input of the public, and the review by my staff, I find the plan recommended by the Chief of Engineers to be technically feasible, environmentally justified, cost effective, in accordance with environmental statutes, and in the public interest.

The Final FR/EIS, incorporated herein by reference, evaluated various alternatives that would restore ecosystem processes, structures, and functions in the study area. The recommended plan is the National Environmental Restoration (NER) plan and includes:

- Removal of a levee at the confluence of the North and South Forks of the Skokomish River near river mile 9;
- Installation of large woody debris and engineered logjams on the South Fork Skokomish River, between river miles 9 and 11;
- Reconnection of an historical side channel of the Skokomish River, between river miles 4.5 and 5.5; and,
- Restoration of wetland habitat on the south bank of the Skokomish River between river miles 8.3 and 9.2 (the River Mile 9 site) and river miles 7.5 and 8.0 (the Grange site).
- A Monitoring and Adaptive Management Plan that provides a framework for evaluating the effectiveness of proposed restoration actions and outlines adaptive measures if the project restoration metrics are not met. It includes monitoring to track progress and the triggers for when a new action may be taken to meet restoration objectives.

In addition to a “no action” plan, six alternatives were evaluated. The alternatives included different locations of levee removal, wetland restoration, side channel reconnections, barrier removals, road relocations, and river channel deepening. Based on the comparison of effects presented in the FR/EIS, Alternative #27 (Confluence Levee removal and 7 additional increments) is the Environmentally Preferable Alternative as it has the greatest net benefits to the biological and physical environment. Based on coordination with the public and sponsors, and project feasibility level designs, Alternative #27 contained three increments with insurmountable real estate issues. As such, these features were removed to formulate the recommended plan (Alternative #18). While smaller in scope than the

environmentally preferred alternative, the recommended plan restores the critical needs of the study area, providing year-round flow for fish passage, in channel habitat and complexity, and off-channel refugia and habitat. The recommended plan is supported by the non-Federal sponsors, the Skokomish Indian Tribe and Mason County, Federal and state agencies, and the public.

All practical means to avoid or minimize adverse environmental effects were analyzed and incorporated into the recommended plan. In accordance with section 7 of the Endangered Species Act of 1973, as amended, the U.S. Fish and Wildlife Service and National Marine Fisheries Service confirmed that the recommended plan falls under the parameters of their respective Programmatic Biological Opinions and will not jeopardize the continued existence of federally listed species or adversely modified designated critical habitat. All terms and conditions resulting from these consultations shall be implemented in order to minimize take of endangered species. No compensatory mitigation is required.

The Corps hosted a public meeting to solicit comments on the Draft FR/EIS on March 20, 2014. Public review of the draft FR/EIS was completed on April 7, 2014. All comments submitted during the public comment period were responded to in the Final FR/EIS. A 30-day waiting period of the Final FR/EIS was completed on October 25, 2015. Comments from state and Federal agencies did not result into any changes to the final FR/EIS.

Technical, environmental, economic and cost-effective criteria used in the formulation of alternative plans were those specified in the Water Resources Council's 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable laws, executive orders, regulations, and local government plans were considered in evaluation of alternatives. Based on the review of these evaluations, I find that the recommended plan reasonably maximizes the ecosystem restoration benefits compared to costs and any adverse effects. This Record of Decision completes the National Environmental Policy Act process.

Date

April 18, 2016

Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

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LIST OF ABBREVIATIONS AND ACRONYMS

AAHU	Average Annual Habitat Unit	LWD	Large Woody Debris
ACE	Annual Chance of Exceedance	LOS	Level of service
ATR	Agency Technical Review	MBTA	Migratory Bird Treaty Act
BA	Biological Assessment	MCACES	Micro-Computer Aided Cost Estimating System
BMP	Best Management Practice	MMPA	Marine Mammal Protection Act
CAA	Clean Air Act	MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
CE/ICA	Cost Effective/Incremental Cost Analysis	NAGPRA	Native American Graves Protection and Repatriation Act
CEQ	Council for Environmental Quality	NEPA	National Environmental Policy Act
CEQA	California Environmental Quality Act	NER	National Ecosystem Restoration
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act	NHPA	National Historic Preservation Act
CFS	Cubic feet per second	NMFS	National Marine Fisheries Service
Corps	U.S. Army Corps of Engineers	NOAA	National Oceanic and Atmospheric Administration
CSYU	Shelton Cooperative Sustained-Yield Unit	NOI	Notice of Intent
CY	Cubic yards	NPDES	National Pollutant Discharge Elimination System
CZMA	Coastal Zone Management Act	NRHP	National Register of Historic Places
DAHP	Department of Archaeology and Historic Preservation	NWI	National Wetlands Inventory
DO	Dissolved Oxygen	O&M	Operations and Maintenance
DPS	Distinct Population Segment	ONF	Olympic National Forest
DQC	District Quality Control	PDT	Project Delivery Team
EA	Environmental Assessment	PED	Preconstruction engineering and design
EC	Engineering Circular	PPA	Project Partnership Agreement
ECO-PCX	Ecosystem Planning Center of Expertise	RCO	Recreation and Conservation Office
EFH	Essential Fish Habitat	RM	River Mile
EO	Ecosystem Outputs	SHPO	State Historic Preservation Officer
ER	Engineer Regulation	SMA	Shoreline Management Act
ERDC	Engineer Research and Development Center	SWAT	Skokomish Watershed Action Team
ESA	Endangered Species Act	TCP	Traditional Cultural Properties
EPA	U.S. Environmental Protection Agency	Tribe	Skokomish Indian Tribe
FERC	Federal Energy Regulatory Commission	TSP	Tentatively Selected Plan
FMP	Fishery Management Plan	U&A	Usual and Accustomed
FPPA	Farmland Protection Policy Act	USACE	U.S. Army Corps of Engineers
FR/EIS	Feasibility Report/Environmental Impact Statement	USC	United States Code
FONSI	Finding of No Significant Impact	USFS	U.S. Forest Service
FSM	Feasibility Scoping Meeting	USFWS	U.S. Fish and Wildlife Service
FWCA	Fish and Wildlife Coordination Act	WDFW	Washington State Department of Fish and Wildlife
GHG	Greenhouse Gas	WDNR	Washington State Department of Natural Resources
GI	General Investigation	WDOE	Washington Department of Ecology
HAPC	Habitat Area of Particular Concern	WRDA	Water Resources Development Act
HCCC	Hood Canal Coordinating Council	WRIA	Water Resource Inventory Area
IDC	Interest during construction	WQC	Water Quality Certification
IEPR	Independent External Peer Review		
IWR	Institute for Water Resources		

Executive Summary

This integrated feasibility report and environmental impact statement presents the results of a U.S. Army Corps of Engineers (Corps) Ecosystem Restoration feasibility study undertaken to identify and evaluate alternatives for restoring degraded ecosystem structures, functions, and processes in the Skokomish River Basin, Washington. The Corps is undertaking this action in partnership with Mason County and the Skokomish Indian Tribe. This report provides documentation of the plan formulation process to select a recommended restoration plan, along with environmental, engineering, and cost details of the recommended plan, which will allow additional design and construction to proceed following approval of this report.

The Skokomish River Basin is located on the Great Bend of Hood Canal, a natural fjord-like arm of the Puget Sound and water of national significance identified by the U.S. Environmental Protection Agency (EPA). The Skokomish River is the largest source of freshwater to Hood Canal and of critical importance to the overall health of Hood Canal. The primary concern to be addressed in this study is ecosystem degradation in the Skokomish River Basin, which includes the Skokomish Indian Reservation. High sediment load, reduced flows, and encroachment on the floodplain by human-made structures are causing continued degradation of natural ecosystem structures, functions, and processes necessary to support critical fish and wildlife habitat throughout the basin. The decline in populations has resulted in the listing of four anadromous fish species under the Endangered Species Act (ESA) (e.g., Chinook salmon, chum salmon, steelhead, and bull trout) that use the river as their primary habitat. The impaired ecosystem has adversely affected riverine, wetland, and estuarine habitats that are critical to these and other important fish and wildlife species such as bears, bald eagles, and river otters to name a few.

As part of the planning process for the study, the Project Delivery Team (PDT) identified the ecosystem restoration goals for the study. Providing year-round fish passage near the confluence of the North Fork and South Fork of the Skokomish River as well as improving the quantity, quality, and complexity of pools were identified as priority objectives for the study. The PDT, in coordination with interested stakeholders and the public, developed a series of measures and alternatives for consideration as potential elements of the project solution. The array of alternatives was formulated based on preliminary data collection and analysis as well as best professional judgment. The study team identified 60 potential restoration sites and completed multiple rounds of screening to identify which sites meet the priority objectives of the study. Each alternative was formulated to include a “base” measure that addresses these critical needs of the study area. Incremental measures (e.g., side channel reconnections, wetland restoration, and placement of large woody debris) were added to these bases to capture supplementary benefits associated with restoration of additional habitat features.

The PDT developed preliminary cost estimates for each site and calculated habitat benefits that could accrue from restoration measures. Habitat benefits were calculated using the Skokomish River Ecosystem Benefits Model, a habitat suitability index model accounting for the quality and quantity of available habitat for salmonids (an indicator species for overall ecosystem health in the Pacific Northwest). The preliminary costs and habitat benefits were used in a Cost Effectiveness and

Incremental Cost Analysis (CE/ICA) to identify alternatives that provide high levels of habitat benefit relative to the costs. The CE/ICA was a primary element used to select the recommended restoration plan.

A recommended restoration plan was selected that includes a levee removal, a side channel reconnection, wetland restoration at two sites, and placement of large woody debris. The total area of the proposed sites included in the recommended plan is approximately 277 acres, the average annual habitat units are estimated at 187, and the total estimated project first cost of the recommended plan is \$19,343,000 (October 2014 price level), which includes monitoring costs of \$374,000 and adaptive management costs of \$127,000. The fully funded cost estimate to the midpoint of construction is \$21,712,000. Minimal operations, maintenance, repair, rehabilitation, and replacement (OMRR&R) expenses is estimated to be \$10,000 per year. The current Federal portion of the cost is \$12,573,000 and the non-Federal sponsors' portion is \$6,770,000, or 65 and 35 percent of the total estimated cost respectively (October 2014 price level). The recommended plan reasonably maximizes environmental benefits considering cost effectiveness and incremental cost analyses, significance of outputs, completeness, efficiency, effectiveness, and acceptability. The alternative referred to as the recommended plan in this document is the agency preferred alternative as it is called under the National Environmental Policy Act (NEPA).

No compensatory mitigation is included in the recommended plan as none is required. During construction, there could be temporary adverse effects such as increases in turbidity, temporary clearing of vegetation, and handling of fish for removal from construction areas. These effects would be minimized by providing erosion and pollution control best management practices and conducting all fish salvage and removal activities according to State and Federal requirements. Conservation measures would be implemented during construction to minimize effects to ESA-listed species.

The recommended plan is one element of an integrated restoration effort in the entire Skokomish River watershed and was conceived as part of a comprehensive restoration effort to help address more chronic, systemic problems such as aggradation. The overall cumulative effects of the recommended plan would be synergistic benefits to all aquatic species through process-based restoration in the lower Skokomish River. The benefits of increasing the number and size of in-channel pools, placing enough large woody debris (LWD) to mimic quantities in nearby more natural rivers, reconnecting aquatic habitats in the adjacent floodplain, and greatly increasing the acreage of riparian zones along the river is predicted to provide substantial benefits to fish and wildlife habitat, especially for salmon species.

1. Introduction

This report documents the planning process for ecosystem restoration in the Skokomish River Basin, Washington, to demonstrate consistency with U.S. Army Corps of Engineers (Corps) planning policy and to meet the regulations that implement the National Environmental Policy Act (NEPA). The following sections provide background information regarding the basis for this study. The sections that are required for NEPA compliance are denoted with an asterisk (*).

1.1 Study Purpose and Scope

The purpose of the Skokomish River Basin feasibility study is to evaluate significant ecosystem degradation in the Skokomish River Basin; to formulate, evaluate, and screen potential solutions to these problems; and to recommend a series of actions and projects that have a Federal interest and are supported by a local entity willing to provide the necessary items of local cooperation.

The Skokomish River Basin is located on Hood Canal, a natural fjord-like arm of the Puget Sound and water of national significance. The Skokomish River is the largest source of freshwater to Hood Canal as it flows into Annas Bay and is of critical importance in the overall health of Hood Canal. Environmental degradation can be seen throughout the Skokomish River Basin including a loss of natural ecosystem structures, functions, and processes necessary to support critical fish and wildlife habitat. Four anadromous fish species (Chinook salmon, chum salmon, steelhead, and bull trout) that use the river as their primary habitat are listed under the Endangered Species Act (ESA) and have experienced population declines. The impaired ecosystem has adversely affected riverine, wetland, and estuarine habitats that are critical to these and other listed species. The underlying need for development of a plan for process-based ecosystem restoration in the Basin has arisen from recognition and analysis of these problems. Process-based restoration in aquatic ecosystems seeks to remove human-made stressors from the channel and landscape so that natural ecosystem forces are allowed the freedom to influence the aquatic environment longitudinally in the channel, laterally across the floodplain, and vertically through the riparian zone.

Since the completion of the Reconnaissance Phase (USACE 2000), continued flooding of the Skokomish Valley has led to significant interest in pursuing a multi-purpose feasibility study (addressing ecosystem restoration and flood risk management) by the public. Mason County has been proactive in flood mitigation projects collaborating with the Federal Emergency Management Agency, the State of Washington's Emergency Management Division and the Department of Ecology (WDOE). Past Corps studies (USACE 1988, 1995) indicate a low benefit-to-cost ratio for flood risk management alternatives. More recent economic analyses indicate very low expected annual flood damages due to the rural nature of the study area and implementation of previous flood risk management projects by Mason County including residential acquisitions (buy-outs), strict development/zoning regulations, implementation of a flood warning system and evacuation plan, and raising of structures in the floodplain. Based on these developments, the non-Federal sponsors and study team have agreed to continue to pursue a single-purpose (ecosystem restoration) feasibility study. Although the study is a single-purpose study focusing on ecosystem restoration, the recommended plan has been formulated and designed to ensure flood heights in the study area will not cause significant changes in future with-

project flood conditions compared to future without-project conditions. Additionally, local and State government agencies will continue locally funded flood damage reduction efforts to achieve local flood risk management goals, such as preserving local business, communities, and historic land uses. Section 4.3.1 and Section 4.3.2 discuss the existing and forecasted flood conditions in the study area absent a Corps flood risk management project.

1.2 Study Authority*

The Feasibility Study for the Skokomish River Basin is being conducted under the Authority of Section 209 of the River and Harbor Act of 1962, Public Law 87-874 (Puget Sound and Adjacent Waters):

"The Secretary of the Army is hereby authorized and directed to cause surveys for flood control and allied purposes, including channel and major drainage improvements, and floods aggravated by or due to wind or tidal effects, to be made under the direction of the Chief of Engineers, in drainage areas of the United States and its territorial possessions, which include the following named localities: Provided, That after the regular or formal reports made on any survey are submitted to Congress, no supplemental or additional report or estimate shall be made unless authorized by law except that the Secretary of the Army may cause a review of any examination or survey to be made and a report thereon submitted to Congress, if such review is required by the national defense or by changed physical or economic conditions: Provided further, That the Government shall not be deemed to have entered upon any project for the improvement of any waterway or harbor mentioned in this title until the project for the proposed work shall have been adopted by law:

Puget Sound, Washington, and adjacent waters, including tributaries, in the interest of flood control, navigation, and other water uses and related land resources."

Seattle District Office of Counsel has confirmed the appropriateness of this authority with USACE Headquarters Office of Counsel. The Act's reference to "other water uses and related land resources" provides sufficient authority to study ecosystem restoration opportunities in the Skokomish River Basin.

1.3 Lead Federal Agency and Non-Federal Sponsors*

The study documented herein has been conducted jointly by the Corps (lead Federal agency) and two non-Federal sponsors, Mason County (County) and the Skokomish Indian Tribe (Tribe). As the non-Federal sponsors, the County and Tribe contribute 50 percent of the total feasibility study costs in the form of cash or in-kind contributions; a feasibility cost sharing agreement was signed in 2006.

1.4 Cooperating Agencies*

Prior to the Feasibility Scoping Meeting on October 7, 2010, the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) expressed willingness to consider a cooperating agency role. Although they declined upon formal invitation, both agencies remain actively involved in the study.

1.5 Location of the Study Area*

The Skokomish River Basin is located on the Olympic Peninsula in northwestern Washington (Figure 1-2). The study area is approximately 11 square miles comprised of the lower Skokomish watershed, the

Skokomish Valley, and Skokomish River estuary (Figure 1-2). The area is characteristic of the enormous beauty and versatile environment of Hood Canal and Puget Sound.

The Skokomish watershed drains approximately 230 square miles from three major tributary basins, the North Fork (118 square miles), the South Fork (76 square miles) and Vance Creek (29 square miles). The river collects flow from these steep, mountainous basins and drains into a flat, alluvial plain approximately $\frac{3}{4}$ to $1\frac{1}{2}$ miles wide known as the Skokomish Valley. Richert Springs, Hunter, Weaver, and Purdy Creeks are predominantly spring fed tributaries that flow through agricultural lands in the southern portion of the Skokomish Valley floodplain before entering the mainstem Skokomish River. The Skokomish River mainstem flows through the Skokomish Valley to the Skokomish estuary, consisting of the mouth of the Skokomish River and the delta that is tidally influenced. It is the largest and most complex river estuary in Hood Canal. The Skokomish River empties into Annas Bay at the southern end of Hood Canal, an arm of Puget Sound.

The Skokomish Valley has a population of approximately 730 residents (2011 Census) with an economy dominated by rural agriculture. The lower six miles of the river, including a substantial portion of the estuary, are located on the 4,950-acre Skokomish Indian Reservation. There are two privately owned hydroelectric dams near the project area, Cushman Dams 1 and 2, which impound flows on the North Fork Skokomish River, and which have historically influenced flows in the lower reach of the river.

The Skokomish River Basin is a large and complex watershed. Numerous Federal, State, and local agencies are working within their individual authorities to implement restoration projects throughout the watershed. While existing restoration efforts will have localized benefits, a need for action by the Corps still exists. The Corps has a unique opportunity to address problems in the Lower South Fork, Skokomish River mainstem, and tributaries (Weaver Creek, Vance Creek, and Purdy Creek) where many impacts from the upper watershed are manifested and where a number of significant ecosystem restoration opportunities exist. As a result, the study area for the General Investigation (GI) will focus on the lower 11 miles of the river. Figure 1-1 and Figure 1-2 show the location of the Skokomish River Basin and GI study area.

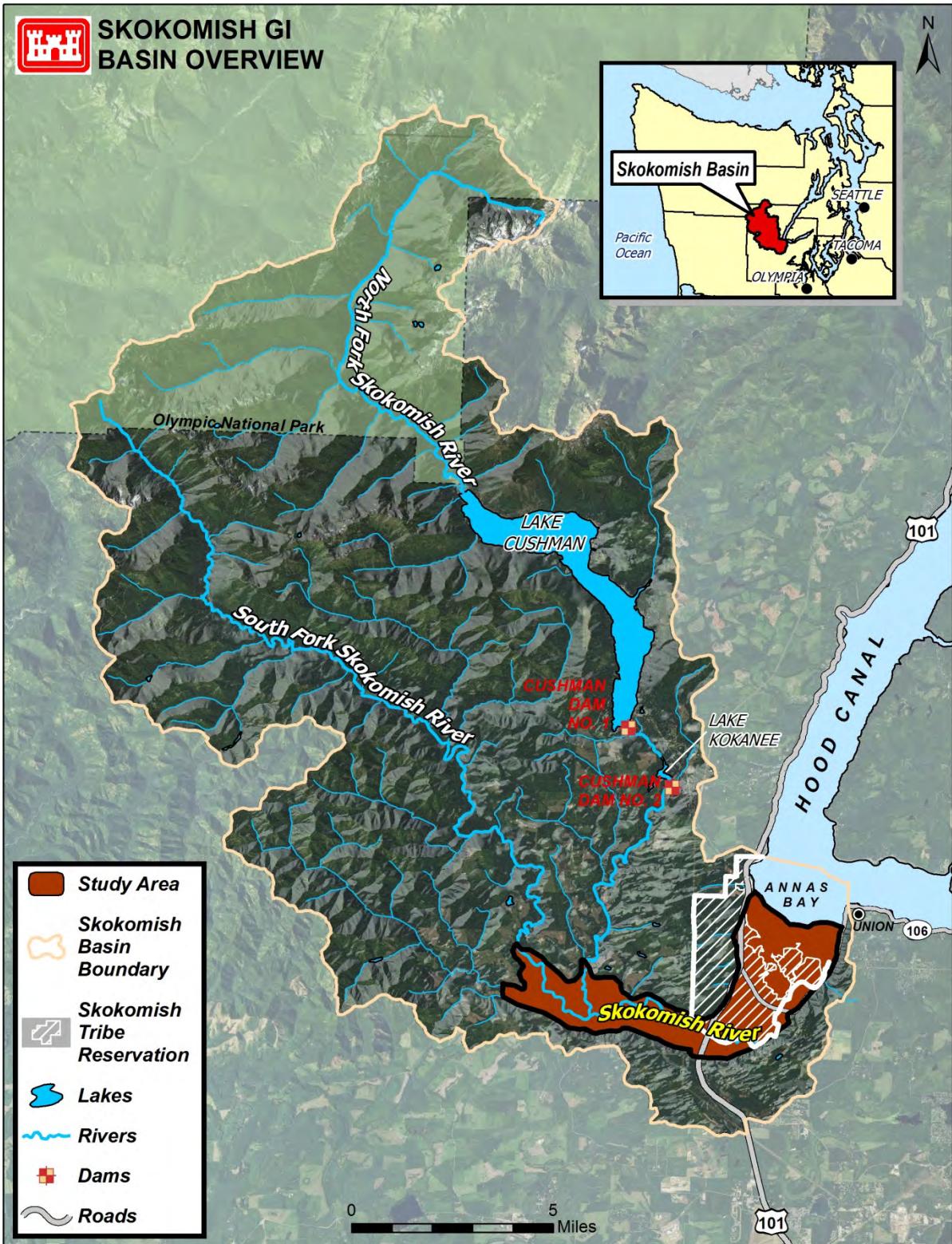


Figure 1-1. Skokomish River Basin Overview

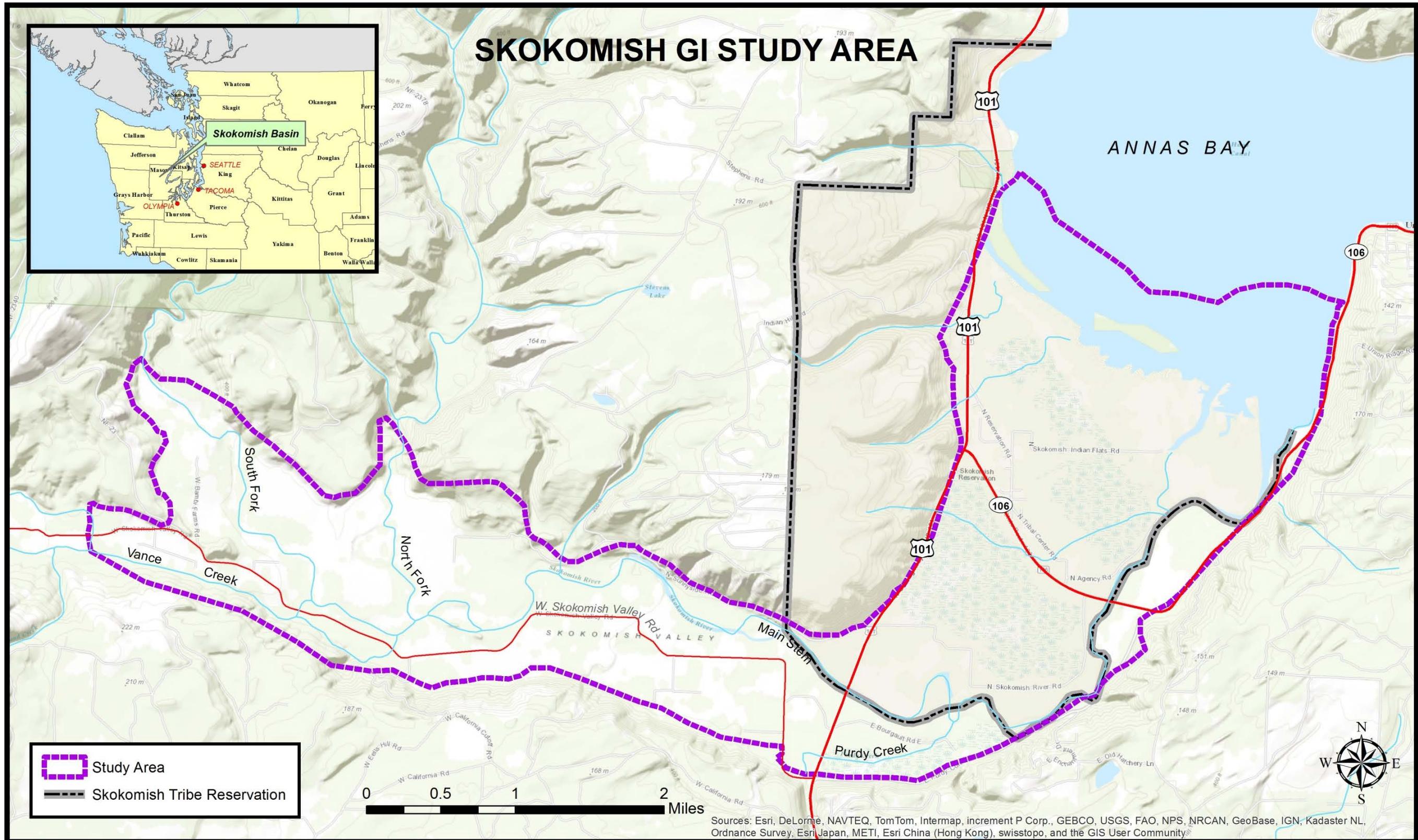


Figure 1-2. Skokomish River Basin GI: Study Area

1.6 Proposal for Federal Action*

The proposal to implement ecosystem restoration in the Skokomish River Basin triggered the NEPA process recorded in this document (40 CFR 1501.2). Based on study results, the Corps is proposing restoration of the Skokomish River in the lower Skokomish Valley. The proposed Federal (Corps) action area is focused on the lower Skokomish Valley because various Federal, State, and local agencies as well as private entities are addressing problems within their individual authorities and in specific areas of the upper watershed as well as the estuary. The Corps has a unique opportunity to address problems in the Lower South Fork, Skokomish River mainstem, and tributaries (Weaver Creek, Vance Creek, and Purdy Creek) where many impacts from the upper watershed are manifested and where a number of significant ecosystem restoration opportunities exist.

1.7 Overview of Integrated FR/EIS

This document is a combined Feasibility Report and Environmental Impact Statement (FR/EIS). The purpose of the feasibility report is to identify the plan that reasonably maximizes ecosystem restoration benefits, is technically feasible, and preserves environmental and cultural values. The purpose of the EIS portion of the report is to identify and present information about any potentially significant environmental effects of the alternatives and to incorporate environmental considerations into the decision-making process. The six steps of the Corps planning process each align with a NEPA requirement. The list of planning steps appears below with the document chapter and NEPA element to which they relate:

Table 1-1. Overview of FR/EIS

Planning Step:	Analogous NEPA Requirement & Document Chapter:
Step One: Problems and Opportunities	Purpose and Need for Action; Chapter 2
Step Two: Inventory and Forecast of Conditions	Affected Environment; Chapter 4
Step Three: Formulate Alternative Plans	Alternatives including Proposed Action; Chapter 3
Step Four: Evaluate Effects of Alternative Plans	Environmental Consequences; Chapter 4
Step Five: Compare Alternative Plans	Alternatives including Proposed Action; Chapter 3 and 4
Step Six: Select Recommended Plan	Agency Preferred Alternative; Chapter 5

2. Need for and Objectives of Action

This chapter presents results of the first step of the planning process, the specification of water and related land resources problems and opportunities in the study area. The chapter also establishes the planning objectives and planning constraints, which are the basis for formulation of alternative plans.

2.1 Problems and Opportunities

The primary concern this study addresses is ecosystem degradation in the Skokomish River Basin, which includes public and private lands and the Skokomish Indian Reservation. Alteration of the river environment and encroachment on the floodplain by human-made structures have degraded and continue to affect natural ecosystem structures, functions, and processes necessary to support critical fish and wildlife habitat throughout the basin. The degraded stream, wetland, and riparian habitat cannot support a healthy population of critical fish and wildlife species.

Historically, the Skokomish River system produced the largest runs of salmon and steelhead in Hood Canal (Correa 2003). Since the settlement of the Skokomish Valley in the 1850s by European and American settlers, human activities have altered the Skokomish River's hydraulic and geomorphic processes and reduced the fisheries resource. Specific anthropogenic impacts to the Skokomish River Basin include the following:

- Removal of large woody debris (LWD) simplified the stream habitat by reducing the occurrence of pools, caused loss of nutrients and substrate to support aquatic insects, and removed the complex rootwad structures that allow juvenile fish to hide from predators. Pools are critical habitat as sheltered areas for spawning adults to rest and for juvenile salmon to rear. Aquatic insects are an important component of a healthy aquatic ecosystem and are the primary food source for juvenile salmonids rearing in the river. LWD is essential for supporting these ecosystem components.
- Removal of the riparian forest has reduced the supply of LWD, overhanging vegetation that provides food sources for terrestrial and aquatic insects, and shade cover (approximately 62% of the mainstem is sparsely vegetated). Leaf and litter fall from overhanging vegetation provides food for aquatic insects, and drops terrestrial insects into the river where they become fish food. The loss of shade cover has contributed to high water temperatures during the summer, which causes stress to adults on their spawning migration and reduces the growth rate of juveniles rearing in the river and off-channel habitats. The substantial loss of riparian forest has reduced these beneficial inputs to the aquatic ecosystem.
- Intensive logging activities that disturbed and destabilized the stream banks reduced streamside vegetation due to erosion. This prevents new vegetation from establishing to provide energy inputs to the river, and the erosion causes sedimentation downstream that can smother salmon eggs or settle at tributary mouths and reduce their accessibility for fish. The accumulation of sediment in the riverbed has resulted in an unfavorable width to depth ratio such that the main channels are too shallow to support good habitat for salmon, and sediment has filled in nearly all the high value pool habitat.

- Protection of agricultural lands from erosion led to construction of bank protection measures. Those measures stopped natural channel migration, which reduces the rate of habitat creation in the river and in the floodplain.
- Logging activities in the South Fork and Vance Creek watersheds may have increased the upper basin sediment supply that is accumulating in the river reaches of the study area. This accumulation of gravel in the riverbed has resulted in cutting off access to aquatic habitats in the floodplain. Such side channel closures eliminated fish access to slack water, an important rearing habitat that supports more juvenile fish than do medium and higher velocities, and important spawning habitat for chum and coho salmon.
- The Cushman Dam Project, channel straightening, and levees have, to varying degrees, reduced ecosystem functions and habitat availability for all riverine fish species and the aquatic-oriented mammals such as beaver, river otter, and mink (construction of Cushman Dam blocked 25% of mainstem habitat and 18% of tributary habitat available to salmon).
- The removal of LWD, disturbance of the stream banks, bank protection, and side-channel closures have all contributed to altering the bedload transport and deposition in the South Fork, Vance Creek, and the mainstem Skokomish River. In addition, flow regulation by the Cushman Project has altered bedload transport and deposition in the mainstem Skokomish River. A significant problem of the sediment accumulation is that the river dries up for a mile for nearly two months each year in the late summer. This poses a total block for upstream and downstream fish migration, and can prevent salmon from reaching their spawning grounds in time to spawn before dying.
- The U.S. Highway 101 and State Route 106 road embankments disrupt overbank flood flows and reduce habitat connectivity. Connections from the mainstem to the aquatic habitats in the adjacent floodplain are highly important for fish to find additional food sources, spawning habitat, and low velocity refuge, as well as pathways back into the mainstem after floodwaters carry them out of the main channel.

The effects outlined above have led to the degradation of ecosystem processes, structures, and functions in the Skokomish Basin. Four ESA-listed salmonid species are represented in six unique populations in the study area; two of these six stocks are already extirpated from the Skokomish River. The major problem affecting salmon survival and migration is extensive aggradation in the South Fork and mainstem riverbeds. One reach of the South Fork Skokomish River near the North Fork confluence started running subsurface in late summer months (Figure 2-1, top row) about 10 years ago. Abundance estimates of coho, chum, Chinook, and steelhead have dropped dramatically since 2004 (Skokomish Tribe 2013). This relatively new blockage problem delays or completely precludes some adult salmon access to upstream habitat and spawning areas preventing successful spawning, and delays juvenile migration downstream to the abundant food sources of the estuary. Additionally, low channel capacity leads to frequent flooding of the river, transporting juvenile and adult salmon out of the river, and stranding them in the floodplain to die during even modest flow events (Figure 2-1, bottom row). Finally, altered bedload deposition causes instability of the gravel bed in the river, the shifting pattern of the

riverbed, and riverbed aggradation, ultimately producing annual changes in spawning gravel locations and negatively affecting spawning success for some of the salmon stocks.



Figure 2-1. Existing Conditions in the Skokomish River. Top Row: Riverbed aggradation blocks fish passage during migration season for some species and limits the availability of high quality pool habitat. Bottom row: Limited channel capacity also leads to frequent flooding of the river, causing fish stranding and mortality.

Based on the above-mentioned anthropogenic impacts, the study team identified the following problems during the early stage of this study:

1. In the Skokomish Basin, salmon populations have been impaired so greatly by anthropogenic actions that two of the ESA-listed populations have been extirpated from the system. Detrimental actions have included channel alterations, large wood removal, overfishing, and the conversion of forestland to agriculture.
2. Aggradation causes areas of the South Fork Skokomish River to run subsurface during the summer low flow period, which blocks passage for endangered fish species during the migration season.
3. Aggradation in the Skokomish River has reduced channel capacity in the mainstem, which causes frequent overbank flows and stranding fish during even modest flow events.

4. Connections of the Skokomish River main channel to side channels, tributaries, and backwater habitats have been reduced due to numerous anthropogenic impacts and land management activities including dam construction, flow diversion, levee construction, and channelization.
5. The Skokomish River mainstem and tributaries lack high quality and complex habitats including pools, side-channels, hiding places, and floodplain habitats because of levee and dike construction, closure of side channels and sloughs, agricultural development, and the removal of large woody debris and riparian vegetation.

Opportunities to address problems for this study include the following:

1. Restore degraded ecosystem structures, functions, and dynamic processes of the Skokomish River for the benefit of four ESA-listed salmonid species.
2. Restore a continuous low flow channel in the Skokomish River to maintain fish passage during summer low flow periods.
3. Restore channel capacity to rebuild critical habitat for ESA-listed salmonid species.
4. Restore the connection of the Skokomish River mainstem to side channels and tributaries.
5. Return habitat quality, complexity, and functionality of the Skokomish River system to a less degraded, more natural state.
6. There is potential for ecosystem projects that secondarily contribute to local flood risk management goals.

2.2 Purpose and Need for Action*

The need for the proposed Federal action arises from the significant degradation of natural processes that sustain the ecological functions of the watershed as described in the previous section. The purpose for the proposed Federal action is to work within the defined study area to enact solutions within the Corps' authority to restore ecosystem process, structure, and function in the aquatic environment by addressing the primary problems identified during the feasibility study. Effort toward improving the aquatic ecosystem should include addressing lack of wetland and side-channel connections, increasing channel complexity, increasing large woody debris, increasing pool depth and frequency, restoring degraded riparian conditions, improving conditions in the reach of the river that dries up each summer, and improving channel capacity to the maximum extent practicable. Restoration of ecosystem structures, functions, and processes will benefit nationally significant resources in the study area.

2.3 Resource Significance – Technical, Institutional, Public

The Skokomish River is the largest and most diverse tributary to Hood Canal, a 70-mile-long natural fjord-like arm of Puget Sound that supports vital natural resources. Significant environmental resources in the Skokomish River Basin have declined to a point that the ecosystem may no longer be self-sustaining without immediate intervention to curtail considerable ecological degradation. These resources are technically, institutionally, and publicly significant as described in the following sections.

2.3.1 Technical Significance

The Pacific Northwest ecoregion is home to many species of the Salmonidae family. These fish serve as an indicator of the overall health of not only the aquatic environment where they dwell, but also the

connected riparian, wetland, and upland habitats. A comprehensive restoration plan for all species in the Salmonidae family, as keystone species, can provide direct and indirect benefits for a broad suite of over 130 other native plant and animal species (Cederholm et al. 2000). Keystone species play a unique and crucial role in the way an ecosystem functions; these fish are extremely sensitive to changes in water quality, trophic webs, and perturbations to the river flow, turbidity, and temperature. Pacific salmon are a food source for a variety of marine, freshwater, and land animals and provide a source of marine-derived nutrients to freshwater environments after spawning (Cederholm et al. 1999). Juvenile salmonids feed on aquatic invertebrates that are indicators of water quality. Additionally, ESA-listed Orca whales, a top predator and iconic species of the Puget Sound region, have been recorded following and feeding on adult Skokomish-bound salmon.

Generally, the more pristine, diverse, and productive the ecosystem is, the healthier the salmon stocks. A decline in the capacity of a watershed to support juvenile salmonids is one indication of declining ecosystem health. Restoration planning centered on habitat for the Salmonidae family reinstates dynamic processes that tend to maintain healthy ecosystem characteristics.

Wetlands in the Skokomish watershed provide significant ecological functions including rearing and resting sites for aquatic and land species, natural drainage, storage areas for floodwater, groundwater discharge areas critical to summer low flow, and significant water purification functions through natural filtration. The wetlands associated with the Skokomish River benefit water quality in Hood Canal.

2.3.2 Institutional Significance

Four ESA-listed fish species of the Puget Sound area occur in the Skokomish River. These are represented by six unique populations: Spring and fall Chinook salmon, Hood Canal summer chum salmon, winter and summer steelhead, and bull trout. Two specific runs of salmon, summer chum salmon and spring Chinook, have been extirpated from the Skokomish River. The decline of these particularly sensitive species indicates degradation of environmental health of the Skokomish River and Hood Canal aquatic systems, representing an urgent need to address degradation in the study area. NMFS designated Essential Fish Habitat (EFH) within the South Fork Skokomish watershed under the Magnuson-Stevens Fishery Conservation and Management Act (NMFS 2002). EFH includes all Chinook, coho, and pink salmon habitat.

Puget Sound is an estuary of national significance identified by the U.S. Environmental Protection Agency (EPA) and encompasses a highly interactive system that depends on the continuing cycle of clean water and nutrients to sustain its biological character. As the largest source of freshwater to Hood Canal, improving the health of the Skokomish River watershed is critical to the overall health of Hood Canal, which forms a significant portion of Puget Sound. Restoration of the Skokomish will contribute to the larger mission of the Puget Sound Partnership, a State agency whose primary goal is to restore Puget Sound by 2020. The Puget Sound Partnership's Action Agenda identifies a number of vital sign indicators and recovery targets for Puget Sound as well as identification of near-term actions and performance measures for Hood Canal salmon recovery.

The Skokomish Tribal Reservation is located at the mouth of the Skokomish River. The multiple species of fish and shellfish resources in the Skokomish River play an integral part of tribal culture, religion, and

physical sustenance. The Skokomish Indian Tribe has treaty-protected harvest rights within their Tribe's usual and accustomed (U&A) harvest area, which reflects the historical region in which finfish, shellfish, and other natural resources were collected. As a Federal agency, the Corps has a Federal trust responsibility to act in the Tribes' best interests, including duties to protect Tribal lands and cultural and natural resources. In addition to supporting the feasibility study as a cost-sharing non-Federal sponsor, the Skokomish Indian Tribe has invested funds in restoration of the Skokomish River estuary through the Estuary Restoration Act and continues to support restoration of the Skokomish River Basin.

2.3.3 Public Significance

Members of the public have recognized the significance of the Skokomish River's resources both formally and informally. Ecosystem restoration was a common theme in comments received during the NEPA scoping period (beginning in September 2010) as well as during public meetings held throughout the course of the study. In addition to the numerous comments and letters of concern from members of the public, multiple partnerships have formed to acknowledge and advocate for restoration of the resources of the Skokomish River Basin. Strong, durable partnerships have formed in the Skokomish watershed and beyond that seek to halt worsening conditions and restore the river's ecosystem. The Skokomish Watershed Action Team (SWAT) – a diverse, informal partnership of governments, land managers, the public, and others (including representatives from the Mason County Conservation District, WDOE, NMFS, Green Diamond Resource Company, Olympic Forest Coalition, Hood Canal Coordinating Council, The Wilderness Society, and more) are working collaboratively to restore a healthy Skokomish watershed. This extraordinary collaborative effort and recognition of a need for restoration is indicative of the public significance of the resources of the Skokomish River.

The Skokomish Valley is the largest agricultural area in Mason County with a long history of agricultural production. Agriculture in the Skokomish Valley is of public importance and declining productivity in the study area is a significant concern. Proposed ecosystem restoration projects presented in this report are intended to be compatible with ongoing farming and agricultural practices and were not formulated to deliberately impact agricultural production in the Skokomish Valley. Ecosystem restoration projects implemented in conjunction with local flood risk management projects, agricultural best management practices, and other actions throughout the watershed are intended to more holistically restore the Skokomish River Basin for the benefit of both humans and ecosystem resources.

Table 2-1 summarizes the technically, institutionally, and publicly valued resources in the study area.

Table 2-1. Technical, Institutional, and Public Significance

Technical Significance	Institutional Significance	Public Significance
<ul style="list-style-type: none"> ✓ Salmon – keystone species; indicators of overall ecosystem health ✓ Wetlands – improve water quality and support unique flora and fauna 	<ul style="list-style-type: none"> ✓ Four ESA-listed salmon species represented in six unique populations ✓ Puget Sound – estuary of national significance (CEQ) ✓ NMFS Essential Fish Habitat ✓ Tribal Trust Responsibility 	<ul style="list-style-type: none"> ✓ NEPA Scoping – Public concern for ecosystem restoration ✓ Skokomish Watershed Action Team

2.4 National Objective

The Federal objective of water and related land resources project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. The objective of ecosystem restoration is to restore degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. Ecosystem restoration aims to reverse the adverse impacts of human activity and restore ecological resources, including fish and wildlife habitat, to as close to previous levels of productivity as feasible, but not a higher level than would have existed under natural conditions in the absence of human activity.

2.5 Planning Objectives

Based on the problems identified in the study area, planning objectives include the following and consist of an effect, subject, location, and timing per Engineer Regulation (ER) 1105-2-100:

- Provide year-round passage for fish species around the confluence of the North Fork and South Fork Skokomish River for the 50-year period of analysis.
- Reconnect and restore the spawning, rearing, and refuge habitats in the study's side channel and tributary networks including Hunter and Weaver Creeks for the 50-year period of analysis.
- Improve the quantity, quality, and complexity of native riparian and floodplain habitats in the study area for the 50-year period of analysis.
- Improve the quantity, quality, and complexity of pools in the Skokomish River to promote spawning and rearing success, as well as reduce stranding of ESA-listed salmonid species for the 50-year period of analysis.

Table 2-2 shows which problem each objective addresses.

Table 2-2. Restoration Objectives and the Problems they Address

Objectives	Problems in the Study Area				
	Year-round passage is blocked during summer low-flow period	Reduced channel capacity causes frequent floods and fish stranding	Disconnected and degraded side channel and tributary networks	Lack of high quality and complex in-channel and floodplain habitats	
Provide year-round passage near confluence	X				
Restore side channel and tributary network			X	X	
Improve riparian and floodplain habitats			X	X	
Improve quantity, quality, and complexity of pools	X	X			

2.6 Planning Constraints

Planning constraints are significant barriers or restrictions that limit the extent of the planning process. Study-specific planning constraints are statements of things unique to a specific planning study that alternative plans should avoid. The following constraints (i.e. limitations on the range of measures and alternatives that can be proposed) have been identified for the study:

1. Cushman Settlement Agreement: The Federal Energy Regulatory Commission (FERC) Settlement Agreement related to Cushman Dam (the “Cushman Settlement Agreement”) affects the existing condition, future without-project condition, and future with-project condition for this study. NMFS, Tacoma Public Utilities, the Skokomish Indian Tribe, and State and other Federal agencies (excluding USACE) signed a settlement and relicensing agreement for Tacoma Power’s Cushman Hydroelectric Project in 2009. The agreement resolved a \$5.8 billion damages claim and long-standing disputes over the terms of a long-term license for Cushman Dam. The licensing settlement agreement concludes two years of negotiations and decades of contention between Tacoma Power, the Skokomish Indian Tribe, and the many State and Federal agencies that will oversee implementation of the terms of the agreement. Due to the history and controversy surrounding this settlement agreement, USACE will not propose structural modifications to Cushman Dam, including dam removal, flow modifications, or operation adjustments.
2. Mason County Flood Ordinance: Comply with Mason County Flood Damage Prevention Ordinance No. 87-08. A special flood risk zone was established for the Zone A and A2 floodplain of the Skokomish River, Vance Creek, and tributaries, as shown on Flood Insurance Rate Maps; these zones are located in the feasibility study area. The special flood risk zone is designated as a floodway and an avulsion risk area, which imposes restrictions on new structures, existing structures, water flow modification structures, bridges, and roadways.
3. The Skokomish Indian Tribe is a federally recognized tribal nation that has treaty-reserved fishing, hunting, and gathering rights on the Skokomish River and has strong cultural and economic interests in the Basin. Proposed projects will avoid negative effects to tribal interests.

2.7 Public Scoping Comments and Resources of Concern*

Several public concerns have been identified during the course of the study. While many public scoping comments were related to the flooding problems in the study area, the non-Federal sponsors and study team have agreed to continue to pursue a single-purpose study focusing on ecosystem restoration only. More discussion of the study’s single-purpose scope appears in Chapter 1.

In addition to the flood risk management concerns raised by the public, scoping comments acknowledged that the problems facing the Skokomish River Basin have had negative effects on aquatic habitat and species including endangered fish species. Comments specifically noted that frequent flooding and sediment buildup contribute to poor water quality, which can negatively affect certain fish species. Comments encouraged channel restoration to improve habitat, as well as to alleviate flooding. These concerns were taken into account during the analysis of which resources should be included in the detailed analysis that appears in Chapter 4 of this document. A discussion of public involvement is included in Chapter 7, Public Involvement, Review, and Consultation.

3. Plan Formulation

The guidance for conducting civil works planning studies (Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook and Principles and Guidelines, 1983) requires the systematic formulation of alternative plans that contribute to the Federal objective. To ensure that sound decisions are made with respect to development of alternatives and ultimately with respect to plan selection, the plan formulation process requires a systematic and repeatable approach. This chapter presents the results of the plan formulation process. Alternatives were developed in consideration of study area problems and opportunities as well as study objectives and constraints with respect to the four evaluation criteria described in the Principles and Guidelines (completeness, effectiveness, efficiency, and acceptability). Figure 3-1 presents a summary of the plan formulation process that will be presented throughout this chapter.

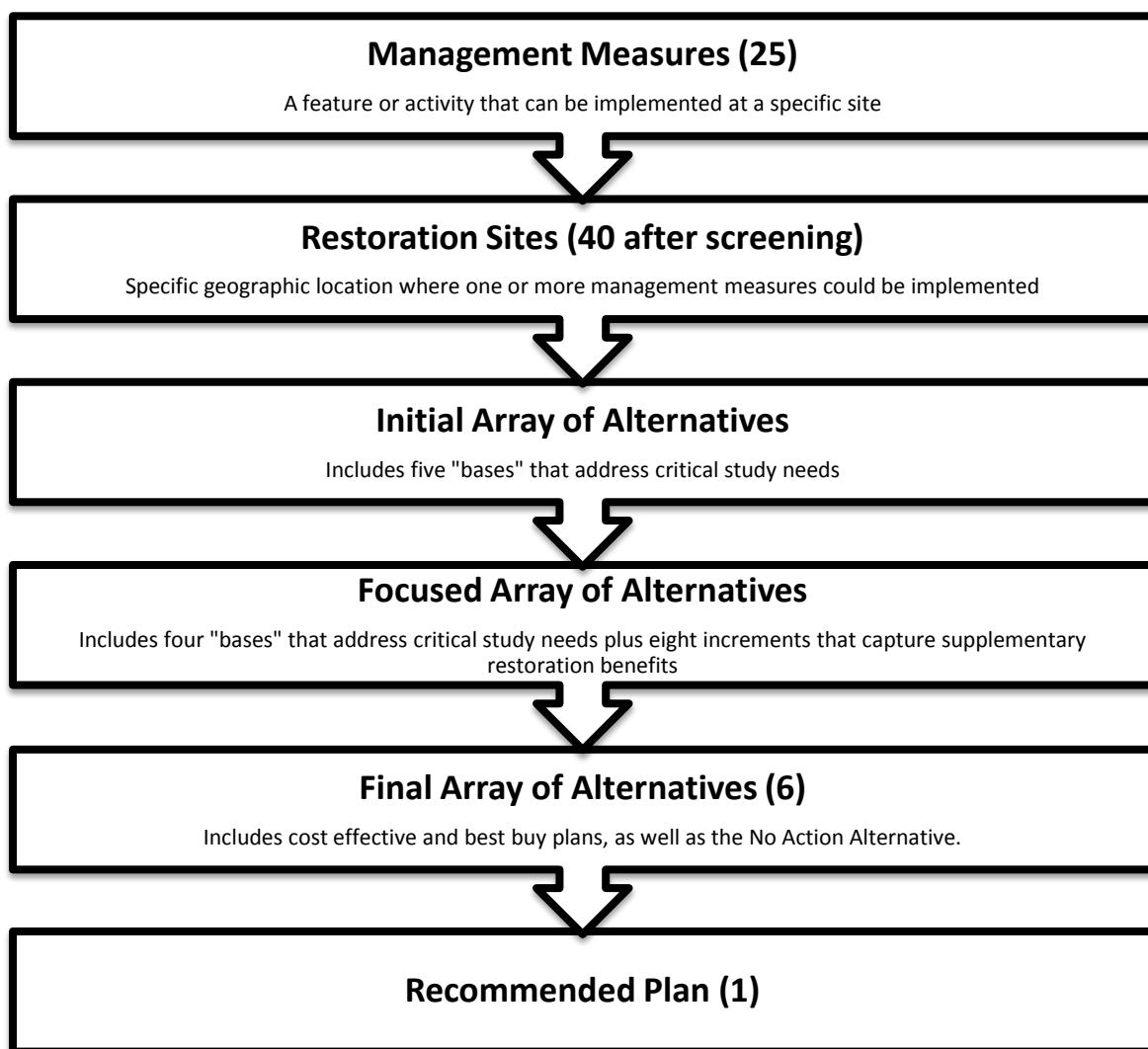


Figure 3-1. Plan Formulation Process

3.1 Management Measures

As part of the planning process for the study, the Project Delivery Team (PDT), in coordination with interested stakeholders and the public, developed a series of measures for consideration as potential elements of the project solution. A management measure is a feature or activity at a site that addresses one or more of the planning objectives and is a discrete element of a recommended project solution. The PDT identified 25 management measures during preliminary planning stages. Management measures for this study appear in the table below, along with the related objective(s) that each measure addresses. Measures include structural and non-structural features.

Table 3-1. Management Measures and Relationship to Planning Objectives

Measure	Objectives			
	Provide Year-Round Passage	Restore Side Channels and Tributaries	Restore Riparian and Floodplain Habitats	Improve Pool Habitats
New channel creation at the historical confluence	X			X
Large-scale sediment removal; environmental dredging	X			X
Spot dredge	X			X
Sediment traps	X			
Selective gravel removal on gravel bars (remove the largest sediment sizes at downstream end of gravel bars) to reduce stream power required to mobilize smaller sediments				X
Remove or breach levees to restore year-round fish passage near confluence	X			X
Wetland restoration - Remove or breach levees, dikes, or berms to reconnect floodplain wetland area			X	
Wetland restoration - Construct hydraulic features (e.g., embankments/water control structures) to improve hydraulic connection to reconnected floodplain wetland area			X	
Create salmonid spawning habitat			X	X
Reconnect and restore side channels, backwater areas, and tributaries		X	X	
Place large woody debris or engineered logjams			X	X
Install fish-passable weirs			X	
Install bank armor to stabilize riverbed sediments				
Plant riparian and estuarine vegetation (non-structural measure)		X	X	
Remove or minimize invasive species (non-structural measure)		X	X	
Culverts: add, remove, replace, or upgrade		X	X	X
Wetland restoration - raise roads, re-route roads, modify bridges or road prisms, decommission or remove roads to improve habitat availability and connectivity			X	

Rehabilitate bank lines: remove riprap, bulkheads, or hardened bank lines			X	
Place hard substrate for oyster attachment				
Install aeration system in Annas Bay				
Reconnect dendritic channels in estuary		X		
Riverbed and wetland vehicle exclusion (fence or barrier installation); non-structural measure				
Reroute power lines in estuary				
Fill estuary farm ditches				
Develop agricultural best management practices (non-structural measure)				

3.2 Screening of Measures

Screening is the process of eliminating, based on planning criteria, those measures that will not be carried forward for consideration. Criteria are derived for the specific planning study, based on the planning objectives, constraints, and the opportunities and problems of the study/project area. Preliminary criteria used to screen measures at this early stage are presented in the list below:

- Meets at least one planning objective
- Avoids planning constraints
- Access/land ownership considerations
- Size or scale is more conducive for local implementation

Table 3-2. Measures Screened from Further Evaluation

Measure Screened	Reason Screened			
	Does not meet at least one planning objective	Does not avoid planning constraints	Access/land ownership considerations	Size or scale is more conducive for local implementation
Place hard substrate for oyster attachment	X			X
Install aeration system in Annas Bay	X	X	X	
Reconnect dendritic channels in estuary				X
Riverbed and wetland vehicle exclusion	X			X
Reroute power lines in estuary	X		X	X
Fill estuary farm ditches	X			X
Develop agricultural best management practices	X			X

Based on these criteria, seven measures were not carried forward after preliminary screening leaving 18 measures for further consideration. Nearly all of the seven measures screened from further evaluation at this stage, listed in Table 3-2, were related to restoration of habitats in the estuary or nearshore of

the Skokomish River. The estuary and nearshore were included in early plan formulation activities; however, due to successful and ongoing restoration of these areas under the Estuary Restoration Act, these areas were removed from formal consideration within the feasibility study area.

3.3 Siting of Measures

After initial screening of measures was completed, remaining measures were analyzed for additional considerations including: (1) combinability, (2) dependability, (3) mutual exclusion, and (4) site identification for project implementation. The study team, non-Federal sponsors, local and regional stakeholders, and the public identified approximately 60 specific sites within the study area where one or more measures could address specific limiting factors. Sites were selected based on locations of severe degradation, physical features that will provide an opportunity to improve types of degradation, access, and consideration of other complimentary proposed projects outside the range of the feasibility study. Preliminary measures were assigned to sites using best professional judgment of those features that will best function at the site for intended benefits. Qualitative considerations of sustainability, operations and maintenance, costs, real estate, scale, risk and reliability of performance, and type of benefit needed were considered when applying measures to sites.

A second round of preliminary screening occurred prior to combining the potential restoration sites into an initial array of alternatives. The 60 sites were qualitatively screened based on two primary factors: (1) plans that have already received funding (or have submitted funding requests) to be constructed by Mason County, the Skokomish Indian Tribe, or other local entity prior to completion of the feasibility study; and (2) plans that could be better accomplished by a local entity (due to the size, scale, or nature of the plan), and not through the feasibility study. After this screening, 40 restoration sites remained for consideration. Figure 3-2 shows the potential project sites in the study area after preliminary screening.

Skokomish GI Potential Projects: 06.22.12

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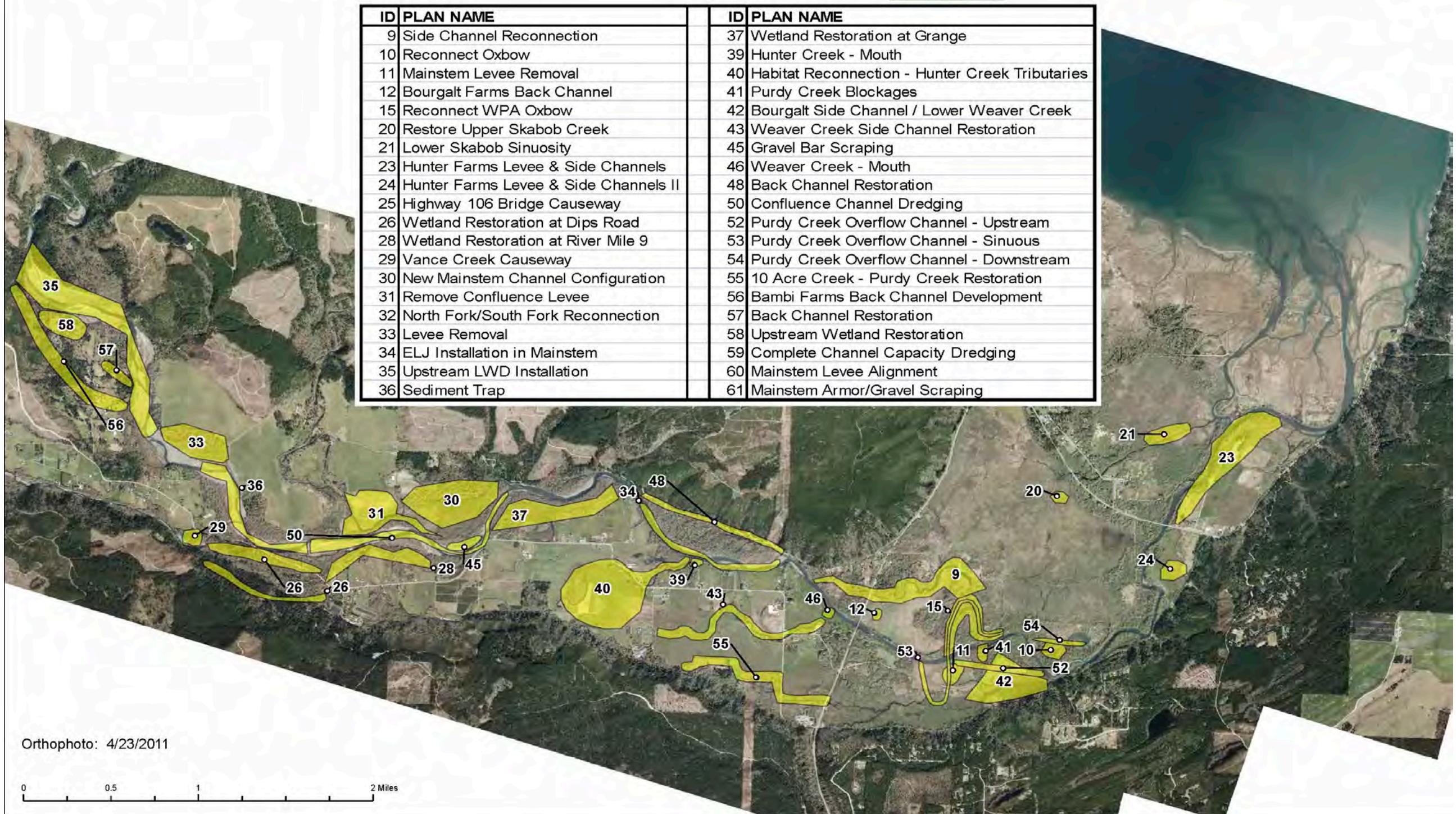


Figure 3-2. Initial Siting of Measures (40 sites after preliminary screening)

*Plan ID numbers 59, 60, and 61 are located along the entire river (RM 0-9) and are not identified by yellow polygons on this map.

3.4 Initial Array of Alternatives

An initial array of alternatives was formulated based on preliminary data collection and best professional judgment. The study team identified which of the 40 potential restoration sites address the critical needs of the study area. This exercise led to the development of an initial array of alternatives that include a “base” measure. The “bases” are key measures that address the critical needs of the study area (improve the quantity, quality, and complexity of pools and provide year-round fish passage) and meet the purpose and need for action. The “bases” are intended to be combined with other restoration measures to form alternatives. Developing alternatives around these base measures ensures the critical needs of the study area are addressed. An alternative cannot be considered complete, acceptable, efficient, or effective unless one of these bases is included. Increments will be added to these base alternatives to capture added benefits associated with restoration of additional habitat features. All increments identified in Table 3-5 are dependent on a base; dependencies and combinability relationships are indicated in Table 3-5. The initial array of “bases” includes the following:

Base #1: Riverbed Excavation (River Mile 0-9)

This base includes two primary measures located at site ID #59: large-scale sediment removal and placement of LWD. The goal of this base is to restore mainstem river habitat by removing accumulated sediment and constructing habitat features from RM 0 to RM 9. This base addresses the project objectives of improving the quality, quantity, and complexity of pools and restoring a year-round channel near the confluence to allow for year-round migration. The river channel would be deepened by 8 to 10 feet, which will restore the channel capacity to roughly a two-year return interval probability. The two-year capacity was chosen to mimic typical Puget Sound channels; a two-year capacity will provide similar habitats and biological processes found within less degraded channels in the Puget Sound region.

The increase in channel capacity would allow the placement of additional habitat features (engineered logjams and LWD) while reducing the frequency of overbank flooding and fish stranding. This base would include roughly two LWD jams per mile from RM 0-8, with more placement opportunities at the mouth. Dredging may also require the construction of 6 to 8 larger LWD jams to provide bank protection for high erosion risk sites near RMs 6 and 7. Approximately 40 to 50 single logs per mile could be placed depending on channel conditions.

This base would require the removal of approximately 2.5 million cubic yards from the mainstem channel. The post-construction deposition rate is predicted to be the same as the without-project rate, approximately 35,000 cubic yards (cy) per year. Maintenance at approximately 20-year intervals would be necessary to remove accumulated sediment and maintain capacity for a two-year flow. Dredged material would be placed in the estuary and nearshore zone of Annas Bay, which would constitute beneficial reuse of material and would provide suitable hard substrate for shellfish attachment.

The short-term construction impacts associated with riverbed excavation include significant turbidity in the river channel for the duration of construction, severe disturbance to spawning habitat of ESA-listed species, and risk of continued instability of gravel for several years after construction possibly preventing successful spawning and incubation. These effects are further discussed in Chapter 4.

Base #2: Confluence Channel Excavation

This base includes two primary measures located at site ID #50: spot-dredging and placement of LWD. The goal of this base is to lower the river thalweg to provide a continuous low flow channel during the late-summer base flow conditions to allow passage of migrating salmon. Fish passage would be restored between RM 7 and RM 9 of the Skokomish River mainstem, which is the reach that experiences subsurface flow during the late-summer/early fall low flow period. This base addresses the project objectives of improving the quality, quantity, and complexity of pools and restoring a year-round channel near the confluence to allow for year-round migration. To re-establish a continuous low flow channel, approximately 150,000 cy of sediment would be removed from the mainstem from RM 7.3 to RM 8.8. The alignment of the dredged channel would follow the thalweg to minimize disturbance of the channel and the dredging volume. The total length of excavation would be 7,000 feet. This excavation could increase the discharge capacity of the river channel by about 4,000 cubic feet per second (cfs) and lower flood elevations locally by up to one foot. However, additional capacity from RM 7.3 to RM 8.8 would not significantly affect lower mainstem channel capacity, and would produce only minor changes in downstream flood conditions. LWD would be placed in this reach to maintain the established channel path within the boundaries of the active river channel. Woody debris would also create deeper pools and hiding places, which are critical needs for fish in the system. This base addresses the project objectives on a much smaller scale than Base #1, focusing on improving channel capacity and habitat in the reach of the river where passage is most often blocked during the late-summer/early fall low flow period. Periodic maintenance may be necessary to remove sediment accumulations. The limited amount of dredged material would be disposed of offsite (versus placement in the estuary and nearshore zone of Annas Bay).

Base #3: North Fork/South Fork Confluence: Confluence Levee Removal

This base includes two primary measures located at site ID #31: removal of levees and placement of LWD. This base proposes removal of the 5,400-foot long levee on the north side of the mainstem near the original North Fork confluence, which would require removal of approximately 15,000 cy. This base primarily addresses the project objective of restoring a continuous low flow channel near the confluence and to a lesser extent the objective of improving the quantity, quality, and complexity of pool habitat in the river. South Fork flows would be diverted into the North Fork channel and reenter the mainstem at the confluence location. This would bypass the subsurface flow reach and provide improved fish migration. A portion of flood flows would stay in the old channel. Installed LWD would direct flow in the new channel and improve fish habitat. As described in Section 4.3.1.2 and 4.3.3.2, the combined discharges of the North and South Forks would be enough water to provide continuous surface flows during the late summer low flow period. It is anticipated that the new channel will aggrade, eventually meandering across the floodplain. This natural meandering process will develop a complex series of stream habitats that will be beneficial to salmon and other fish. This base is designed to work with natural river processes including aggradation to provide habitat benefits; therefore, it is anticipated that limited O&M will be required to maintain the channel.

Corps staff conducted a site visit in October 2013 and observed approximately five car bodies at the base of the western section of the Confluence Levee, which is locally referred to as "Car Body Levee". A

Phase II HTRW investigation was complete in July 2014. There were no sampling results that warranted further evaluation or investigation within the footprint of the recommended plan, including the Confluence Levee site. At this time, the cars are assumed to be solid waste that will be disposed of by the Non-Federal Sponsors at an appropriate disposal site. Please refer to Appendix I (HTRW Assessment) for additional information about the Confluence Levee investigation.

The short-term construction impacts associated with this base are expected to be temporary and minor. These effects are further discussed in Chapter 4.

Base #4: North/South Fork Confluence Channel

This base includes three primary measures located at site ID #30: spot-dredging, construction of a levee, and placement of LWD. The goal of this base is to restore the North Fork/South Fork confluence to its pre-2003 location at RM 8.4. This base addresses the project objective of restoring flow continuity for year-round passage near the confluence by increasing summer low flow. Approximately 50,000 cy of sediment would be removed from the mainstem and North Fork channels. LWD would be placed to maintain channel alignment and facilitate creation of pools and hiding places. The North Fork habitat would remain as quality backwater/rearing habitat for salmonids and other fish. Periodic maintenance may be necessary to remove sediment accumulations from the restored confluence. The limited amount of dredged material would be disposed of offsite (versus placement in the estuary and nearshore zone of Annas Bay).

Base #5: Riverbed Excavation (River Mile 3.5-9)

This base includes two primary measures located at site ID #59: large-scale sediment removal and placement of LWD. Dredging for Base #5 would start at RM 3.5 and continue upstream to RM 9. This base addresses the project objectives of improving the quality, quantity, and complexity of pools and restoring a year-round channel near the confluence to allow for year-round migration. The downstream limit was chosen because it will deliver the design discharge and associated bedload to a point where the river has some natural capacity to convey them to the mouth. It will channelize the flows through the reach between RMs 3.5 and 4 where bedload transport is at a minimum under existing conditions. For floods larger than the design discharge, flooding and low bedload transport will still occur between RMs 3.5 and 4. To assure the late summer connection to the South Fork, dredging must continue upstream past the old North Fork confluence to RM 9. If this base were implemented, channel capacity and flood patterns would remain unchanged downstream of RM 3.5.

Similar to Base #1, an increase in channel capacity would allow the placement of additional habitat features (engineered logjams and LWD) while reducing the frequency of fish stranding caused by overbank flooding, which may enhance recovery of listed species. This base would include roughly two LWD jams per mile from RM 3.5-8, with more placement opportunities at the mouth. Dredging may also require the construction of 6 to 8 larger LWD jams to provide bank protection for high erosion risk sites near RMs 6 and 7. Approximately 40 to 50 single logs per mile could be placed depending on channel conditions.

This base would require removal of approximately 1.9 million cubic yards from the mainstem channel. Similar to Base #1, periodic maintenance would be required to remove sediment accumulations. Dredged material would be placed in the estuary and nearshore zone of Annas Bay, which would provide suitable hard substrate for shellfish attachment constituting beneficial reuse of material.

The short-term construction impacts associated with riverbed excavation include significant turbidity in the river channel for the duration of construction, severe disturbance to spawning habitat of ESA-listed species, and risk of continued instability of gravel for several years after construction possibly preventing successful spawning and incubation. These effects are further discussed in Chapter 4.

Large Woody Debris

As noted in the descriptions above, all bases include placement of LWD. LWD is not a separable element of the bases. While the size, scale, and number of logjams to be installed vary among the bases, this measure was identified to be a critical habitat feature that should be included in any recommended plan in addition to the base. LWD has many benefits for juvenile salmon including increasing habitat complexity and number of pools, providing instream cover and predation refugia, and serves as a substrate for aquatic invertebrates that salmon rely on as a food source (Quinn 2005). Large accumulations of LWD also provide habitat for small mammals that serve as prey for owls and raptors, and perches for aquatic-oriented birds like belted kingfishers and American dippers. The general goal is to achieve approximately 64 logs, two to three feet in diameter and 15 to 30 feet long, per river mile based on recommendations found in Fox and Bolton (2007).

3.5 Evaluation of Initial Array

The initial array of bases was evaluated based on the decision criteria outlined in Table 3-3.

Table 3-3. Criteria for Evaluating the Initial Array of Bases

Evaluation Criteria	Metric / Threshold
Meets planning objectives	Number of objectives met
Avoids planning constraints	Yes / No
Environmental factors	Benefit to salmonids and other ESA-listed species Benefit to other fish and wildlife species Potential negative effects to salmonids and/or other habitat
Sustainability (ecological)	Low / Medium / High
Impact on fluvial geomorphic processes	Cubic yards of sediment to remove Discharge capacity
O&M requirements	Low / Medium / High

Table 3-4. Evaluation of Initial Array of Bases

Base #	Base Name	Base Description	Cubic Yards to Remove/Length of Excavation	Discharge Capacity (With-Project Condition)	Meets Study Objectives*	Benefits to Salmonids/Habitat	Impacts to Salmonids/Habitat	O&M Requirements	Sustainability
1	Riverbed Excavation (RM 0-9)	Dredge from RM 0 to RM 9 (complete mainstem dredge). Includes placement of LWD.	2.5 million cubic yards; RM 0 to 9	2-year flood capacity within the dredged reach	1, 4	Increases channel capacity to allow construction of additional in-channel habitat features; reduces fish stranding; may enhance recovery of listed species	Short-term construction impacts associated with large-scale dredging (risk of perhaps 2 to 3 years/spawning cycles)	High	Medium
2	Confluence Channel Excavation	South Fork channel dredged at confluence reach, RM 7.3 to 9.0. Includes limited placement of LWD.	150,000 cubic yards; RM 7.3 to 9.0; 7,000 ft.	Capacity increased by ~4,000 cfs within the dredged reach	1	Maintains two active channel habitats; maintains a continuous flow of water in S. Fork	Temporary disturbance of substrate reducing prey (aquatic insects) in this reach for up to 1 year	High	Medium
3	North Fork/South Fork Confluence: Confluence Levee Removal	Remove Confluence Levee on north side of mainstem near original North Fork confluence. South Fork flows would naturally divert into the North Fork channel and reenter the mainstem at the existing confluence location. Includes limited placement of LWD.	15,000 cubic yards/~5,400 feet	No Change	1	Improves fish migration in subsurface reach; allows for continuous passage for fish; levee removal restores river processes	Temporary construction disturbance reducing prey (aquatic insects) in this reach for up to 1 year; potential loss of North Fork habitat near mouth	Low	High
4	North Fork/South Fork Confluence Channel	Reconstruct confluence to return North Fork flows to the mainstem channel. Includes limited placement of LWD.	50,000 cubic yards	No Change	1	Provides continuity; North Fork habitat will remain as quality backwater/rearing habitat	Continued deposition in South Fork; cuts off high quality North Fork habitat; restricts habitat to a single active channel; prey reduction for 1 year	High	Low
5	Riverbed Excavation (RM 3.5-9)	Dredge from RM 3.5 to RM 9 (intermediate mainstem dredge). Includes placement of LWD.	1.9 million cubic yards; RM 3.5 to 9	2-year flood capacity within the dredged reach	1, 4 (smaller scale than Base #1)	Increases channel capacity to allow construction of additional habitat features; reduces fish stranding; may enhance recovery of listed species	Short-term construction impacts associated with large-scale dredging (risk of perhaps 2 to 3 years/spawning cycles)	High	Medium

*Study Objectives: (1) Provide year-round passage near confluence; (2) Restore side channels and tributary network; (3) Restore in-channel and floodplain habitats; (4) Increase quantity, quality, and complexity of pools

3.6 Focused Array of Alternatives

Based on an evaluation of the initial array of bases using the decision criteria, which appears in Table 3-4, the Corps PDT recommended carrying Bases #1, #2, and #5 forward into the focused array of alternatives because they meet the study objectives and have the largest anticipated benefits to species of concern in the Basin. In addition, the study sponsors requested that Base #3 be carried forward into the focused array because the Confluence Levee removal would allow natural river processes to be restored in a sustainable way. Thus, the focused array of bases includes the following:

- No-Action Alternative
- Base #1 (Riverbed Excavation: RM 0-9)
- Base #2 (Confluence Channel Excavation)
- Base #3 (Confluence Levee Removal)
- Base #5 (Riverbed Excavation: RM 3.5-9)

Base #4 was not carried forward for further analysis because directing North Fork flows into the original confluence area would disrupt high quality fish habitat that already exists in this reach. Bases #1, #2, #3, and #5 meet a greater number of study objectives and are anticipated to have greater positive effects to salmonid habitat compared to Base #4, which was not carried forward to the focused array. All bases carried forward to the focused array meet the purpose and need for action.

Increments

Increments were added to the focused array of four bases to capture supplementary benefits associated with restoration of additional channel and floodplain habitat features. Potential increments considered for addition to the bases were selected from the list of 18 proposed management measures and 40 potential restoration sites using best professional judgment. Of the approximately 40 potential restoration sites, the study team identified eight sites as high priority in-channel or floodplain increments that would optimize the environmental benefits for an alternative plan. Potential floodplain increments include removal of blockages at the mouths of tributaries, restoration of side channel habitat, creation of new side channels, and wetland restoration. A cost-effectiveness/incremental cost analysis (CE/ICA) determined the appropriate number and scale of cost effective increments. The combinability of projects to base plans is further described in Section 3.6.2 along with the overall CE/ICA framework for the study.

Management measures that have been identified as potential increments include upstream LWD installation, four side channel reconnections/restorations, and three wetland restorations; these measures could be constructed at eight high-priority sites identified by the PDT. All but one of these measures can be included as an increment to any of the bases carried forward in the focused array.

Table 3-5 includes key information about the proposed increments that could be added to the bases to capture added benefits associated with restoration of additional habitat features. Figure 3-3 shows the location of the focused array of bases and proposed increments within the study area.

Table 3-5. Proposed Restoration Increments

Project Site # (ID#)	Increment Name	Site Problem or Need	Increment Description	Increment to Base #	Dependencies
9	Side Channel Reconnection	Rearing and migration opportunities are significantly limited in this remnant river channel with a poor connection to the mainstem.	An abandoned channel that lies between RM 4 and 5.6 would be reconnected to the mainstem to provide high flow refuge and rearing habitat for fish. Restoration would involve constructing improvements to the channel inlet and outlet, while most of the channel would not be disturbed. The reconnected channel would only be connected to the mainstem river during high discharges and would not convey water year round. During high river discharges, the reconnected channel would provide a low velocity refuge. During most of the year, the channel would provide pond habitat for fish rearing. Reconnecting the channel to the river could provide 45 acres of high quality, low velocity fish habitat. This increment would include planting of native vegetation.	1, 2, 3, 5	Stand Alone
26	Wetland Restoration at Dips Road	West Valley Road (located at the “Dips”) acts as a physical barrier to riparian habitat connectivity.	The Dips Road relocation, located at RM 9.5-9.7, is intended to provide additional floodplain habitat and reduce the stranding potential for fish. A 3,700-foot section of the road between the Vance Creek and Swift Creek bridges would be relocated about 400 feet landward (south). This would place 17 acres of riparian forest on the riverward side of the road to develop into highly valued forested wetland. The roadbed would be partially removed. Where the road embankment is higher than the adjacent ground, the asphalt and roadbed material would be removed. Where the road is lower than adjacent ground only the asphalt would be removed. River sediments are expected to deposit in the remaining roadbed material and provide soil for vegetation to grow. This increment would include planting of native vegetation. This increment is considered a relocation and will be entirely non-Federal sponsor expense.	1, 2, 3, 5	Stand Alone
28	Wetland Restoration at River Mile 9	The river has been hydraulically disconnected from the floodplain by agricultural berms, restricting the connection to riparian and floodplain wetland habitats. Loss of connection between floodplain wetlands reduces available spawning, incubation, rearing, and over-wintering habitats. The berms also make it more difficult or impossible for juveniles that find their way onto the floodplain to return to the river when flows recede.	This wetland restoration increment, located from RM 8.3-9.2, is intended to reconnect and restore high quality wetland habitat. An existing agricultural berm will be breached and a new wetland embankment will be constructed landward (south) varying distances, generally around 200-300 feet. The breaches will allow for reconnection and improvement of a wetland in the floodplain, allowing flood waters to flow freely within the reconnected area and providing salmon access to the riparian habitat. While breaching the existing berm will provide reconnection of a wetland, construction of a wetland embankment is integral to achieving complete restoration benefits at this site. In addition to the berm breaches, a wetland embankment will be constructed to improve hydraulic conditions in the reconnected wetland area and is expected to hold water within the wetland at a greater depth and longer duration, thereby improving and expanding wetland conditions. The wetland embankment is a structural mechanism required to allow targeted reconnection to riparian wetlands multiple times a year; it is not a flood risk management feature. The wetland embankment contains flow during moderate winter storm events (approximately 6,000 cfs; these events occur multiple times a year), providing high flow refuge for fish as well as reconnection and restoration of high-value forested wetland during frequent, moderate winter storm events. The wetland embankment also diverts flows back into the river rather than across the entire floodplain to the south where there is no defined channel or ecologically beneficial habitat for salmonid species. Finally, the wetland embankment acts as a substitute streambank where none exists, providing an opportunity for the river to develop a secondary side channel over time. This increment would include planting of native grasses and trees to provide continuous vegetation cover in a buffer zone.	1, 2, 3, 5	Stand Alone
35	Upstream LWD Installation	Spawning, rearing, and refuge habitats (including pools) are limited in RM 9 to 11 due to a lack of large woody debris in the upstream reaches of the Skokomish River.	This increment, located from RM 9-11, would include placement and installation of large woody debris. Small LWD jams could be used in this reach to increase meandering and bar formation and provide cover for salmon. Under either base alternative, this reach of the channel may be able to incorporate 6 to 12 jams per mile without adverse flooding or erosion effects. Because there is already some LWD in the channel, this reach would only require 30 to 40 new single logs per mile to satisfy the biological criteria.	1, 2, 3, 5	Stand Alone

Project Site # (ID#)	Increment Name	Site Problem or Need	Increment Description	Increment to Base #	Dependencies
37	Wetland Restoration at Grange	The river has been hydraulically disconnected from the floodplain by agricultural berms, restricting the connection to riparian and floodplain wetland habitats.	Similar to the River Mile 9 Wetland Restoration increment described above, this wetland restoration increment, located from RM 7.5-8, is intended to reconnect and restore high quality wetland habitat. An existing agricultural berm will be breached and a new wetland embankment will be constructed landward (south) up to 1,200 feet. The breaches will allow for reconnection of a wetland in the floodplain, allowing flood waters to flow freely within the reconnected area and providing salmon access to the riparian habitat. While breaching the existing berm will provide reconnection of a wetland, construction of a wetland embankment is integral to achieving complete restoration benefits at this site. The wetland embankment is expected to hold water within the wetland at a greater depth and longer duration thereby improving and expanding wetland conditions. This increment would include planting of native grasses and trees to provide continuous vegetation cover in a buffer zone.	1, 2, 3, 5	Stand Alone
39	Hunter Creek Mouth Restoration	There is a poor connection between the mouth of Hunter Creek and the mainstem.	This increment involves a small-scale excavation at the mouth of Hunter Creek to provide year-round access between the Creek and mainstem river near RM 6.5.	2, 3	Stand Alone
40	Hunter Creek Tributary Restoration	Fish stranding commonly occurs at this site due to limited side channels off Hunter Creek; spawning and rearing opportunities are severely limited in Hunter Creek.	This increment involves the construction of tributary channels to Hunter Creek to provide additional fish rearing and refuge habitat. Hunter Creek is a perennial groundwater fed stream. The proposed restoration would consist of excavating small channels along existing swales down to slightly below the water table. The Hunter Creek channels would have a 4-foot bottom width and approximately 5-foot depth. The total length of channel would be approximately 21,250 feet. This increment would include planting of native vegetation.	1, 2, 3, 5	Dependent on Increment #39 (Hunter Creek Mouth Restoration) for Bases #2 and #3
43	Weaver Creek Tributary Restoration	Weaver creek lacks juvenile salmonid rearing habitat and experiences stranded fish during high flow events.	This increment involves the construction of tributary channels to Weaver Creek to provide additional fish rearing and refuge habitat. Weaver Creek is a perennial groundwater fed stream. The proposed restoration would consist of excavating small channels along existing swales down to slightly below the water table. The Weaver Creek channels would have a 4-foot bottom width and approximately 5-foot depth. The total length of channel would be approximately 27,110 feet. This increment would include planting of native vegetation.	1, 2, 3, 5	Stand Alone

*All increments are dependent on a base. No bases are combinable. Increment #39 (Hunter Creek Mouth Restoration) is not combinable with Base #1 or Base #5.

Skokomish GI
Focused Array of Alternatives:
25JAN2013

Skokomish GI Projects			
BASE #1 (59)			
BASE #2 (50)			
BASE #3 (31)			
BASE #5 (62)			
Increments			
+ River Miles			

ID	PLAN NAME	SITE PROBLEM OR NEED	PLAN DESCRIPTION
59	BASE #1: Riverbed Excavation (RM 0-9)	Aggradation reduces fish access and migration.	Dredge from RM 0 to RM 9 (complete mainstem dredge). Removal of ~2.5 million cubic yards of material. Includes placement of LWD in dredged reaches.
50	BASE #2 Confluence Channel Excavation	Subsurface flow, limited connectivity to upper reaches due to aggradation.	Dredge near the confluence (RM 7-9.5). Removal of ~150,000 cubic yards of material. Includes limited placement of LWD in dredged reaches.
31	BASE #3: North Fork/South Fork Confluence - Confluence Levee Removal	Confluence levees act as an unnatural buffer and limits habitat connectivity to side channels and riparian zones.	Remove confluence levee & reconnect channel on North Fork. Mainstem flows would naturally divert into the current North Fork channel and reenter the mainstem at the existing confluence location.
62	BASE #5: Riverbed Excavation (RM 3.5-9)	Aggradation reduces fish access and migration.	Dredge from RM 3.5 to RM 9 (intermediate mainstem dredge). Includes placement of LWD in dredged reaches.
9	Side Channel Reconnection	Rearing and migration opportunities are significantly limited in this remnant river channel with a poor connection to the mainstem.	Reconnect abandoned side channel between RM 4 and 5.6 to provide high flow refuge and rearing habitat for fish.
26	Wetland Restoration at Dips Road	West Valley Road (located at the "Dips") acts as a physical barrier to riparian habitat connectivity.	Relocate a small area of West Valley Road in the vicinity of the Dips to provide additional floodplain habitat and reduce the stranding potential for fish.
28	Wetland Restoration at River Mile 9	The river has been hydraulically disconnected from the floodplain by agricultural berms, restricting the connection to riparian and floodplain wetland habitats.	Breach an existing agricultural berm to allow for reconnection and restoration of a wetland in the floodplain. Construct a wetland embankment to improve hydraulic conditions in the reconnected wetland area.
35	Upstream LWD Installation	Spawning, rearing, and refuge habitats (including pools) are limited in RM 9 to 11 due to a lack of large woody debris in the upstream reaches of the Skokomish River.	Place and install large woody debris from RM 9-11 to increase meandering and bar formation and provide cover for salmon.
37	Wetland Restoration at Grange	The river has been hydraulically disconnected from the floodplain by agricultural berms, restricting the connection to riparian and floodplain wetland habitats.	Breach an existing agricultural berm to allow for reconnection and restoration of a wetland in the floodplain. Construct a wetland embankment to improve hydraulic conditions in the reconnected wetland area.
39	Hunter Creek Mouth Restoration	There is a poor connection between the mouth of Hunter Creek and the mainstem.	Small-scale excavation at the mouth of Hunter Creek to provide year-round access between the Creek and mainstem river in the vicinity of RM 6.5.
40	Hunter Creek Tributary Restoration	Fish stranding commonly occurs at this site due to limited side channels off of Hunter Creek; spawning and rearing opportunities are significantly limited in Hunter Creek.	Construct tributary channels to Hunter Creek to provide additional fish rearing and refuge habitat.
43	Weaver Creek Tributary Restoration	A lack of juvenile salmonid rearing habitat & stranded fish during high flow events.	Construct tributary channels to Weaver Creek to provide additional fish rearing and refuge habitat.

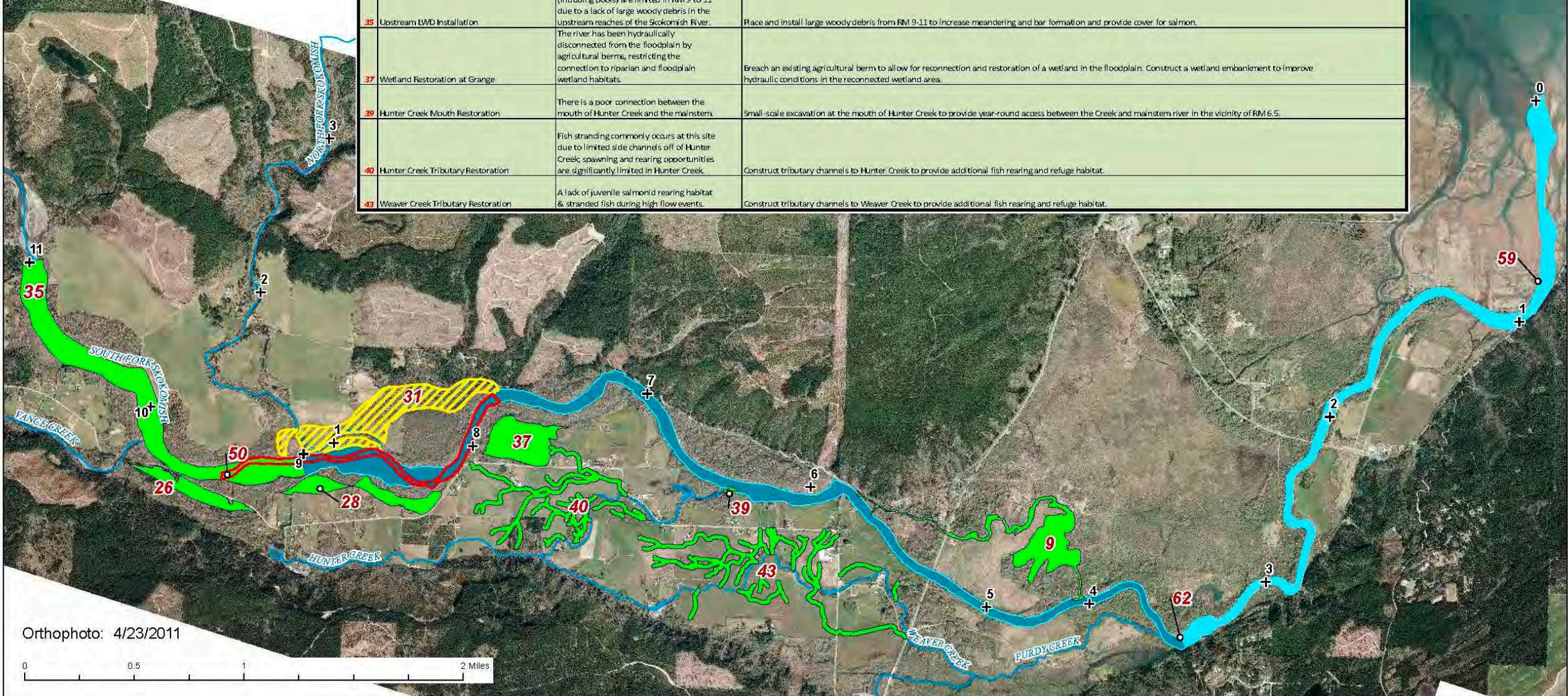


Figure 3-3. Focused Array of Bases and Potential Increments. Legend key: bases are shaded in blue in the table; increments are shaded in green. Bases will be combined with increments to form alternatives.

3.7 Evaluation of Focused Array of Alternatives

To effectively evaluate the focused array of alternatives, the PDT completed additional analysis including development of conceptual designs, development of parametric cost estimates, and evaluation of environmental outputs. All of the bases and increments selected for the focused array of alternatives were carried through these analyses. Based on these parameters, a CE/ICA was completed to help evaluate and quantify significant contributions or effects of individual plans. The following sections outline the assumptions and outcomes of this work in addition to the results of the CE/ICA.

3.7.1 Cost Estimates

The cost estimates for CE/ICA were based on the conceptual design drawings. Additional information developed by the PDT is incorporated into the estimate. The cost estimates were prepared using Micro-Computer Aided Cost Estimating System (MCACES) MII version 4, build 4. Some aspects of the dredging work associated with the project were developed using the most current version of the Corps of Engineers Dredge Estimating Program. The MCACES estimate carefully documents the basis of information used in development of costs, down to the lowest reasonable level.

The conceptual cost estimates summarized below were prepared at a Class 4 level; Per ER 1110-2-1302, these Class 4 estimates are generally associated with a conceptual level of design and were developed based on parametric designs and quantities developed by the PDT. Earthwork quantities used available topography using average end areas. Tree sizes were estimated by canopy size and LWD estimates used log counts and lengths. Certified Class 3 cost estimates were developed for the recommended plan based on feasibility-level designs. Final feasibility-level cost estimates are presented in Section 5.6 and Appendix K.

Table 3-6 shows the present value construction and real estate costs, computed interest during construction (IDC), periodic operations and maintenance (O&M) costs, total investment costs, and annualized costs for each base alternative and increment. It was assumed that the increments would require minimal maintenance; aiming for process-based restoration, in which human-made stressors are removed from the landscape, has an inherent goal of no O&M costs. Minimal maintenance for Base #3 and the increments is expected to be approximately \$10,000 per year or less and focus on minor inspection and periodic wetland embankment maintenance activities. Based on the expected sediment deposition, Bases #1, #2, and #5 would require periodic sediment excavation to maintain channel capacity. For Bases #1 and #5, maintenance is estimated to occur every 20 years (see Section 4.3.2.2), or for two cycles during the period of analysis (in years 20 and 40). The shallower Base #2 channel would require more frequent maintenance to preserve the channel. Base #2 is expected to require maintenance every 10 years, or five cycles during the period of analysis (in years 10, 20, 30, 40, and 50). More detailed cost information appears in Appendix K.

Costs were annualized using the Institute for Water Resources (IWR) Planning Suite Annualization Tool (USACE certified version 2.0.6.0) using the construction cost, real estate cost, construction period (in months) for IDC computations, estimated O&M, the discount rate (3.75 percent), and a 50-year period of analysis. Costs are presented at the October 2013 price level.

Table 3-6. Average Annual Cost of Bases and Increments (Oct 2013 price level, 3.75% discount rate)

Project Site Number (ID #)	Project Name	Construction Cost (1,000s)	Real Estate Cost Estimate (\$1,000s)	Interest During Construction (\$1,000s)	Total Investment Cost (\$1,000s)	Cost for periodic O&M / Frequency	Total Average Annual Cost (\$1,000s)
59	Base #1: Riverbed Excavation (RM 0-9)	\$141,391	\$2	\$7,173	\$148,567	\$43.4 M / Every 20 years (2x)	\$8,035
50	Base #2: Confluence Channel Excavation	\$14,017	\$2	\$65	\$14,084	\$6.2 M / Every 10 years (5x)	\$1,153
31	Base #3: Confluence Levee Removal	\$6,721	\$741	\$62	\$7,525		\$335
62	Base #5: Riverbed Excavation (RM 3.5-9)	\$94,756	\$2	\$2,816	\$97,575	\$38.0 M / Every 20 years (2x)	\$5,548
9	Side Channel Reconnection	\$1,024	\$2,069	\$3	\$3,096		\$138
26	Wetland Restoration at Dips Road	\$5,148	\$97	\$40	\$5,285		\$236
28	Wetland Restoration at River Mile 9	\$2,250	\$101	\$14	\$2,365		\$105
35	Upstream LWD Installation	\$870	\$2,357	\$3	\$3,229		\$144
37	Wetland Restoration at Grange	\$2,722	\$538	\$17	\$3,277		\$146
39	Hunter Creek Tributary Mouth Restoration	\$11	\$193	\$0	\$204		\$9
40	Hunter Creek Tributary Restoration	\$4,190	\$1,100	\$13	\$5,303		\$236
43	Weaver Creek Tributary Restoration	5,318	\$2,261	\$25	\$7,603		\$339

3.7.2 Environmental Outputs

The Skokomish River Ecosystem Benefits Model is a habitat suitability index model, also called an ecosystem outputs (EO) model, accounting for the quality (suitability index score between 0.0 and 1.0) and quantity (area of restoration site) of available habitat for native salmonids, which are an indicator species for overall ecosystem health in the Pacific Northwest. Data published by the Washington Conservation Commission (Correa 2003) and USFWS (Peters et al. 2011) on the species' habitat requirements, preferences, and limiting factors were synthesized into a series of variables and suitability indices, which are mathematical representations of hypotheses regarding species-habitat relationships.

The EO model focuses on three key habitat requirements that most affect salmonid rearing, reproduction, and mortality in the Skokomish River – channel habitat quality, floodplain habitat quality, and channel capacity. Each key habitat requirement includes assessment metrics that were identified as indicators of the limiting factors. Channel habitat quality includes metrics for pools and woody debris to assess migration, resting, and rearing habitat. Floodplain habitat quality includes metrics for riparian cover and floodplain connectivity to assess refugia, feeding, and rearing habitat. Finally, the channel capacity factor is included to provide a score for reducing overbank flood probability of occurrence. In

aggrading rivers, lack of channel capacity causes displacement of juvenile and adult fish during overbank flows in which they become stranded in floodplain areas without access to return to the river. No entities have made an effort to quantify losses from stranding thus far; however, studies on other aggrading rivers in the region show a high correlation between high river flows and reduced survival of incubating eggs to reach migrant fry life stage (Seiler et al. 2003, Beamer et al. 2005). In the example from Beamer et al. (2005), egg-to-fry survival decreased from 10% to 2% for the 0.2 ACE over a 70-year period. This metric is used as a surrogate for quantifying mortality due to stranding, which affects reproduction, adult and juvenile migration, and survival (see Figure 7 and Figure 8 in Appendix F). Table 3-7 summarizes the benefits for each base or increment to be carried forward for the CE/ICA. Complete documentation of the Skokomish River Environmental Benefits Model is presented in Appendix F.

Table 3-7. Environmental Outputs by Restoration Project

Project Site Number (ID #)	Project Name	Total Acres Affected	AAHU [†] (EO Model)	AAHU (Shellfish Substrate)	Total AAHU
59	Base #1: Riverbed Excavation (RM 0-9)	219 + 843 shellfish = 1,062	184.2	210.8	395.0
50	Base #2: Confluence Channel Excavation	26	17.5	n/a	17.5
31	Base #3: Confluence Levee Removal	68	45.9	n/a	45.9
62	Base #5: Riverbed Excavation (RM 3.5-9)	132 + 219 shellfish = 643	111.0	127.8	238.8
9	Side Channel Reconnection	45	25.7	n/a	25.7
26	Wetland Restoration at Dips Road	17	12.7	n/a	12.7
28	Wetland Restoration at River Mile 9	23	13.6	n/a	13.6
35	Upstream LWD Installation	107	82.9	n/a	82.9
37	Wetland Restoration at Grange	34	18.5	n/a	18.5
39	Hunter Creek Tributary Mouth Restoration	0.5	0.3	n/a	0.3
40	Hunter Creek Tributary Restoration	29	20.1	n/a	20.1
43	Weaver Creek Tributary Restoration	25	19.4	n/a	19.4

[†]Average Annual Habitat Units

As the study team developed conceptual designs and cost estimates for the bases, several disposal options were identified for the riverbed excavation bases. Placement of dredged material in the

Skokomish estuary and nearshore zone appeared as the most feasible disposal option (other options included disposal in a nearby quarry or open-water disposal). Appropriate technical experts have identified dredged material from the Skokomish River as suitable for placement. Placement of dredged material in approximately 800 acres of the estuary would create high quality shellfish habitat (i.e., hard substrate for oyster attachment) and would significantly reduce costs associated with transportation and disposal of up to 2.5 million cubic yards of dredged material outside the study area.

It should be noted that the EO model does not formally account for the benefits associated with placing dredged material in the estuary for shellfish attachment; the model only captures benefits related to channel habitat quality, floodplain habitat connectivity, and mainstem channel capacity to calculate Average Annual Habitat Units (AAHUs). To capture the approximate benefits associated with placement of hard substrate in the estuary for shellfish habitat, the study team developed a conservative estimate for the habitat quality change in the estuary and nearshore that would result from placement of dredged material. These outputs are presented in the “AAHU (Shellfish Substrate)” column of Table 3-7 and are fully described in the Economics Appendix (Appendix G). Habitat Units calculated by the EO model (presented in the “AAHU (EO Model)” column of Table 3-7 were added to habitat units calculated outside of the ecosystem benefits model (shellfish substrate) to determine total habitat units. The total outputs appear in the “Total AAHU” column of Table 3-7.

3.7.3 Cost Effectiveness and Incremental Cost Analysis

This section describes the model inputs for performing the CE/ICA using the IWR Planning Suite, version 2.0.6.0 (USACE certified model). The Corps’ IWR developed this software to assist with the formulation and comparison of alternative plans. The software can assist with plan formulation by combining solutions to planning problems and calculating the additive effect of each combination, or “plan”, by utilizing inputs on outputs (AAHUs), costs, and rules (combinability and dependency relationships) for combining solutions into plans. Plans are then compared in IWR Planning Suite by conducting CE/ICA, identifying the plans that are the best financial investments, and displaying the effects of each on a range of decision variables.

3.7.3.1 Cost Effectiveness Analysis

Multiple runs of CE/ICA were completed that included various sensitivity analyses. The complete CE/ICA results are presented in Appendix G. Cost effective plans are plans that provide a level of environmental output at the least cost. The CE/ICA results presented in this section include the additional shellfish substrate benefits that were discussed in Section 3.7.2. While the inclusion of these benefits in the analysis is an important factor, it should be noted that the array of best buy plans identified by the CE/ICA analysis does not change if CE/ICA is run without the inclusion of these additional benefits. Because inclusion of shellfish benefits more appropriately captures all possible benefits of the proposed restoration alternatives, they are presented in the CE/ICA results below.

The CE/CIA analysis evaluated 705 possible plan combinations. Of these, 60 plans (including the No-Action Alternative) were identified as cost effective. These plans are listed in Table 3-8 and displayed in Figure 3-4 as those plans that provide a given level of output at the lowest cost denoted by blue

triangles (cost effective plans) and red squares (best buy plans, refer to Section 3.6.3.2). Those plans that are not cost effective are denoted by clear circles.

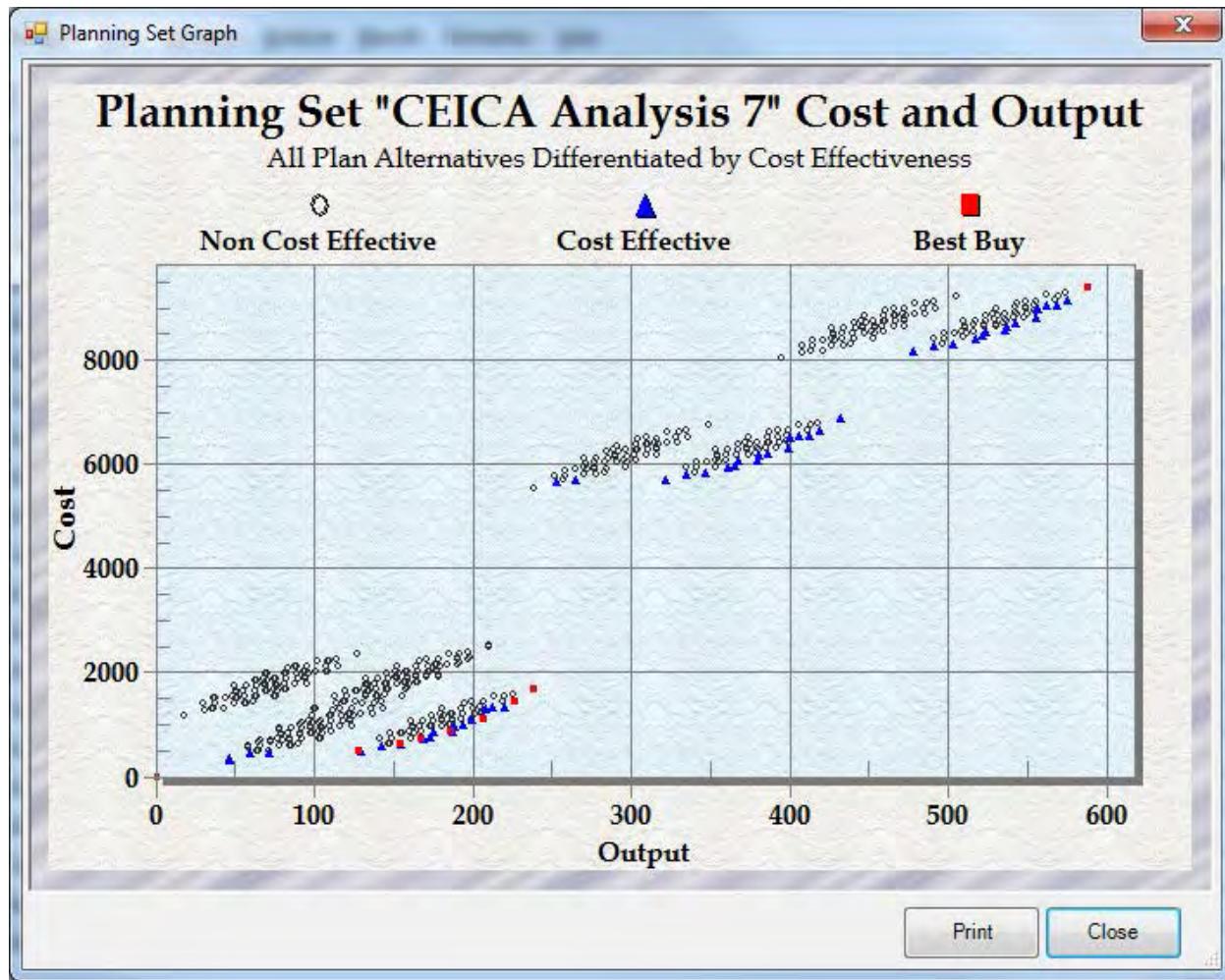


Figure 3-4. Cost Effectiveness Results

The table below outlines the 60 cost effective plans (including the No-Action Alternative) as identified using the CE/ICA analysis. Plans in bold represent “best buy” plans. The plans identified in color were carried forward into the final array of alternatives; this screening and evaluation process is described in subsequent sections of this chapter.

Table 3-8. Cost Effective Plans† (Oct 2013 price level, 3.75% discount rate)

Alternative #	Plan Components	AAHU (In-Channel, Floodplain, and Capacity)	AAHU (Shellfish Substrate)	Total AAHU	Total Average Annual Cost (\$1,000s)	Average Annual Cost/AAHU
1	No-Action Plan	0.0	0.0	0.0	0	
2	Base 3	45.9	0.0	45.9	335	7.30
3	Base 3+ Increment 39	46.2	0.0	46.2	344	7.45
4	Base 3+ Increment 28	59.5	0.0	59.5	440	7.39

Alternative #	Plan Components	AAHU (In-Channel, Floodplain, and Capacity)	AAHU (Shellfish Substrate)	Total AAHU	Total Average Annual Cost (\$1,000s)	Average Annual Cost/AAHU
5	Base 3+ Increments 28+39	59.8	0.0	59.8	449	7.51
6	Base 3+ Increment 9	71.6	0.0	71.6	473	6.61
7	Base 3+ Increment 35	128.8	0.0	128.8	479	3.72
8	Base 3+ Increments 35+39	129.1	0.0	129.1	488	3.78
9	Base 3+ Increments 35+28	142.4	0.0	142.4	584	4.10
10	Base 3+ Increments 35+28+39	142.7	0.0	142.7	593	4.16
11	Base 3+ Increments 35+9	154.5	0.0	154.5	617	3.99
12	Base 3+ Increments 35+9+39	154.8	0.0	154.8	626	4.04
13	Base 3+ Increments 35+9+28	168.1	0.0	168.1	722	4.30
14	Base 3+ Increments 35+9+28+39	168.4	0.0	168.4	731	4.34
15	Base 3+ Increments 35+9+37	173.0	0.0	173.0	763	4.41
16	Base 3+ Increments 35+9+37+39	173.3	0.0	173.3	772	4.45
17	Base 3+ Increments 35+9+39+40	174.9	0.0	174.9	862	4.93
18	Base 3+ Increments 35+9+28+37	186.6	0.0	186.6	868	4.65
19	Base 3+ Increments 35+9+28+37+39	186.9	0.0	186.9	877	4.69
20	Base 3+ Increments 35+9+39+40+28	188.5	0.0	188.5	967	5.13
21	Base 3+ Increments 35+9+37+39+40	193.4	0.0	193.4	1,008	5.21
22	Base 3+ Increments 35+9+28+37+26	199.3	0.0	199.3	1,104	5.54
23	Base 3+ Increments 35+9+28+37+39+40	207.0	0.0	207.0	1,113	5.38
24	Base 3+ Increments 35+9+28+39+40+43	207.9	0.0	207.9	1,306	6.28
25	Base 3+ Increments 35+9+37+39+40+43	212.8	0.0	212.8	1,347	6.33
26	Base 3+ Increments 35+9+28+37+39+40+26	219.7	0.0	219.7	1,349	6.14
27	Base 3+ Increments 35+9+37+39+40+43+28	226.4	0.0	226.4	1,452	6.41
28	Base 3+ Increments 35+9+37+39+40+43+28+26	239.1	0.0	239.1	1,688	7.06
29	Base 5+ Increment 28	124.6	127.8	252.4	5,653	22.40
30	Base 5+ Increment 9	136.7	127.8	264.5	5,686	21.50
31	Base 5+ Increment 35	193.9	127.8	321.7	5,692	17.69
32	Base 5+ Increments 35+28	207.5	127.8	335.3	5,797	17.29
33	Base 5+ Increments 35+9	219.6	127.8	347.4	5,830	16.78
34	Base 5+ Increments 35+9+28	233.2	127.8	361.0	5,935	16.44
35	Base 5+ Increments 35+9+37	238.1	127.8	365.9	5,976	16.33
36	Base 5+ Increments 35+9+40	239.7	127.8	367.5	6,066	16.51
37	Base 5+ Increments 35+9+28+37	251.7	127.8	379.5	6,081	16.02
38	Base 5+ Increments 35+9+28+40	253.3	127.8	381.1	6,171	16.19
39	Base 5+ Increments 35+9+40+37	258.2	127.8	386.0	6,212	16.09
40	Base 5+ Increments 35+9+40+37+28	271.8	127.8	399.6	6,317	15.81
41	Base 5+ Increments 35+9+28+40+43	272.7	127.8	400.5	6,510	16.25
42	Base 5+ Increments 35+9+28+40+43+37	277.6	127.8	405.4	6,551	16.16
43	Base 5+ Increments 35+9+40+37+28+26	284.5	127.8	412.3	6,553	15.89
44	Base 5+ Increments 35+9+40+37+28+43	291.2	127.8	419.0	6,656	15.89
45	Base 5+ Increments 35+9+40+37+28+43+26	303.9	127.8	431.7	6,892	15.96
46	Base 1+ Increment 35	267.1	210.8	477.9	8,179	17.11
47	Base 1+ Increments 35+28	280.7	210.8	491.5	8,284	16.85

Alternative #	Plan Components	AAHU (In-Channel, Floodplain, and Capacity)	AAHU (Shellfish Substrate)	Total AAHU	Total Average Annual Cost (\$1,000s)	Average Annual Cost/AAHU
48	Base 1+ Increments 35+9	292.8	210.8	503.6	8,317	16.52
49	Base 1+ Increments 35+9+28	306.4	210.8	517.2	8,422	16.28
50	Base 1+ Increments 35+9+37	311.3	210.8	522.1	8,463	16.21
51	Base 1+ Increments 35+9+40	312.9	210.8	523.7	8,553	16.33
52	Base 1+ Increments 35+9+28+37	324.9	210.8	535.7	8,568	15.99
53	Base 1+ Increments 35+9+28+40	326.5	210.8	537.3	8,658	16.11
54	Base 1+ Increments 35+9+40+37	331.4	210.8	542.2	8,699	16.04
55	Base 1+ Increments 35+9+40+37+28	345.0	210.8	555.8	8,804	15.84
56	Base 1+ Increments 35+9+28+40+43	345.9	210.8	556.7	8,997	16.16
57	Base 1+ Increments 35+9+28+40+43+37	350.8	210.8	561.6	9,038	16.09
58	Base 1+ Increments 35+9+40+37+28+26	357.7	210.8	568.5	9,040	15.90
59	Base 1+ Increments 35+9+40+37+28+43	364.4	210.8	575.2	9,143	15.90
60	Base 1+ Increments 35+9+40+37+28+43+26	377.1	210.8	587.9	9,379	15.95

†Plans in bold represent “Best Buy” plans.

3.7.3.2 Incremental Cost Analysis

An incremental cost analysis identified nine of the above plans as “Best Buy” plans, defined as those cost effective plans that provide the greatest incremental increase in output (benefits) for the lowest incremental increase in cost. These best buy plans are listed in Table 3-9 and displayed as a bar graph in Figure 3-5. Plans highlighted in color have been carried forward into the final array of alternatives, which changed during feasibility level design phase after release of the Draft FR/EIS. It should be noted that the Draft Feasibility Report/Environmental Impact Statement (January 2014) presented a different final array of alternatives than those identified below (the original final array of alternatives included #7, #23, #28, #45, and #60). This Final FR/EIS presents the latest results of the alternatives evaluation and screening process including a discussion of changes to alternatives in subsequent iterations of the planning process. The process used to carry these plans forward is described in the following sections.

Table 3-9. Incremental Cost Analysis: Best Buy Plans (Oct 2013 price level, 3.75% discount rate)

Alternative #	Plan Components	Total Output in AAHU's	Total Average Annual Cost (AAC in \$K)	AAC/AAHU (\$K)	Incremental Cost/Incremental Output (\$K)	Total Present Value Cost (\$K)	Cost Effective and/or Best Buy?	Improves Egg-to-Fry Survival?
1	No-Action Plan	0.0	0				Best Buy 1	No
7	Base #3: Confluence Levee Removal +35	128.8	479	\$3.71	\$3.71	\$10,754	Best Buy 2	No
11	Base #3: Confluence Levee Removal +35+9	154.5	617	\$3.99	\$5.37	\$13,850	Best Buy 3	No
13	Base #3: Confluence Levee Removal +35+9+28	168.1	722	\$4.30	\$7.72	\$16,215	Best Buy 4	No
18	Base #3: Confluence Levee Removal +35+9+28+37	186.6	868	\$4.65	\$7.89	\$19,492	Best Buy 5	No
23	Base #3: Confluence Levee Removal +35+9+28+37+39+40	207.0	1,113	\$5.38	\$12.01	\$24,999	Best Buy 6	No
27	Base #3: Confluence Levee Removal +35+9+37+28+39+40+43	226.4	1,452	\$6.41	\$17.47	\$32,602	Best Buy 7	No
28	Base #3: Confluence Levee Removal +35+9+37+28+39+40+43+26	239.1	1,688	\$7.06	\$18.58	\$37,887	Best Buy 8	No
45	Base #5: Riverbed Excavation RM 3.5-9 +35+9+37+28+40+43+26	431.7	6,892	\$15.96	\$27.02	\$154,623	Cost Effective	Yes
60	Base #1: Riverbed Excavation RM 0-9 +35+9+37+28+40+43+26	587.9	9,379	\$16.00	\$22.05	\$210,434	Best Buy 9	Yes

As discussed in Section 3.8, Alternative #45 is cost effective only and does not appear as a best buy plan in Figure 3-5 or Figure 3-6.

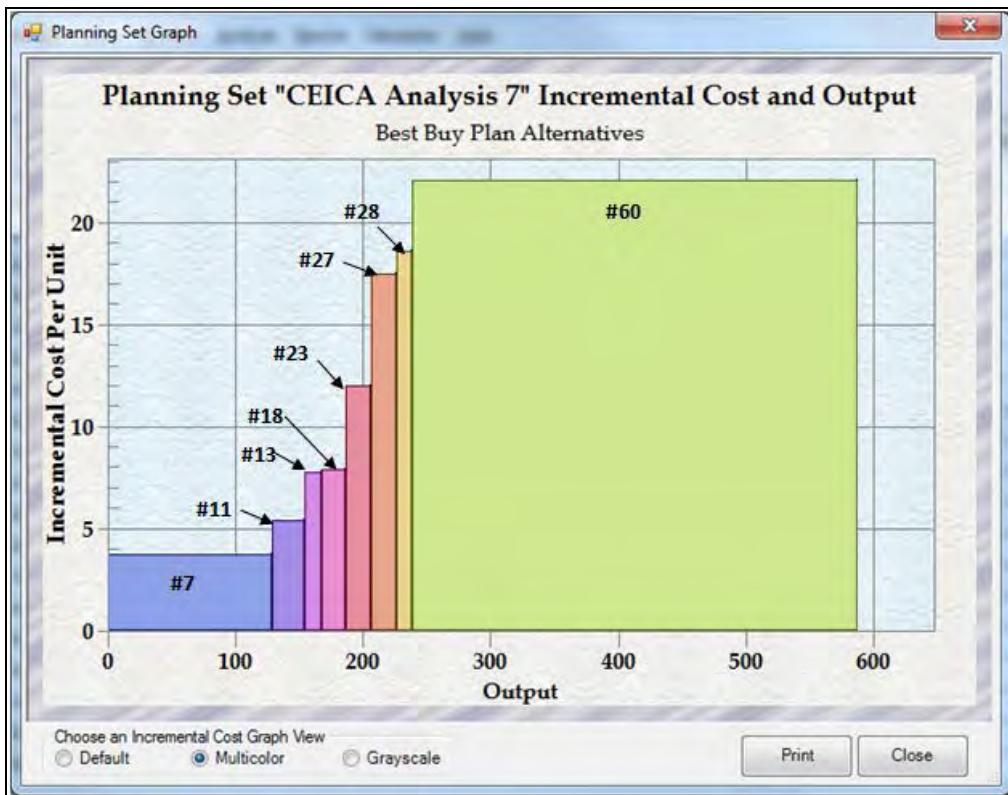


Figure 3-5. CE/ICA Results

3.7.4 Supplemental CE/ICA Analysis: Optimization of Wetland Embankment Sites

The study team completed additional evaluation and optimization of two sites that include proposed wetland embankment measures: Wetland Restoration at River Mile 9 and Wetland Restoration at Grange. These embankments were evaluated at two additional elevations (one lower and one higher which reasonably bracket the range of elevations to consider for optimization), as well as a “breach only” scenario (no embankment). The following scenarios were evaluated for each site:

- Without-project (No Action)
- With-project “original” scale scenario (original plan design, or average height of 5 ft for River Mile 9 and 6 ft for Grange)
- With-project “breach only” scenario (evaluated for benefits only but not carried to CE/ICA)
- With-project small-scale scenario (based on 6,000 cfs flow containment at each embankment site; approximate 2-3ft reduction in average height for each embankment)
- With-project large-scale scenario (approximate 1 ft increase in average height for each embankment)

For each site, a habitat model output score was derived using the methods outlined in Appendix F, Ecosystem Benefits Model Documentation. Parametric costs for each scenario were also developed. A CE/ICA analysis was conducted to determine cost effective and best buy alternatives for optimized plans at each site.

Supplemental Analysis Results: Breach Only Scenario

While the “breach only” scenario was evaluated for ecosystem outputs, these scenarios were not carried forward because they did not meet the planning objectives for the study. The following summarizes the habitat quantity (acres) and quality (HQI scores for riparian cover and connectivity) scoring using the methodology outlined in the EO model:

- The quantity score (acres) increased based on greater wetted areas once existing agricultural berms are breached.
- The quality score for riparian cover decreased based on GIS analysis conducted on the larger wetted areas to determine the proportion of perimeter with the buffer around the riparian area using the same methodology described in Appendix F, Ecosystem Benefits Model Documentation. There is no riparian zone in the farm fields south of the proposed wetland embankment alignment; these areas would not provide high-quality riparian zones and are not likely to develop native riparian wetland vegetation over time. Further, the perimeter of the wetted area includes a county road where no plantings could be installed.
- The quality score for connectivity is 0. This metric score is based on a two-way connection of flow into the reconnected riparian zone and diversion of flows back into the mainstem Skokomish River. This two-way connection would not exist under the “breaching-only” scenario.

While acreage increases for the “breach only” scenario for each embankment, the riparian cover score is lower than the without project condition score and this scenario does not achieve floodplain connectivity as reflected in connectivity scores of 0. Therefore, the “breach only” scenarios provide an increase in acreage of low quality habitat that is not of a habitat type identified as a problem or in need of restoration in this area and does not achieve the project goals and objectives.

Supplemental Analysis Results: Wetland Embankment Incremental Evaluation of Height

Cost and benefit information for Wetland Restoration at River Mile 9 and Grange were input into IWR Planning Suite and evaluated for cost effectiveness and incremental cost analysis. The results indicated two best buy plans (No Action/without-project and small-scale scenario) for each site. The original plan design and large-scale scenarios are not cost effective as the environmental output model was not sensitive to have an effect on benefits; therefore, they provide the same benefits as the small-scale scenario, but at an additional cost. Additional information is needed to confirm the embankment heights, but at this time it is likely that the optimum embankment heights fall within the range of heights between the small-scale and original recommended plan scale heights for each of the embankment sites. As described in Section 5.1.4 and 5.1.5, the small-scale wetland embankment scenario has ultimately been carried forward in the recommended plan. Risks and uncertainties associated with the small-scale wetland embankments are summarized in Section 5.12. Additional detail about this supplemental analysis is presented in Appendix G, Economics.

3.8 Final Array of Alternatives

The alternatives carried forward for detailed evaluation in the final array were chosen based on CE/ICA results, total cost, incremental cost, and ecological value added between increments. This step resulted in carrying forward six alternatives into the final array of alternatives. The final array of alternatives includes the No-Action Alternative, three Confluence Levee Removal alternatives, and two Riverbed Excavation alternatives.

Logic for screening was based on habitat types restored by each alternative. Side channel or tributary increments provide rearing and refuge habitats in an active channel setting. In contrast, the wetland restoration increments (located at River Mile 9 and the Grange) reconnect floodplain and riparian zones but do not directly provide an active channel habitat in the reconnected zone. Both of these types of increments provide important but slightly different ecosystem restoration benefits.

Alternative #11 was carried forward because it is the first alternative that includes reconnection of a side channel, identified as critical rearing and refuge habitat in the study area. Alternative #18 was carried forward because it includes two wetland restoration increments at River Mile 9 and the Grange; these increments improve floodplain habitat connectivity in critical forested riparian zones of the study area, providing benefits to all riverine life stages of salmonids by increasing available spawning, incubation, rearing, and over-wintering habitats as well as providing high flow refuge for fish during frequent winter storm events, and improving and expanding wetlands. Alternative #27 was carried forward because it represents one of the largest-scale Confluence Levee Removal alternatives with all but one increment (a road relocation) included in the plan. While Alternative #45 is cost effective only, it was carried forward into the final array of alternatives because it meets the critical needs of the study area while requiring a smaller extent of dredging compared to Alternative #60. Alternative #60 was carried forward because it is the largest-scale Best Buy Plan and represents the most significant Federal investment for the study.

Alternatives #7, #13, #23, and #28 were not carried forward into the final array of alternatives. While Alternative #7 represents the least cost best buy plan, it was not carried forward because it does not include side channel reconnections, wetland restoration increments or tributary restorations, which are all critical habitat types requiring restoration in the study area. Although Alternative #13 includes a side channel reconnection, it was not carried forward because it only includes a single wetland restoration increment (Wetland Restoration at River Mile 9); restoration and reconnection of floodplain habitat in two riparian zone wetlands represents a more complete alternative. Similarly, Alternative #23 was not carried forward because it only includes one of two tributary restoration increments, significantly limiting the area of tributary restoration in the study area. Hunter Creek and Weaver Creek are the only two perennial groundwater-fed streams in the lower Skokomish Basin and restoration of fluvial and biological processes in both tributaries represents a more complete alternative.

Finally, Alternative #28 was not carried forward into the final array of alternatives. The only difference between Alternative #27 (carried forward into the final array) and Alternative #28 is the inclusion of wetland restoration at Dips Road, a road relocation increment that is not a feature that could be cost-

shared as part of a proposed National Ecosystem Restoration Plan. This individual increment may be constructed by the non-Federal sponsors but was not carried forward as a best buy plan (Alternative #28) in the final array of alternatives. While the CE/ICA analysis presented in this report includes the Dips Road increment, Section 8.2 of the Economics Appendix (Appendix G) presents the results of a sensitivity analysis of CE/ICA that does not include the Dips Road increment. This sensitivity run removed the Dips Road increment and re-ran CE/ICA to determine whether the cost effective and incremental analysis results would change significantly without this feature. The analysis indicates that the final array of alternatives presented in this report are still considered to be cost effective and best buy plans.

Each alternative included in the final array meets the purpose and need for action. The final array of alternatives is described below and identified in Figure 3-6. As noted above, Alternative #45 is cost effective only and does not appear as a best buy plan in Figure 3-6.

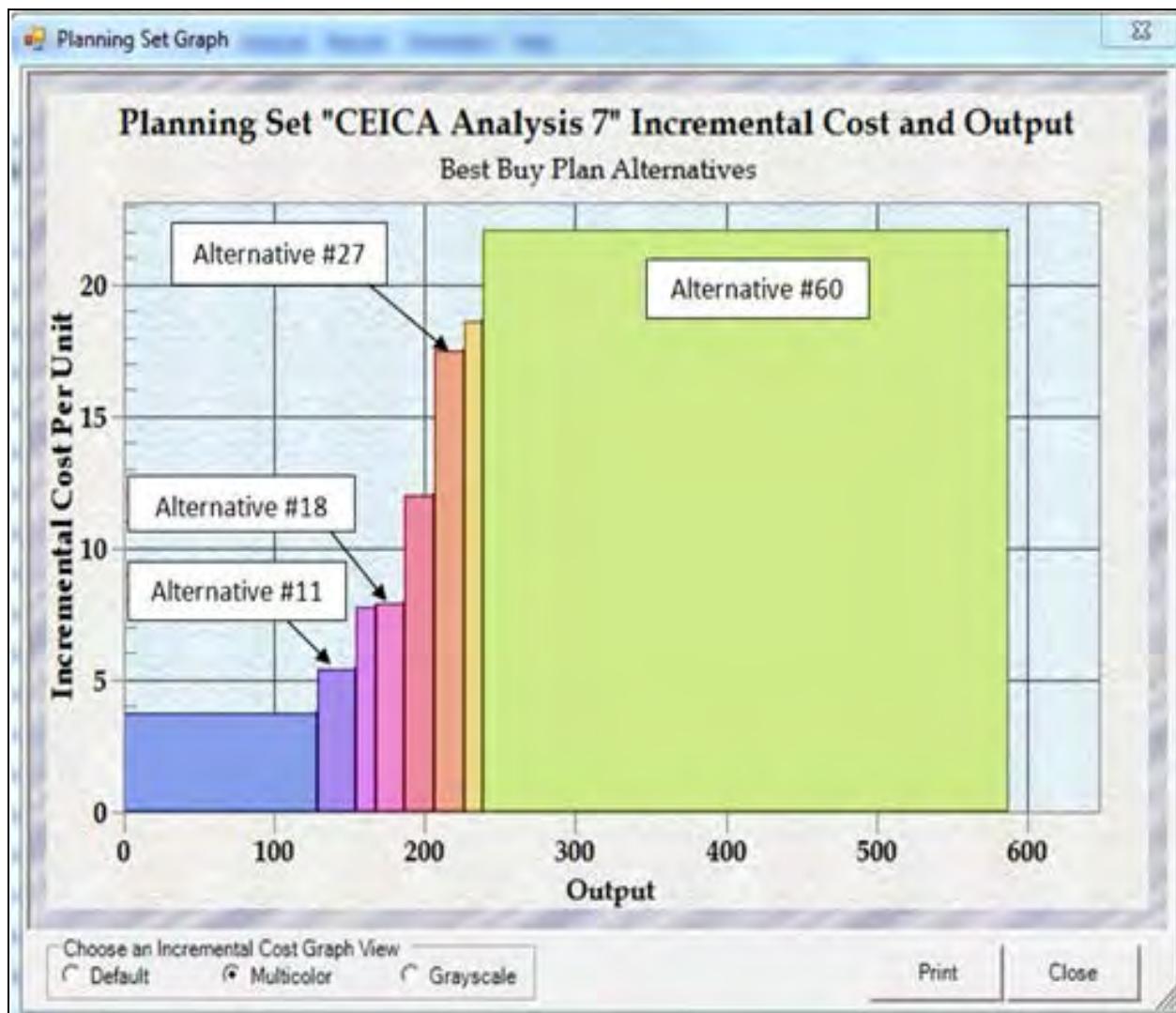


Figure 3-6. Final Array of Alternatives

No-Action Alternative*

Under the No-Action plan, which is synonymous with the “Future Without-Project Condition,” the assumption is that no project would be implemented by the Corps to achieve the planning objectives. As described throughout Chapter 4, the Skokomish River will remain degraded under the No-Action Alternative. Habitat availability, quality, complexity, and connectivity will continue to deteriorate. As sediment continues to accumulate in the mainstem, upstream passage will continue to be delayed or completely blocked during summer low flows. The overall condition of the channel is anticipated to remain severely degraded; reduced holding pool quality and availability will continue to render adults vulnerable to predation/harassment, and reduced channel complexity will lead to more frequent and severe scouring of redds. Ultimately, the future without-project condition for fish in the mainstem and South Fork reaches of the study area is expected to remain in a severely degraded state and would not be able to support recovery of ESA-listed species.

Confluence Levee Removal Alternatives #11, #18, and #27

Three Confluence Levee Removal Alternatives were evaluated during this step of the planning process. Each plan represents a best buy plan identified during the CE/ICA. Alternative #11 is the first alternative that includes restoration of side channels, identified as critical habitat in the study area. Alternative #18 was carried forward because it includes two critical wetland restoration increments at River Mile 9 and the Grange; these increments improve floodplain habitat connectivity in critical forested riparian zones of the study area, providing benefits for all riverine life stages of salmonids by increasing available spawning, incubation, rearing, and over-wintering habitats as well as high flow refuge for flood survival. Alternative #27 was carried forward because it represents one of the largest-scale Confluence Levee Removal alternatives with all but one increment (a road relocation) included in the plan. The increments included in each scale of the Confluence Levee Removal Alternative are outlined in Table 3-10.

Table 3-10. Confluence Levee Removal Alternatives

Confluence Levee Removal (Alternative #11)	Confluence Levee Removal (Alternative #18)	Confluence Levee Removal (Alternative #27)
Base #3: Confluence Levee Removal	Base #3: Confluence Levee Removal	Base #3: Confluence Levee Removal
Increment #35: Upstream LWD Installation	Increment #35: Upstream LWD Installation	Increment #35: Upstream LWD Installation
Increment #9: Side Channel Reconnection	Increment #9: Side Channel Reconnection	Increment #9: Side Channel Reconnection
	Increment #37: Wetland Restoration at Grange	Increment #37: Wetland Restoration at Grange
	Increment #28: Wetland Restoration at River Mile 9	Increment #28: Wetland Restoration at River Mile 9
		Increment #39: Hunter Creek Tributary Mouth Restoration
		Increment #40: Hunter Creek Tributary Restoration
		Increment #43: Weaver Creek Tributary Restoration

The map shown below (Figure 3-7) indicates the location of the project features included in the largest Confluence Levee Removal Alternative carried forward in the final array (Alternative #27).



Skokomish GI Confluence Levee Removal: 09-AUG-2013

Confluence Levee Removal

- BASE #3 (31)
- Increments
- + River Miles

ID	PLAN NAME	SITE PROBLEM OR NEED	PLAN DESCRIPTION
31	BASE #3: North Fork/South Fork Confluence - Confluence Levee Removal	Confluence levees act as an unnatural buffer and limits habitat connectivity to side channels and riparian zones.	Remove confluence levee & reconnect channel on North Fork. Mainstem flows would naturally divert into the current North Fork channel and reenter the mainstem at the existing confluence location.
9	Side Channel Reconnection	Rearing and migration opportunities are significantly limited in this remnant river channel with a poor connection to the mainstem.	Reconnect abandoned side channel between RM 4 and 5.6 to provide high flow refuge and rearing habitat for fish.
25	Wetland Restoration at Dips Road	West Valley Road (located at the "Dips") acts as a physical barrier to riparian habitat connectivity.	Relocate a small area of West Valley Road in the vicinity of the Dips to provide additional floodplain habitat and reduce the stranding potential for fish.
28	Wetland Restoration at River Mile 9	The river has been hydraulically disconnected from the floodplain by agricultural berms, restricting the connection to riparian and floodplain wetland habitats.	Breach an existing agricultural berm to allow for reconnection and restoration of a wetland in the floodplain. Construct a wetland embankment to improve hydraulic conditions in the reconnected wetland area.
35	Upstream LWD Installation	Spawning, rearing, and refuge habitats (including pools) are limited in RM 9 to 11 due to a lack of large woody debris in the upstream reaches of the Skokomish River.	Place and install large woody debris from RM 9-11 to increase meandering and bar formation and provide cover for salmon.
37	Wetland Restoration at Grange	The river has been hydraulically disconnected from the floodplain by agricultural berms, restricting the connection to riparian and floodplain wetland habitats.	Breach an existing agricultural berm to allow for reconnection and restoration of a wetland in the floodplain. Construct a wetland embankment to improve hydraulic conditions in the reconnected wetland area.
39	Hunter Creek Mouth Restoration	There is a poor connection between the mouth of Hunter Creek and the mainstem.	Small-scale excavation at the mouth of Hunter Creek to provide year-round access between the Creek and mainstem river in the vicinity of RM 6.5.
40	Hunter Creek Tributary Restoration	Fish stranding commonly occurs at this site due to limited side channels off of Hunter Creek; spawning and rearing opportunities are significantly limited in Hunter Creek.	Construct tributary channels to Hunter Creek to provide additional fish rearing and refuge habitat.
43	Weaver Creek Tributary Restoration	A lack of juvenile salmonid rearing habitat & stranded fish during high flow events.	Construct tributary channels to Weaver Creek to provide additional fish rearing and refuge habitat.

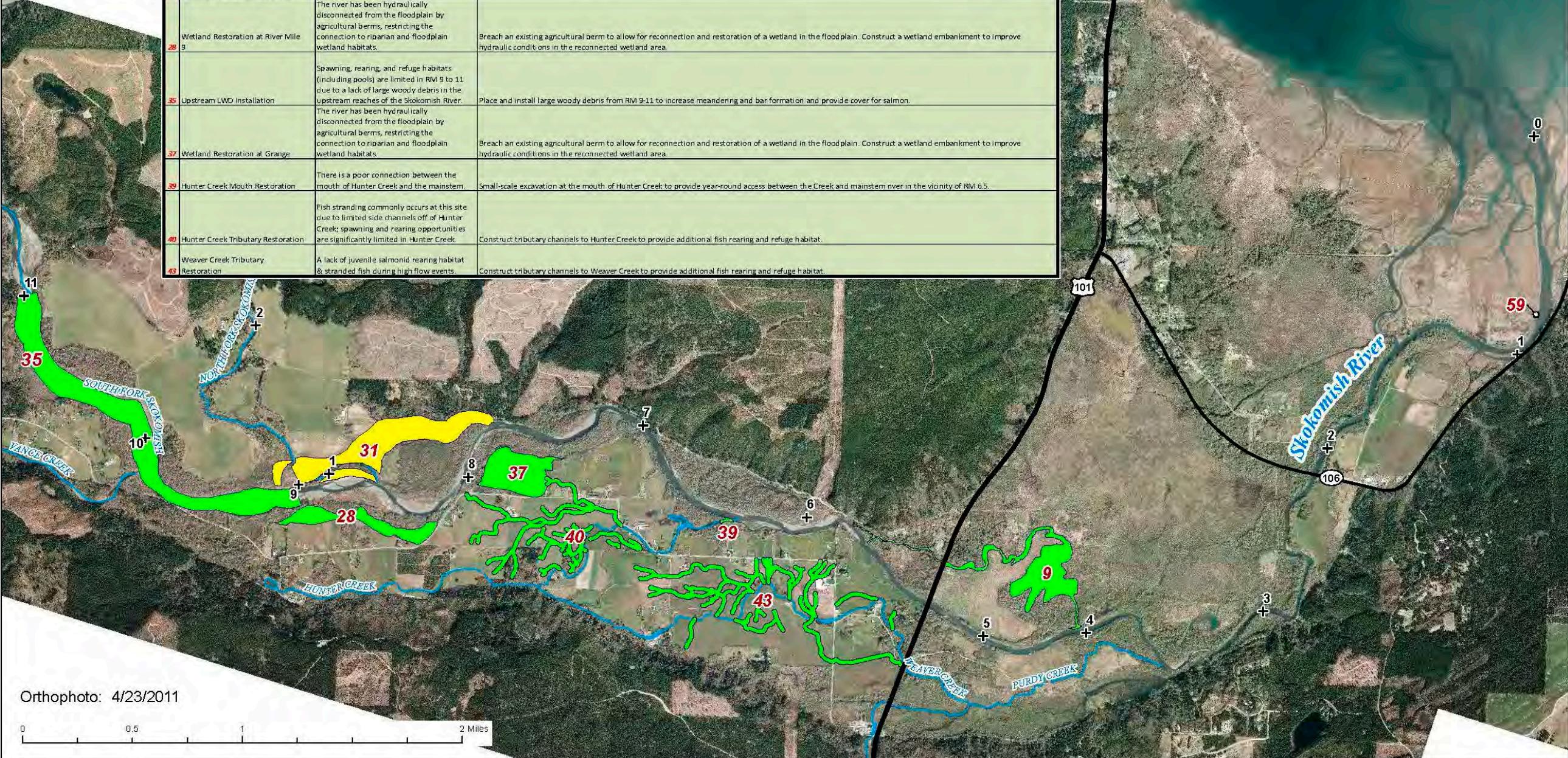


Figure 3-7. Confluence Levee Removal Alternative (Alternative #27)

Riverbed Excavation Alternatives #45 and #60

Two Riverbed Excavation alternatives were evaluated during this step of the planning process. Alternative #45 represents a smaller scale of riverbed excavation alternative. It should be noted that this plan is a cost effective plan only. The CE/ICA analysis did not indicate this plan is a best buy; however, it was carried forward to this stage of analysis because it meets the critical needs of the study area while requiring a smaller extent of dredging compared to Alternative #60. Alternative #60 represents the largest-scale best buy plan and represents the most significant Federal investment for this study.

The increments included in each scale of the riverbed excavation alternative appear in Table 3-11.

Table 3-11. Riverbed Excavation Alternatives

Riverbed Excavation (Alternative #45)	Riverbed Excavation (Alternative #60)
Base #5: Riverbed Excavation (RM 3.5-9)	Base #1: Riverbed Excavation (RM 0-9)
Increment #35: Upstream LWD Installation	Increment #35: Upstream LWD Installation
Increment #9: Side Channel Reconnection	Increment #9: Side Channel Reconnection
Increment #37: Wetland Restoration at Grange	Increment #37: Wetland Restoration at Grange
Increment #28: Wetland Restoration at River Mile 9	Increment #28: Wetland Restoration at River Mile 9
Increment #40: Hunter Creek Tributary Restoration	Increment #40: Hunter Creek Tributary Restoration
Increment #43: Weaver Creek Tributary Restoration	Increment #43: Weaver Creek Tributary Restoration
Increment #26: Wetland Restoration at Dips Road	Increment #26: Wetland Restoration at Dips Road

The map shown below (Figure 3-8) indicates the location of the project features included in the largest scale of the Riverbed Excavation Alternative (Alternative #60).



Skokomish GI Riverbed Excavation Alternative: 09-AUG-2013

Riverbed Excavation
+ BASE #1 (59)
+ Increments
+ River Miles

ID	PLAN NAME	SITE PROBLEM OR NEED	PLAN DESCRIPTION
29	BASE #1: Riverbed Excavation (RM 0-9)	Aggradation reduces fish access and migration.	Dredge from RM 0 to RM 9 (complete mainstem dredge). Removal of ~25 million cubic yards of material. Includes placement of LWD in dredged reaches.
9	Side Channel Reconnection	Rearing and migration opportunities are significantly limited in this remnant river channel with a poor connection to the mainstem.	Reconnect abandoned side channel between RM 4 and 5.6 to provide high flow refuge and rearing habitat for fish.
26	Wetland Restoration at Dips Road	West Valley Road (located at the "Dips") acts as a physical barrier to riparian habitat connectivity.	Relocate a small area of West Valley Road in the vicinity of the Dips to provide additional floodplain habitat and reduce the stranding potential for fish.
28	Wetland Restoration at River Mile 9	The river has been hydraulically disconnected from the floodplain by agricultural berms, restricting the connection to riparian and floodplain wetland habitats.	Breach an existing agricultural berm to allow for reconnection and restoration of a wetland in the floodplain. Construct a wetland embankment to improve hydraulic conditions in the reconnected wetland area.
35	Upstream LWD Installation	Spawning, rearing, and refuge habitats (including pools) are limited in RM 9 to 11 due to a lack of large woody debris in the upstream reaches of the Skokomish River.	Place and install large woody debris from RM 9-11 to increase meandering and bar formation and provide cover for salmon.
37	Wetland Restoration at Grange	The river has been hydraulically disconnected from the floodplain by agricultural berms, restricting the connection to riparian and floodplain wetland habitats.	Breach an existing agricultural berm to allow for reconnection and restoration of a wetland in the floodplain. Construct a wetland embankment to improve hydraulic conditions in the reconnected wetland area.
40	Hunter Creek Tributary Restoration	Fish stranding commonly occurs at this site due to limited side channels off of Hunter Creek; spawning and rearing opportunities are significantly limited in Hunter Creek.	Construct tributary channels to Hunter Creek to provide additional fish rearing and refuge habitat.
43	Weaver Creek Tributary Restoration	A lack of juvenile salmonid rearing habitat & stranded fish during high flow events.	Construct tributary channels to Weaver Creek to provide additional fish rearing and refuge habitat.

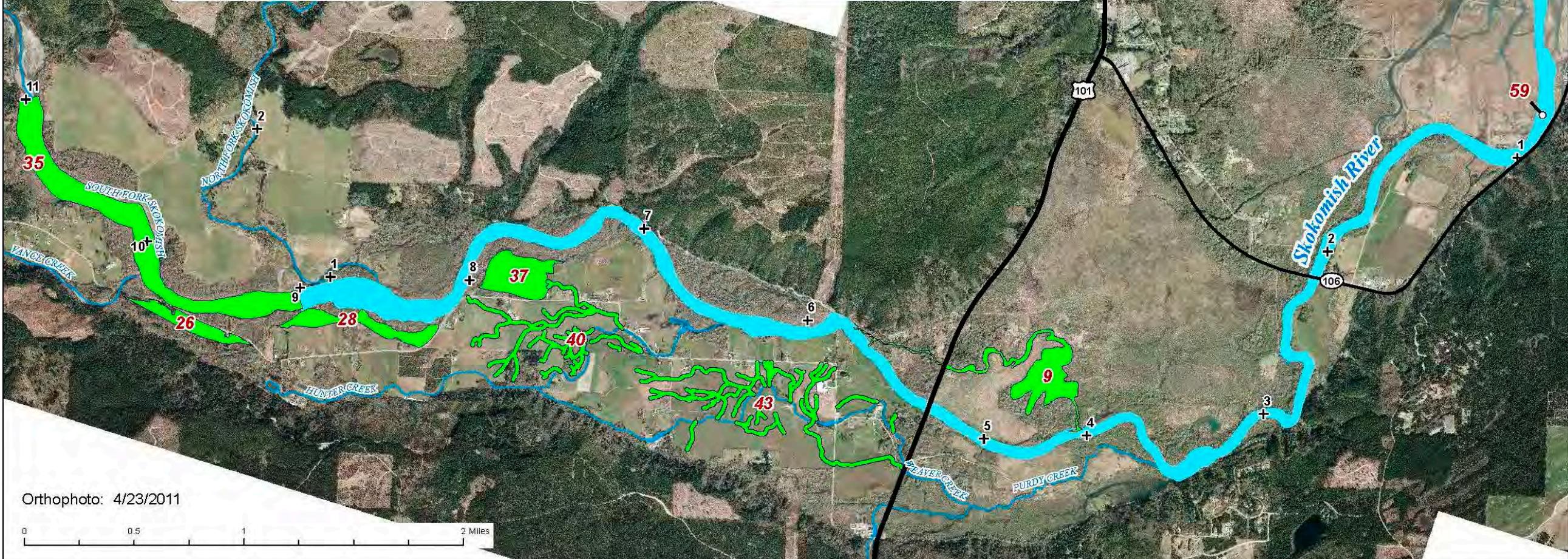


Figure 3-8. Riverbed Excavation Alternative (Alternative #60)

3.9 Evaluation and Comparison of Final Array of Alternatives*

Alternatives are evaluated by assessing or measuring the differences between each with- and without-plan condition and by appraising or weighting those differences. Evaluation consists of four tasks: (1) forecast the most likely with-project conditions expected from each alternative; (2) compare each with-project conditions to the without-project conditions and document differences between the two; (3) characterize the beneficial and adverse effects by magnitude, location, timing, and duration; and (4) qualify plans for further consideration. The following sections outline these steps and describe the final evaluation, comparison, and trade-off analyses to identify a recommended plan.

Plans were evaluated based on the following criteria: outputs and plan effects, contributions to the Federal objective (National Ecosystem Restoration - NER), the study goals and objectives, the Planning Guidance Notebook's four evaluation criteria (completeness, effectiveness, efficiency, and acceptability), and other criteria deemed significant by participating stakeholders. The following sections outline the results of the evaluation and comparison steps. The results of the evaluation and comparison of effects to significant resources are presented in Chapter 4 while evaluation of compliance with environmental protection requirements is presented in Chapter 6.

3.9.1 Outputs and Plan Effects

Table 3-12 summarizes the costs and beneficial environmental outputs for each alternative.

Table 3-12. Costs and Outputs of the Final Array of Alternatives (Oct 2013 price level, 3.75% discount rate)

Alternative #	Plan Components	Habitat Units (In-Channel, Floodplain, and Capacity)	Habitat Units (Shellfish Substrate)	Total Habitat Units	Total Acres Restored	Total Average Annual Cost (\$1,000s)
No-Action Alternative						
1	No-Action Plan	0	n/a	0	0	\$0
Confluence Levee Removal Alternatives						
11	Confluence Levee Removal Alternative #11: <i>Base #3: Confluence Levee Removal</i> Increment 35 – Upstream LWD Increment 9 – Side Channel Restoration	154.5	n/a	154.5	220 In-Channel, Floodplain, & Capacity	\$617
18	Confluence Levee Removal Alternative #18: <i>Base #3: Confluence Levee Removal</i> Increment 35 – Upstream LWD Increment 9 – Side Channel Restoration Increment 37 – Wetland Restoration at Grange Increment 28 – Wetland Restoration at River Mile 9	186.6	n/a	186.6	277 In-Channel, Floodplain, & Capacity	\$868

Alternative #	Plan Components	Habitat Units (In-Channel, Floodplain, and Capacity)	Habitat Units (Shellfish Substrate)	Total Habitat Units	Total Acres Restored	Total Average Annual Cost (\$1,000s)
27	Confluence Levee Removal Alternative #27: <i>Base #3: Confluence Levee Removal</i> Increment 35 – Upstream LWD Increment 9 – Side Channel Restoration Increment 37 – Wetland Restoration at Grange Increment 28 – Wetland Restoration at River Mile 9 Increment 39 – Hunter Creek Tributary Mouth Increment 40 – Hunter Creek Tributary Restoration Increment 43 – Weaver Creek Tributary Restoration	226.4	n/a	226.4	331.5 In-Channel, Floodplain, & Capacity	\$1,452
Riverbed Excavation Alternatives						
45	Riverbed Excavation Alternative #45: <i>Base #5: Riverbed Excavation (RM 3.5-9)</i> Increment 35 – Upstream LWD Increment 9 – Side Channel Restoration Increment 37 – Wetland Restoration at Grange Increment 28 – Wetland Restoration at River Mile 9 Increment 40 – Hunter Creek Tributary Restoration Increment 43 – Weaver Creek Tributary Restoration Increment 26 – Wetland Restoration at Dips Road	303.9	127.8	431.7	412 In-Channel, Floodplain, & Capacity + 511 Shellfish = 923 Total Acres Restored	\$6,892
60	Riverbed Excavation Alternative #60: <i>Base #1: Riverbed Excavation (RM 0-9)</i> Increment 35 – Upstream LWD Increment 9 – Side Channel Restoration Increment 37 – Wetland Restoration at Grange Increment 28 – Wetland Restoration at River Mile 9 Increment 40 – Hunter Creek Tributary Restoration Increment 43 – Weaver Creek Tributary Restoration Increment 26 – Wetland Restoration at Dips Road	377.1	210.8	587.9	499 In-Channel, Floodplain, & Capacity + 843 Shellfish = 1,342 Total Acres Restored	\$9,379

3.9.2 Contributions to the Federal Objective (NER) and Study Objectives

Alternative plans were compared to each other with emphasis on benefits and impacts with respect to study goals, objectives, and NER objectives. Table 3-13 provides a summary of how each alternative plan meets the study objectives. Alternatives #11, #18, and #27 partially meet the planning objective of improving the quantity, quality, and complexity of pools in the Skokomish River; only Alternative #45

and #60 would fully achieve this objective. While improving pool habitat in the Skokomish River is an important objective that would help to address significant problems in the study area, it cannot be fully accomplished by implementing Alternatives #11, #18, or #27. In addition, Alternative #45 and #60 do not fully meet planning objectives due to environmental, real estate, and cost considerations. The analysis presented in Section 3.9.4 outlines these and other trade-offs between the alternatives.

Table 3-13. Comparison of Alternative Plans and Study Objectives

Objectives	Provide year-round passage near confluence	Restore side channel and tributary network	Improve quality and complexity of floodplain habitats	Improve quantity, quality, and complexity of pools
Alternative 1: No-Action	No	No	No	No
Alternative #11	Yes	Partially	Partially	Partially
Alternative #18	Yes	Partially	Yes	Partially
Alternative #27	Yes	Yes	Yes	Partially
Alternative #45	Yes	Yes	Yes	Yes
Alternative #60	Yes	Yes	Yes	Yes

3.9.3 Completeness, Effectiveness, Efficiency and Acceptability

Completeness, effectiveness, efficiency, and acceptability are the four evaluation criteria specified in the Council for Environmental Quality (CEQ) Principles and Guidelines (Paragraph 1.6.2(c)) in the evaluation and screening of alternative plans. Alternatives considered in any planning study should meet minimum subjective standards of these criteria in order to qualify for further consideration and comparison with other plans.

Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects.

Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities.

Efficiency is the extent to which an alternative plan is the most cost effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the nation's environment.

Acceptability is the workability and viability of the alternative plan with respect to acceptance by State and local entities, tribes, and the public and compatibility with existing laws, regulations, and public policies.

Table 3-14. Comparison of Completeness, Effectiveness, Efficiency, and Acceptability

	Completeness	Effectiveness	Efficiency	Acceptability
Alternative 1: No-Action	No	No	No	No
Alternative #11	Yes	Yes	Yes	Yes
Alternative #18	Yes	Yes	Yes	Yes
Alternative #27	Yes	Yes	Yes	Yes
Alternative #45	Yes	Yes	No	Partially
Alternative #60	Yes	Yes	Yes	Partially

Alternative 1 (No-Action Alternative)*

The No-Action Alternative does not meet the completeness criterion because it does not provide any means to realize the planning objectives of this feasibility study.

The No-Action Alternative does not meet the effectiveness criterion because it does not achieve any of the planning objectives.

The No-Action Alternative is the least efficient alternative because it is not the most cost effective means of alleviating the problems and realizing the opportunities of the study area.

The No-Action Alternative is the least acceptable plan with respect to acceptance by State and local entities and the public.

Alternative #11 – Confluence Levee Removal

All actions required to achieve the planning objectives are accounted for in Alternative #11 and it is not significantly dependent on the actions of others. Alternative #11 is a complete plan that will enhance the overall goals of restoring the Skokomish River Basin by complementing other restoration efforts.

Alternative #11 is effective because it alleviates the specified problems and achieves the specified opportunities.

Alternative #11 is an efficient plan. It has low incremental costs and is considered a best buy plan.

Alternative #11 is acceptable. This alternative does not violate public laws or regulations.

Alternative #18 – Confluence Levee Removal

All actions required to achieve the planning objectives are accounted for in Alternative #18 and it is not significantly dependent on the actions of others. Alternative #18 is a complete plan that will enhance the overall goals of restoring the Skokomish River Basin by complementing other restoration efforts.

Alternative #18 is effective because it alleviates the specified problems and achieves the specified opportunities. Compared to Alternative #11, Alternative #18 includes more features that will contribute to restoring ecosystem structures, functions, and processes. Inclusion of two additional wetland restoration increments adds significant value to overall restoration goals of the study and meets planning objectives to a higher degree than Alternative #11. These increments improve productivity of all life stages of salmonids by increasing available spawning, incubation, rearing, and over-wintering habitats as well as providing high flow refuge for fish during frequent winter storm events, and are expected to hold water within the wetland at a greater depth and longer duration thereby improving and expanding wetland conditions.

Alternative #18 is an efficient plan. It has higher incremental costs compared to Alternative #11 but meets all the planning objectives to some degree.

Alternative #18 is acceptable. This alternative does not violate public laws or regulations.

Alternative #27 – Confluence Levee Removal

All actions required to achieve the planning objectives are accounted for in Alternative #27 and it is not significantly dependent on the actions of others. Alternative #27 is a complete plan that will enhance the overall goals of restoring the Skokomish River Basin by complementing other restoration efforts. This alternative can be considered more complete than Alternative #18 because it represents a more comprehensive restoration alternative; it restores one of the largest tributaries in the study area and reconnects a significant area of floodplain habitat.

Alternative #27 is more effective than Alternative #18 because it includes more features that will contribute to restoring ecosystem structure and function. Inclusion of two additional tributary restoration increments adds significant value to overall restoration goals of the study and meets planning objectives to a higher degree than Alternative #18.

Alternative #27 is an efficient plan. The incremental cost for this alternative compared to Alternative #18 is negligible (approximately \$10/unit). This incremental cost is commensurate to the increase in habitat units (40 additional HUs) and acres restored (55 additional acres) compared to Alternative #18.

Alternative #27 is acceptable because it does not violate public laws or regulations. However, this alternative is not acceptable in terms of landowner willingness because there are insurmountable real estate issues associated with the Hunter and Weaver Creek tributary increments.

Alternative #45 – Riverbed Excavation

All actions required to achieve the planning objectives are accounted for in Alternative #45 and it is not significantly dependent on the actions of others. Alternative #45 is a complete plan that will enhance the overall goals of restoring the Skokomish River Basin by complementing other restoration efforts.

Alternative #45 is effective because it alleviates the specified problems and achieves the specified opportunities. However, this plan is less effective than Alternatives #11, #18, or #27 because there are significant short-term environmental impacts associated with construction activities for this plan as well as risks of longer-term impacts to salmon spawning habitat.

Alternative #45 is not efficient compared to Alternative #60. This alternative is a cost effective plan only and does not provide the greatest incremental increase in output (benefits) for the lowest incremental increase in cost.

Alternative #45 is partially acceptable. Resource agencies are not supportive of large-scale dredging for ecosystem restoration due to the anticipated significant short-term environmental consequences associated with construction of this plan as well as significant risk that salmon would not be able to find appropriate spawning habitat for one or more years as sediments stabilize and the river experiences higher channel-forming flows. This alternative does not violate public laws or regulations.

Alternative #60 – Riverbed Excavation

All actions required to achieve the planning objectives are accounted for in Alternative #60 and it is not significantly dependent on actions of others. Alternative #60 is a complete plan that increases channel

capacity throughout the most important part of the study area, RM 3.5-9. This alternative will enhance the overall goals of restoring the Skokomish River Basin by complementing other efforts.

Alternative #60 is effective because it alleviates the specified problems and achieves the specified opportunities. However, this plan is less effective than Alternatives #11, #18, or #27 because there are significant short-term negative environmental effects associated with construction activities for this plan as well as risks of longer-term negative effects to salmon spawning habitat.

Alternative #60 is a cost effective means of achieving the study objectives. Incremental costs of Alternatives #45 and #60 are nearly the same; however, due to significantly greater incremental costs compared to Alternative #27, Alternative #60 is a less efficient means of achieving study objectives.

Alternative #60 is partially acceptable. Resource agencies are not supportive of large-scale dredging for ecosystem restoration due to the anticipated significant short-term environmental consequences associated with construction of this plan as well as significant risk that salmon would not be able to find appropriate spawning habitat for one or more years as sediments stabilize and the river experiences higher channel-forming flows. This alternative does not violate public laws or regulations.

3.9.4 Trade-Off Analysis

Trade-off analysis is the procedure the Corps uses to identify the potential gains and losses associated with producing a larger or lesser amount of given outputs. The results of trade-off analysis inform the formulation, evaluation, comparison, and selection of the recommended plan. The study team identified several trade-offs between the Confluence Levee removal alternatives and the riverbed excavation alternatives. Although the final array of alternatives includes three scales of the Confluence Levee Alternative and two scales of the Riverbed Excavation Alternative, the following table summarizes the key trade-offs between the medium scale of the Confluence Levee Removal Alternative (Alternative #18) and the largest scale of the Riverbed Excavation Alternative (Alternative #60). Trade-off criteria were developed by the study team and generally relate to the following categories: cost considerations, types of habitat restored, positive and negative environmental impacts, and real estate considerations. The trade-off criteria were intended to highlight key differences among the alternatives to assist the study team in evaluating, comparing, and ultimately selecting a recommended plan.

Among the factors considered, this analysis identified key trade-offs between the alternatives. Additional trade-offs are presented in the environmental consequences documentation in Chapter 4.

The bases of the two Riverbed Excavation alternatives are considered to be highly engineered versus the more process-based restoration components included in the Confluence Levee Removal alternatives. While the Riverbed Excavation Alternative restores significantly more acres compared to the Confluence Levee Removal alternatives, provides benefits to shellfish, and allows for placement of habitat features like LWD in the mainstem river channel by directly increasing channel capacity, it has significant expected short-term environmental impacts and is cost-prohibitive in construction and O&M costs.

The benefits of river sediment excavation (Alternatives #45 and #60) are that providing the capacity for the 50% annual chance of exceedance (ACE) would greatly reduce the frequency of overbank flows and thereby reduce the problem of fish stranding on high ground after they are flooded out of the river and

then trapped with no channel access back into the river. However, such broad-scale alteration of the river bottom would cause significant short-term risks to salmon habitat; these are described in detail in section 4.4.1.2. As of yet, no entity or agency has been able to quantify the adult and juvenile fish stranding problem beyond the anecdotal reports from Skokomish Valley residents and local news media reports. Given the lack of quantification of the magnitude of the stranding problem and the level of potential environmental risks from riverbed excavation, it is difficult to weigh the risks versus benefits of Alternatives #45 and #60.

While Alternative #45 and #60 would have additional direct benefits to shellfish through the disposal of dredged gravel in the estuary, availability of real estate for disposal of dredged material in the estuary and avoiding negative effects to eelgrass beds in the estuary complicates the overall design and implementation of this alternative.

Table 3-15. Trade-Off Analysis

Trade-Off Criteria	No-Action Alternative	Confluence Levee Removal (Alternative #18)	Riverbed Excavation (Alternative #60)
Cost (Total First Cost)	\$0	\$19 million	\$258 million
Total Habitat Units	0 AAHUs	187 AAHUs	588 AAHUs
Acres Restored	0 acres	277 acres (in-channel, floodplain, and channel capacity only)	1,342 acres (499 in-channel, floodplain, and channel capacity acres + 843 shellfish acres)
Cost Per Acre (total first cost divided by total acres)	\$0	\$70K	\$192K
Direct benefit to shellfish or oysters	No	No	Yes (placement of dredged material in nearshore zone for shellfish attachment)
Directly increases channel capacity	No	No	Yes
Allows for placement of additional in-channel habitat features (LWD)	No	Yes, RM 9 to RM 11	Yes, RM 0 to RM 11
Addresses summer low flow reach; restores year-round channel near confluence	No	Yes	Yes
Improves habitat connectivity	No	Yes	Yes
Reduces fish stranding	No	Provides high flow refuge during frequent winter storm events; improves floodplain connectivity	Yes
Short-term negative environmental effects	None	Low	High
Sustainability	N/A	High	Medium
O&M	None	Minimal	Periodic re-dredging (\$43M every 20 years)
Private property impacts	None	Low	High

Finally, construction and maintenance of the Riverbed Excavation alternatives are extremely cost prohibitive. Per Corps' cost-sharing policies for construction of ecosystem restoration projects, the non-

Federal sponsors would be required to contribute 35% of the construction costs with the Corps and would be responsible for all O&M activities associated with the alternative (estimated to be up to \$80 million for the largest-scale riverbed excavation alternative). These non-Federal funding requirements are beyond the budget capacity of Mason County and the Skokomish Indian Tribe, and are also likely beyond the means of local or State grant opportunities. As such, the study sponsors do not have the financial capability to cost-share in construction of these alternatives or maintain them per Corps O&M requirements. If O&M cannot be sustained, it is anticipated that restoration benefits would be foregone at some time during the 50-year project life. Additionally, the requirement for maintenance (re-dredge the channel every 20 years) for the Riverbed Excavation alternatives would have similar short-term construction impacts as those experienced during initial construction (environmental impacts are discussed in Chapter 4), causing these alternatives to be less sustainable compared to the Confluence Levee Removal alternatives.

The base of all of the Confluence Levee Removal alternatives is a minimally engineered restoration solution and includes features that restore the ecosystem structures, functions, and processes of the study area. Confluence Levee Removal would restore fewer acres of habitat and would not provide direct benefits to shellfish. However, it improves habitat connectivity and restores a year-round channel near the confluence with minimal negative environmental effects. It also has lower construction costs and requires minimal O&M. Although this alternative does not allow for placement of additional in-channel habitat features like LWD because it does not directly increase channel capacity, additional floodplain increments (e.g., side channel reconnection) are warranted to create a comprehensive restoration solution.

The information developed by the CE/ICA and evaluation, comparison, and trade-off analyses have informed the decision-making process by helping to answer whether the proposed Federal investment of each alternative in the final array is justifiable and viable from a cost perspective; that is, whether the environmental benefit of the additional output in the next level of investment is worth its additional cost. Per the general decision-making guidelines outlined in Appendix E of ER-1105-2-100, the following factors assist in making it justifiable and viable from a cost perspective:

- Output target: Although a formal habitat unit target has not been identified for the study, the PDT has indicated that restoration of side channel and floodplain habitats adds significant value to the proposed alternatives. Additional investment to restore these critical habitat types are worth the relatively small cost of doing so; alternatives that include additional increments that propose restoration of floodplain or side channel habitats are worth the investment. The additional restoration of side channels and floodplain wetlands will have high returns in ecosystem functions.
- Cost affordability: Non-Federal sponsor implementation funds are a constraint. The Riverbed Excavation Alternatives are not affordable to the Non-Federal sponsors in terms of both construction costs and O&M requirements.
- Unintended effects: The Riverbed Excavation Alternatives have anticipated significant short-term environmental consequences associated with construction of this plan as well as significant risk that salmon would not be able to find appropriate spawning habitat for one or more years

as sediments stabilize and the river experiences higher channel-forming flows. Chapter 4 describes these environmental effects in more detail.

3.10 Summary of the Tentatively Selected Plan (Environmentally Preferable Alternative)*

The evaluation and comparison of alternatives led the study team to initially recommend Alternative #27 as the Tentatively Selected Plan (TSP) as well as the environmentally preferable alternative. Alternative #27 is environmentally preferable because it has the greatest quantity of Average Annual Habitat Units without the significant temporary construction impacts and environmental risk to salmon spawning habitat of Alternatives #45 and #60.

The TSP presented in the Draft FR/EIS (January 2014) included the removal of Confluence Levee, the installation of large woody debris, reconnection of a side channel, wetland restoration at two sites, and restoration of two tributaries. In subsequent coordination efforts between the Corps, the non-Federal sponsors, and local landowners in the study area, three increments that were originally included in the TSP are no longer being carried forward. The Hunter Creek Mouth (Increment #39), Hunter Creek Tributary Restoration (Increment #40), and Weaver Creek Tributary Restoration (Increment #43) are no longer included in the recommended plan due to a lack of landowner willingness. As the feasibility-level design phase was completed, these increments were determined to have insurmountable real estate and access issues that had not manifested earlier the analysis.

3.11 Summary of the Recommended Plan*

As described in the previous section, the TSP presented the Draft FR/EIS has been modified following agency, technical, and public review of the report as well as completion of feasibility-level design efforts. While the Draft FR/EIS presented the Corps' tentative proposal for a selected plan, this Final FR/EIS presents the Corps' recommended NER plan. Based on subsequent coordination efforts between the Corps, the non-Federal sponsors, and local landowners in the study area, Alternative #18 (Figure 3-9) is presented as the recommended plan. This best buy plan includes the same increments as the original TSP (Confluence Levee removal, installation of large woody debris, reconnection of a side channel, and two wetland restoration increments) but does not include the Hunter and Weaver Creek tributary restorations. While less comprehensive than the original recommended plan, Alternative #18 is still considered complete, acceptable, efficient, and effective, and it restores the critical needs of the study area (restores year-round flow for fish passage). Alternative #18 is a best buy plan, is economically justified, and is more acceptable in terms of landowner willingness/support.

Key considerations of the recommended plan are summarized below:

Total project cost: \$19.3 million (October 2014 price level); \$21.7 million (fully funded cost estimate to the midpoint of construction)

Acres restored: 277

Cost per acre: ~\$70k/acre (October 2014 price level)

Total habitat units: 187

Habitat scarcity: The recommended plan restores nationally scarce habitats including those described in the U.S. Fish and Wildlife Service's Biological Sampling in the Skokomish River Basin (Appendix A).

Connectivity: The recommended plan fully restores a critical, direct physical connection of existing habitat areas (restoration of year-round flow near the confluence of the North & South Fork Skokomish River). The plan also provides critical life requisites including a migration corridor as well as rearing and refuge habitat for ESA-listed salmonids species.

Special species status: The recommended plan directly restores habitat for federally listed salmonid species including Chinook salmon, chum salmon, steelhead, and bull trout.

Hydrologic character: System hydrology is restored to the best attainable condition, but remains a limited factor in ecosystem health of the Skokomish River Basin.

Geomorphic condition: Geomorphology is restored to the best attainable condition, but remains a limiting factor in ecosystem health of the Skokomish River Basin.

Self-sustaining: The recommended plan is designed to be environmentally self-sustaining with little to no O&M costs.

Plan recognition: As described in Section 5.13, the recommended plan is one element of an integrated restoration effort in the entire Skokomish River watershed, contributing to a regional plan for restoration of the Skokomish River Basin.

Alternative #18 is the recommended plan, the National Ecosystem Restoration (NER) plan, and the agency preferred alternative as determined by all of the evaluation criteria discussed throughout Chapter 3. The NER plan reasonably maximizes environmental benefits considering cost effectiveness and incremental cost analyses, significance of outputs, completeness, efficiency, effectiveness, and acceptability. The NER plan is also more acceptable than the original TSP in terms of landowner willingness and constructability on available lands. The following chapters describe the direct, indirect, and cumulative environmental effects of each alternative including the recommended plan.

Skokomish River Basin Ecosystem Restoration - Recommended Plan

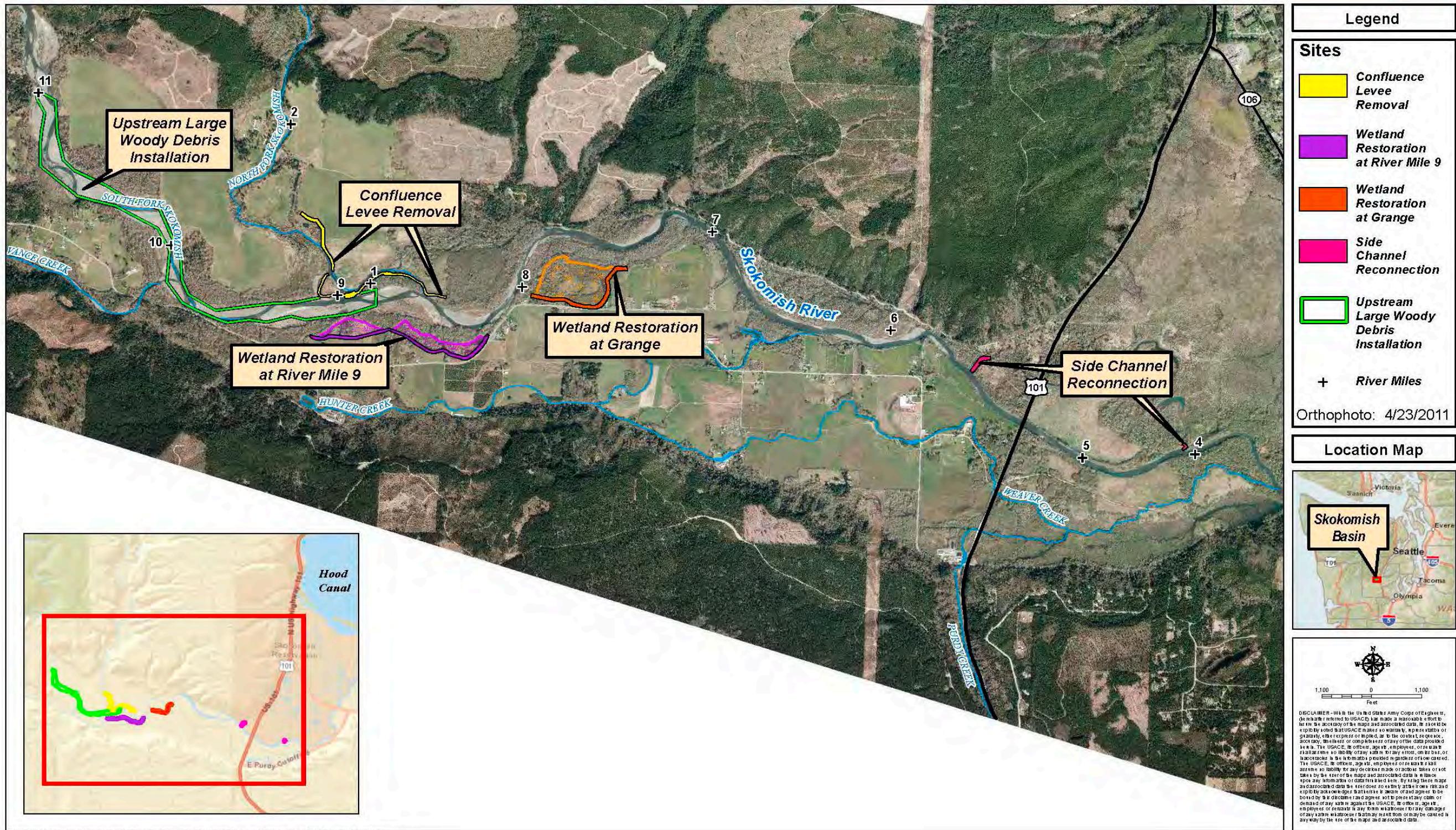


Figure 3-9. Recommended Plan

4. Affected Environment and Environmental Consequences of the Alternatives*

This chapter describes the existing conditions and future without-project conditions used for analysis during the Skokomish River Basin feasibility study, as well as the probable environmental outcomes of implementing each proposed alternative. Existing conditions are the physical, chemical, biological, and sociological characteristics of the study area. Characterizing resource conditions is critical for understanding the probable future condition of those resources (i.e. the future without-project condition) and for defining problems and opportunities. The assessment of environmental effects is based on a comparison of conditions with and without implementation of the proposed plan and a reasonable range of alternatives. In this case, the five action alternatives formulated through the screening process are grouped into two types: Confluence Levee Alternatives and Riverbed Excavation Alternatives and are compared to the No-Action Alternative. The No-Action Alternative and the two groups of action alternatives were analyzed for direct and indirect effects on each resource and whether those direct and indirect effects result in a significant adverse cumulative effect when added to other past, present, and reasonably foreseeable future actions. The analysis focuses only on significant resources that are potentially affected by the alternatives and have a material bearing on the decision-making process. The spatial scale of analysis focuses on the locations of the proposed sites to provide a comparison between the No-Action Alternative and the various scales of the two action alternatives. The time scale for analysis is a 50-year period beginning in 2015 and extending to 2065.

Chapter 3 outlines the formulation and evaluation of alternatives. The final array of alternatives carried forward for the assessment of environmental effects in Chapter 4 is the following:

No-Action Alternative

Confluence Levee Removal Alternatives

Confluence Levee Removal (Alternative #11)	Confluence Levee Removal (Alternative #18)	Confluence Levee Removal (Alternative #27)
Base Alternative #3: Confluence Levee Removal	Base Alternative #3: Confluence Levee Removal	Base Alternative #3: Confluence Levee Removal
Increment #35: Upstream LWD Installation	Increment #35: Upstream LWD Installation	Increment #35: Upstream LWD Installation
Increment #9: Side Channel Reconnection	Increment #9: Side Channel Reconnection	Increment #9: Side Channel Reconnection
	Increment #28: Wetland Restoration at River Mile 9	Increment #28: Wetland Restoration at River Mile 9
	Increment #37: Wetland Restoration at Grange	Increment #37: Wetland Restoration at Grange
		Increment #39: Hunter Creek Mouth Restoration
		Increment #40: Hunter Creek Side Channel Restoration
		Increment #43: Weaver Creek Side Channel Restoration

Riverbed Excavation Alternatives

Riverbed Excavation (Alternative #45)	Riverbed Excavation (Alternative #60)
Base Alternative #5: Riverbed Excavation (RM 3.5-9)	Base Alternative #1: Riverbed Excavation (RM 0-9)
Increment #35: Upstream LWD Installation	Increment #35: Upstream LWD Installation
Increment #9: Side Channel Reconnection	Increment #9: Side Channel Reconnection
Increment #37: Wetland Restoration at Grange	Increment #37: Wetland Restoration at Grange
Increment #28: Wetland Restoration at River Mile 9	Increment #28: Wetland Restoration at River Mile 9
Increment #40: Hunter Creek Tributary Restoration	Increment #40: Hunter Creek Tributary Restoration
Increment #43: Weaver Creek Tributary Restoration	Increment #43: Weaver Creek Tributary Restoration
Increment #26: Wetland Restoration at Dips Road	Increment #26: Wetland Restoration at Dips Road

4.1 Resources Analyzed and Resources Screened from Detailed Analysis

Table 4-1 identifies the resources analyzed or screened from detailed analysis including a rationale for inclusion or exclusion. Resources were excluded from detailed analysis if they are not potentially affected by the alternatives or do not have a material bearing on the decision-making process.

Table 4-1. Resources Analyzed and Resources Screened from Detailed Analysis

Resource	Included in Detailed Analysis (Y/N)	Rationale for inclusion or exclusion
Hydraulics and Hydrology	Y	Problems identified center on the relationships among hydraulics, hydrology, and sedimentation. The alternatives require study of these characteristics. Local residents raised groundwater as a significant concern and it was reviewed in project screening.
Geomorphology and Sediment Transport	Y	Problems identified center on the relationships among hydraulics, hydrology, and sedimentation. Proposed alternatives require study of these characteristics.
Water Quality	Y	Riverbed excavation alternatives would have significant short-term effects to turbidity.
Air Quality	Y	Required to be analyzed as named in NEPA. This analysis appears in Chapter 6.
Greenhouse Gas Emissions	Y	Required to be analyzed by CEQ guidance (2010).
Climate Change and Sea Level Change	Y	USACE Engineering Circular 1165-2-212 requires feasibility studies to consider the sensitivity and adaptability of projects to sea level change. Predicted effects of climate change are described for the alternatives.
Underwater and Airborne Noise	N	Airborne noise from construction would attenuate by distance from the source to any sensitive receptors. Underwater noise from construction would occur when sensitive receptors would not be present, and in shallow water such that the sound waves would be attenuated quickly. Therefore, there would not be a significant impact.
Hazardous, Toxic, and Radiological Waste (HTRW)	Y	This analysis appears in Appendix I. The proposed action alternatives would not create any hazard to the public or the environment through transport, use, or disposal of hazardous materials. There are no CERCLA-regulated substances involved with any of the proposed restoration sites. The few cars at Confluence Levee have been present for decades and have not contaminated the surrounding area. Mason County contracted a consulting firm to test the soil for a Phase II HTRW investigation; results confirm that there is no hazardous or toxic waste resulting from the abandoned cars. Of the 33 samples taken at Confluence Levee, only 5 locations had detections of gasoline, all of which were below MTCA Method A Soil Cleanup Levels for Unrestricted Land Use. WDOE has provided a letter confirming that there are no active or proposed cleanup sites within the Skokomish River Basin.
Fish	Y	One of the proposed alternatives may have a significant negative effect to fish populations in the mainstem river channel. All alternatives would provide long-term significant benefits for fish populations.
Mammals	Y	Beaver, raccoon, river otter, mink, and other small mammals are associated with and dependent upon riparian and aquatic habitats.

Resource	Included in Detailed Analysis (Y/N)	Rationale for inclusion or exclusion
Birds	Y	The low levels of development in the Skokomish watershed have allowed many sensitive bird species to remain in their native habitat. The proposal is analyzed for its potential to disturb or displace birds.
Shellfish and other Macroinvertebrates	Y	Shellfish would likely benefit from the proposed ecosystem restoration. Two of the action alternatives may have a significant negative effect to benthic macroinvertebrates in the river.
Vegetation (Wetland, Riparian, Estuarine)	Y	Proposed action alternatives may affect size and type of wetlands, and may affect estuarine vegetation such as eelgrass.
Rare, Threatened, and Endangered Species	Y	Riverbed excavation alternatives may have a significant short-term impact on ESA-listed salmonid species.
Cultural Resources	Y	Potential exists for inadvertent discovery of cultural resources; discovery during construction could have an adverse effect to those resources.
Indian Trust Assets	Y	Riverbed excavation alternatives have a risk for negative effects to tribal resources through disturbance and potential harm to salmon.
Environmental Justice Communities	Y	Required to be analyzed by Presidential Executive Order. The result of this analysis appears in Chapter 6 Compliance with Environmental Statutes.
Aesthetics	N	None of the proposed alternatives will affect scenic resources or visual characteristics. Four segments of the South Fork Skokomish River have been proposed for designation as wild, scenic, or recreational under the Wild and Scenic Rivers Act; these sections are upstream from the study area and none of the alternatives would affect these reaches.
Land Use and Agricultural Resources	Y	Population in the study area is predicted to decline, and many area residents are likely to abandon agriculture as an economic base. The proposed alternatives area analyzed to determine whether there would be a significant effect on present or forecasted land use or agricultural resources across the study area.
Recreation Resources	N	Significant recreation activities (boating, camping, bicycling, hunting, etc.) occur outside the study area in the upper watershed or downstream from the study area in Annas Bay. The alternatives would not have more than a negligible effect on fishing activity within the study area.
Public Services and Utilities	N	None of the alternatives would have a substantial effect on electricity, water, wastewater and stormwater collection, sewer and solid waste, natural gas, oil/petroleum, or telecommunications services.
Public Health and Safety	Y	Public health and safety are a concern for any water resources project. The alternatives are analyzed to determine the scale and significance of effects.
Transportation and Traffic	Y	Construction may cause temporary disruptions to local traffic, and construction vehicles could require additional traffic controls for the duration of work.

4.2 Cumulative Effects Approach

Cumulative effects can result from the incremental effects of the proposed action when added to the effects of other past, present, and future actions, regardless of which government agency or private entity undertakes such actions. When effects that are individually minor combine over space or time, the cumulative effects can be significant. NEPA requires analyzing whether the incremental effect of the proposed action will cause a significant impact to the environment when added to past, present, and reasonably foreseeable future actions. This section will summarize actions that have affected the environment, and each resource in Sections 4.3 through 4.6 will be analyzed for whether it would accrue a significant adverse cumulative effect.

Past Actions

The Skokomish River channel has migrated within a narrow band along its present course for at least 400 years. The watershed remained relatively unaltered by human activity until Euro-American settlers

arrived in the mid-nineteenth century. During the last 150 years, there have been many changes to the environment along that alignment caused by both natural and anthropogenic factors. High bedload transport caused by the removal of LWD and disturbance of the stream banks, combined with altered depositional patterns caused by bank protection, side-channel closures, and flow regulation by the Cushman Project have caused riverbed aggradation and increased flooding. Logging and agricultural development have reduced riverbank riparian habitat and cleared LWD from the channel. The riverbank has been stabilized in places to protect roads and farmland. Land management has been geared toward agriculture and timber harvest. Significant land use and development including mining, logging, and fishing have altered the historical physical and biological characteristics of the Skokomish Basin. Table 4-2 outlines the historical timeline of significant events in the Skokomish Watershed.

Table 4-2. Skokomish Watershed Settlement and Development Historical Timeline

Decade	Event
Pre-1850	Only minor alterations of watershed by humans; homeland of Twana people
1850	Euro-Americans begin settling lower Skokomish floodplain
1860	Land clearing and agricultural development of lower Skokomish floodplain
late-1800's	Commercial and recreational fishing became popular among non-Tribal settlers
1899	Fish stocks had become so depleted that a hatchery was built on the river
1900	Logging of lower valleys; Logjam clearing; Log driving; Farm development continued
1910	Extensive logging of lower NF; State Route 106 (old State Road 21 and 14)
1920	Construction of Cushman dams; diversion of NF flow out of Basin at Cushman Dam No. 2 in 1930
1922	Hood Canal was closed to commercial fishing due to decreased salmon runs
1930	Clearcut logging begins on USFS lands in the SF; Diking within river delta for farm development; Channel straightening; River channel gravel mining; Highway 101 bridges built at Purdy Cr., Weaver Cr., north Skokomish overflow channel, and the Skokomish River; Evidence of aggradation in river.
1940	Creation of Shelton Cooperative Sustained Yield Unit (CSYU) Agreement on Simpson Timber and USFS lands in the SF (1946); logging accelerates
1940	Lower mainstem experiences 29 floods in 29 years between 1912 and 1941; Lower mainstem aggrades 1.5 feet
1950	Clearcutting in SF anticipating hydroelectric project; Diking in Vance Creek and lower river; Minimal aggradation in lower river between 1944 and 1964
1960	Extensive dike building; Accelerating road building and logging in the CSYU; Aggradation resumed in lower river
1970	Dike and revetment system lengthened and repaired; Road building and logging in CSYU occurring at high rates; Highway 101 bridge at Weaver Creek re-built
1980	Rapid logging of CSYU continues to early 1980s, then declines later in the decade; structural repairs and additions to various dikes made; Highway 101 bridges over the Skokomish and State Route 106 bridge rebuilt
1990	Logging on Olympic National Forest (ONF) lands in SF reduced significantly then essentially stopped (mid-1990's); Watershed restoration begins on ONF lands: over 200 miles of roads decommissioned or stabilized, 247 miles of upland soil stabilization, nearly 4 miles of instream restoration and riparian enhancement (Anderson et al. 2007); Extensive logging of second growth on Simpson lands; Forest and Fish Law enacted (1999); nearly 4 feet of aggradation since 1964 measured at Highway 101

Decade	Event
1999	Puget Sound Chinook Salmon, Hood Canal Summer-Run Chum Salmon, and the Coastal/Puget Sound Bull Trout listed as threatened under the Endangered Species Act; Corps GI Reconnaissance Study concluded.
2000	Logging of second growth timber on Simpson lands; Continued aggradation in lower river; Restoration work in upper SF to close logging roads; Bourgault/North channel and North channel oxbow restoration; LWD bank protection projects on the Skokomish mainstem, South Fork, and Vance Creek (2000-2012); Corps GI initiated; Cushman Dam settlement reached (2009)
2007	Puget Sound Steelhead listed as threatened under the Endangered Species Act.
2010	Cushman settlement agreement implemented; Floodplain restoration in South Fork by USFS; Estuarine restoration commences with dikes removed and borrow ditches filled on Nalley Island and Slough by the Skokomish Indian Tribe; Purdy Creek Bridge improved by WSDOT in 2009

Notes: NF = North Fork, SF = South Fork, CR = Creek

Sources: Peters et al. 2011, Barreca 2001, Smoker et al, 1952

Present Actions

The Skokomish Watershed Action Team (SWAT) is a diverse, informal partnership of government agencies, land managers, and others collaborating to restore the Skokomish watershed. In 2007, the SWAT designed a three-year action plan to implement over 40 projects in the upper and lower watershed at an approximate cost of \$48.6 million. This action plan is currently being updated to identify restoration projects to be implemented from 2015 to 2020. Types of ecosystem restoration projects the SWAT has undertaken within the past 10 years include significant lengths of road decommissioning and stabilization, culvert replacements, in-stream large wood placement, riparian plantings, and control of invasive species. Similar actions are underway. The Skokomish Indian Tribe and Mason County have recently restored the estuary in three phases of construction to remove dikes and restore hydrology. A query of the WDFW Habitat Work Schedule and Recreation and Conservation Office (RCO) Project Information System (PRISM) databases reveal the following active projects within the study area: Phase 3 of estuary restoration; Southern Hood Canal Riparian enhancement along the mainstem Skokomish; floodplain restoration near Purdy Creek, near Highway 101 bridge, and at RM 8; Five Mile Creek LWD placement; removal of car bodies along the lower mainstem with riparian restoration; and riparian planting near Sunnyside Road (WDFW et al. 2013).

Skokomish Valley has remained relatively undeveloped for many years, and no significant building is occurring at the time of this analysis. Among the activities in the valley, aerial photography analysis reveals that the most significant land disturbances in the watershed over the past five years are large patches of clear-cut logging in the uplands.

Future Actions

Proposed ecosystem restoration projects that Olympic National Forest plans to implement include more road decommissioning, additional large wood in the South Fork, Pine Lake restoration, trail stabilization, prairie restoration, and thinning of overstocked forest stands to enhance wildlife habitat and biodiversity (USFS 2011a, 2011b). The WDFW Habitat Work Schedule and the Washington State RCO databases list the following proposed projects within the study area: Lower Skabob Creek restoration of

habitat complexity; Vance Creek LWD placement; Southern Hood Canal Riparian enhancement along the Skokomish Phase 2; placing engineered logjams after the confluence reach is restored; 150 acres of floodplain restoration at the confluence reach; and parcel acquisition for permanent protection of a side channel just upstream from the Highway 101 bridge (WDFW et al. 2013).

Planned developments within Skokomish Valley include adding 19 homes into the 746-acre property of Skokomish Valley Farms (Capitol Press 2013); these will be 40-acre parcels in which 35 acres will have a permanent agricultural easement. This farm qualifies for two programs under the Natural Resources Conservation Service's Environmental Quality Incentives Program: a permanent easement on land that is frequently inundated, as well as a five-year wildlife protection program. Approximately 24,000 trees have been planted under these programs (Capitol Press 2013).

Cushman Settlement Agreement

A settlement and relicensing agreement for Tacoma Power's Cushman Hydroelectric Project was signed in 2009. The agreement resolved a \$5.8 billion damages claim and long-standing disputes over the terms of a long-term license for Cushman Dam. The licensing settlement agreement concludes nearly two years of negotiations and decades of contention between Tacoma Power, the Skokomish Indian Tribe, and the many State and Federal agencies that will oversee implementation of the terms of the agreement. Although the Corps is not a signatory of the Cushman Settlement Agreement, the terms outlined in the settlement have been considered in this report as actions undertaken by Tacoma Power in accordance with the settlement may have the potential to affect the existing and future without-project conditions of the Skokomish River. While multiple sections of this chapter outline the existing, future without-project conditions, and future with-project conditions under specific provisions of the Cushman Settlement, a summary of the key requirements of the agreement as they relate to this study are outlined below.

Current and future activities required by the Cushman Settlement occur primarily in the North Fork Skokomish River, which is outside the Corps' General Investigation study area. These activities include the construction of fish passage facilities, construction and operation of two fish hatcheries, construction of a new powerhouse at Cushman Dam No. 2, and recreation improvements near Lake Cushman. As described in Section 4.4.1.1., these activities would benefit separate stocks of fish that use different forks of the Skokomish River; habitat for the ESA-listed fish species that are found within the Corps' study area remains in a severely degraded state.

At this time, there are no confirmed activities required under the Cushman Settlement within the Corps' study area. Additionally, Tacoma Power is not yet required to develop or implement additional measures to address flooding, channel capacity, sediment transport, or habitat restoration within the Corps' study area. Any future action to be taken by Tacoma Power under the Cushman Settlement is dependent upon procedural and technical findings. Provisions in the Cushman Settlement limit the financial obligations for future action by Tacoma Power, so future activities would likely be smaller in scale and have only localized effects that are not expected to negatively affect the recommended plan. Additional funds provided by Tacoma Power in the future are unlikely to substantially increase mainstem channel capacity. If findings determine action by Tacoma Power is required on the mainstem

Skokomish River, activities must be approved by NMFS, BIA, USFWS, and the Skokomish Indian Tribe; Tacoma Power is also required to seek comments and recommendations from the Corps to ensure that any recommendations will be complementary to the recommended plan and will not affect the success or benefits accrued from the Federal (Corps) project.

Table 4-3 provides a summary of known and assumed components of construction of the base alternatives and increments. These construction components were used for the analysis of effects to environmental resources in the following sections.

Table 4-3. Summary of Construction Components Analyzed for Effects to Environmental Resources

Project Features		Included in Alternative	Staging area cleared (acres)	Construction acres cleared (project footprint)	Material excavated	Material placed	Equipment on site (# calculated for schedule)	Estimated construction duration	Estimated number of truckloads (12 CY Truck)	Total haul distance
Bases	Riverbed Excavation (RM 0-9)	Alternative #60	3 Staging areas totaling: 30,000 SF 0.69 AC	219	2,684,000 cy O&M: 700,000 cy ea. 20 years	50 logs per mile	(1) 16" cutter head, pipeline dredge (3) 4 CY, Crawler, dragline crane (18) 18 CY, 6x6 off-road dump trucks (3) 3.2 CY, crawler, loader (3) Trailer mounted, 6'x20' grizzly screener	631 work days	199,728 + 65 (Staging area)	10-Mile cycle
	Riverbed Excavation (RM 3.5-9)	Alternative #45	3 Staging areas totaling: 30,000 SF 0.69 AC	132	1,870,000 cy O&M: 600,000 cy ea. 20 years	50 logs per mile	(3) 4 CY, Crawler, dragline crane (18) 18 CY, 6x6 off-road dump trucks (3) 3.2 CY, crawler, loader (3) Trailer mounted, 6'x20' grizzly screener	363 work days	137,313 + 65 (Staging area)	10-Mile cycle
	Confluence Levee Removal	Alternatives #11, 18, and 27	3 Staging areas totaling: 30,000 SF 0.69 AC	3.6	15,058 cy	30 logs	(3) 2 CY, Crawler, Excavators (12) 18 CY, 6x6 off-road dump trucks (3) 3.2 CY, crawler, loader (1) 75 HP, Dozer	107 total work days; 42 hauling days; minimal or no in-water work	714 + 65 (Staging area)	20-Mile cycle
Increments	Upstream LWD Installation	Alternatives #45 and 60 Alternatives #11, 18, and 27	3 staging areas totaling: 123,750 SF 2.84 AC	14	30,523 cy	80-100 logs 80-100 stones @ 5'diameter	(1) 2 CY, Crawler, Excavator (1) Log Skidder (1) 1.5 CY, Crawler, Excavator w/ Thumb	26 work days	~6 stone per truck ~3 rootwads per truck	20-Mile cycle
	Side Channel Reconnection	Alternatives #45 and 60 Alternatives #11, 18 and 27	Staging areas assumed to be within footprint	0.8	3,614 cy	30 logs 30 stones to anchor logs	(6) 1.5 CY, Crawler, Excavator (4) 18 CY, 6x6 off-road dump trucks (1) 3.2 CY, Crawler,	10 work days	170	20-Mile cycle
	Wetland Restoration at Grange	Alternatives #45 and 60 Alternatives #18 and 27	1 Staging area: 12,250 SF 0.28 AC	4	3,789 cy	27,134 cy	(3) 2 CY, Crawler, Excavators (12) 18 CY, 6x6 off-road dump trucks (3) 3.2 CY, crawler, loader (1) 75 HP, Dozer	63 work days No in-water work	2,992	20-Mile cycle
	Wetland Restoration at River Mile 9	Alternatives #45 and 60 Alternatives #18 and 27	1 Staging area: 14,000 SF 0.32 AC	5.7	8,062 cy	19,891 cy	(3) 2 CY, Crawler, Excavators (12) 18 CY, 6x6 off-road dump trucks (3) 3.2 CY, crawler, loader (1) 75 HP, Dozer	63 work days No in-water work	2,396	20-Mile cycle
	Hunter Creek Side Channel	Alternatives #45 and 60 Alternatives #18 and 27	1 Staging area: 10,000 SF 0.23 AC	29	Approx 75,000 cy	None	(6) 1.5 CY, Crawler, Excavator (4) 18 CY, 6x6 off-road dump trucks (1) 3.2 CY, Crawler, Loader	39 work days	6,493	20-Mile cycle
	Hunter Creek Mouth	Alternatives #45 and 60 Alternatives #18 and 27	Staging areas assumed to be within footprint	0.5	Approx 200 cy	None	(6) 1.5 CY, Crawler, Excavator (4) 18 CY, 6x6 off-road dump trucks (1) 3.2 CY, Crawler, Loader	7 work days	16	20-Mile cycle
	Weaver Creek Side Channel	Alternatives #45 and 60 Alternative #27	1 Staging area: 10,000 SF 0.23 AC	25	Approx 75,000 cy	None	(6) 1.5 CY, Crawler, Excavator (4) 18 CY, 6x6 off-road dump trucks (1) 3.2 CY, Crawler, Loader	47 work days	8,283	20-Mile cycle
	Wetland Restoration at Dips Road	Alternatives #45 and 60	Staging areas assumed to be within footprint	17	1,800 cy at old road loc. 10,000-11,000 cy of organic material	11,000-12,000 cy	(1) 0.8 CY, wheel, loader (1) Excavator, pulverizer, 3,000 lb (1) 3.5 CY, wheel, loader (1) 1.5 CY, wheel, excavator (1) 2.7 ton, vibratory, double drum, roller (1) 135 HP, grader w/ blade (1) 250 hp, crawler, dozer (1) 10' wide, asphalt paver	99 work days No in-water work	3,274	20-Mile cycle

Note: After release of the Draft FR/EIS, the project underwent feasibility-level design. The primary changes relevant to this table are that the logjams are larger than those presented in the conceptual level design, and pile driving has been proposed for anchoring the larger logjams. The Corps will conduct further analyses during PED phase, such as the Wave Equation Analysis for Piles, and other on-site investigations to determine whether driving timber piles at these locations is feasible. Additionally, the staging areas that will be cleared and replanted were changed for Upstream LWD installation, Wetland Restoration at Grange, and Wetland Restoration at River Mile 9. These had been assumed to be within the project footprint of the conceptual level design, but have now been specifically delineated in the feasibility-level design.

4.3 Physical Environment

This section provides an analysis of the existing and future without-project condition of the significant physical resources in the study area, as well as how each alternative would affect these resources.

4.3.1 Hydrology and Hydraulics

A summary of the basin hydrology appears in this report and detailed analyses appear in the Skokomish River Flooding and Sedimentation Baseline report (Appendix H, Annex H-4). The Skokomish River drains approximately 240 square miles of forested terrain into Hood Canal. Three main tributaries contribute to the river system: the North Fork, the South Fork, and Vance Creek. Tacoma's Cushman Hydroelectric Project (Cushman Project), regulates the North Fork's flow, provides flood discharge reductions, and maintains year-round base flows in the 150 to 180 cfs range. The South Fork and Vance Creek are unregulated and provide most of the flood discharges. Average monthly discharges in the South Fork, at the USGS gage upstream of Vance Creek, range from less than 200 cfs in August and September to about 1,400 cfs in December and January. Downstream of the North Fork/South Fork confluence, average monthly discharge ranges from 250 cfs in August to 2,400 cfs in December. In recent years, North Fork and mainstem Skokomish summer base flows below the North Fork confluence have increased because of higher releases from the Cushman Project. Hunter and Weaver creeks are groundwater fed tributaries to the mainstem Skokomish River.

Channel capacity of the mainstem and South Fork Skokomish Rivers, as well as Vance Creek has been significantly reduced due to sediment accumulation. The mainstem has lost about 10,000 cfs of flow capacity since 1941 (Appendix H, Annex H-4). Typically, flooding occurs three to four times every year because of the low channel capacity. Along the south bank of the river, floodwater flows away from the river channel in the upper valley causing widespread, shallow flooding. The southern floodwaters flow southeast through Purdy Creek and rejoin the river downstream of Highway 101 near RM 3.5. The recently completed Purdy Creek bridge improved flood conveyance and should lower flood depths immediately upstream of Highway 101.

Flooding does not generally pose a life safety threat in the Skokomish Valley. Flooding occurs frequently and local residents have learned to cope with floodwaters. During the near record flood in December 2010, there were no reported injuries or deaths due to flooding. Most of the Valley would experience only shallow (less than three feet) flooding during a 1% annual chance of exceedance (ACE) flood event. Ponding areas fill repeatedly each year to depths of five to seven feet and are largely undeveloped.

There is not a continuous, competent, well-planned levee system along the Skokomish River. The levees, berms, and revetments were built by valley residents to combat local flood problems. The levees were built using available materials, and were constructed without engineering design. Most of the levees along the river were originally constructed in the 1950s and 1960s, and were raised or connected during the 1980s and 1990s. None of the levees are considered competent enough to provide reliable flood risk management, although they do provide some localized relief (less than a 2-year level of protection) from the frequent small floods that occur several times a year. The levees are approximately 4 to 6 feet high in some areas and should be considered to perform more like agricultural berms rather than fully

engineered levees. During a flood in 2003, the Confluence Levee was breached near RM 9, diverting the North Fork and moving the confluence downstream nearly 1 ½ miles to RM 7.7.

The sediment accumulation has altered flow conditions in the summer. The riverbed of the South Fork is higher than that of the North Fork near the old confluence at RM 9. Since the North Fork was diverted in 2003, the reduced summer discharges have contributed to all the South Fork flow going subsurface in the late-summer/early fall. This dry riverbed prevents access for ESA-listed fish to critical spawning habitat in the upper reaches of the South Fork.

A study of nine groundwater wells showed increases for six of the nine wells (Figlar-Barnes and Bullchild 2011). This investigation showed that since 1996, notable upward trends in these wells during a downward trend in rainfall suggests increases in overall groundwater levels in the Skokomish Valley that are not necessarily associated with rainfall. This report concluded that additional monitoring is required for a better understanding of groundwater trends.

Finally, the Cushman Settlement includes provisions for a minimum volume and distribution of flow releases to the North Fork as well as provisions to allow for releases of sediment transport flows (i.e., “flushing flows”) to increase sediment transport in the mainstem Skokomish River. While the future without-project condition for hydrology and hydraulics includes the anticipated minimum flow releases now and in the future, the flushing flows are not assumed to be implemented in the future. Flushing flows were attempted in the past but this approach has been abandoned because (1) limited channel capacity causes downstream flooding when larger flushing flows are released, and (2) flushing flows that do not worsen downstream flooding are ineffective at transporting sediment throughout the system.

4.3.1.1 No-Action Alternative/Future Without-Project Conditions

Skokomish River hydrology is not expected to change significantly over the study period. Logging will likely continue in the South Fork and Vance Creek watersheds. Logging on Forest Service land could increase or decrease depending on Federal policy, but either course is unlikely to significantly influence seasonal or flood hydrology. The Cushman Project FERC license has been issued for a 50-year term, so North Fork hydrology should remain very similar to the existing conditions, at least through 2060.

Sediment accumulation is expected to continue to reduce channel capacities of the mainstem and South Fork Skokomish Rivers as well as Vance Creek. Flooding is expected to become even more frequent, but only small increases in flood depths are anticipated due to the broad floodplain in the valley. Continuing aggradation is expected to increase the frequency and duration of the subsurface flows in the South Fork and Vance Creek during the late summer. A channel avulsion that would create an entirely new channel is possible within 20 years (see Geomorphology and Sediment Transport, Section 4.3.2.1.). The Figlar-Barnes and Bullchild (2011) groundwater study did not offer speculation on future trends.

Finally, provisions in the Cushman Settlement are not expected to change the hydrology and hydraulics of the study area in the future without-project condition because potential future actions by Tacoma Power have not been identified, determined to be necessary from a legal or technical standpoint, and are not specifically described.

4.3.1.2 Action Alternatives/Future With-Project Conditions

Aspects common to both groups of action alternatives

Reconnecting the abandoned channel between RM 4 and 5.6 to the river would provide a high flow side channel. This channel carries overbank floodwaters, but is not directly connected to the river. Restoration would involve constructing improvements to the channel inlet and outlet, while most of the channel would not be disturbed. The reconnected channel would be connected to the river only during high discharges and would not convey river flows most of the time.

Two wetland restoration increments, located at RM 7.5-8 and RM 8.3-9.2, are intended to provide additional floodplain habitat for fish and to expand the area of forested wetland adjacent to the river. The wetland embankments would be constructed landward (south) varying distances, around 200 to 300 feet between RMs 8.3-9.2, and up to 1,200 ft between RMs 7.5-8. This would place more riparian forest and floodplain ponds on the riverward side of the agricultural berm. The new wetland embankments are expected to hold water within the wetlands at a greater depth and longer duration thereby improving and expanding wetland conditions. Strategically located sections of the existing agricultural berms would be removed to allow floodwaters to flow freely within the restored wetland area. The wetland embankments will be constructed to improve hydrologic conditions in the reconnected wetland area. The wetland embankments are not flood risk management features; rather, they are a structural mechanism required to allow targeted reconnection to riparian wetlands multiple times a year. The wetland embankments contain flow during moderate winter storm events up to approximately 6,000 cfs (these events occur multiple times a year), providing high flow refuge for fish as well as reconnection and restoration of high-value forested wetland during frequent, moderate winter storm events. The wetland embankments also divert flows back into the river rather than across the entire floodplain to the south where there is no defined channel or ecologically beneficial habitat for salmonid species. The wetland embankments would not cause significant changes in the future with-project flooding conditions. These project components are included in all of the alternatives except for Alternative #11.

Small LWD jams would be placed in the South Fork from RM 9 to 11 to increase meandering and bar formation, and provide cover for salmon. The river channel in this reach is wider and has more flow capacity than the downstream river channels in the study area. The LWD jams would have small cross-sectional areas and be built parallel to flow to minimize the hydraulic disturbance. The channel may be able to incorporate 6 to 12 jams per mile without adverse flooding or erosion effects. During feasibility-level design, the Corps determined pile driving might be required for anchoring bar-apex logjams. Further investigation during PED phase will be conducted to determine whether pile driving is feasible at these locations. Installation of logjams will require implementation of specific best management practices (BMPs) for diversion and care of water, which will be determined in a later phase of design.

The construction of tributary channels to Hunter and Weaver Creeks, included in Alternatives #27, #45, and #60, would expand the valley's drainage network. The existing creeks are perennial groundwater fed streams. The proposed restoration would consist of excavating small channels along existing swales down to slightly below the water table. The new channels may facilitate faster drainage of floodwaters.

Finally, provisions in the Cushman Settlement are not expected to change the hydrology and hydraulics of the study area in the future with-project condition. As discussed in Section 4.2, any future action(s) taken by Tacoma Power as the result of technical and procedural findings are not anticipated to negatively impact the future success or function of the alternatives proposed in the Corps' study area.

Confluence Levee Removal Alternatives #11, #18, and #27

Removing the Confluence Levee and diverting the South Fork into the North Fork near the pre-2003 confluence would provide a year-round connection from the South Fork to the mainstem. Similar to the river conditions prior to the 2003 North Fork diversion, the combined discharges of the North and South Forks would be enough water to provide continuous surface flows during the late summer low flow period. The reach of the South Fork that runs subsurface in late-summer/early-fall would be abandoned during those low flow periods. These alternatives would have little effect on flooding since the South Fork channel would still convey flood discharges, and both sides of the river frequently flood in this location already. These alternatives would only have minor localized effects to groundwater. An analysis of potential effects to groundwater concluded that the actions proposed under all three scales of the Confluence Levee removal alternative would have no effect to groundwater. The study team's assessment is that elevated groundwater could be better addressed with Natural Resource Conservation Service (NRCS) BMPs on individual properties.

Riverbed Excavation Alternatives #45 and #60

Alternative #60, excavation of the mainstem and South Fork Skokomish Rivers from RM 0-9, would increase the channel capacity and is expected to greatly reduce the chances of the South Fork channel running subsurface in late summer/early fall. The riverbed excavation would average 8 to 11 feet deep. The river would be returned to a cross-section size similar to what may have existed in the early-1900s. The proposed excavation would produce a river channel with an approximate 50% ACE, or two-year flood capacity, considerably reducing the flood risk in the valley. Floods larger than the 50% ACE would still cause overbank flooding, but to a lesser degree than present. The increased channel capacity allows the placement of LWD habitat structures in the river without increasing the flood risks in the valley. Effects to groundwater would be minor and localized and dependent on localized geomorphology along the reaches of the river.

The smaller scale of this alternative, #45, is excavation of RM 3.5-9. This action starts just upstream of where the southern floodwaters re-enter the mainstem. It would provide 50% ACE flow capacity in the excavated reach and reduce flood risks in much of the valley. Downstream of RM 3.5, channel capacity and flooding would be unchanged. LWD habitat structures could be placed in the excavated reach of the river and flood risks would still be less than they are now.

For both alternatives #45 and #60, the excavated riverbed would have less capacity for subsurface flow (less gravel to transmit water through) and is expected to place the thalweg below the existing water table. Both of these factors should help to maintain surface flows in the mainstem and South Fork during summer low flow conditions.

Wetland restoration at Dips Road would not initially alter river geometry and thus would not affect river hydraulics. This location is one of the first in the study area to flood; to avoid increasing downstream flood risks, the wetland restoration features would be designed and built to allow flooding to occur similar to existing conditions.

Cumulative Effects

No significant adverse cumulative effects to hydrology or hydraulics are anticipated to accrue from any of the alternatives. The alternatives would not alter rainfall/runoff hydrology on restored USFS lands in the headwaters. Riverbed Excavation alternatives could work in conjunction with the new Highway 101 Purdy Creek Bridge to reduce flood risks.

4.3.2 Geomorphology and Sediment Transport

The Skokomish River Basin headwaters are typified by steep, rugged terrain carved by past glaciations. Numerous small mountain streams discharge into the three principal tributaries, which flow through deep, narrow valleys and gorges to the head of the Skokomish Valley. Channels in the valley have little bedrock control. Valley channel morphology ranges from wide and braided in the South Fork, to a narrow single thread throughout most of the mainstem.

The dominant geomorphic process within the study area is sediment aggradation in the South Fork and mainstem Skokomish Rivers. The total duration of active riverbed aggradation is unknown, but it has been documented that mainstem aggradation has been underway since at least 1965. It is likely that aggradation was underway prior to 1912 as the frequent flooding experienced at that time suggests an undersized channel already existed. The headwaters of the Skokomish basin contain large volumes of glacially derived unconsolidated sediment. During storms, gravel and cobbles eroded from landslide deposits and active river channels in the upper watershed are slowly transported to the Skokomish Valley channels as bedload. In the valley, the South Fork and mainstem Skokomish Rivers do not have enough stream energy to transport the incoming bedload to Hood Canal; thus, bedload sediment has accumulated in the channels causing them to aggrade.

Various human activities have altered geomorphic processes. Around the turn of the twentieth century, loggers cleared logjams, removed riparian trees, and transported logs in the Skokomish Valley river channels. Stream stabilization measures such as bank protection and side-channel closures have been constructed on Vance Creek and the South Fork and mainstem Skokomish Rivers to protect farmlands from erosion. The flood peak reductions from the Cushman Project have reduced bedload transport in the mainstem. The above actions have all contributed to altering the bedload transport and deposition in the South Fork, Vance Creek, and the mainstem Skokomish River.

The Skokomish River channels had an abundance of natural LWD. By the early 1900s, loggers and farmers had removed most of the natural LWD. Today, LWD typically lies along the channel margins where it has been transported by floodwaters. In-channel LWD suitable for fish habitat is scarce.

4.3.2.1 No-Action Alternative/Future Without-Project Conditions

Sediment deposition is expected to continue to aggrade the channels of the mainstem and South Fork Skokomish Rivers and Vance Creek. Abundant sediment sources in the upper watersheds can be

expected to supply sediment to the lower rivers throughout the project life. The amount of LWD in the river channels is expected to increase.

How floods and aggradation will interact to alter channel alignment is very uncertain. However, there is a substantial risk of a channel avulsion in the foreseeable future. While an unexpected event such as a large logjam could alter the river very rapidly, the most likely scenario is for the river channel to aggrade to a level where base flows would divert onto the floodplain. Locations with the highest risk of avulsion are near the old North Fork confluence (RM 8-9) and near the Purdy Creek confluence (RM 3.5-4).

The most likely location for an avulsion to originate is near the old North Fork confluence (near RM 8-9). The cause of an avulsion at this location would be the filling of the channel to elevations high enough to divert the winter base flows, approximately 800 to 1,000 cfs, onto the floodplain. The surfaces of some of the gravel bars in this reach are already near the top of bank elevations and are higher than the nearby floodplains. The channel is expected to continue to fill slowly, as has been occurring for decades, until the riverbed elevation exceeds the bankline elevation and then low flows could be diverted onto the floodplain. Based on the recent deposition rates, this could occur in about 20 years. There is a risk that the low flow channel could fill rapidly if a logjam blocks the channel during a flood. The flow could be diverted to either the south or north side of the main channel, depending on the depositional pattern. Given the uncertainty of river processes, the timing of an avulsion could be anytime from the next big storm to 20 years in the future.

An avulsion to the south at RM 8-9 would likely follow a path south and east across farmland toward Purdy Creek and re-enter the river near RM 3.5. This path has no defined channels and the river would have to undergo a long-term process of channel and riparian development. The river channel would likely be very unstable as erosion and deposition could cause the channel to meander. This avulsion would cut across Skokomish Valley Road, disrupting transportation in the valley. These types of effects would be anticipated unless the river was redirected to its original channel under emergency actions.

If an avulsion occurred to the north near RM 9, flow would combine with the North Fork and return to the existing channel near RM 7.3. This reach was an active channel in the 1930s before it was blocked. Portions of the South Fork winter base flows have already been diverted into the North Fork at this location. The existing (North Fork) channel would become unstable with the increased discharge and bedload from the South Fork. The combined channel is likely to aggrade and widen. As the combined channel aggrades, it is likely to meander across the northern floodplain, forming and abandoning gravel bars as it migrates. Eventually, the river may meander across the entire 1,000- to 2,000-foot wide floodplain between the old and new confluences and north of the existing channel. Based on the recent deposition rates in the vicinity, deposition could average 1 to 2 feet over this area in a 20-year period. Gravel bars covered approximately 170 acres in this area in 1938.

The second highest risk of an avulsion is near the Purdy Creek confluence (RM 3.5-4). The bedload volume reaching this location is much smaller than that reaching the North Fork confluence, yet the riverbed is aggrading here and has a very low capacity. When this channel fills, base flows will most likely divert to the wetlands on the north side of the river and return to the river at State Route 106 (RM 1.9). Based on the recent deposition rates, the timing of this diversion is estimated to be in the next 30

to 50 years. However, it could also occur quickly if a logjam blocks the channel. A logjam could accelerate a diversion by increasing deposition at a point or causing bank erosion that could erode through the natural levee along the north bank.

In addition to the near-term risk of avulsion in the future without-project condition, long-term projections show sediment will continue to travel from the upper to lower watershed. Sediment already in the upper watershed channels may take 20 to 160 years to travel downstream to the Skokomish Valley. Channel aggradation and instability can be expected to continue for the foreseeable future.

4.3.2.2 Action Alternatives/Future With-Project Conditions

Aspects common to both groups of action alternatives

Reconnecting the abandoned channel between RM 4 and 5.6 to the river would provide a high flow side channel. This channel carries overbank floodwaters but is not directly connected to the river. The direct connection would produce higher suspended sediment loads than this channel currently receives from overbank flows. This could cause some additional deposition along the channel. Most of this channel is heavily vegetated and erosion is not expected to be an issue. The Monitoring and Adaptive Management Plan (Appendix E) was refined during the feasibility-level design phase to include a component to determine whether deposition is occurring.

Two wetland restoration increments (included in all alternatives except for #11), located at RM 7.5-8 and RM 8.3-9.2, are intended to provide additional floodplain habitat for fish and to expand the area of forested wetland adjacent to the river. The wetland embankments would allow flooding to occur similar to existing conditions, thus there would be no significant change in sediment deposition or erosion. The riverbanks in this reach have been stable in recent years and are expected to continue to be stable with the South Fork diverted toward the northern floodplain. Section 5.12 includes additional discussion about the risks and uncertainties associated with future sediment deposition in the study area.

Small wood clusters as well as larger engineered logjams (ELJs) would be installed from RM 9 to 11 to increase low flow channel meandering, encourage mid-channel bar formation, and provide multiple types of habitat benefits for salmon. The volume of added wood will improve the quantity, quality, and complexity of pools in the Skokomish River to promote rearing success and provide year round fish passage. Three of the wood structure types are included in the design: bar apex ELJ, 5-log channel cluster, and single log placements. These features are intended to restore much of the missing habitat and channel complexity afforded by the historical wood load. Over the 50-year project life, additional LWD is likely to accumulate on some of the constructed LWD jams and some jams are likely to be abandoned as the river naturally migrates; it is likely that the natural formation and accumulation of LWD jams would influence geomorphic processes more than the installed jams.

The construction of tributary channels to Hunter and Weaver Creeks, included in Alternatives #27, #45, and #60, would expand the valley's drainage network. The proposed restoration would consist of excavating small channels along existing swales down to slightly below the water table. Small, steady flow rates and vegetated banks should keep erosion to a minimum along these tributary channels. The drainage of floodwaters could cause some erosion and possibly headcutting in some channels.

Confluence Levee Removal Alternatives #11, #18, and #27

Removing the Confluence Levee would divert much of the South Fork water and bedload into the existing North Fork channel. The abandoned reach of the South Fork would remain active during high flows. These alternatives would have a very similar geomorphic effect as the northern avulsion near RM 9 described in the Future Without-Project Conditions section above.

The South Fork is already depositional in this reach and bedload deposition is expected to quickly begin to aggrade the combined South Fork/North Fork channel. A large bedload supply, coupled with the downstream slope reduction and loss of water to the floodplains during high discharges contribute to aggradation in the channel. High discharges and sediment supplies will continue to come from the South Fork, as the North Fork is highly regulated by the Cushman project. Based on the recent deposition rates, the initial deposition rate in the combined channel could be in the 0.1 +/- 0.05 feet/year range. As the channel aggrades, it would meander across the floodplain, forming and abandoning gravel bars. This natural meandering process will develop a complex series of stream habitats that will be beneficial to salmon and other fish; the migration will renew channel habitats and recruit new LWD to the channel. During the 50-year project life, there could be two to three feet of deposition across the entire 1,000- to 2,000-foot wide floodplain between the old and new confluences and north of the channel. The levee removal and flow diversion would greatly reduce the risk of the avulsion to the south near RM 9 that is described in the Future Without-Project Conditions section above because the existing South Fork riverbed is 3 to 5 feet higher than the northern floodplain.

Removing the Confluence Levee would greatly reduce the avulsion potential to the southern floodplain described in the Future Without-Project Conditions section above.

Riverbed Excavation Alternatives #45 and #60

Alternative #60, excavation of the mainstem and South Fork Skokomish Rivers from RM 0-9, would increase channel capacity and increase the bedload transport potential. The riverbed excavation would average around 8 to 11 feet deep. The river would be returned to a cross-section size similar to what it may have been in the early-1900s. The proposed excavation would produce a river channel with an approximate 50% ACE flood capacity. The higher in-channel discharges would increase the bedload transport and reduce deposition from RM 9 downstream to Highway 101 (RM 5). The bankfull bedload transport at Highway 101 could increase from approximately 2,500 tons/day to around 10,000 tons/day. Between Highway 101 and RM 3.5 there would be a proportional increase in deposition, as the minimum bedload transport capacity (less than 200 tons/day) occurs just upstream on RM 3.5. Downstream of RM 3.5, bedload transport potential would increase, but transport would be limited by the amount of material available to be scoured from the riverbed. The average bedload deposition rate is expected to remain at about 0.08 to 0.14 feet per year, the range observed in recent years. At that deposition rate, sediment accumulation in the excavated channel would aggrade the riverbed by about two feet in 20 years, lowering the channel capacity from 50% ACE (17,500 cfs) to 75% ACE (13,500 cfs). It is recommended that maintenance be done at 20-year intervals to retain the design channel capacity. If the channel is not excavated to maintain the channel capacity, it could return to its pre-excavation

capacity in roughly 65 to 75 years. The excavation would allow the placement of LWD to form pool habitat. LWD jams would be small, typically four to six logs, and placed to encourage meandering and bar formation. A few LWD structures would be placed along the riverbank to reduce the risk of accelerated bank erosion due to the channel excavation.

Alternative #45 would involve excavation of RM 3.5-9. This would have the same channel dimensions as the longer excavation alternative, but would start just upstream of where the southern floodwaters re-enter the mainstem. As with the longer alternative, it increases the bedload transport and reduces deposition from RM 9 downstream to Highway 101 (RM 5). Between Highway 101 and RM 3.5 there would be a proportional increase in deposition. Downstream of RM 3.5, bedload transport potential would not change. The channel aggradation rates would be similar to the longer alternative and the channel could return to pre-excavated conditions in 65 to 75 years. The excavation would allow placement of LWD for habitat and bank protection along the deeper channel.

Wetland restoration at Dips Road would not initially alter river geometry and thus would not affect sedimentation or geomorphology. If the final design includes removal of the bank protection, then the river would be able to erode the bank and migrate south toward the new road. The new road would limit any channel migration to about 400 feet.

Cumulative Effects

No significant adverse cumulative effects to geomorphology or sediment transport are anticipated to accrue from any of the alternatives. Hydraulic effects of Alternative #60 could benefit sediment transport processes in estuary channels adjacent to the Skokomish Indian Tribe's restored estuarine habitats.

4.3.3 Water Quality

Water quality within the Skokomish River, tributaries, and estuary is influenced by the dominant land uses of the Basin, which are largely agricultural fields and livestock pastures with rural homes on septic systems. Water quality impairments such as fecal coliform, dissolved oxygen (DO), and temperature can affect salmonids and marine life, recreation opportunities, commercial fishing, tribal fishing, and cultural resource use rights. Recreational and commercial shellfish beds are an important resource at Annas Bay and are sensitive to the water quality affected by the land uses in the valley. Characteristic uses of the study area such as recreation, domestic water supply, and shellfish harvesting are commonly inhibited due to fecal coliform levels. Sources of fecal coliform pollution include humans, domestic animals, wild animals, and septic system failures due to flooding and high water tables. Excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas as well as bacteria and nutrients from livestock can contribute to non-point source water pollution in the study area. Reduced vegetative cover in combination with aggradation have led to concerns about reduced DO levels and increased temperature in lower reaches of the river following review of past sampling data from near the Highway 101 Bridge (Peters et al. 2011). Two stream segments in the upper watershed upstream from the study area are on EPA's Clean Water Act Section 303(d) list; these are a segment of LeBar Creek and one reach of the South Fork Skokomish River listed for temperature impairment. One reach at the mouth of the

river is listed for fecal coliform bacteria. The identified cause is recreational anglers at the fishing access point from Highway 106 (Seattle Times 2009).

Hood Canal has exhibited the symptoms of hypoxia (inadequate DO) and monitoring data confirms that low DO conditions persist for extended periods (Correa 2009). Low concentrations of DO are causing increased stress to the ecosystem including extensive fish kills. Valuable species such as shellfish and Dungeness crabs may be adversely affected by hypoxic conditions. Restoring conditions to benefit these species is critical to overall health of the Skokomish River, Hood Canal, and ultimately Puget Sound.

4.3.3.1 No-Action Alternative/Future Without-Project Conditions

In the future without-project condition, fecal coliform levels will continue to be a concern in the lower Basin and pose a risk to public health. Operation of the Cushman Project for power generation, forestry practices, road building, construction of levees, agricultural practices, and other land use practices will continue to contribute non-point-source pollution (Correa 2003). The three fish hatcheries in the study area will continue to contribute point-source pollution. Changes to forestry, agricultural, or fish hatchery practices to reduce point and non-point pollution would occur outside Corps authorities. Continued nutrient input from humans, domestic and wild animals, and agricultural activities (livestock culture, hay production, etc.) may enter Hood Canal from the Skokomish River and tributaries, contributing to an ecological imbalance and low DO levels. Annas Bay may continue to experience hypoxia, which causes death to fish and marine bottom-dwelling species in the summer when DO levels become critically low.

4.3.3.2 Action Alternatives/Future With-Project Conditions

Aspects common to both groups of action alternatives

Construction work for ecosystem restoration projects in the Skokomish Valley may have a temporary negative effect to turbidity through the duration of construction. Turbidity is the primary water quality concern for determining whether the alternatives would have a significant impact. Short-term exceedances, such as up to 12 hours, of the state water quality regulations at WAC 410-201A do not typically constitute a significant impact. For activities that would cause prolonged elevated turbidity levels (e.g., longer than 24 hours), exceptional effort would need to occur to minimize effects.

Potential benefits of ecosystem restoration are that restored wetlands may assist with reducing pollution from the non-point sources through the added filtration that increased wetland area and quality would provide. Restoration would increase pool habitat, which would provide cooler water temperatures important for most aquatic species in the Pacific Northwest.

Confluence Levee Removal Alternatives #11, #18, and #27

Confluence Levee removal would have minimal or no in-water work; however, several of the increments would involve significant in-water disturbance of substrates and thereby cause turbidity in the channel. These include installation of LWD at the upstream end of the study area, reconnection of the side channel at RMs 4 and 5.6, and installation of LWD at the breach in Confluence Levee. During feasibility level design, installation of LWD increased in scope to include piles for anchoring larger groupings of logs, which means pile driving would be a temporary construction impact for water quality. Implementing these projects would cause localized turbidity during construction. The Corps would

implement all best management practices and adhere to fish work windows established by WDFW to minimize effects. Alternative #27 would have the greatest amount of turbidity during construction among the Confluence Levee Removal alternatives due to the tributary restoration increments for this Alternative, and Alternatives #11 and 18 would have much less in-water work. The Corps initiated coordination with the relevant natural resource agencies on the preferred methods for minimizing impacts related to LWD installation, primarily the methods for diversion and care of water. Coordination would continue during further design phases.

Among the post-construction benefits to water quality, the Hunter Creek and Weaver Creek increments, included in Alternatives #27, #45, and #60, would provide additional pool habitat, and improved flow through these tributary habitats may help to deliver cooler water into the mainstem. The levee removal site as well as all increments except for LWD placement would have riparian planting, which would improve shading of the river to help cool water temperature in the summer.

Risk of HTRW contamination from excavation of the old cars parked on the levee is believed to be extremely low based on surveys conducted by the Corps and a statement by WDOE that appears in Appendix L. A Phase II HTRW investigation was completed in July 2014. There were no sampling results that warranted further evaluation or investigation within the footprint of the recommended plan, including the Confluence Levee site. The cars are assumed to be solid waste that will be disposed of by the Non-Federal sponsors at an appropriate disposal site. Please refer to Appendix I (HTRW Assessment) for additional information; this topic is further discussed in Section 5.12 Risk and Uncertainties.

Riverbed Excavation Alternatives #45 and #60

Riverbed excavation would cause significant amounts of turbidity throughout the duration of the work, which would take from three to five years or longer to complete, depending on dredge productivity and timing limitations of fish work windows. This work would cause gill irritation and stress for all fish in the river over the relatively long-term duration of work. Sediments in the river are generally coarse, so plumes of turbidity would likely dissipate within the length of mixing zone that is allowed under State law, 300 feet downstream from the source (WAC 173-201A-400). Alternative #60 would take over 600 days of in-water work for dredging, and Alternative #45 would have roughly 350 days of in-water work for dredging. For estimates of excavation quantities and construction duration, see Table 4-3. The resulting channel morphology after construction of either Alternative #45 or #60 would likely have a vastly improved number of pools throughout the study area. This would allow cooler water temperatures in the depths of the pools.

Cumulative Effects

The short-term cumulative effects to water quality during and immediately following the Confluence Levee Removal alternatives would not be measurable, and would end as construction ended. Long-term cumulative effects are anticipated to be an overall benefit to water quality in the Skokomish Valley.

The short-term cumulative effects to water quality during construction of the Riverbed Excavation alternatives would be a temporary significant increase to turbidity due to the dredging action added to other degraded water quality conditions of high summer temperatures and increased fecal coliform

levels that occur in summer. Summertime water temperatures are high enough to cause stress to aquatic species, and the added stress of the significant amount of turbidity may cause mortality of fish and benthic invertebrates.

4.3.4 Greenhouse Gas Emissions

Estimating the total quantity of greenhouse gasses (GHG) that each alternative would produce would require extensive analysis and numerous assumptions about each site's final design and construction. Qualitative comparisons, however, can be drawn from a simplified estimation of GHG production. Emissions of carbon dioxide from hauling activities represent a significant fraction of GHG that would be produced under the various alternatives. Furthermore, all of the action alternatives feature significant hauling requirements for their completion. Therefore, the Corps performed a simplified estimation of GHG emissions for hauling activities for all alternatives and compared the results.

Table 4-4 shows the estimated volumes of materials to be excavated for each alternative, total gallons of diesel consumed, including an estimate of truck trips for material placement as well as for excavation hauling, and an estimate of carbon dioxide that would be produced by all truck trips. The estimate assumes that trucks hold 12 cy of material and have an average fuel efficiency of 6.5 miles per gallon of diesel. The estimate further assumes that haul routes for most activities are 20 miles round trip, and for hauling associated with dredging (Alternatives #45 and #60) that the haul routes are 10 miles round trip.

Table 4-4. Estimated Volumes of Excavated Material and Carbon Dioxide Produced by Hauling Activities

	Estimated cubic yards excavated material	Total gallons of diesel consumed	Tons carbon dioxide
No-Action Alternative	0	0	0
Confluence Levee Removal Alternatives			
#11	18,600	4,907	55.0
#18	125,620	43,583	487.7
#27	213,420	69,172	774.0
Riverbed Excavation Alternatives			
#45	2,180,220	318,407	3,563.0*
#60	3,014,220	425,375	4,759.9*

*Actual amounts of CO₂ for these alternatives are likely to be significantly higher than these figures; these figures do not include emissions from the hundreds of hours of operating dredge equipment.

To put these quantities into perspective, a passenger vehicle that travels 10,000 miles per year and burns diesel at a rate of 20 miles per gallon emits approximately 5.6 tons of carbon dioxide per year.

4.3.4.1 No-Action Alternative/Future Without-Project Conditions

GHG emissions would not be expected to increase or decrease as a result of the No-Action Alternative.

4.3.4.2 Action Alternatives/Future With-Project Conditions

Confluence Levee Removal Alternatives #11, #18, and #27

The estimated amount of carbon dioxide produced under these alternatives varies from approximately 55 tons to 774 tons. Alternatives #11, 18, and 27 are not expected to cause any substantial adverse cumulative impacts associated with global climate change, and there are no formally adopted NEPA thresholds of significance for GHG emissions.

Riverbed Excavation Alternatives #45 and #60

The estimated amount of carbon dioxide produced under these alternatives varies from approximately 3,500 tons to 4,800 tons. These figures likely significantly underestimate GHG emissions as they do not account for emissions associated with dredging operations. Alternatives #45 and 60 are not expected to cause any substantial cumulative impacts associated with global climate change, and there are no formally adopted NEPA thresholds of significance for GHG emissions.

Cumulative Effects

The potential effects of GHG emissions are by nature global and cumulative because they mix throughout Earth's atmosphere from various global sources. While the GHG releases from the proposed project will contribute to the GHG accumulating in Earth's atmosphere, an effect to global climate change would only occur when GHG emissions from all sources and sinks combine with the GHG emissions from the proposed actions on a global scale. Therefore, it is reasonable to assume that none of the alternatives for this project is large enough to have an appreciable effect on the climate because it would represent a very small portion of the total GHG emissions produced globally.

4.3.5 Climate Change and Sea Level Change

Climate change may cause unprecedented alterations to the hydrology and hydraulics in the Skokomish Basin. The basin's seasonal hydrology and flood conditions may be altered. The three main parameters of interest in this study are sea level change, altered hydrology, and increased sediment yields.

4.3.5.1 No-Action Alternative/Future Without-Project Conditions

USACE Engineering Circular 1165-2-212, 1 October 2011 (SLC Circular), requires feasibility studies to examine three scenarios to consider the sensitivity and adaptability of projects to sea level change (SLC). These scenarios include a low, intermediate, and high forecast of SLC for the period of analysis, which is 2015 to 2065. The guidelines require an active tide station with at least a 40-year record to estimate sea-level change for a project. Therefore, data from the National Oceanic and Atmospheric Administration (NOAA) tide station in Seattle, established in 1900, was used for the analysis, as data at the Union (local) Station has only been collected since 1996 and is of insufficient duration for developing sea level trends. The long-term trend for the Seattle station indicates the range of increases for the mouth of the Skokomish River are low 0.37 foot, intermediate 0.79 foot and high 2.15 feet. The effects predicted for global sea level change may be partially offset by vertical land rise of 0.6 foot at the mouth of the Skokomish River. A two-foot increase in average sea level would move the intertidal estuary environment landward about 1,000 feet. Higher sea level would increase the cross-sectional area and decrease velocities of estuary channels, resulting in a decrease in bedload transport to Hood Canal.

Skokomish Basin hydrology may change due to global climate change. Recent climate change projections for the Olympic Peninsula predict rising temperatures will cause more fall and winter precipitation to fall

as rain rather than snow, decreasing winter snow packs. Those projections indicate that such a change in precipitation would increase winter stream flows and reduce summer base flows. Because the Skokomish Basin already receives most of its precipitation as rain, this shift in runoff is expected to be moderate. Climate change could make winter flooding even more frequent in the valley. Any reductions in summer base flows in the South Fork or Vance Creek could aggravate the summer/fall subsurface channel conditions in both streams. In the North Fork and mainstem Skokomish River, the climate change effects may be partially offset by the regulated discharges from the Cushman Project.

Climate change caused increases in winter storm discharges would result in increased bedload inflow and channel aggradation. Channel aggradation would be accelerated and potential for avulsions could develop earlier. The magnitude and timing of any increase in aggradation would depend on the unknown magnitude of the climate change related hydrologic changes.

4.3.5.2 Action Alternatives/Future With-Project Conditions

Confluence Levee Removal Alternatives #11, #18, and #27

Sea level change would not affect the Confluence Levee removal alternatives, as none of the proposed actions are within the estuary.

Climate change influences on flooding with the Confluence Levee removal alternatives would be similar to those in the without-project condition (No-Action Alternative). The summer/fall subsurface channel would not occur on the South Fork, as the combined North Fork/South Fork discharges should be enough to maintain a flowing stream in the new combined channel. Subsurface channel conditions on Vance Creek would be similar to the future without-project conditions. Increased storm discharges and bedload inflows would accelerate the sediment deposition in the combined South Fork/North Fork channel formed by the Confluence Levee removal. Increased suspended sediment inflows would also increase deposition in the reconnected channel at RM 4-5.6 and in the riparian areas of the two wetland restoration sites (RM7.5-8 and RM 8.3-9.2).

Riverbed Excavation Alternatives #45 and #60

Higher sea levels would increase the cross-sectional area and decrease velocities of the estuary channels, resulting in a decrease in bedload transport to Hood Canal. The RM 0-9 channel excavation would likely experience some reduction in bedload transport near the mouth due to sea level change. In the RM 3.5-9 excavated channel, sea level change would not directly affect bedload transport, but the natural channel downstream of RM 3.5 would experience a reduction in bedload transport similar to that expected for the without-project conditions (No-Action Alternative).

Increases in winter storm discharges are expected to result in increased bedload and suspended sediment inflow. Deposition in the reconnected channel at RM 4-5.6 and in the riparian areas of the two wetland restoration sites (RM 7.5-8 and RM 8.3-9.2) would depend on the magnitude of the increase in flood discharges. Higher discharges generally produce higher suspended sediment loads that would cause higher deposition; however, the higher suspended sediment load would be countered in the excavated channel by the reduced frequency of flooding.

Climate change effects on flooding with the channel excavation alternatives would be less than those in the without-project condition. The increased channel capacity provided by the excavated channel would reduce the frequency of flooding. The risk of lower summer/fall discharges causing a subsurface channel on the South Fork would be low, as the excavated channel bottom is expected to be below the groundwater table. Subsurface channel conditions on Vance Creek would be similar to the without-project conditions.

Increased storm discharges and bedload inflows would accelerate the sediment deposition in the excavated channels. The channel aggradation rates would be higher than current rates and the channels could likely return to pre-excavation conditions in less than 65 years. Increased suspended sediment inflows would also increase deposition in the reconnected channel at RM 4-5.6 and in the riparian areas of the two wetland restoration sites (RM 7.5-8 and RM 8.3-9.2).

4.4 Biological Environment

The Skokomish River Basin is a diverse landscape with abrupt changes in elevation, making the watershed home to a variety of different habitat types and wildlife resources. Located in the Olympic Mountain Range, the Skokomish Basin is somewhat geographically isolated and not as diverse as the river basins in the neighboring Cascade Mountain Range. Over the last 150 years, there have been significant alterations to the habitats of the Skokomish watershed. Subsequently, wildlife populations, distribution, and diversity have been similarly affected. Much of the Basin's species composition (wildlife and vegetation), structure (trees, snags, soil, and tree canopy), as well as some physical processes (evapotranspiration, surface and subsurface flow of water) have been altered at a very large scale. See Appendix A, Peters et al. 2011, for a comprehensive analysis of biological baseline conditions of aquatic habitats, and Appendix C, Anchor QEA 2011 for a brief description of wildlife in the study area.

During feasibility-level design, the Increments of Hunter Creek mouth, Hunter Creek Side Channel, and Weaver Creek Side Channel were eliminated from the proposed action due to landowners' objections to these project components. The Final Recommended Plan does not include these Increments.

4.4.1 Fish and Wildlife

Fish resources in the study area

The Skokomish River system hosts at least 22 species of fish (Watershed Management Team 1995; Peters et al. 2011). Nearly half of these are in the Salmonidae family, which includes salmon, trout, and char. Species present include Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), chum salmon (*O. keta*), rainbow trout/steelhead (*O. mykiss*), sea-run and resident cutthroat trout (*O. clarki*), bull trout (*Salvelinus confluentus*), and mountain whitefish (*Prosopium williamsoni*) (Peters et al. 2011). Sockeye salmon (*O. nerka*) and pink salmon (*O. gorbuscha*) were historically found in the Skokomish River but have been functionally extirpated (Peters et al. 2011). Five species of sculpin (*Cottus* sp.) inhabit the river, including prickly (*C. asper*), coast range (*C. aleuticus*), riffle (*C. gulosus*), reticulate (*C. perplexus*), and shorthead sculpin (*C. confusus*). River lamprey (*Lampetra ayrsii*), western brook lamprey (*L. richardsoni*), and Pacific lamprey (*L. tridentata*) occur in the Basin (Peters et al. 2011). Three-spined sticklebacks (*Gasterosteus aculeatus*) are abundant. Species associated with the estuarine

and nearshore habitat include shiner perch (*Cymatogaster aggregata*), surf smelt (*Hypomesus pretiosus*), Pacific staghorn sculpin (*Leptocottus armatus*), and starry flounder (*Platichthys stellatus*).

Two WDFW hatcheries, George Adams and McKernan, release hatchery Chinook, coho, chum, and steelhead into the Skokomish River Basin. The two facilities release approximately 3.8 million Chinook, 300,000 coho, 8.5 million chum, and 34,000 steelhead annually (Peters et al. 2011). A third hatchery, Eels Springs, raises cutthroat trout, rainbow trout, and kokanee salmon (i.e., land-locked sockeye salmon; [*O. nerka*]) for put-and-take fisheries in local lakes (Peters et al. 2011).

Salmonid species can have separate stocks, also called runs, within a single river system. Table 4-5 is a summary of the stocks known to occur in the Skokomish watershed, including those that are functionally extinct but that may still have a few representatives each year.

Table 4-5. Salmonid Stocks that Occur in the Skokomish Watershed with Their Spawning Timing and Locations Summarized from Peters et al. (2011)

Species and stock designation	Spawning timing	Spawning location
Chinook – Fall/summer	Sept-Oct	Mainstem, S. and N. Forks, Purdy, Weaver, Vance Creeks
Chinook – Spring (extinct)	July	Mainstem, S. and N. Forks, Purdy, Weaver, Vance Creeks
Chum – upper Skok late fall	Dec-Jan	Most tributaries and lower 5 miles of N. Fork
Chum – lower Skok fall	Nov-Dec	Purdy and Weaver Creeks, and lower mainstem
Chum – summer (extinct)	Mid-Sept to mid-Oct	Lower watershed
Coho	Oct through March	Most tributaries, N. Fork, Vance Creek
Steelhead – summer	Feb to April	S. Fork canyon reach
Steelhead – winter	Mid-Feb to Mid June	Mainstem and S. Fork
Bull trout – South Fork stock	Mid-Sept through Dec	Use S. Fork and all tributaries, but specific spawning locations are unknown
Cutthroat (sea-run)	Late winter through spring, peak in Feb	Small tributaries

Riffle and side channel habitats are important for lamprey spawning. Lamprey larvae are most abundant where the stream channel is relatively deep (0.4–0.5 m), gradient is low (<0.5%) and the riparian canopy is open (Torgerson and Close 2004). Ammocoetes (juvenile lamprey) rear in reaches where spawning occurred (Pletcher 1963). At finer scales, larval occurrence corresponds positively with low water velocity, pools, and suitable burrowing habitat (Roni 2002; Pirtle et al. 2003; Torgerson and Close 2004; Graham and Brun 2005). Prickly sculpin and coastrange sculpin typically inhabit the lower reaches with prickly sculpin inhabiting pools and other slow-water habitats while coastrange sculpin inhabit riffles and other fast-water habitats. Riffle sculpin and reticulate sculpin usually occur in middle reaches in a variety of habitat types. Shorthead sculpin typically occur at higher elevations than the other four species.

Degraded conditions continue to affect fish populations in the study area. Habitat requirements for the Salmonidae family make a good surrogate for overall ecosystem health when considering the full range of anadromous fish habitat requirements, including off-channel habitats, food web interactions, and

spatial relationships among habitats. Each salmonid species differs in the timing of critical life history events and the way it uses various habitats, but all of the anadromous fish in the system have the same basic requirements:

- Adequate water quality and appropriate water temperatures
- Balanced sediment budget
- Stable spawning gravels
- Pools and in-stream structure including large boulders and logs
- A functional riparian zone
- Connected freshwater migratory and refuge habitats
- A complex of healthy estuarine and nearshore habitats to allow transition from freshwater to seawater

These habitat requirements are the focus of the discussion of future without-project conditions (No-Action Alternative) and effects of the alternatives on fish species in the study area.

All of these critical factors were found to be compromised or lacking to some extent in the study area. Much of the degradation originates from alteration of the river environment by the removal of LWD, channel realignments, bank protection, aggradation in the channel, changes in flows, and disconnection of access for fish into aquatic habitats in the floodplain and off-channel wetlands.

As discussed in Section 4.3.1, the lack of channel capacity for even the one-year return interval discharge causes displacement of fish during overbank flows. Effects of this are that the adults may become stranded in floodplain areas where they die before spawning, or they are forced to spawn in areas that become dewatered killing the eggs; additionally, the offspring that do survive in isolated ponds are unable to return to the river to rear and migrate out to sea. Those that remain in the channel have little refuge habitat and are therefore forced downstream to the lower river and estuary where they become vulnerable to predators or are unable to survive in saltwater as they have not yet smolted (changed physiology for saltwater life stage).

Along with reduced channel capacity, significant aggradation causes the river to flow subsurface during the summer months. Subterranean flow occurs in the South Fork and lower Vance Creek and significantly affects fish. In recent years during the late summer and early fall, no surface hydraulic connection has existed between the mainstem and the South Fork and Vance Creek (USACE 2000). Lack of access to upstream habitat means a drastically reduced area for spawning and blocked migration for fish moving to upstream or downstream reaches. Another characteristic of the Skokomish River is that the removal of large wood decades ago and the filling of pools due to wood removal and sedimentation have significantly reduced the variety of habitat types. This reduction in habitat complexity leads to reduced resilience of the river's salmon populations (Waples et al. 2009). The Ecosystem Benefits Model developed to quantify benefits of the alternatives includes a detailed description of habitat limiting factors for salmonids in the Skokomish watershed (see Appendix F).

Bird and mammal resources in the study area

Beaver (*Castor Canadensis*), raccoon (*Procyon lotor*), river otter (*Lontra canadensis*), mink (*Neovison vison*), and many other small mammals are associated with and dependent upon riparian and aquatic

habitats. Beavers live along rivers, streams, and ponds and build lodges of tree branches and mud to live in, or they may build burrows in the banks of rivers. They primarily eat tree bark and cambium, which is the soft tissue under tree bark. Favorite species include willow, maple, birch, cottonwood, and alder; all of these are common riparian species in the study area. Beavers are territorial and live in small family colonies. Raccoons live in riparian zones and have a widely varying diet as omnivores. They rinse their food as they eat and are therefore reliant on shoreline habitat of rivers and lakes. River otters live exclusively in riparian habitat and usually occupy bank dens that beavers have abandoned. Their diet is primarily aquatic animals such as crayfish, frogs, and fish. River otters live in family groups of 4 to 8 individuals. Mink live in forested areas near rivers, lakes, and marshes; they dig dens in riverbanks or use hollow logs or abandoned beaver dens as dwellings. Mink are carnivores and target a variety of other riparian species by spending a lot of time swimming and diving.

Bird species associated with the river corridor include the following:

- Bald eagle (*Haliaeetus leucocephalus*)
- Osprey (*Pandion haliaetus*)
- Great blue heron (*Ardea herodias*)
- Raven (*Corvus corax*)
- Belted kingfisher (*Megaceryle alcyon*)
- American dipper (*Cinclus mexicanus*)

Other species groups found in the river corridor and adjacent forested riparian zone include waterfowl, woodpeckers, and songbirds.

Riparian zones represent a small component of the complete watershed landscape in western states; however, they provide essential habitat for more species of breeding birds than any other habitat type (Knopf et al. 1988). The primary factor affecting bird populations in the study area is the past timber harvest activities, which was the dominant land use around the South Fork Skokomish River from the 1920s through the 1990s. Additionally, the width of the forested riparian zone has decreased in many areas as land was cleared for timber harvest, farming, and residences.

4.4.1.1 No-Action Alternative/Future Without-Project Conditions

The Skokomish River will continue to face numerous limiting factors for fish. Major problems affecting salmon survival and migration will continue. Habitat availability, quality, complexity, and connectivity will continue to deteriorate. Winter high flows will continue to transport both juvenile and adult salmon out of the river, stranding them in the floodplain to die. As sediment continues to accumulate in the mainstem, upstream passage will continue to be delayed or completely blocked during summer low flows. The overall condition of the channel is anticipated to remain severely degraded; reduced holding pool quality and availability will continue to render adults vulnerable to predation/harassment, and reduced channel complexity will lead to more frequent and severe scouring of redds. Ultimately, the future without-project condition for fish in the mainstem and South Fork reaches of the study area is expected to remain in a severely degraded state and would not be able to support recovery of ESA-listed species.

Salmon return to spawn in the streams and tributaries where their parents spawned and where they spent the first months of their lives. Therefore, the stocks that use the North Fork habitat (the area of the basin affected by the Cushman Settlement) are largely distinct from the populations that use the mainstem and South Fork reaches of the Skokomish River. For this reason, the Cushman Settlement will benefit mainly the North Fork stocks of fish. While the Cushman Settlement will benefit the estuary and lower eight miles of River, conditions will not significantly improve the habitat of the entire recommended plan area. The recommended plan includes off-channel habitats and tributaries that are not affected by the Cushman Settlement. Additionally, the ESA-listed runs of fish that use habitat upstream from the confluence will still encounter severely degraded habitat conditions. The summer low-flow blockage problem is upstream from the confluence and therefore requires attention that the Cushman Settlement measures do not address. The Cushman Settlement measures are complementary to, but independent from the action alternatives described in this chapter.

Birds and mammals associated with the riparian zone will continue to endure the reduced total area of the width of the riparian buffer without attempts to remove levees to widen the area available for hydrologic connection to the river.

4.4.1.2 Action Alternatives/Future With-Project Conditions

Confluence Levee Removal Alternatives #11, #18, and #27

Construction for removal of the Confluence Levee would have no in-water work and minimal disturbance for fish as machinery works on the riverbank above the water; however, temporary culverts or stream crossings for machinery to access the levee will be necessary. Construction work for the increments associated with all three alternatives would involve some in-water work and would therefore have short-term disturbance to fish species such as sculpin, lamprey, and steelhead that are still present during the fish work window that is timed for when juvenile salmon are absent, 15 July to 15 September. Turbidity is the primary concern for stress to fish species. Background turbidity during the summer is typically very low. Construction methods would employ best management practices to minimize turbidity. For duration of construction for each increment, see Table 4-3.

Confluence Levee removal would resolve the problem of the river going subsurface in the summer months by providing a bypass to this reach as the South Fork combines with the North Fork. The benefit of this year-round connection for fish is that adult salmon migrating upstream would have access to their spawning areas and would not have to endure delays to migration and the complete blockage of access to critical spawning habitat. The proposal has potential for increasing spawning productivity by reducing stress and increasing accessibility.

Birds and mammals associated with the riparian zone would greatly benefit from the increased area of wetlands and the width of the riparian zone afforded by breaching the agricultural berms and constructing wetland embankments under Alternatives #18 and 27. Since many of these species rely directly or indirectly on salmonid populations, the improved salmonid habitat would thereby influence improvement to bird and mammal habitat and diets. Construction of the action alternatives may temporarily disrupt activities or displace wildlife, but would not occur during nesting season, which is early March to mid-July for the many bird species that nest within the study area. Birds and mammals

would endure short-term disruption during construction but would see long-term benefits of ecosystem restoration. The agency preferred alternative, #18, includes the net gain of 51 acres of forested riparian zone from the wetland restoration increments, so benefits to birds and mammals would be substantial, but not as great as those for Alternative #27.

Riverbed Excavation Alternatives #45 and #60

Alternatives #45 and #60 would have substantial short-term detrimental effects to all fish species in the Skokomish River due to the wide-scale sediment excavation. These alternatives are designed to remove the top 8 to 10 feet of riverbed sediments for 9 miles in #60 and for 5.5 miles in #45. This work would remove the benthic macroinvertebrates that serve as the primary food source for most fish, and would potentially kill most of the sculpin and lamprey species present in the length of channel that would be dredged. Construction would adhere to fish work windows, but these are timed to protect salmon that are in the channel only during juvenile and adult life stages. Sculpin and lamprey inhabit the river throughout their lives, and are less capable of avoiding dredge machinery. Steelhead rear in the river for the first 1 to 3 years of their lives and would therefore be present during dredging. Loss of these fish populations could take many years to recover.

Such broad-scale alteration of the river bottom would cause substantial risk to salmon habitat. Salmon spawn throughout the lower 12 miles of the river and in-stream sediment removal directly alters the channel geometry and risks leaving morphology unfavorable to salmonids. Some risks include the following: salmon have a narrow range of parameters for spawning depth, velocity, and substrate size (Bjornn and Reiser 1991), and therefore may not find appropriate spawning habitat for one or more years as sediments stabilize and channel morphology adjusts (Kondolf et al. 2002); disturbed substrate has a lower velocity threshold for scour of eggs incubating in the gravel (NOAA Fisheries 2004); and such significant quantity of gravel removal can reduce the amount of water that flows through the hyporheic zone, which can lead to elevated water temperatures without the cooling effect of intragravel flow. Many other biological consequences are associated with sediment extraction from streams (Collins 1995, Kondolf et al. 2002).

Risks to juvenile salmonids in the nearshore zone from placement of dredged material would involve risk of loss of some area of eelgrass although impacts to eelgrass would be avoided to the maximum extent practicable. Other risks include turbidity, although construction would be timed for the season when juvenile salmon are least likely to be present. The change in substrate size from fine sand and mud to coarse river sediments could cause a shift in species use of the area, or avoidance of this substrate type; however, the area proposed for dredged material placement does not cover the entire estuary, so sand and mud habitat would still be available in the center and north reaches of the estuary.

Benefits of river sediment excavation for both Riverbed Excavation alternatives are that providing the capacity for the 50% ACE would greatly reduce the problem of fish stranding on high ground after being flooded out of the river and then trapped with no channel access back into the river. Additionally, the increased flow capacity would allow for placement of LWD habitat structures throughout the excavated reach of river without exacerbating flooding in the valley. Dredging would also resolve the problem of flow going subsurface in the late summer.

Birds and mammals associated with the riparian zone would greatly benefit from the increased area of wetlands and the width of the riparian zone afforded by the wetland restoration increments under Alternatives #45 and #60. Since many of these species rely directly or indirectly on salmonid populations, the improved salmonid habitat would thereby influence improvement to bird and mammal habitat and diets. Construction of the action alternatives may temporarily disrupt activities or displace wildlife, but would not occur during nesting season, which is early March to mid-July for the many bird species that nest within the study area. Birds and mammals would endure short-term disruption during construction but would see long-term benefits of ecosystem restoration.

Cumulative Effects

Cumulative effects of Alternatives #11, #18, and #27 are assumed to be countervailing to the history of development in the Skokomish Valley and are expected to be additive to the benefits of all other restoration effort that has occurred in the estuary and upper watershed.

Short-term effects of Riverbed Excavation pose a significant risk to all fish species, and especially to salmon that may not find suitable spawning habitat for an unpredictable number of years. This potential negative effect would be added to the list of events in Table 4-2 that have caused environmental degradation around the Skokomish watershed. Long-term cumulative benefits of Riverbed Excavation are assumed that increased channel capacity would significantly reduce stranding of juvenile and adult salmon such that they may be able to rebuild their populations to some degree above the low numbers that have endured for at least a decade. Similar to the Confluence Levee Removal alternatives, the benefits of the Riverbed Excavation alternatives would be additive to all other restoration work around the watershed.

4.4.2 Shellfish and other Macroinvertebrates

Shellfish

The Annas Bay estuary area contains a rich shellfish resource that is used by tribal, commercial, and recreational harvesters. Shellfish species common in Annas Bay include Dungeness (*Cancer magister*) and red rock (*Cancer productus*) crabs; butter (*Saxidomus giganteus*), manila (*Venerupis philippinarum*), littleneck (*Protothaca staminea*), and purple varnish (*Nuttallia obscurata*) clams; and Pacific oysters (*Crassostrea gigas*) (Dethier 2006; WDFW 2013a). The WDFW Priority Habitats and Species database has a record of geoduck in narrow bands along the shorelines around Annas Bay (WDFW 2013b). These native and non-native species are associated with the intertidal and subtidal zones; crabs and oysters dwell on the substrate surface while the clams bury themselves at various shallow depths. The substrate preferences range from mud and sand to gravel and rocks (Dethier 2006).

Shellfish resources have been declining due to reduced availability of suitable substrate for shellfish attachment in the estuary as well as high fecal coliform levels in Annas Bay and Hood Canal. The Washington State Department of Health downgraded 300 acres on the east side of Annas Bay growing area from *Approved* to *Prohibited* in August 2005 based on high fecal coliform bacteria levels. Mason County was therefore required by RCW 90.72.045 to establish a shellfish protection district and program

to address the cause of the pollution. The Corps' feasibility study area includes a significant portion of the shellfish protection district (Figure 4-1).

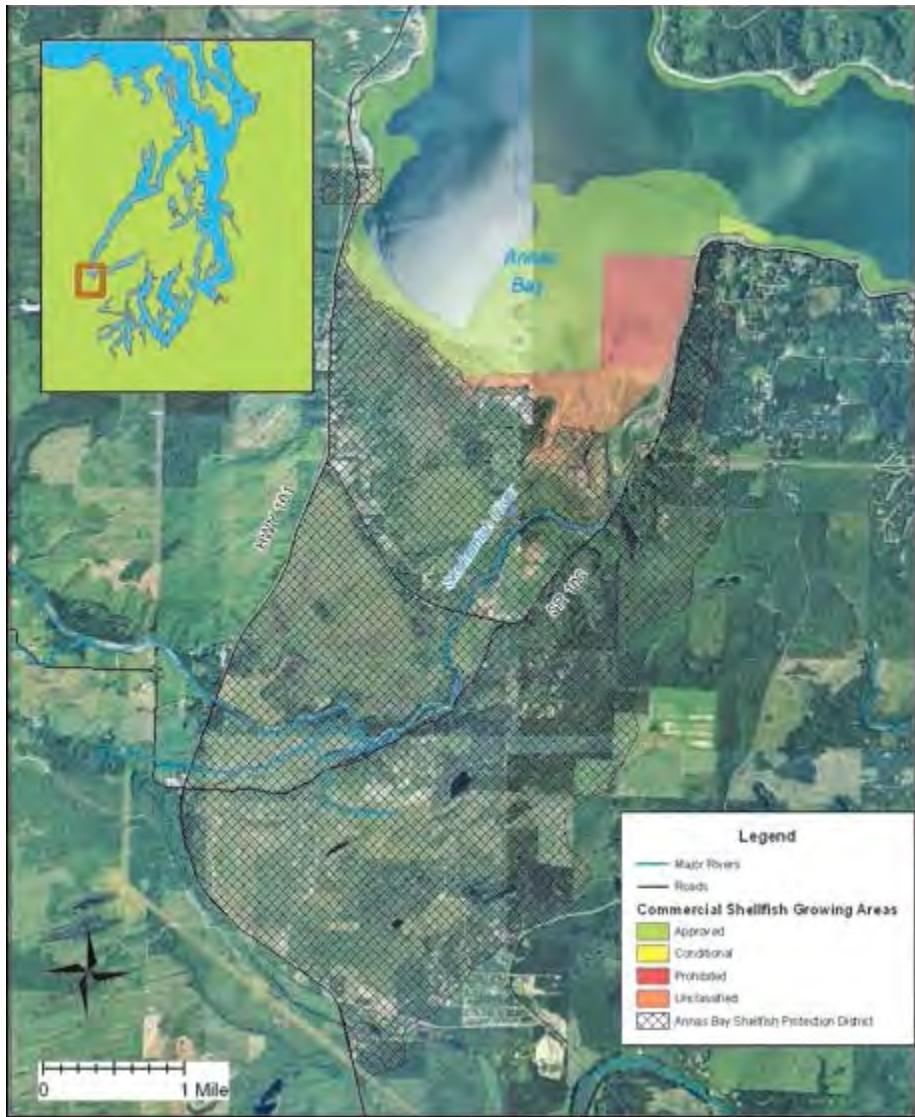


Figure 4-1. Mason County Public Health Department Shellfish Protection District and designations of shellfish harvest areas in the Skokomish River estuary and extended nearshore area

Benthic Macroinvertebrates

The freshwater benthic macroinvertebrates of concern in this feasibility study are the aquatic insects that dwell in the substrate of the river and tributaries. The five orders of insects that typically inhabit Pacific Northwest freshwater habitats are the black flies including mosquitoes (Diptera), caddisflies (Trichoptera), mayflies (Ephemeroptera), stoneflies (Plecoptera), and true bugs (Hemiptera). Dragonflies and damselflies (Odonata) are associated with wetlands and pools at the edges of streams as well. These aquatic insects provide critical ecosystem services such as the following (Allan 1995):

- Breaking down detritus inputs from riparian vegetation (shredders)

- Removing excess algae from rocks and other surfaces (scrapers)
- Water filtration by collecting suspended particles (collector-filterers)
- Mixing bottom sediments (burrowers)
- Population control of other invertebrates (predators)
- Serving as key food sources for fish, birds, and other aquatic-oriented animals (prey)

USFWS conducted biological monitoring for this feasibility study, which revealed that the aquatic insect population is generally healthy, but that long-lived species populations are very low (see Appendix A, Peters et al. 2011).

4.4.2.1 No-Action Alternative/Future Without-Project Conditions

Shellfish – The crabs, clams, and oysters in Annas Bay may continue the recent population declines that have been occurring due to reduced suitable substrate. Local work to reduce fecal coliform will slowly improve conditions. Given multiple confounding factors, it is difficult to predict with any confidence what the shellfish populations could be through the 50-year study period.

Benthic Macroinvertebrates – The aquatic insect community in the river is not expected to change as no activities are planned for the reach of river in the study area that would cause shifts in population or community structure. Aggradation and/or frequent flooding may be the cause of the dearth of long-lived species, and these two characteristics are not expected to change in the 50-year study period. Recent restoration in the estuary is anticipated to improve the community structure of the benthic macroinvertebrates found there.

4.4.2.2 Action Alternatives/Future With-Project Conditions

Confluence Levee Removal Alternatives #11, #18, and #27

Shellfish – None of these alternatives would be expected to have a significant effect on the shellfish populations, although improved water quality expected from Alternatives #18 and 27 may be of benefit to shellfish. Without the 51 acres represented by the wetland restoration sites, Alternative #11 does not include enough wetland restoration to provide water quality benefits that would reach the estuary.

Benthic Macroinvertebrates – All three Confluence Levee Removal alternatives would have measurable, localized improvements in numbers and diversity of the aquatic insect communities. This may have a positive effect upstream and downstream from the restoration sites; however, ability to quantify improvements decreases with distance from the restored area. Alternative #27 would see the greatest improvement as this alternative has the most increments. Alternative #11, would provide the least improvement of all the alternatives. The agency preferred alternative, #18, would see substantially greater productivity than #11 due to the 51 acres of wetland restoration.

Riverbed Excavation Alternatives #45 and #60

Shellfish – For Alternatives #45 and #60, sediment excavated from the river would be strategically placed at specific locations in the lower intertidal and subtidal areas of the estuary and adjacent nearshore zone. Material would be placed to create swales that are two to eight feet high over an area that is approximately 800 acres. Alternative #60 disposal quantity would be nearly 2.7 million cubic

yards, and Alternative #45 would be less at just under 1.9 million cubic yards. The grain size distribution of this dredged and disposed material would be beneficial for the shellfish species that attach to the substrate, such as oysters and mussels. Other benthic invertebrates in the estuary would be expected to recover within about one year (Bolam and Rees 2003).

Benthic Macroinvertebrates – Alternatives #45 and #60 would have substantial negative effects to the aquatic insect populations in the river. Dredging effectively removes and kills nearly all aquatic insects within the dredged channel, and insects that remain in the channel are subjected to the settling of fine sediments that become suspended during the dredging work (Kondolf et al. 2002). Recolonization across the many miles of river would take varying amounts of time depending on species mobility and trophic habits (Mackay 1992). A direct effect of such widespread removal of the benthic macroinvertebrates that dwell among the substrate is that any fish remaining in the river that were not killed during dredging would have little to no food source available. Additionally, the young salmon that emerge from redds the following spring will have extremely poor feeding conditions as their primary food sources would not likely have had enough time to recover to previous abundance.

Cumulative Effects

Cumulative effects that would accrue for shellfish and benthic macroinvertebrates with implementation of any of the action alternatives are the improved water quality from restoration of wetlands, which would add to the efforts of Mason County Public Health Department to improve water quality for the Shellfish Protection District. The Riverbed Excavation Alternatives would have additional direct benefits to shellfish through the disposal of dredged gravel in the estuary. However, the negative effects from riverbed excavation for benthic macroinvertebrates would have significant cumulative effects for salmonid species that already face greatly reduced and degraded habitats in the channel and floodplain.

4.4.3 Vegetation (Wetland, Riparian, Estuarine)

The Skokomish watershed's topography is widely varied, consisting of steep mountain slopes, moderately sloping foothills, and flat valley bottoms, which causes a corresponding variation in vegetation throughout the Basin. Logging and forest management for timber production have caused large-scale alteration of flora and fauna. Effects include reduction of habitat diversity, fragmentation of the landscape, and soil disruption that led to mass wasting. Mass wasting can completely alter the vegetation potential of the land; plant communities that colonize these sites are usually much different from the preceding mature communities. Logging and road construction effects are felt throughout the Basin; however, the proposed action focuses on aquatic habitats. This section therefore focuses on the riparian, wetland, and estuarine habitats for analysis of the future with and without-project conditions.

Agricultural conversion of the Valley began in the late 1800s with removal of large Douglas fir and cedar trees that were cut and floated down the Skokomish River to Hood Canal. By the early 1900s, most of the Skokomish River floodplain had been cleared of timber and converted to pastureland, reducing the amount of riparian forest along the river. By 1995, about 2,700 acres in the study area had been converted to agriculture and urban uses (USFS 1995).

Wetland Vegetation

The Lower Skokomish Basin is one of the few areas in the Hood Canal area to increase in wetland coverage over the last 20 years. Since the study area is an extremely large geographic area, the inventory of wetland habitats was conducted by using existing aerial topography surveys, color infrared imagery, and field-verification methods. A thorough assessment of the entire study area using the Corps' standard three-parameter approach was not practical, as it would be extremely labor-intensive and cost-prohibitive to conduct formal wetland delineations on the entire area. The analysis resulted in mapping 231 individual wetland habitat polygons covering 4,553 acres within the study area and an additional 995 acres of subtidal wetland in the Skokomish river delta. In addition to areas of development including the Skokomish Tribal Reservation, there are 1,640 acres of agricultural lands in the study area. Of these 1,640 acres, about 216 acres (13 percent) are wetlands.

Riparian Vegetation

Riparian zones have a diverse selection of vegetation including an overstory of red cedar, cottonwood, alder, and Douglas fir as well as an understory of salmonberry, snowberry, Indian plum, swordfern, blackberry, willow, and various grasses. In addition to preventing pollution and stabilizing bank erosion, the diverse vegetation of the riparian zone sustains a wide variety of fauna. The fish and wildlife that live in the stream and along riverbanks are very dependent on the zone for their food and habitat requirements. Suitable habitat characteristics including LWD, riparian vegetation, and aquatic vegetation are necessary for providing refugia from predation and optimal growth for juvenile salmon. Riparian vegetation provides shade to keep water temperatures lower during summer months.

Although there are pockets of good riparian vegetation in the mainstem Skokomish, approximately 62% of the mainstem is sparsely vegetated, has been cleared for agriculture, has a riparian buffer less than 66 feet wide, and does not provide LWD recruitment necessary to maintain structurally diverse channels (WDFW and PNPTT 2000). Deciduous trees dominate the riparian areas where historically the riparian corridor was mixed forest (Correa 2003). Riparian vegetation appears to be degraded within the Skokomish Basin, with the greatest degradation occurring in the lower Skokomish reach and in mainstem channels relative to upstream tributaries. The Skokomish River's riparian zones consist of younger tree age classes with higher percentages of hardwoods and reduced LWD potential (U.S. Dept. of Agriculture 1995). The Skokomish mainstem, Weaver Creek, Hunter Creek, and the lower South Fork Skokomish have poor riparian conditions (Correa 2003).

The U.S. Forest Service, Mason Conservation District, and Mason County Weed Board have efforts underway to control and eradicate invasive species in the Skokomish watershed. Some of these species include reed canary grass, Japanese knotweed, and tansy ragwort among others. Some of these efforts include assistance to private property owners.

Estuarine Vegetation

The Skokomish River has the largest estuary and intertidal delta in the Hood Canal Basin. The delta includes a broad estuarine wetland complex and supports extensive submerged aquatic vegetation including eelgrass beds. Analysis of historical maps indicates that emergent vegetation dominated up to 75 percent of the estuarine wetlands in the Skokomish delta (Collins and Sheikh 2005). Estuarine scrub-shrub wetlands comprised about 13 percent of the complex, compared to current wetland maps

showing no scrub-shrub wetlands in the complex (Collins and Sheikh 2005). Recent projects have breached dikes around islands in the lower estuary to restore tidal inundation of historic salt marsh areas. These breached areas make up the majority of the estuarine wetlands across the delta.

Eelgrass (*Zostera marina*) is the most common native vegetation in intertidal and subtidal beach habitats and embayments of Puget Sound. Large eelgrass beds can grow on the fringes of large river deltas where the salinity is high enough and sediment supply is sufficient. Biological diversity of eelgrass beds is much higher than that of surrounding areas because the three dimensional structure provides substantial habitat value. Eelgrass meadows support many small vertebrate and invertebrate organisms that provide prey for larger species, including juvenile salmon and sea-going trout that use the area heavily for feeding and protective cover during their outmigration. Eelgrass beds provide habitat for other fish, adult and larval crabs, great blue herons, crustaceans, and many other kinds of marine life. Eelgrass serves an important spawning substrate for Pacific herring (Penttila 2007). Additionally, eelgrass supplies organic material to nearshore areas, and its roots stabilize sediments.

The Skokomish estuary has about 17% less eelgrass compared to historical conditions (Jay and Simenstad 1996). Recent sampling shows Annas Bay has approximately 10 acres of eelgrass coverage (WDNR 2009). Based on data collected from 2000 to 2008, the Washington Department of Natural Resources (WDNR) places Hood Canal in a category of high concern for eelgrass decline; however, the sampling location in Annas Bay showed no evidence of decline as of 2008 (WDNR 2009), and has actually been increasing in coverage area according to the 2010 surveys. One of WDNR's survey results of the extent of eelgrass coverage is shown in Figure 4-2.

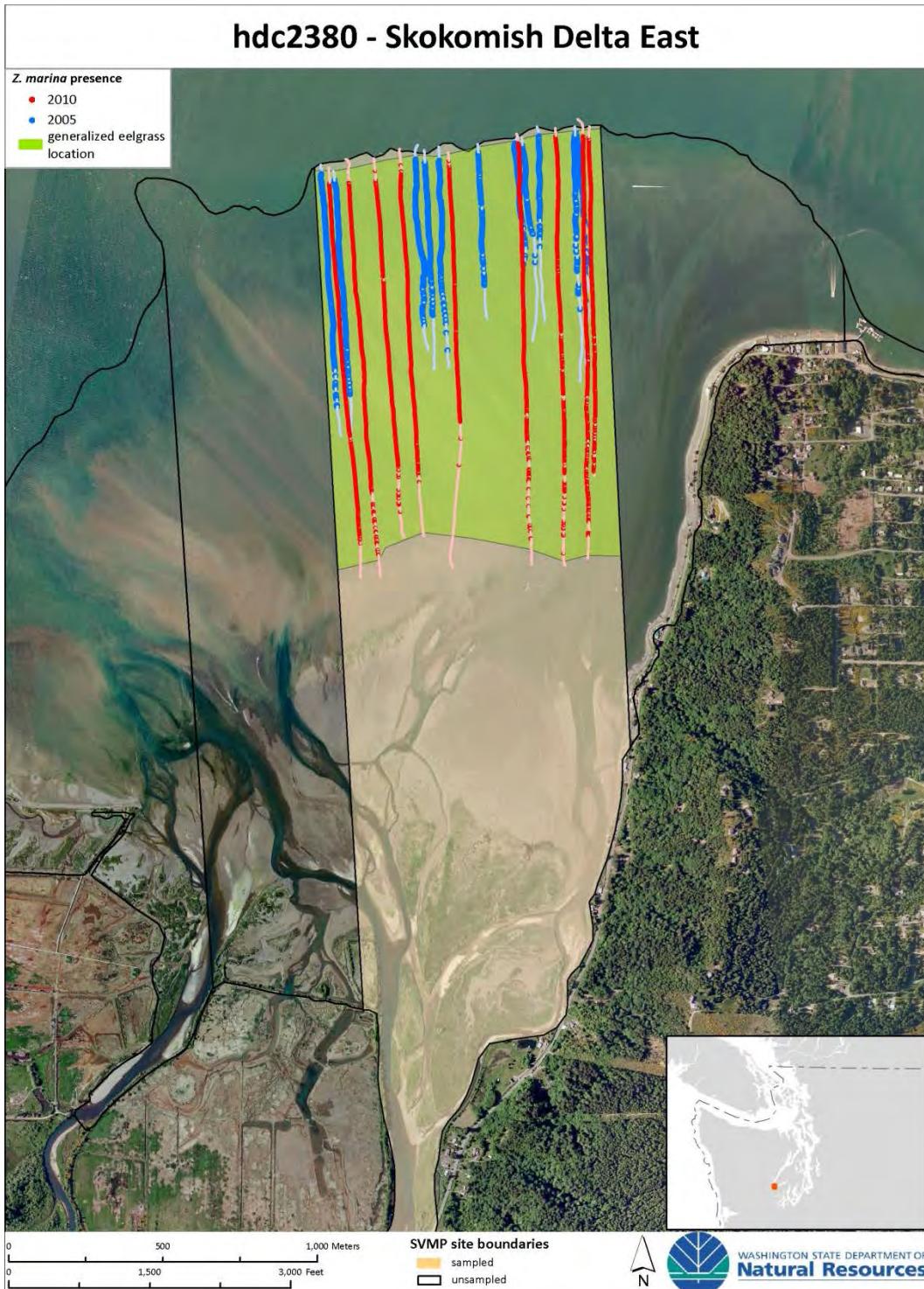


Figure 4-2. One of the eelgrass monitoring sites with sampled transects from 2005 (blue) and 2010 (red). Image courtesy of Washington Department of Natural Resources.

4.4.3.1 No-Action Alternative/Future Without-Project Conditions

Wetlands in the study area may continue their trend of increasing in area even without directed restoration efforts to restore or increase their area and quality.

In the higher elevations, riparian zones are recovering as improved forestry practices focus on increasing riparian buffers and providing vegetated corridors. However, without restoration actions in valley, the upper watershed improvements will not be realized in the lower river. Local entities are expected to undertake various vegetation enhancement projects to address the loss of riparian vegetation. Mason Conservation District is employing invasive species removal and riparian restoration efforts in the Skokomish Valley including working with Washington Conservation Corps crews to inventory and treat Japanese knotweed. Efforts to restore native riparian vegetation are focused on a 70-acre Conservation Reserve Enhancement Program buffer and a 43-acre floodway easement. In addition, approximately 25 to 30 acres have been planted on Skokomish Farms, WDNR, and Skokomish Reservation lands. However, due to the large percentage of privately owned lands, the extent to which these actions can comprehensively restore vegetation depends on the willingness of private landowners to participate in the restoration projects. With no large-scale changes planned to improve riparian vegetation on the tributaries and the mainstem, riparian vegetation is anticipated to remain in poor condition.

Estuarine emergent marshes will slowly continue to improve due to the restoration efforts of the Skokomish Indian Tribe and Mason County at dike breaching in the estuary. Without the proposed restoration efforts, eelgrass around Hood Canal is expected to continue its decline, although the eelgrass meadow in the Skokomish estuary may remain the same size or continue its trend of expansion (WDNR 2009).

4.4.3.2 Action Alternatives/Future With-Project Conditions

Confluence Levee Removal Alternatives #11, #18, and #27

Construction impacts to vegetation from Alternative #27 would be temporary clearing of approximately 1.15 acres of upland vegetation bordering on riparian zones for staging areas for the base and all increments in this alternative. The area of wetland vegetation displaced due to construction of the two wetland embankments is approximately 2.7 acres for wetland restoration at Grange and approximately 2.3 acres for wetland restoration at River Mile 9. Alternative #18 would have 0.92 acre of uplands cleared for staging areas and the same impacts to wetlands as Alternative #27. Alternative #11 would have 0.28 acre of wetland vegetation temporarily disturbed and no wetlands filled for wetland embankments. The Corps selected staging areas based partly on avoidance of large trees and would replant all staging areas at the end of construction. Vegetation would be expected to reach preconstruction conditions within approximately three years. Therefore, all staging areas would be temporary impacts, and the construction of the two wetland embankments for Alternatives #18 and #27 would have 5 acres of wetland function loss in their footprint with a 51-acre net gain in forested riparian wetlands. This impact represents a change since the release of the Draft FR/EIS. These wetland impacts were determined during feasibility-level design in which the footprint of the wetland embankments expanded to accommodate for a shallow backslope of each structure to prevent erosion during over-topping.

The proposed actions would have great benefits to riparian and wetland vegetation. Implementation of Alternative #27 would involve creation or improvement of 242 acres of mixed riparian and wetlands habitats. The proposed restoration would result in improvement of existing wetland and riparian zones

and connection of uplands to riverbank, creating new riparian zones and large areas of wetlands through wetland restoration projects. Restoring wetlands by breaching existing agricultural berms and constructing wetland embankments at River Mile 9 and Grange would reconnect 19 acres and 32 acres of forested wetland riparian zone respectively. Alternative #18 would provide the same types of improvements, but to less acreage at 200 total acres of wetlands and riparian zone improved or created. Alternative #11 would provide reconnection of 68 acres of riparian uplands at the location of the Confluence Levee removal, and the side channel reconnection would provide increased inundation of 44 acres of wetland. None of the alternatives would affect more than one acre of invasive species in the Skokomish Valley, and none of the alternatives would increase invasive populations. None of these three alternatives would have any effect on eelgrass in the estuary.

Riverbed Excavation Alternatives #45 and #60

Both of these alternatives would have the same acreage of staging areas at approximately 1.15 acres. Construction impacts to vegetation would be the same as described for the Confluence Levee Removal alternatives. Alternatives #45 and 60 include all of the increments; therefore, both would affect 5 acres of wetlands for wetland embankments, but would improve the same acreage of wetland and riparian vegetation as Alternative #27 at approximately 242 acres. None of the alternatives would affect more than one acre of invasive species in the Skokomish Valley, and none of the alternatives would increase invasive populations. Riverbed excavation could have negative effects to eelgrass in the estuary from significant amounts of turbidity caused by the dredging action. This would cause reduced photosynthesis during the growing season and may cause some burial of eelgrass.

Cumulative Effects

The Corps anticipates no adverse cumulative effects to vegetation from any of the alternatives. Restoration of riparian and wetland vegetation in the Skokomish Valley would add to the work of the USFS in the Federal forestlands in the upper watershed and to the 1,000 acres of estuarine restoration that the Skokomish Indian Tribe and Mason County have achieved. The proposed restoration would provide an important connection between these two valuable habitat types in the Skokomish Basin and would therefore have a cumulative benefit to overall biodiversity of the vegetation communities.

4.4.4 Rare, Threatened, and Endangered Species

Nine species identified under the ESA as endangered or threatened potentially occur in the study area: four fish species, four bird species, and rare sightings of killer whales (USFWS 2010a; NOAA-NMFS 2009, 2010). These species are presented in Table 4-6. No federally listed plants, invertebrates, amphibians, or reptiles are found in the study area (USFWS 2010a; NOAA-NMFS 2009, 2010). The Corps conducted ESA Section 7(a) consultation as part of the EIS process. Effects determinations are included in the following descriptions of effects of the alternatives. All effects from this Federal action are covered under two Biological Opinions as described in Chapter 6.

The existing condition and future without-project condition (No-Action Alternative) for each confirmed or likely ESA species are discussed below, followed by analysis of effects in the future with-project condition (action alternatives) for the broader group of species.

Table 4-6. Federally Listed, Proposed, and Candidate Species that May Occur in the Study Area

Common Name (<i>Scientific name</i>)	Federal Listing Status/ Critical Habitat	Year Listed	Potential for Occurrence	Effect Determination of the recommended plan / agency preferred alternative
Northern spotted owl (<i>Strix occidentalis caurina</i>) ^{/1}	Endangered / Designated	1990	Likely	No effect
Marbled murrelet (<i>Brachyramphus marmoratus</i>) ^{/1}	Endangered / Designated	1992	Likely	No effect
Streaked horned lark (<i>Eremophila alpestris strigata</i>) ^{/1}	Threatened / Designated	2012	Unlikely	No effect
Western yellow-billed cuckoo DPS (<i>Coccyzus americanus</i>) ^{/1}	Proposed/ None designated	2001	Unlikely	No effect
Southern Resident killer whale (<i>Orcinus orca</i>) ^{/2}	Endangered / Designated	2003	Unlikely	No effect
Puget Sound Chinook Salmon ESU (<i>Oncorhynchus tshawytscha</i>) ^{/2}	Threatened / Designated	1999	Confirmed	Likely to adversely affect
Hood Canal Summer-Run Chum Salmon ESU (<i>Oncorhynchus keta</i>) ^{/2}	Threatened / Designated	1999	Extirpated from System	No effect*
Puget Sound Steelhead DPS (<i>Oncorhynchus mykiss</i>) ^{/2}	Threatened / Proposed	2007	Confirmed	Likely to adversely affect
Coastal/Puget Sound Bull trout DPS (<i>Salvelinus confluentus</i>) ^{/1}	Threatened / Designated	1999	Confirmed	Likely to adversely affect

^{/1}USFWS 2010a

^{/2}NMFS 2009

*NMFS confirmed that summer chum are considered extirpated from the Skokomish River and stated that there is no need to consult on this species for projects in the Skokomish River (Matt Longenbaugh, pers. comm. 2014).

Northern Spotted Owl

Northern spotted owls inhabit old growth or late successional coniferous or mixed conifer-hardwood forests, and the Skokomish watershed is within their range. The only report of spotted owls recorded in the WDFW (2013b) database is a sighting in 1994 at Frigid Creek, a tributary to the North Fork Skokomish River. No critical habitat is located within five miles of the study area. In the future without-project condition, northern spotted owl populations are expected to continue to decline due to habitat loss, reduction in prey, and competition for home range from other species such as the barred owl.

Marbled Murrelet

Marbled murrelets occur in the Hood Canal region in small numbers compared to the more northern areas of Puget Sound. Marbled murrelets nest in mature and old growth forests and forage in deeper water of entrance channels of rocky shores, estuaries, and protected bays where they dive in pursuit of prey fish such as Pacific herring, sand lance, and surf smelt. Critical habitat includes upland forested stands used for nesting, but does not include marine water. Marbled murrelets have been observed within their designated critical habitat in forested areas upstream from the study area (WDFW 2013b).

Recent trends indicate a continued steady decline of marbled murrelets, with a decrease in population of eight percent from 2000 to 2009 in Puget Sound and the Strait of Juan de Fuca (USFWS 2009). The

2010 population estimate for Puget Sound and Strait of Juan de Fuca was around 4,000 (Pearson et al. 2011). Population declines occur through habitat loss from timber harvest and natural events such as wildfires, insect outbreak, and windthrow in their terrestrial environment, and harmful algal blooms, declining prey availability (forage fish), and catastrophic events such as oil spills in their marine environment. In the future without-project condition, marbled murrelet population declines may occur through habitat loss and catastrophic events beyond the scope of this feasibility study, such as oil spills.

Streaked Horned Lark

The historical breeding range for Streaked horned lark extended from southern British Columbia through the Puget lowlands and Washington Coast south to the Willamette and Rogue River valleys. These birds nest on bare ground in sparsely vegetated sites that are mostly grassy, such as prairies, coastal dunes, fallow agricultural fields, and seasonal wetlands. There are no historical breeding records for Mason County and this species is considered not likely to occur in the study area.

Yellow-billed cuckoo

This migratory bird had a range across much of North America, but is now limited primarily to the eastern and central United States with a few populations in the West. The preferred breeding habitat is open lowland deciduous woodlands with clearings and shrubby vegetation, especially near rivers and streams with nests in willows and cottonwoods of long contiguous riparian zones. Yellow-billed cuckoos are not expected to occur in the study area because their habitat requirements are not present.

Puget Sound Chinook salmon

Puget Sound Chinook salmon are ESA-listed as threatened (NMFS 2005). Critical habitat was designated throughout Puget Sound and its tributaries in 2005. Puget Sound populations are largely summer/fall runs; however, the Skokomish River once supported a run of spring Chinook salmon. The stock was reported in decline as early as 1950, but still used the lower five miles of the South Fork and 13 miles of the North Fork. Nehlsen et al. (1991) reported the stock extinct in 1991. This extinction is likely due to overfishing and the construction of the Cushman Dams (James 1980), which blocked access to a major component of their habitat and altered hydraulic patterns in the system (Skokomish Indian Tribe and WDFW 2010). Fall/Summer Skokomish Chinook were classified as threatened as a component of Puget Sound Chinook ESA listing in 1999, and this status was reaffirmed in 2005 (70 FR 37160); they were designated as their own stock in WDFW's 2002 Salmonid Stock Inventory (SASSI) based on geographic location and have been rated as depressed.

According to Peters et al. (2011), for the last several years, fewer than 100 fall Chinook were documented in the South Fork. Juvenile Chinook were observed in the mainstem, tributaries, and off-channel pond habitats in the Skokomish Valley. Juvenile Chinook were common in the estuary and were quite abundant (i.e., 55,000) compared to their observed abundance in freshwater habitats, despite the fact that a very small portion of the estuary was sampled. This suggests that a majority of juvenile Chinook in the system may be migrating directly to the estuary without rearing in the freshwater environment, likely due to the severe lack of appropriate pool habitat.

Although a recovery plan is in place, poor habitat conditions continue to affect Chinook in the study area. The lack of LWD, poor riparian corridors, and riverbed aggradation have reduced channel capacity to critically low levels in several locations. Summer low flows can block adult migration, resulting in an unsuccessful migration to spawning grounds. Eggs are susceptible to smothering by sediment or scouring during floods. In the future without-project condition, fall Chinook numbers in the North Fork may increase due to actions from the Cushman Dam settlement agreement. Habitat conditions on the South Fork, Vance Creek, and mainstem will continue to degrade, leading to a decline in fall Chinook numbers and potential extirpation from these areas. The Skokomish Indian Tribe and Mason County have collaborated to accomplish significant restoration in the estuary, but without complementary restoration of the freshwater habitat, this effort will have limited success at restoring Chinook numbers.

Hood Canal Summer-Run Chum Salmon

Hood Canal summer-run chum salmon were listed as threatened in March 1999; this status was reaffirmed in 2005 (70 FR 37160). Critical habitat was designated in September 2005. Today, summer-run chum are extirpated from the Skokomish River. A few adults are observed in the mainstem each year, but are not enough to be described as a self-sustaining population. In the future without-project condition, summer-run chum are not anticipated to recover in the Skokomish River.

Puget Sound Steelhead

Puget Sound steelhead were listed as a threatened species in May 2007 (72 FR 26722); critical habitat is under development. An estimated 300 to 400 winter steelhead occur in the South Fork but there are no credibly documented summer steelhead in this area (Peters et al. 2011; Skokomish Tribe 2011). In the future without-project condition, steelhead numbers may increase in the North Fork due to actions from the Cushman Dam settlement agreement. South Fork, Vance Creek, and mainstem habitat conditions would continue to degrade due to the excessive sediment input and lack of LWD. This is expected to continue the decline in steelhead numbers downward from the 1,000 natural adult winter steelhead in the Skokomish River.

Bull Trout

The Coastal/Puget Sound bull trout was listed as a threatened species in November 1999 (64 FR 14307); critical habitat was designated in September 2005 (USFWS 2005) and revised in 2010 (USFWS 2010b). The Skokomish River Watershed hosts three distinct stocks of bull trout, a fluvial population in the South Fork, a lacustrine-adfluvial population in Lake Cushman, and a fluvial population in the upper North Fork (Peters et al. 2011). Bull trout in the Skokomish River watershed do not appear to be anadromous (Correa 2003) indicating that they are almost entirely dependent on freshwater habitats throughout their life histories (Brenkman et al. 2007; Peters et al. 2011). It is thought they can be found in all reaches of the watershed below anadromous barriers.

Bull trout populations above Lake Cushman are healthy and are not likely to face habitat limiting factors in the foreseeable future. Bull trout numbers may remain stable on the North Fork due to actions from the Cushman Dam settlement agreement. The depressed South Fork population could improve in the future without-project condition due to reduced logging activities, decommissioning of logging roads,

and other restoration activities in the upper watershed; however, positive effects of restoration activities may not be fully realized without complementary restoration action in the lower watershed.

4.4.4.1 No-Action Alternative/Future Without-Project Conditions

In the future without-project condition, ESA-listed salmonid species will continue to face obstacles within the mainstem migration corridor including the following: spawning at less than optimal sites due to variable gravel movement; inability to gain access to the upper watershed to spawn due to continued blockage of key migration corridors; winter high flows transporting juvenile and adult salmon out of the river; and high water temperatures in the summer and early fall affecting various salmon species during rearing and migration seasons. The degraded and absent riparian zone vegetation is not expected to see improved conditions without breaching the agricultural berms, constructing new wetland embankments to improve wetland hydrology, and adding plantings. Continued loss of high quality rearing and off-channel habitat is anticipated during low flows due to sediment deposition at the mouths of tributaries.

The No-Action alternative would have no effect on the listed bird species.

4.4.4.2 Action Alternatives/Future With-Project Conditions

Aspects common to both groups of action alternatives

Marbled murrelets would likely only be flying high over the action area in transit between aquatic foraging areas and roosts in the upper watershed and the other listed bird species are not expected to be in the action area. None of the proposed action alternatives would be expected to affect the behaviors or habitats of the four listed bird species. Therefore, the Corps has determined that there would be *no effect* to these species.

Confluence Levee Removal Alternatives #11, #18, and #27

Construction effects to listed salmonid species may involve some turbidity during in-water construction; however, the Corps would adhere to fish work windows that are timed to protect salmon. The fish work window for the Skokomish River is 15 July to 15 September. This period may be adjusted based on consultation with the natural resource agencies such as WDFW, NMFS, and USFWS. The Confluence Levee removal will have minimal or no in-water work, and each of the increments will have an in-water work duration that will not exceed the duration of the fish work window. Construction methods would employ all best management practices to minimize turbidity. Although the fish work window extends to September 15, it is likely that adult Chinook salmon would be present for their spawning migration beginning in early September. Additionally, bull trout and steelhead have potential for early and sub-adult life stages to be present in the river system year-round. Due to the threshold for adverse effects being determined to occur even when it occurs to very few fish, the Corps has determined that the in-water work required for this project is *likely to adversely affect* Chinook, steelhead, and bull trout. Effects would occur to only a very low number of fish and would not likely be lethal. Effects would be temporary disturbance or displacement, and temporary stress from turbidity. The project is *not likely to adversely affect* critical habitat for these species.

Fisheries managers and scientists have determined that Hood Canal summer chum have been extirpated from the Skokomish River watershed; however, there is interest in re-introducing a run from other

genetic sources around Hood Canal rivers, so critical habitat remains designated in the Skokomish River. Therefore, the Corps has determined there would be *no effect* to Hood Canal summer chum salmon from this alternative, and the action is *not likely to adversely affect* critical habitat.

Alternatives #11, 18, and 27 would benefit the listed salmonid species by resolving the problem of blocked spawning migration by providing a year-round connection to upstream spawning areas. Alternative #27 provides the greatest acreage of improved or reconnected riparian zones, wetlands, and aquatic habitats that would benefit all listed salmonid species. Alternative #18, the agency preferred alternative, although smaller in scope than #27, still includes the substantial increase of 51 acres in forested riparian zone wetlands that would be reconnected to the river through construction of the wetland restoration increments, which is a significant benefit over Alternative #11.

Riverbed Excavation Alternatives #45 and #60

Increasing channel capacity to reduce the frequency of over-bank flooding is assumed to reduce the acknowledged fish-stranding problem in which adult and juvenile salmonids escape the river channel in sheet flow across roads and agricultural fields and have no pathway back to the river or other off-channel aquatic habitat. While direct mortality from stranding has been regularly observed in the Skokomish Valley during winter floods, not much has been researched regarding long-term consequences of stranding on population dynamics (Nagrodska et al. 2012).

Riverbed excavation has potential for high risks to the listed salmonids and their critical habitat. Dredging poses a risk of negative effects from turbidity and direct mortality for juvenile salmonids present in the river channel during dredging. After construction, there is risk that the resulting channel morphology would not support favorable spawning conditions (Collins 1995). The sediment excavation work would need to be designed to mimic preferred spawning conditions to the greatest extent practicable.

Due to the substantial loss of benthic invertebrates from dredging and risk of significant negative effects to spawning habitat, the Corps has determined that these alternatives would *likely adversely affect* the listed salmonid species and would constitute an *adverse modification of critical habitat*.

Cumulative Effects

Aggradation of the Skokomish River has multiple causes as described in Bureau of Reclamation (2009) and briefly summarized in Section 4.2 of this report. The extensive sediment excavation proposed for the Riverbed Excavation alternatives would have a countervailing effect in an attempt to reduce the environmental consequences of reduced channel capacity. The post-construction risk of lack of suitable spawning habitat for several years may have an additive effect to the habitat limiting factors that have reduced salmon populations in this watershed. The Confluence Levee Removal alternatives would have no significant negative cumulative effects. Combining removal of the Confluence Levee with the wetland restoration at River Mile 9, which is included in Alternatives #18 and #27 but not Alternative #11, would have a significant cumulative benefit of widening the channel migration zone and enhancing forested riparian wetlands because these two project features are directly across the river from each other.

4.5 Cultural Resources

Cultural resources are locations on the physical landscape of past human activity, occupation, or use and typically include archaeological sites such as lithic scatters, villages, procurement areas, resource extractions sites, rock shelters, rock art, shell middens; and historic era sites such as trash scatters, homesteads, railroads, ranches, logging camps, and any structures or buildings that are over 50 years old. Cultural resources include traditional cultural properties, which are aspects of the landscape that are a part of traditional lifeways and practices and are considered important to a community.

Very little cultural resource survey has occurred within the study area; however, a cultural resource survey was conducted for specific project components of the TSP for the feasibility study. To compare the alternatives and identify potential impacts to cultural resources, the Corps reviewed previous inventory reports and site forms, historic maps, ethnographic literature, and did a “windshield” survey in 2009 to characterize the nature of the resources present in the basin and to determine whether there were any historic structures or other clearly visible resources that should be avoided during alternative development. The Corps requested information about cultural resource concerns from the Skokomish Indian Tribe’s Tribal Historic Preservation Officer in a meeting in 2010 and gathered information from local residents through oral histories later that year (Montgomery and Lahren 2011). A Corps archaeologist attended the Public Scoping meeting held on October 7, 2010 and one of the informal scoping meetings discussed in section 7.1. A cultural resource survey was conducted January 2015. Results of these efforts are summarized below and additional information about cultural resources in the study area appears in the Cultural Resources Appendix (D).

According to the Washington Department of Archaeology and Historic Preservation’s (DAHP) online database WISAARD (last queried January 2015), seven cultural resource inventories have occurred in the study area since 1995. The database lists all archaeological sites that have been officially recorded and sent to DAHP. The majority of inventories known to have occurred in the study area have been small in scale, typically under three acres, or linear surveys that simply bisected the study area. Most of the inventory in the study area has clustered around Hood Canal. The study area has 17 recorded archaeological sites. Eleven of these are prehistoric sites. Shell middens and small lithic scatters are the predominant site types. Historic era sites consist of the remains of two bridges and small domestic refuse scatters without clear temporal markers. Of those 17 recorded archaeological sites, only three are recorded within 1.50 miles of project components that make up the TSP.

A cursory review of information reveals that the survival of buildings and structures from the earliest settlement period is limited. Not surprisingly, extensive flooding, logging, and later agricultural pursuits have swept away many of these properties. A “windshield” survey of the valley’s most accessible structures and buildings suggests that those that remain are products of accelerated agricultural growth in the early part of the twentieth century, the general period 1920-1940. There is also the strong possibility that some of these homes and agricultural buildings are the products of pattern books or “pre-cut and assemble” building packages selected from local hardware stores and shipped by train.

In addition to the archaeological and structural inventories, Bouchard and Kennedy (1994) completed an extensive ethnographic study of the Basin. They interviewed 22 Skokomish tribal members in 1991-1992 and identified 72 areas of tribal concern. Bouchard and Kennedy’s study built off of previous work in the

area such as Dr. W.W. Elmendorf's ethnography *The Structure of Twana Culture* (1960), Edward Curtis's (1913) volume on the Salishan Tribes of the Coast, and T.T. Waterman's (1920) collection of over 120 Twana place names in the vicinity of Hood Canal.

A cultural resources survey was conducted in January 2015 for the TSP. This consisted of walking the River Mile 9/Grange agricultural berm (locally referred to as the River Mile 9 Levee) and shovel testing the proposed wetland embankment alignment at River Mile 9 and Side Channel Reconnection at RM 5.6. Subsurface shovel probing was only conducted on property where the landowner had signed right of entry. In addition to the subsurface shovel probes, the Confluence Levee (locally known as Car Body Levee) and the River Mile 9/Grange berm were recorded. No significant cultural material was identified during the subsurface investigation. Based on the Corps internal guidelines for flood control systems and structures, the Corps has determined that the Confluence Levee and the River Mile 9/Grange berm are not eligible for listing on the National Register of Historic Places (NRHP). Though both the Confluence Levee and the River Mile 9/Grange berm are fifty years of age, these structures are a ubiquitous type of flood control structure and are not distinguished for their engineering value. In addition, both the Confluence Levee and the River Mile 9/Grange berm show clear loss of essential integrity due to loss of linear continuity due to breaches and both structures are experiencing erosion. While both the Confluence Levee and the River Mile 9/Grange berm were built to protect agricultural fields from flooding, these structures did not play a central role in the agricultural development of the Skokomish River Valley. Finally, neither the Confluence Levee nor the River Mile 9/Grange berm can provide additional cultural information beyond what is already known.

4.5.1.1 No-Action Alternative/Future Without-Project Conditions

Without an ecosystem restoration project, conditions would remain the same within the Skokomish River Valley. Flooding would still occur and the groundwater may continue to rise. To date, a small number of archaeological sites have been identified and recorded within the Skokomish River Valley. Within the project area, no archaeological sites were identified on the parcels that were surveyed. Three historic age properties – the River Mile 9 Levee, the Grange Levee, and the Confluence levee – were recorded and determined not eligible for listing on the National Register of Historic Places. However, due to lack of land owner permission not all of the project area was able to be surveyed. Therefore, it is unknown what effects may occur to unrecorded archaeological sites that may exist within the project area. Taking no action toward ecosystem restoration in the Skokomish Valley would have no effect to the sites identified in the project area thus far.

4.5.1.2 Action Alternatives/Future With-Project Conditions

Both NEPA and the National Historic Preservation Act (NHPA) require that Federal agencies consider impacts to cultural resources; however, the NHPA specifies the process by which Federal agencies determine the significance of these resources and assess a project's effects. The NHPA considers impacts to "historic properties" as opposed to "cultural resources". A historic property is defined as a cultural resource that has met certain standards of age, integrity, and significance. The phrase "adverse effect" (used in the NHPA) and "significant impact" (used in NEPA) are not equivalent terms but are similar in

concept. Impacts to cultural resources are typically examined in terms of how the project will impact the qualities that make the resource eligible for listing on the National Register of Historic Places (NRHP).

The cultural resources survey did not find any significant cultural resources and the Corps has determined that no historic properties will be affected. The Corps will require additional cultural resource surveys to be conducted once the landowner permission has been received for project components that will affect private property (e.g. proposed access routes for the LWD/ELJ placement).

Section 304 of the NHPA prohibits Federal agencies from publicly disclosing specific information about cultural resources that could lead to their harm through vandalism or looting regardless of their eligibility. Therefore, specific site locations are not discussed in this analysis.

Confluence Levee Removal Alternatives #11, #18, and #27

Removal of the Confluence Levee would require three staging areas with a total of less than one acre of ground disturbance. Ethnographic literature suggests that the confluence of the north and south forks with the mainstem has a higher potential for containing archaeological sites. Elmendorf (1960) referenced a campsite near the Confluence Levee; however, it was not in use in the 1930s and archaeological evidence has not been discovered at the junction. The staging area would be placed to avoid adversely affecting any significant cultural resources. The Confluence Levee may be over 50 years old; however, based on the Corps' internal guidelines for flood control systems and structures, the Corps has determined that the Confluence levee is not eligible for listing on the NRHP.

In general, projects that are proposed within the river channel or that have little ground disturbance have less potential for adversely affecting cultural resources. Of the eight proposed increments, the installation of LWD at RM 9-11, the reconnection of the side channel between RM 4 and 5.6, and restoring the mouth of Hunter Creek have little potential to affect historic properties because there is little likelihood that sites exist within each project footprint.

The wetland restoration increments at Grange and RM 9 (included in #18 and #27) would involve construction of new features on the landscape, so in addition to direct impacts within the construction footprint and staging areas, the wetland embankment could indirectly adversely affect surrounding historic properties by changes in the viewshed. Other considerations include the area in front of the newly constructed features that would be more exposed to erosion and changes in soil moisture that could affect buried archaeological materials. Cultural resource monitoring would be required during construction for the following locations: construction of the wetland embankments at River Mile 9 and at Grange, and the channel reconnection locations at RM 4 and RM 5.6. While the channel reconnection location at RM 4 was not surveyed, both channel reconnection locations are relict channels of the Skokomish River and reconnection would involve re-excavating the former inlet and outlet of the relict channels. In addition, excavation would only be deep enough to allow water to pass into the channel during higher flows.

For the proposed wetland restoration at the Grange, the Corps would conduct a cultural resources report if this project component were to move forward through the next phase of design. The placement of the Upstream LWD will be within the current Skokomish River channel. Proposed access

routes currently include private property and will be finalized during PED phase. The Corps will conduct a cultural resources survey when the proposed locations of the Upstream LWD and access routes are finalized in PED phase.

Riverbed Excavation Alternatives #45 and #60

In general, in-water work such as dredging has little likelihood of directly impacting archaeological sites or historic structures. However, changes in channel capacity and morphology could lead to changes in rates of bank erosion and flooding, which have potential to indirectly impact archaeological sites, historic structures, or important aspects of traditional cultural properties (TCPs).

For Alternatives #45 and #60, sediment excavated from the river would be placed within the lower intertidal and subtidal areas of the estuary and adjacent nearshore zone. Of the 17 recorded sites within the basin, 10 have been recorded along the edges of Hood Canal and within the estuary. Prehistoric sites associated with the Twana, and historic era sites associated with the establishment of Nalley's Ranch, logging, and early commerce are expected to be present. Placement of dredged materials within the estuary would need to be coordinated to avoid impacts to significant cultural resources. Potential impacts associated with the eight proposed increments would be the same as discussed above.

The Hunter Creek side channel and the Weaver Creek side channel would require excavating small channels along existing swales and therefore could affect sub-surface archaeological materials adjacent to the creeks. The most likely resources to be present include short-term prehistoric and historic campsites, middens, and historic refuse areas. Due to the nature of the proposed projects, indirect impacts to surrounding historic properties are not likely.

Cumulative Effects

The proposed undertakings evaluated in this document would contribute to the overall restoration projects proposed by the SWAT and others and should lead to a general improvement in ecological functions. Many of the areas identified as important to the Twana were related to fishing; therefore, any improvement in fisheries would have a beneficial effect on fishing related TCPs within the area.

4.6 Social and Economic Resources

This section presents an overview of major socioeconomic characteristics and trends within the study area, including demographics and economics.

4.6.1 Indian Trust Assets

In addition to the Federal government's responsibilities under NHPA, the Federal government must consider the effects its actions may have on American Indian traditions and cultural practices. The Federal basis of a tribe's legal status rests within the context of U.S. Constitutional provisions for Federal government's powers for treaty making with other sovereign nations, and American Indian tribes' inherent sovereignty.

The Skokomish Indian Tribe, with other Tribes and bands of the Twana, Clallam, and Chimakum peoples, signed the Treaty of Point-No-Point with the Federal Government on January 26, 1855. The Skokomish Indian Reservation was formed through this treaty and required these Indians to move to the current

reservation location at the mouth of the Skokomish River. The reservation boundaries were expanded by executive order in February 25, 1874 and the current location consists of 4,950 acres, with nearly 2,700 acres of residential areas and many tribal government services. Today, many tribal members continue to work within the region's fishing and logging industries. In an attempt to diversify its economy, the Tribe has purchased property for economic development (including the operation of a local casino) and resource enhancement, as well as for housing. The Tribe operates its own businesses including a tribal hatchery and a gas station/convenience store.

The priorities of the Skokomish Indian Tribe are protection of the marine, freshwater, and land resources of Hood Canal that are the backbone of the Tribal economy and spiritual beliefs. One of the treaty-reserved rights is the ability to conduct fishing and hunting activities on all U&A locations. Hunting, fishing, and gathering are central to the cultural and economic existence of the Tribe and its members. Acquisition of food through hunting, fishing, and gathering is part of a complex culture that emphasizes the concept that all of life is interrelated. Fish, wildlife, and other natural resources sustain the cultural and spiritual identity of the community in addition to providing economic stability for present and future generations.

In addition to salmon, shellfish have been a mainstay of the Skokomish Indian Tribe for thousands of years. Clams, crab, and oysters were readily available for harvest year-round. The rapid decline of many western Washington salmon stocks, due in large part to habitat loss from the region's burgeoning human population, has pushed shellfish to the forefront of many tribal economies. Today, the Annas Bay estuary contains a significant shellfish resource used by Tribal, commercial, and recreational harvesters. However, shellfish resources have been declining due to reduced availability of suitable substrate for shellfish attachment in the estuary as well as high fecal coliform levels in Annas Bay and Hood Canal.

Along with hunting, fishing, and gathering, the intricate basketry and artwork of the Skokomish Indian Tribe is widely renowned and culturally significant. Until the 1930s, the Twana women from the Skokomish Indian Reservation harvested sweetgrass (*Scirpus americanus*) from the estuary for making baskets and other items. Industrial and agricultural development in western Washington estuaries has all but eliminated sweetgrass, and only a few remnants of the Skokomish sweetgrass were found outside of the estuary dike system by the 1970s.

4.6.1.1 No-Action Alternative/Future Without-Project Conditions

In the future without-project condition (No-Action Alternative), U&A fishing areas and fisheries resources will continue to degrade. As salmon populations continue to decline and shellfish habitat is lost, the cultural and spiritual identity of the Tribe would be significantly impacted.

4.6.1.2 Action Alternatives/Future With-Project Conditions

Confluence Levee Removal Alternatives #11, #18, and #27

Removal of the Confluence Levee will create a year-round connection from the mainstem to the North Fork and will solve the issue of the river going subsurface in the summer months. All three alternatives would benefit salmon and consequently would have a positive effect for tribal fisheries. Alternatives #18 and 27 include wetland restoration by breaching the agricultural berms at Grange and River Mile 9 and

constructing wetland embankments, which would provide an additional 51 acres of forested riparian zone reconnection to the river. Alternative #11 does not include these two project components and therefore lacks a significant opportunity to increase the channel migration zone, improve and expand forested wetlands, and provide salmon habitat and reduce fish stranding during floods. These alternatives would have a minimal effect to other tribal trust resources such as game and sweetgrass.

Riverbed Excavation Alternatives #45 and #60

While both riverbed excavation alternatives would address the issue of fish stranding, the removal of sediments would have significant detrimental effects to all fish species in the Skokomish River due to its effects on benthic macroinvertebrates that serve as the primary food source as well as spawning areas. The placement of gravels within the estuary would benefit shellfish; however, placement of the gravel would need to be coordinated to avoid affecting the last stands of sweetgrass in the estuary. This alternative has a high risk of negative effects on tribal resources.

Cumulative Effects

The preferred alternative's benefits to fish and wildlife would have a beneficial effect on fishing related traditions and cultural practices and these benefits are assumed to be cumulative when added to other ecosystem restoration efforts around the Skokomish River watershed.

4.6.2 Land Use and Agricultural Resources

Section 4.2 provides a summary of past land uses and events that have influenced the present conditions of the valley. Many of the farm properties have been held within families for multiple generations. Current land uses in the study area are primarily farming and cattle grazing along with rural-residential areas. Non-residential structures in the study area include schools, barns and other farming-related buildings, tribal services buildings such as a health clinic and administrative offices, a fish hatchery that covers roughly six acres, a fire station, the local Grange Hall, and a church. The area surrounding the lower river and estuary is reservation land for the Skokomish Indian Tribe.

4.6.2.1 No-Action Alternative/Future Without-Project Conditions

The future without-project conditions shows potential for continuing a shift in types of agricultural land uses based on crops that can tolerate increasing frequency of inundation and slow drainage, or changes in groundwater levels. Flooding is expected to become more frequent, but only small increases in flood depths are anticipated due to the broad floodplain in the valley. Taking no action toward ecosystem restoration would have no effect on land use or agricultural resources.

4.6.2.2 Action Alternatives/Future With-Project Conditions

Aspects common to both groups of action alternatives

The action alternatives would not involve any condemnation of properties or takings by the government, and no sites would move forward without necessary land ownership or easements in place. Project components would not occur without willingness of the affected property owners.

The Upstream LWD project component would involve the need for permanent road easements along existing dirt road pathways as well as flowage easements across parcels that area already inundated by

the existing river channel. These are not anticipated to cause any change to present land uses or prevent economic benefits of future property uses.

The two wetland restoration increments, included in all alternatives except #11, will require perpetual easements. Breaching existing berms and constructing wetland embankments would contain floodwater within an expanded area of forested riparian wetland and would cause small acreages of infrequently harvested agricultural fields to revert to forested riparian wetland. This constitutes a change of approximately 10 acres from farmland to uncultivated riparian zone wetland at the River Mile 9 wetland embankment location.

The area surrounding the Side Channel Reconnection increment is abandoned farm fields that have not been cultivated in more than 20 years. No change to the land use is anticipated from opening the inlet and outlet channels at this site.

Confluence Levee Removal Alternatives #11, #18, and #27

Construction access for Confluence Levee Removal would require a permanent road easement along existing dirt road pathways and a temporary work area easement. The opened flowage area will convert the upland levee soils and vegetation to wetland soils and will be planted with species tolerant of frequent inundation. These features are not anticipated to cause any change to present land uses or prevent economic benefits of future property uses.

Riverbed Excavation Alternatives #45 and #60

Alternatives #45 and #60, excavation of the mainstem and South Fork Skokomish Rivers, would increase the channel capacity and would produce a river channel with an approximate 50% ACE, or two-year flood capacity, considerably reducing the frequency of overbank flooding in the valley. Floods larger than the 50% ACE would still cause overbank flooding, but to a lesser degree than present. This would have benefits for agricultural uses in the valley, but it is unknown to what degree the reduced inundation would allow a shift in types of crops.

Cumulative Effects

No significant cumulative effects to land use and agricultural resources are anticipated to accrue from any of the alternatives.

4.6.3 Public Health and Safety

NEPA requires the consideration of public safety in any Federal proposal. Public safety is a primary concern for any Federal water resources project. The following features under consideration have relevance for public safety: wetland embankments, engineered logjams, and temporary river crossings within the construction zones.

4.6.3.1 No-Action Alternative/Future Without-Project Conditions

The future without-project conditions would have the same level of public assurances of health and safety as the existing conditions. Flooding is expected to become even more frequent, but only small increases in flood depths are anticipated due to the broad floodplain in the valley. Taking no action toward ecosystem restoration poses no risk or benefit toward public health and safety.

4.6.3.2 Action Alternatives/Future With-Project Conditions

Aspects common to both groups of action alternatives

Each action alternative contains ecosystem restoration features that must be designed to maintain public safety. The ELJs, clusters, and single anchored logs in the Upstream LWD component will be designed for the appropriate level of risk for their loss or mobilization, typically a recommended safety factor of two in most situations, which is expected to remain in place through large floods. The two wetland restoration sites that include wetland embankment features at Grange and River Mile 9 would not change the existing flooding conditions in the study area. While the goal for the new wetland embankments is to cause water retention on the riparian and floodplain wetlands and direct flow back to the river, this retention is only up to river flows of around 6,000 cfs, which is a moderate storm event that occurs multiple times per year. The wetland embankments are designed for overtopping with a shallow backslope to prevent erosion. These wetland embankments are included in all of the alternatives except for #11.

Confluence Levee Removal Alternatives #11, #18, and #27

Removal of Confluence Levee has been determined to pose no additional risk of flooding populated areas. Temporary river crossings would be installed for construction access to remove Confluence Levee, but these would not be open to public access and construction limits would be tightly controlled.

Riverbed Excavation Alternatives #45 and #60

Alternative #60, excavation of the mainstem and South Fork Skokomish Rivers from RM 0-9, would increase the channel capacity. The proposed excavation would produce a river channel with an approximate 50% ACE, or two-year flood capacity, considerably reducing the flood risk in the valley. Floods larger than the 50% ACE would still cause overbank flooding, but to a lesser degree than present.

The smaller scale of riverbed excavation, Alternative #45, is excavation of RM 3.5-9. This action starts just upstream of where the southern floodwaters re-enter the mainstem. It would provide 50% ACE flow capacity in the excavated reach and reduce flood risks in much of the valley. Downstream of RM 3.5, channel capacity and flooding would be unchanged.

Cumulative Effects

No significant negative cumulative effects to public health and safety are anticipated to accrue from any of the alternatives. Riverbed Excavation alternatives could work in conjunction with the new Highway 101 Purdy Creek Bridge to reduce flood risks.

4.6.4 Transportation and Traffic

Two highways are located in the study area: US Highway 101 (US-101) and State Route 106 (SR-106). The principal arterial road, Skokomish Valley Road, runs the length of the Skokomish Valley and provides the primary access to residences and farms in the study area. Skokomish Valley Road is the most frequently flooded road, which affects access for valley residents. Public transit is limited to bus service in the Skokomish Valley. Commute times average around 29 minutes for Skokomish Valley residents, which is greater than the national average of 25 minutes and most residents commute by car alone

(Census 2013). Average daily traffic volume through the study area for US-101 is 5,800 and for SR-106 is 1,600 (WSDOT 2013a); US-101 is classified as a rural-principal arterial (WSDOT 2013b). US-101 is designated a Highway of Statewide Significance by the Transportation Commission (WSDOT 2009).

4.6.4.1 No-Action Alternative/Future Without-Project Conditions

In the future without-project condition, inundation of local roads in the study area will continue to be a problem. The pattern of flooding may have a slight increase in depth and frequency across the floodplain. Traffic and commute times in the study area are not expected to change substantially as US-101 is a rural-principal arterial, which provides access to rural Washington coastal communities away from urban centers. The level of service (LOS) for US-101 is Class C, or stable flow, at or near free flow (WSDOT 2010). Population in the Skokomish Valley has been declining due to a building moratorium and frequent flooding in the basin, and development and population growth is not expected to increase.

4.6.4.2 Action Alternatives/Future With-Project Conditions

For analysis of effects to transportation and traffic in the study area, the Corps used guidance from the California Environmental Quality Act (CEQA) to assist with determining levels of significance of impacts (State of California and Bureau of Land Management 2010). Under CEQA, the proposed project would have a significant impact if it would cause an increase in traffic that is substantial in relation to the existing traffic load and capacity of the street system; exceed, either individually or cumulatively, an LOS standard established by the regional transportation planning organizations; result in inadequate emergency access; or result in closure of a major roadway (arterial or collector classification) to through traffic as a result of construction activities with no suitable or alternative route available.

Confluence Levee Removal Alternatives #11, #18, and #27

Confluence Levee removal would cause temporary impacts during construction, with approximately 17 truck trips per day over 42 working days for material hauling. Additional temporary traffic increases for each alternative depend on the number of increments, construction sequencing, and quantity of hauling, but are assumed to range from an additional 10 hauling days (17 truck trips per day) for Alternative #11 to approximately 70 additional hauling days for Alternative #27 work (see Table 4-3, Summary of construction components analyzed for effects to resources). Temporary traffic delays will depend on the construction sequencing, timing, and intensity. Trucks are assumed to have up to a 20-mile round-trip cycle to and from the study area. Traffic control structures may be required for restoration work along Skokomish Valley Road and US-101 for each alternative.

Residents may experience minor delays (less than 5 minutes) as they commute around the study area on local roads. Construction activities are not expected to cause significant increases in traffic and delay on US-101 and SR-106. These alternatives are not expected to cause an increase in traffic that is substantial in relation to the existing traffic load and capacity of the system; result in closure of a major roadway to through traffic with no suitable or alternative route available; nor meet thresholds for any of the other CEQA impact significance criteria. Given the CEQA criteria and the assumed impacts, these alternatives are not expected to cause significant temporary or long-term effects to traffic and transportation.

Riverbed Excavation Alternatives #45 and #60

Riverbed Excavation Alternatives would cause temporary impacts during construction, with approximately 300 or more truck trips per day over 631 working days for #60 and 363 working days for #45. Trucks for dredged material disposal have a shorter round-trip cycle of 10 miles, while the increments are assumed to have up to a 20-mile cycle to and from the study area. The project increment Dips Road would relocate a portion of Skokomish Valley Road and may reduce traffic delays associated with flooding. Traffic control structures may be required for restoration work along Skokomish Valley Road and US-101 for both of these alternatives.

Residents may experience longer delays (greater than 5 minutes) as they commute to and from the study area on local roads. Construction activities will increase traffic and may cause traffic delays on US-101 and SR-106 with an estimated 10 percent increase in traffic within the study area. Alternatives #45 and 60 are assumed to require periodic dredging to maintain channel capacity approximately every 20 years, or two periodic dredge cycles over the period of analysis. Periodic sediment excavation is expected to be 30 to 40 percent of the initial construction and would cause temporary traffic and transportation delays. Given the CEQA criteria and the assumed impacts, Alternatives #45 and 60 are expected to cause significant temporary effects to traffic and transportation as part of initial construction and periodic maintenance.

Cumulative Effects

No cumulative effects from implementation of the preferred alternative are anticipated to occur as permanent changes to transportation and traffic in the Skokomish Valley.

5. Recommended Plan – Agency Preferred Alternative

The Corps' objective in ecosystem restoration planning is to contribute to national ecosystem restoration (NER). Contributions to NER (outputs) are increases in the net quantity and/or quality of desired ecosystem resources. The NER Plan must reasonably maximize ecosystem restoration benefits compared to costs, consistent with the Federal objective. The selected plan must be shown to be cost effective and justified to achieve the desired level of output.

5.1 Description of the Recommended Plan (NER Plan)

The annual costs and benefits of the recommended plan (Alternative #18) using planning level cost estimates are shown in Table 5-1. Features included in the recommended plan range from 23 acres to 107 acres restored with costs ranging from approximately \$1.9 to \$6.1 million per feature. The total area of the proposed sites included in the recommended plan is approximately 277 acres restored. The average annual habitat units are estimated at 186.6, total annual cost using feasibility-level cost estimates are estimated at \$824,000 (October 2014 price level, 3.375% discount rate), and the total estimated costs of the recommended plan using a more detailed cost estimate is approximately \$19,343,000 at the October 2014 price level (Section 5.5 outlines the recommend plan cost estimate).

Table 5-1. Recommended Plan Components (October 2014 price level, 3.375% discount rate)

Plan ID	Plan Components	Habitat Units (In-Channel, Floodplain, and Capacity)	Habitat Units (Shellfish Substrate)	Total Habitat Units	Total Acres Restored	Total Real Estate Parcels Affected	Total Annual Cost (\$1,000s)
18	Base Alternative #3: Confluence Levee Removal	45.9	0	45.9	68	8	\$177
	Increment 35 – Upstream LWD	82.9	0	82.9	107	37	261
	Increment 9 – Side Channel Reconnection	25.7	0	25.7	45	22	79
	Increment 28 –Wetland Restoration at River Mile 9	13.6	0	13.6	23	21	153
	Increment 37 –Wetland Restoration at Grange	18.5	0	18.5	34	17	154
	Totals for Recommended Plan	186.6	0	186.6	277	105	\$824

No costs or features (local betterments) over the NER Plan have been identified for implementation.

The following sections describe the key design elements included in each of the components of the recommended plan.

5.1.1 Confluence Levee Removal

The Confluence Levee Removal, located in the vicinity of the North Fork and South Fork confluence (RM 9), removes approximately 5,400 linear feet of levee and diverts flow from the South Fork into the North Fork through a small (300-foot) diversion channel (Figure 5-1). The diversion channel is designed to pass all flow up to a typical winter flow of approximately 2,000 cubic feet per second (cfs). A number of

engineered logjams and single log structures will be placed adjacent to the diversion to assist in keeping low flows in the diverted channel and to prevent the main channel from migrating around the diversion. This wood will also encourage recruitment and aid in formation of the newly diverted channel. The diverted flows are expected to do geomorphic work downstream of the diversion for many years after the project, as high flows will split between the existing and new flow paths. The existing terrain will erode and existing vegetation will be altered as a new, larger active channel forms in the area. This process will be allowed to occur naturally over time.

Some project benefits will commence within the first year after construction, and other components of restoration will accrue more slowly. For example, in the first high flows of the first winter following Confluence Levee removal, the South Fork will already be diverting into the diversion channel, and higher flows will activate the established main channel where the bar-apex logjams will initiate habitat formation. In the summer following removal of Confluence Levee, migrating adult salmon will find a year-round channel for migration to critical spawning grounds for the first time since approximately 2004. Benefits of plantings will accrue over time as it takes roughly 3-7 years for some shrubs to become mature and longer for taller trees to grow.

Levee construction has affected the process of channel dynamics that create more complex habitat than what levees allow. Removal of Confluence Levee will alleviate a channel constriction that is more than a mile long. This action will remove the blockage to upstream and downstream fish passage and allow salmon access to spawning grounds. The river will be able to follow a more natural path, which will allow its forces to influence channel morphology. Over time, riparian wetlands will develop more fully on the north side of the river, which will enhance habitat for birds and mammals associated with the riparian and river corridor such as beavers, mink, river otters, as well as bald eagles and osprey that target fish as a prey base.

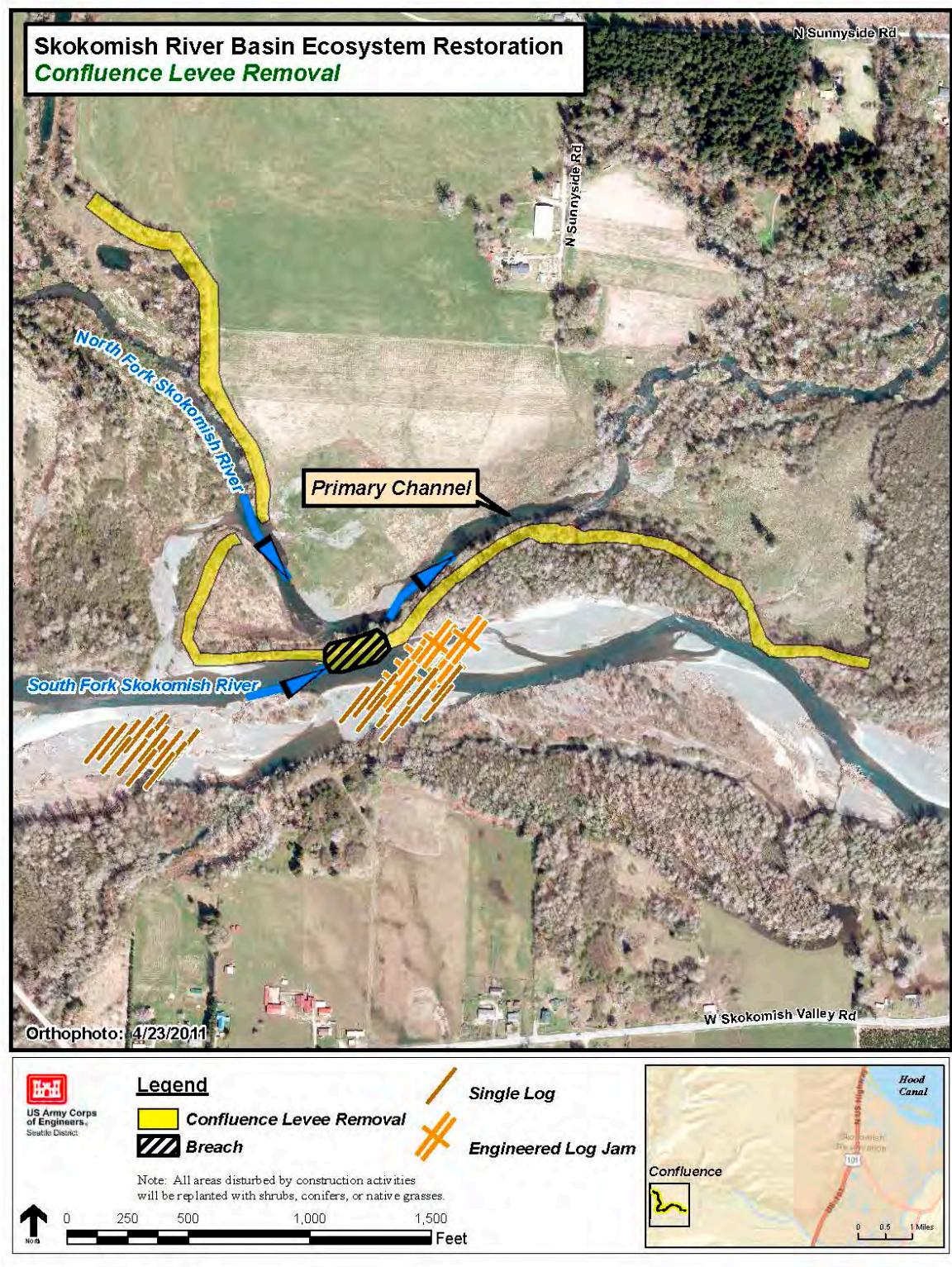


Figure 5-1. Confluence Levee Removal

5.1.2 Upstream Large Woody Debris

This plan component, located from RM 9-11, would include placement and installation of large woody debris (Figure 5-2). As described in Appendix H, multiple wood structure types are included in the design: bar apex engineered logjams, 5-log channel clusters, and single log placements. These large woody debris installations are intended to restore much of the missing habitat and channel complexity afforded by the historical wood load. All wood included in the South Fork has been preliminarily located and designed with stable anchoring. Location and size of wood structures will be refined in preconstruction engineering and design (PED) phase as additional LIDAR and channel surveys are obtained.

The LWD for this project will be supplied by the non-Federal sponsors. The source material has not been determined at this time; however, similar LWD projects in the Skokomish basin have used trees from managed timber-production forests as part of routine land management. The most probable source for LWD for this project would be privately owned forests managed for timber production in the North and South Fork Skokomish watersheds. Trees could also come from a permitted logging operation for clearing or selective thinning, or from private land that will be cleared for development. Another source for other past projects was from forestland used for enhancement of elk browse habitat in which tree removal provided an environmental benefit to the largest mammals in the watershed.

The ecosystem processes of forest succession and large woody debris recruitment have been curtailed in this basin due to human activities. Large woody debris is severely lacking throughout the study area as a direct result of channel clearing. Installation of logs and logjams will restore this vital ecosystem component and renew the process of woody debris accumulation at the structures. This action will directly improve fish habitat and will create and maintain channel characteristics resembling nearby watersheds that are far less disturbed due to their location within Olympic National Park. The large woody debris will provide substrate for aquatic insects and structure for aquatic-oriented mammals. The logjam structures will also create pools for rearing and refuge habitat for juvenile and adult salmon, which will help with their survival and productivity.

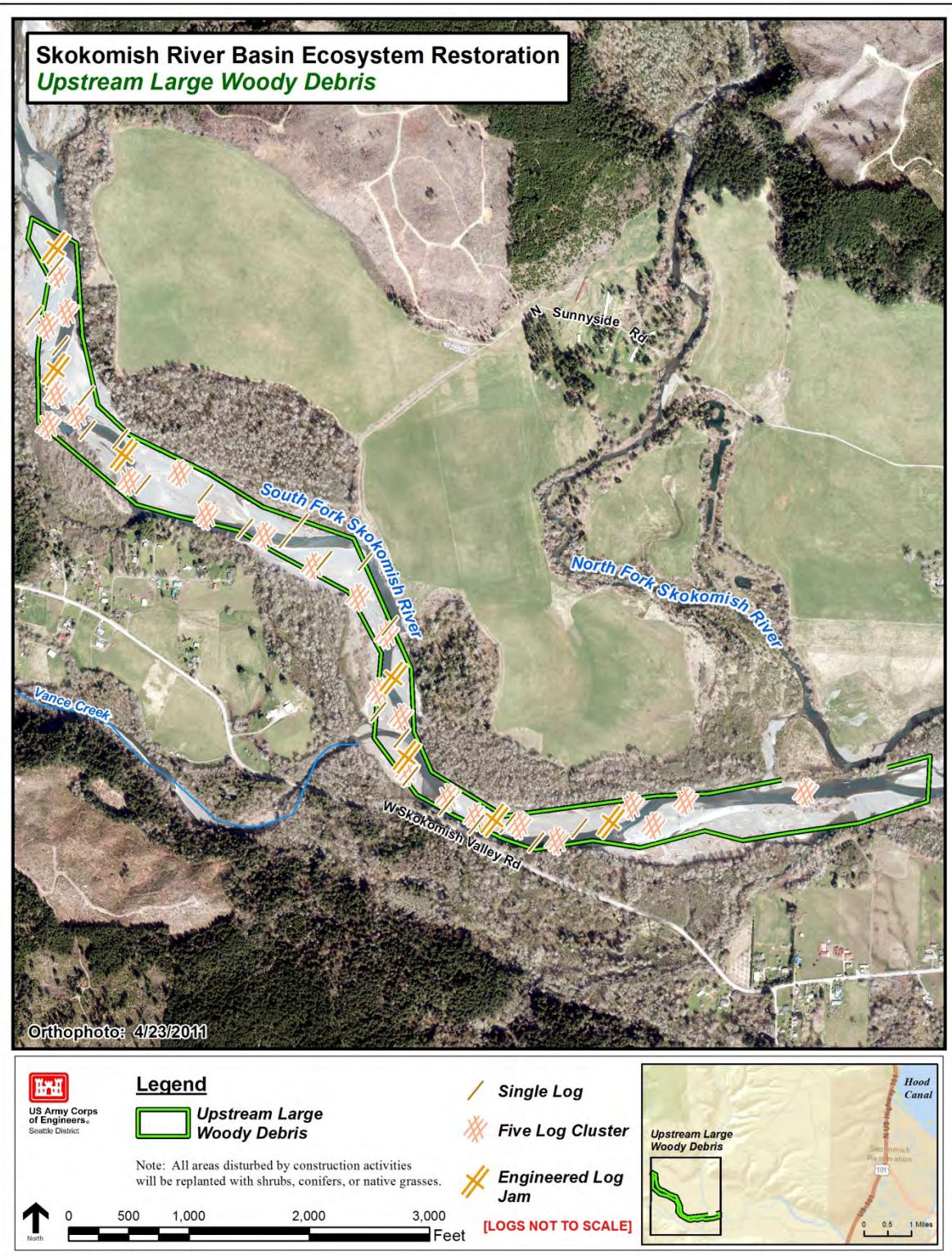


Figure 5-2. Upstream Large Woody Debris

5.1.3 Side Channel Reconnection

This component will reconnect an abandoned channel that exists between RMs 4 and 5.6 (Figure 5-3). Restoration will involve constructing improvements to the channel inlet and outlet. The reconnected channel would only be connected to the river during moderate discharges and would not convey water year round. The inlet is located directly downstream from a large natural logjam at RM 5.7 and was placed to provide for a stable connection to the mainstem Skokomish River that is not likely to accumulate significant wood. At the downstream end of this site, the channel would be reconnected through an existing outlet that presently backwaters at the lowest flow. A small number of 5-log bank clusters will be placed at the inlet and outlet to provide for stable banks and refuge for salmonids. The existing Highway 101 Bridge is near this site and is estimated to be adequate in width and height to convey flows associated with this restoration project.

Floodplain connectivity for fish and wildlife is a critical component of the riverine ecosystem. Human activities have led to many disconnections of these habitats. Opening the 44 acres of wetlands that were once the main channel of the river will provide a vast area of habitat connected for fish, which will greatly expand the prey base for birds and mammals that consume fish such as river otters and great blue herons. The area will serve as over-wintering habitat for coho salmon, which will also enhance productivity of a key resource for recreational and tribal fishing the Skokomish River.

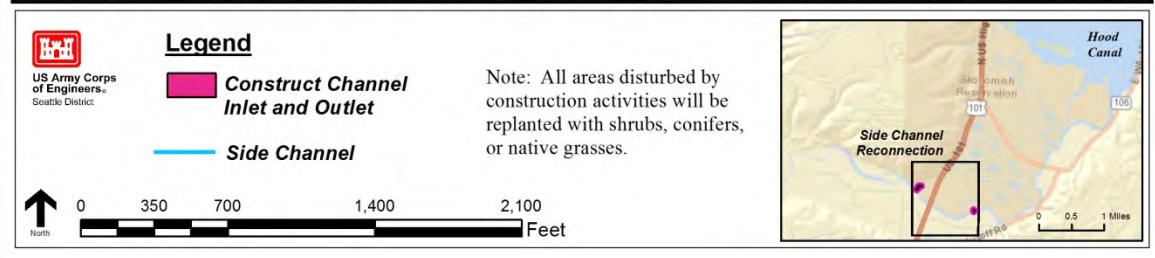
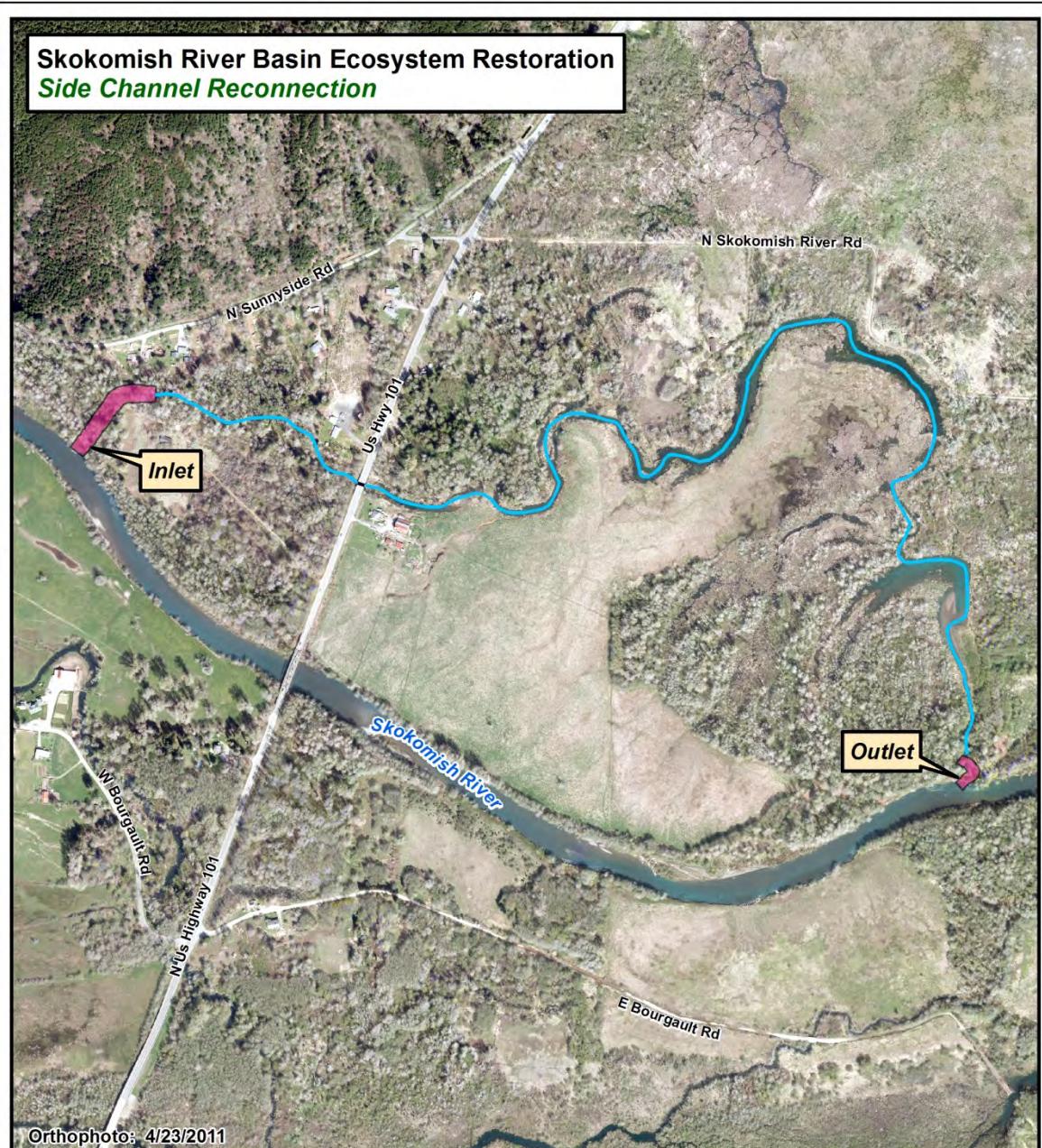


Figure 5-3. Side Channel Reconnection

5.1.4 Wetland Restoration at River Mile 9

This wetland restoration increment, located from RM 8.3-9.2, is intended to reconnect and restore high quality wetland habitat (Figure 5-4). An existing agricultural berm will be breached and a new wetland embankment will be constructed landward (south) varying distances, generally around 200-300 feet. The breaches will allow for reconnection and restoration of a wetland in the floodplain, allowing flood waters to flow freely within the reconnected area and providing salmonids access to the riparian habitat. While breaching the existing berm will provide reconnection of a wetland, construction of a wetland embankment is integral to achieving complete restoration benefits at this site. In combination with the berm breaches, a wetland embankment will be constructed to maintain hydraulic conditions in the reconnected wetland area.

The wetland embankment is a structural mechanism which is necessary to allow targeted reconnection to riparian wetlands multiple times a year; it is not a flood risk management feature but is integral to the function of the riparian wetland. The wetland embankments contain flow from frequent winter storm events (approximately 6,000 cfs), providing high flow refuge for fish as well as reconnection and restoration of high-value forested wetland.

The height and alignment of the proposed wetland embankments are designed to meet ecological criteria established by fisheries biologists from the Corps, Skokomish Indian Tribe, and USFWS. The embankments are designed to direct water to flow through the reconnected areas and back into the river, ensuring two-way flow in the reconnected area. The wetland embankments are also designed to generally contain flows up to approximately 6,000 cfs (frequent winter storm events), allowing flow depths of 1-3 feet to be consistently held in the riparian wetland area, ultimately allowing hydric soils to develop and favoring native wetland vegetation. Designing for a lesser flow (i.e., smaller than 6,000 cfs) would not provide sufficient depth of flows over the reconnected wetland; hydric soils would not develop over time and flows may not reach the riparian zone targeted for restoration. Therefore, project objectives would not be met under this scenario.

The existing agricultural berms to be breached range from approximately 5-8 feet in height at both locations. The proposed wetland embankment at River Mile 9 is approximately 4,370 linear feet in length and varies in height along its alignment from 0-4.5 feet in height with an average height of approximately 2 feet over the existing variable terrain. These heights reflect the outcomes of the supplemental analysis conducted on the embankment site as presented in Section 3.7.4, and are consistent with the small-scale wetland embankment which was identified as a best buy plan for that site. Height variation of the embankments is based on the natural topography in the study area. Some areas of the embankments are taller where the structure crosses depressions, while some areas of the embankments are lower in height where high ground is crossed. Foundation soils in the low areas are loose fine-grained soils so an overbuild was included in the design to account for future settlement.

The proposed wetland embankments are located on the landward edge of existing riparian zones. The embankments reconnect the existing area of forested wetland that is currently cutoff from the river channel, while avoiding cleared farm fields that do not provide high-quality riparian zones and are not likely to develop native riparian wetland vegetation due to lack of hydric soil conditions. The embankments are also aligned to divert flows back into the mainstem Skokomish River rather than

across the floodplain to the south where there is no defined channel or ecological beneficial habitat for salmonids and other aquatic species. The alignment also captures depressions in the riparian zone, which would attract and support river otters, beavers, and mink.

This action will improve productivity of all riverine life stages of salmonids by increasing available spawning, incubation, rearing, and over-wintering habitats. These types of benefits are only achieved if the existing berm is breached and a new wetland embankment is constructed, as both measures are integral to restoring the wetland area in the floodplain. Construction of the new wetland embankment would serve to hold overbank flows on the site at slightly greater depth and longer duration, which would improve and expand wetlands as well as provide fish a pathway back to the river. The restored wetland and forested areas would export invertebrates and organic material as well as provide direct refuge habitat during high flows. This type of off-channel habitat is crucial to overwintering juveniles such as coho and steelhead, which use inundated wetlands to escape high winter flows. Off-channel habitats are also used as predator refugia by juvenile salmonids, and some adult salmon species utilize off channel habitat for spawning. The existing agricultural berms located in the study area can make it more difficult or impossible for juveniles that find their way onto the floodplain to return to the river proper when flows recede, so restoration and reconnection of riparian wetlands provides critical ecological benefits to nationally significant resources. Finally, the wetland embankments will not only serve the purpose of restoring and improving wetland habitat, but would also prevent fish stranding for most of the moderate winter storm events.

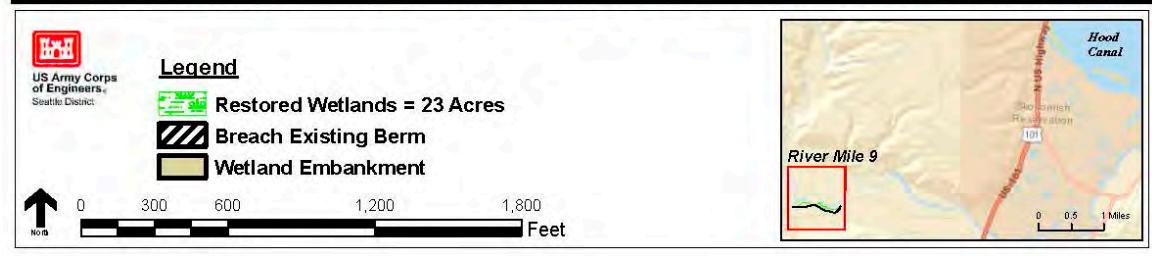
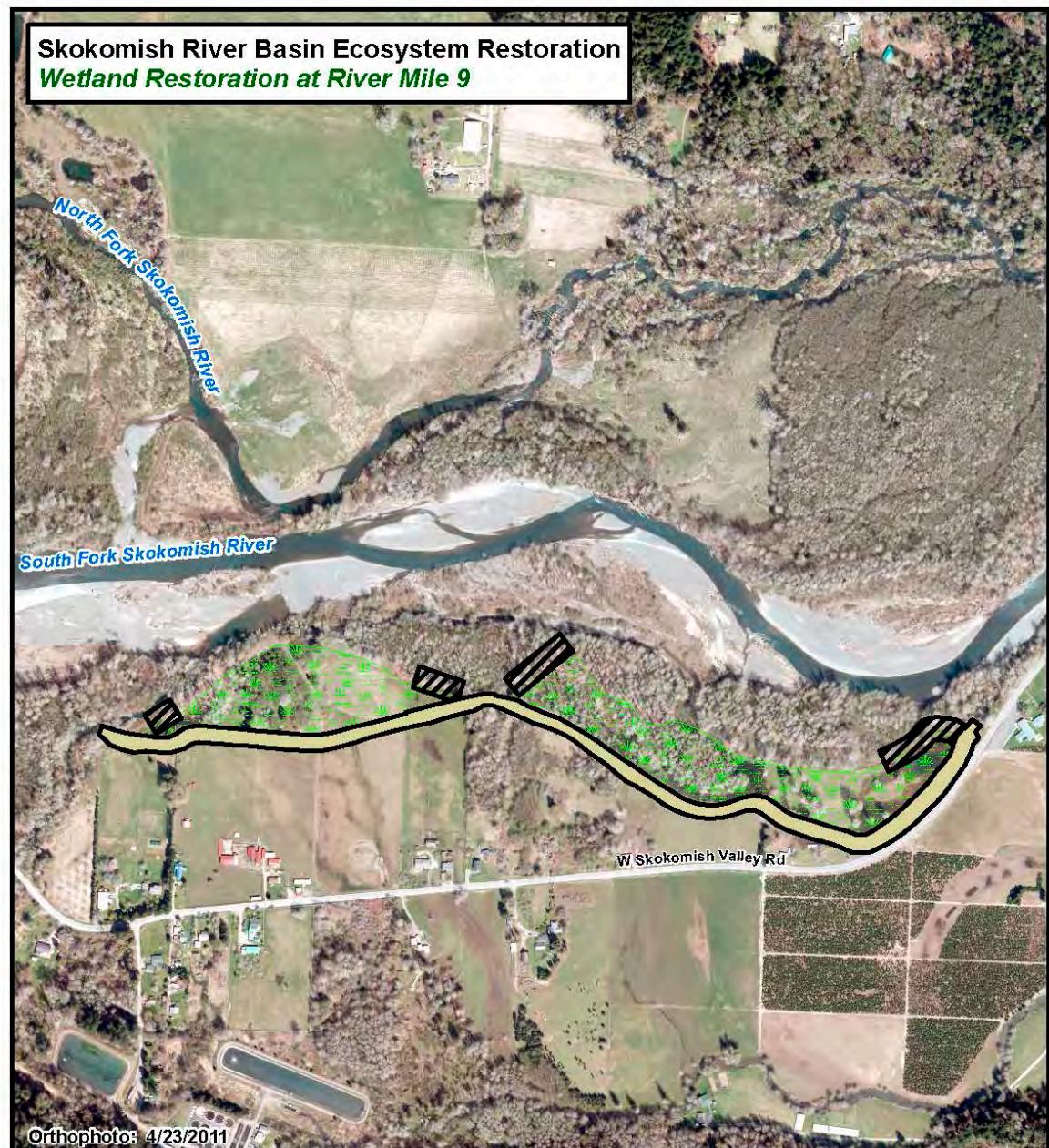


Figure 5-4. Wetland Restoration at River Mile 9

5.1.5 Wetland Restoration at Grange

Similar to the River Mile 9 Wetland Restoration increment described above, this wetland restoration increment, located from RM 7.5-8, is intended to reconnect and restore high quality wetland (Figure 5-5). An existing agricultural berm will be breached and a new wetland embankment will be constructed landward (south) up to 1,200 feet. The breaches will allow for reconnection of a wetland in the floodplain, allowing flood waters to flow freely within the reconnected area and providing salmonid access to the riparian habitat. While breaching the existing berm will provide reconnection of a wetland, construction of a wetland embankment is integral to achieving complete restoration benefits at this site.

The height and alignment of the proposed wetland embankments are designed to meet ecological criteria established by fisheries biologists from the Corps, Skokomish Indian Tribe, and USFWS. The embankments are designed to direct water to flow through the reconnected areas and back into the river, ensuring two-way flow in the reconnected area. The wetland embankments are also designed to generally contain flows up to approximately 6,000 cfs (frequent winter storm events), allowing flow depths of 1-3 feet to be consistently held in the riparian wetland area, ultimately allowing hydric soils to develop and favoring native wetland vegetation. The proposed wetland embankment at Grange is approximately 2,750 linear feet in length and varies in height along its alignment from 0-6.5 feet in height with an average height of approximately 4 feet over the existing variable terrain. These heights reflect the outcomes of the supplemental analysis conducted on the embankment site as presented in Section 3.7.4, and are consistent with the small-scale wetland embankment which was identified as a best buy plan for that site. Height variation of the embankments is based on the natural topography in the study area. Some areas of the embankments are taller where the structure crosses depressions, while some areas of the embankments are lower in height where high ground is crossed. Foundation soils in the low areas are loose fine-grained soils so an overbuild was included in the design to account for future settlement. This action will improve productivity of all riverine life stages of salmonids by increasing available spawning, incubation, rearing, and over-wintering habitats. These types of benefits are only achieved if the existing berm is breached and a new wetland embankment is constructed, as both measures are integral to restoring the wetland area in the floodplain. Construction of the new wetland embankment would serve to hold overbank flows on the site at slightly greater depth and longer duration, which would improve and expand wetlands as well as provide fish a pathway back to the river. The restored wetland and forested areas would export invertebrates and organic material as well as provide direct refuge habitat during high flows. This type of off-channel habitat is crucial to overwintering juveniles such as coho and steelhead, which use inundated wetlands to escape high winter flows.

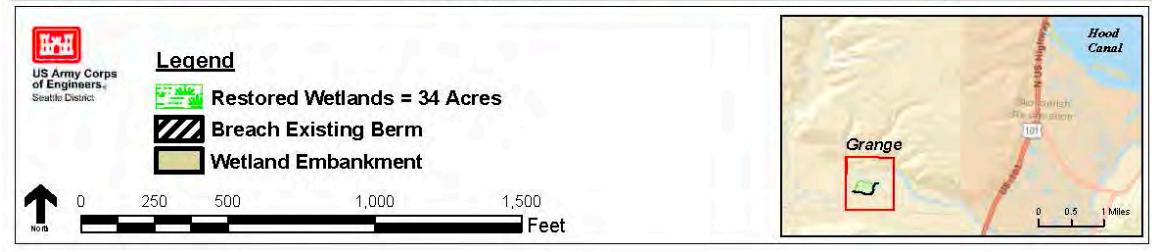
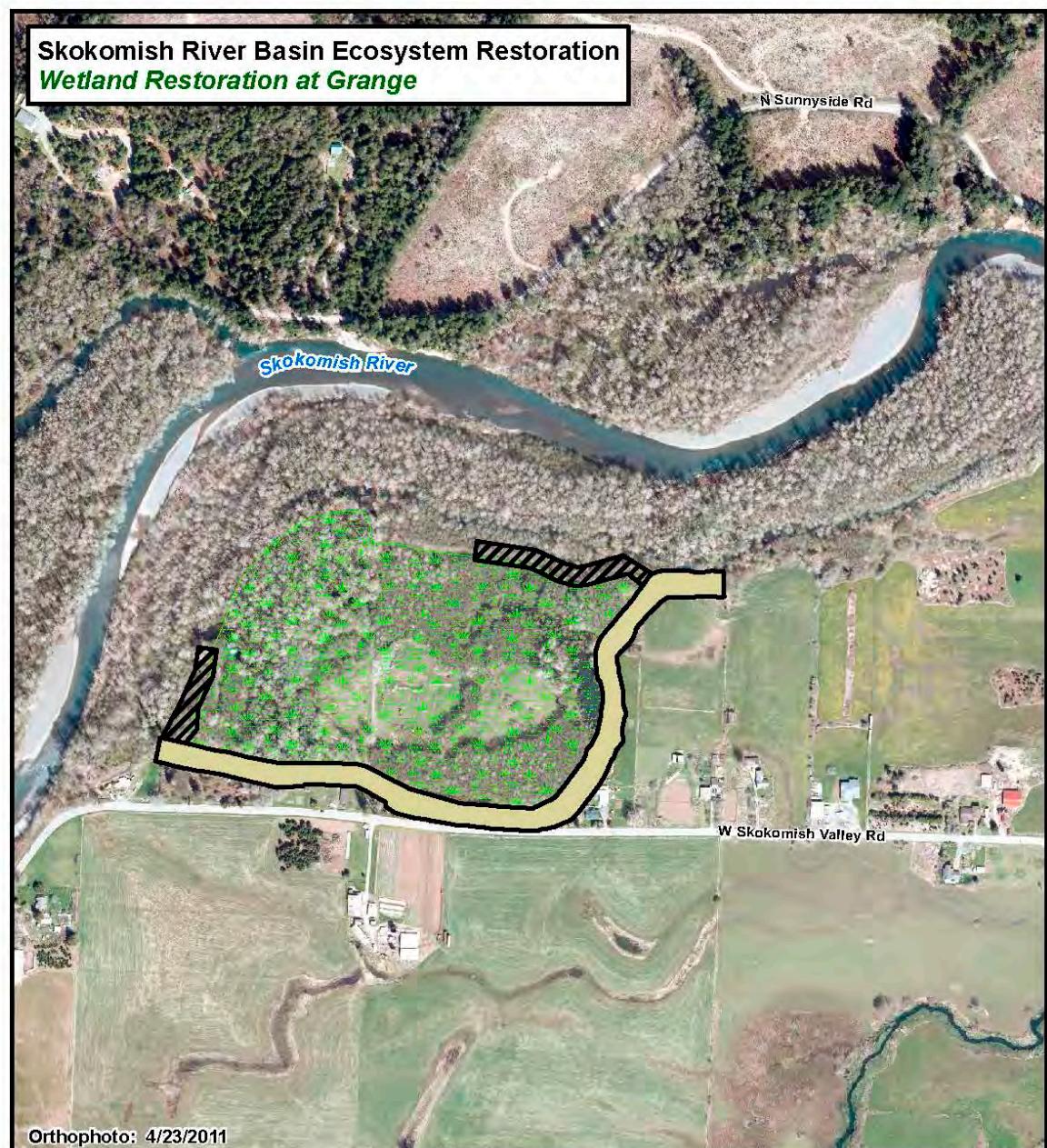


Figure 5-5. Wetland Restoration at Grange

5.2 Effects of the Recommended Plan

Corps policy establishes four accounts to facilitate the evaluation and display of the effects of the recommended plan. These accounts are National Economic Development (NED), Environmental Quality (EQ), Regional Economic Development (RED), and Other Social Effects (OSE). These four accounts encompass all significant effects of plan implementation, including economic, socioeconomic, and environmental effects that must be considered in water resources planning. Effects of the recommended plan in the four evaluation accounts are displayed in Table 5-2.

Table 5-2. Evaluation of the Recommended Plan

Evaluation Accounts	Recommended Plan / NER Plan: Alternative #18 Confluence Levee Removal
National Economic Development Account	
Flood Risk Management	The combined effects of the recommended plan are not anticipated to significantly reduce flood risk in the study area. However, projects are designed to ensure flooding is not made worse for people, property, or infrastructure in the study area.
Commercial Navigation	No significant difference expected between with- and without-project conditions.
Recreation	A marginal improvement is expected between with- and without-project conditions.
Commercial/Recreational Fishing	A marginal improvement expected between with- and without-project conditions.
Regional Economic Development Account	Improvement to the health of the Skokomish River will support local-based recreation, fishing, and tourism businesses. Additional RED benefits are associated with job creation and income during construction of the project.
Environmental Quality Account	Refer to 4.4, 4.5, and 4.6 for a discussion of ecological, cultural, and aesthetics attributes.
Other Social Effects Account	Opportunities for participation of affected groups were provided in each phase of the planning process.

5.3 Design and Construction Considerations

The study team has taken a risk-based approach to the level of design developed in the feasibility phase. The designs included in this FR/EIS (Appendix H) are detailed enough to support certifiable cost estimates and defensible Section 902 cost limit. The study team has identified the necessary studies and data collection to be performed during PED phase to manage specific risks and uncertainties. A full description of each site, proposed construction features, risk/uncertainty, and additional studies to be completed in PED appears in Appendix H.

The study team coordinated with the relevant natural resource agencies during feasibility-level design phase, which commenced after release of the Draft FR/EIS and the Agency Decision Milestone. This coordination process began with a meeting to present preliminary designs to representatives from USFWS, NMFS, WDFW, and the Bureau of Reclamation as well as the non-Federal sponsors. Following the meeting, the Corps sought further input from these agencies as the designs were refined. The Corps incorporated recommendations from the natural resource agencies into the feasibility-level designs presented in Appendix H. Some of these recommendations included planting species and spacing,

ensuring designs avoid fish stranding, using established roads and open areas for access and staging and avoiding vegetation removal, and to increase the size of the large wood structures from what was proposed in the conceptual designs.

In addition to coordination with natural resource agencies, the study team and non-Federal sponsors met with landowners during the feasibility-level design phase. As described in Section 3.10, landowner input during the feasibility-level design phase led the study team to remove increments from the tentatively selected plan based on insurmountable real estate or access issues that had not manifested earlier in the analysis. The Corps and non-Federal sponsors will continue to coordinate with landowners as designs are finalized in the PED phase.

5.4 Fish and Wildlife Coordination Act Considerations

Compliance with the Fish and Wildlife Coordination Act (FWCA) is documented in Chapter 6. The Draft Coordination Act Report includes several recommendations from USFWS for minimizing negative effects and maximizing restoration benefits. USFWS pointed out the following recommendations the Corps should address during project design:

- Any remaining sections of Confluence Levee and the other levee breach/removal increments may pose a stranding risk to fish; therefore, all of the levee material should be removed.
- LWD installations can have unintended consequences of locking a channel in place preventing natural migration.
- A planted riparian buffer is critical to the success of added productivity.
- The recommended plan should include effort toward returning the river to its reference condition of island-braided morphology.
- The Corps should either collect sufficient data to show benefits outweigh the impacts of excavation at Hunter Creek mouth, or remove this project component from the plan.
- The Corps should evaluate whether the areas proposed for floodplain restoration at Grange and River Mile 9 could be expanded to facilitate natural channel migrations and riverine processes.

The Final Coordination Act Report confirms that the Corps considered all of the recommendations during feasibility level design phase. To further incorporate advice from the natural resource agencies into designs, the Corps held an interdisciplinary design coordination meeting inviting the design team, USFWS, WDFW, NMFS, Reclamation, WDOE, and the local sponsors on September 23, 2014. In the months following this meeting, the Corps sought further advice from the natural resource agencies on best practices and methods for installations of LWD and methods for diversion and care of water during construction. It was determined that most of these decisions are highly dependent on site-specific conditions and would need to be determined as detailed designs are developed in the PED phase. The Corps evaluated the risk of fish stranding at the wetland restoration sites in which agricultural berms will be strategically breached but not completely removed. The Corps concluded that the wetland embankments that will be constructed will not only serve the purpose of restoring and improving wetland habitat, but would also prevent fish stranding for most of the moderate winter storms. In addition, the Corps evaluated whether these areas could be expanded by moving the alignment of the

wetland embankments landward away from the river. At this time, landowners are willing to allow only portions of properties to restore wetland conditions, but not their entire properties.

The design for Confluence Levee is to remove all levee material down to the natural grade at this site. Regarding LWD installations, the Corps will use design assistance from technical experts to maximize benefits and avoid inappropriate design given the reach being restored. The Corps will re-plant all areas of the riparian zone that are disturbed or excavated during construction; plantings will include native shrubs and conifers. Regarding a braided-island plan form, during feasibility-level design phase, the Corps incorporated bar-apex logjams into the Upstream LWD project component, which are anticipated to assist with this type of habitat formation. The design for the wetland restoration increments at River Mile 9 and Grange is to breach the agricultural berms at strategic locations based on the direction of water flow and to construct new wetland embankments for longer periods of inundation in which fish stranding risk would be evaluated and minimized. These wetland embankments will contain moderate winter storms that would otherwise escape as sheet flow across the valley to the south valley wall. By retaining these river flows on the wetland restoration sites, the areas will experience geomorphic change and potentially develop highly valuable side channel habitat that would remain connected to the mainstem of the river. Excavation at Hunter Creek mouth was eliminated during the feasibility-level design phase.

The Final Coordination Act Report included a final recommendation regarding Increments #28 and #37, which are the Wetland Restoration at Grange and River Mile 9. At the time of coordination with USFWS for the Final Coordination Act Report, Alternative #11 was the selected plan. After receipt of the Final Coordination Act Report, the Corps re-evaluated these wetland restoration increments and selected Alternative #18 as the Recommended Plan, which now includes the wetland restoration increments and is better aligned with recommendations from USFWS.

5.5 Real Estate Considerations

Approximately 105 parcels of varying sizes and public/private ownership lie within the project footprint of the recommended plan. Based on the Gross Appraisal, dated February 4, 2015, the real estate values for the affected lands of the project total \$1,467,000 (not including contingency).

As discussed in Section 5.11.1, the primary non-Federal Sponsors for the project are Mason County and the Skokomish Indian Tribe. The Washington State Department of Natural Resources (WDNR) has also indicated their willingness to be a co-signer of the Project Partnership Agreement (PPA) for the sole purpose of providing the Skokomish riverbed land (RM 9-11) in fee. As a result, the realty interests identified for the required project lands consist of standard estates, i.e., Fee Simple, Perpetual Road Easement, Channel Improvement Easement, and Temporary Work Area Easement.

5.6 Cost Estimate

Based on October 2014 price levels, the estimated total project first cost is \$19,343,000, which includes monitoring costs of \$374,000 and adaptive management costs of \$127,000. The fully funded cost estimate to the midpoint of construction is \$21,712,000. In accordance with the cost share provisions in Section 103(c) of WRDA of 1986, as amended {33 U.S.C. 2213(c)}, the Federal share of the total project cost is estimated to be \$12,573,000 and the non-Federal share is estimated to be \$6,770,000, which

equates to 65% Federal and 35% non-Federal. The non-Federal costs include the value of lands, easements, rights of-way, relocations, and dredged or excavated material disposal areas (LERRD) estimated to be \$1,687,000, or 9% of total project cost. Table 5-3 outlines the project first costs of the recommended plan.

Table 5-4 displays the cost share of the recommended plan.

Table 5-3. Recommended Plan Cost Summary (October 2014 price level)

	Total Estimated First Cost (October 2014 price level)
Construction Item	
01 Lands & Damages (LERRD)	\$1,687,000
Elements	
06 Fish & Wildlife Facilities	\$12,806,000
06 Monitoring	\$374,000
06 Adaptive Management	\$127,000
<i>Subtotal</i>	\$14,994,000
30 Planning, Engineering and Design (PED)	\$2,545,000
31 Construction Management	\$1,804,000
Total Estimated Cost	\$19,343,000

Table 5-4. Project Cost Share of Recommended Plan (October 2014 price level)

	Federal (\$1,000s)	Non-Federal (\$1,000s)	Total (\$1,000s)
Ecosystem Restoration			
Lands & Damages		\$1,687	\$1,687
Fish & Wildlife Facilities	\$12,806		\$12,806
Monitoring & Adaptive Management	\$501		\$501
Planning, Engineering & Design	\$2,545		\$2,545
Construction Management	\$1,804		\$1,804
Cash Contribution/Reimbursement	(\$5,083)	\$5,083	\$0
Total Project Cost Share	\$12,573	\$6,770	\$19,343
Total Project Cost Share (%)	65%	35%	100%

5.7 Monitoring and Adaptive Management*

The Corps' Implementation Guidance for Section 2039 of the Water Resources Development Act (WRDA) of 2007 defines monitoring as "the systematic collection and analysis of data that provides information useful for assessing project performance, determining whether ecological success has been achieved, or whether adaptive management may be needed to attain project benefits" (USACE 2009a). Even the most strategically planned restoration actions can yield unexpected results. Monitoring

includes documenting and diagnosing these results especially in the early, formative stages of a project, providing information useful for taking corrective action. In this way, monitoring reduces the risk of failure and enables effective, responsive management of restoration actions.

The Monitoring and Adaptive Management Plan (Appendix E) provides a plan for evaluating the effectiveness of proposed restoration actions and for developing corrective actions if management measures are not meeting performance metrics. At the state of project planning during which the monitoring plan was written, the tentatively selected plan that went through feasibility-level design was used for the description of monitoring methods and potential adaptive management efforts. Refinements can be made during the PED phase concerning the exact project features, monitoring elements, and adaptive management opportunities. Proposed monitoring protocols follow those used in monitoring other restoration projects in Puget Sound and the Pacific Northwest (Heitke et al. 2010, Crawford 2011).

Effectiveness monitoring provides data to determine whether projects are meeting their objectives. The Corps will use decision criteria to evaluate project performance for the degree of success, or for the need for corrective actions. Details and uncertainties will be addressed in PED phase, and refinements can be made to this monitoring and adaptive management plan, including a revised cost estimate.

The plan outlines a 10-year monitoring period per guidance associated with the Water Resources Development Act of 2007. As described in Section 5.12, there is residual risk of channel migration beyond a 10-year period after construction. To maintain ecological performance after the initial 10-year monitoring and adaptive management period, LWD structures and/or minor channel excavations could be used to maintain the South Fork diversion and an actively flowing channel. In addition, LWD structures could also be used to supplement habitat in the river. These types of activities could supplement the scope of the monitoring and adaptive management plan and could be presented in a long-term monitoring and adaptive management plan. However, any additional monitoring required beyond 10 years will be a non-Federal responsibility. The Corps will continue to provide recommendations for monitoring and adaptive management timeline, activities, and budget with the cost-sharing non-Federal sponsors as needed.

5.8 Summary of Cumulative Effects of the Recommended Plan (Agency Preferred Alternative)*

The overall cumulative effects of the recommended plan would be synergistic benefits to all aquatic species through process-based restoration in the lower Skokomish River. The benefits of increasing the number and size of in-channel pools, placing enough LWD to mimic quantities in nearby more natural rivers, reconnecting aquatic habitats in the adjacent floodplain, and greatly increasing the acreage of riparian zones and wetlands along the river will provide significant benefits to fish and wildlife habitat, especially for salmon species. As an indicator species in Pacific Northwest ecosystems, the Corps assumes benefits to salmon would accrue for all other fish, wildlife, and plants in the study area. A synergistic effect is expected because salmon are also a keystone species that over 100 other fish, wildlife, and invertebrate species benefit from directly. These benefits would combine with the more than 1,000 acres of restored estuarine habitat at the downstream end of the study area, as well as the improving forested habitat in the upper watershed; the estuarine and upper watershed restoration

actions are led by other local, State, or Federal entities and complement the Corps' preferred alternative. The reach of river proposed for restoration in this feasibility study is a critical link between these habitats.

5.9 Summary of Environmental Consequences*

The following sections summarize the analysis provided in Chapter 4 on the potential environmental effects from implementation of the recommended plan (agency preferred alternative).

5.9.1 Unavoidable Adverse Environmental Effects

To facilitate the construction of all of the proposed restoration measures of the recommended plan, some adverse environmental effects, most only temporary, could occur within the project area. The following list summarizes adverse environmental effects that are more fully described in Chapter 4:

- Temporary, minor, and localized degradation of water quality from increases in turbidity during in-water work.
- Temporary, minor disturbance to fish and aquatic insects through increased turbidity and construction activity in the water.
- Temporary clearing of upland and riparian vegetation for access and staging areas.
- Fill of up to 5 acres of wetland where wetland embankments are constructed, which is offset by a net gain of 51 acres of wetlands by these increments; plus another 1 acre of disturbance to wetlands for the Side Channel Reconnection inlet
- Temporary and localized disruptions to traffic caused by construction vehicle access to worksites.

5.9.2 Irreversible and Irretrievable Commitment of Resources

The environmental analysis includes identification of "any irreversible and irretrievable commitments of resources, which would be involved in the preferred alternative should it be implemented." This clause in NEPA refers to the use of nonrenewable resources and the effects that the use of these resources have on future generations. Irreversible effects primarily result from use or destruction of a specific resource (e.g., energy and minerals) that cannot be replaced within a reasonable period. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored because of the action (e.g., extinction of a species or the disturbance of a cultural site).

As an ecosystem restoration project, the proposed Federal action is designed to have little or no irreversible and irretrievable commitment of resources. The recommended plan would result in an irreversible use of fossil fuels to execute the construction of the habitat restoration. Machinery types were estimated during the cost estimate work for the alternatives analysis and these are listed in Table 4-3 in Chapter 4. All construction effects are assumed to be short-term reductions in fish, aquatic insect, and plant resources, which would recover their abundances in a relatively short period.

5.9.3 Relationship between Short-Term Uses and Long-Term Productivity

Chapter 4 of this document evaluates the direct, indirect, and cumulative effects that could result from the alternatives. The environmental analysis also looks at the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity. For the

recommended plan, “short-term” refers to the temporary phase of construction of the proposed project, while “long-term” refers to the 50-year period of analysis of the proposed project and beyond.

Construction of the recommended plan would result in minor, short-term construction-related impacts within small parts of the project area and would include to some extent interference with local traffic, minor limited air emissions, and increases in ambient noise levels, negligible disturbance of fish and wildlife, and increased turbidity levels. These impacts would be temporary and would occur only during construction, and are not expected to alter the long-term productivity of the natural environment.

The recommended plan would enhance the long-term productivity of the natural communities throughout the study area by facilitating the growth and productivity of riparian zones and wetlands and the invertebrates, fish, and wildlife that use these habitats. The recommended plan would improve the critical habitat limiting factors for salmonids. Benefits to fish populations would have long-term benefits for recreational and tribal fishing in the study area. Long-term beneficial effects of the recommended plan would vastly outweigh the short-term impacts caused by construction activities.

5.9.4 Areas of Controversy and Unresolved Issues

The recommended plan has no unresolved issues that must be addressed prior to construction. A significant proportion of public comments submitted at the public scoping meeting indicated that flood risk reduction is a major concern for Skokomish Valley residents. Since that time, an unfavorable cost-benefit analysis led to removal of the flood risk management portion of the feasibility study. Valley residents continue to request government action to alleviate flooding problems in the valley. The proposed Federal action and alternatives analyzed in this FR/EIS focus only on the ecosystem restoration problems and opportunities.

As described in Section 3.10, landowner input during the feasibility-level design phase led the study team to remove increments from the tentatively selected plan based on insurmountable real estate or access issues that had not manifested earlier in the analysis. While landowners are generally supportive of the remaining increments included in the recommended plan, the Corps and non-Federal sponsors will continue to coordinate with landowners as designs are finalized in the PED phase.

5.10 Mitigation for Adverse Environmental Effects*

No compensatory mitigation is included in the recommended plan as none is required. This section summarizes efforts to avoid and minimize the minor effects of the proposed construction. Implementation of the recommended plan would involve three ecosystem restoration sites with only minor construction activities in the aquatic environment, primarily for temporary culvert installation for access. Each of the proposed sites would have negligible, short-term construction related effects. All of these minor and temporary effects can be avoided and minimized through construction designs and standard best management practices (BMPs). Specific measurable and enforceable measures would be developed for each site based on the specific effects of the project. The Corps would require construction contractors to adhere to BMPs to protect water quality. Standard construction stormwater BMPs can be incorporated into site designs, operational procedures, and physical measures on site. There are no legal requirements to mitigate for GHG emissions; however, BMPs are available for fuel and material conservation during construction.

5.11 Implementation Requirements and Permits

The following sections outline the requirements for implementation of the recommended plan.

5.11.1 Non-Federal Sponsor

Mason County and the Skokomish Indian Tribe are the cost-sharing non-Federal sponsors of the study. Both sponsors have provided letters of reaffirmation indicating their support of the recommended plan, as well as statements of financial capability to partner with the Corps in PED and construction activities. The Corps will request additional letters of intent prior to execution of a design agreement (DA) and project partnership agreement (PPA).

The Washington State Department of Natural Resources (WDNR) claims ownership of the riverbed for River Mile 9-11 of the Skokomish River. As a result, WDNR has indicated that they will be a co-signatory of the PPA for the sole purpose of providing aquatic lands associated with the Upstream Large Woody Debris project increment.

5.11.2 Institutional Requirements

The schedule for project implementation is dependent on project authorization. After project authorization, the project would be eligible for construction funding. The project would be considered for inclusion in the President's budget based on national priorities, magnitude of the Federal commitment, economic and environmental feasibility, level of local support, willingness of the non-Federal partner to fund its share of the project cost, and the budget constraints at the time of funding. Once Congress appropriates Federal construction funds (earliest anticipated fiscal year is 2017), the Corps and the non-Federal partner(s) would enter into a DA and eventually a PPA. The DA would define the Federal and non-Federal responsibilities for completion of final designs for the project. The PPA would define the Federal and non-Federal responsibilities for implementing, operating, and maintaining the project.

5.11.3 Operation, Maintenance, Repair, Rehabilitation, and Replacement Requirements

After completion of construction, the non-Federal sponsor(s) will assume O&M responsibility for the entire project footprint. The non-Federal sponsor is responsible for all long-term project operations, maintenance, repairs, replacements, and rehabilitations following completion of construction. O&M costs have been estimated for the base measure and increments recommended in the proposed plan.

Aiming for process-based restoration, in which human-made stressors are removed from the landscape, has an inherent goal of no O&M costs. The features included in the recommended plan are intended to be environmentally self-sustaining. The recommended plan does not require specific channel forms or habitats to be maintained over the project life, thus avoiding the need for frequent O&M to correct minor changes. Based on feasibility-level designs and associated modeling, it is assumed that the recommended plan will require minimal maintenance only (approximately \$10,000 per year) with O&M activities focusing on minor inspection of the upstream LWD features and periodic maintenance of the wetland embankments at the River Mile 9 and Grange wetland restoration sites. As described in Section 4.3.1.2 and 4.3.3.2, the combined discharges of the North and South Forks would be enough water to provide continuous surface flows during the late summer low flow period. It is anticipated that the new

channel will aggrade, eventually meandering across the floodplain. This natural meandering process will develop a complex series of stream habitats that will be beneficial to salmon and other fish. This base is designed to work with natural river processes (including aggradation) to provide habitat benefits. As described in Section 5.12 below, future aggradation is not expected to be detrimental to project goals; therefore, it is anticipated that limited O&M will be required to maintain the new combined North Fork/South Fork channel near the confluence levee removal as well as the reconnected wetland areas. Detailed O&M manuals will be developed for each site during the PED phase.

5.11.4 Schedule

The Corps will officially request the non-Federal partner(s) to acquire the necessary real estate immediately after the signing of the PPA. The advertisement of the construction contract will follow the certification of the real estate. The final acceptance and transfer of the project to the non-Federal partner(s) will occur after delivery of an operations and maintenance manual and as-built drawings.

5.12 Risk and Uncertainty

The PDT has used a risk and uncertainty-based strategy in their approach to formulating the project from the early stages of the study. Risks and uncertainties associated with the formulation of alternatives, development of conceptual designs and cost estimates, quantification of environmental benefits, and assumptions associated with selection of a recommended plan are captured in the study's risk register. Key risks or uncertainties associated with the recommended plan include the following, along with the strategy to reduce risk as the study continues:

Quantities for Wetland Embankment Measures

Risk and Cause: Given the results of the supplemental cost effectiveness and incremental cost analyses performed for the two wetland embankment sites at River Mile 9 and Grange (summarized in Section 3.7.4), it is likely that the optimum embankment height necessary to achieve the ecosystem restoration function falls within the range of heights between a small-scale (average height of 2-4 feet) increment and original recommended plan (average height of 5-6 feet) increment. The elevation change for the embankment increments of 2 to 3 feet, on average, between the current recommended embankment height and the lower scale embankment height is within the margin of error of the existing terrain data used to develop the embankment heights.

Evaluation: The Cost Schedule Risk Analysis (CSRA) for the project has identified risks associated with the variability in existing survey/LIDAR data with varying resolution (ranging approximately 6 to 10 feet depending on location and density of vegetative cover). Cost contingencies reflect the uncertainty in optimized wetland embankment height, quantities of material required for construction, and PED costs to include additional survey and hydraulic analysis to refine the size and scale of the measures.

Future Risk Management: Additional survey data and LIDAR will be obtained during the PED phase. Additional hydraulic modeling will also be conducted to refine the optimum embankment elevations to achieve the desired ecosystem functions. PED costs include estimates for both

obtaining new survey data and performing necessary engineering analysis to refine the wetland embankment elevation.

Aggradation and Future Channel Migration

Risk & Cause: Sediment deposition is one of the key considerations for project sustainability. Sediment deposition is expected to continue to aggrade the channels of the mainstem and South Fork Skokomish Rivers, as sediment is transported to the lower rivers throughout the project life. Future aggradation may cause channel migration in the study area.

Evaluation: The study team completed 2-dimensional hydraulic modeling of the entire study area, 1-dimensional sediment transport modeling of the confluence area, and sediment transport analysis of the reconnected wetland areas during feasibility-level design.

Results: As described in Section 4.3.2.2., deposition in the combined North Fork/South Fork channel is expected to be around 0.1 foot/year, which is similar to that in the existing South Fork channel. Over time, the channel is expected to aggrade and meander across the 1,000 to 2,000 foot wide northern floodplain. Spreading deposition across the northern floodplain would reduce the initial deposition rate, resulting in a long term deposition rate of approximately 0.02 foot/year (or approximately 1 foot during the 50-year project life). This would result in an active riverbed 2-4 feet lower than the existing South Fork channel at the end of the 50-year period. Over a long-term analysis (10-50 years), the natural migration of the new channel will renew channel habitats and recruit new LWD to the channel. This natural meandering process will develop a complex series of stream habitats that will be beneficial to salmon and other fish.

As described in Section 5.11.3, the confluence levee removal aims to provide year-round fish passage by removing a human-made stressor (the Confluence Levee) from the river. The goal of this action is to provide a continuous flowing channel that will evolve naturally over time. No specific channel forms or habitats are required to be maintained over the project life. Only minimal O&M is expected to be required because 1 foot, or even 2 feet, of sediment accumulation will not cause the river to move away from the new mainstem channel as the existing South Fork riverbed will remain 2-4 feet above the new channel. For this area, the likelihood of unacceptable deposition occurring was determined to be low or none.

The Confluence Levee removal would greatly reduce the risk of the avulsion to the south near RM 9. To further reduce this risk, a large levee could be constructed along the south side of the river between RM 7 and 11. The levee would confine the river to the new mainstem channel, regardless of rate or amount of sediment deposition. However, this would result in a large takings area due to the transfer of floodwaters within the Skokomish Valley and would not achieve the process-based restoration goals established by the study team. Thus, inclusion of a large levee as a feature to minimize risk of future aggradation or channel migration is not recommended.

Maintenance to include sediment removal is not anticipated to be required at the Grange or River Mile 9 Wetland Restoration sites. The majority of bedload (i.e. gravel, cobbles, and boulders) will pass through the diversion to the re-connected North and South Forks, thereby bypassing the reach

where the proposed wetland restoration sites are located. The probability of aggradation resulting from movement of fine material (i.e., smaller than gravel, cobbles, and boulders) into the re-connected wetland areas at Grange and River Mile 9 is very low; 2D modeling indicates that flows will keep these fine sediments mobile, reducing the likelihood of aggradation in the wetland restoration areas.

The Side Channel Reconnection inlet is elevated above the riverbed to avoid the bedload transport. There may be some suspended sediment deposition near the side-channel entrance, but this should require only infrequent O&M action, which is accounted for in the existing O&M estimate (approximately \$10,000 per year).

Summary: Even with continued sediment accumulation, the study team has determined that residual risk to long-term accrual of environmental benefits associated with the recommended plan within the study area is low. In addition, the risk of an avulsion to the south near RM 9 is greatly reduced in the with-project condition.

Future Risk Management: Monitor the project; implement adaptive management strategies as needed.

Landowner Willingness

Risk & Cause: There may be unwilling landowners located within the project footprint.

Future Risk Management: Continue formal and informal landowner outreach; refine construction footprints based on real estate needs.

Cushman Dam Settlement Agreement / Future Actions Required of Tacoma Power

Risk & Cause: Based on future technical and procedural findings, Tacoma Power may be required to implement restoration or flood risk management actions within the Corps' study area in the future. Because these actions have not been identified or determined to be necessary, and are not specifically described, the future with-project condition and future without-project condition remains somewhat uncertain.

Evaluation: The assumptions for project conditions are described in this report and will be revisited as future actions by Tacoma Power are confirmed (refer to Sections 2.6 and 4.2 for additional information regarding the Cushman Dam Settlement Agreement).

Summary: Potential future action(s) taken by Tacoma Power as the result of technical and procedural findings are not likely to negatively impact the success or function of the recommended plan, as Tacoma Power is required to seek comments and recommendations from the Corps to ensure that any future actions will be complementary to the recommended plan and will not affect the success or benefits accrued from the Federal (Corps) project. Additionally, provisions in the Cushman Settlement limit the financial obligations for future action by Tacoma Power, so future activities would likely be smaller in scale and have only localized effects that are not expected to negatively affect the recommended plan.

Future Risk Management: Continue close coordination with the Skokomish Indian Tribe and Tacoma Power.

5.13 Complementary Restoration Actions for Local Implementation

There is a strong, united effort by Federal, State, and local agencies as well as the Skokomish Indian Tribe for restoration of the Skokomish River Basin. Various Federal and State agencies as well as local entities are working within their individual authorities and within specific areas of the Basin to implement restoration activities throughout the upper and lower watersheds. Section 4.2 outlines present and future actions to restore the Skokomish River Basin; these actions are compatible with the Corps' recommended plan and capture synergies associated with process-based restoration.

Through ongoing collaborations, the Corps and non-Federal sponsors have continually reviewed all potential options for restoration work across the entire basin. This collaboration and coordination among the Corps, Mason County, Skokomish Indian Tribe, and key stakeholders/landholders will continue to ensure any future proposed actions will not negatively affect the recommended plan. The Corps and non-Federal sponsors are continuing to coordinate both formally and informally to ensure the sustainability of all proposed restoration projects within the Skokomish River Basin. To ensure the sustainability of the recommended plan, best practices have (and will continue to be) encouraged and/or required. For example, modern State and Federal forestry regulations require environmentally sound logging practices that will limit any adverse impacts to the recommended plan. The Cushman Settlement Agreement provides a new flow regime intended to improve the North Fork and main stem environments and does not contain any provisions that would reduce the benefits of the recommended plan. Project landowner agreements will also contain provisions to support the sustainability of the recommended plan. The Corps and Non-Federal sponsors will continue to assess the applicability of legal and policy mechanisms (e.g., memoranda of understanding) and will seek to implement these types of mechanisms if applicable in the future.

In addition to the proposed present and future restoration projects outlined in Chapter 4, the study team, non-Federal sponsors, local and regional stakeholders, and the public identified approximately 60 specific sites within the study area where one or more measures could address various limiting factors. As Section 3.3 describes, sites were selected based on locations of severe degradation, physical features that will provide an opportunity to improve types of degradation, access, and consideration of other complementary proposed projects outside the range of the feasibility study. These proposed projects are generally smaller in scale and could be easily implemented by a local entity. These projects are generally compatible with the Corps' recommended plan and further restore the structures, functions, and processes of the Skokomish River. Members of the Corps PDT will continue to be available to Mason County and the Skokomish Indian Tribe to ensure any proposed actions will not adversely affect the Federal investment in restoration of the Skokomish River Basin.

Finally, the recommended plan is one element of an integrated restoration effort in the entire Skokomish River watershed. The recommended plan recommends restoration of the lower Skokomish River, which is complementary to, yet independent from, restoration actions in the upper watersheds (the Upper South Fork and North Fork) and estuary. Attainment of benefits associated with the

recommended plan is not dependent on restoration activities led by the USFS in the Upper South Fork. Similarly, implementation of proposed flow regimes at Cushman Dam, construction of fish passage facilities or hatcheries in the North Fork, or other activities required by the Cushman Settlement are independent of the Federal action, but will complement the recommended plan. The synergistic efforts of those involved in restoration of the entire Skokomish River watershed will produce positive, cumulative effects across the Basin.

6. Compliance with Environmental Statutes

This chapter provides documentation of how the recommended plan (agency preferred alternative) complies with all applicable Federal environmental laws, statutes, and executive orders.

6.1 National Environmental Policy Act

The National Environmental Policy Act (NEPA) (42 U.S.C. §4321 et seq.) commits Federal agencies to considering, documenting, and publicly disclosing the environmental effects of their actions. NEPA documents must provide information regarding the proposed action and alternatives, the environmental impacts of the alternatives, appropriate mitigation measures, and any adverse environmental impacts that cannot be avoided if the agency implements the proposal. Agencies are required to demonstrate that decision makers have considered these factors prior to undertaking actions, which is documented in signing a Record of Decision for Environmental Impact Statements such as this one. The FR/EIS is the primary vehicle to achieve NEPA compliance for the proposed project. Before preparing the Draft FR/EIS, the Corps published a Notice of Intent to prepare an EIS in the Federal Register on 24 September 2010, and held a public scoping meeting 7 October 2010. The Corps published the Draft FR/EIS for a 45-day public comment period that ran from February 21 through April 7, 2014. All public comments received appear with Corps responses in Appendix M. Following publication of this Final version of the FR/EIS and a 30-day wait period, the Assistant Secretary of the Army for Civil Works will sign a Record of Decision, while the Chief of Engineers will sign the Corps-required Chief's Report.

6.2 Endangered Species Act of 1973

The Endangered Species Act (ESA) (16 U.S.C. §1531-1544), Section 7(a) requires that Federal agencies consult with the NMFS and USFWS, as appropriate, to ensure that proposed actions are not likely to jeopardize the continued existence of endangered or threatened species or to adversely modify or destroy their critical habitats. The Corps coordinated with NMFS and USFWS to ensure the protection of those threatened and endangered species under their respective jurisdictions and to anticipate potential negative effects that may result from the project.

The proposed Federal action is compliant with ESA based on two separate Programmatic Biological Opinions. Project designs incorporate all necessary components to comply with the requirements of the Programmatic Biological Opinion for Fish Passage and Restoration Projects (FPRP) issued in 2008. For species under the jurisdiction of USFWS, the Corps submitted a Specific Project Information Form and received a verification letter on February 20, 2015 that the project is compliant with the FPRP Biological Opinion.

For species under the jurisdiction of NMFS, approval authority is granted to the State of Washington in the ESA Section 4(d) Rule, Limit 8 Programmatic Biological Opinion (See Appendix L for approval authority) for projects in the State's Habitat Restoration Program (HRP). The Corps received a letter from NMFS dated February 3, 2015 confirming their approval of the HRP under the ESA Section 4(d) Rule, Limit 8, as administered by the Washington Recreation and Conservation Office (RCO). NMFS also stated their agreement that the project fits within the HRP. The Corps certifies that the project is

consistent with all of the elements of the Habitat Restoration Program 4(d) Rule, Limit 8 Programmatic Biological Opinion and communicated this to the Washington Recreation and Conservation Office. The project occurs within the Puget Sound Salmon Recovery Region covered in this Biological Opinion, and the proposed Federal action is listed in the Mid Hood Canal Chinook Recovery Planning Chapter of the Puget Sound Salmon Recovery Plan. The Corps received a letter from the Washington Recreation and Conservation Office on February 17, 2015 providing their approval of the project's ESA coverage under the 4(d) Limit 8 Programmatic Biological Opinion. See Appendix L for compliance documents.

6.3 Clean Water Act of 1972

The project is in compliance with the Clean Water Act.

Section 401 – Any project that requires a Federal license or permit, which may result in any discharge into waters of the United States or wetlands, or mechanized clearing of wetlands, requires a water quality certification from the State agency or from EPA. For the Upstream LWD, Confluence Levee removal, wetland restoration sites with construction of wetland embankments, and the inlet channel of the Side Channel Reconnection components of the recommended plan, WDOE has Section 401 authority. The outlet channel of the Side Channel Reconnection project component is entirely on Skokomish Indian Tribe reservation land and is therefore under the jurisdiction of EPA.

This project will have approximately 6 acres of wetland fill and vegetation disturbance to construct the new wetland embankments at the wetland restoration sites at Grange and River Mile 9 and to excavate the inlet channel at the Side Channel Reconnection. Individual Section 401 review is required for the Corps to obtain a 401 Water Quality Certification.

The Corps coordinated the feasibility level design of all project components with WDOE including via meeting invitations, e-mail consultations for construction methods to protect water quality, and a site visit to determine extent of wetland impacts. The feasibility-level designs include standard BMPs to protect water quality and these are accounted for in the cost estimate. Based on experience with the standard methods in the proposed design, there is no expectation for costs of water quality protection to substantially increase due to any conditions that may appear in the 401 certification. All proposed construction components and methods are standard ecosystem restoration methods used in Pacific Northwest ecosystems.

The Corps verified with WDOE that all standard project design documentation (e.g. NEPA document, 95% design drawings, water quality monitoring plan) are required for their review to certify that State water quality standards will not be violated. The Corps will continue to coordinate project designs with WDOE and provide all necessary documentation to WDOE and EPA as it is developed during PED phase. These documents will be prepared in advance of finalizing PED, which will ensure that the Corps obtains Section 401 Water Quality Certification from both agencies well in advance of signing the Project Partnership Agreement. All applicable water quality standards will be met.

Section 402 – The National Pollutant Discharge Elimination System (NPDES), controls discharges into waters of the United States. NPDES permits contain industry-specific, technology-based, and/or water-quality-based limits, and establish pollutant monitoring and reporting requirements. EPA has established

a program to address stormwater discharges. These regulations require that facilities or construction sites with stormwater discharges from a site that is one acre or larger apply for an NPDES permit.

The proposed Federal action will have greater than one acre of temporary clearing for construction and will therefore require obtaining a Section 402 NPDES permit. The Corps will fulfill this obligation by obtaining a Construction General Stormwater Discharge Permit during PED phase prior to construction when the site-specific environmental protection plans are developed. These plans include a Diversion and Care of Water Plan, Spill Prevention and Clean-up Plan, and a Temporary Erosion and Sedimentation Control Plan. The Section 402 permit requires identification of the Certified Erosion and Sedimentation Control Lead personnel, which is not identified until immediately prior to construction and is therefore not available in feasibility phase.

Section 404 – The Corps administers regulations under Section 404(b)(1) of the Clean Water Act, which establishes a program to regulate the discharge of dredged and fill material into waters of the U.S., including wetlands. The Corps has evaluated potential project-induced effects subject to these regulations during feasibility-level design. Appendix L includes a completed 404(b)(1) evaluation.

6.4 Coastal Zone Management Act of 1972

The Coastal Zone Management Act (CZMA) of 1972 as amended (16 U.S.C. §1451-1464) requires Federal agencies to carry out their activities in a manner that is consistent to the maximum extent practicable with the enforceable policies of the approved State Coastal Zone Management Program (CZMP). The aim of the act is to “preserve, protect, develop, and where possible, to restore or enhance the resources of the nation’s coastal zone.” Ecology is the agency in the State of Washington that has an approved CZMP, therefore Ecology has authority for Federal consistency review with the 15 coastal counties. In compliance with State law, Mason County has developed its own Shoreline Master Program under the State Shoreline Management Act. The project is fully consistent with the enforceable polices of Mason County’s Shoreline Master Program. The Corps prepared a CZMA Consistency Determination during feasibility-level design phase according to the relevant county code (see Appendix L).

The Corps will submit the CZMA Consistency Determination to WDOE for their review at the same time as submission of all of the documents required for Clean Water Act Section 401 review. WDOE’s concurrence with the CZMA Consistency Determination is contingent upon receipt of a 401 Water Quality Certification. The Corps will continue coordination with WDOE throughout PED to ensure the project meets requirements for 401 certification as a prerequisite for WDOE concurrence on the CZMA Consistency Determination.

6.5 Clean Air Act of 1972

The Clean Air Act (CAA) as Amended (42 U.S.C. §7401, et seq.) prohibits Federal agencies from approving any action that does not conform to an approved State or Federal implementation plan. Three agencies have jurisdiction over air quality in the project area: EPA, WDOE, and the Olympic Region Clean Air Agency. The EPA sets standards for concentrations of pollutants in outdoor air and the State establishes regulations that govern contaminant emissions from air pollution sources.

The air-pollutant concentrations in the study area are consistently below the National Ambient Air Quality Standards. Mason County (which includes the study area) does not have a non-attainment area. Air quality for the study area is rated 8.8 on a scale of 0 to 10 where 10 is the best indicator of air quality. Proposed action alternatives are predicted to have a negligible contribution to pollutants; however, the effect would be only during construction and would not be expected to exceed the ecological or human tolerance standards, nor change the rating of 8.8. Construction activities associated with the NER plan will create air emissions, but the emissions are not expected to affect implementation of Washington's CAA implementation plan and would have no lasting effect on the study area. The Corps' assessment is that the Recommended Plan will have temporary and minor effects, but no substantial impact.

6.6 National Historic Preservation Act of 1966

The National Historic Preservation Act (NHPA) and its implementing regulations 36 CFR §800 provides a regulatory framework for the identification, documentation, and evaluation of cultural resources that may be affected by Federal undertakings. Under the Act, Federal agencies must take into account the effects of their undertakings on historic properties (cultural resources that have been found to be eligible for listing in the National Register of Historic Places) and afford the Advisory Council a reasonable opportunity to comment on such undertaking. Additionally, a Federal agency shall consult with any tribe that attaches religious and cultural significance to such properties.

To meet the Agency's responsibilities under NHPA, the Corps consulted with the Washington State Historic Preservation Officer (SHPO) and the Skokomish Indian Tribe. In addition, the Corps conducted a cultural resources survey of project components for the TSP. Due to the majority of the project components occurring on privately owned property, the cultural resources survey was only conducted on property where landowners had signed rights of entry. The cultural resources survey conducted in January 2015 did not identify any significant cultural resources. Based on the Corps' internal guidelines for flood control systems and structures, the Corps has determined that the Confluence Levee and the River Mile 9/Grange agricultural berm are not eligible for listing on the National Register of Historic Places (NRHP). Though the Confluence Levee is fifty years of age, this levee is a ubiquitous type of levee and is not distinguished for its engineering value. In addition, the Confluence levee shows clear loss of essential integrity due to loss of linear continuity due to breaches and it is experiencing erosion. While the Confluence levee was built to protect agricultural fields from flooding, this levee did not play a central role in the agricultural development of the Skokomish River Valley. Finally, the Confluence Levee does not provide additional information beyond what is already known.

The Corps has determined a finding of *no historic properties affected* and will require monitoring during construction for the Side Channel Reconnection locations at RM 4 and RM 5.6. The placement of the Upstream LWD will be within the current Skokomish River channel. Proposed access routes currently include private property and will be finalized during PED phase. The Corps will conduct a cultural resources survey when the proposed locations of the Upstream LWD and access routes are finalized in PED. The Corps began consulting with the Washington SHPO in November 2013. At that time, the Corps was in the process of identifying the TSP and invited the SHPO to participate in the preparation of a Programmatic Agreement (PA). At that time, the Corps believed that a PA would be the most

appropriate course of action. Over the course of feasibility-level design development, the Corps had the opportunity to conduct cultural resources fieldwork. On February 9, 2015, the Corps sent a letter to the Washington SHPO that provided project updates, the results of the cultural resources fieldwork and provided the Corps determination of *no historic properties affected* with monitoring required during construction. In addition, the Corps informed the SHPO that future cultural resources surveys will be conducted (if necessary) as the project moves forward for areas where the project will affect private landowners. The SHPO concurred with the Corps determination of *no historic properties affected* in a letter dated February 10, 2015 and requested a draft of the monitoring plan for review prior to the start of construction (Appendix L). In addition, the Corps sent a letter on February 9, 2015 to the Skokomish Indian Tribe that provided project updates and described the results of the cultural resources survey. The Skokomish Indian Tribal Historic Preservation Officer responded by email on February 18, 2015 and concurred that no historic properties would be affected and agreed that construction monitoring should take place (Appendix L).

6.7 Federal Trust Responsibility

The Federal trust responsibility to Native American Tribes arises from the treaties signed between them. Under Article VI, Clause 2 of the U.S. Constitution, treaties with the Tribes are the supreme law of the land, superior to State laws, and equal to Federal laws. In these treaties, the United States made a set of commitments in exchange for tribal lands, including the promise that the United States would protect the tribe's people. The Supreme Court has held that these commitments create a trust relationship between the United States and each treaty tribe, and impose upon the Federal government "moral obligations of the highest responsibility and trust." The scope of the Federal trust responsibility is broad and incumbent upon all Federal agencies. The U.S. government has an obligation to protect tribal land, assets, and resources that it holds in trust for the Tribes, and a responsibility to ensure that its actions do not abrogate Tribal treaty rights.

The Skokomish Indian Tribe has had representation in this feasibility study planning phase as one of the two non-Federal sponsors. The study team anticipates that the proposed ecosystem restoration would have significant benefits to ecosystem and fisheries resources, which are of economic and cultural value to the Tribe, and is consistent with the Tribe's treaty rights.

6.8 Executive Order 13175 Consultation and Coordination with Indian Tribal Governments

Executive Order 13175 reaffirmed the Federal government's commitment to a government-to-government relationship with Indian Tribes, and directed Federal agencies to establish procedures to consult and collaborate with tribal governments when new agency regulations would have tribal implications. The Corps has a government-to-government consultation policy to facilitate the interchange between decision makers to obtain mutually acceptable decisions. In accordance with this Executive Order, the Corps has engaged in regular and meaningful consultation and collaboration with the Skokomish Indian Tribe throughout the course of the study.

6.9 Bald and Golden Eagle Act of 1940

The Bald and Golden Eagle Protection Act (16 U.S.C. §668-668c) applies to Corps civil works projects through the protection of bald and golden eagles from disturbance. Construction activities associated

with the proposed actions have potential to disturb bald and golden eagles due to the presence of heavy machinery and elevated noise levels. The Corps will develop an eagle monitoring plan during the next phase of design, and will minimize construction effects by surveying each site for nests and roosts prior to and during construction, and, if nests and/or roosts are nearby, will coordinate with USFWS. Review of the WDFW database of Priority Habitats and Species showed there are no recorded eagle nesting sites within two miles of the project area.

6.10 Fish and Wildlife Coordination Act of 1934

The Fish and Wildlife Coordination Act (FWCA) of 1934 as amended (16 U.S.C. §661-667e) provides authority for the USFWS involvement in evaluating effects to fish and wildlife from proposed water resource development projects. It requires that fish and wildlife resources receive equal consideration to other project features. It requires Federal agencies that construct, license, or permit water resource development projects to consult with the USFWS, NMFS, and State resource agencies regarding the effects to fish and wildlife resources and measures to mitigate these effects. Section 2(b) requires the USFWS to produce a Coordination Act Report that describes fish and wildlife resources in a project area, potential negative effects of a proposed project, and recommendations for a project. The draft report includes the USFWS positions and recommendations. This draft document and a planning aid letter pursuant to FWCA are in Appendix L. The Corps considered these recommendations and implemented further coordination during feasibility level design phase. The design changes are described in this Final FR/EIS and in the Final Coordination Act Report received from USFWS on February 27, 2015, which appears in Appendix L. Subsequent to receiving the Final Coordination Act Report, the Corps reconsidered USFWS' strong recommendation for the restoration plan with a greater scope and have added the wetland restoration increments back into the plan. Further recommendations will be incorporated during the PED phase.

6.11 Magnuson-Stevens Fishery Conservation and Management Act of 1976

The Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §1801 et. seq.) requires Federal agencies to consult with NMFS on activities that may adversely affect Essential Fish Habitat (EFH). The objective of an EFH assessment is to determine whether the proposed action(s) "may adversely affect" designated EFH for relevant commercial, federally managed fisheries species within the proposed action area. EFH includes those waters and substrate necessary for fish spawning, breeding, feeding, or growth to maturity. The assessment describes conservation measures proposed to avoid, minimize, or otherwise offset potential adverse effects to designated EFH resulting from the proposed action. Although habitat disturbance may have temporary adverse effects to designated EFH for salmonids, the conservation measures that the Corps will include as part of the proposed site design to address ESA concerns have been determined adequate to avoid, minimize, or otherwise offset potential adverse effects to the EFH. The proposed restoration sites would result in long-term benefits to salmonids, but are not anticipated to have any effect on EFH of the coastal pelagic species or groundfish. The Programmatic Biological opinion for ESA Section 4(d) Limit 8 includes the results of the consultation on likely effects on Essential Fish Habitats (EFH) pursuant to Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act. It includes no conservation recommendation. All measures to avoid, minimize, or otherwise offset potential adverse effects to EFH

are already included in the proposed project or as permit conditions. See Appendix L for compliance documents related to ESA Section 4(d) Limit 8.

6.12 Marine Mammal Protection Act of 1972

The Marine Mammal Protection Act (MMPA) of 1972 (16 U.S.C. §1361-1407) restricts harassment of marine mammals and requires interagency consultation in conjunction with the ESA consultation for Federal activities. The preferred alternative would have no effect to marine mammals. In the event that changes in design would affect marine mammals, the Corps would consult with NMFS on effects to marine mammals. The Corps would implement all practicable conservation measures and adhere to a marine mammal monitoring plan as needed.

6.13 Migratory Bird Treaty Act of 1918 and Executive Order 13186 Migratory Bird Habitat Protection

The Migratory Bird Treaty Act (16 U.S.C. §703-712) as amended protects over 800 bird species and their habitat, and commits that the U.S. will take measures to protect identified ecosystems of special importance to migratory birds against pollution, detrimental alterations, and other environmental degradations. EO 13186 directs Federal agencies to evaluate the effects of their actions on migratory birds, with emphasis on species of concern, and inform the USFWS of potential negative effects to migratory birds. Implementation of the preferred alternative will not have any negative effects to migratory bird habitat. Neo-tropical migratory birds that use the forested riparian zone in the river corridor will benefit from any levee removal actions that increase the forested area adjacent to the river. The Corps will continue to coordinate with USFWS through the PED phase.

6.14 Wild and Scenic Rivers Act of 1968

The Wild and Scenic Rivers Act (Public Law 90-542; 16 U.S.C. 1271 et seq.) establishes a National Wild and Scenic Rivers System to preserve, protect, and enhance the wilderness qualities, scenic beauties, and ecological regimes of rivers and streams. Any construction within 100 feet of a scenic stream requires a scenic streams permit. Four sections of the South Fork Skokomish River are designated as “wild”, “scenic”, or “recreational”; however, these segments are several river miles upstream from the study area. All of the proposed restoration work would occur several miles away in the lower mainstem Skokomish River and would not affect the protected reaches or any aspect of their designations.

6.15 Executive Order 12898 Environmental Justice

Executive Order 12898 directs Federal agencies to take the appropriate steps to identify and address any disproportionately high and adverse human health or environmental effects of Federal programs, policies, and activities on minority and low-income populations. The Corps has analyzed the potential effects of the alternatives on communities in the Skokomish Valley and found that there would be no disproportionately high and adverse human health impacts to any environmental justice communities. Further, the Tribe as a community protected under this Executive Order has been actively engaged in the study and environmental review process.

6.16 Executive Order 11990 Protection of Wetlands

The purpose of Executive Order 11990 is to "minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands". To meet these objectives, the order requires Federal agencies, in planning their actions, to consider alternatives to wetland sites and limit potential damage if an activity affecting a wetland cannot be avoided. The preferred alternative would have the overall effect of enhancing wetlands and increasing their total area in the Skokomish Valley.

6.17 Executive Order 11988

Executive Order 11988 requires Federal agencies to recognize the significant values of floodplains and to consider the public benefits that would be realized from restoring and preserving floodplains. It is the general policy of the Corps to formulate projects that, to the extent possible, avoid or minimize adverse impacts associated with use of the base floodplain and avoid inducing development in the base floodplain unless there is no practicable alternative that meets the project purpose. Per the procedures outlined in ER 1165-2-26 (Implementation of Executive Order 11988 on Flood Plain Management), the Corps has analyzed the potential effects of the recommended plan on the overall floodplain management of the study area. The proposed action is in the base floodplain and there are no practicable alternatives to the action as the entire feasibility study area is within the base floodplain. The public has been advised of the proposed action and the Corps has requested their comments on the recommended plan. Chapter 4 outlines beneficial and adverse effects of the action. A discussion of benefits to natural floodplain values including restoration of fish and wildlife values (e.g., wetlands, marshes, and related natural habitat) is also included in Chapter 4. The action is not likely to induce development in the floodplain, as Mason County already imposes stringent restrictions on development within the study area (refer to Section 2.6 for more information regarding development ordinances). The Corps has recommended the plan that is most responsive to the study's planning objectives and is consistent with the requirements of this Executive Order.

The recommended plan will not cause significant changes in future with-project flood conditions compared to future without-project conditions. Coordination with the Federal Emergency Management Agency (FEMA) is ongoing; the Corps will formally submit a no-rise certificate to FEMA during the PED phase as H&H modeling continues to be refined.

6.18 Farmland Protection Policy Act

Congress passed the Farmland Protection Policy Act (FPPA) because of substantial decreases in farmland acreage. The purpose of the Act is to minimize the extent to which Federal actions contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses. Projects are subject to FPPA requirements if they may irreversibly convert farmland (directly or indirectly) to nonagricultural use and are completed by a Federal agency or with assistance from a Federal agency. None of the farmland in the Skokomish Valley has been designated as prime and unique farmland under the FPPA.

7. Public Involvement, Review, and Consultation

Stakeholders, agencies, and the public are integral in providing input for defining restoration opportunities, objectives, constraints, and for developing restoration strategies that support development of the range of alternatives to be analyzed for feasibility and environmental compliance. Public involvement activities and agency coordination are summarized in this chapter.

7.1 Public Involvement Process

Corps Planning Policy and NEPA emphasize public involvement in government actions affecting the environment by requiring that the benefits and risks associated with the proposed actions be assessed and publicly disclosed. In accordance with NEPA public involvement requirements (40 CFR 1506.6) and Corps Planning Policy (ER 1105-2-100), opportunities were presented for the public to provide oral or written comments on potentially affected resources, environmental issues to be considered, and the agency's approach to the analysis. Efforts to involve the public included a public scoping meeting, soliciting relevant information from the public, holding a number of informal public meetings, and explaining procedures of how interested parties can get information on the planning process.

7.1.1 Public Scoping Meeting

Scoping is a critical component of the overall public involvement program to solicit input from affected Federal, State, and local agencies; tribes; and interested stakeholders. The scoping process provides early and open means of determining the scope of issues (problems, needs, and opportunities) to be identified and addressed in the DFR/EIS. The Skokomish scoping process was conducted jointly with Mason County and the Skokomish Indian Tribe.

To announce the start of the feasibility phase, a Federal notice of intent (NOI) was issued to residents, Federal, State and local agencies, Tribal governments, and interested groups and was published in the Federal Register on September 24, 2010. The recipients were invited to comment on the results of the earlier completed reconnaissance study and to provide input to the feasibility study, including the scoping of the environmental issues that should be addressed throughout the study. The NOI announced a public scoping meeting, which was held on October 7, 2010 at Mason County Public Works, 100 West Public Works Drive, Shelton, Washington. An open house ran from 4:00 p.m. to 7:00 p.m., with a presentation and opportunity for formal public comment at 5:30 p.m. The public scoping meeting aimed to provide an overview of the Skokomish feasibility study, identify project purpose and need, identify preliminary measures, and describe the NEPA process.

During the comment period, the Corps received 28 comments; three comment forms and one photo were submitted during the scoping meeting, nine verbal comments were given during the scoping meeting, eight letters were mailed, and eight email messages were submitted. Comments included several themes, primarily agriculture, aquatic ecosystem restoration/channel restoration, Cushman Dam, flooding, habitat (specific organisms or animals), and sediment management. A complete list of public comments from the scoping period is contained in Appendix M.

7.1.2 Draft Feasibility Report / EIS Public Review

The public comment period, during which any person or organization may comment on the Draft FR/EIS, is mandated by State and Federal laws. For the Skokomish study, the Draft FR/EIS public comment period ran for 45 days beginning February 21, 2014 and ending April 7, 2014. The Study Team hosted one public hearing in the study area on March 20, 2014. In addition to accepting comments during the public hearings, comments were accepted via mail, fax, and email. The Corps considered all comments received during the comment period. The complete list of comments regarding the Draft FR/EIS and the Corps' responses are included in Appendix M of this Final FR/EIS.

7.2 Agency and Tribal Government Consultation and Coordination Process

Preparation of the Draft and Final FR/EIS was coordinated with appropriate Federal, State, and local interests as well as environmental groups and other interested parties.

7.2.1 Federal Agencies

Several Federal agencies participated in early study activities, particularly in the process of identifying problems and opportunities in the basin. The Bureau of Reclamation has provided information critical to understanding the geomorphology and sediment transport processes of the river. The Corps has briefed the NMFS Restoration Center Northwest on the study as NMFS continues to express interest in the study's progress. The Corps contracted a baseline study through USFWS to conduct biological sampling throughout the study area. Additionally, the Corps coordinated with USFWS in compliance with the FWCA. The Council for Environmental Quality regulations for implementing NEPA encourage agencies to formally agree to "cooperating agency" status, thus ensuring their expertise will be applied when formulating feasible alternative plans. Prior to the Feasibility Scoping Meeting, NMFS and USFWS expressed willingness to consider a cooperating agency role; although they declined upon formal invitation, both agencies remain actively involved in the study.

7.2.2 State Agencies

The Corps has coordinated with the WDFW to seek input on potential restoration projects and has sought information regarding shellfish and eelgrass habitat from the WDNR. Further consultation with WDFW and WDOE occurred during feasibility level design phase to seek their input on maximizing benefits and minimizing impacts of the proposed action. The Corps consulted with the DAHP regarding cultural resources and will conduct monitoring during construction per the SHPO's requirement.

7.2.3 Indian Tribes

The Corps has engaged in formal and informal coordination with the Skokomish Indian Tribe throughout the feasibility phase. The Skokomish Indian Tribe has had a critical role throughout the feasibility study as one of the two non-Federal sponsors (Mason County is the other). Tribal coordination will continue throughout the feasibility phase, PED phase, and construction in accordance with Executive Order 13175 Consultation and Coordination with Indian Tribal Governments.

7.3 Additional Coordination and Consultation

The following Federal and State agencies, tribal partners, and non-governmental organizations have been involved during the feasibility study:

- National Marine Fisheries Service
- U.S. Fish and Wildlife Service
- U.S. Bureau of Reclamation
- Washington Department of Fish and Wildlife
- Washington Department of Natural Resources
- Washington Department of Archaeology and Historic Preservation
- Washington Recreation and Conservation Office
- Washington Department of Ecology
- Puget Sound Partnership
- Washington Salmon Recovery Funding Board
- Northwest Indian Fisheries Commission
- Skokomish Watershed Action Team
- Hood Canal Coordinating Council
- Taylor Shellfish Company
- Green Diamond Resource Company
- Tacoma Public Utilities

7.4 Peer Review Process

In 2011, the PDT developed the Review Plan for the Feasibility Study of the Skokomish River Basin, Mason County, Washington (Peer Review Plan; USACE 2011), which the Corps Ecosystem Restoration Planning Center of Expertise (ECO-PCX) approved. Peer review was designed to meet all pertinent Corps policies (e.g. Engineering Circulars [EC] including EC 1165-2-214; USACE 2012). This plan requires external review of the project's technical reports as well as the Draft and Final FR/EIS. The Skokomish study has adhered to this guidance and completed multiple rounds of District Quality Control (DQC) and Agency Technical Review (ATR) on feasibility phase deliverables. The Draft FR/EIS went through DQC, ATR, and Independent External Peer Review (IEPR). The DQC, ATR, and IEPR reports are submitted with the Final FR/EIS. The IEPR report will also be posted for public access and transmitted to Congressional committee.

In accordance with guidelines set by the Corps for planning and ecosystem output models (e.g., ER 1165-2-501 and EC 1105-2-412, Seattle District requested approval for one-time use of a planning model. The model review plan was submitted to the ECO-PCX in March 2013. The complete model documentation report (Appendix F) has undergone peer review by the ECO-PCX and was approved for one-time use on October 8, 2013.

8. Recommendations

The following language outlines the Corps' recommendations for project approval and authorization for implementation.

I recommend that the recommended plan for ecosystem restoration for the Skokomish River Basin project area as generally described in this report be authorized for implementation as a Federal project, with such modifications thereof as in the discretion of the Commander, USACE may be advisable. The estimated project first cost of the recommended plan is \$19,343,000 (October 2014 price level), which includes monitoring costs of \$374,000 and adaptive management costs of \$127,000. Minimal operations, maintenance, repair, rehabilitation, and replacement (OMRR&R) expenses are estimated at \$10,000 per year. The Federal portion of the estimated first cost is \$12,573,000. The non-Federal sponsors' portion of the required 35% cost share of total project first costs is \$6,770,000. The non-Federal partners shall, prior to implementation, agree to perform the following items of local cooperation:

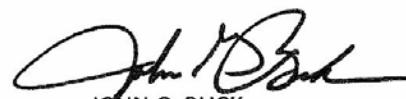
1. Provide 35 percent of total project costs as further specified below:
 - 1.a. Provide the required non-Federal share of design costs;
 - 1.b. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs;
 - 1.c. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the project;
 - 1.d. Provide, during construction, any additional funds necessary to make its total contribution equal to 35 percent of total project costs;
2. Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds are authorized to be used to carry out the project.
3. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;
4. Shall not use the project or lands, easements, and rights-of-way required for the project as a wetlands bank or mitigation credit for any other project;

5. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;
6. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;
7. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;
8. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;
9. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of three years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;
10. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a *et seq.*), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 *et seq.*), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c *et seq.*);
11. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal

Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

12. Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;
13. Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and
14. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

The recommendations contained herein reflect the information available at this time and current departmental policies governing the formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of the national civil works construction program or the perspective of higher levels within the executive branch. Consequently, the recommendations may be modified before they are transmitted to Congress for authorization and/or implementation funding. However, prior to transmittal to Congress, the State of Washington, interested Federal agencies, and other parties will be advised of any significant modifications in the recommendations and will be afforded an opportunity to comment further.



JOHN G. BUCK
Colonel, Corps of Engineers
District Commander

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10. References

- Allan, J. D. 1995. Stream ecology, structure, and function of running waters. Chapman and Hall, London. 388 pages.
- Anchor QEA. 2011. Wetland Inventory and Evaluation for the Skokomish Basin. Prepared for the Seattle District U.S. Army Corps of Engineers.
- Anderson, M., R. Brocksmith, P. Case, R. Geiger, J. Turner, K. Dublanica. 2007. Restoring the Skokomish Watershed: A Three-Year Action Plan. Skokomish Watershed Action Team, June 2007.
- Barreca, J. 2001. Skokomish River Basin Fecal Coliform Total Maximum Daily Load Submittal Report: Washington Department of Ecology, Water Quality Program
- Beamer, E., B. Hayman, and S. Hinton. 2005. Linking watershed conditions to egg-to-fry survival of Skagit Chinook salmon. An appendix to the Skagit River System Cooperative Chinook recovery plan.
- Bjorner, T.C. and D.W. Reiser. 1991. Habitat Requirements of Salmonids in Streams. In: Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. W.R. Meehan, editor. American Fisheries Society Special Publication 19:83-138
- Bolam, S.G. and H.L. Rees. 2003. Minimizing Impacts of Maintenance Dredged Material Disposal in the Coastal Environment: A Habitat Approach. Environmental Management. 32(2):171-188
- Bureau of Reclamation (Reclamation). 2007. Flood Frequency, Flow Duration, and Trends: Skokomish Geomorphic Study, Skokomish River, Washington
- Bureau of Reclamation (Reclamation). 2009. Geomorphic Analysis of the Skokomish River, Mason County, Washington.
- Capitol Press: The West's Ag Website. 2013. Western innovator: dream farm created for sharing. By Steve Brown, posted January 31, 2013. Available online: <http://www.capitalpress.com/content/SB-farm-village-0020113-art> (Accessed 27 August 2013)
- Cederholm, C. J., D. H. Johnson, R. E. Bilby, L.G. Dominguez, A. M. Garrett, W. H. Graeber, E. L. Greda, M. D. Kunze, B.G. Marcot, J. F. Palmisano, R. W. Plotnikoff, W. G. Pearcy, C. A. Simenstad, and P. C. Trotter. 2000. Pacific Salmon and Wildlife - Ecological Contexts, Relationships, and Implications for Management. Special Edition Technical Report, Prepared for D. H. Johnson and T. A. O'Neil (Managing Directors), Wildlife-Habitat Relationships in Oregon and Washington. WDFW, Olympia, Washington.
- Collins, B. 1995. Riverine Gravel Mining in Washington State, Physical Effects with Implications for Salmonid Habitat, and Summary of Government Regulations. Report prepared for U.S. Environmental Protection Agency for Grant X-000694-01-0
- Collins, B., and Sheikh, A. 2005. Historic reconstruction, classification, and change analysis of Puget Sound tidal marshes: Olympia, Wash., Washington Department of Natural Resources, Aquatic Resources Division.
- Correa, G. 2003. Salmon and Steelhead Habitat Limiting Factors: Water Resource Inventory Area 16 Dosewallips-Skokomish Basin. Washington State Conservation Commission Final Report
- Correa, L.E. 2009. An evaluation of ecological responses to hypoxia in Hood Canal and an example of regional marine ecosystem-based management in practice. Master's thesis. School of Marine Affairs, University of Washington. Seattle, Washington

- Council on Environmental Quality (CEQ). 2010. Memorandum for Heads of Federal Departments and Agencies: Draft NEPA Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas Emissions. Available online:
<http://www.whitehouse.gov/sites/default/files/microsites/ceq/20100218-nepa-consideration-effects-ghg-draft-guidance.pdf>
- Crawford, B. 2011. Protocol for monitoring effectiveness of floodplain enhancement projects (dike removal/setback, riprap removal, road removal/setback, and landfill removal, off-channel habitat creation, side channel creation). MC-5 and 6 Washington Salmon Recovery Funding Board.
- Dethier, M. 2006. Native Shellfish in Nearshore Ecosystems of Puget Sound. Puget Sound Nearshore Partnership Report No. 2006-04. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington. Available online: http://www.pugetsoundnearshore.org/technical_papers/shellfish.pdf
- Figlar-Barnes, R. and L. Bullchild. 2011. Ground Water Condition: Shallow Wells Lower Skokomish Valley, Washington. Prepared by Skokomish Indian Tribe Natural Resources
- Fox, M. and S. Bolton. 2007. A Regional and Geomorphic Reference for Quantities and Volumes of Instream Wood in Unmanaged Forested Basins of Washington State. North American Journal of Fisheries Management 27(1):342-359
- Graham, J. C., and C. V. Brun. 2005. Determining lamprey species composition, larval distribution, and adult abundance in the Deschutes River, Oregon Subbasin. Report to BPA.
- Heitke, Jeremiah D.; Archer, Eric K.; and Roper, Brett B. 2010. Effectiveness monitoring for streams and riparian areas: sampling protocol for stream channel attributes. Unpublished paper available online: <http://www.fs.fed.us/biology/fishecology/emp>. (Accessed 2 October 2013)
- Hruby, T. 2004. Washington State wetland rating system for western Washington – Revised. Washington State Department of ecology Publication #04-06-025.
- Knopf, F.L., R.R. Johnson, T. Rich, F.B. Samson, and R.C. Szaro. 1988. Conservation of riparian ecosystems in the United States. The Wilson Bulletin 100:(2)272-284 Available online:
http://www.fs.fed.us/rm/boise/AWAE/labs/awae_flagstaff/Hot_Topics/riptrreatbib/knopf_etal_consripecous.pdf (Accessed January 27, 2015)
- Kondolf, G.M., M. Smeltzer, and L. Kimball. 2002. Freshwater Gravel Mining and Dredging Issues. White paper prepared for Washington Department of Fish and Wildlife, Washington Department of Ecology, and Washington Department of Transportation. Center for Environmental Design Research, Berkeley, CA.
- Mackay, R.J. 1992. Colonization by lotic macroinvertebrates: a review of processes and patterns. Canadian Journal of Fisheries and Aquatic Sciences 49:617-628
- Molenaar, D. and J.E. Cummins. 1973. Water resources of the Skokomish Indian Reservation, Washington: Tacoma, Washington, U. S. Geological Survey Open-File Report, 75 p.
- Molenaar, D. and J.B. Noble. 1970. Geology and related ground-water occurrence, southeastern Mason County, Washington: Olympia, Washington, Washington Department of Water Resources, Water Supply Bulletin No. 29, 2 plates, 145 p.
- Nagrodska, A., G.D. Raby, C.T. Hasler, M.K. Taylor, S.J. Cooke. 2012. Fish stranding in freshwater systems: sources, consequences, and mitigation. Journal of Environmental Management 103:133-141

- NMFS (National Marine Fisheries Service). 2002. Final rule for implementing the EFH provisions of the Magnuson-Stevens Fishery Conservation and Management Act. 67 Fed. Reg. 2343. January 17, 2002.
- NMFS. 2005. Endangered and Threatened Species: Final Listing Determinations for 16 ESUs of West Coast Salmon, and Final 4(d) Protective Regulations for Threatened Salmonid ESUs: Final rule. Federal Register 70(123):37160-37204.
- NOAA Fisheries. 2004. Sediment Removal from Freshwater Salmonid Habitat: Guidelines to NOAA Fisheries Staff for the Evaluation of Sediment Removal Actions form California Streams. NOAA Fisheries – Southwest Region
- Pearson, S.F., M.G. Raphael, M.M. Lance, and T. D. Bloxton, Jr. 2011. Washington 2010 at-sea marbled murrelet population monitoring: Research Progress Report. Washington Department of Fish and Wildlife, Wildlife Science Division and USDA Forest Service Pacific Northwest Research Station, Olympia, WA.
- Penttila, D. 2007. Marine forage fishes in Puget Sound. Puget Sound Nearshore Partnership Report No. 2007-03. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, WA.
- Peters R., M. Li, K. Denton, M. Liermann, S. Sanders, R. Tabor, and C. Cook-Tabor. 2011. Biological Sampling in the Skokomish River Basin, Washington. Prepared by Washington Fish and Wildlife Office, USFWS, Lacey, WA and Northwest Fisheries Science Center, NOAA Fisheries, Seattle, WA
- Pletcher, F. T. 1963. The life history and distribution of lamprey in the Salmon and certain other rivers in British Columbia, Canada. Master's thesis. University of British Columbia, Vancouver. B.C.
- Pirtle, J., J. Stone, and S. Barndt. 2003. Evaluate habitat use and population dynamics of lamprey in Cedar Creek. Annual report for 2002 sampling season. Prepared for the Department of Energy, Bonneville Power Administration, (Project No. 2000-014-00, Project NO. 200001400), Portland, OR
- Roni, P. 2002. Habitat use by fishes and Pacific giant salamanders in small western Oregon and Washington streams. Transactions of the American Fisheries Society 131:743-761
- Seattle Times. 2009. *Sport fishermen's waste fouling shellfish harvest*. Lynda V. Mapes, Seattle Times staff reporter. Published August 28, 2009. Available online:
http://seattletimes.com/html/localnews/2009760901_skok28m.html
- Seiler, D., S. Neuhauser, and L. Kishimoto. 2003. 2002 Skagit River wild 0+ Chinook production evaluation. Annual Project Report funded by Seattle City Light. Washington Department of Fish and Wildlife, Olympia
- Simpson Timber Company and Washington Department of Natural Resources. 1997. South Puget Sound Region. South Fork Skokomish Watershed Analysis.
- Skokomish Tribe. 2013. Skokomish River adult escapement estimates from 2003-2012. Unpublished data
- State of California and Bureau of Land Management. 2010. Final Environmental Impact Report/Environmental Impact Statement, Southern California Edison's Eldorado-Ivanpah Transmission Line Project. Available online:
http://www.cpuc.ca.gov/Environment/info/ene/ivanpah/Ivanpah_FEIR-EIS.html.
- Stover, S.C. and D.R. Montgomery. 2001. Channel change and flooding, Skokomish River, Washington. Journal of Hydrology 243(3-4): 272–286.

- Torgerson, C. E. and D. A. Close. 2004. Influence of habitat heterogeneity on the distribution of larval Pacific lamprey (*Lampetra tridentata*) at two spatial scales. *Freshwater Biology* 49:614-630.
- USACE. 1995. Analysis of Skokomish River Hypothetical Dredging Options. Prepared for the Skokomish Indian Tribe by the Seattle District USACE. February 1, 1995. 96 p with cover letter and appendix.
- USACE. 1888. Flood Risk Management Study (81128). Puget Sound and Adjacent Waters, Skokomish River, Washington.
- USACE. 2000. Skokomish River General Investigation Reconnaissance Study. 905(b) Analysis. Seattle, WA
- U.S. Census Bureau. 2013. 2007-2012 American Community Survey. Available online: http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_11_5YR_D_P03 (Accessed 25 Sep 2013).
- USFS (U.S. Forest Service). 2011a. USDA Forest Service Watershed Condition Framework, FY2012 Transition Watershed Restoration Action Plan, Lower South Fork Skokomish River. Pacific Northwest Region, Olympic National Forest, Hood Canal Ranger District.
- USFS. 2011b. USDA Forest Service Watershed Condition Framework, FY2012 Transition Watershed Restoration Action Plan, Upper South Fork Skokomish River. Pacific Northwest Region, Olympic National Forest, Hood Canal Ranger District.
- USFWS. 2009. 5 Year Review for the Marbled Murrelet. Washington Fish and Wildlife Office. Lacey, WA.
- WADOE (Washington Department of Ecology). 1985. Skokomish-Dosewallips Instream Resources Protection Program (Water Resource Inventory Area 16) Including Proposed Administrative Rules (Chapter 173-516 WAC)
- WDFW. 2013a. Recreational Shellfishing: Public Clam and Oyster Beaches – Potlatch Beaches. <http://wdfw.wa.gov/fishing/shellfish/beaches/270440/> (Accessed 30 July 2013).
- WDFW. 2013b. Washington Department of Fish and Wildlife – Priority Habitats and Species Database. Available online: <http://wdfw.wa.gov/mapping/phs/>
- WDFW, Washington State Recreation and Conservation Office, U.S. Fish and Wildlife Service. 2013. Habitat Work Schedule – Lead Entity Public Portal. Available online: <http://hws.ekosystem.us/> (Accessed 26 August 2013)
- WDNR. 2009. Puget Sound Submerged Vegetation Monitoring Project: 2008 Monitoring Report. Published October 2009 by the Nearshore Habitat Program, Aquatic Resources Division of the Washington Department of Natural Resources, Olympia, WA. Available online: http://www.dnr.wa.gov/Publications/aqr_nrsh_2008_svmp_report_final.pdf
- WSDOT (Washington State Department of Transportation). 2010. Level of Service Standards for Washington State Highways. Available online: <http://www.wsdot.wa.gov/NR/rdonlyres/6AF72388-2455-47B9-B72D-2BE9A89A0E19/0/LOSStandardsforWAHwys.pdf> (Accessed 21 October 2013)
- WSDOT. 2013a. 2012 Annual Traffic Report. Available online: http://www.wsdot.wa.gov/mapsdata/travel/pdf/Annual_Traffic_Report_2012.pdf (Accessed 25 September 2013).
- WSDOT. 2013b. 2012 Washington State Highway Log. Available online: <http://www.wsdot.wa.gov/mapsdata/roadway/pdf/HwyLog2012Statewide.pdf> (Accessed 25 September 2013).